Energy Conservation
DOE Best Practices Tools

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TUR Planner Continuing Education Conference

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Newton, MA

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Outline

- Advanced Manufacturing Office Programs Technology Deployment Activities
  - Industrial Assessment Centers
  - Better Plants Program (ISO 50001) – Superior Energy Performance Program
  - Clean Energy Application Centers
- Overview of BestPractices Tools

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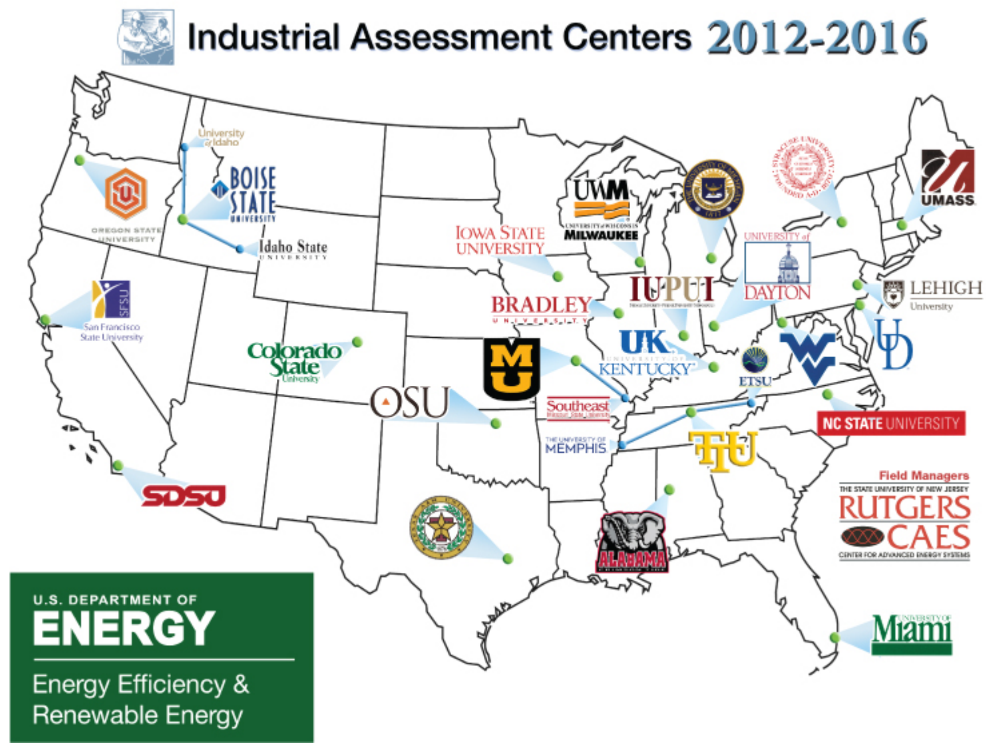
Beginning in 1984 with four Schools



Currently 24 Centers at 29 Universities Nationwide

For more information on IAC program and participating schools visit: **http://iac.rutgers.edu/database/centers/**

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Industrial Assessment Center at the University of Massachusetts

- Provides assistance to New England Industry since 1984

- US DOE Funding allows the IAC Program to provide no cost energy conservation, waste prevention and productivity assistance to small and medium sized industrial firms within S.I.C. 20 through 39

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IAC Program Goals

- Reduce Industrial Energy Use
- Reduce waste and prevent pollution in manufacturing operations
- Raise productivity
- Lower Operating Costs
- Increase Profitability
- Provide Professional Training for Students

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Client Criteria

- Have Annual Energy Costs Less Than $ 2.5 Million
- Have Gross Sales Less Than $100 Million
- Have Less Than 500 Employees
- Have No In-house Energy Staff
- Be Within 150 Miles of Amherst, MA

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UMASS Clients 1984-2012

- Over 700 plants visited since 1984
- Over $12 billion in gross annual sales
- $310 million in annual energy costs
- Over 82,000 employees
- Over 4,300 recommendations with $62,000 average annual cost savings per assessment
- 51% Implementation Rate; 1.04 years payback period
- $125,000 average savings per assessment in 2010-2011

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IDENTIFYING EFFECTIVE ENERGY SAVING OPTIONS

- Major energy users
- Major pieces of equipment
- Motors
- Boilers and Furnaces
- Compressors/Chillers
- Hot exhausts
- Compressed air leaks
- Cooling Towers

→

- Variable Frequency Drives
- Energy-efficient Motors
  Consider CHP
- Energy Management Systems
- Steam Trap Replacement
  High-efficiency Boiler
- Chiller Water Plant Operation
- Process Heat Recovery

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TOP $$ SAVERS

- Convert To VSD For Pumps & Blowers
- Process Heat Recovery
- Use High Efficiency Lamps & Ballasts
- Reduce Fluid Flows
- Change Electrical Rates
- Use Energy Efficient Equipment
- Consider Cogeneration
- Preheat Fluids With Waste Heat
- Insulate Equipment
- Switch From Electrical To Fossil Fuels

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Superior Energy Performance

- The SEP certification program provides facilities with a pathway for continual energy efficiency improvements

- To earn SEP Certification facilities must:
  - Conform to the ISO 50001 energy management system standard
  - Verify an improvement in energy performance using the SEP Measurement and Verification Protocol for Industry.

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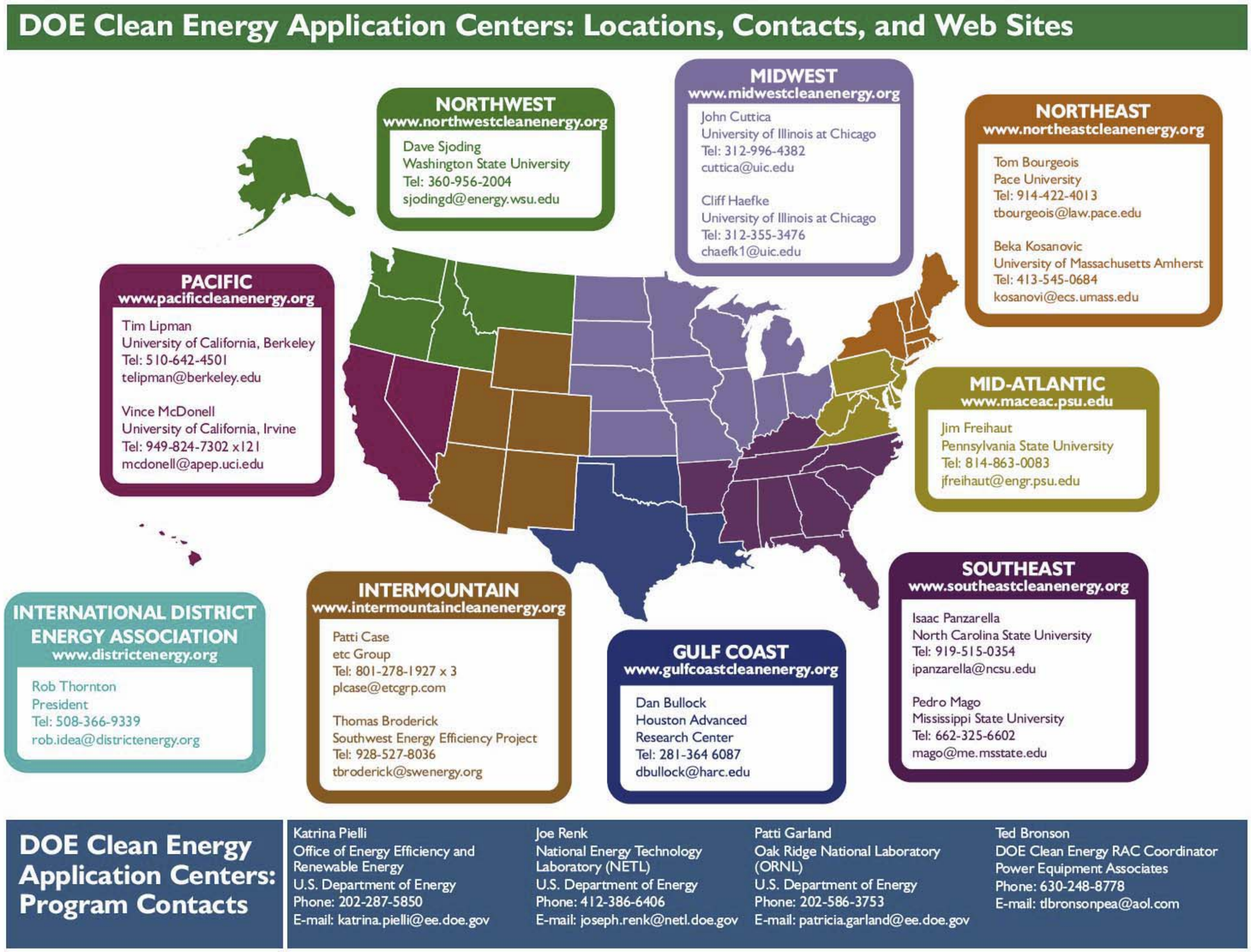
Clean Energy Application Centers



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AMO BestPractices Tools

- Motor Driven Systems
  - CWSAT (Chilled Water System Assessment Tool)
  - AirMaster + (Compressed air system assessment tool)
  - FSAT (Fan System Assessment Tool)
  - MotorMaster + (Motor management tool)
  - PSAT (Pumping System Assessment Tool)
  - ChemPEP (Plant Energy Profiler for the Chemical Industry)

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AMO BestPractices Tools (Continued)

- Process Heating
  - PHAST (Process Heating Assessment and Survey Tool)
  - NxEAT (NOx and Energy Assessment Tool)
  - Combined Heat and Power Application Tool
- Steam Systems
  - SSST (Steam System Scoping Tool)
  - SSAT (Steam System Assessment Tool)
  - 3E Plus – Insulation Assessment Tool

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CWSAT Program

Purpose: Reduce the energy consumption of installed chilled water systems

Goal: Create a simple but useful software tool for analyzing potential energy savings in chilled water systems

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CWSAT INTRODUCTION

- A central chilled water system may account for a quarter to a third of facility energy consumption.
- ULTIMATE GOAL
  - Provide adequate cooling to process or comfort load.
  - Reduce energy consumption of chilled water SYSTEMS (important to look at it as a SYSTEM and not as a collection of components).
- The Program IS NOT intended to determine system energy use down to the kWh or MMBtu
- Program IS intended to direct analysis effort toward the most promising cost reduction opportunities

