NASA 2011 Facilities Engineering and Real Property Conference

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Energy Improvement Tips, Tools, and Resources for Industrial Buildings

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Where I'm Coming From…

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- Roles at the Laboratory
  - Technical Account Manager for DOE's Save Energy Now LEADER program
    - Provide energy management guidance
    - Deliver technical assistance
    - Perform facility utility baselining
  - Program manager for DOE's Industrial Assessment Center program
    - 26 IACs at universities across the U.S.
  - FEMP Support
    - Perform comprehensive energy audits
    - Implementation Follow-up

Overview

1. Background
2. Assessment Process
3. Energy Saving Opportunities
4. Other Opportunities
5. Useful Tools
6. Case Study Examples

Federal Energy Management Program (FEMP)

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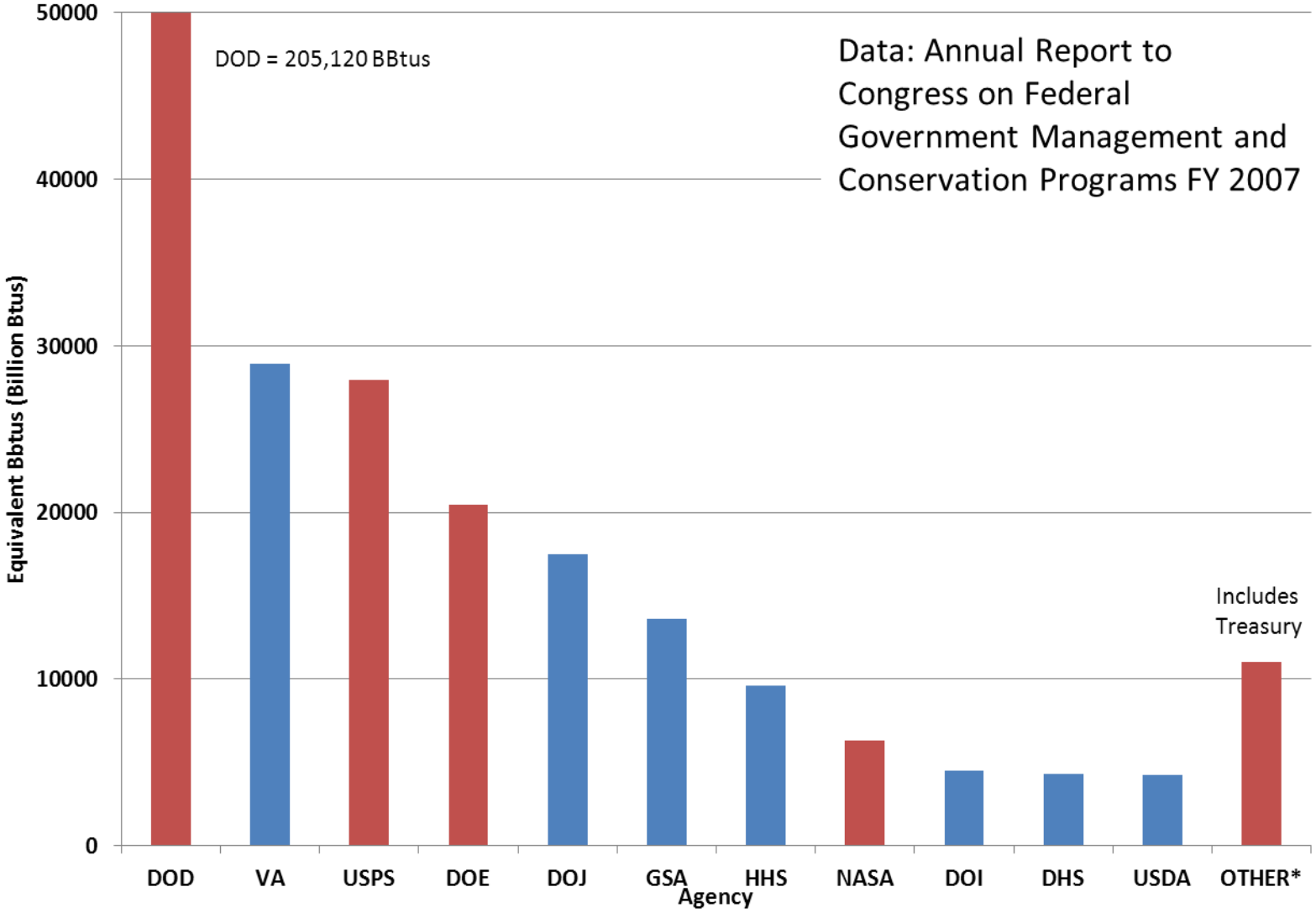
"facilitates the Federal Government's implementation of sound, cost-effective energy management and investment practices to enhance the nation's energy security and environmental stewardship."

http://www1.eere.energy.gov/femp/

Federal Energy Use by Agency



Industrial Facilities Initiative (IFI)

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- Partnership between DOE's FEMP and Industrial Technologies Program (ITP) began in 2000
- Federal facilities received assessments using the same methodology developed under the Save Energy Now program
- Provided technical expertise from:
  - Oak Ridge National Laboratory
  - Industrial Assessment Centers
  - ITP BestPractices Qualified Specialists

Simply…Industrial

- **Not creature comfort!**
- Identified by the facility's mission:
  - Production, manufacturing, refurbishment, destruction
  - Heat-treating
  - Chemical Treatment
  - Welding
  - Painting
  - Cutting, Forming
  - Mission-critical requirements (temperature/humidity)

Industrial Energy Assessments

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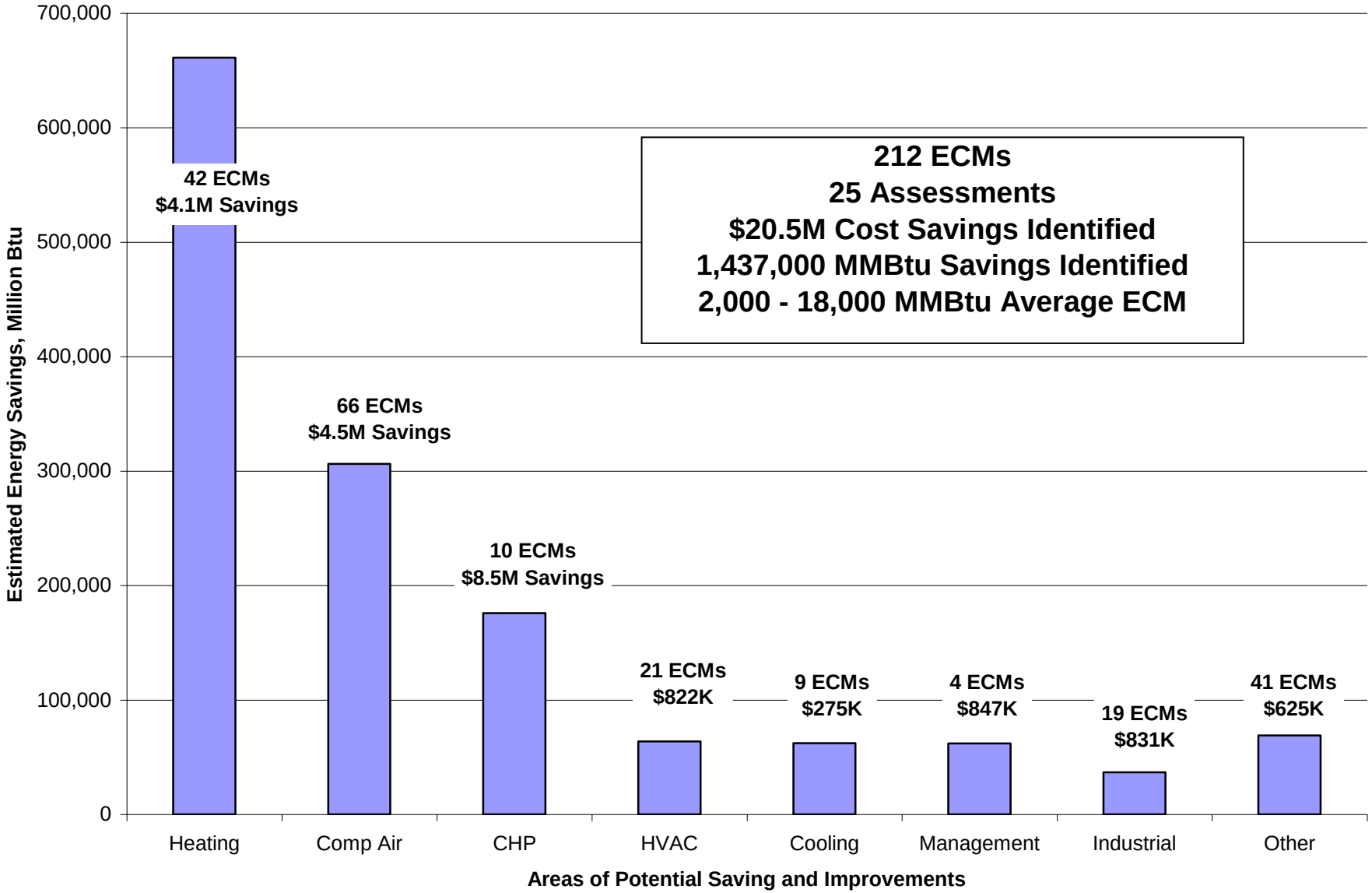
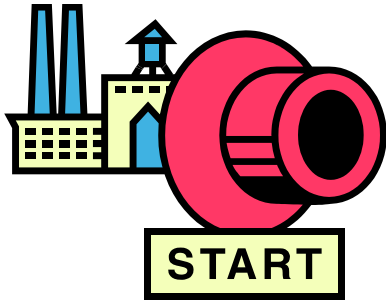
- Provided entire industrial process assessments
- Targeted system assessments
  - Steam
  - Process Heating
  - Compressed Air
  - Pumps/Fans/Motors (direct drive equipment)
  - Chilled Water
  - Service Water

