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# Online Learning Series – Webinar #9

## Process Heating and Waste Heat Reduction

Eli Levine

Office of Energy Efficiency and Renewable Energy



Eli Levine

U.S. Department of Energy



## Better Plants Online Learning Series

Webinar Topic	Speaker	Date	Time	Link
7. Energy Treasure Hunts with EPA	Alex Floyd (Tyson) Walt Brockway (ORNL) Walt Tunnessen (EPA)	08/20/20	1:00 - 2:00pm EST	
8. Pumps and Fans	Thomas Wenning (ORNL)	08/27/20	1:00 - 2:30pm EST	
9. Process Heating and Waste Heat Reduction	Sachin Nimbalkar (ORNL)	09/03/20	1:00 - 2:30pm EST	<a href="#">Register</a>
10. Field Validation	TBD	09/10/20	1:00 - 2:30pm EST	<a href="#">Register</a>
11. Energy Management During a Pandemic	TBD	09/17/20	1:00 - 2:30pm EST	<a href="#">Register</a>
12. MEASUR Tool Suite	Kristina Armstrong (ORNL)	09/24/20	1:00 - 2:00pm EST	<a href="#">Register</a>
13. Process Cooling	Wei Guo (ORNL)	10/01/20	1:00 - 2:30pm EST	<a href="#">Register</a>

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**#DOE**

# Agenda for Today

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1

Process Heating and Waste Heat Reduction– Overview

2

Q&A using Slido



Sachin Nimbalkar, Ph.D.  
Oak Ridge National Laboratory



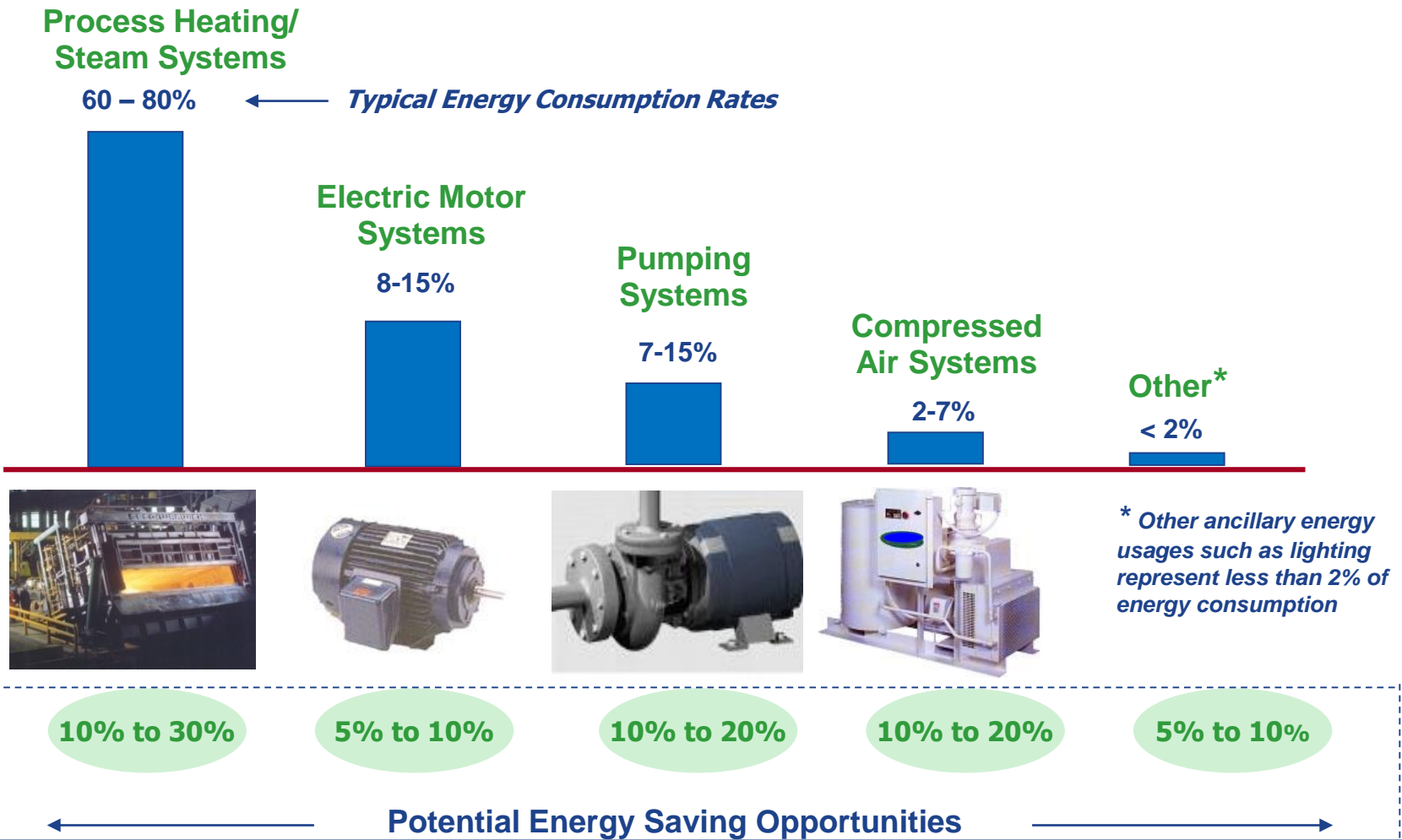
# Improving Process Heating System Performance and Waste Heat Management Options

Sachin Nimbalkar, PhD  
Oak Ridge National Lab

September 3, 2020

# System Opportunities

## High-level Plant Energy & Savings Profile



# What Is Process Heating?

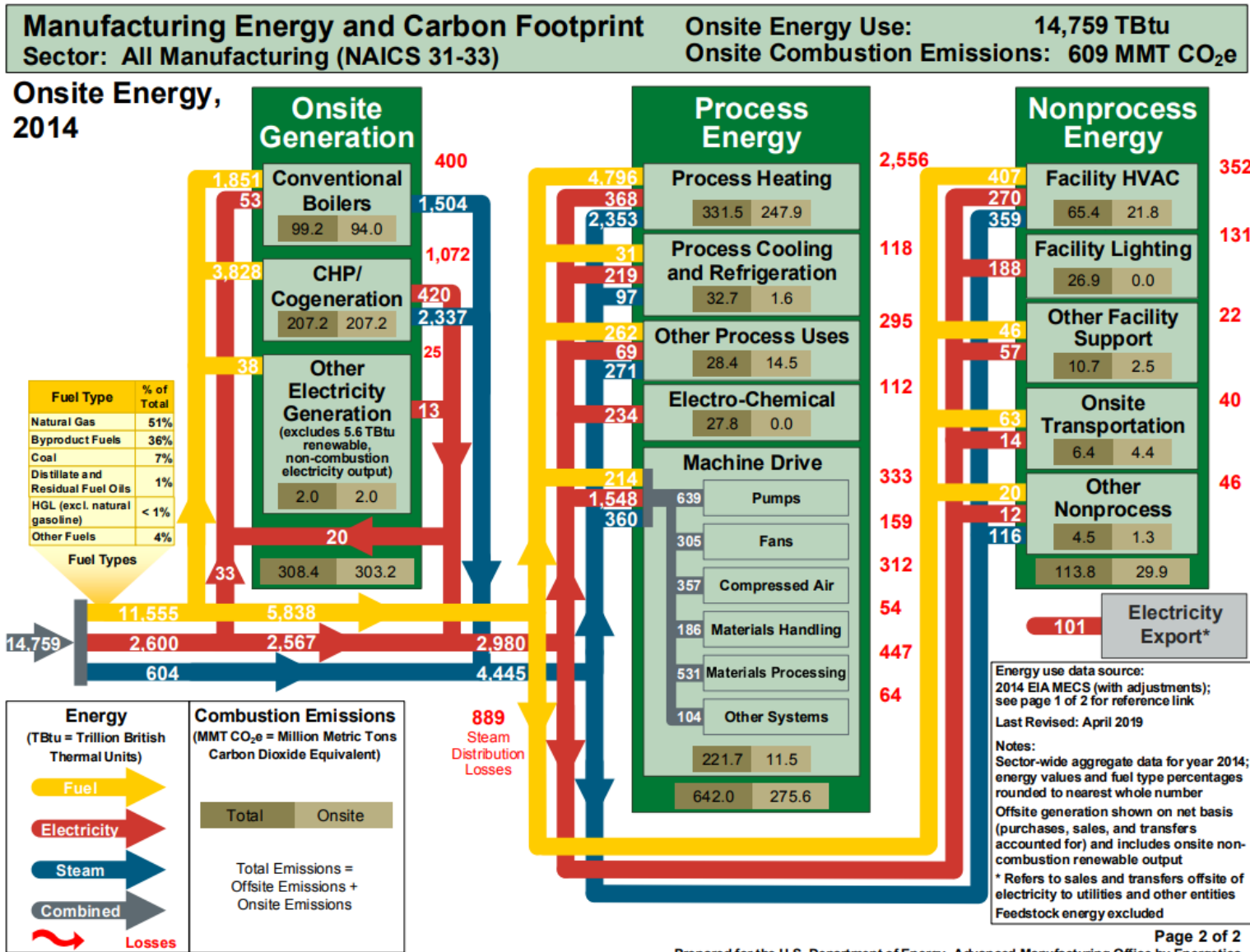
## Supplying Heat to Materials in

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



# Process Heating Systems have Significant Losses

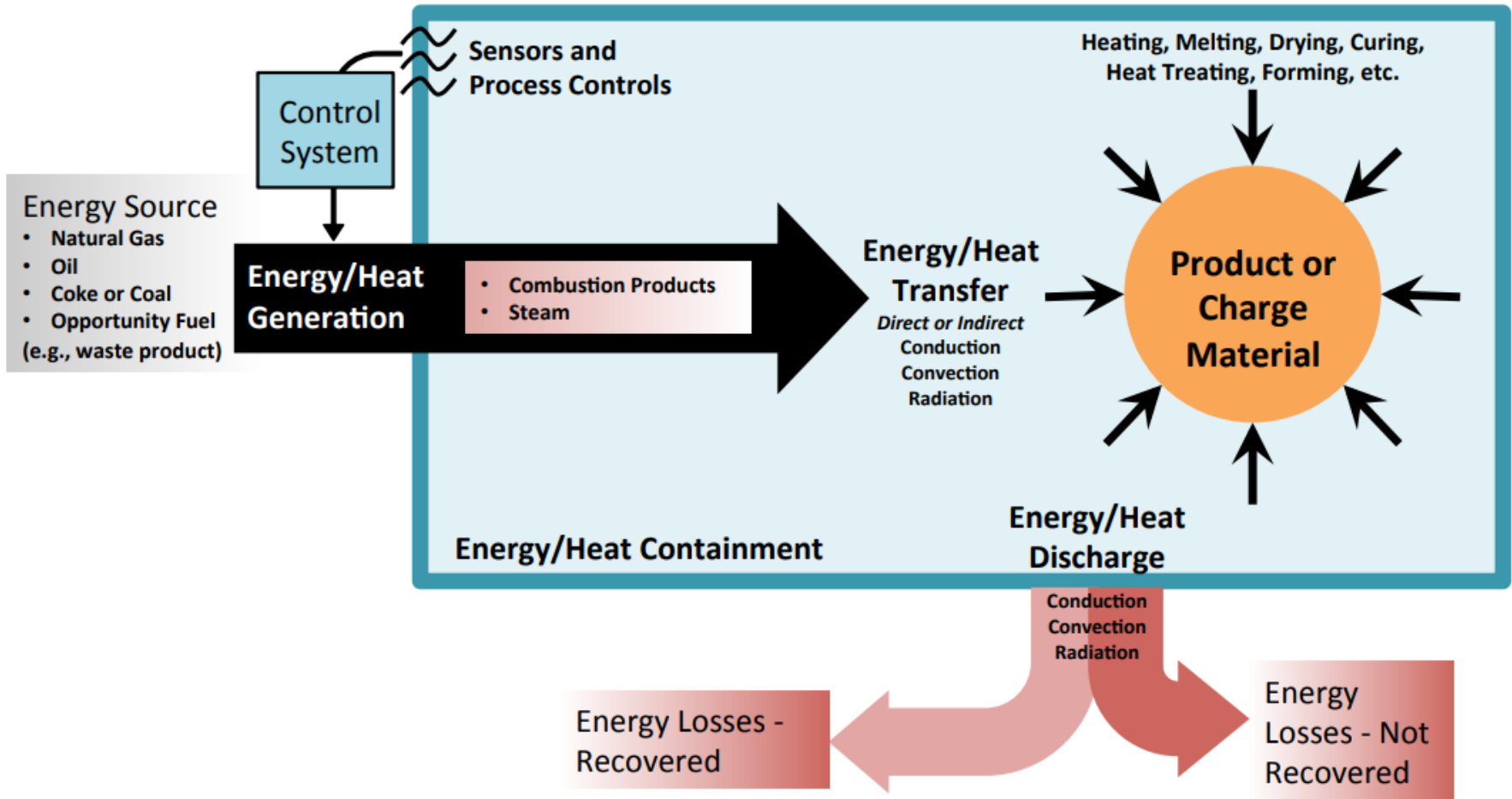
(~32% of PH energy in the entire manufacturing industry)