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CWSAT ECM Capabilities

- New Equipment Specification
  - Chillers, Towers, Pumps
- Variable Speed Drive Installation
  - Centrifugal Chillers, Tower Fans, & Pumps
- Various Chilled and Condenser Water Strategies
- Air-Cooled to Water-Cooled System Conversion
- Use Free Cooling When Possible
- Sequence Chillers

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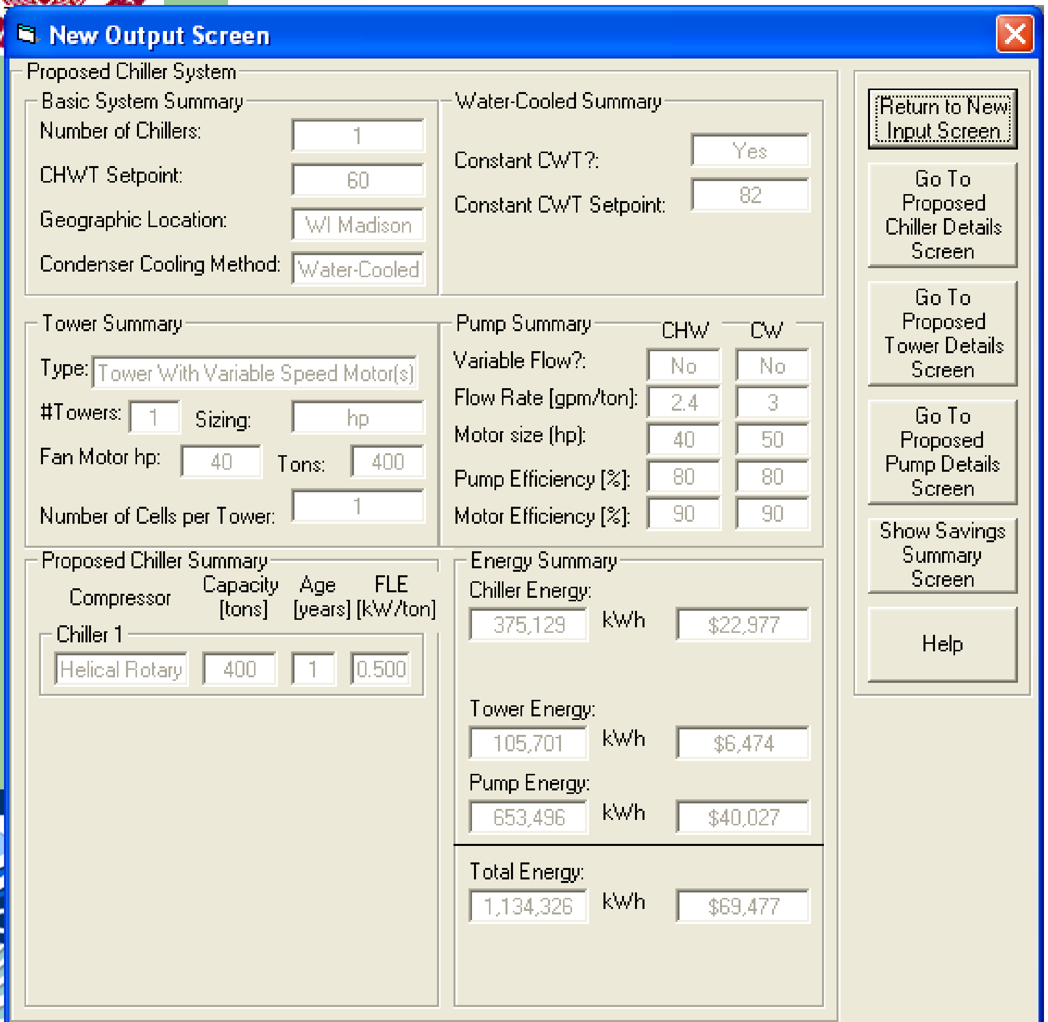
Annual Cooling System Operations



- Chiller
  - 375,100 kWh
  - $23,000
- Tower
  - 105,700 kWh
  - $6,500
- Pumps
  - 653,500 kWh
  - $40,000
- ~1,134,300 kWh
- $69,500

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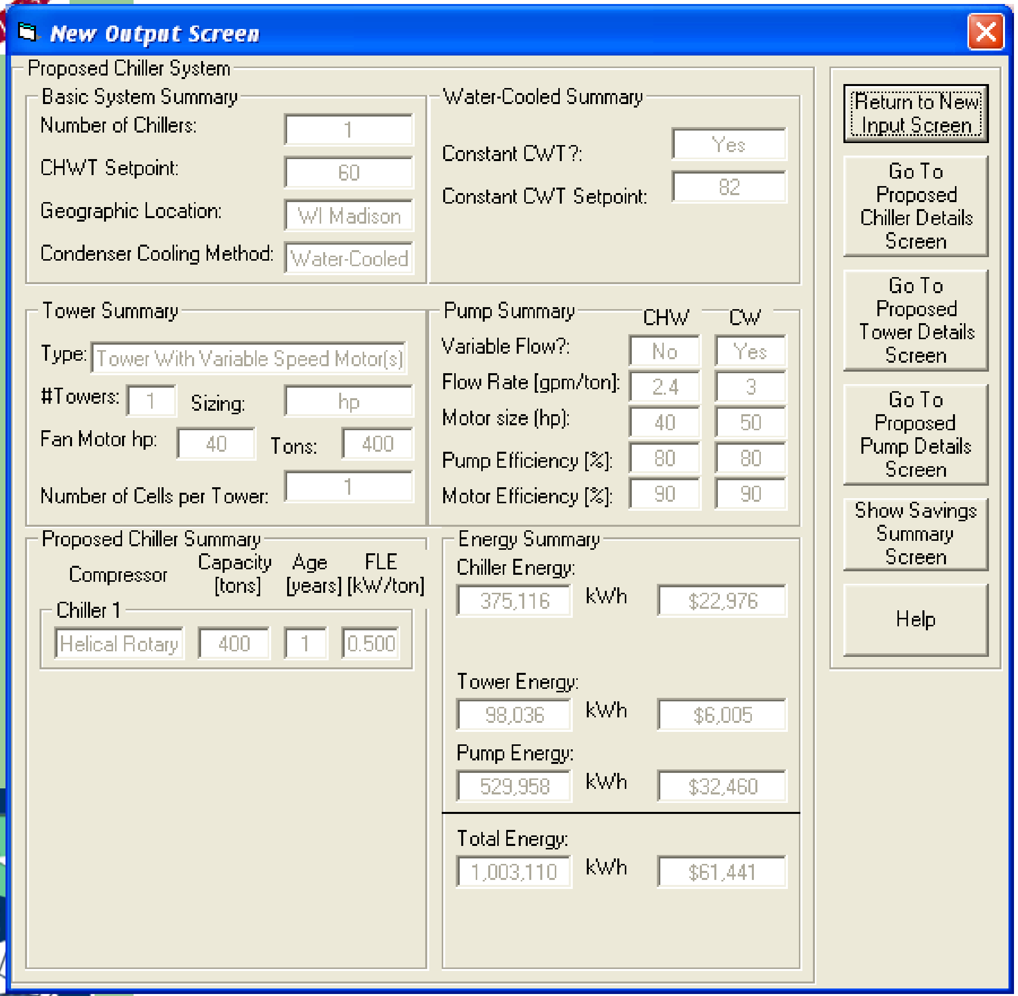
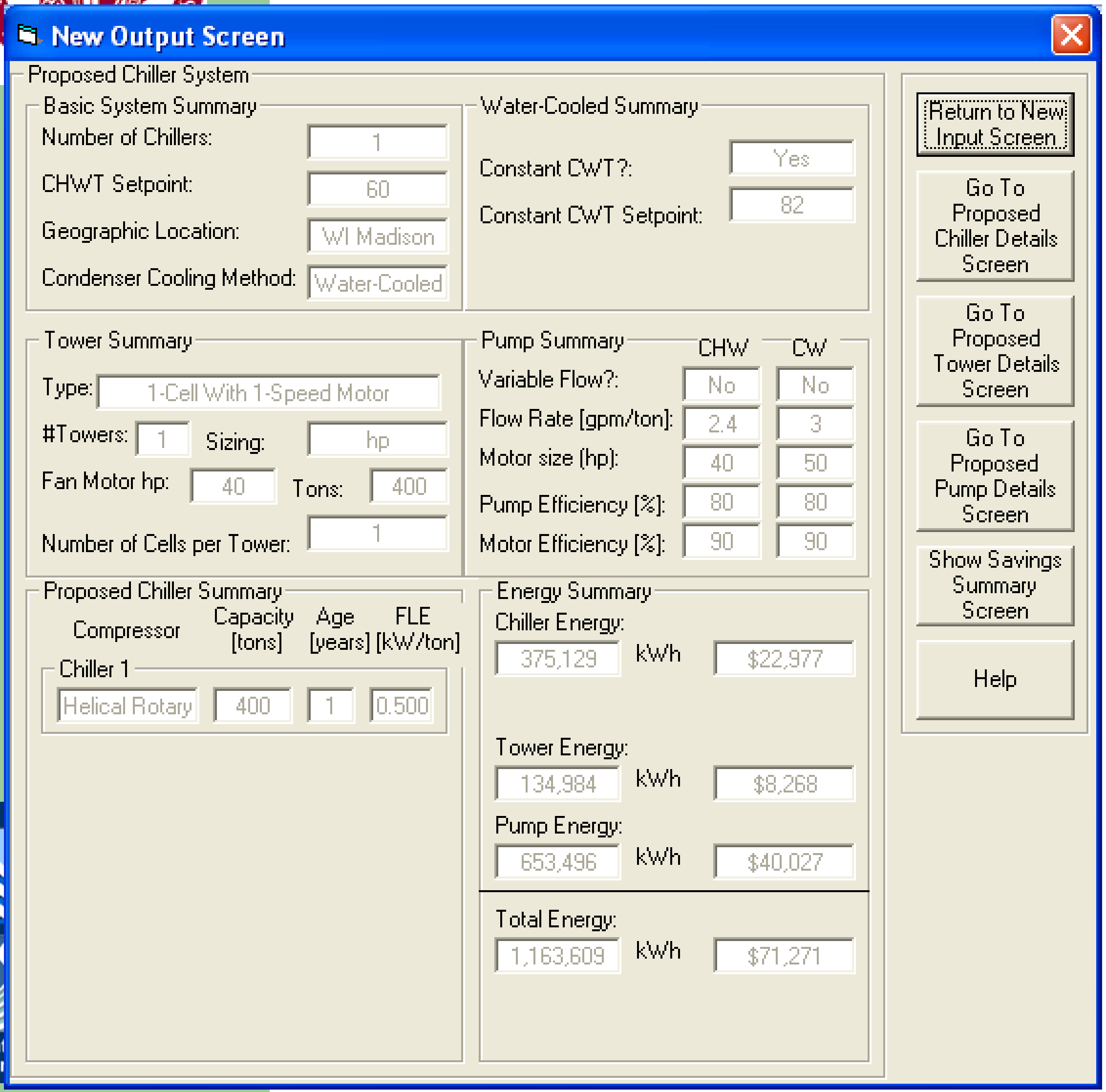
Install VFD on Tower Pumps