Identified Energy Savings from Prior IFI Assessments



Where to Start?

How do you start to identify Energy and Cost Saving Opportunities?



Getting Started at Your Facility

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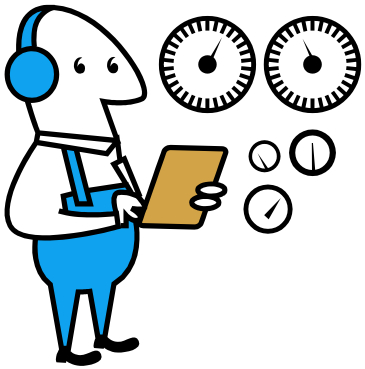
- Prioritize Buildings/Systems in Scope of Work
- Preliminary Data Collection
  - Annual Energy Consumption of Buildings/Systems
    - Rate Schedules and contracted services
  - Preliminary Discussions with Personnel
  - Any Data, Drawings, previous Assessments
  - Maintenance Data
  - Planned Projects (Upgrades, Replacements, etc)
- Coordinate Site and Craft Support
  - Temporary Installation of Instruments
  - Access to equipment rooms, process areas

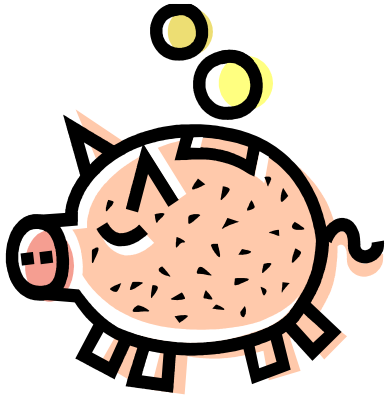


Site Visit

- Utilize DOE assessment tools
- Reference DOE publications
- Measurements and Data Collection
- Interviews with Site Personnel
  - occupants
  - operators
  - building managers

With Potential Projects Identified

- "Sell, Sell, Sell"
- Management/Staff Approval
- Funding Sources
  - Fix Energy Problems that Fix Maintenance Problems
  - Appropriations Requests
  - Alterative Financing
  - Demonstration Project
- Buy-In from Personnel
  - "I don't want to stop production"
  - "It has always been this way"



Common System Opportunities…

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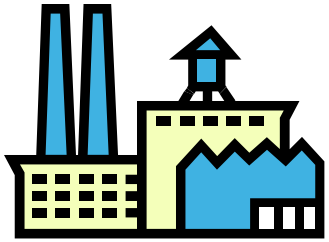
What are the typical Energy and Cost Saving Opportunities?



Heating (Steam) Improvements

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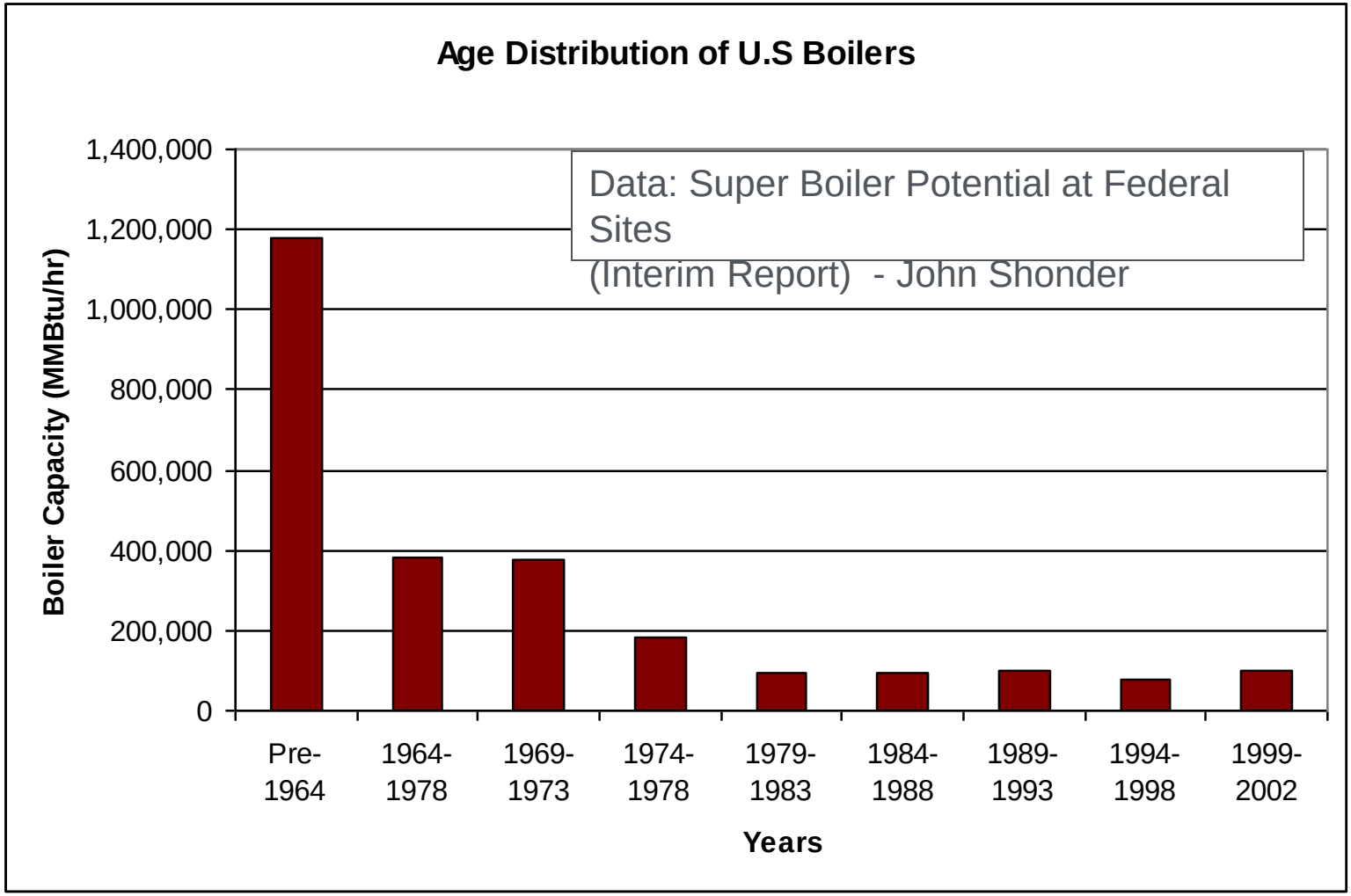
- Change in Steam Consumption/Conditions
  - Steam Demand Reduction (End Use)
  - Temperature, Pressure
- Dedicated Boiler / Seasonal Shutdown
- Steam Leak and Trap Repair
- Boiler Combustion Control
- Boiler Blowdown
- Condensate Recovery/Return
- Heat Recovery
- Co-generation
- Equipment Upgrades
- Configuration Improvements

