U. S. Department of Energy
Energy Savings Assessment (ESA)

Process Heating Assessment and Survey Tool (PHAST)

Introduction

Date: January 30, 2007

Instructor: Dr. Arvind Thekdi

Agenda

- ESA Training Web Cast Introduction – 15 minutes
- Process Heating Assessment and Survey Tool (PHAST) Software Demonstration – 45 minutes
  - Q & A – 20 minutes
- PHAST BestPractices– 30 minutes
  - Q & A – 20 minutes
- Conclusion – 10 minutes
- Reference Information
  - DOE Resources
  - Calendar for Future ESA Training Web Casts

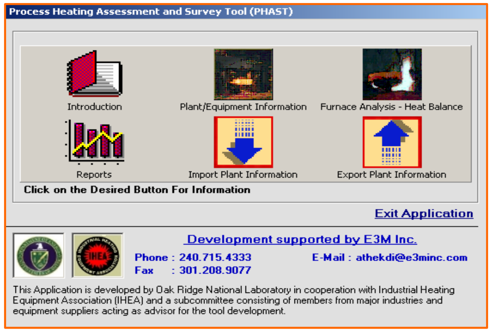
Process Heating ESA Plant Lead Web Cast

- Purpose:

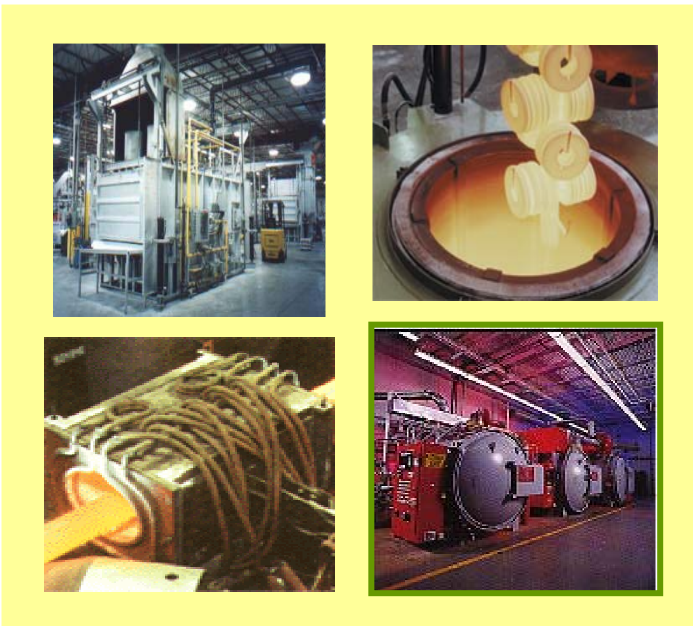
  Help Plant Leads selected for a Department of Energy (DOE) Energy Savings Assessment (ESA) prepare for a successful assessment.

- Format:
  - Introduce functionality, functions and results of the PHAST software
  - Provides an overview. (In-depth training available.)

- Use DOE Software Tools to:
  - Identify opportunities
  - Provide estimates of energy and cost savings
  - Not a replacement for in-depth project analysis.



What Is Process Heating ?