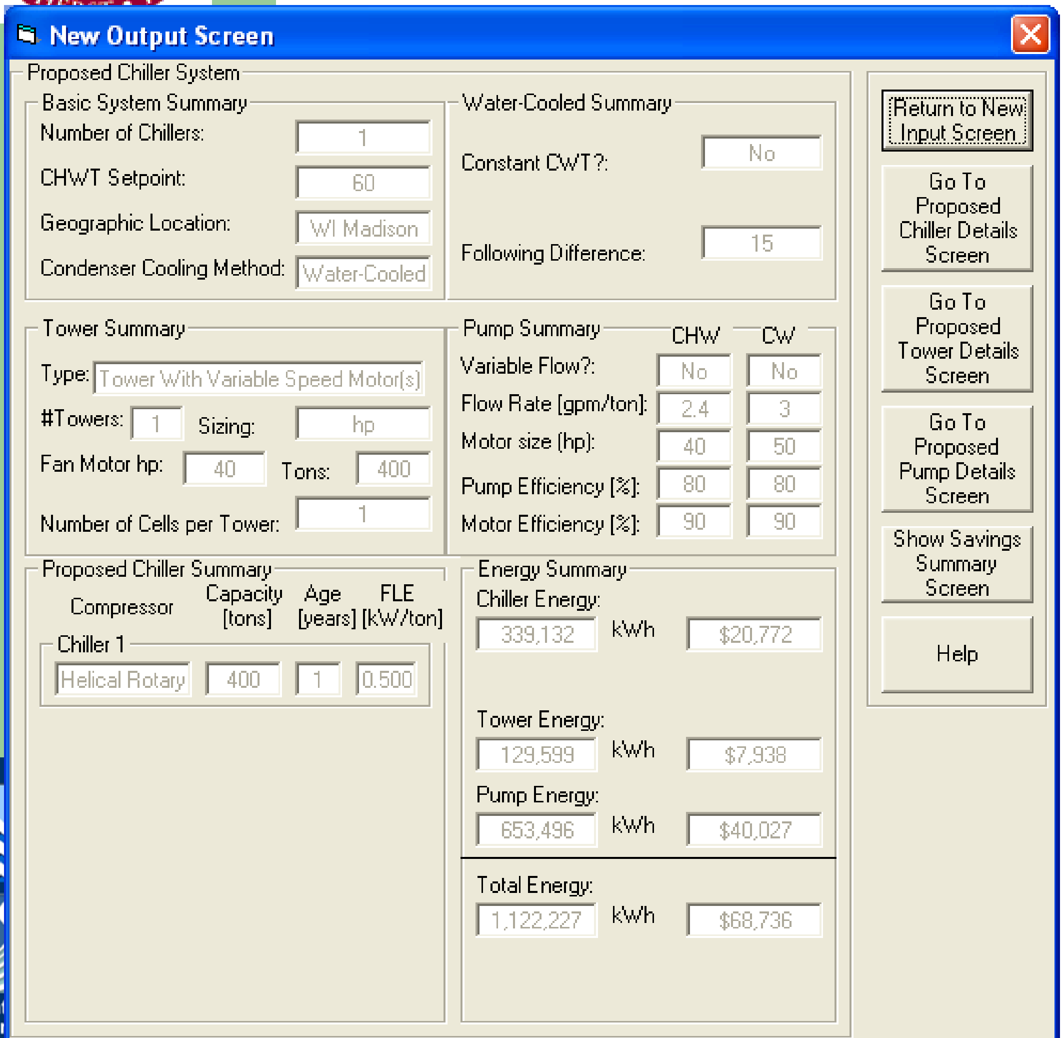
- **Potential Annual Savings:**
  - 131,216 kWh
  - $8,036

Install VFD on Tower Fan



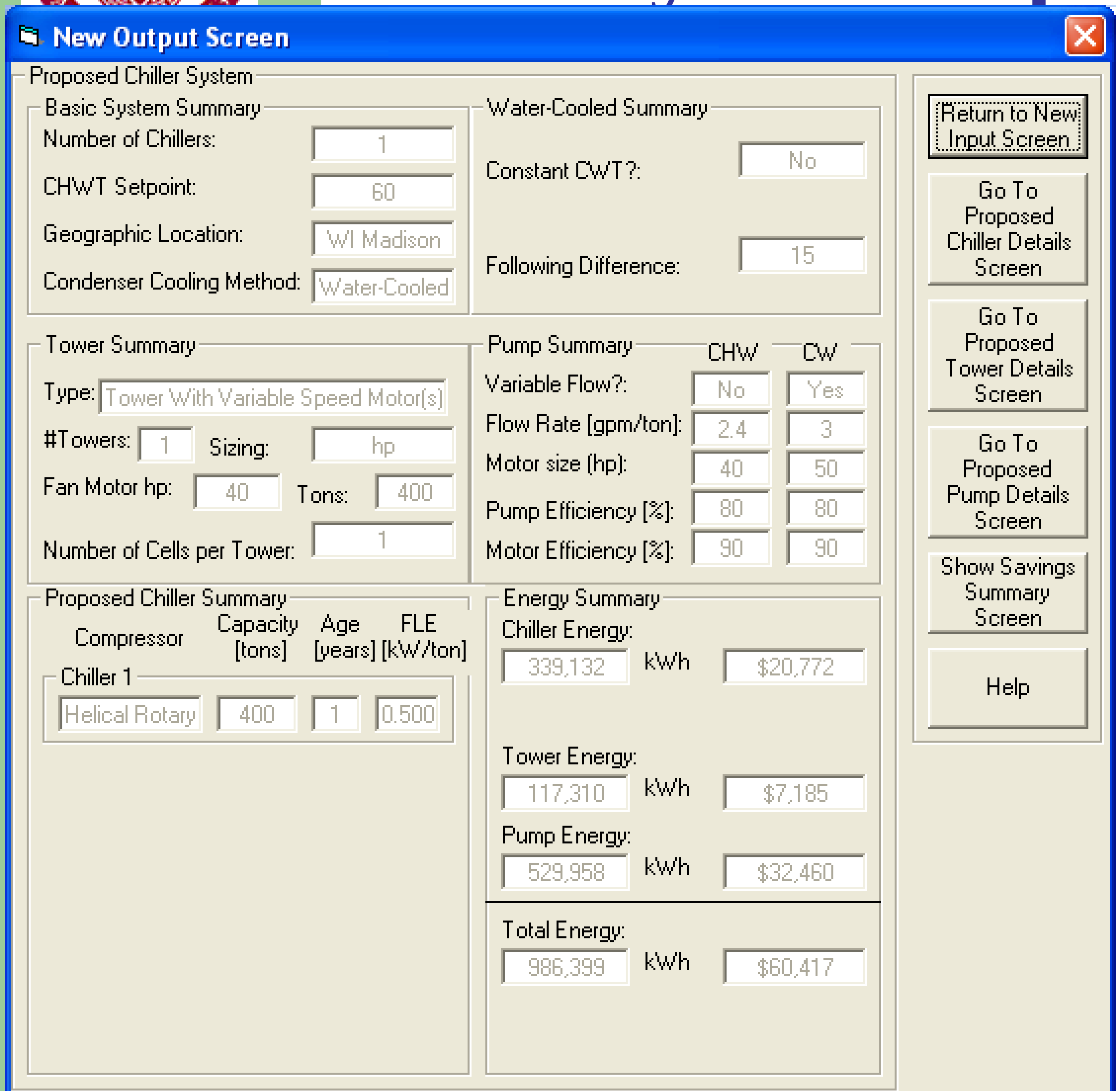
- **Potential Annual Savings:**
  - 29,283 kWh
  - $1,794