# Process Heating System Components

## (Combustion-based PH System)

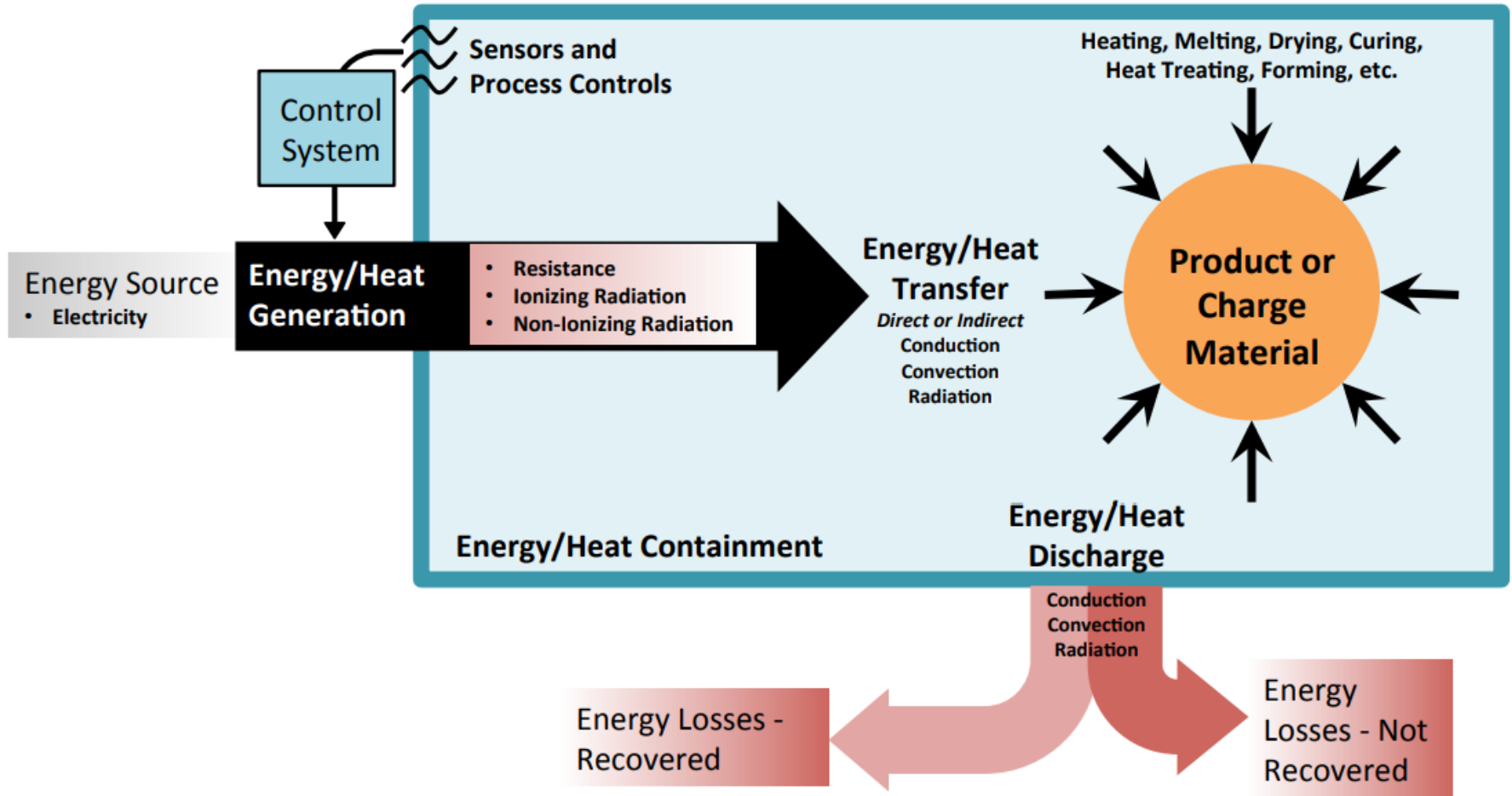
### Combustion-based Process Heating System



# Process Heating System Components

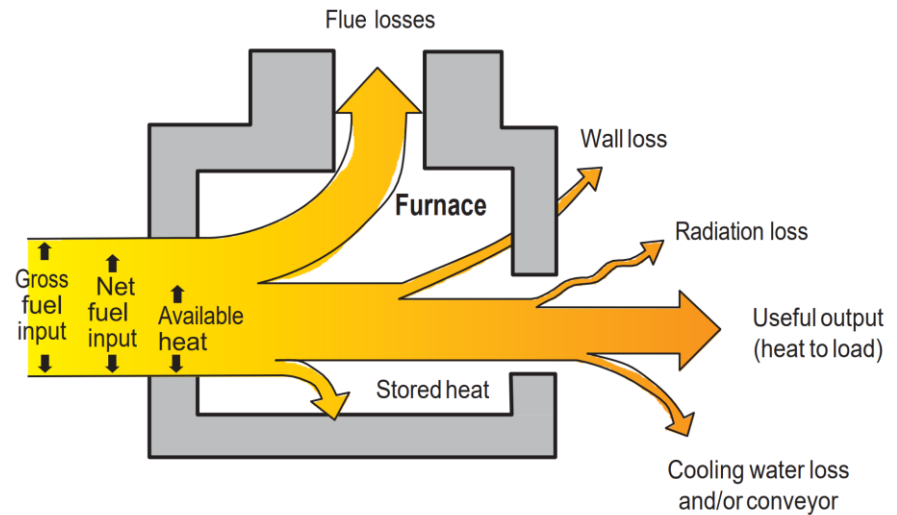
(Electricity-based PH System)

## Electricity-based Process Heating System



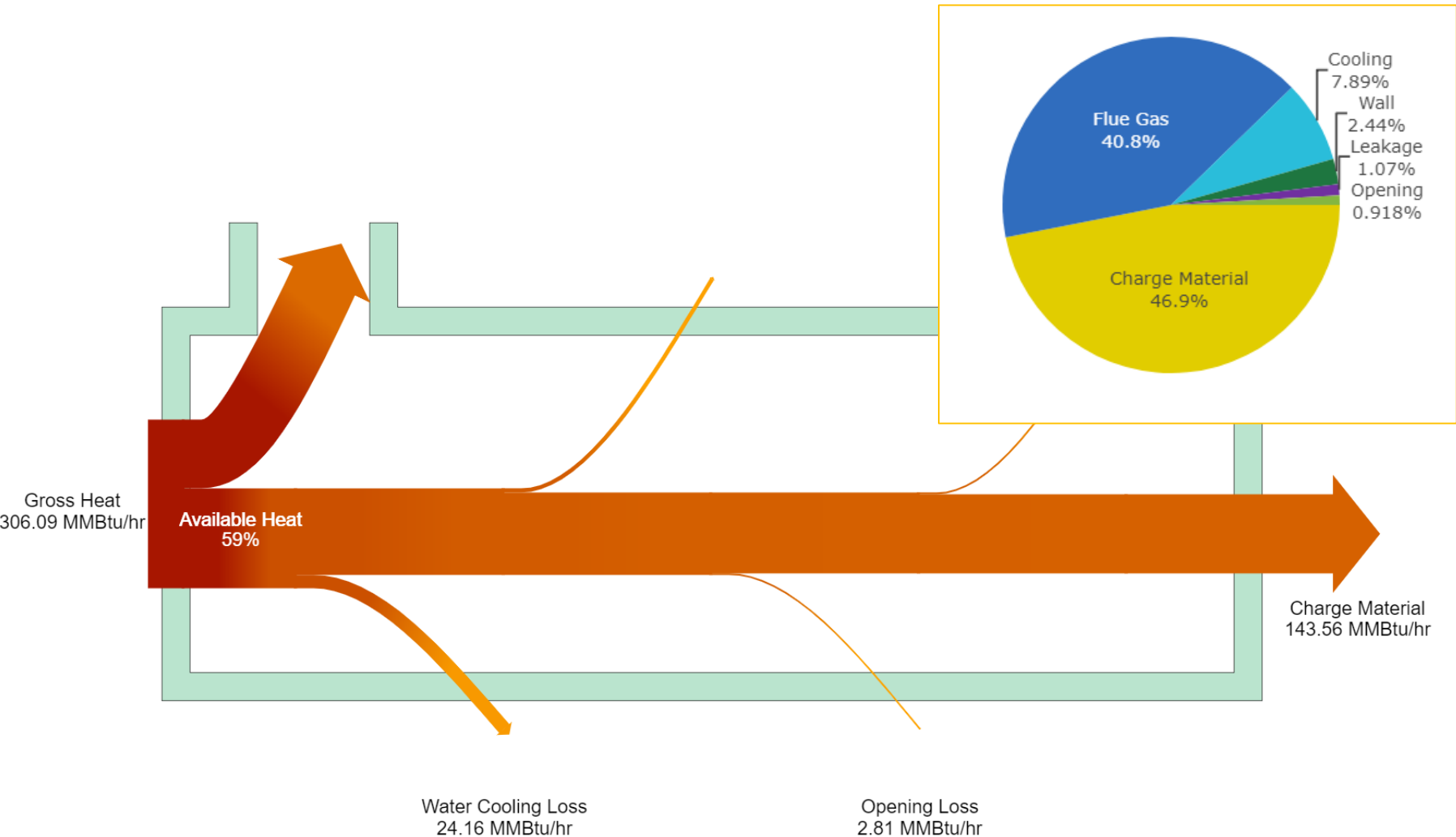
# Major Areas for Energy Savings Potential in Process Heating System

1. **Load/charge material**
2. Material handling
3. **Heat supply/heat generation**  
(combustion system, electric, & other)
4. **Furnace exhaust and heat recovery**
5. Furnace-oven walls
6. Furnace openings and doors
7. Water or air cooling
8. Control system
9. Auxiliary systems
10. Other losses (i.e. atmosphere, makeup air, ex-filtration of gases etc.)