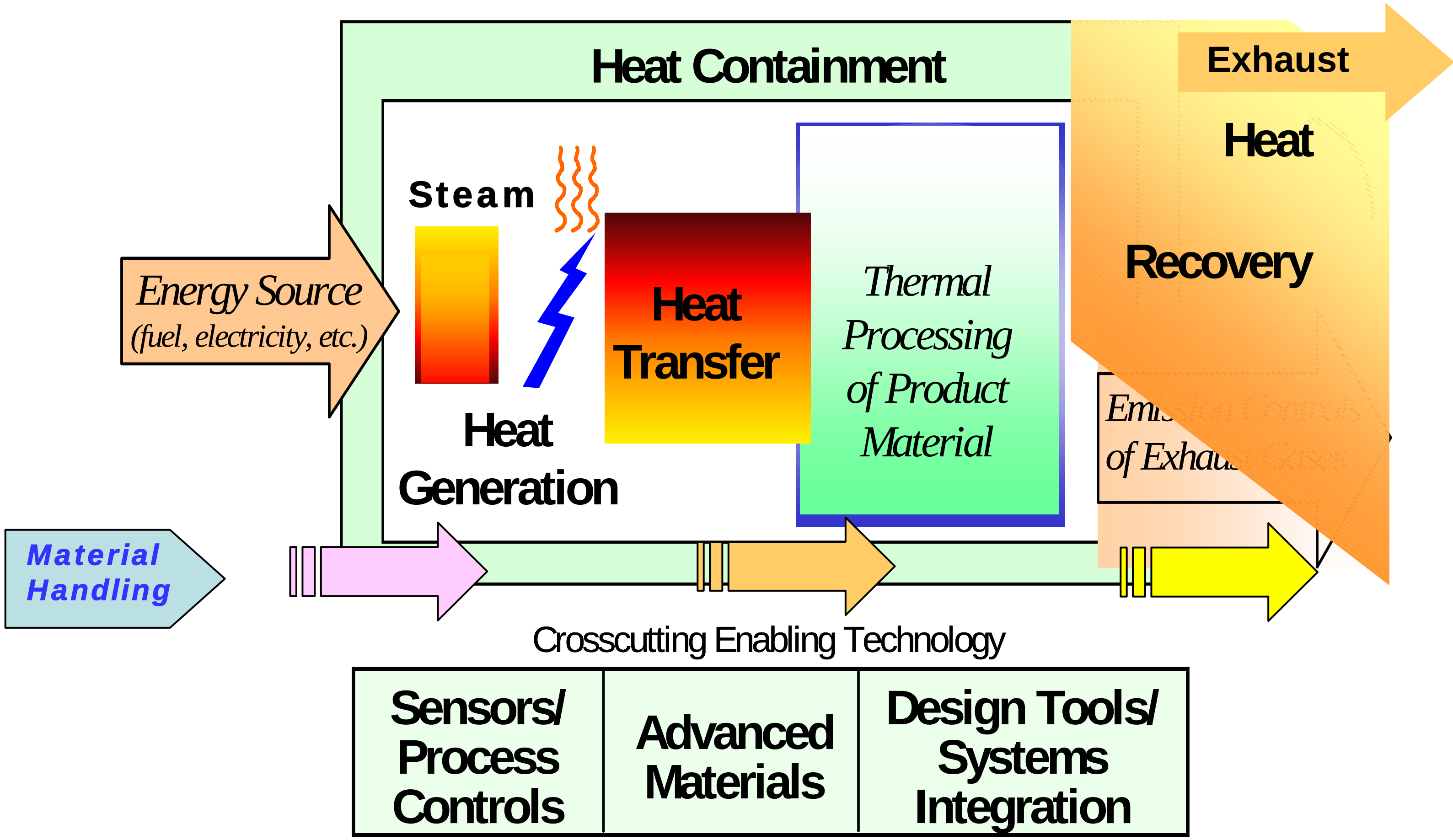
Supplying heat to materials in

- Furnaces
- Ovens
- Heaters
- Thermal oxidizers
- Dryers
- Boilers
- Other heating equipment

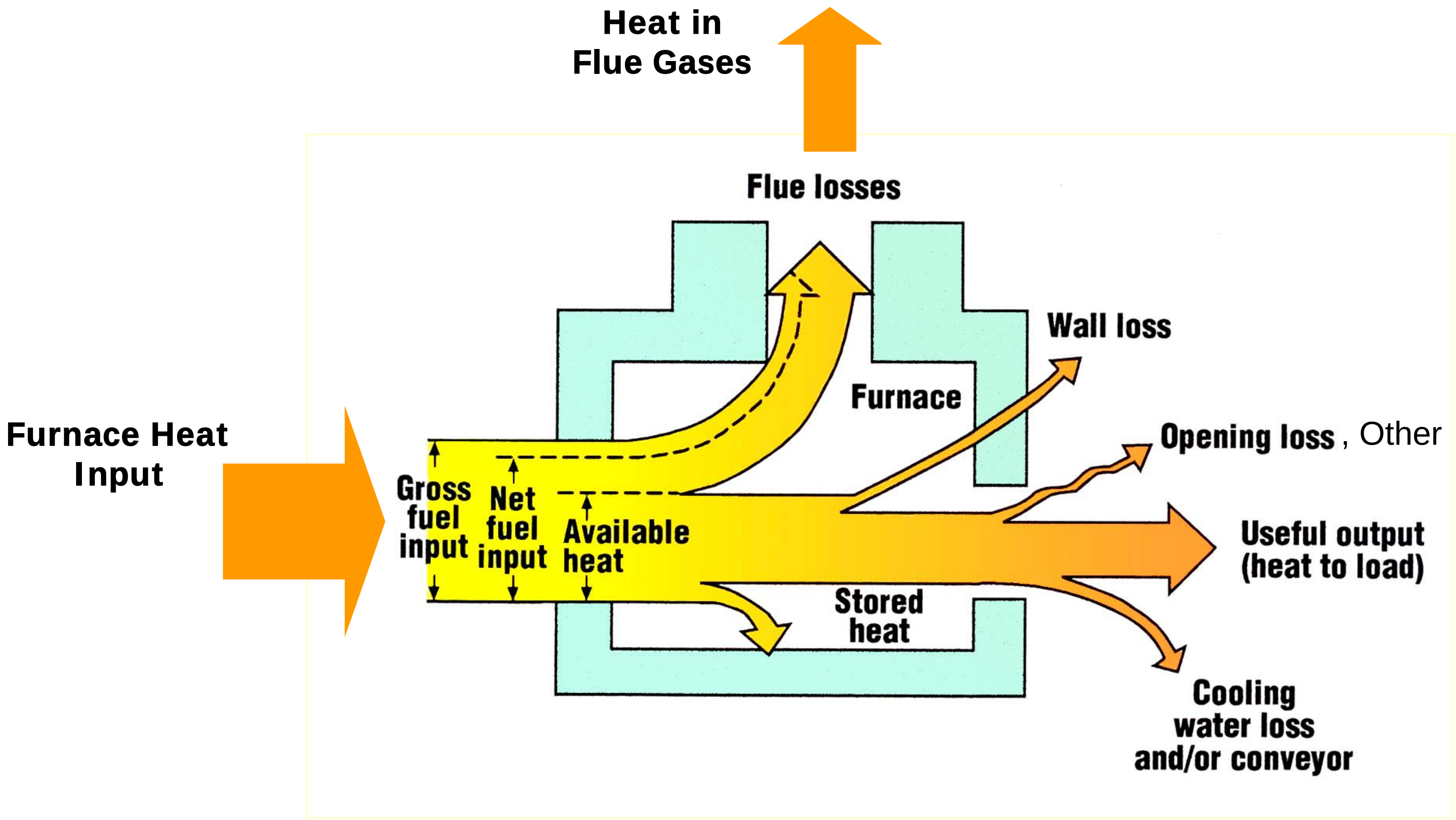
Commonly Used Equipment for Process Heating