US Boiler Age Distribution
Short Term Savings of 11 TBtu/yr



Compressed Air Improvements

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- Appropriate End Use and Conditions
- Leak Repairs
  - Remove Abandoned/Unused Distribution Lines
- Controls and Sequencing Compressors
- Optimize System Configuration
  - Right-size / Upgrade Compressors
  - Reduce Pressure to Meet Demand
  - Adequate Grade for Purpose
    - Dedicated/Satellite Compressors
- Heat Recovery

Compressed Air is "not free air." $100-$950/scfm

Pumping and Fan Improvements

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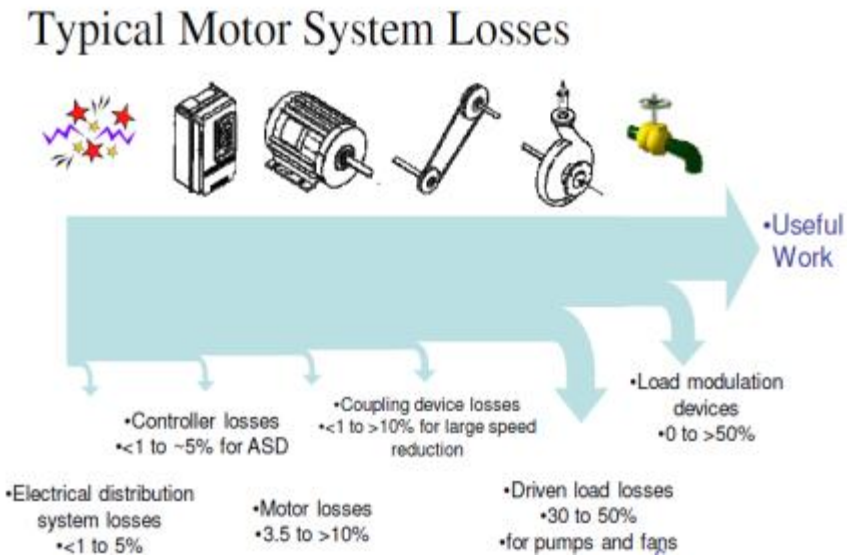
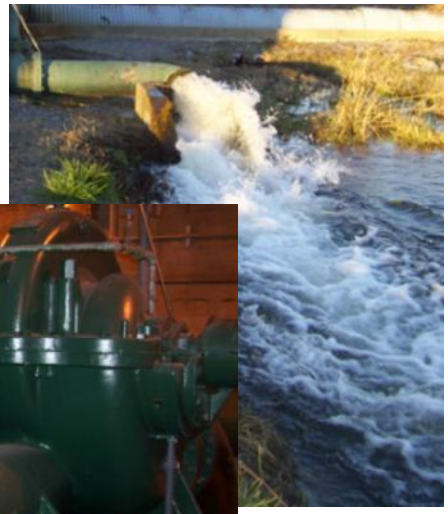
- "Pump long and pump slow"
  - Reduce pressure
  - Reduce flow
- Utilize most efficient control
  - Variable Frequency Drive (VFD)
  - Inlet Vanes, Outlet Dampers, Throttling Valves
- Optimize System Configuration
  - Right-size pump/fan
  - "System effect"
  - Reduce friction & avoid "T's"
- Use appropriate drive coupling
- Utilize most efficient motors





General Improvements

- Shut off equipment when not needed
- Preventative maintenance programs
- Utilize high efficiency lighting
  - Including sunlight
- Insulation
  - Walls
  - Pipes
- Reduce building air exchanges
  - Exhaust fans & dust collectors
  - Close doors/windows
- Geothermal & River Water

Other “Big Ticket” Possibilities:

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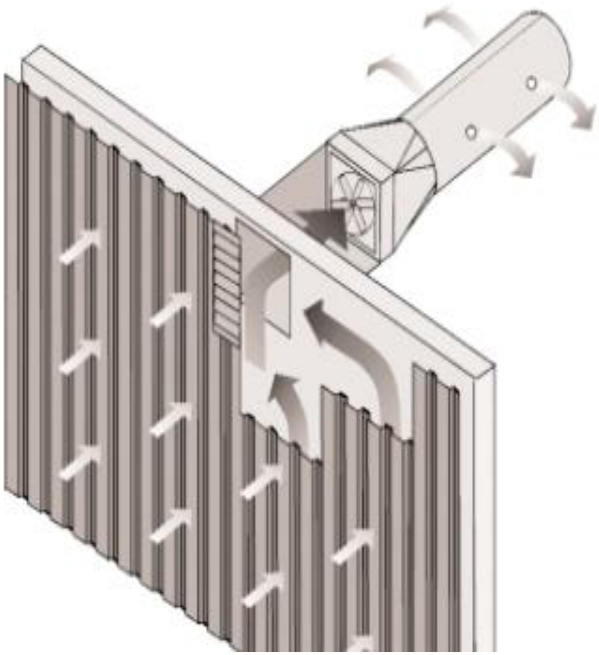
Renewable Options

- Transpired “Solar Wall” collectors
- Solar thermal
- Solar photovoltaic
- Wind turbines
- Biomass



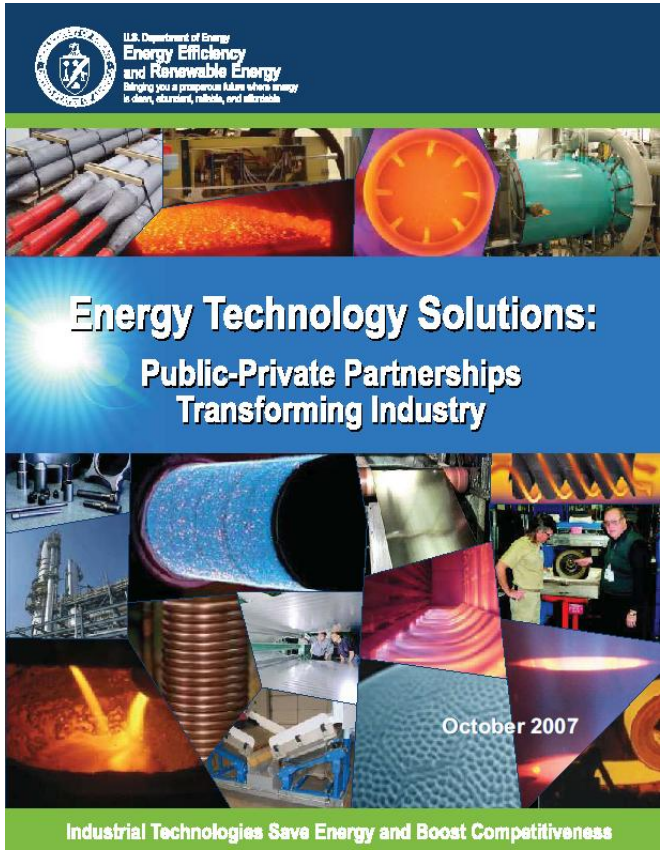
Combined Heat and Power

- Back-pressure steam turbines
- Gas Turbines
- Fuel Cells, IC engines, etc

Other Areas to Investigate

Investigating process and other, more advanced components may provide additional opportunities in industrial areas.