# Heat Supply, Demand and Losses

## Example – Reheat Furnace



Source: DOE MEASUR Process Heating Assessment Module

# Top Ten PH Recommendations

## DOE ENERGY SAVING ASSESSMENTS - 2006 to 2011

Top Ten Frequently Identified Process Heating Opportunities (ESAs - 2006 to 2011)	Average Energy Cost Savings Identified (\$)	Average Energy Cost Savings % Identified (%)	Average of Payback Period Actual (yr)
Reduce oxygen content of flue (exhaust) gases	\$178,000	1.3	0.9
Use of flue (exhaust) gas heat for combustion air preheating	\$407,000	2.6	1.9
Proper insulation and maintenance of furnace structure or parts	\$167,000	1.1	1.4
Reduce-eliminate openings and air leakage in the furnace	\$155,000	1.3	1.0
Load or charge preheating using heat from flue or exhaust gas or other source of waste heat	\$246,000	1.8	2.0
Heat cascading - use of flue or Exhaust gas heat from higher temp. process to supply heat to lower temperature processes	\$407,000	2.3	1.5
Use of proper heating methods - replace inefficient and uneconomical methods with economical/efficient system	\$408,000	3.6	3.0
Heat recovery from hot products or other heat sources (i.e. from walls) from a furnace - oven	\$559,000	3.3	1.8
Furnace scheduling, loading, shut down - avoiding delays, waits, cooling between operations etc.	\$324,000	2.8	0.4
Use of oxygen for combustion	\$598,000	3.2	1.9

Source: DOE PH Energy Saving Assessments 2006 to 2011. Numbers are as of October 1, 2011.

# Top Ten PH Recommendations

## IAC ASSESSMENTS - MEDIUM PLANTS\*

Top Ten PH Recommendations	Average Cost Savings Recommended (\$)	Average Payback (Years)
Use Waste Heat With A Closed-cycle Gas Turbine-generator Set To Cogenerate Electricity And Heat	\$420,000	2.6
Replace Existing Equipment With More Suitable Substitutes	\$416,000	2.8
Use A Fossil Fuel Engine To Cogenerate Electricity Or Motive Power; And Utilize Heat	\$203,000	5.2
Purchase Gas Directly From A Contract Gas Supplier	\$125,000	0.0
Use Hot Process Fluids To Preheat Incoming Process Fluids	\$125,000	3.6
Use Waste Heat From Hot Flue Gases To Preheat Incoming Fluids	\$88,000	2.6
Recover Heat From Engine Exhausts	\$84,000	2.1
Make Ice During Off Peak Hours For Cooling	\$83,000	4.4
Recover Heat From Hot Wastewater	\$77,000	1.0
Heat Water With Exhaust Heat	\$72,000	1.0
Replace Fossil Fuel Equipment With Electrical Equipment	\$69,000	1.1

\* Plants with annual energy consumptions in between 26 to 500 BBtu/yr

# Ranges of Energy Use and Savings Potential

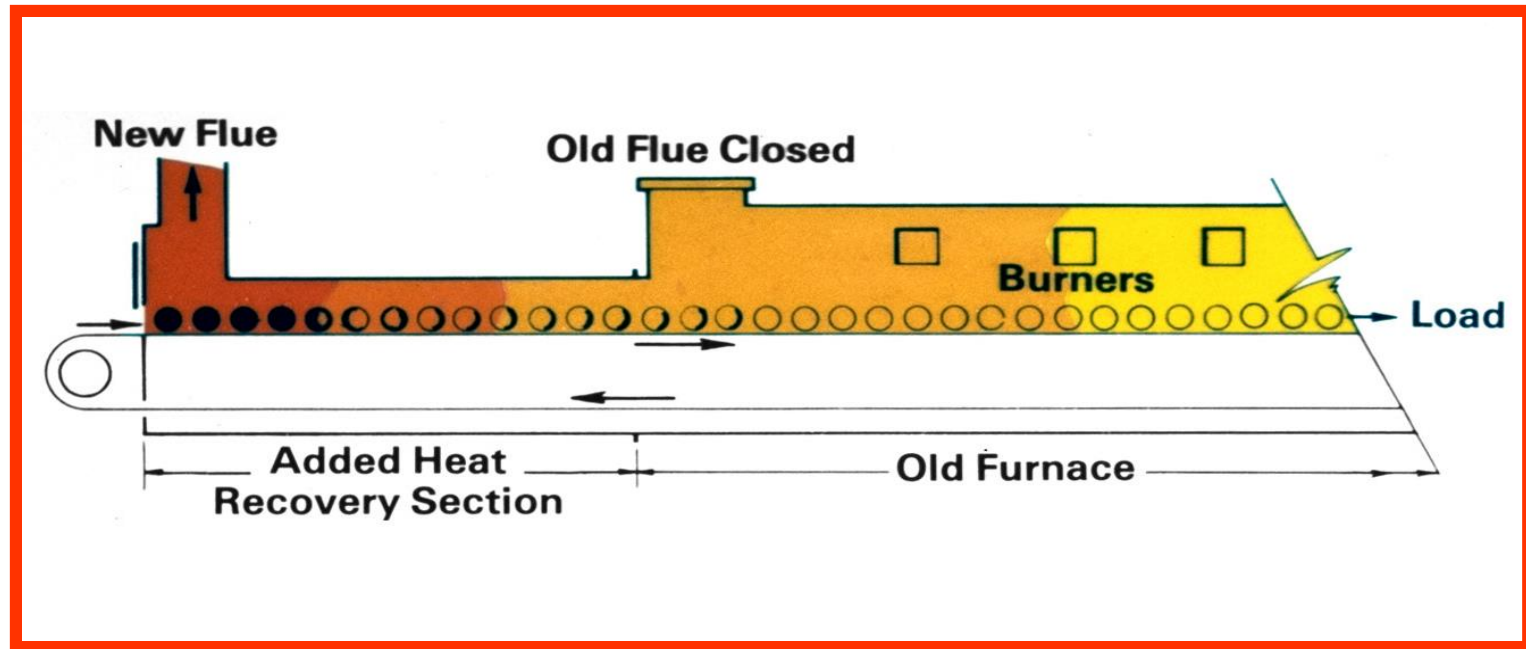
	Area of energy use or loss	Range of energy use as % of the input	Range of energy savings use as % of energy use
1	Load/charge material	15 to 75	0 to 25
	Material handling	0 to 20	0 to 50
3	Heat supply/heat generation (combustion system, electric, and other)	N/A	0 to 50
4	Furnace exhaust and heat recovery	10 to 60	0 to 50
	Furnace-oven walls	2 to 15	0 to 25
	Furnace openings and doors	0 to 20	0 to 100
	Water or air cooling (furnace internals – if any)	0 to 15	0 to 50
	Control system	N/A	0 to 10
	Auxiliary systems	2 to 10	0 to 25
	Other losses (i.e. atmosphere, makeup air, ex-filtration of gases etc.)	0 to 50	0 to 50

**Note: The exact values depend on a number of factors and they can be obtained only by conducting a good heat balance. The US DOE tool – PHAST can be used effectively to prepare a heat balance and estimate range of values.**

# 1. Load Charge Material

- Hot charging of the load where possible
- Preheating of the load or charge:
  - External preheating
    - Using heat from furnace flue gases
    - Using auxiliary preheating
  - Internal preheating
- Drying or moisture removal
- Charging at or near design capacity and frequency
- Proper load arrangement for optimum heat transfer
- Use of new processes and technologies

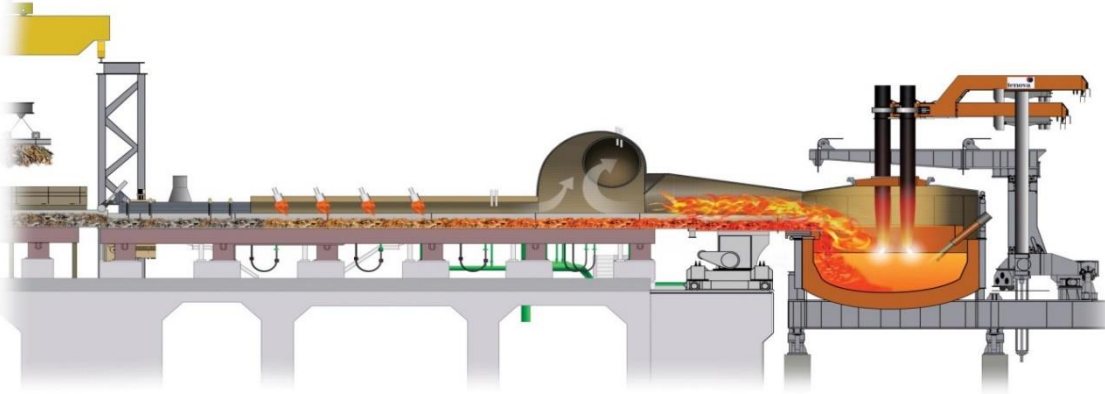
# Load Preheating: Steel Reheat Furnace



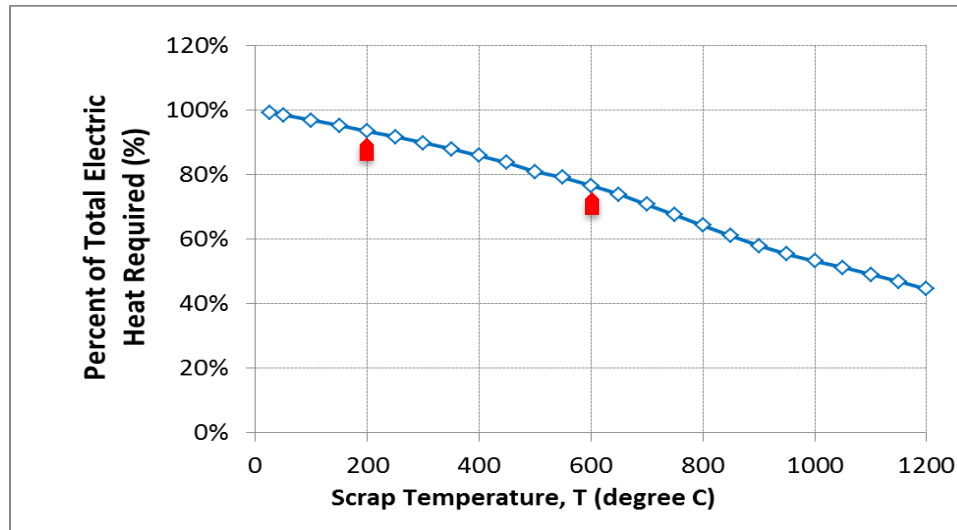
- Use of the furnace flue gases to preheat the furnace charge material in continuous heating or heat-treating furnaces
- Furnace flue gases are passed “over” the charge material
- Potential energy savings – 15% to 20% for steel reheating furnaces

# Steel Scrap: EAF

## Dryer and Preheater



- Steel scrap is separated by using a magnetic separation system
- Off gases from EAF are diverted to a conveyor carrying a steel scrap charge for the EAF
- Necessary to use air for combustion of CO, H<sub>2</sub>, and other combustible components of off gases
- Temperature control is crucial to avoid unsafe conditions, overheating of the system, or damage to property or personnel



If we increase the scrap temperature from 390°F to 1110°F, the amount of electric energy needed for melting the scrap drops by additional 15%.