- Fuel fired furnaces
  - Natural draft
  - Forced draft
  - Balanced draft
- Boilers
  - Direct fired
  - Process heat recovery
  - Heat recovery with use of duct burners
- Cogeneration Systems
- Thermal oxidizers

Process Heating System Components

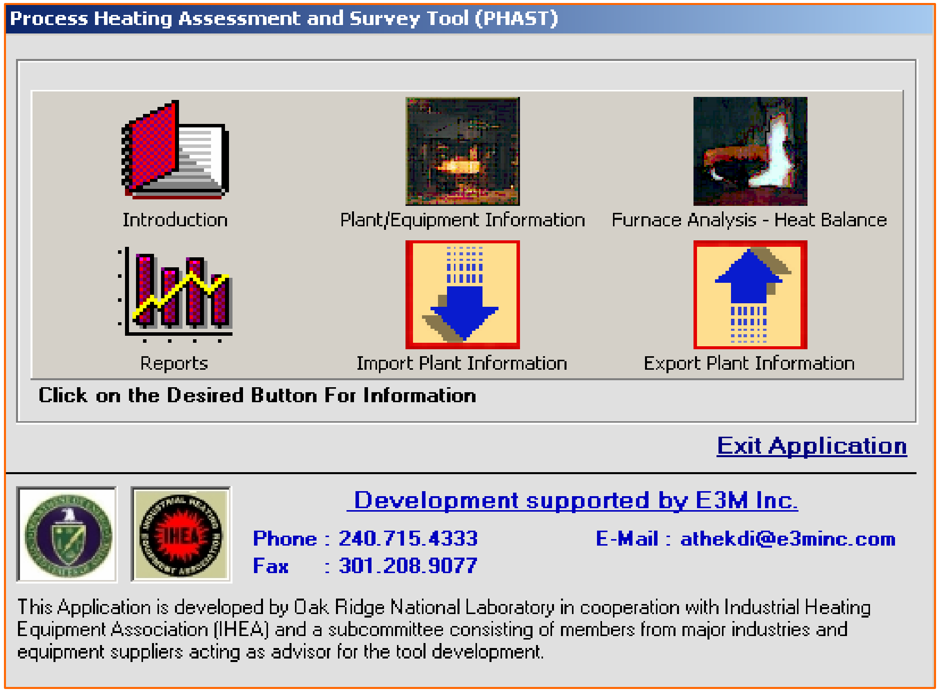


Heat Supply, Demand and Losses in a Heating System



Process Heating Assessment and Survey Tool (PHAST)

A Tool Developed by Industry – Government Collaboration



Process Heating Assessment and Survey Tool (PHAST)

Download it from

http://www.eere.energy.gov/industry

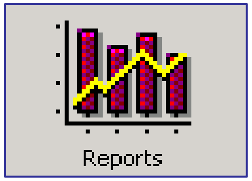
It includes

- Installation instructions for MS Windows 2000 and XP
- User manual
- Useful calculators
- Survey forms
- PHAST program

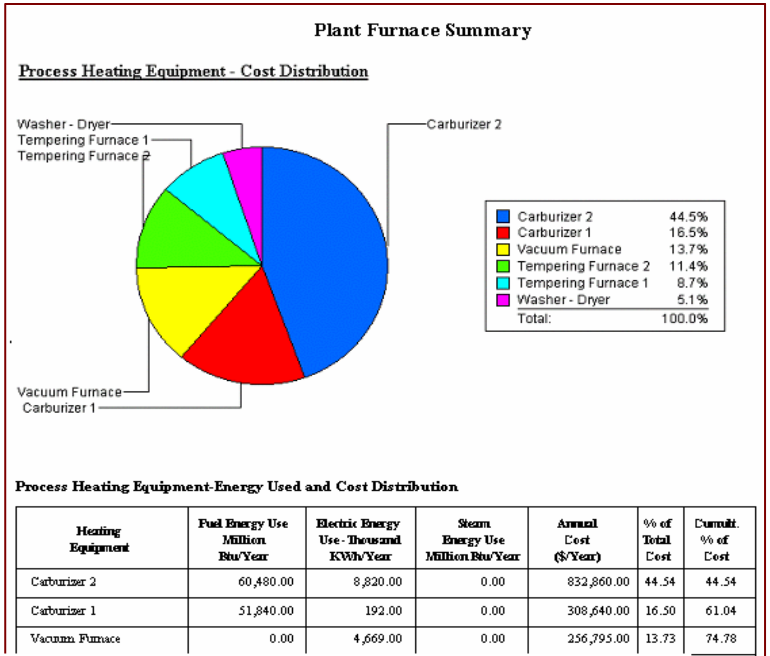
Process Heating Assessment and Survey Tool (PHAST)

How can PHAST help my facility?

