



Energy Conservation DOE Best Practices Tools

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Newton, MA

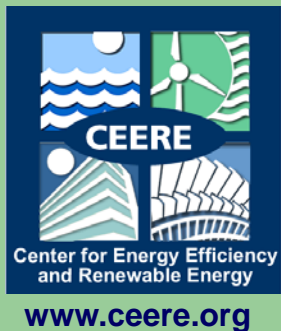


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Outline

- 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

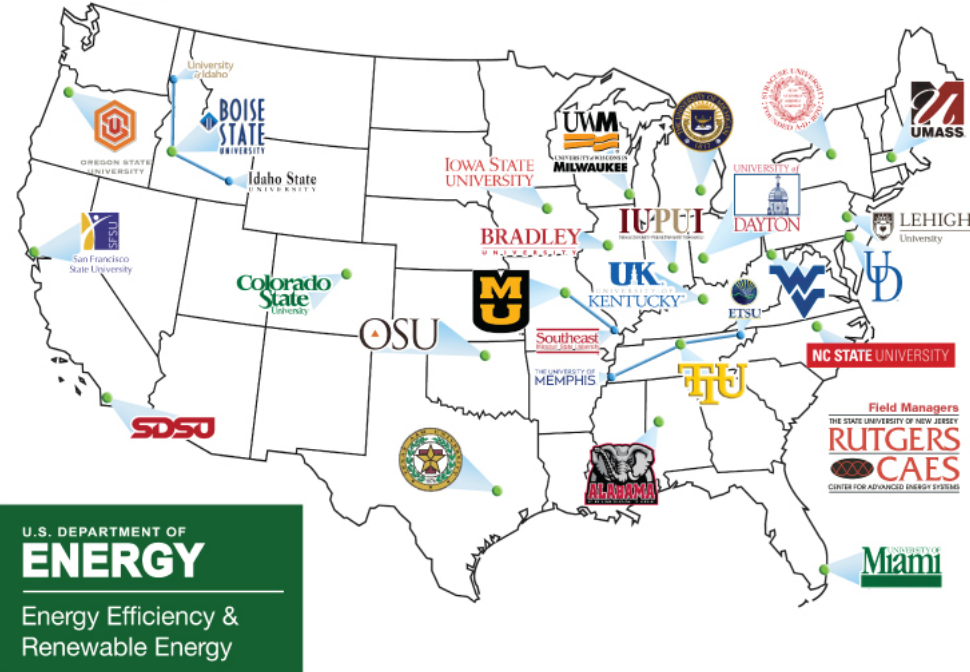




Beginning in 1984 with four Schools

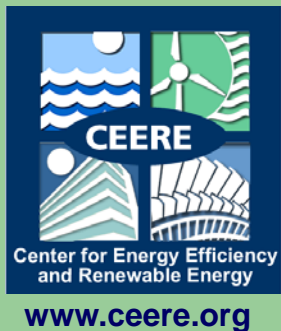


Industrial Assessment Centers 2012-2016



Currently 24 Centers at 29 Universities
Nationwide

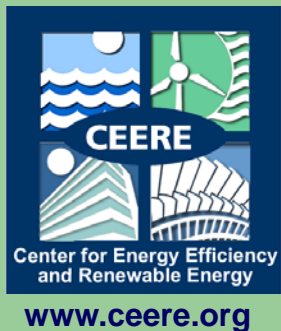
For more information on IAC program and participating schools visit: <http://iac.rutgers.edu/database/centers/>





Industrial Assessment Center at the University of Massachusetts

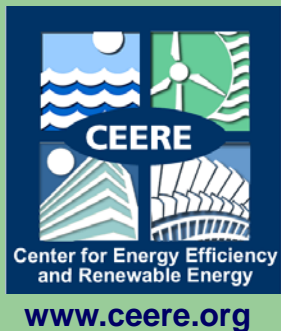
- Provides assistance to New England Industry since 1984
- US DOE Funding allows the IAC Program to provide no cost energy conservation, waste prevention and productivity assistance to small and medium sized industrial firms within S.I.C. 20 through 39





IAC Program Goals

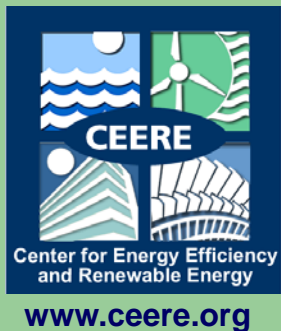
- Reduce Industrial Energy Use
- Reduce waste and prevent pollution in manufacturing operations
- Raise productivity
- Lower Operating Costs
- Increase Profitability
- Provide Professional Training for Students





Client Criteria

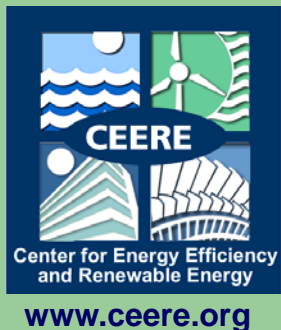
- Have Annual Energy Costs Less Than \$ 2.5 Million
- Have Gross Sales Less Than \$100 Million
- Have Less Than 500 Employees
- Have No In-house Energy Staff
- Be Within 150 Miles of Amherst, MA





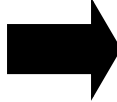
UMASS Clients 1984-2012

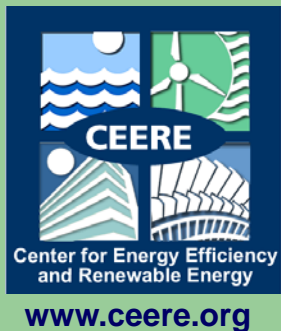
- Over 700 plants visited since 1984
- Over \$12 billion in gross annual sales
- \$310 million in annual energy costs
- Over 82,000 employees
- Over 4,300 recommendations with \$62,000 average annual cost savings per assessment
- 51% Implementation Rate; 1.04 years payback period
- \$125,000 average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





IDENTIFYING EFFECTIVE ENERGY SAVING OPTIONS

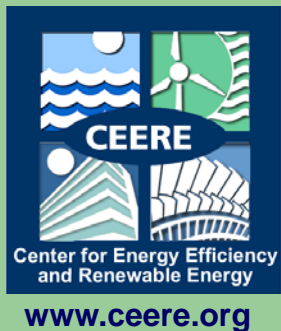
- Major energy users
 - Major pieces of equipment
 - Motors
 - Boilers and Furnaces
 - Compressors/Chillers
 - Hot exhausts
 - Compressed air leaks
 - Cooling Towers
- 
- Variable Frequency Drives
 - Energy-efficient Motors
 - Consider CHP
 - Energy Management Systems
 - Steam Trap Replacement
 - High-efficiency Boiler
 - Chiller Water Plant Operation
 - Process Heat Recovery





TOP \$\$ SAVERS

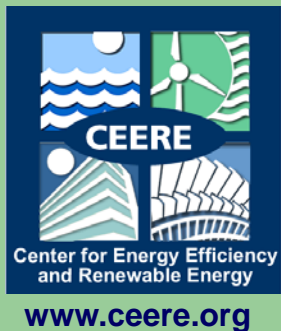
- Convert To VSD For Pumps & Blowers
- Process Heat Recovery
- Use High Efficiency Lamps & Ballasts
- Reduce Fluid Flows
- Change Electrical Rates
- Use Energy Efficient Equipment
- Consider Cogeneration
- Preheat Fluids With Waste Heat
- Insulate Equipment
- Switch From Electrical To Fossil Fuels





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.