Vary Tower Water Temperature with Outside Temperature



- **Potential Annual Savings:**
  - 12,100 kWh
  - $740

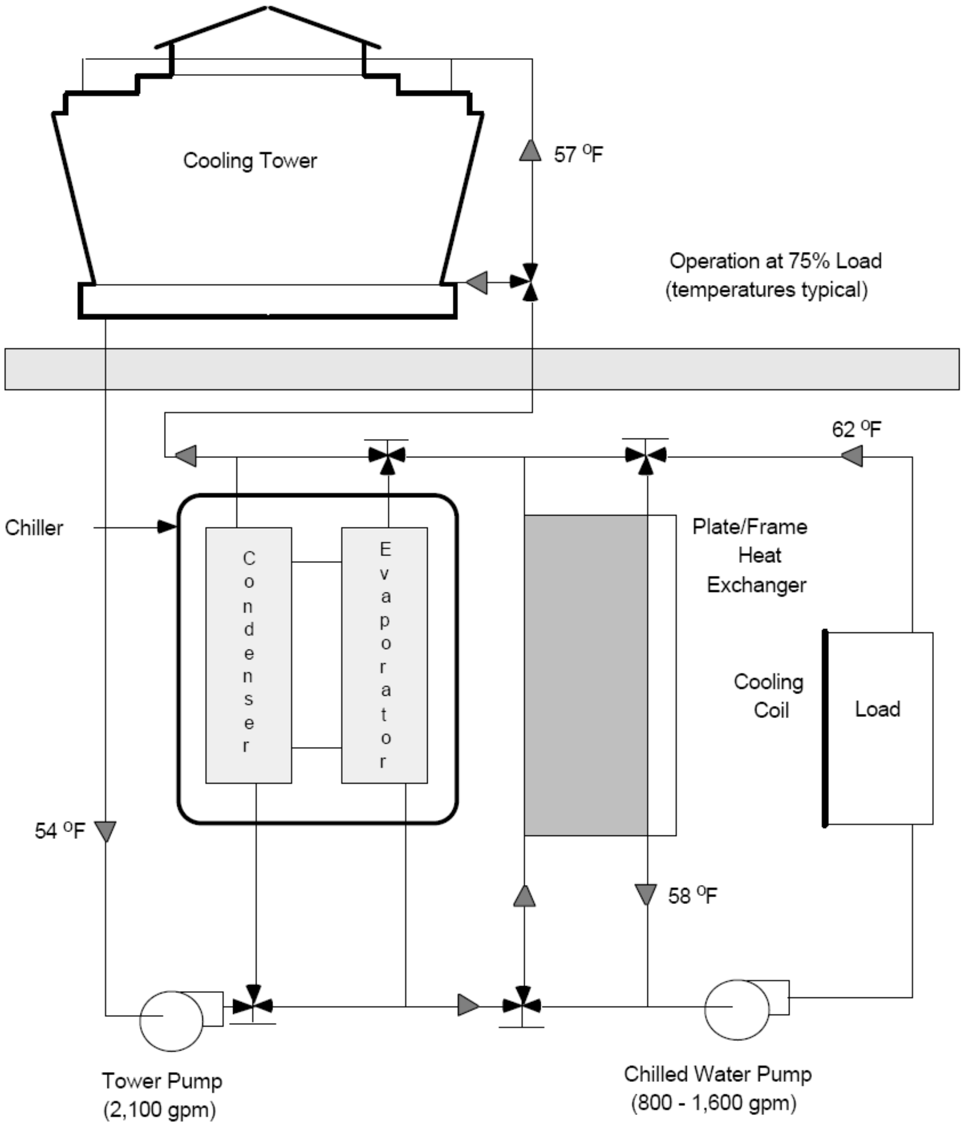
Implementation of All Cooling System Improvements



Potential Annual Savings:

- 147,927 kWh
- $9,060

“Free Cooling”



Free Cooling: Case Study

Without Using Free Cooling

- 3,478,900 kWh actual ($296,000 annually)
- 3,436,900 kWh predicted
- Difference: 41,974 kWh (-1.2%)

With Free Cooling

- 489,100 kWh and $41,570 actual savings
- 513,500 kWh and $43,644 predicted savings (+4.9%)

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Process Heating Assessment and Survey Tool (PHAST)

What is PHAST?

A tool that can be used to:

- **Estimate annual energy use and energy cost for furnaces and boilers in a plant**
- **Perform detail heat balance and energy use analysis that identifies areas of energy use and energy losses for a furnace or a boiler**
- **Perform "what-if" analysis for possible energy reduction and efficiency improvements through changes in operation, maintenance and retrofits of components/systems**
- **Obtain information on energy saving methods and identify additional resources**

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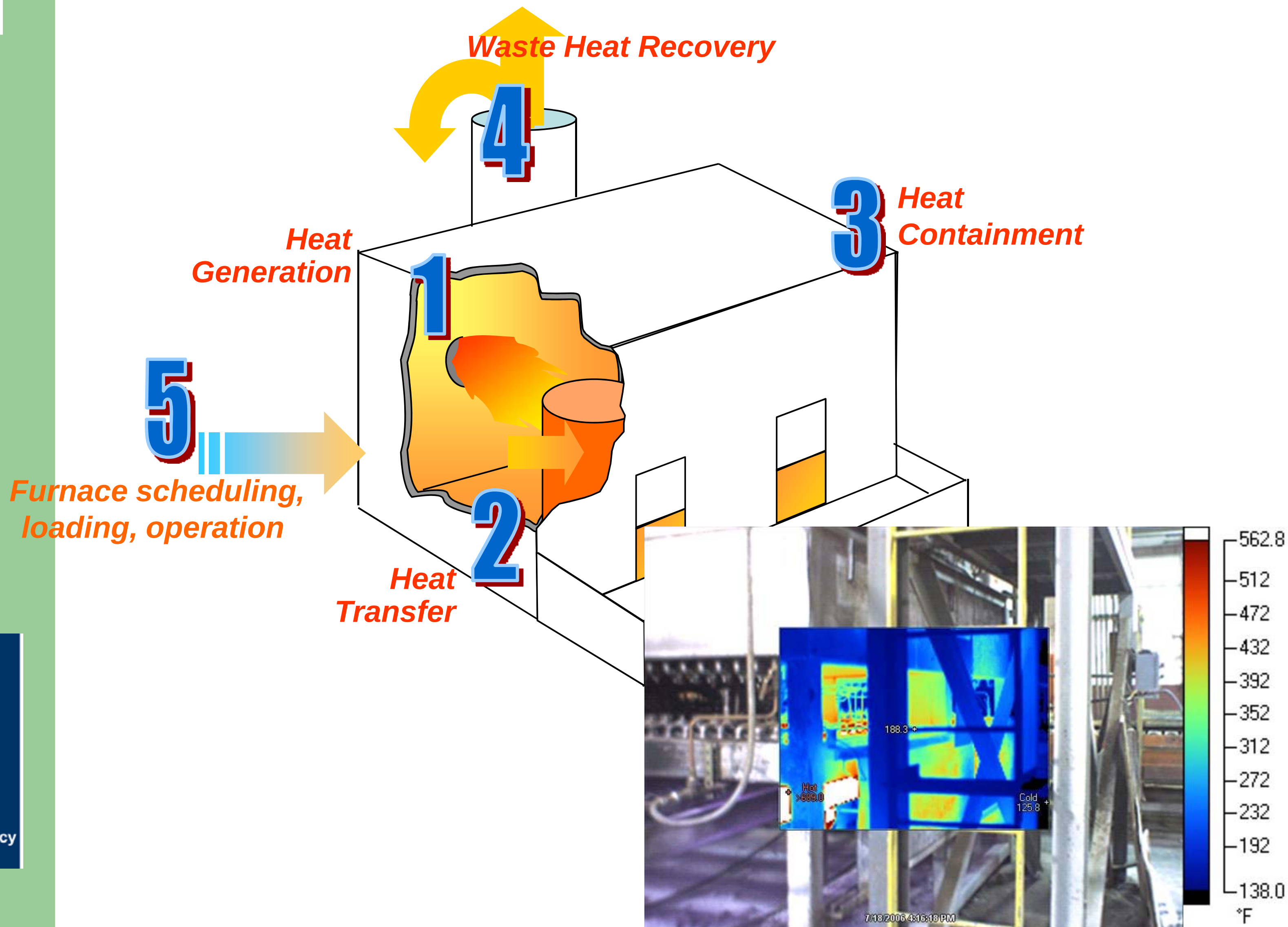
Areas of Energy Saving Opportunities



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Heating Systems - Heat Generation Energy Saving Opportunities

	Energy Saving Techniques	Energy Savings (% Range)
1	Air-fuel ratio control	5 to 25
2	High turndown combustion system	5 to 10
3	Air Infiltration (Furnace sealing)	5 to 10
4	Use of Preheated Air	15 to 30
5	Use of oxygen enrichment or oxy fuel burners	5 to 25