- Estimate annual energy use and energy cost for:
  - furnaces, heaters and boilers
- Identify furnace energy use, efficiency and losses
  - detail heat balance and energy use analysis
- Perform “what-if” analysis for potential energy reduction and efficiency improvements
  - Analyzes changes in operation, maintenance and retrofits of components/systems
- Obtain information on energy saving methods
- Identify additional resources



Energy Use and Cost Distribution Report for Heating Systems



Plant Furnace Summary

Process Heating Equipment - Cost Distribution

Carburizer 2	44.5%
Carburizer 1	16.5%
Vacuum Furnace	13.7%
Tempering Furnace 2	11.4%
Tempering Furnace 1	8.7%
Washer - Dryer	5.1%
Total:	100.0%

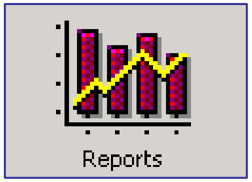
Process Heating Equipment-Energy Used and Cost Distribution

Heating Equipment	Fuel Energy Use Million Btu/Year	Electric Energy Use - Thousand KWh/Year	Steam Energy Use Million Btu/Year	Annual Cost ($/Year)	% of Total Cost	Cumult. % of Cost
Carburizer 2	60,480.00	8,820.00	0.00	832,860.00	44.54	44.54
Carburizer 1	51,840.00	192.00	0.00	308,640.00	16.50	61.04
Vacuum Furnace	0.00	4,669.00	0.00	256,795.00	13.73	74.78
						86.19
						94.86
						100.00

- Estimated annual energy use and cost for heating equipment
- Lists heating equipment and % of total energy cost used for each piece of equipment
  - Ranked by annual cost of energy used.

Use this report to:

1. **identify equipment with high energy use, and**
2. **select one or more furnaces for further analysis**

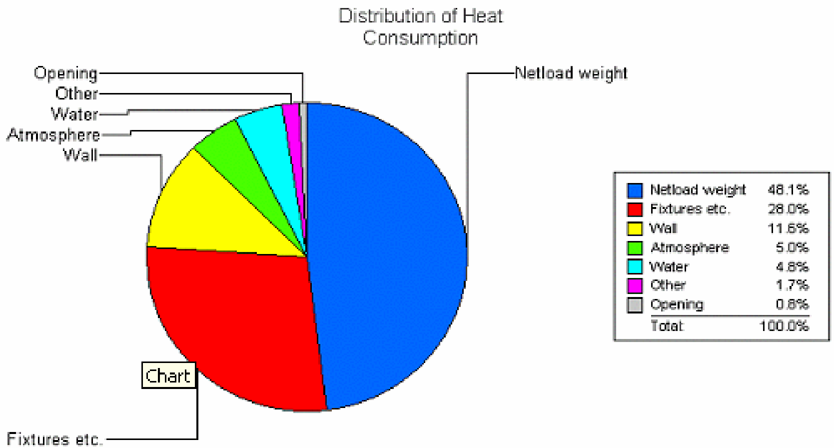


"Furnace" Heat Balance Energy Use – Losses Distribution

Furnace Analysis Report

Company : ABC Corporation **Furnace :** Carburizer 1
Plant : Excellent Heat Treating

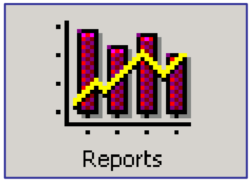
Current Condition **Net Heat Consumption Data**



Heat Storage (Btu) : 50,320,220.00 **Thermal Efficiency (%) :** 21.02

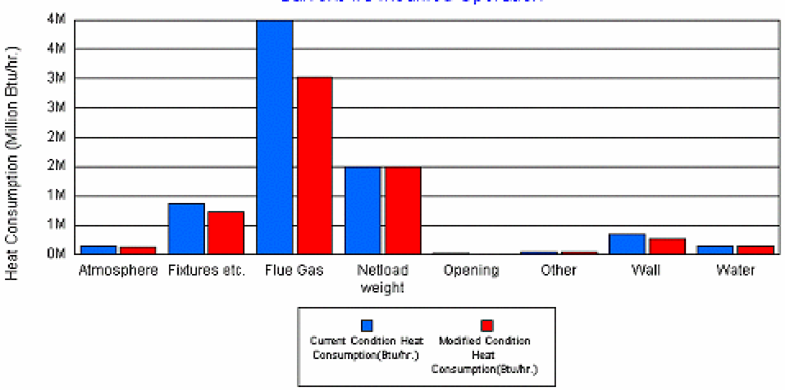
Area of Heat Consumption	Btu/hour
Netload weight	1,490,190.00
Fixtures etc.	868,000.00
Wall	358,068.00
Atmosphere	155,000.00
Water	150,300.00
Other	53,396.00
Opening	24,783.00
Total	**3,099,737.00**

- Analysis of energy used in part of a furnace under a given operating condition.



Energy Use in Current vs. Modified Conditions

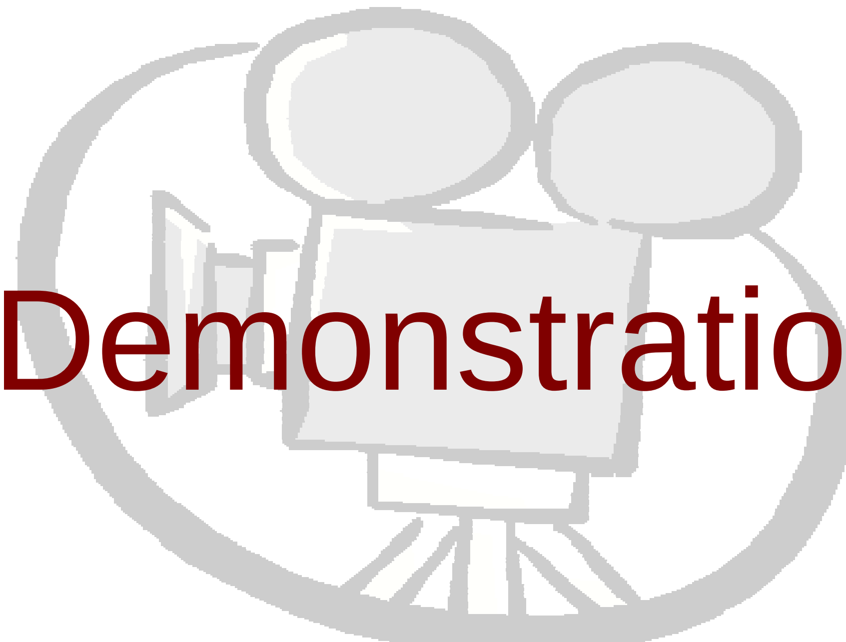
Company: ABC Corporation   Furnace: Carburizer1
Plant: Excellent Heat Treating