Clean Energy Application Centers

DOE Clean Energy Application Centers: Locations, Contacts, and Web Sites

NORTHWEST
www.northwestcleanenergy.org
 Dave Sjoding
 Washington State University
 Tel: 360-956-2004
 sjodingd@energy.wsu.edu

MIDWEST
www.midwestcleanenergy.org
 John Cuttica
 University of Illinois at Chicago
 Tel: 312-996-4382
 cuttica@uic.edu
 Cliff Haefke
 University of Illinois at Chicago
 Tel: 312-355-3476
 chaefk1@uic.edu

NORTHEAST
www.northeastcleanenergy.org
 Tom Bourgeois
 Pace University
 Tel: 914-422-4013
 tbourgeois@law.pace.edu
 Beka Kosanovic
 University of Massachusetts Amherst
 Tel: 413-545-0684
 kosanovi@ecs.umass.edu

PACIFIC
www.pacificcleanenergy.org
 Tim Lipman
 University of California, Berkeley
 Tel: 510-642-4501
 telipman@berkeley.edu
 Vince McDonell
 University of California, Irvine
 Tel: 949-824-7302 x121
 mcdonell@apep.uci.edu

MID-ATLANTIC
www.maceac.psu.edu
 Jim Freihaut
 Pennsylvania State University
 Tel: 814-863-0083
 jfreihaut@enr.psu.edu

INTERNATIONAL DISTRICT ENERGY ASSOCIATION
www.districtenergy.org
 Rob Thornton
 President
 Tel: 508-366-9339
 rob.idea@districtenergy.org

INTERMOUNTAIN
www.intermountaincleanenergy.org
 Patti Case
 etc Group
 Tel: 801-278-1927 x 3
 plcase@etcgrp.com
 Thomas Broderick
 Southwest Energy Efficiency Project
 Tel: 928-527-8036
 tbroderick@swenergy.org

GULF COAST
www.gulfcoastcleanenergy.org
 Dan Bullock
 Houston Advanced Research Center
 Tel: 281-364 6087
 dbullock@harc.edu

SOUTHEAST
www.southeastcleanenergy.org
 Isaac Panzarella
 North Carolina State University
 Tel: 919-515-0354
 ipanzarella@ncsu.edu
 Pedro Mago
 Mississippi State University
 Tel: 662-325-6602
 mago@me.msstate.edu

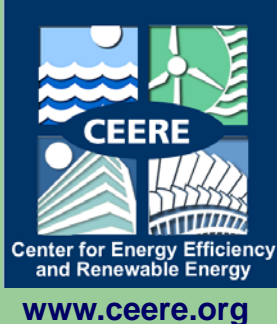
DOE Clean Energy Application Centers: Program Contacts

Katrina Pielli
 Office of Energy Efficiency and Renewable Energy
 U.S. Department of Energy
 Phone: 202-287-5850
 E-mail: katrina.pielli@ee.doe.gov

Joe Renk
 National Energy Technology Laboratory (NETL)
 U.S. Department of Energy
 Phone: 412-386-6406
 E-mail: joseph.renk@netl.doe.gov

Patti Garland
 Oak Ridge National Laboratory (ORNL)
 U.S. Department of Energy
 Phone: 202-586-3753
 E-mail: patricia.garland@ee.doe.gov

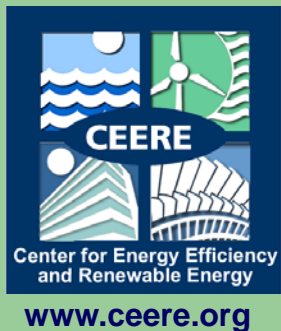
Ted Bronson
 DOE Clean Energy RAC Coordinator
 Power Equipment Associates
 Phone: 630-248-8778
 E-mail: tbronsonpea@aol.com





AMO BestPractices Tools

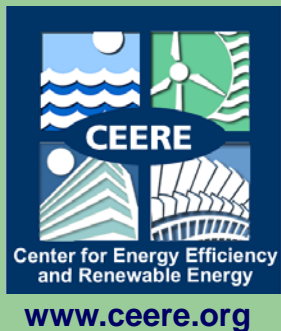
- Motor Driven Systems
 - CWSAT (Chilled Water System Assessment Tool)
 - AirMaster + (Compressed air system assessment tool)
 - FSAT (Fan System Assessment Tool)
 - MotorMaster + (Motor management tool)
 - PSAT (Pumping System Assessment Tool)
 - ChemPEP (Plant Energy Profiler for the Chemical Industry)





AMO BestPractices Tools (Continued)

- Process Heating
 - PHAST (Process Heating Assessment and Survey Tool)
 - NxEAT (NO_x 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

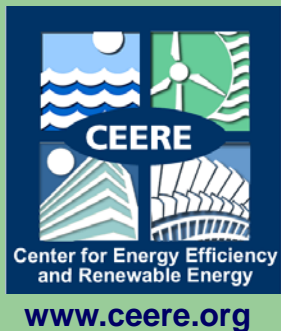




CWSAT Program

Purpose: Reduce the energy consumption of installed chilled water systems

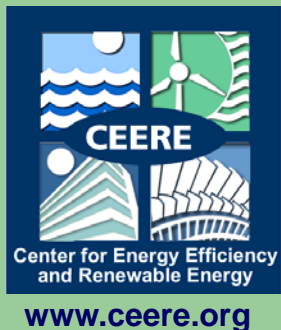
Goal: Create a simple but useful software tool for analyzing potential energy savings in chilled water systems