# Savings: Load Preheating Aluminum Furnace – Gas Fired

**Charge preheating in a typical gas-fired furnace can save up to \$30,000/year in energy cost and may help increase production**

Calculations for Savings - Furnace Charge Preheating using Exhaust Gases			
		Base	New
11	Charge Material	Aluminum	
12	Charging rate (as charged with moisture) (Lbs./hr)	4,000	
13	Base Charge Initial temperature (°F)	82	
14	New Charge Preheat temperature (°F)		400
15	Specific heat of the charge in temp. range of preheat (Btu/lb. F)	0.21	0.21
16	Base % moisture content in the charge (cold)	1.00%	
17	New % moisture content in the charge (preheated)		0.25%
18	Net heat reduction due to preheat (Btu/hr)	300,269	
19	Flue gas temperature from oven/furnace (°F)	1100	1100
20	Air preheat temperature (°F)	80	80
21	Current O2 in flue gases (%)	4.50	4.50
22	Available heat (%)	63.00%	63.00%
23	Savings in gross heat supplied to oven/furnace (Btu/hr.)	Base	476,607
24	Total energy savings (MM Btu/hr)	Base	0.477
25	Energy Cost (\$/MM Btu)	\$8.00	\$8.00
26	Operating Hrs (per year)	8000	8000
27	<b>Energy savings (MM Btu/year)</b>		<b>3,813</b>
28	<b>Savings - Energy cost (\$/year)</b>	<b>Base</b>	<b>\$30,502.82</b>
29	<b>CO2 savings based on fuel: natural gas(tons/year)</b>		<b>223</b>

# Summary for Load/Charge Related Measures

<b>Actions</b>	<b>Potential energy savings*</b>
Hot charge load wherever possible	5% to 30%
Preheat load or charge material using furnace flue gases or an auxiliary externally fired preheater	5% to 30%
Moisture removal prior to loading in the furnace	10% to 25%
Charge at near design capacity and frequency - minimize hold or idling	2% to 5%
Proper load arrangement for optimum heat transfer	1% to 2%

\* Percentage of total furnace heat supply

# 3. Combustion System Energy Saving Measures

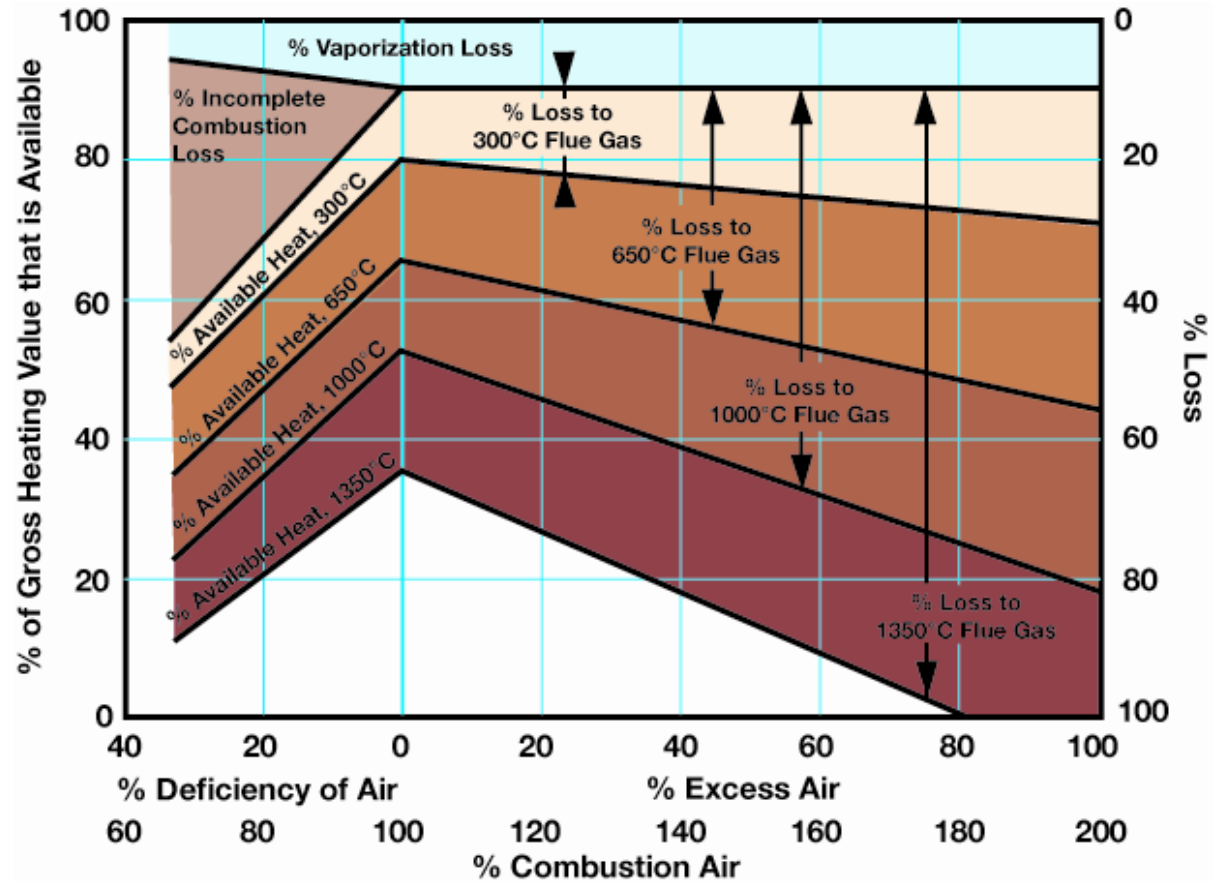
- Use proper burners
- Use proper fuel-to-air ratio control system
  - Eliminate or reduce excess air operation
  - Always maintain proper fuel-to-air ratio
  - Avoid fuel-rich operating conditions
- Use preheated air
- Use preheated fuel where possible
- Use oxygen-enriched combustion air
- Use an alternate burner control system (pulse firing) to extend the operating range (turn-down) for the burners

# Excess Air Control

## The Most Cost-Effective Methods to Save Energy for Furnaces and Ovens

- Excess air may enter from several sources:
  - Combustion air in burners
  - Air-leakage from openings
  - Make-up air used for ovens and dryers
- Control furnace pressure to eliminate or minimize cold air entering the furnace
- Reduce the size and number of openings
- Control make-up air to the minimum required value
- Review the burner firing control system to avoid use of high excess air at low fire conditions
- Use sealed burners to avoid cold air “draft” through hot tubes for radiant tubes with and on/off control

# Effect of Excess Air on Available Heat and Heat Loss



Adapted from *North American Combustion Handbook, Second Edition*. Courtesy Fives North American

Note: This information can be used for fuel oil with less than 5% error.

# Energy Savings: Reduction of Excess Air

Control Air-Fuel Ratio or Reduction of Excess Air (or Oxygen) in Flue Gases			
		Current	New
11	Furnace flue gas temperature (°F.)	1,200	1,200
12	Percent O <sub>2</sub> (dry) in flue gases	8.00	3.00
13	% Excess air	55.08	14.92
14	Combustion air temperature (°F.)	70	70
15	Fuel consumption (MM Btu/hr) - Avg. current	20.00	17.32
16	Available Heat (%)	53.8%	62.2%
17	Fuel savings (%)	Base	13.39%
18	No. of operating hours (hours/year)	8000	8000
19	Heat energy used per year (MM Btu/year)	160,000	138,579
20	Heat energy saved (MM Btu/year)	Base	21,421
21	Cost of fuel (\$/Million Btu)	\$ 5.00	\$ 5.00
22	Annual savings (\$/year)	Base	\$ 107,105
23	CO <sub>2</sub> savings (Tons/year)	Base	1,253

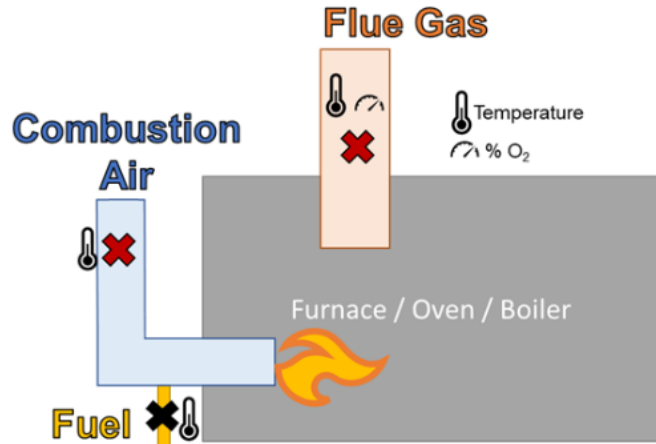
- Firing rate: 20 MMBtu/hr
- Current flue gases
  - O<sub>2</sub> (dry) in flue gas: 8%
  - Flue gas temperature: 1,200°F
- After burner tune-up, leak check, and sealing of the heater:
  - O<sub>2</sub> (dry) in flue gas : 3.00%
  - Flue gas temperature: 1,200°F
- Fuel savings: 13.4%
- Energy cost savings: \$107,000/year
- Basis for calculations:
  - Fuel cost – \$5/MMBtu
  - Operating hours – 8,000/year

# Summary for Combustion System Related Measures

<b>Actions</b>	<b>Potential energy savings*</b>
Use proper burner type	2% to 5%
Use proper air-to-fuel ratio control system	5% to 15%
Use preheated air	5% to 30%
Use oxygen-enriched combustion air or oxy-fuel burners where economically justified or required	5% to 35%
Use alternate burner control system to extend burner turn-down if necessary	1% to 5%

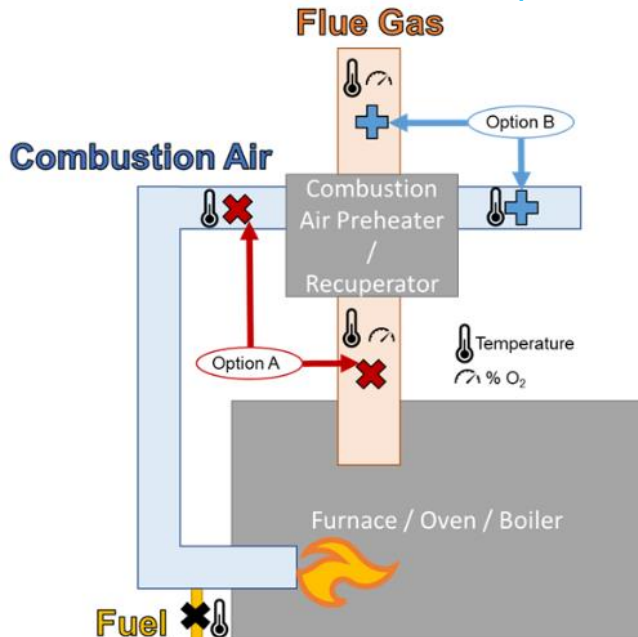
# 4. Energy Saving Measures Exhaust Gases or Flue Gases

Measurement location without recuperator



- Flue gases from a furnace may contain:
  - Combustion products
  - Water vapor
  - Liquid vapors
  - Volatiles
  - Condensable solids
  - Non-condensable particles
  - Furnace “atmosphere” or gases