New and Emerging Technologies

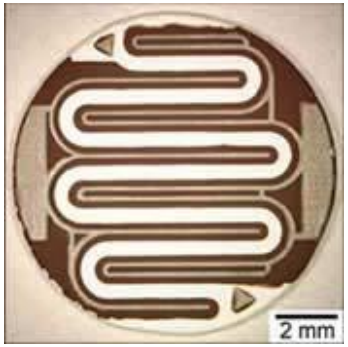


- Many applications for specific industry and components
  - Process-specific
    - Aluminum
    - Metal Casting
    - Steel…
  - Cross cutting technology
    - Combustion
    - Sensors
    - Auxiliary Equipment…

http://www1.eere.energy.gov/industry/bestpractices/pdfs/itp_successes.pdf

Wireless Sensor Technology

- Reduced installation costs– no wires!
  - $50-$2,000 per foot wiring cost
- Increase Productivity
  - Real-time monitoring of performance
  - Identification of repair needs
- Reduction in Maintenance Costs
  - Easily replaced
  - Remote sensing for hazardous environments
  - Reduces need for manual inspections
- Energy Tracking



Exhaust Gas Sensor
Courtesy of ORNL

http://www1.eere.energy.gov/industry/sensors_automation/pdfs/transformational_wireless.pdf

Super Boiler Technology

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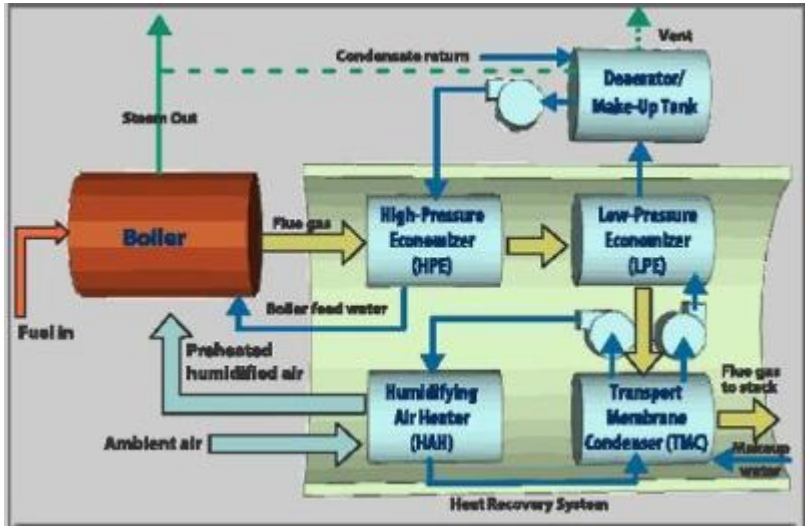
- What makes it 'Super'?
  - Advanced controls
  - Heat Recovery of Flue Gas
  - Staged and intercooled combustion system
  - Ultra-low emissions



http://apps1.eere.energy.gov/industry/bestpractices/energymatters/articles.cfm/article_id=265

- EERE: 25% increase in steam generation efficiency
  - SuperBoiler is reported at 90-94% efficiency
  - Traditional Boilers are typically mid-80's efficiency

http://www1.eere.energy.gov/industry/combustion/pdfs/superboiler.pdf

Combined Heat and Power (CHP) – On-Site Generation

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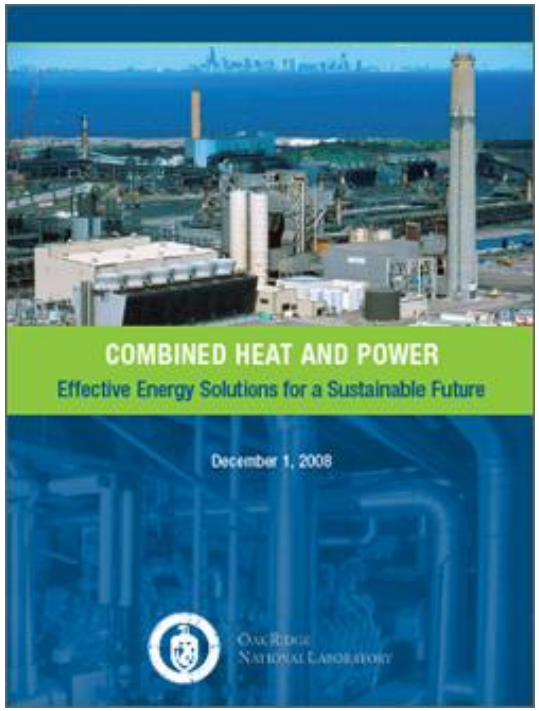
- Grid Independency / Energy Security
- Utilize Waste Heat
  - Absorption Chillers
  - Heat Recovery for Steam/Hot Water
  - Heat Recovery for Process
  - Desiccant Dehumidification
- Excess Steam Generation
- Carbon Dioxide Reduction
- Minimizes Distribution Loss
- Alternative Fuels
  - Biomass, Landfill Gas

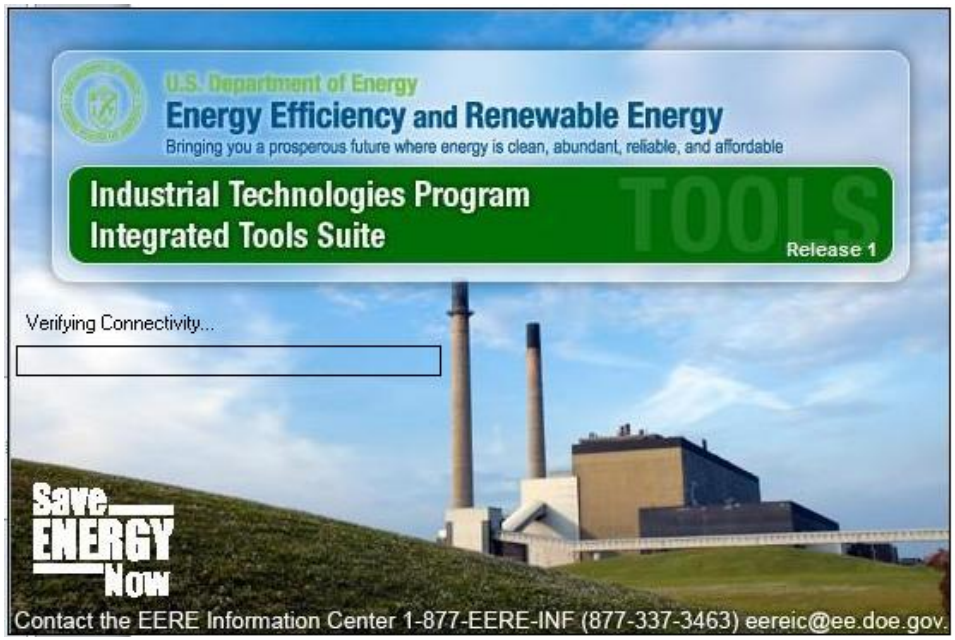


http://www1.eere.energy.gov/industry/distributedenergy/pdfs/chp_report_12-08.pdf

http://www1.eere.energy.gov/industry/distributedenergy/chp_basics.html

System Level Software Tools

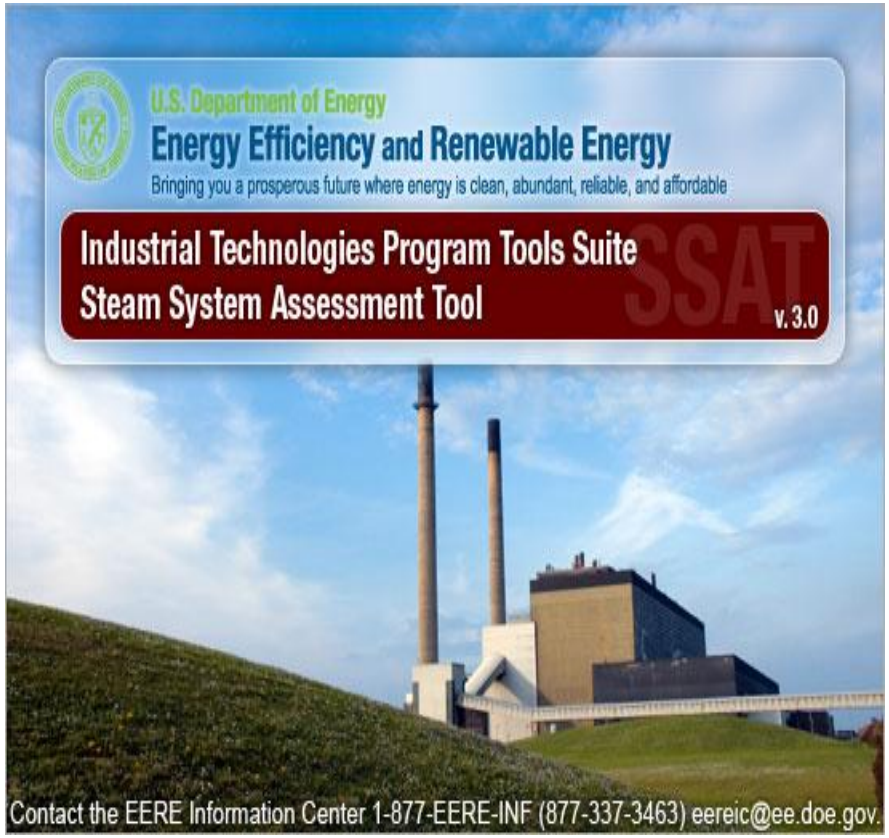
- Steam Systems
- Pumping Systems
- Fan Systems
- Chiller Water Systems
- Compressed Air Systems
- Motor Systems
- Data Centers



http://www1.eere.energy.gov/industry/bestpractices/software.html

The Steam System Tool Suite

- Steam System Tool Suite consists of three downloadable software tools:
  - Steam System Scoping Tool (SSST)
  - Steam System Assessment Tool (SSAT)
  - 3E Plus