CWSAT INTRODUCTION

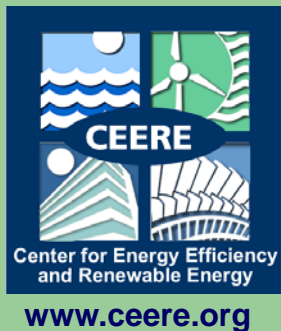
- A central chilled water system may account for a quarter to a third of facility energy consumption.
- **ULTIMATE GOAL**
 - Provide adequate cooling to process or comfort load.
 - Reduce energy consumption of chilled water **SYSTEMS** (important to look at it as a **SYSTEM** and not as a collection 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





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





Annual Cooling System Operations

New Output Screen

Proposed Chiller System

Basic System Summary

Number of Chillers:

CHWT Setpoint:

Geographic Location:

Condenser Cooling Method:

Water-Cooled Summary

Constant CWT?:

Constant CWT Setpoint:

Tower Summary

Type:

#Towers: Sizing:

Fan Motor hp: Tons:

Number of Cells per Tower:

Pump Summary

	CHW	CW
Variable Flow?:	<input type="text" value="No"/>	<input type="text" value="No"/>
Flow Rate [gpm/ton]:	<input type="text" value="2.4"/>	<input type="text" value="3"/>
Motor size (hp):	<input type="text" value="40"/>	<input type="text" value="50"/>
Pump Efficiency [%]:	<input type="text" value="80"/>	<input type="text" value="80"/>
Motor Efficiency [%]:	<input type="text" value="90"/>	<input type="text" value="90"/>

Proposed Chiller Summary

Compressor	Capacity [tons]	Age [years]	FLE [kW/ton]
Chiller 1			
<input type="text" value="Helical Rotary"/>	<input type="text" value="400"/>	<input type="text" value="1"/>	<input type="text" value="0.500"/>

Energy Summary

Chiller Energy: kWh

Tower Energy: kWh

Pump Energy: kWh

Total Energy: kWh

Return to New Input Screen

Go To Proposed Chiller Details Screen

Go To Proposed Tower Details Screen

Go To Proposed Pump Details Screen

Show Savings Summary Screen

Help

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





Install VFD on Tower Pumps

New Output Screen

Proposed Chiller System

Basic System Summary

Number of Chillers:

CHWT Setpoint:

Geographic Location:

Condenser Cooling Method:

Water-Cooled Summary

Constant CWT?:

Constant CWT Setpoint:

Return to New Input Screen

Go To Proposed Chiller Details Screen

Go To Proposed Tower Details Screen

Go To Proposed Pump Details Screen

Show Savings Summary Screen

Help

Tower Summary

Type:

#Towers: Sizing:

Fan Motor hp: Tons:

Number of Cells per Tower:

Pump Summary

	CHW	CW
Variable Flow?:	<input type="text" value="No"/>	<input type="text" value="Yes"/>
Flow Rate [gpm/ton]:	<input type="text" value="2.4"/>	<input type="text" value="3"/>
Motor size (hp):	<input type="text" value="40"/>	<input type="text" value="50"/>
Pump Efficiency [%]:	<input type="text" value="80"/>	<input type="text" value="80"/>
Motor Efficiency [%]:	<input type="text" value="90"/>	<input type="text" value="90"/>

Proposed Chiller Summary

Compressor	Capacity [tons]	Age [years]	FLE [kW/ton]
Chiller 1			
<input type="text" value="Helical Rotary"/>	<input type="text" value="400"/>	<input type="text" value="1"/>	<input type="text" value="0.500"/>

Energy Summary

Chiller Energy:	<input type="text" value="375,116"/> kWh	<input type="text" value="\$22,976"/>
Tower Energy:	<input type="text" value="98,036"/> kWh	<input type="text" value="\$6,005"/>
Pump Energy:	<input type="text" value="529,958"/> kWh	<input type="text" value="\$32,460"/>
Total Energy:	<input type="text" value="1,003,110"/> kWh	<input type="text" value="\$61,441"/>

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



Install VFD on Tower Fan

New Output Screen

Proposed Chiller System

Basic System Summary

Number of Chillers:

CHWT Setpoint:

Geographic Location:

Condenser Cooling Method:

Water-Cooled Summary

Constant CWT?:

Constant CWT Setpoint:

Tower Summary

Type:

#Towers: Sizing:

Fan Motor hp: Tons:

Number of Cells per Tower:

Pump Summary

	CHW	CW
Variable Flow?:	<input type="text" value="No"/>	<input type="text" value="No"/>
Flow Rate [gpm/ton]:	<input type="text" value="2.4"/>	<input type="text" value="3"/>
Motor size (hp):	<input type="text" value="40"/>	<input type="text" value="50"/>
Pump Efficiency [%]:	<input type="text" value="80"/>	<input type="text" value="80"/>
Motor Efficiency [%]:	<input type="text" value="90"/>	<input type="text" value="90"/>

Proposed Chiller Summary

Compressor	Capacity [tons]	Age [years]	FLE [kW/ton]
Chiller 1 <input type="text" value="Helical Rotary"/>	<input type="text" value="400"/>	<input type="text" value="1"/>	<input type="text" value="0.500"/>

Energy Summary

Chiller Energy: kWh

Tower Energy: kWh

Pump Energy: kWh

Total Energy: kWh

Return to New Input Screen

Go To Proposed Chiller Details Screen

Go To Proposed Tower Details Screen

Go To Proposed Pump Details Screen

Show Savings Summary Screen

Help

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



Vary Tower Water Temperature with Outside Temperature

New Output Screen

Proposed Chiller System

Basic System Summary

Number of Chillers:

CHWT Setpoint:

Geographic Location:

Condenser Cooling Method:

Water-Cooled Summary

Constant CWT?:

Following Difference:

Tower Summary

Type:

#Towers: Sizing:

Fan Motor hp: Tons:

Number of Cells per Tower:

Pump Summary

	CHW	CW
Variable Flow?:	<input type="text" value="No"/>	<input type="text" value="No"/>
Flow Rate [gpm/ton]:	<input type="text" value="2.4"/>	<input type="text" value="3"/>
Motor size (hp):	<input type="text" value="40"/>	<input type="text" value="50"/>
Pump Efficiency [%]:	<input type="text" value="80"/>	<input type="text" value="80"/>
Motor Efficiency [%]:	<input type="text" value="90"/>	<input type="text" value="90"/>

Proposed Chiller Summary

Compressor	Capacity [tons]	Age [years]	FLE [kW/ton]
Chiller 1			
<input type="text" value="Helical Rotary"/>	<input type="text" value="400"/>	<input type="text" value="1"/>	<input type="text" value="0.500"/>