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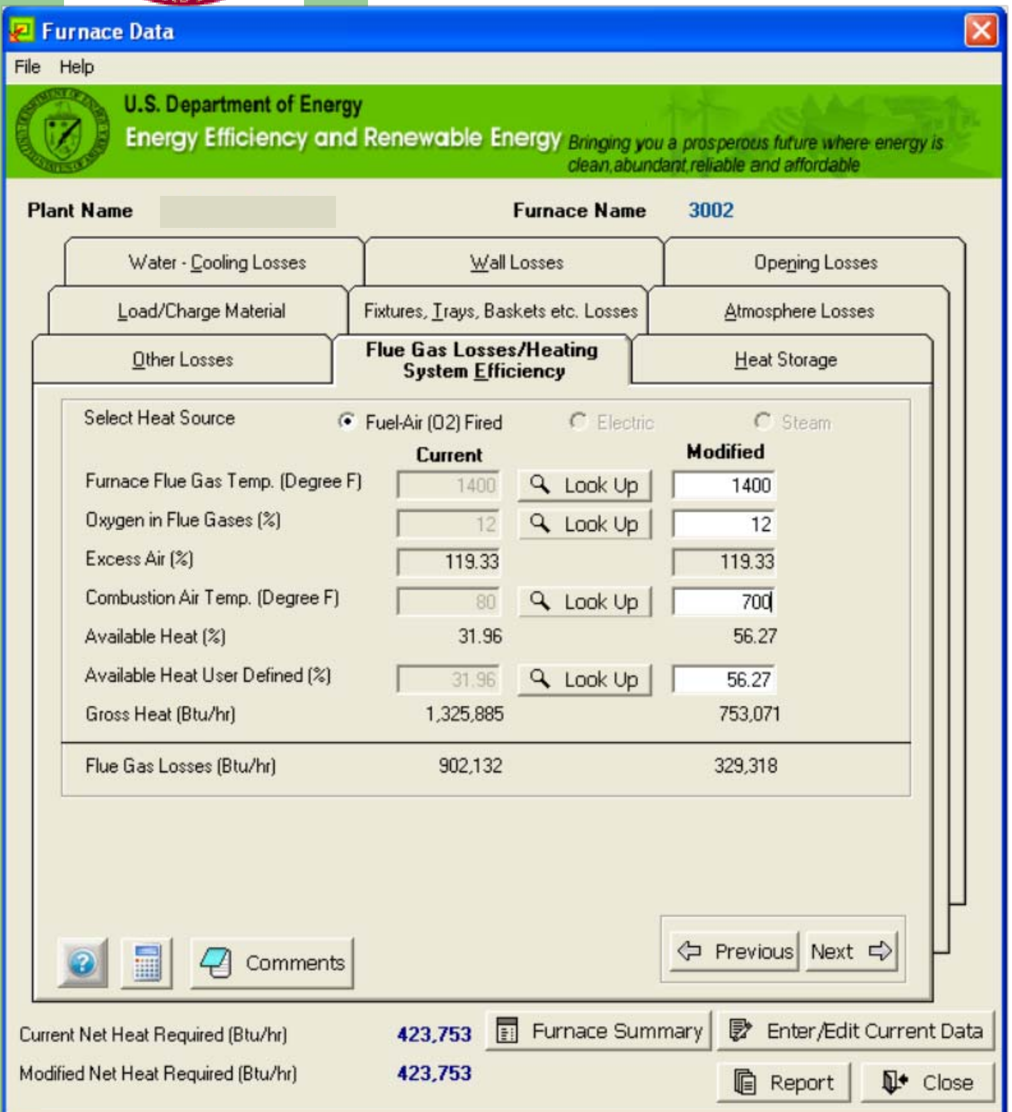
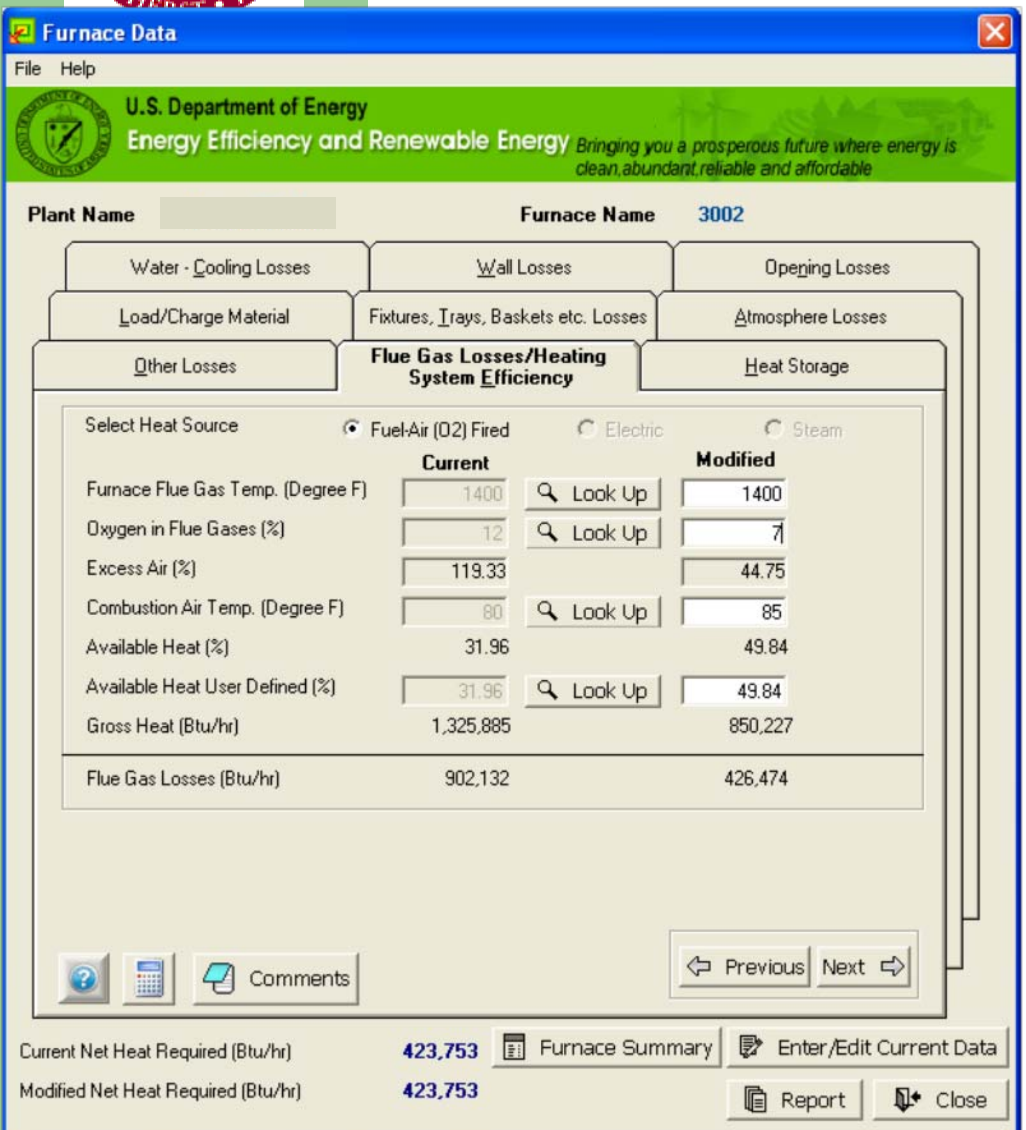
Preheat Furnaces #1 Combustion Air



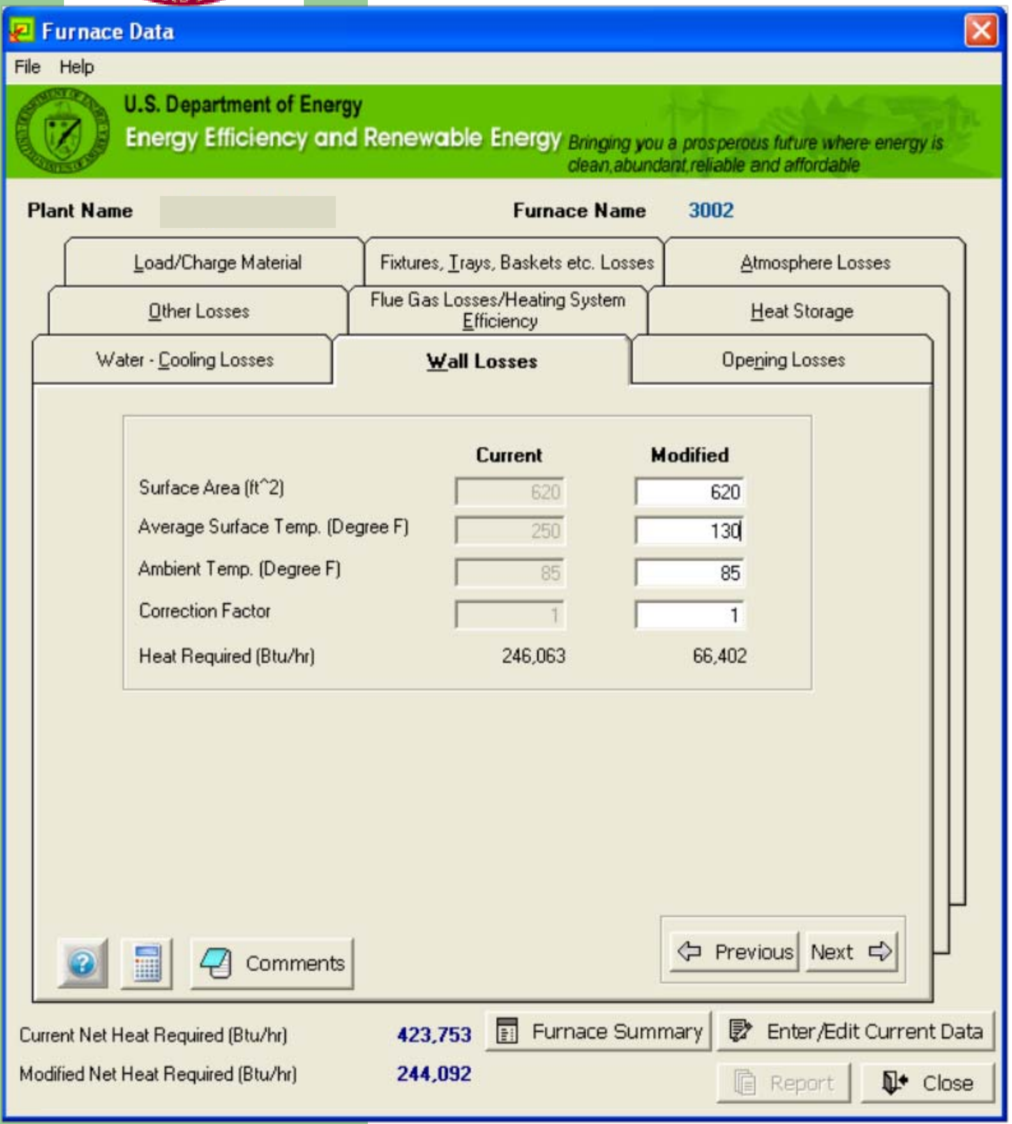
- Currently Using Room Air for Combustion @ 80-100 ºF
- Furnace Exhaust Gas @ 1400 ºF
- Preheat air to ~700 ºF
- Annual Energy Savings: 4,812 MMBtu/yr
- Potential Cost Savings: $48,120
- Potential Savings for Three Furnaces: ~$145,000

Improve Furnace #2 Combustion Efficiency



- O_2 measured @ 12%
- Should be reduced to 7%
- Annual Energy Savings: 3,996 MMBtu/yr per furnace
- Potential Cost Savings: $39,960
- Potential Savings for Three Furnaces: ~$119,900

Improve Furnace Insulation



- Annual Energy Savings:

  1,510 MMBtu/yr

  Potential Cost Savings: $15,100
- Potential Savings for Three Furnaces: ~$45,300

Pumping System Assessment Tool (PSAT)

- An <u>opportunity</u> quantification tool
- Relies on field measured (or estimated) fluid and electrical performance data
- Uses achievable pump efficiency algorithms from the Hydraulic Institute
- Motor performance (efficiency, current, power factor) curves developed from average motor data available in MotorMaster+ (supplemented by manufacturer data for larger size, slower speed motors)

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Some symptoms of interest

- Throttle valve-controlled systems
- Bypass (recirculation) line normally open
- Multiple parallel pump system with same number of pumps always operating
- Constant pump operation in a batch environment or frequent cycle batch operation in a continuous process
- Cavitation noise (at pump or elsewhere in the system)
- High system maintenance
- Systems that have undergone change in function

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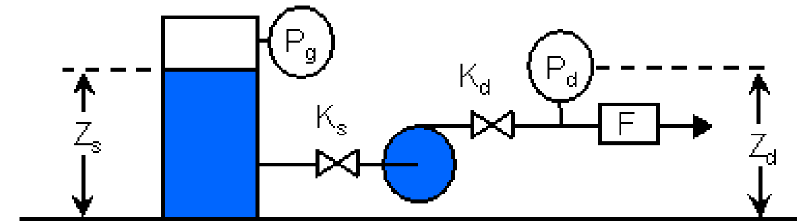
Head calculation

PSAT includes a pump head calculator to support user-measured pressure, flow data

Type of measurement configuration

Suction tank elevation, gas space pressure, and discharge



K_s represents all suction losses from the tank to the pump

K_d represents all discharge losses from the pump to gauge P_d

Suction pipe diameter (ID), inches	19.500	Discharge pipe diameter (ID), inches	15.500
Suction tank gas overpressure (Pg), psig	0.00	Discharge gauge pressure (Pd), psig	75.50
Suction tank fluid surface elevation (Zs), feet	12.00	Discharge gauge elevation (Zd), feet	5.00
Suction line loss coefficients, Ks	0.50	Discharge line loss coefficients, Kd	2.50