SSST & SSAT

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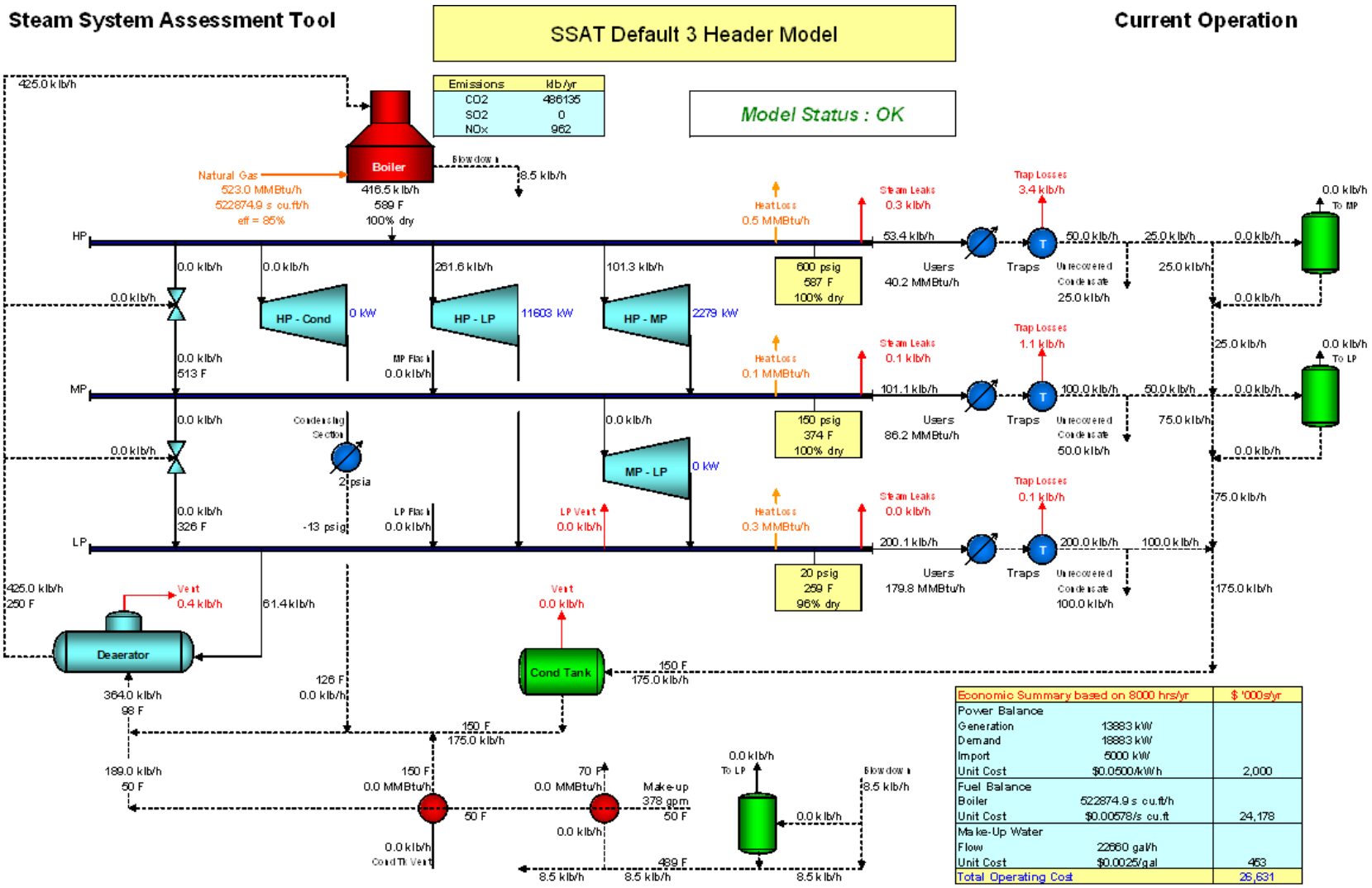
Steam System Scoping Tool (SSST)

- A scorecard designed to perform initial self-assessments of steam systems to identify areas of improvement
- Evaluate your steam system operations and management against best practices
- Use SSAT to analyze potential projects to consider

Steam System Assessment Tool (SSAT)

- Can develop approximate models of real steam systems
- Contains key features of typical steam systems
- Can quantify the magnitude—energy, cost, and emissions-savings—of potential steam improvement opportunities

SSAT (cont)


Steam System Assessment Tool
SSAT Default 3 Header Model
Current Operation
Emissions klb/yr
CO2 486135
SO2 0
NOx 962
Model Status : OK
Boiler
Natural Gas
523.0 MMBtu/h
522874.9 s cu.ft/h
eff = 85%
416.5 klb/h
589 F
100% dry
Blowdown
8.5 klb/h
425.0 klb/h
HP
MP
LP
HP - Cond
0 kW
HP - LP
11603 kW
HP - MP
2279 kW
MP - LP
0 kW
Heat Loss
0.5 MMBtu/h
Steam Leaks
0.3 klb/h
Trap Losses
3.4 klb/h
600 psig
587 F
100% dry
Users
40.2 MMBtu/h
Traps
Unrecovered Condensate
25.0 klb/h
0.1 MMBtu/h
0.1 klb/h
1.1 klb/h
150 psig
374 F
100% dry
86.2 MMBtu/h
50.0 klb/h
0.3 MMBtu/h
0.0 klb/h
0.1 klb/h
20 psig
259 F
96% dry
179.8 MMBtu/h
100.0 klb/h
To MP
To LP
Condensing Section
2 psia
-13 psig
MP Flash
LP Flash
LP Vent
Vent
0.4 klb/h
Deaerator
Cond Tank
364.0 klb/h
98 F
61.4 klb/h
126 F
150 F
175.0 klb/h
189.0 klb/h
50 F
70 F
Make-up
378 gpm
Cond Tk Vent
439 F
Economic Summary based on 8000 hrs/yr
$ '000s/yr
Power Balance
Generation 13883 kW
Demand 18883 kW
Import 5000 kW
Unit Cost $0.0500/kWh 2,000
Fuel Balance
Boiler 522874.9 s cu.ft/h
Unit Cost $0.00578/s cu.ft 24,178
Make-Up Water
Flow 22660 gal/h
Unit Cost $0.0025/gal 453
Total Operating Cost 26,631