Energy Summary

Chiller Energy: kWh

Tower Energy: kWh

Pump Energy: kWh

Total Energy: kWh

Return to New Input Screen

Go To Proposed Chiller Details Screen

Go To Proposed Tower Details Screen

Go To Proposed Pump Details Screen

Show Savings Summary Screen

Help

- **Potential Annual Savings:**

- 12,100 kWh
- \$740



Implementation of All Cooling System Improvements

New Output Screen

Proposed Chiller System

Basic System Summary

Number of Chillers:

CHWT Setpoint:

Geographic Location:

Condenser Cooling Method:

Water-Cooled Summary

Constant CWT?:

Following Difference:

Tower Summary

Type:

#Towers: Sizing:

Fan Motor hp: Tons:

Number of Cells per Tower:

Pump Summary

	CHW	CW
Variable Flow?:	<input type="text" value="No"/>	<input type="text" value="Yes"/>
Flow Rate [gpm/ton]:	<input type="text" value="2.4"/>	<input type="text" value="3"/>
Motor size (hp):	<input type="text" value="40"/>	<input type="text" value="50"/>
Pump Efficiency [%]:	<input type="text" value="80"/>	<input type="text" value="80"/>
Motor Efficiency [%]:	<input type="text" value="90"/>	<input type="text" value="90"/>

Proposed Chiller Summary

Compressor	Capacity [tons]	Age [years]	FLE [kW/ton]
Chiller 1			
<input type="text" value="Helical Rotary"/>	<input type="text" value="400"/>	<input type="text" value="1"/>	<input type="text" value="0.500"/>

Energy Summary

Chiller Energy: kWh

Tower Energy: kWh

Pump Energy: kWh

Total Energy: kWh

Return to New Input Screen

Go To Proposed Chiller Details Screen

Go To Proposed Tower Details Screen

Go To Proposed Pump Details Screen

Show Savings Summary Screen

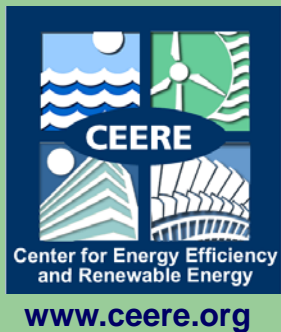
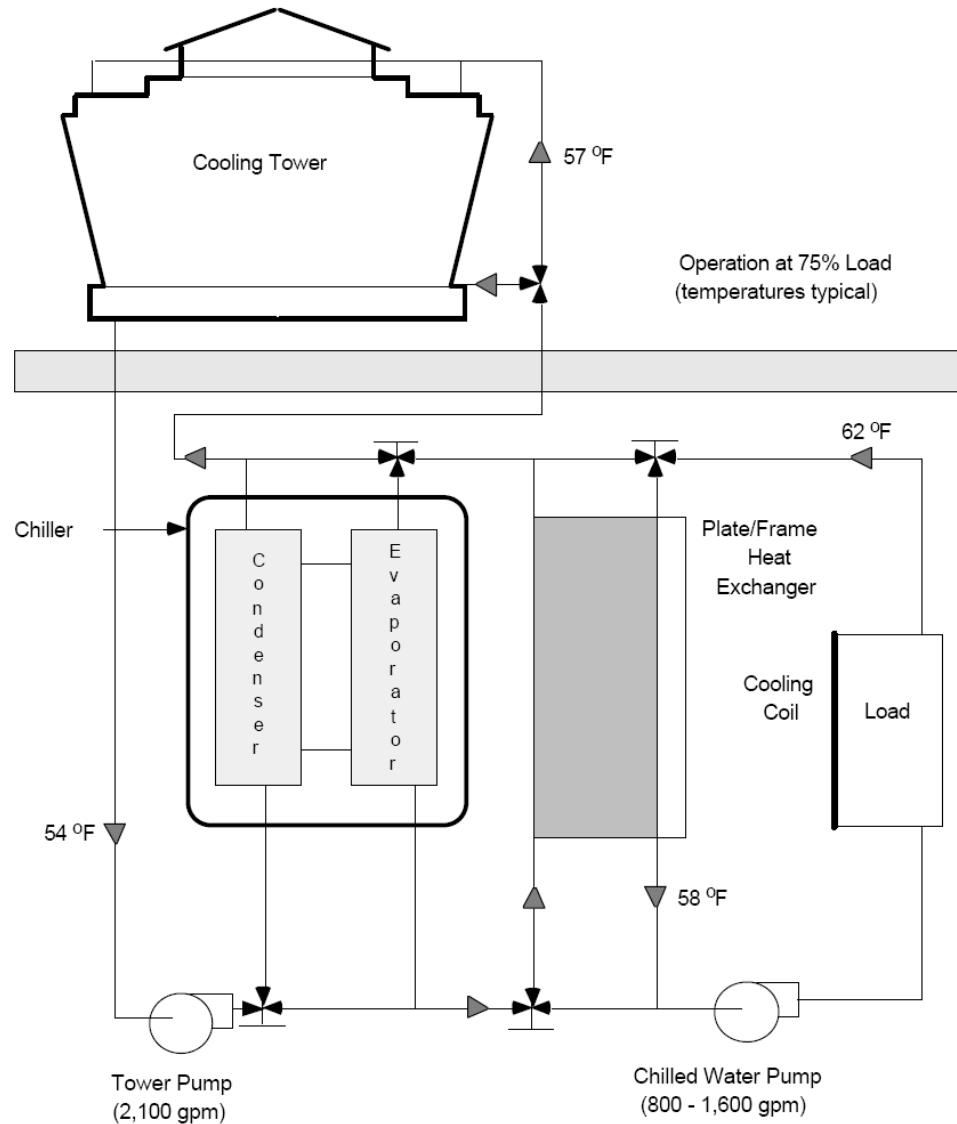
Help

Potential Annual Savings:

- 147,927 kWh
- \$9,060



“Free Cooling”





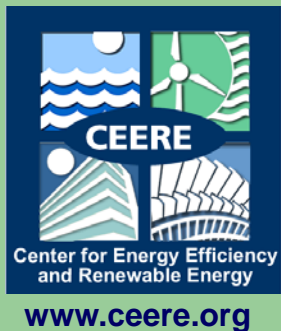
Free Cooling: Case Study

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%)



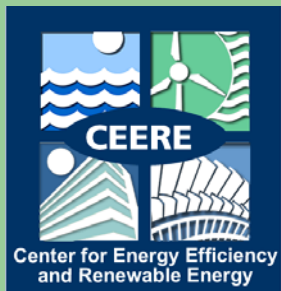


Process Heating Assessment and Survey Tool (PHAST)

What is PHAST?