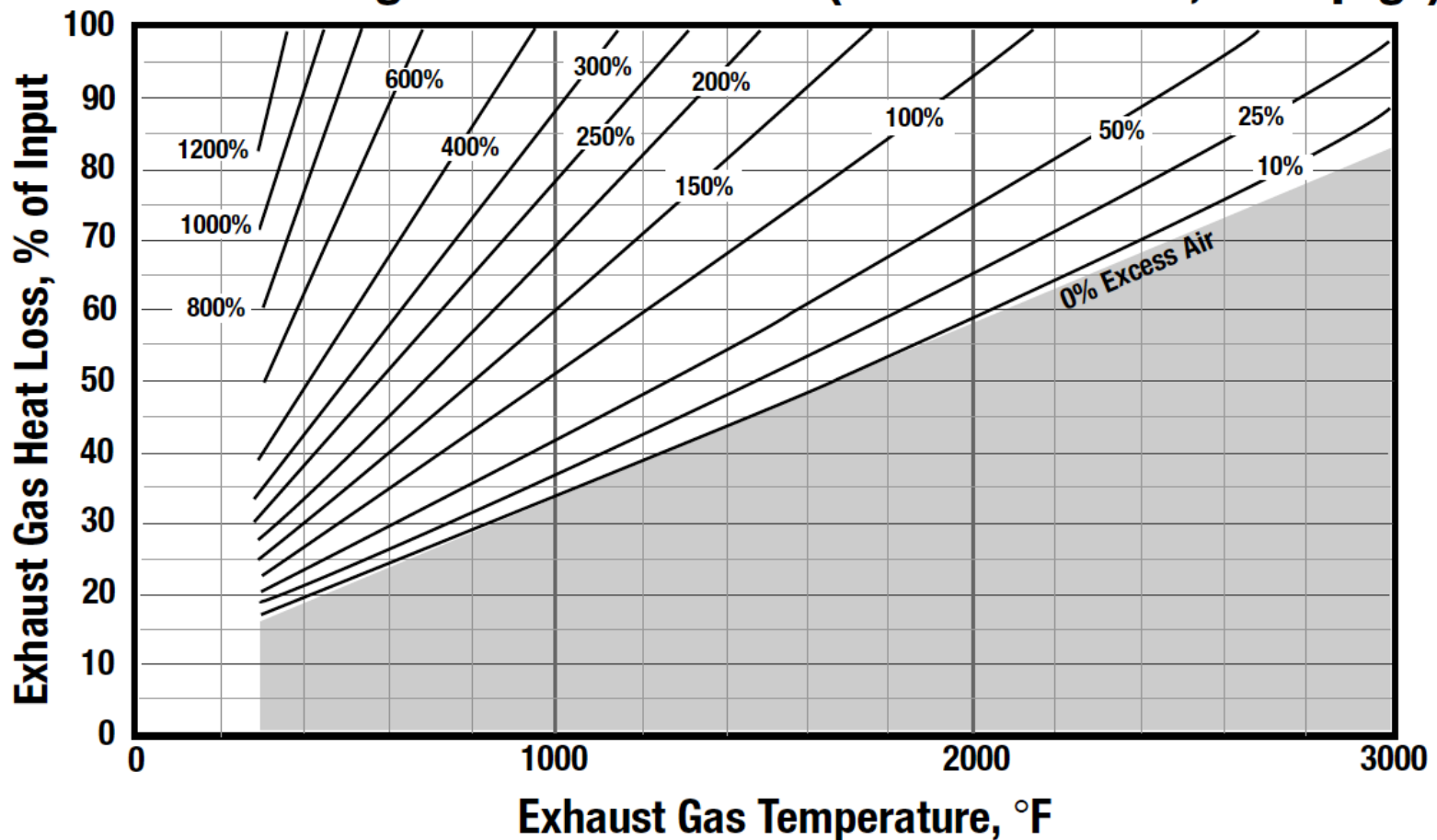
Measurement location with recuperator



- Flue gas analysis may get affected by the presence of non-condensable gases
- Flue gas O<sub>2</sub> and temperature are measured at the same location to maintain accuracy of the calculations

# Reduce Flue Gas Losses

**Fuel: Birmingham Natural Gas (1002 Btu/cu ft, 0.6 sp gr)**



Flue losses increase with: Temperature of flue gases; O<sub>2</sub> level in flue gases

# Waste Heat Management Options



- Waste heat Reduction within the heating system itself
- Waste heat Recycling within the heating system itself
- Waste heat Recovery:
  - Use of waste heat outside the heating system – utilize heat in (or for) other systems within the plant or outside the plant
  - Waste heat to power conversion

# Exhaust Gas Waste Heat Reduction

- Reduce mass flow rate
  - Reduce/control excess air for burners
  - Control make-up air
  - Reduce/eliminate air leaks
  - Reduce moisture content of exhaust gases where possible
  - Process specific actions (i.e. pretreatment of charge material)
  - Use of oxygen enriched air
  - Use of air and/or fuel preheating
  
- Reduce temperature of exhaust gases
  - Use of proper temperature controls
  - Use of advanced controls to optimize zone temperature (i.e. on-line process modeling)
  - Avoid over-firing of burners
  - Control air-fuel ratio to avoid sub-stoichiometric (rich) combustion

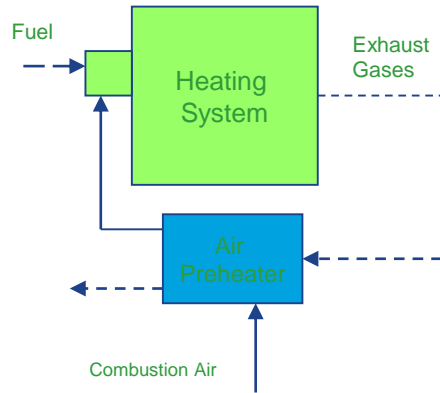


# Summary for Exhaust Gas Reduction Related Measures

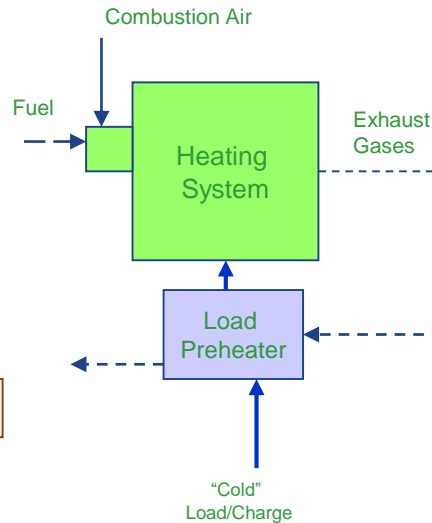
<b>Reduce excess air used for fuel combustion in burners</b>	<b>2% to 10%</b>
<b>Control and minimize the amount of make-up air, if used, in ovens and dryers</b>	<b>5% to 20%</b>
<b>Minimize air leakage by reducing the size and number of openings</b>	<b>1% to 5%</b>
<b>Use pressure control to reduce/eliminate air infiltration or hot gases exfiltration</b>	<b>1% to 5%</b>
<b>Use proper controls for zone temperature and furnace firing rate to avoid excessively high exhaust gas temperature</b>	<b>2% to 10%</b>
<b>Avoid discharge of excessive moisture or process gases if possible by pre-processing the load/charge material</b>	<b>0% to 2%</b>

# Exhaust Gas Waste Heat Recycling

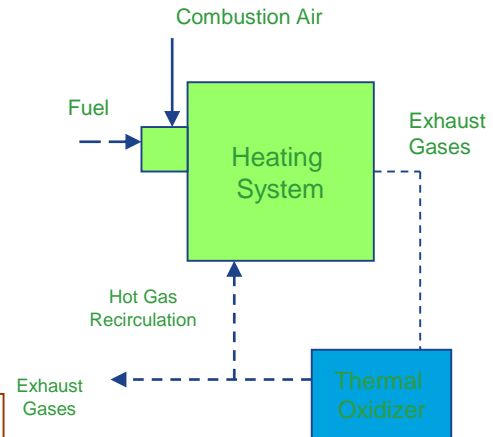
## Waste Heat Recycling Options



1. Combustion Air Preheating



2. Load-Charge Preheating



3. Internal heat recycling - cascading

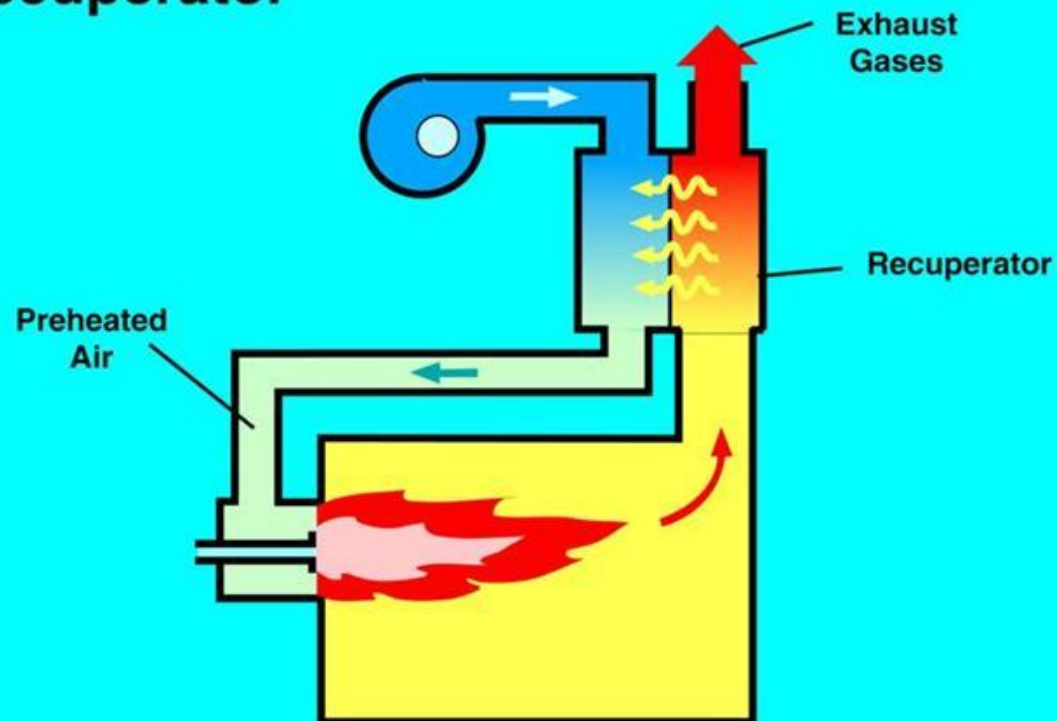
**These other options: use similar technology and hardware as the systems 1,2 and 3.**

**4. Make up air heating**

**5. Water (liquid) heating**

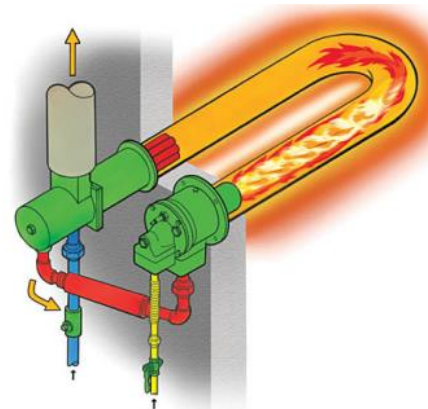
# Preheat Combustion Air with Recuperator

## Recuperator



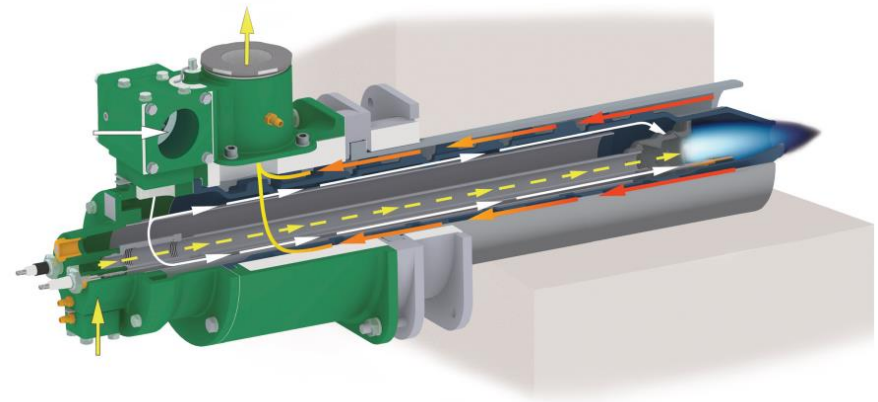
- Continuous, simultaneous flow of exhaust & combustion air.
- A physical barrier separates air & exhaust flows.