3E Plus

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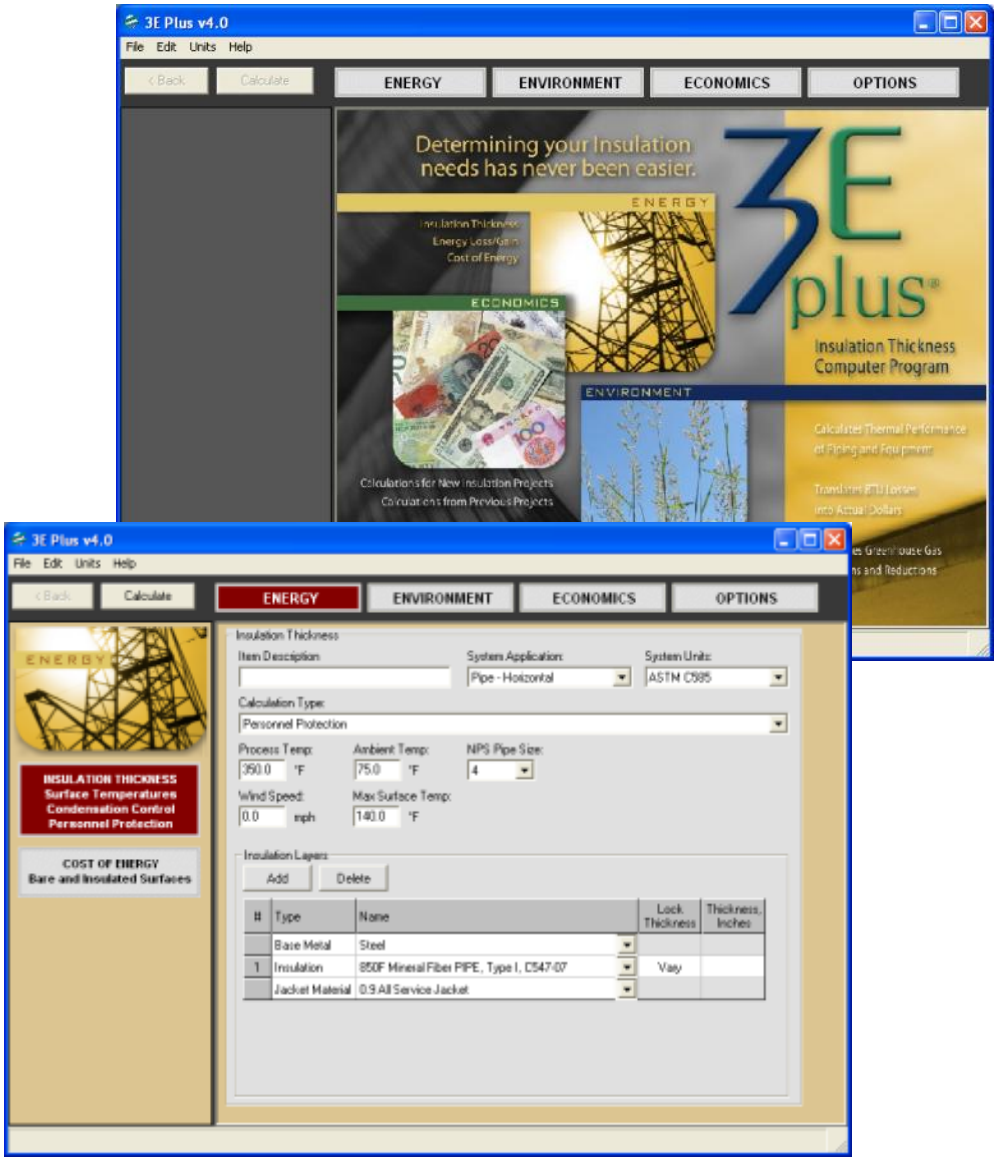
- Calculates the heat loss of various types and thickness of insulation for given operating conditions
- Uses built-in thermal performance relationships of generic insulation materials
- Estimates project cost and emissions savings



Pumping System Assessment Tool (PSAT)

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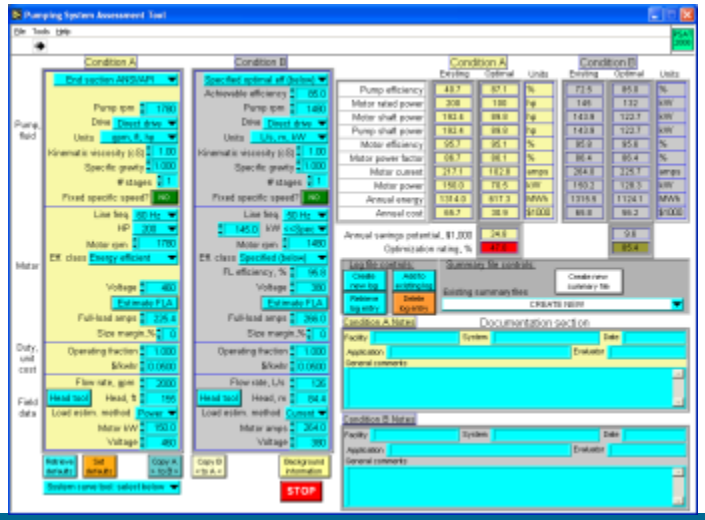
- Helps users assess efficiency improvements of pumping system operations
- Can calculate potential energy and associated cost savings
- Uses pump performance data from Hydraulic Institute standards



Fan System Assessment Tool (FSAT)

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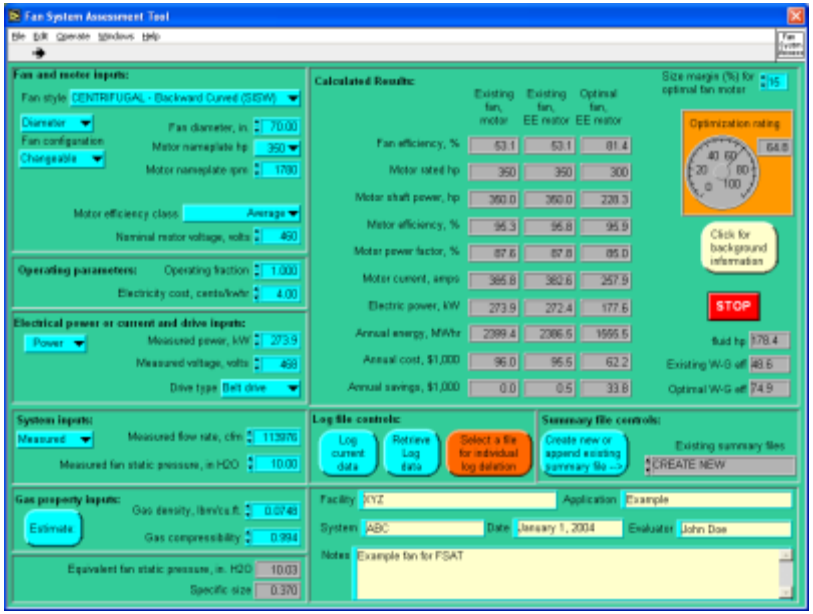
- Helps users assess efficiency of their fan systems
- Provides an efficiency rating of the current system and the best commercial available
- Determine the economic benefit of system modifications