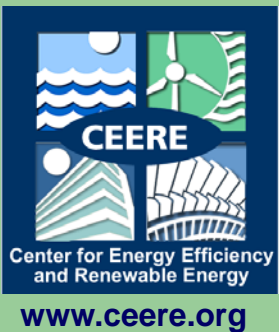
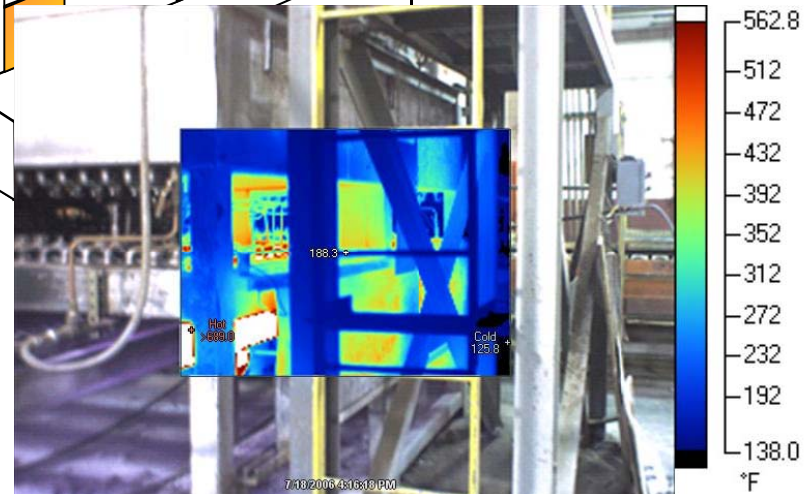
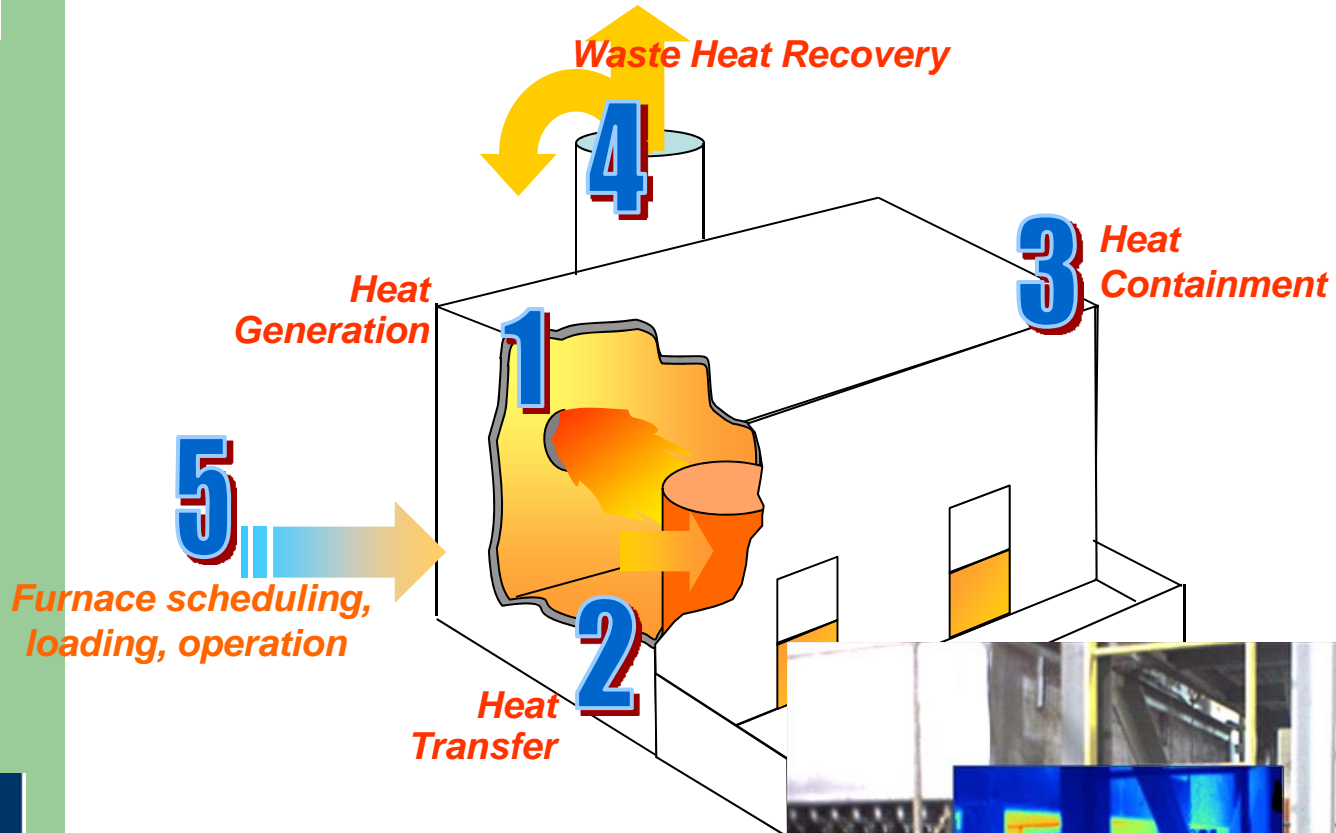
A tool that can be used to:

- 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





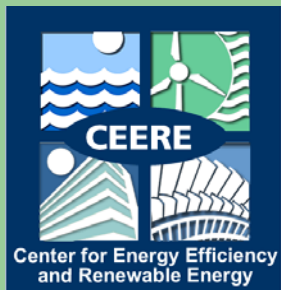
Areas of Energy Saving Opportunities





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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and Renewable Energy

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Preheat Furnaces #1 Combustion Air

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

Furnace Data

File Help

U.S. Department of Energy
Energy Efficiency and Renewable Energy *Bringing you a prosperous future where energy is clean, abundant, reliable and affordable*

Plant Name: _____ Furnace Name: **3002**

Water - Cooling Losses Wall Losses Opening Losses

Load/Charge Material Fixtures, Trays, Baskets etc. Losses Atmosphere Losses

Other Losses **Flue Gas Losses/Heating System Efficiency** Heat Storage

Select Heat Source: Fuel-Air (O2) Fired Electric Steam

	Current	Modified
Furnace Flue Gas Temp. (Degree F)	1400 [Look Up]	1400
Oxygen in Flue Gases (%)	12 [Look Up]	12
Excess Air (%)	119.33	119.33
Combustion Air Temp. (Degree F)	80 [Look Up]	700
Available Heat (%)	31.96	56.27
Available Heat User Defined (%)	31.96 [Look Up]	56.27
Gross Heat (Btu/hr)	1,325,885	753,071
Flue Gas Losses (Btu/hr)	902,132	329,318