Tank to pipe entrance loss

Check valve, SR elbow

Fluid specific gravity 0.990 Flow rate, gpm 6050

Don't update: Click to leave the main panel head unchanged

Accept and update: Click to Accept and return the calculated head

Differential elevation head, ft	-7.00
Differential pressure head, ft	176.17
Differential velocity head, ft	1.64
Estimated suction friction head, ft	0.33
Estimated discharge friction head, ft	4.11
Pump head, ft	175.25

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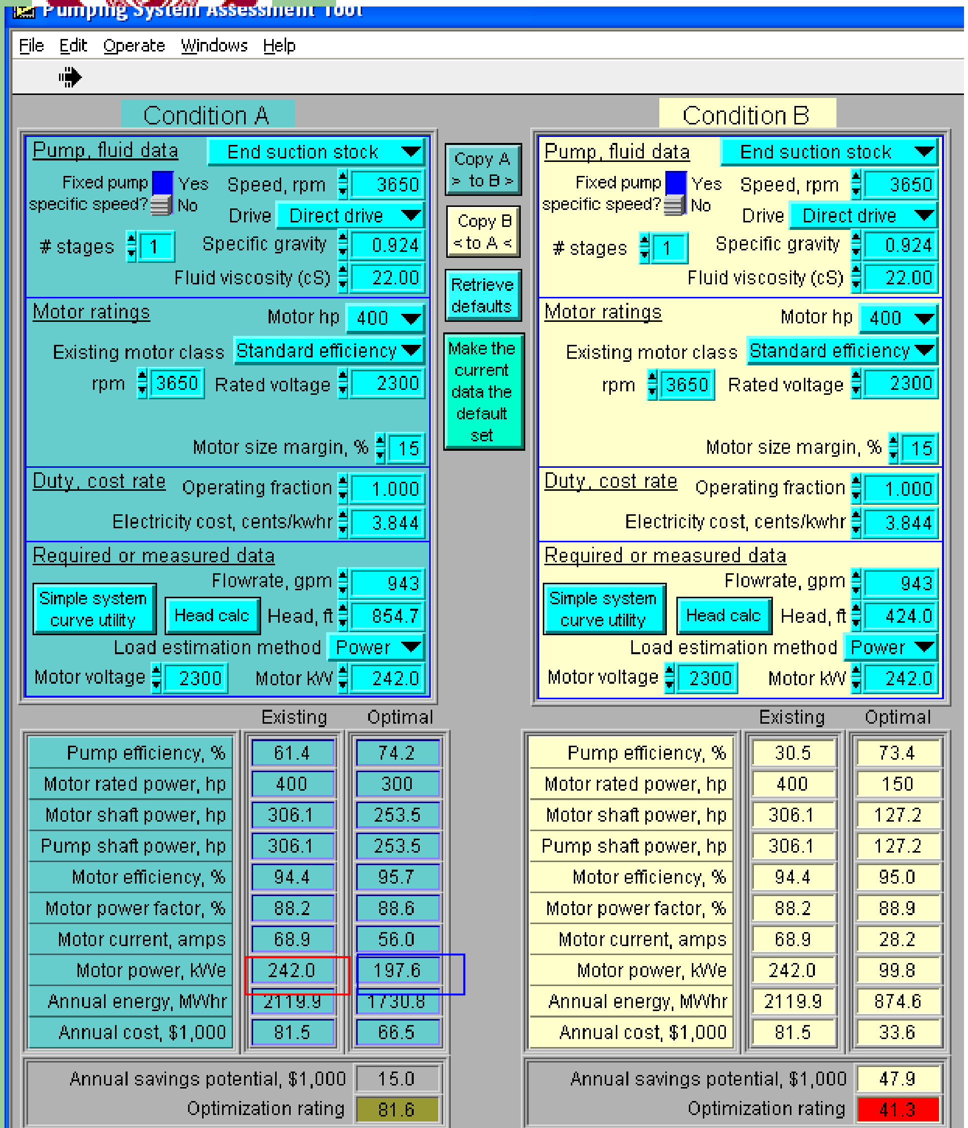
Raw Crude



- Head loss: 358 ft
- Friction loss:

  78.7 hp

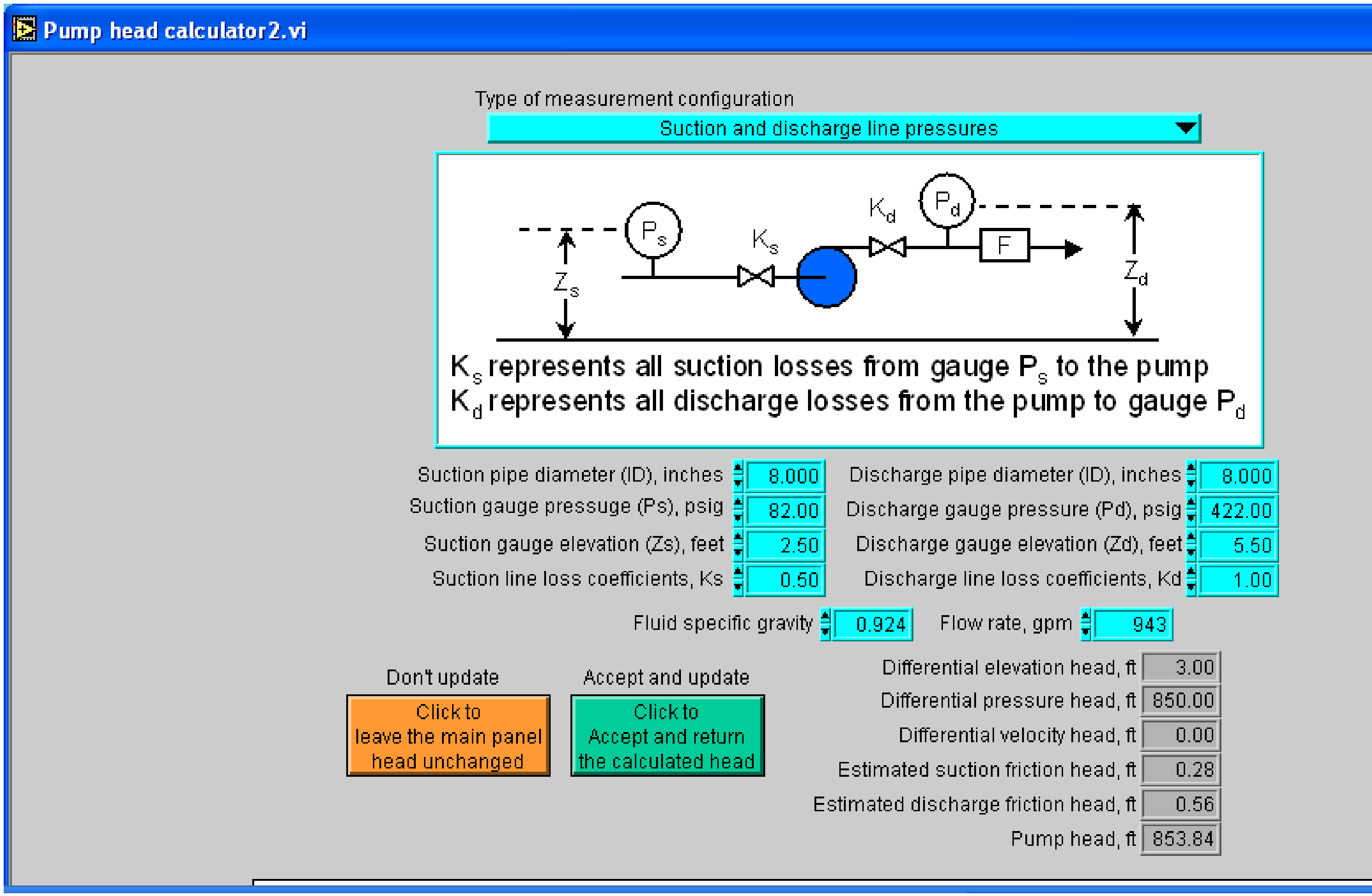
  83.2 kW
- Annual Cost:

  $28,000

Optimization Rating:

$$\frac{197.6}{242.0} = 0.816\ (81.65\%)$$

Raw Crude



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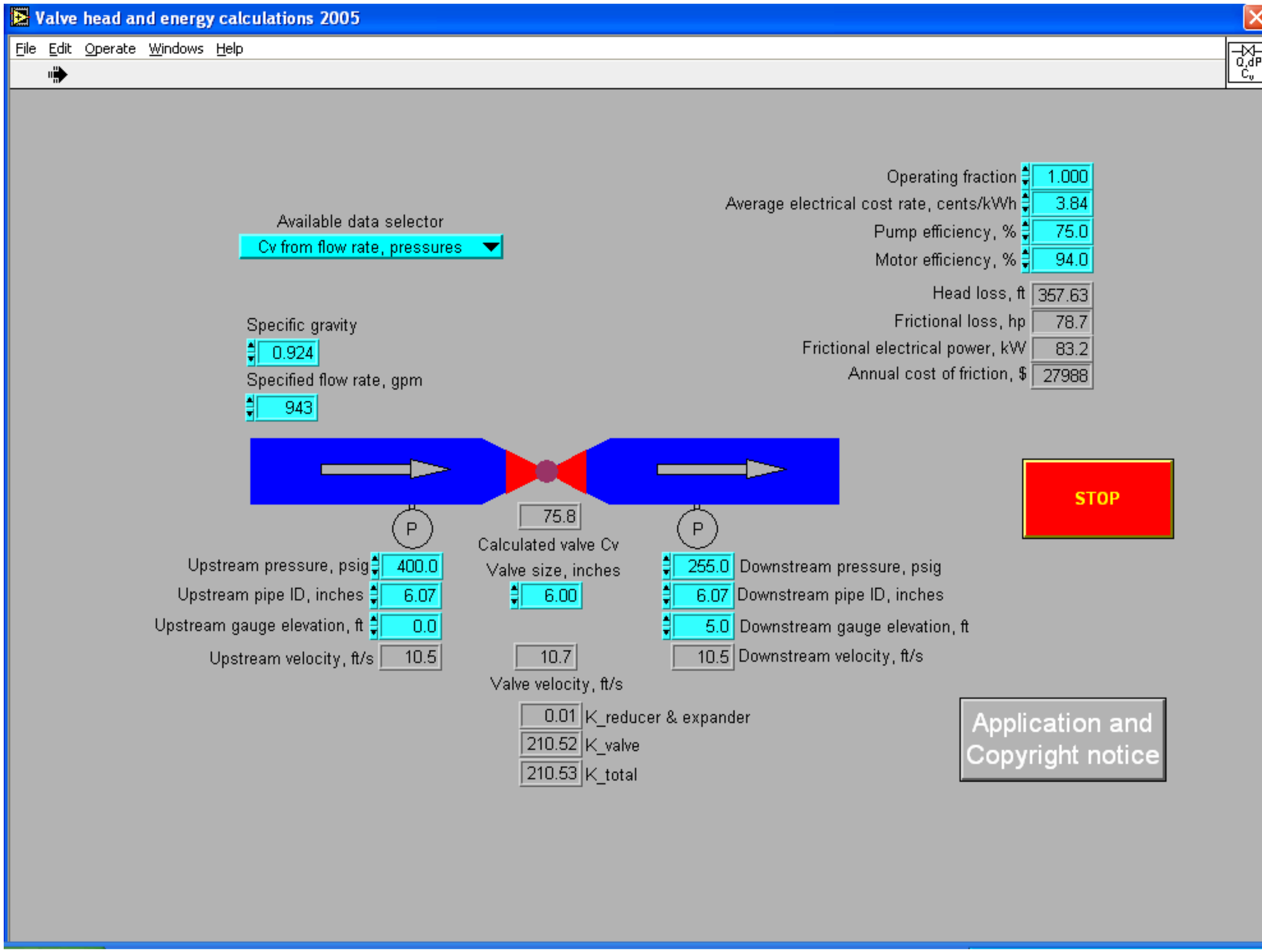
Raw Crude