	Current Condition Heat Consumption(Btu/hr.)	Modified Condition Heat Consumption(Btu/hr.)
Atmosphere	155,000.00	130,000.00
Fixtures etc.	868,000.00	728,000.00
Flue Gas	3,990,238.00	3,024,342.00
Netload weight	1,490,190.00	1,490,190.00
Opening	24,783.00	10,468.00
Other	53,394.00	53,394.00
Wall	358,068.00	274,432.00
Water	150,300.00	150,300.00
Total	7,089,975.00	5,861,128.00

- Compares energy use for current operations and with potential changes (what-if analysis) in operating conditions for the furnace.
- Results calculated with furnace energy balance.

Process Heating Assessment and Survey Tool (PHAST)

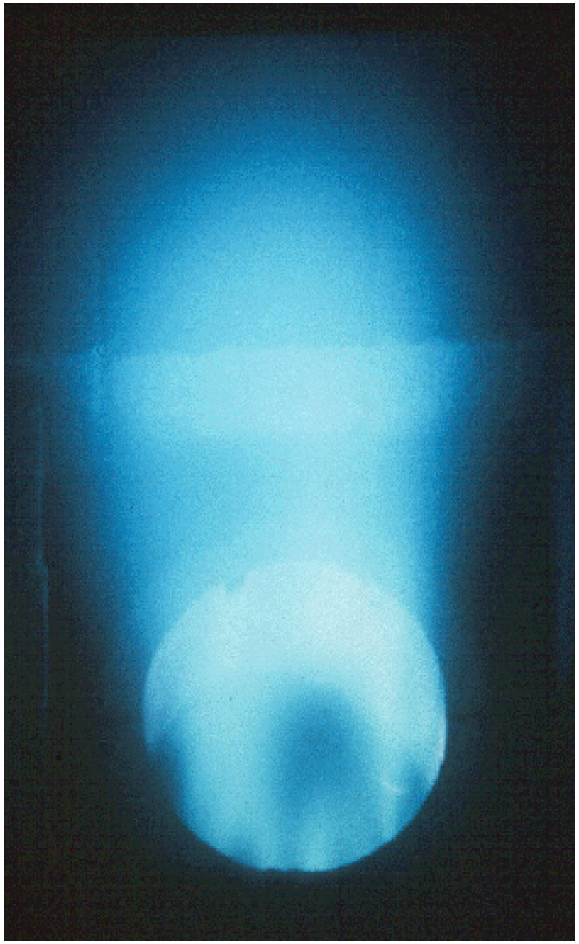


Demonstration

Process Heating Best Practices: Heat Generation

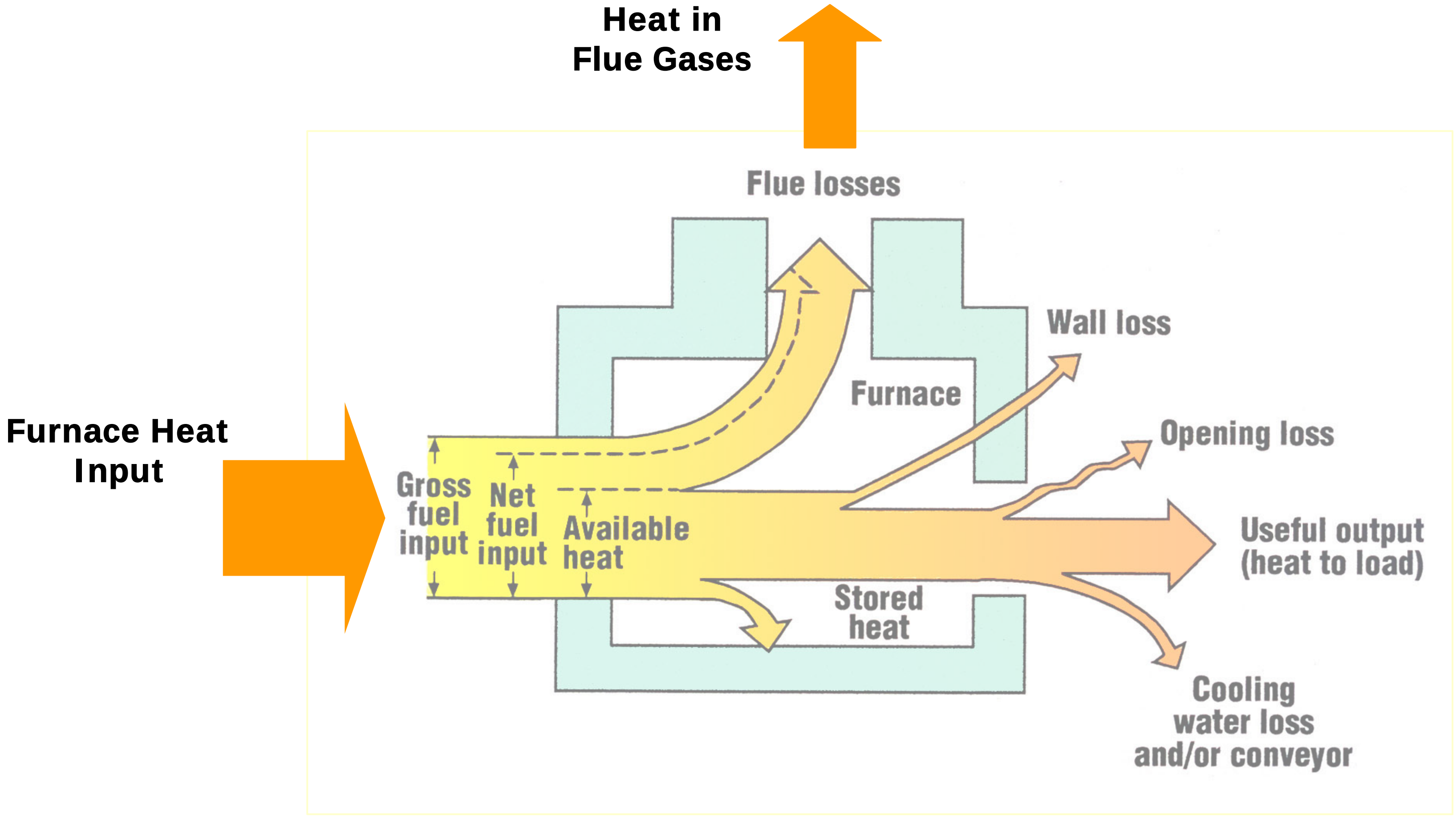
- Best Practices for Air Flow
  - Control burner fuel/air ratio to maintain near Stoichiometric combustion - usually less than 2% O_2 and minimum CO (<10 ppm), combustibles in flue gases
  - Avoid excess air, replace constant-air-supply burners
  - Control make-up air to minimum required for applications where it is necessary for safety reasons
  - Use forced air burners with on-ratio high turndown
- Preheat combustion air for high temperature processes
- Use O_2 enrichment where economical based on energy savings, productivity gains, etc.
- Control flame size, shape to ensure complete combustion within the furnace.