Chilled Water System Analysis Tool

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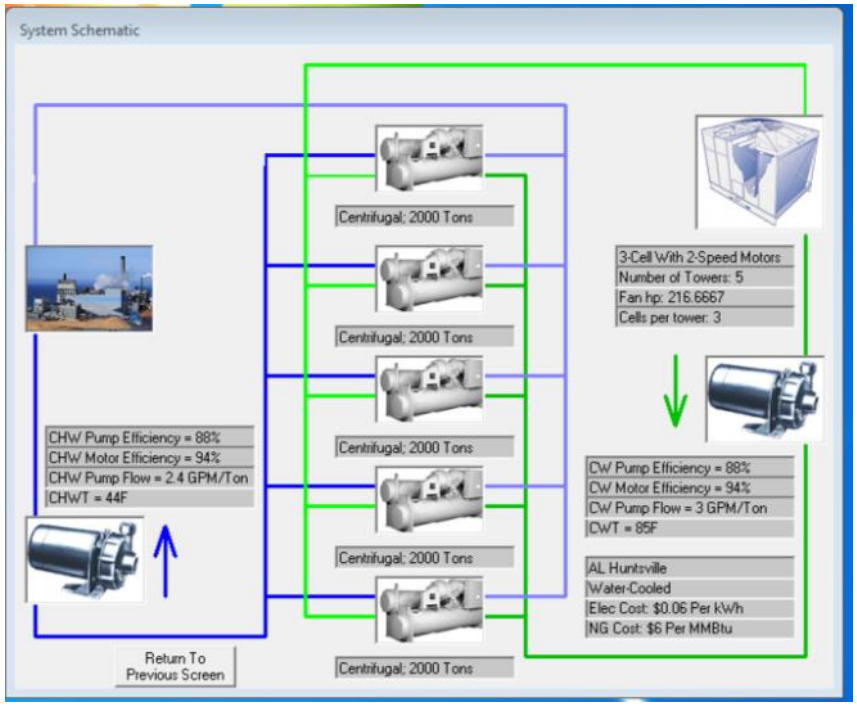
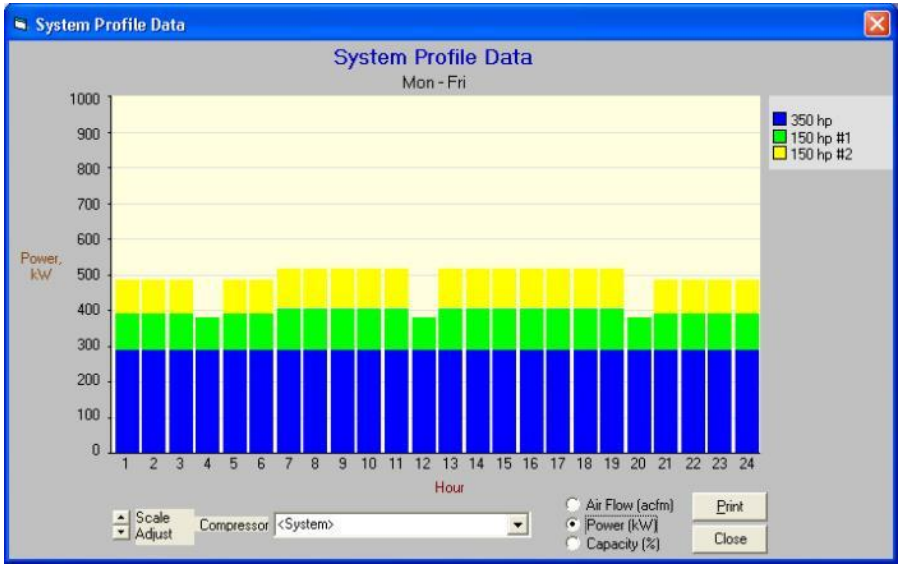
- Helps optimize the performance of chilled water systems
- Determines energy consumption and costs of operating the chillers, pumps, and towers in a chilled water system
- Examines the impact of varying operating scenarios
- Quantifies potential cost and energy savings



AIRMaster+

- Provides a systematic approach to assessing compressed air systems
- Models existing and future improved system operations
- Can model an unlimited number of interconnected compressors
- Contains database of most commercially available compressors



MotorMaster+

- A motor selection and management tool
- Contains a catalog of more than 20,000 low-voltage induction motors
- Features motor inventory management tools
  - Maintenance log tracking
  - Efficiency analysis
  - Savings evaluation

Data Center Profiler Tool Suite

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- DC Pro Tool Suite is designed to:
  - Diagnose how energy is being used by their data centers
  - Determine ways to save energy and money
- Tool suite consists of three tools
  - Profiling Tool
  - Air-Management Tool
  - Electrical Systems Tool

http://www1.eere.energy.gov/industry/bestpractices/software.html

Software Tools

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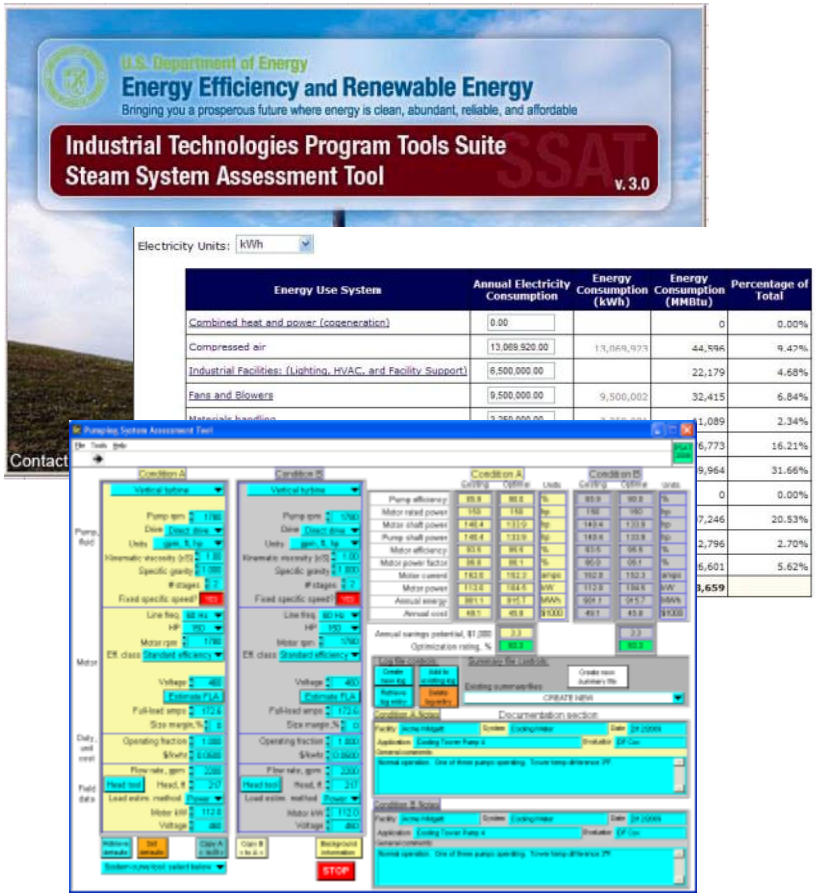
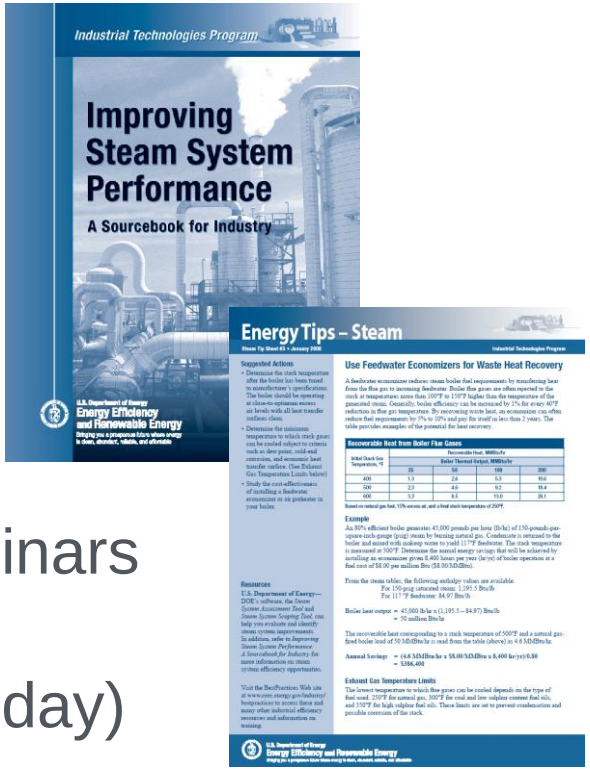
- QuickPep
- Steam System Tool Suite
  - Steam System Scoping Tool
  - Steam System Assessment Tool
  - 3E Plus ® Insulation Thickness Tool
- AIRMaster+ (Compressed Air)
- Pumping System Assessment Tool
- Fan System Assessment Tool
- Process Heating Assessment & Survey Tool
- Industrial Facilities Tool Suite
- Chilled Water System Analysis Tool
- MotorMaster+



http://www1.eere.energy.gov/industry/bestpractices/software.html
http://www1.eere.energy.gov/femp/information/access_tools.html