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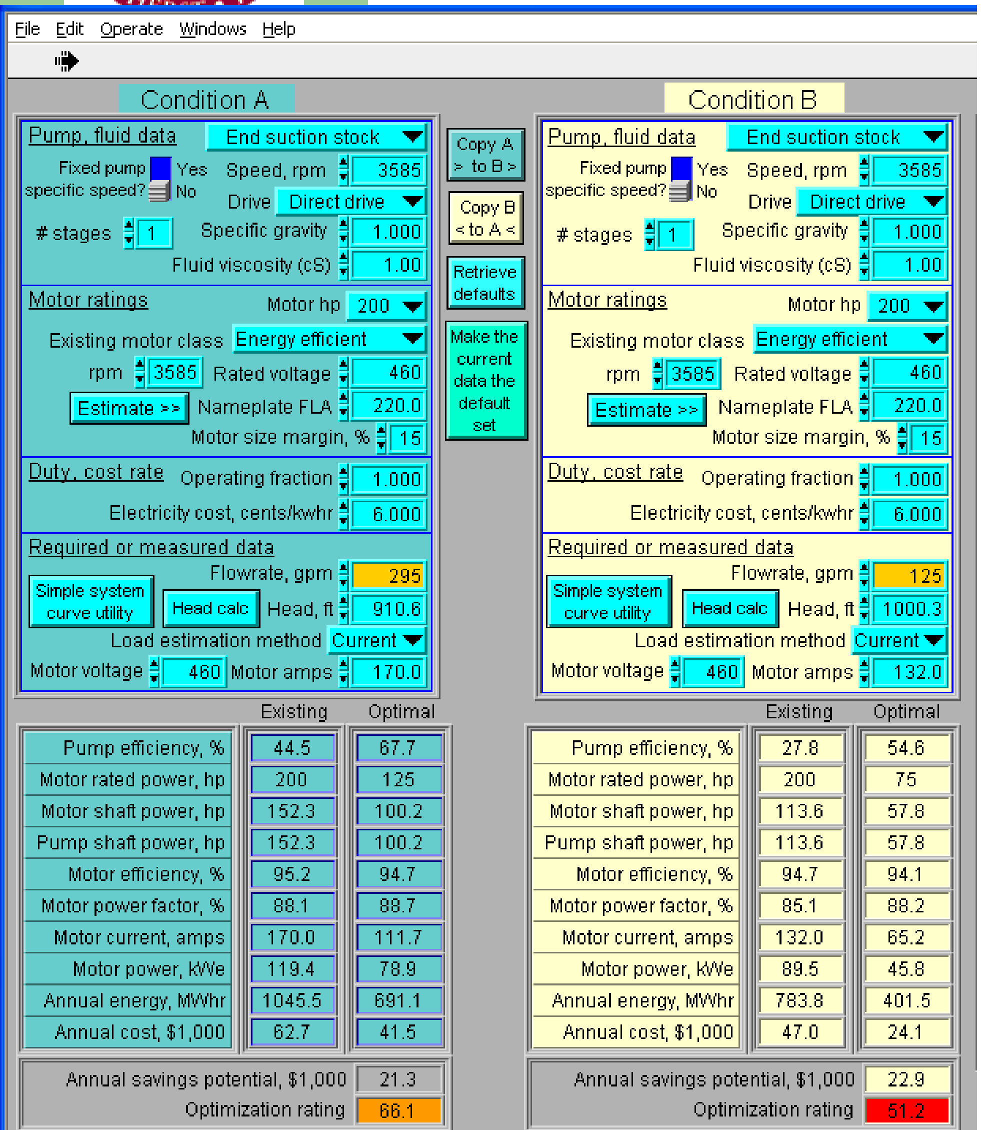
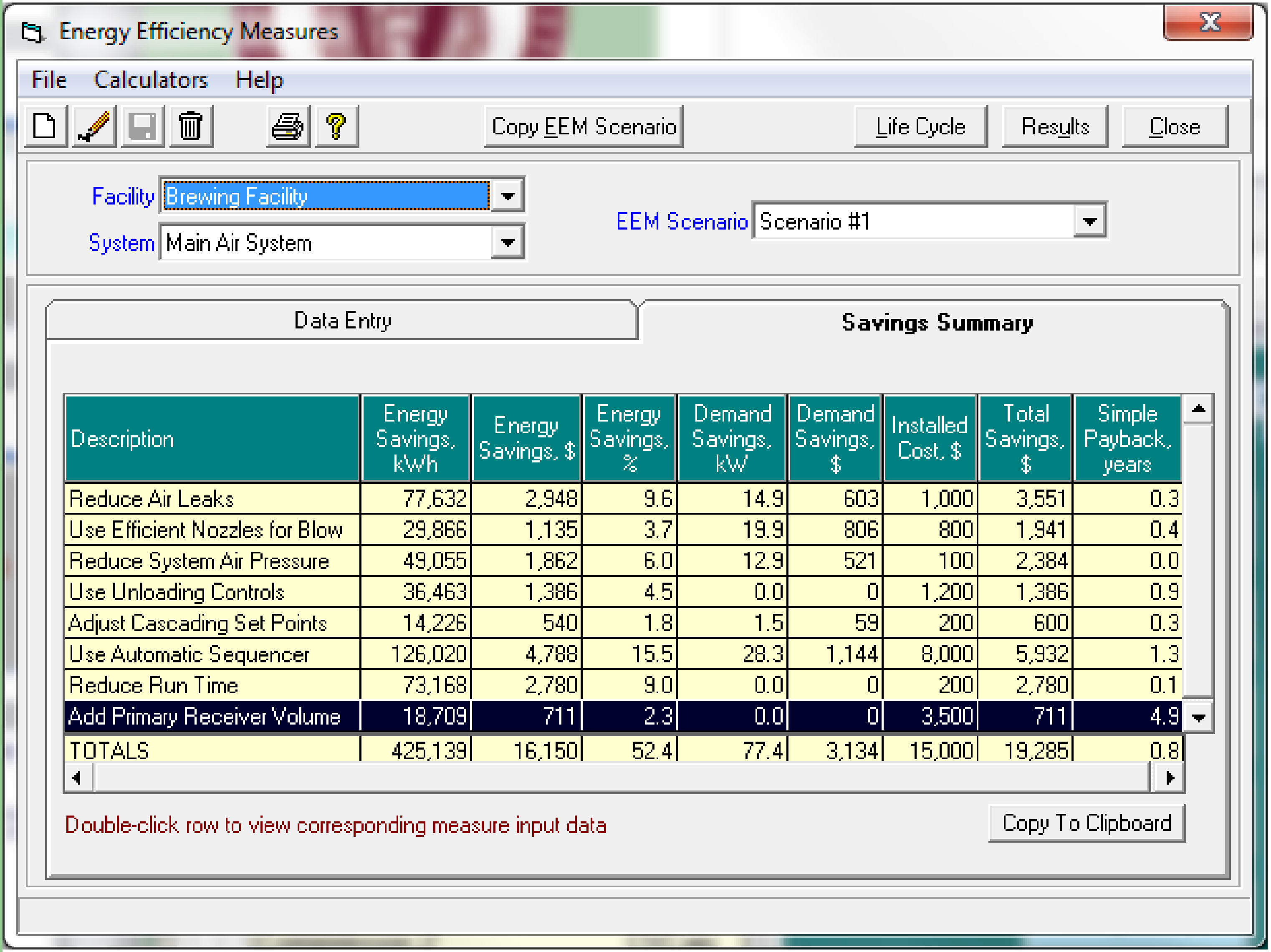
Hood and Saturation Spray Pumps



- Use VSD to control the flow – reduce flow 50% during off periods

- Potential Savings:
  321,000 kWh
  $19,000

Compressed Air - Air Master



Description	Energy Savings, kWh	Energy Savings, $	Energy Savings, %	Demand Savings, kW	Demand Savings, $	Installed Cost, $	Total Savings, $	Simple Payback, years
Reduce Air Leaks	77,632	2,948	9.6	14.9	603	1,000	3,551	0.3
Use Efficient Nozzles for Blow	29,866	1,135	3.7	19.9	806	800	1,941	0.4
Reduce System Air Pressure	49,055	1,862	6.0	12.9	521	100	2,384	0.0
Use Unloading Controls	36,463	1,386	4.5	0.0	0	1,200	1,386	0.9
Adjust Cascading Set Points	14,226	540	1.8	1.5	59	200	600	0.3
Use Automatic Sequencer	126,020	4,788	15.5	28.3	1,144	8,000	5,932	1.3
Reduce Run Time	73,168	2,780	9.0	0.0	0	200	2,780	0.1
Add Primary Receiver Volume	18,709	711	2.3	0.0	0	3,500	711	4.9
TOTALS	425,139	16,150	52.4	77.4	3,134	15,000	19,285	0.8