Benefits of Heat Generation Best Practices



- Energy Saving Potential
  - 2% to 10%
- Typical implementation
  - 1 to 8 weeks
- Typical payback period
  - 1 to 6 months

Recall: Heat Supply, Demand and Losses

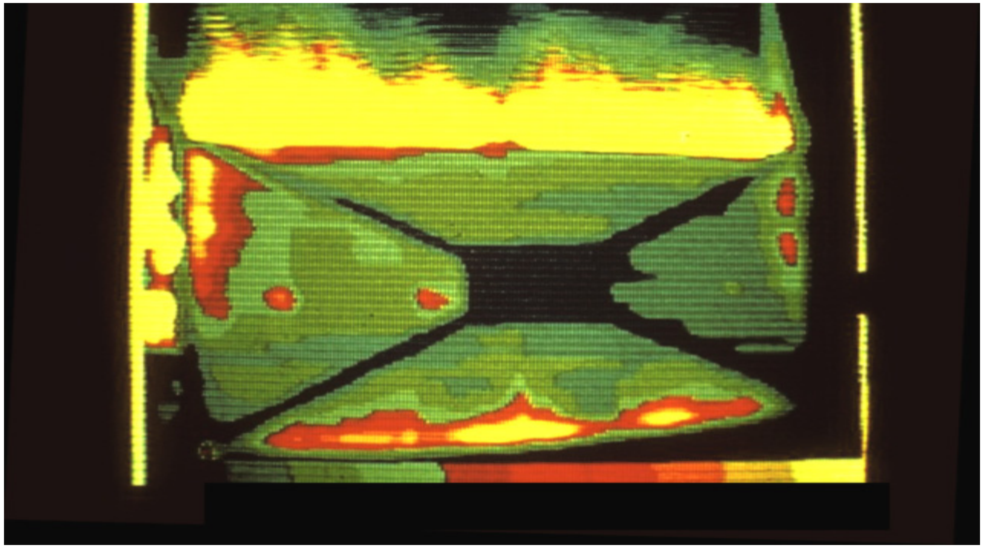


Process Heating Best Practices: Heat Containment

- Optimize insulation (type and thickness)
- Reduce cooling losses by insulating water or air-cooled parts in a heating system
- Reduce radiation losses by eliminating or minimizing furnace openings
- Use devices (e.g., radiation shields) to minimize radiation and convection losses
- Use draft control to eliminate or reduce furnace leakage (cold air into *or* hot gas out)
- Repair cracks, openings, seals in refractory, burner blocks, around doors or heater tubes.

Benefits of Heat Containment

- Energy Saving Potential
  - 2% to 10%
- Typical implementation
  - 1 to 8 weeks
- Typical payback period
  - 1 to 6 months



Reduce Flue Gas Heat Losses

dry stack loss = $W \quad C_p \quad (T_2 - T_1)$

$W \downarrow$

less excess air

oxygen enrichment

$T_2 \downarrow$

lower setpoint

$\downarrow$

heat recovery

$\downarrow$

more heat transfer

Process Heating Best Practices: Heat Recovery

- Use heat of flue gases
  - Combustion air preheating
  - Charge/Load preheating
  - Steam generation
  - Water, liquid or air heating for use in other processes (e.g., plant building heat or cooling)
  - Cascade heat to lower temperature processes
  - Use absorption cooling systems where chilled water (liquid) or air (gases) are required in the plant.
- Use energy from heated products after thermal processing
  - Many of the methods suggested above

Benefits of Heat Recovery

- Energy Saving Potential
  - 10% to 30%
- Typical implementation
  - 4 to 12 weeks
- Typical payback period
  - 6 to 24 months

Process Heating Best Practices: Heat Transfer

- BestPractices for heating equipment (e.g., furnace, heat exchanger)
  - Clean heat transfer surfaces
  - Enhance convection heat transfer (e.g., recirculation fans, jets)
  - Control temperature profile (LMTD) to maximize heat transfer.
- Avoid flame impingement on heater tubes by selecting proper burner and flame shape-size
- Use process modeling to optimize temperature profile during heating to maximize heat transfer while avoiding product overheating.