Technical Resources

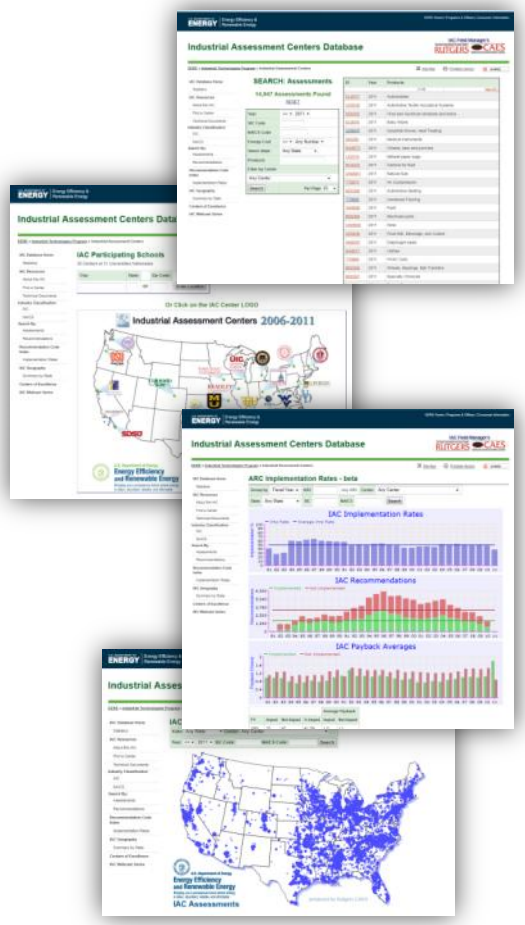
- BestPractices Publications
  - Handbooks, Sourcebooks
  - Tip Sheets, Fact Sheets
- Training
  - BP Software Tool Introduction Webinars
  - BP End User Training (1-day)
  - BP Qualified Specialist Training (3-day)



http://www1.eere.energy.gov/industry/bestpractices/resources.html

IAC Online Database System

- Collection of publicly available assessment and recommendation data
- Contains ~15,000 Assessments
- Access to:
  - Assessments results
  - Energy and cost savings by recommendation
  - Recommendation statistics
  - Case studies
  - Technical documents



http://iac.rutgers.edu/database/

Observations from Industry: Building Internal Capacity

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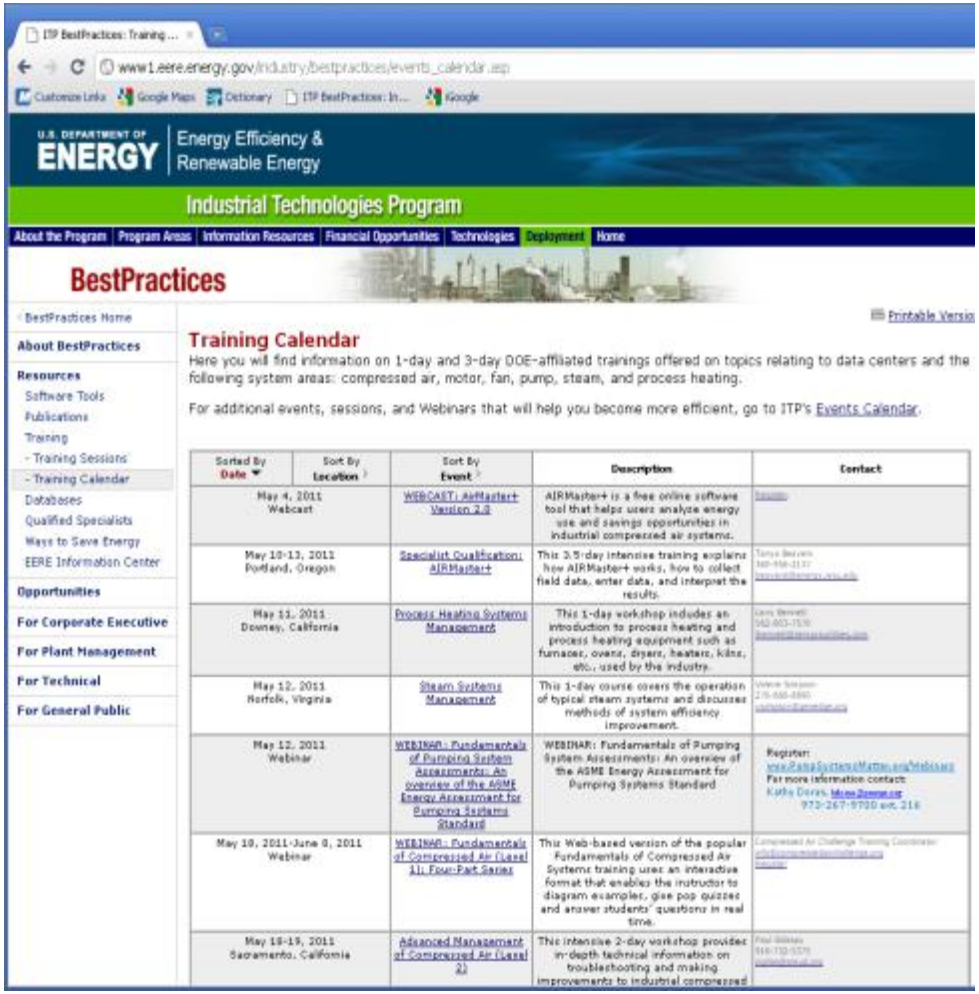
- Seeing industries and organizations use DOE training to build internal capacity
- Assemble traveling teams to perform assessments
- Rely on DOE available tools and training



NASA - Michoud

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Scope – Steam System (generation and distribution)

- Determine current operating condition
- Determine most cost effective operating scheme
- Determine appropriate long term strategy

Process –

- Week long assessment

Results –

- Several ECMs/Scenarios identified
  - Thermal Energy Recovery
  - Insulation upgrades
  - Steam trap survey
  - Demand Reduction
- Individual Savings
  - $5K-80K Cost Savings
    - Immediate to 1 yr Simple Payback
  - Savings potential of ~16% of operating costs

NASA - Stennis

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<u>Scope</u> – High Pressure Compressed Air System

- Reviewed generation and distribution
- Identify low-cost energy conservation measures
- Determine most cost effective operating scheme

<u>Process</u> –

- 5-day long assessment

<u>Results</u> –

- Several ECMs/Scenarios identified
  - Optimize System Pressure
  - Reduce Consumption
  - Eliminate Leaks
- Individual Savings
  - $2K-35K Cost Savings
  - Savings potential of ~17% of operating costs

For More Information…

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- ITP Headquarters Sponsor
  - James Quinn
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  - james.quinn@ee.doe.gov

- FEMP Headquarters Technology Deployment Sponsor
  - Shawn Herrera
  - 202-586-1511
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Questions?

Thank-you

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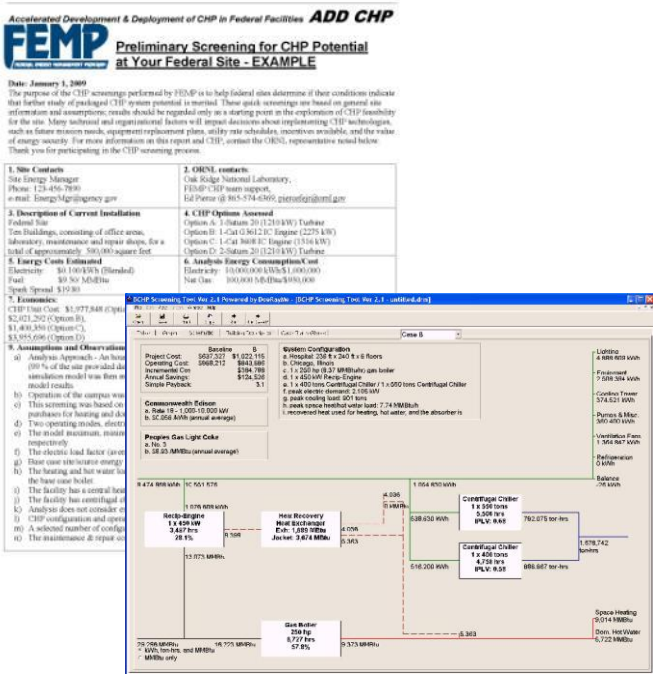
Resources for More Information

- Visit the DOE BestPractices Web site:
  - www.eere.energy.gov/industry/bestpractices/
- Training Information & Calendar:
  - www.eere.energy.gov/industry/bestpractices/training_compressed_air.html
  - www.eere.energy.gov/industry/bestpractices/events_calendar.asp
- Download Assessment Tools:
  - www.eere.energy.gov/industry/bestpractices/software.html
- Become a Qualified Specialist:
  - www.eere.energy.gov/industry/bestpractices/qualified_specialists/

CHP Screenings and Analysis

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

- CHP technologies and Operating Scenarios
  - Gas Turbines
  - Internal Combustion Engines
  - Microturbines
  - Fuel Cells
  - Backpressure Steam Turbines
  - Biomass Opportunities
    - Landfill Gas
    - Wood Waste



- Determine if CHP Scenarios Merit Additional Study

http://www1.eere.energy.gov/industry/distributedenergy/tools.html