Current Net Heat Required (Btu/hr) **423,753** Furnace Summary Enter/Edit Current Data

Modified Net Heat Required (Btu/hr) **423,753** Report Close

Improve Furnace #2 Combustion Efficiency



Furnace Data

U.S. Department of Energy
Energy Efficiency and Renewable Energy *Bringing you a prosperous future where energy is clean, abundant, reliable and affordable*

Plant Name: _____ Furnace Name: **3002**

Water - Cooling Losses Wall Losses Opening Losses

Load/Charge Material Fixtures, Trays, Baskets etc. Losses Atmosphere Losses

Other Losses **Flue Gas Losses/Heating System Efficiency** Heat Storage

Select Heat Source: Fuel-Air (O2) Fired Electric Steam

	Current	Modified
Furnace Flue Gas Temp. (Degree F)	1400	1400
Oxygen in Flue Gases (%)	12	7
Excess Air (%)	119.33	44.75
Combustion Air Temp. (Degree F)	80	85
Available Heat (%)	31.96	49.84
Available Heat User Defined (%)	31.96	49.84
Gross Heat (Btu/hr)	1,325,885	850,227
Flue Gas Losses (Btu/hr)	902,132	426,474

Current Net Heat Required (Btu/hr) **423,753** Furnace Summary Enter/Edit Current Data

Modified Net Heat Required (Btu/hr) **423,753** Report Close

- O₂ 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

Furnace Data

File Help

U.S. Department of Energy
Energy Efficiency and Renewable Energy *Bringing you a prosperous future where energy is clean, abundant, reliable and affordable*

Plant Name: _____ Furnace Name: **3002**

Load/Charge Material Fixtures, Trays, Baskets etc. Losses Atmosphere Losses

Other Losses Flue Gas Losses/Heating System Efficiency Heat Storage

Water - Cooling Losses **Wall Losses** Opening Losses

	Current	Modified
Surface Area (ft ²)	620	620
Average Surface Temp. (Degree F)	250	130
Ambient Temp. (Degree F)	85	85
Correction Factor	1	1
Heat Required (Btu/hr)	246,063	66,402

Current Net Heat Required (Btu/hr) **423,753** Furnace Summary Enter/Edit Current Data

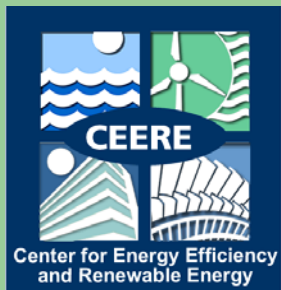
Modified Net Heat Required (Btu/hr) **244,092** Report Close

- Annual Energy Savings:
1,510 MMBtu/yr
Potential Cost Savings: \$15,100
- Potential Savings for Three Furnaces:
~\$45,300



Pumping System Assessment Tool (PSAT)

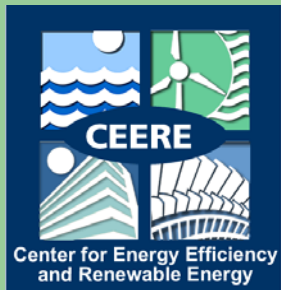
- An opportunity quantification tool
- Relies on field measured (or estimated) fluid and electrical performance data
- Uses achievable pump efficiency algorithms from the Hydraulic Institute
- Motor performance (efficiency, current, power factor) curves developed from average motor data available in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





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



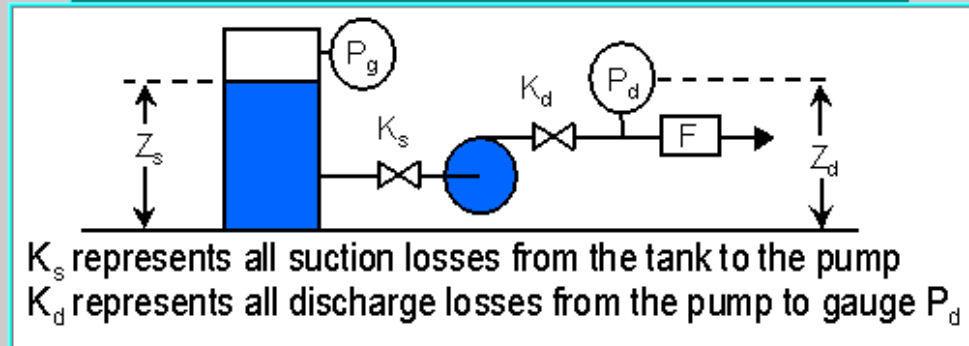


Head calculation

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

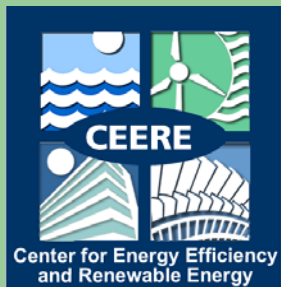


Suction pipe diameter (ID), inches	19.500	Discharge pipe diameter (ID), inches	15.500
Suction tank gas overpressure (P_g), psig	0.00	Discharge gauge pressure (P_d), psig	75.50
Suction tank fluid surface elevation (Z_s), feet	12.00	Discharge gauge elevation (Z_d), feet	5.00
Suction line loss coefficients, K_s	0.50	Discharge line loss coefficients, K_d	2.50

Tank to pipe entrance loss

Check valve, SR elbow

Don't update	Accept and update	Fluid specific gravity	0.990	Flow rate, gpm	6050
Click to leave the main panel head unchanged	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





Raw Crude

Pumping System Assessment Tool

File Edit Operate Windows Help

Condition A Condition B

Pump, fluid data End suction stock

Fixed pump Yes Speed, rpm 3650

specific speed? No Drive Direct drive

stages 1 Specific gravity 0.924

Fluid viscosity (cS) 22.00

Motor ratings Motor hp 400

Existing motor class Standard efficiency

rpm 3650 Rated voltage 2300

Motor size margin, % 15

Duty, cost rate Operating fraction 1.000

Electricity cost, cents/kwhr 3.844

Required or measured data

Simple system Flowrate, gpm 943

curve utility Head calc Head, ft 854.7

Load estimation method Power

Motor voltage 2300 Motor kW 242.0

Existing Optimal

Pump efficiency, %	61.4	74.2
Motor rated power, hp	400	300
Motor shaft power, hp	306.1	253.5
Pump shaft power, hp	306.1	253.5
Motor efficiency, %	94.4	95.7
Motor power factor, %	88.2	88.6
Motor current, amps	68.9	56.0
Motor power, kW	242.0	197.6
Annual energy, MWhr	2119.9	1730.8
Annual cost, \$1,000	81.5	66.5