# Preheat Combustion Air

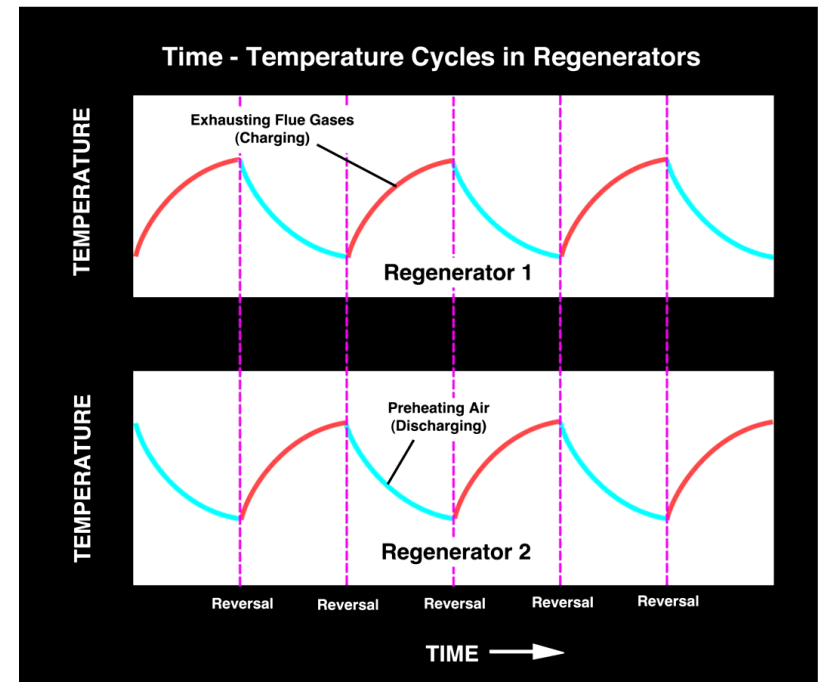
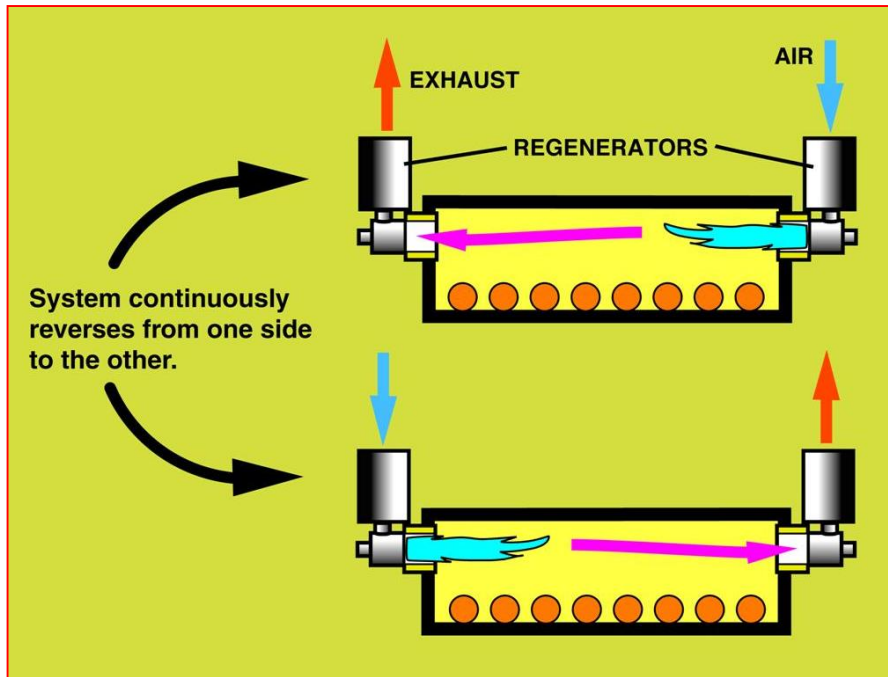


Self recuperative radiant  
tube burner

Self recuperative direct  
fired burner



# Preheat Combustion Air with Regenerators

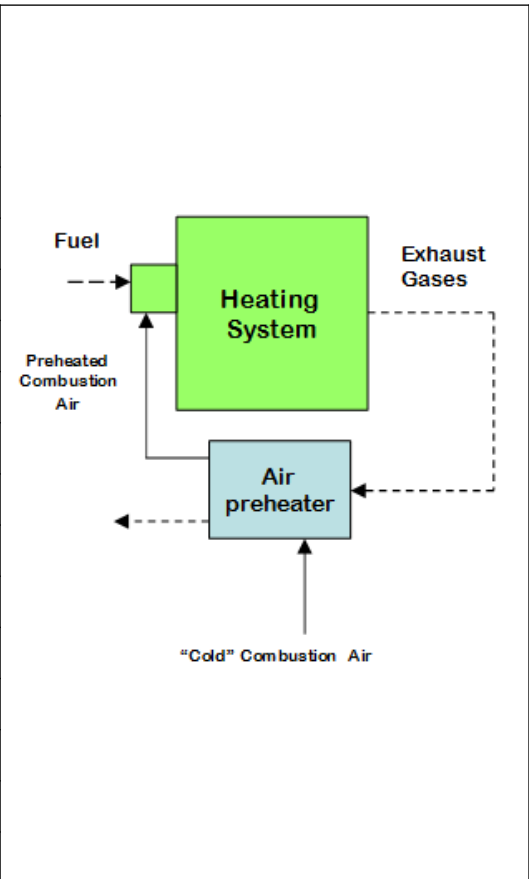


**Note: Regenerators have been used to preheat low calorific value fuels such as blast furnace gas. Fuel preheating is rarely used for high calorific value fuels.**

# Combustion Air Preheating Savings

Gas fired reheat furnace saves approx. \$23,000 per year. This is a preliminary evaluation for possible heat recovery using heat of exhaust gases.

Use of Preheated Combustion Air			
Note: The combustion air is heated by using heat from flue or exhaust gases.			
		Current	New
11	Furnace flue gas temp. (°F)	1,000	1,000
12	Percent O2 (dry) in flue gases	3.00	3.00
13	% Excess air	14.92	14.92
14	Combustion air temperature (°F)	60	600
15	Fuel consumption (MM Btu/hr) - Avg. current	5.00	4.36
16	Volume of fuel gas scfh - based on fuel heating value	4,945.19	4,308.71
17	Available Heat (%)	66.89	76.77
18	Fuel savings (%)	Base	12.87%
19	No. of operating hours (hours/year)	6000	6000
20	Heat used per year (MM Btu/year)	30,000	26,139
21	<b>Heat saved per year (MM Btu/year)</b>	<b>Base</b>	<b>3,861</b>
22	Cost of fuel (\$/Million Btu)	\$ 6.00	\$ 6.00
23	<b>Annual savings (\$/year)</b>	<b>Base</b>	<b>\$ 23,167</b>
24	<b>CO2 savings (tons/year)</b>	<b>Base</b>	<b>227</b>



# Exhaust Gas Waste Heat Recovery Options

Heat recovery system	Waste heat Temperature (deg. C)	Typical applications	Typical installed cost
Steam generation	350 <sup>o</sup> C and higher	Large furnaces with >25 GJ /hr. firing rate. Reheat furnaces, process heaters, glass melting furnaces etc.	\$35 to \$60 per 500 kg lb. steam generation
Hot water heating	150 <sup>o</sup> C and higher	Heating equipment of all sizes. Heat treating, reheating, forging, ovens, dryers etc.	\$30,000 to \$50,000 per GJ heat transferred
Plant or building heating	100 <sup>o</sup> C and higher	Mostly in cold climate areas. Can be used for medium to large size (5 GJ/hr. and larger size).	\$25,000 to \$50,000 per GJ transferred
Absorption cooling systems	175 <sup>o</sup> C and higher	Low to medium temperature systems, large size furnaces, ovens, heaters etc.	\$750 to \$1500 per ton of refrigeration capacity
Cascading to lower temperature heating processes	400 <sup>o</sup> C and higher	For gases from medium to large size systems supplying heat to lower temperature heating systems.	\$40,000 to \$100,000 per GJ transferred

**Note:**

The costs are very preliminary and based on US conditions hence given in US\$.

They can be different for other countries and even vary by as much as 100%.

**DO NOT** use the costs for economic analysis for site specific cases.

# Waste Heat to Power

## Application Considerations

- Need relatively **clean & contamination free source of waste heat** (gas or liquid source). Avoid heavy particulate loading and/or presence of condensable vapors in waste heat stream.
- **Continuous or predictable flow** for waste heat source.
- Relatively moderate waste heat stream temperature (at least 300°F, but >600°F is preferred) at constant or predictable value.
- **Cannot find or justify use of heat within process or heating equipment itself.**
- Cannot find or justify alternate **heat recovery methods** (steam, hot water, cascading etc.) that can be used in plant.
- Try to **avoid or reduce use of supplementary fuel** for power generation. It can have negative effect on overall economics unless power cost can justify it.

# Waste Heat to Power Options

Comparison	Steam Rankine	Organic Rankine (ORC)	Ammonia (NH <sub>3</sub> ) - Water	CO2 Power Cycle
<b>Source Temperature Range Deg. C.)</b>	400 plus	150 to 300	100 to 450	225 to 650
<b>Working Fluid</b>	Treated water	HCFCs or Hydrocarbons	Ammonia - water mixture	Carbon Dioxide
<b>Working Fluid Attributes</b>	Requires treatment to reduce corrosion and mineral deposition	Limited temperature range, flammability, thermally unstable at higher temperature	Limited temperature range, corrosive, ammonia leaks	Non-corrosive, non-toxic, non-flammable, thermally stable
<b>Conversion Efficiency (%)</b>	20% plus	8% to 12%	8% to 15%	13% to 17%
<b>Reported Cost (\$/kW)</b>	\$600 plus	\$2500 plus	\$2500 plus	\$2000 plus

**Note: This is a fast changing field. The efficiency values highly dependent on the source temperature. Cost could vary significantly with size, supplier and incentives from several sources.**

The costs are very preliminary and based on US conditions hence in US\$. They can be different for other countries and even vary by as much as 100%

# Waste Heat Management Options Summary

## Recycling and Recovery

- Three possible options should be considered and evaluated for use of waste heat from a heating system.
  1. Use waste heat within the process or system itself. This is the most economical and effective method of using waste heat.
  2. Use waste heat within the plant boundary itself. Options include use in or for plant utilities or use in other processes.
  3. Waste heat to power conversion.
- Very few options are available for recycling or recovery of “contaminated” waste heat streams, particularly at higher temperatures.

# DOE Resources

# DOE Resources on Process Heating

<https://betterbuildingsolutioncenter.energy.gov/better-plants/process-heating>

## ■ Online Material

- Process Heating Tip Sheets (11 tip sheets)
- Sourcebook for Industry
- Case Studies
- Info Cards
- Pre-recorded webinars

## ■ Software Tools

- MEASUR – PHAST and PH Calculators
- PHASTEx – Excel version

# Process Heating Tip Sheets & Other Resources

The tip sheets and other resources can be downloaded from the AMO Process Heating site at:

<https://betterbuildingsolutioncenter.energy.gov/better-plants/process-heating>.

- Preheated Combustion Air (recovery)
- Check Burner Air to Fuel Ratios (generation)
- Oxygen-Enriched Combustion (recovery)
- Check Heat Transfer Surfaces (transfer)
- Reduce Air Infiltration in Furnaces (containment)
- Furnace Pressure Controllers (generation)
- Reduce Radiation Losses from Heating Equipment (containment)
- Install Waste Heat Recovery Systems for Fuel-Fired Furnaces (recovery)
- Load Preheating Using Flue Gases from a Fuel-Fired Heating System (recovery)
- Using Waste Heat for External Processes (recovery)
- Use Lower Flammable Limit Monitoring Equipment to Improve Oven Efficiency

# MEASUR – Process Heating Module

The screenshot displays the MEASUR software interface. At the top left is the U.S. Department of Energy logo. The main header features the MEASUR logo and a welcome message: "Welcome to the most efficient way to manage and optimize your plant's systems and equipment." Below this, instructions state: "Create an assessment to model your system and find opportunities for efficiency or run calculations from one of our many property and equipment calculators. Get started with one of the following options." Two curved arrows point to two main sections: "Create Assessment" and "Properties & Equipment Calculators".