Benefits of Heat Transfer Best Practices

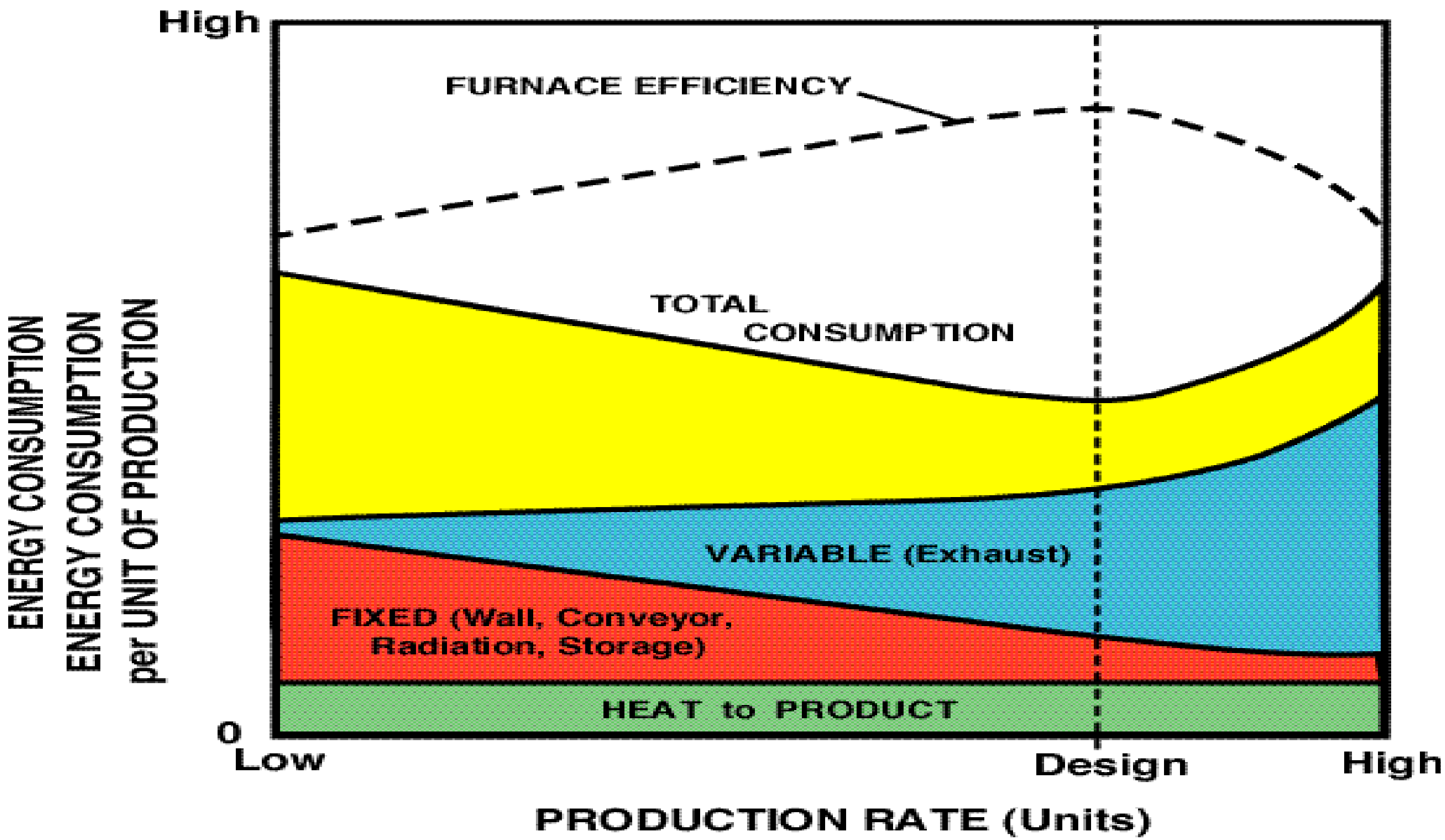
- Energy Saving Potential
  - 5% to 10%
- Typical implementation
  - 1 to 12 months
- Typical payback period
  - 6 to 30 months

Use Sensors & Controls, and Advanced Materials

- Use computer models to set furnace controls and operating conditions
- Monitor in-line process parameters (e.g., surface temperature, pressure) and couple with models
- Continuous monitoring of flue gas composition (e.g., O_2, combustibles) for optimum operations
- Use advanced materials (alloys, ceramics and insulation) for radiant tubes, fixtures, rails, etc.

- Energy Saving Potential
  - 2% to 10%
- Typical implementation
  - 1 to 8 weeks
- Typical payback period
  - 1 to 24 months

Optimize Production Rate for Energy Consumption Per Unit of Production



Process Heating Best Practices: Operations and Maintenance

- Operate the systems close to design capacity
- Avoid part load operations, especially for systems using fixtures, trays, conveyors, etc.
- Schedule nearly continuous operations to avoid long delays and hold periods
- Analyze system performance to determine equipment operating mode (e.g., shut-down or maintain operating temperature or maintain at intermediate temperature).
    - There is no one answer for all situations.
- Consider using variable (or two) speed motors for fans, blowers to save power.