Annual savings potential, \$1,000 15.0

Optimization rating 81.6

Pump, fluid data End suction stock

Fixed pump Yes Speed, rpm 3650

specific speed? No Drive Direct drive

stages 1 Specific gravity 0.924

Fluid viscosity (cS) 22.00

Motor ratings Motor hp 400

Existing motor class Standard efficiency

rpm 3650 Rated voltage 2300

Motor size margin, % 15

Duty, cost rate Operating fraction 1.000

Electricity cost, cents/kwhr 3.844

Required or measured data

Simple system Flowrate, gpm 943

curve utility Head calc Head, ft 424.0

Load estimation method Power

Motor voltage 2300 Motor kW 242.0

Existing Optimal

Pump efficiency, %	30.5	73.4
Motor rated power, hp	400	150
Motor shaft power, hp	306.1	127.2
Pump shaft power, hp	306.1	127.2
Motor efficiency, %	94.4	95.0
Motor power factor, %	88.2	88.9
Motor current, amps	68.9	28.2
Motor power, kW	242.0	99.8
Annual energy, MWhr	2119.9	874.6
Annual cost, \$1,000	81.5	33.6

Annual savings potential, \$1,000 47.9

Optimization rating 41.3

- Head loss: 358 ft

- Friction loss:

78.7 hp

83.2 kW

- Annual Cost:

\$28,000

Optimization Rating:

197.6

242.0

=0.816 (81.65%)

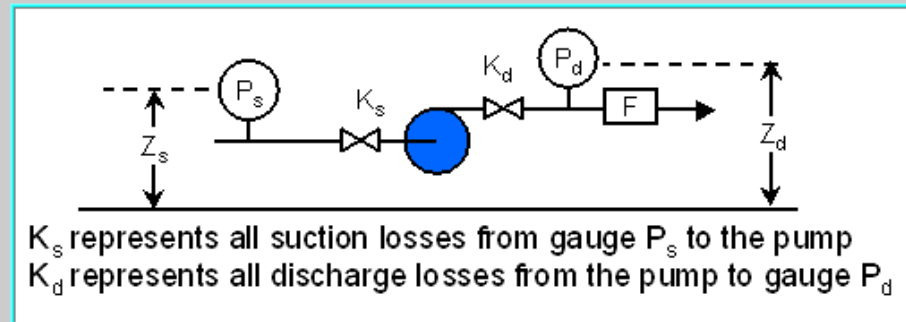


Raw Crude

Pump head calculator2.vi

Type of measurement configuration

Suction and discharge line pressures



Suction pipe diameter (ID), inches	8.000	Discharge pipe diameter (ID), inches	8.000	
Suction gauge pressure (P_s), psig	82.00	Discharge gauge pressure (P_d), psig	422.00	
Suction gauge elevation (Z_s), feet	2.50	Discharge gauge elevation (Z_d), feet	5.50	
Suction line loss coefficients, K_s	0.50	Discharge line loss coefficients, K_d	1.00	
Fluid specific gravity		0.924	Flow rate, gpm	943

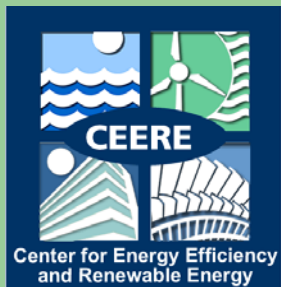
Don't update

Accept and update

Click to
leave the main panel
head unchanged

Click to
Accept and return
the calculated head

Differential elevation head, ft	3.00
Differential pressure head, ft	850.00
Differential velocity head, ft	0.00
Estimated suction friction head, ft	0.28
Estimated discharge friction head, ft	0.56
Pump head, ft	853.84





Raw Crude

Valve head and energy calculations 2005

File Edit Operate Windows Help

Available data selector
 Cv from flow rate, pressures

Specific gravity
 0.924

Specified flow rate, gpm
 943

Operating fraction 1.000
 Average electrical cost rate, cents/kWh 3.84
 Pump efficiency, % 75.0
 Motor efficiency, % 94.0
 Head loss, ft 357.63
 Frictional loss, hp 78.7
 Frictional electrical power, kW 83.2
 Annual cost of friction, \$ 27988

STOP

Upstream pressure, psig 400.0
 Upstream pipe ID, inches 6.07
 Upstream gauge elevation, ft 0.0
 Upstream velocity, ft/s 10.5

75.8
 Calculated valve Cv
 Valve size, inches 6.00

10.7
 Valve velocity, ft/s

0.01 K_reducer & expander
 210.52 K_valve
 210.53 K_total

Downstream pressure, psig
 Downstream pipe ID, inches 6.07
 Downstream gauge elevation, ft 5.0
 Downstream velocity, ft/s 10.5

Application and Copyright notice





Hood and Saturation Spray Pumps

- Use VSD to control the flow – reduce flow 50% during off periods
- Potential Savings:
321,000 kWh
\$19,000

File Edit Operate Windows Help

Condition A

Condition B

Pump, fluid data End suction stock

Fixed pump Yes Speed, rpm 3585
specific speed? No Drive Direct drive

stages 1 Specific gravity 1.000
Fluid viscosity (cS) 1.00

Motor ratings Motor hp 200

Existing motor class Energy efficient

rpm 3585 Rated voltage 460
Nameplate FLA 220.0
Motor size margin, % 15

Duty, cost rate Operating fraction 1.000
Electricity cost, cents/kwhr 6.000

Required or measured data

Simple system curve utility Head calc Flowrate, gpm 295
Head, ft 910.6
Load estimation method Current

Motor voltage 460 Motor amps 170.0

Existing Optimal

Pump efficiency, %	44.5	67.7
Motor rated power, hp	200	125
Motor shaft power, hp	152.3	100.2
Pump shaft power, hp	152.3	100.2
Motor efficiency, %	95.2	94.7
Motor power factor, %	88.1	88.7
Motor current, amps	170.0	111.7
Motor power, kW	119.4	78.9
Annual energy, MWhr	1045.5	691.1
Annual cost, \$1,000	62.7	41.5
Annual savings potential, \$1,000		21.3
Optimization rating		66.1