**Create Assessment**  
Model a system and explore multiple optimization scenarios.

- Create Pump Assessment**  
*formerly DOE Pumping System Assessment Tool (PSAT)*
- Create Process Heating Assessment**  
*formerly DOE Process Heating Assessment and Survey Tool (PHAST)*
- Create Fan Assessment**  
*formerly DOE Fan System Assessment Tool (FSAT)*
- Create Steam Assessment**  
*formerly DOE Steam System Modeler Tool (SSMT)*
- Create Treasure Hunt**  
*Energy efficiency calculators for facilitating a Treasure Hunt*

[View All Your Assessments](#)

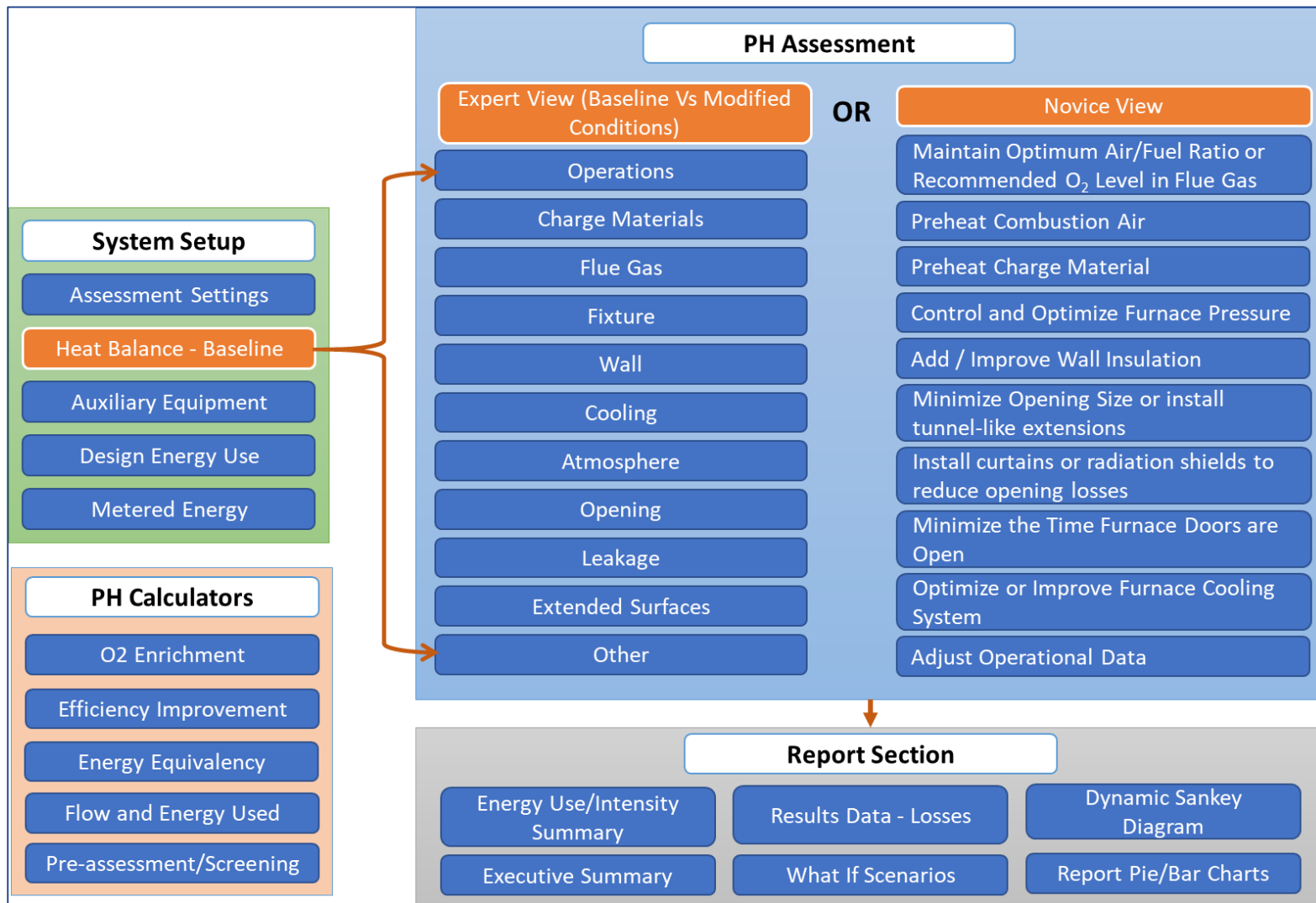
**Properties & Equipment Calculators**  
Generate detailed properties and test a variety of adjustments.

- Motors
- Pumps
- Fans
- Process Heating
- Steam
- Compressed Air
- Lighting
- General

**Left Sidebar:**

- U.S. DEPARTMENT OF ENERGY  
Energy Efficiency & Renewable Energy
- Add Assessment
- Home
- All Assessments
  - New Assessment
  - Boiler
  - ArcelorMittal
  - Baking Oven
  - ArcelorMittal Warren OH
- Examples
  - Reheat Furnace Case Study
  - Example Pump
  - Fan Example
- All Calculators
  - Motors
  - Pumps
  - Fans
  - Process Heating
  - Steam
  - Compressed Air
  - Lighting
  - General
- Settings
- Custom Materials
- Tutorials
- About
- Feedback
- Acknowledgments
- v0.5.3-beta

# Overview of the MEASUR PH Assessment Module Capabilities



# e.g. Reheat Furnace Assessment— Expert View with notes

Reheat Furnace AISTech  
Fuel-fired  
Last modified: Feb 28, 2020

System Setup **Assessment** Diagram Report Sankey Calculators

Explore Opportunities **Modify All Conditions**  
Novice View Expert View

Repair wall insulation  
Selected Scenario [View / Add Scenarios](#)

Operations ● Charge Materials ① Flue Gas ① Fixture **Wall ①** Cooling ① Atmosphere Opening ② Leakage Extended Surface Other

BASELINE	
Loss #1	
Average Surface Temperature	175 °F
Ambient Temperature	70 °F
Wind Velocity	0 mph
Surface Shape / Orientation	Vertical plates
Surface Shape / Orientation Factor	1.394
Surface Emissivity	0.9
Total Outside Surface Area	11100 ft <sup>2</sup>
Correction Factor	1
<b>Loss #1 Total</b>	<b>2.67494 MMBtu/hr</b>
<b>Wall Loss Total</b>	<b>2.67494 MMBtu/hr</b>

REPAIR WALL INSULATION	
Loss #1	
Average Surface Temperature	150 °F
Ambient Temperature	70 °F
Wind Velocity	0 mph
Surface Shape / Orientation	Vertical plates
Surface Shape / Orientation Factor	1.394
Surface Emissivity	0.9
Total Outside Surface Area	11100 ft <sup>2</sup>
Correction Factor	1
<b>Loss #1 Total</b>	<b>1.91731 MMBtu/hr</b>
<b>Wall Loss Total</b>	<b>1.91731 MMBtu/hr</b>


RESULTS HELP NOTES

\* Repair insulation and remove hot spots

Back



Next View Report

# e.g. Reheat Furnace Assessment— Novice View with results



Reheat Furnace AISTech  
Fuel-fired  
Last modified: Feb 28, 2020

System Setup
Assessment
Diagram
Report
Sankey
Calculators

**Explore Opportunities**

Novice View

Modify All Conditions

Expert View

**SELECT POTENTIAL ADJUSTMENT PROJECTS**

*Select potential adjustment projects to explore opportunities to increase efficiency and the effectiveness of your system.*

Add New Scenario

Modification Name

---

Maintain Optimum Air/Fuel Ratio or Recommended O<sub>2</sub> Level in Flue Gas

---

Preheat Combustion Air

---

Preheat Charge Material

Modify Initial Temperature

Material #1

Baseline Initial Temperature  °F

Modification Initial Temperature  °F

---

Add / Improve Wall Insulation

---

Minimize Opening Size or install tunnel-like extensions

---

Install curtains or radiation shields to reduce opening losses

---

Minimize the Time Furnace Doors are Open

---

Optimize or Improve Furnace Cooling System

---

Adjust Operational Data

---

**Warm charging of slabs**

*Selected Scenario*

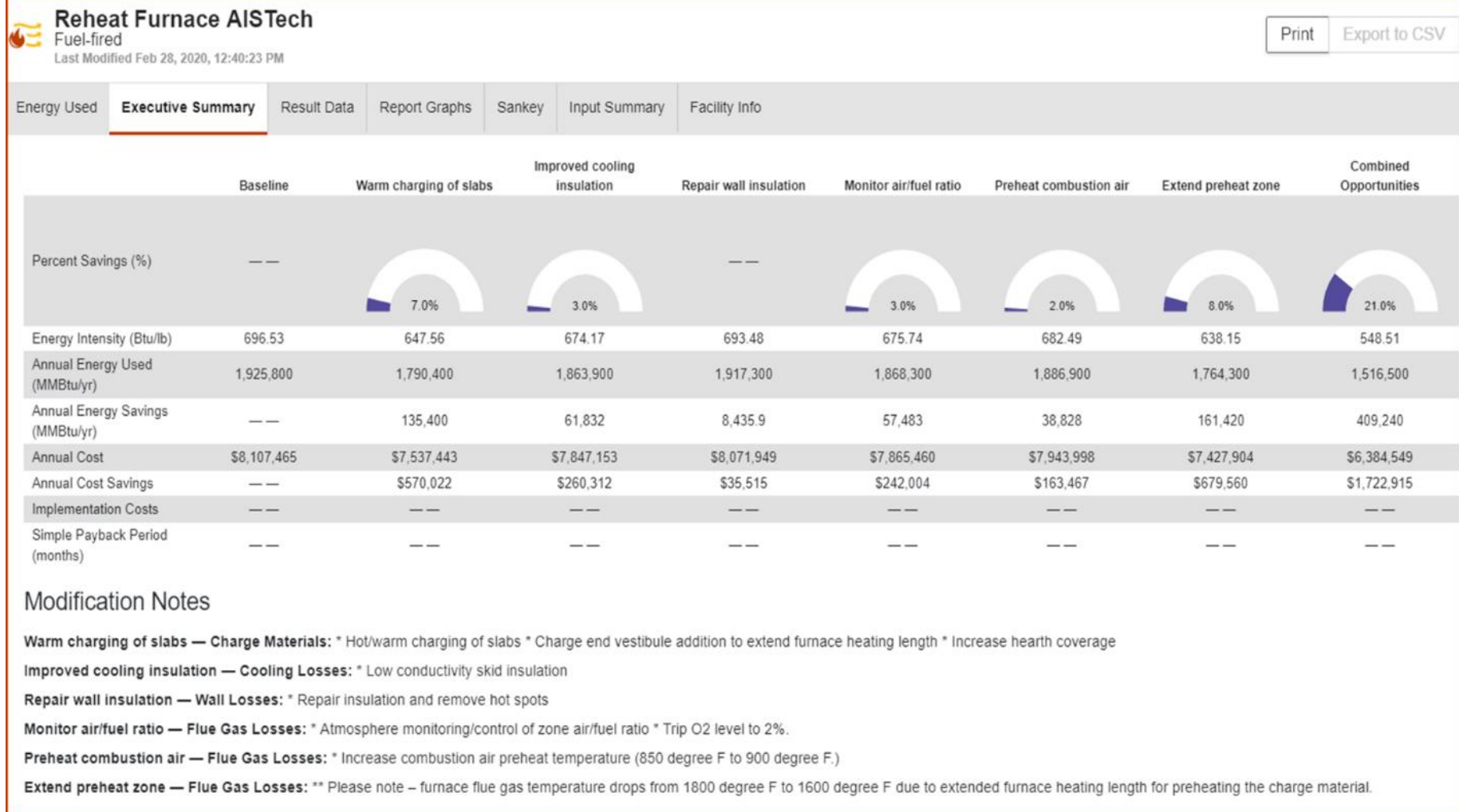
View / Add Scenarios

RESULTS	HELP	NOTES
Energy Loss/Use	Baseline MMBtu/hr	Warm charging of slabs MMBtu/hr
Charge Materials	143.36	131.20
Fixtures, trays etc.	—	—
Wall Losses	2.67	2.67
Cooling Losses	24.06	24.06
Atmosphere Losses	—	—
Opening Losses	3.41	3.41
Leakage Losses	—	—
Extended Surface Losses	—	—
Other Losses	—	—
Total Net Heat Required	173.51	161.35
Available Heat (%)	62.1%	62.1%
Flue Gas Losses	106.00	98.57
Exothermic Heat from Process	-0.90	-0.90
<b>Gross Heat Input</b>	<b>278.61</b>	<b>259.02</b>