Questions and Answers

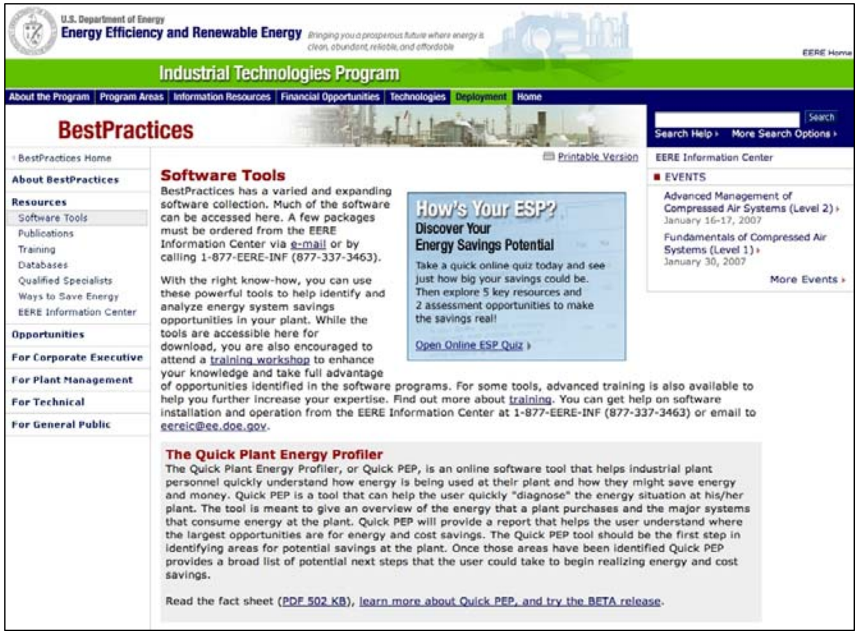
Use PHAST at Your Plant to Analyze Heating Systems

- Understand energy use and cost
- Analyze energy distribution and losses
- Identify potential project areas for energy savings and cost reduction
- Benchmark plants at a corporate level
- Benchmark individual systems at the plant level
- Monitor performance over time.

Download the Tool

DOE BestPractices Web site:

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



Find Additional Training

Visit the DOE BestPractices Training Web site:

www.eere.energy.gov/industry/bestpractices/training

See the Training Calendar for events in your area:

www.eere.energy.gov/industry/bestpractices/events_calendar.asp

Become a Qualified Specialist:

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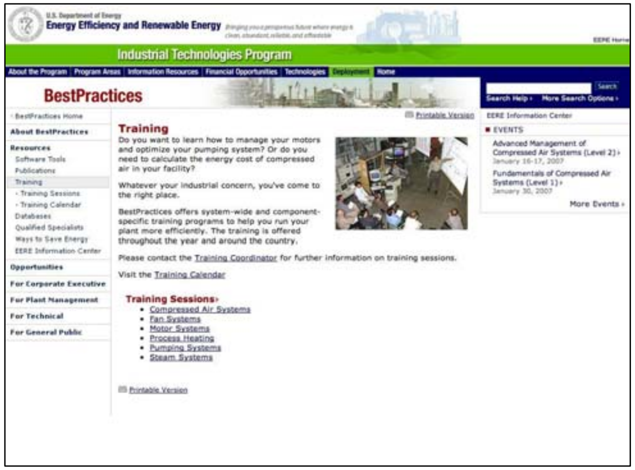
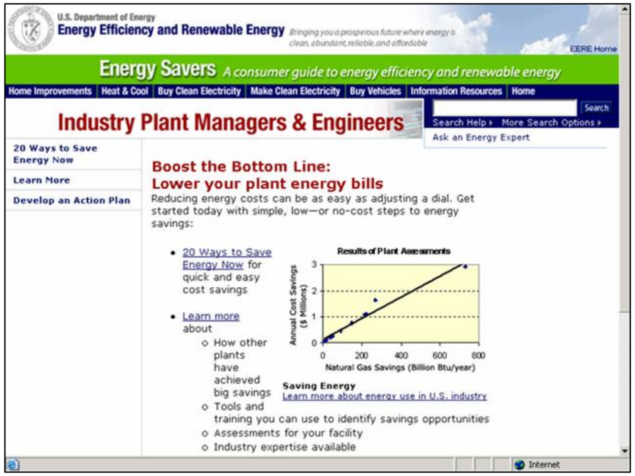


See the “Industrial Energy Savers” Web Site

- 20 ways to save energy now
- Tools & training you can use to identify savings opportunities
- Industry expertise available
- Assessments for your plant
- Develop an Action Plan
- Learn how others have saved
- Access the National Industrial Assessment Center (IAC) Database



EERE Information Center

On-call team of professional engineers, scientists, research librarians, energy specialists, and communication information staff.

Voice: 877-337-3463

Fax: 360-236-2023

E-mail: eereic@ee.doe.gov

Web site: www.eere.energy.gov/informationcenter

Web Site and Resources

Visit these DOE Web sites for the latest information and resources:

Industrial Technologies Program (ITP) Web site:

www.eere.energy.gov/industry/

BestPractices Web site:

www.eere.energy.gov/industry/bestpractices

Save Energy Now Web site:

www.eere.energy.gov/industry/saveenergynow

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Acknowledgments

U.S. Department of Energy's

Industrial Technologies Program