Condition B

Pump, fluid data End suction stock

Fixed pump Yes Speed, rpm 3585
specific speed? No Drive Direct drive

stages 1 Specific gravity 1.000
Fluid viscosity (cS) 1.00

Motor ratings Motor hp 200

Existing motor class Energy efficient

rpm 3585 Rated voltage 460
Nameplate FLA 220.0
Motor size margin, % 15

Duty, cost rate Operating fraction 1.000
Electricity cost, cents/kwhr 6.000

Required or measured data

Simple system curve utility Head calc Flowrate, gpm 125
Head, ft 1000.3
Load estimation method Current

Motor voltage 460 Motor amps 132.0

Existing Optimal

Pump efficiency, %	27.8	54.6
Motor rated power, hp	200	75
Motor shaft power, hp	113.6	57.8
Pump shaft power, hp	113.6	57.8
Motor efficiency, %	94.7	94.1
Motor power factor, %	85.1	88.2
Motor current, amps	132.0	65.2
Motor power, kW	89.5	45.8
Annual energy, MWhr	783.8	401.5
Annual cost, \$1,000	47.0	24.1
Annual savings potential, \$1,000		22.9
Optimization rating		51.2



Compressed Air - Air Master

Energy Efficiency Measures

File Calculators Help

Copy EEM Scenario Life Cycle Results Close

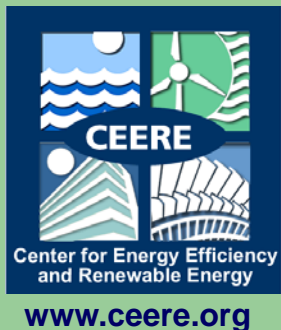
Facility: **Brewing Facility** EEM Scenario: **Scenario #1**

System: **Main Air System**

Data Entry				Savings Summary				
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

Double-click row to view corresponding measure input data

Copy To Clipboard





AC – Reduce Air Leaks

EEM - Reduce Air Leaks

File Calculators Help

Facility System

Description Measure cost, \$

Measured data

Compressor Operations To Feed Leaks

Compressor	Units	Airflow, %C
Compressor 1	%Cap	40.0
Compressor 2	%Cap	0.0

Maximum hourly system airflow, acfm (according to entered profile values)

Leak Airflow Values

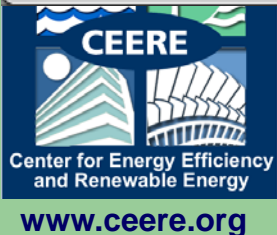
	Airflow, acfm	% Cs.
Peak system requirement + leaks	<input type="text" value="1021"/>	<input type="text" value="77.7"/>
Leaks	<input type="text" value="190"/>	<input type="text" value="14.4"/>
Peak system requirement	<input type="text" value="831"/>	<input type="text" value="63.2"/>

Reduce leaks by acfm %

- Annual Energy Savings: 77,632 kWh

- Potential Cost Savings: \$3,551

- Measure Cost: \$1,000



AC – Add Receiver Tank



EEM - Add Primary Receiver Volume

File Calculators Help

Results Close

Facility: Brewing Facility
System: Main Air System

Description: Add Primary Receiver Volume

Measure cost, \$: 3500

	cubic feet	gallons
Existing air storage capacity	63.0	471
Increased volume	200.5	1500
Proposed air storage capacity	263.5	1971

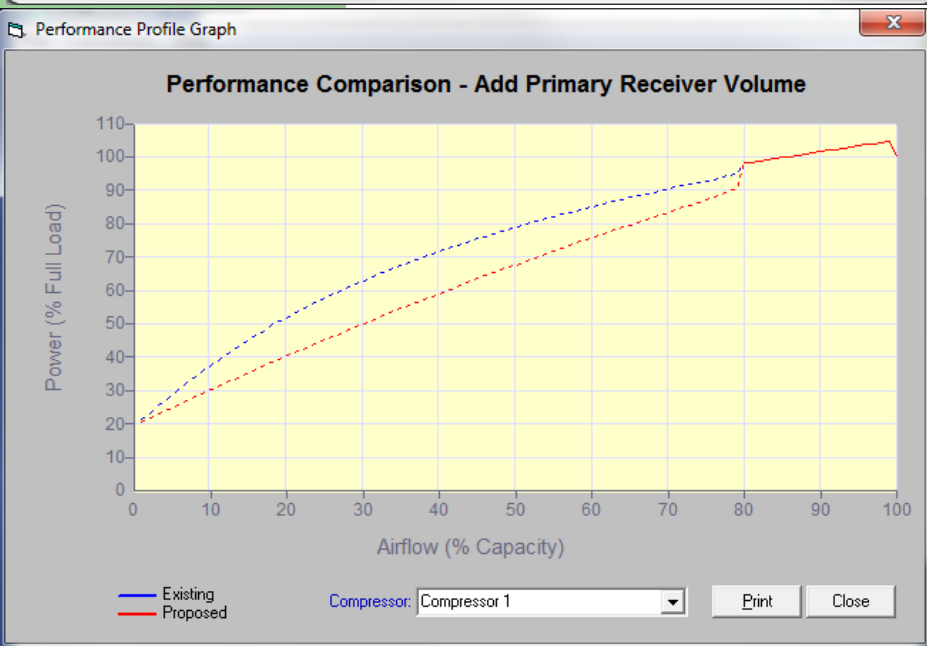
Volume to be added to the unregulated (primary) side of the system.

Performance Profile

- Annual Energy Savings: 18,709 kWh

- Potential Cost Savings: \$711

- Measure Cost: \$3,500





Information, Tools and Training

Industrial Technologies

A Best Practices Steam Technical Brief

How To Calculate The True Cost of Steam

U.S. Department of Energy
Energy Efficiency and Renewable Energy

Energy Tips

By David L. King, P.E.

Steam Heating System
 • Control Temperature in...
 • Insulate...
 • Use...
 • ...

Check Blower Air to Fuel Ratio
 • ...
 • ...
 • ...

Monitoring Data

MOTORS

Cost Reduction Strategies

Improve the Energy Efficiency of Motor Systems

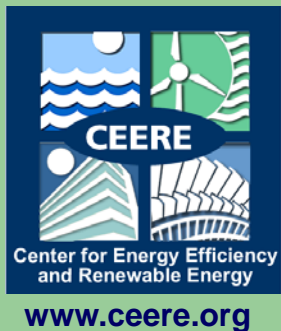
Did you know...
 • ...
 • ...

Motor System/Code	Estimated Potential Savings per Year	Savings as % of Operating Costs
40-5000	\$100,000	2%

System Analysis
 1. Substandard input voltage can be hazardous.
 2. Motor overload is a common problem.
 3. Motor efficiency is a key factor.

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 - Packets of Information for Plants





Questions ?

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Fax: 413-545-1027