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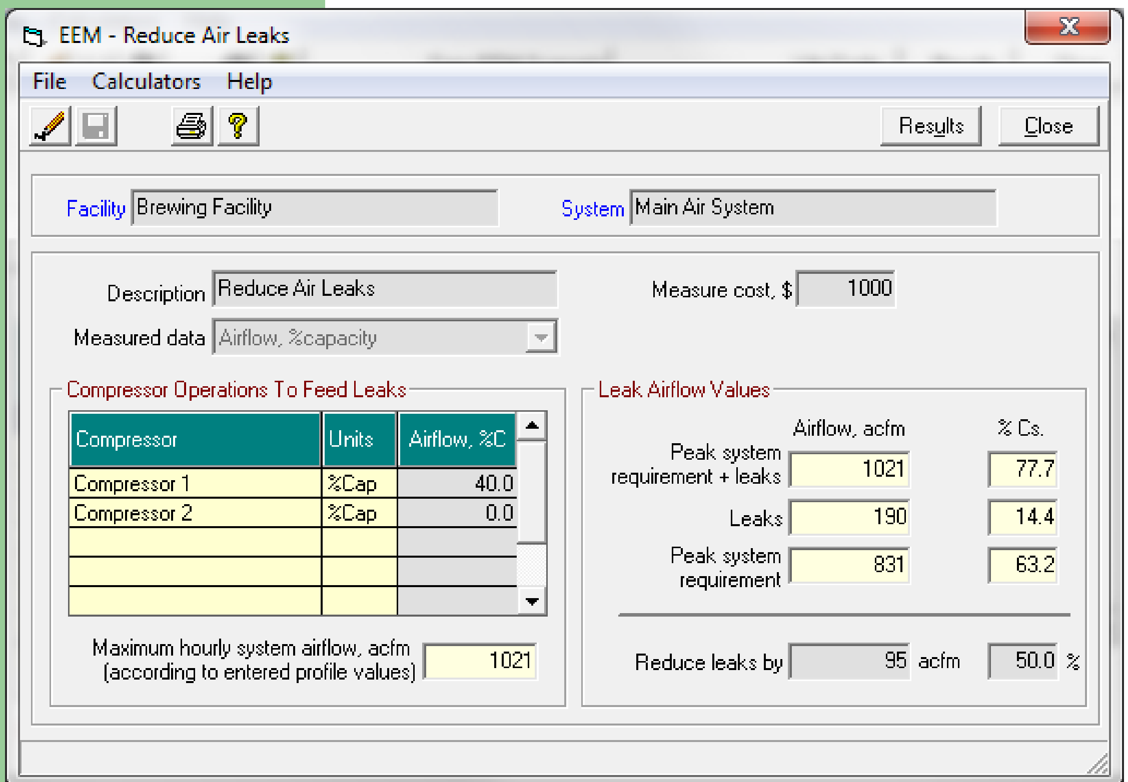
AC – Reduce Air Leaks



- Annual Energy Savings: 77,632 kWh
- Potential Cost Savings: $3,551
- Measure Cost: $1,000

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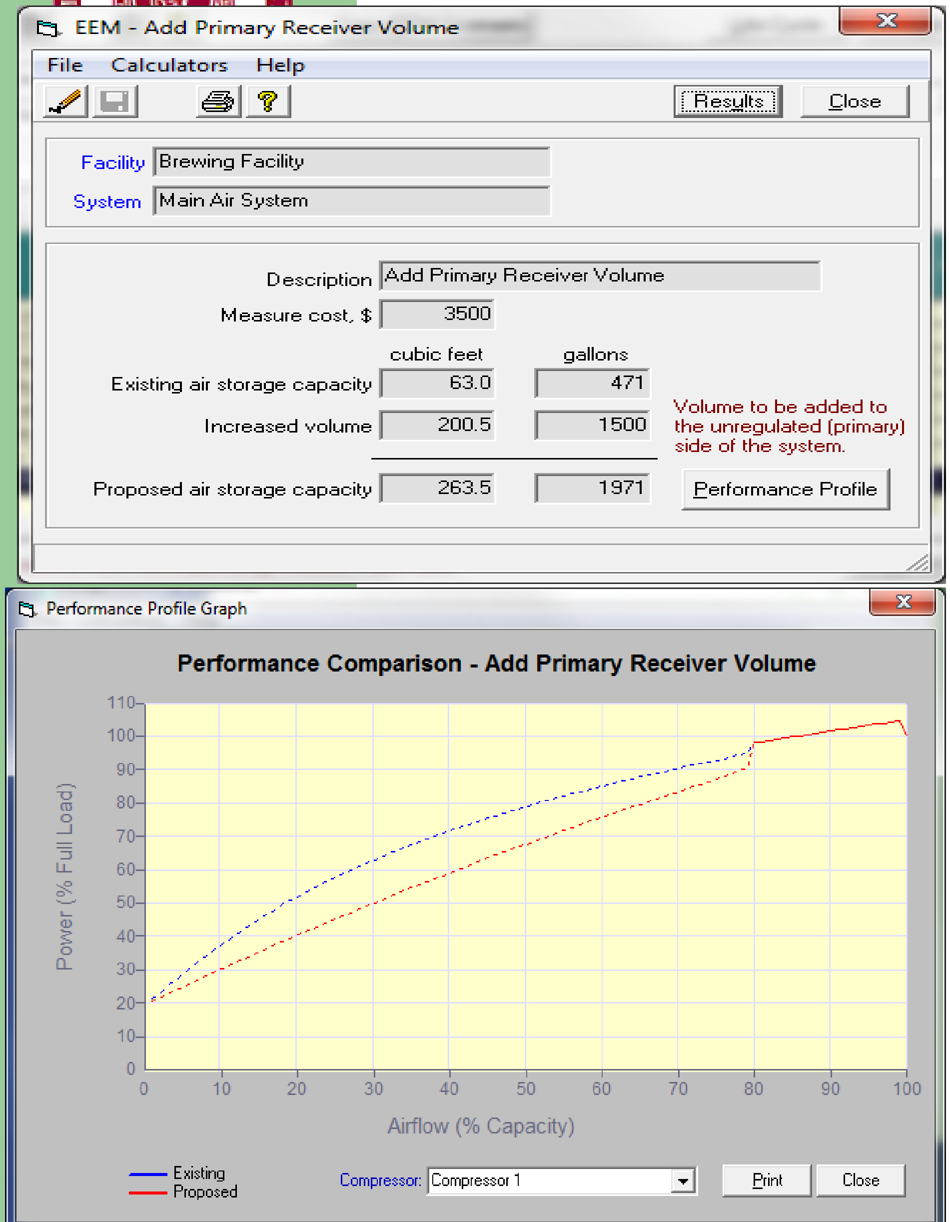
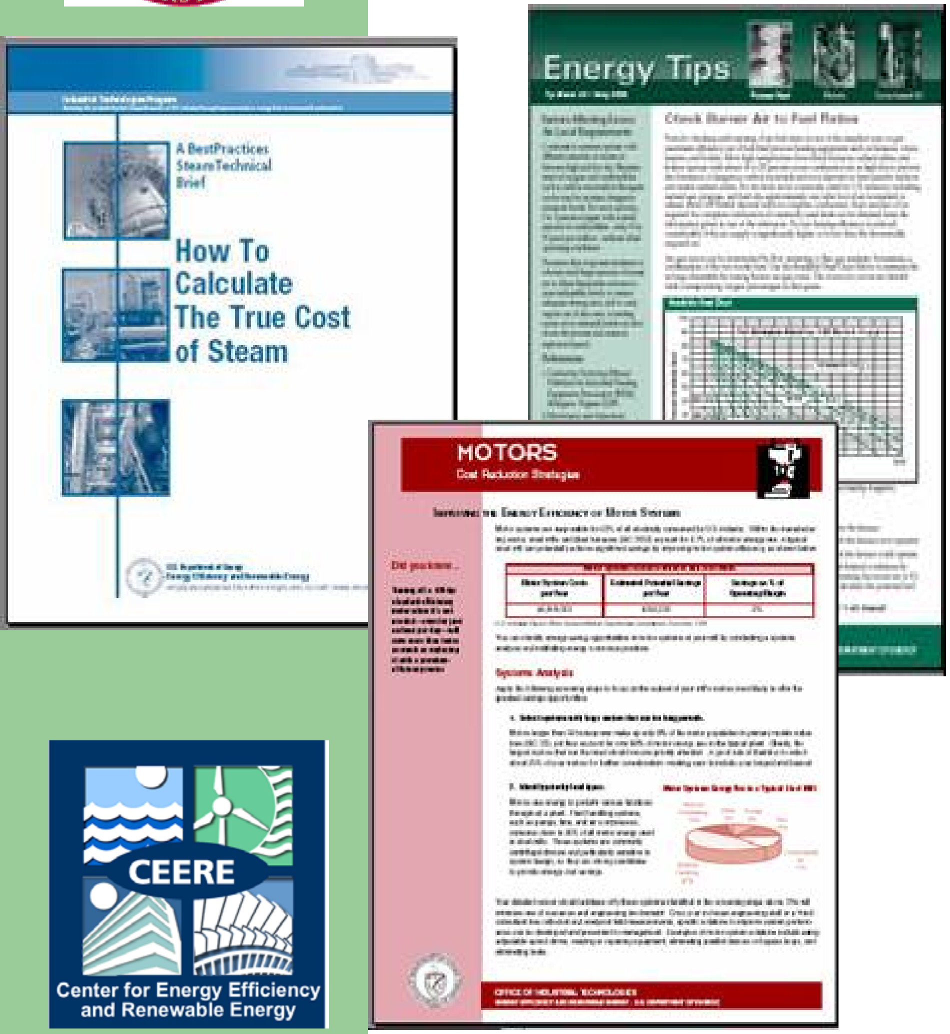
AC – Add Receiver Tank



- Annual Energy Savings: 18,709 kWh
- Potential Cost Savings: $711
- Measure Cost: $3,500

Information, Tools and Training



- **Tip sheets, case studies, brochures, technical briefs etc.**
- ***Energy Matters* newsletter**
- **Industrial Technologies Monthly e-bulletin**
- **Software tools**
- **Training workshops and webcasts**
- **Web sites**
- **New:**
  - **Packets of Information for Plants**

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Questions ?

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