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View Report

# Reheat Furnace Results—Executive Summary



# Reheat Furnace Results Data



## Reheat Furnace AIStech

Fuel-fired

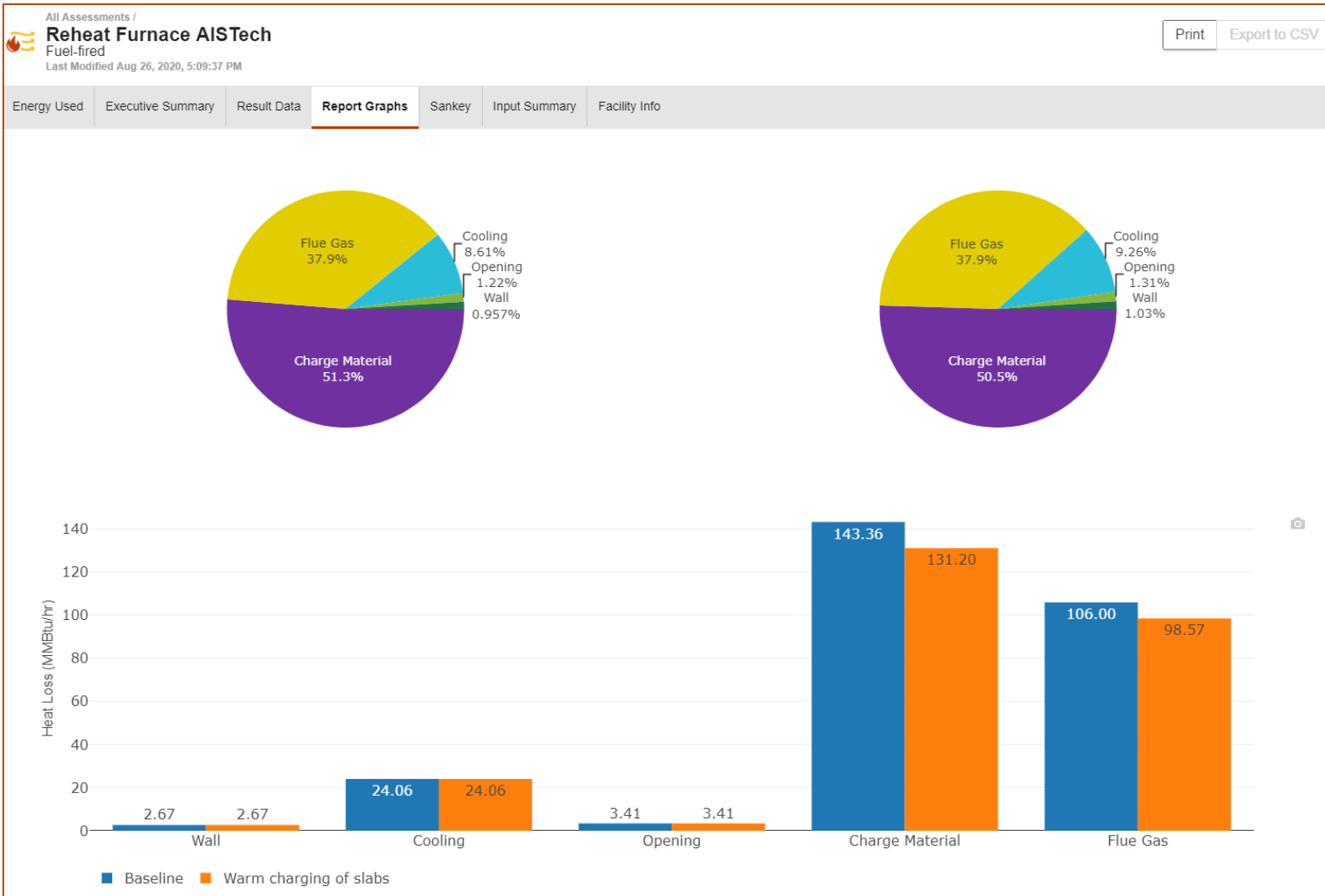
Last Modified Feb 28, 2020, 12:40:23 PM

Print

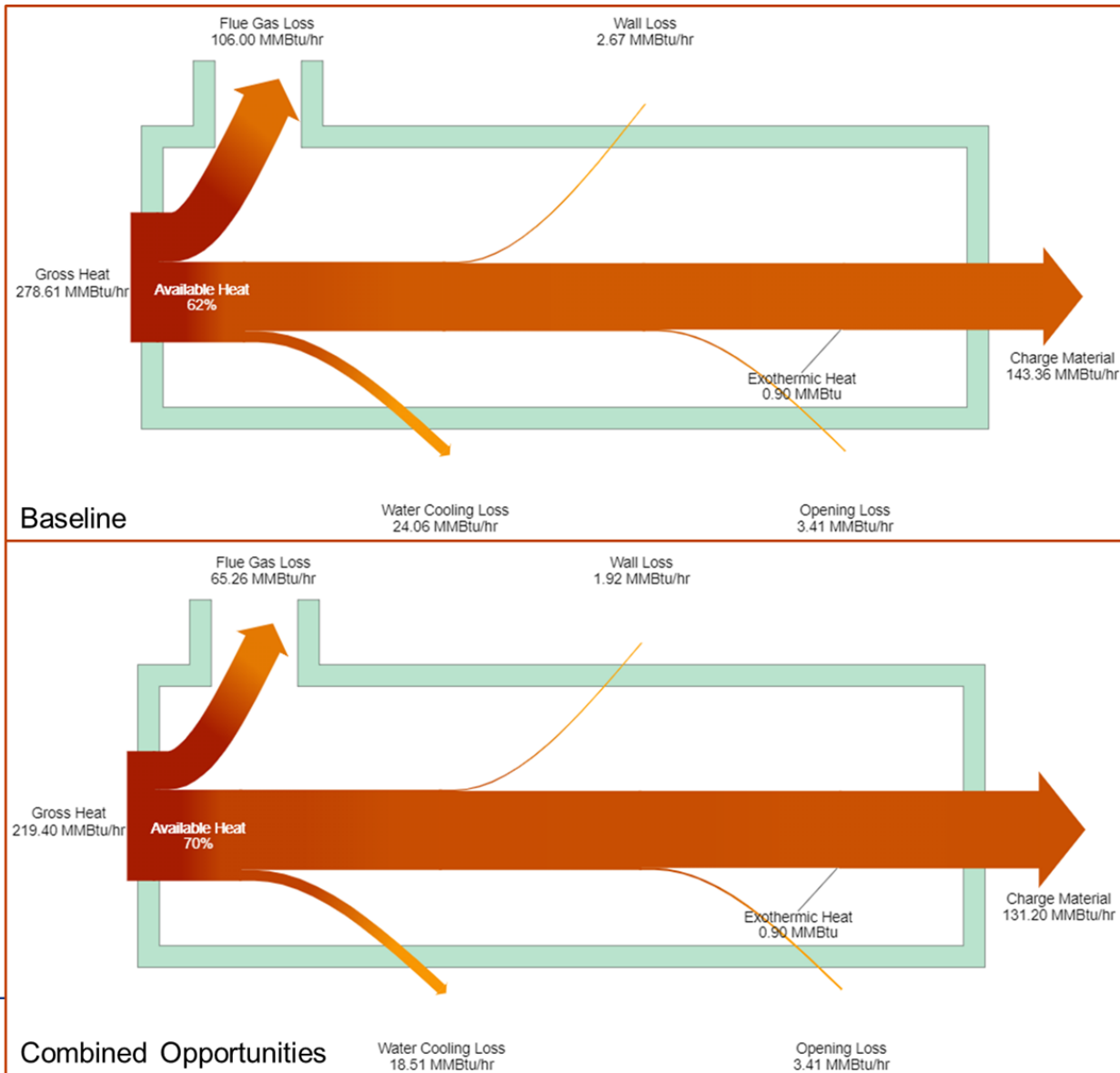
Export to CSV

Energy Used	Executive Summary	<b>Result Data</b>	Report Graphs	Sankey	Input Summary	Facility Info				
<b>Energy Loss/Use</b>	<b>Baseline</b>	<b>Warm charging of slabs</b>	<b>Improved cooling insulation</b>	<b>Repair wall insulation</b>	<b>Monitor air/fuel ratio</b>	<b>Preheat combustion air</b>	<b>Extend preheat zone</b>	<b>Combined Opportunities</b>		
	MMBtu/hr	MMBtu/hr	MMBtu/hr	MMBtu/hr	MMBtu/hr	MMBtu/hr	MMBtu/hr	MMBtu/hr		
Charge Materials	143.36	131.20	143.36	143.36	143.36	143.36	143.36	131.20		
Fixtures, trays etc.	---	---	---	---	---	---	---	---		
Wall Losses	2.67	2.67	2.67	1.92	2.67	2.67	2.67	1.92		
Cooling Losses	24.06	24.06	18.51	24.06	24.06	24.06	24.06	18.51		
Atmosphere Losses	---	---	---	---	---	---	---	---		
Opening Losses	3.41	3.41	3.41	3.41	3.41	3.41	3.41	3.41		
Leakage Losses	---	---	---	---	---	---	---	---		
Extended Surface Losses	---	---	---	---	---	---	---	---		
Other Losses	---	---	---	---	---	---	---	---		
<b>Total Net Heat Required</b>	<b>173.51</b>	<b>161.35</b>	<b>167.96</b>	<b>172.75</b>	<b>173.51</b>	<b>173.51</b>	<b>173.51</b>	<b>155.04</b>		
<b>Available Heat (%)</b>	<b>62.1%</b>	<b>62.1%</b>	<b>62.1%</b>	<b>62.1%</b>	<b>64.0%</b>	<b>63.3%</b>	<b>67.7%</b>	<b>70.4%</b>		
Flue Gas Losses	106.00	98.57	102.61	105.54	97.68	100.38	82.65	65.26		
Exothermic Heat from Process	-0.90	-0.90	-0.90	-0.90	-0.90	-0.90	-0.90	-0.90		
<b>Gross Heat Input</b>	<b>278.61</b>	<b>259.02</b>	<b>269.67</b>	<b>277.39</b>	<b>270.30</b>	<b>272.99</b>	<b>255.26</b>	<b>219.40</b>		

# Reheat Furnace Results—Executive Summary



# Reheat Furnace Results—Sankey diagrams



# Measurements and Diagnostic Equipment

## ■ Combustion Measurement

- Combustion Analyzer
- Combustion Efficiency
- O<sub>2</sub>, CO, CO<sub>2</sub>
- Inlet Temperature, Flue, Temperature, Draft, Excess Air

## ■ Surface Heat Loss

- Temperature



# Technical Assistance: Diagnostic Equipment Program

Field data is best for evaluating system performance



- Free of charge, including shipping
- Use equipment for one day, or up to four weeks
- Some technical assistance with selection and usage
- First come, first serve application

Website link - [The Diagnostic Equipment Program](#)

# Acknowledgements

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---

# Q & A

Submit Questions  
[www.slido.com](https://www.slido.com) event code **#DOE**



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Thr, Aug 20, 2020 | 1:00 - 2:00 PM ET

## PUMPS AND FANS

Thr, Aug 27, 2020 | 1:00 - 2:30 PM ET

## PROCESS HEATING & WASTE HEAT RECOVERY

Thr, Sep 3, 2020 | 1:00 - 2:30 PM ET

## FIELD VALIDATION

Thr, Sep 10, 2020 | 1:00 - 2:00 PM ET

[REGISTER TODAY >](#)

## ENERGY MANAGEMENT DURING A PANDEMIC

Thr, Sep 17, 2020 | 1:00 - 2:00 PM ET

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## MEASUR TOOL SUITE

Thr, Sep 24, 2020 | 1:00 - 2:00 PM ET

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## PROCESS COOLING

Thr, Oct 1, 2020 | 1:00 - 2:00 PM ET

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# Additional Questions?

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