

CASE STUDY

Large Scale Industrial Waste Heat-to-Power / Cogeneration

Port Arthur Steam Energy LP

Presented to:



AUGUST 17-21, 2020

Raymond Deyoe
Managing Director
Integral Power, LLC



PASE Project at a Glance

Project: Port Arthur Steam Energy LP (PASE)

Location: Port Arthur, Texas

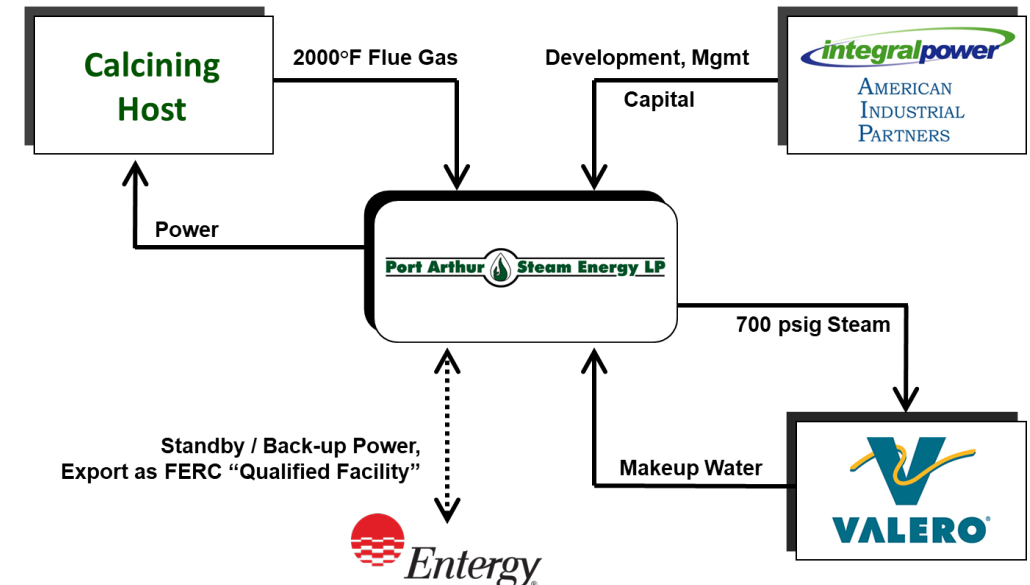
Developer & Asset Manager: Integral Power, LLC

Collaborators: Great Lakes Carbon, Valero, Entergy Gulf States, Integral Power LLC

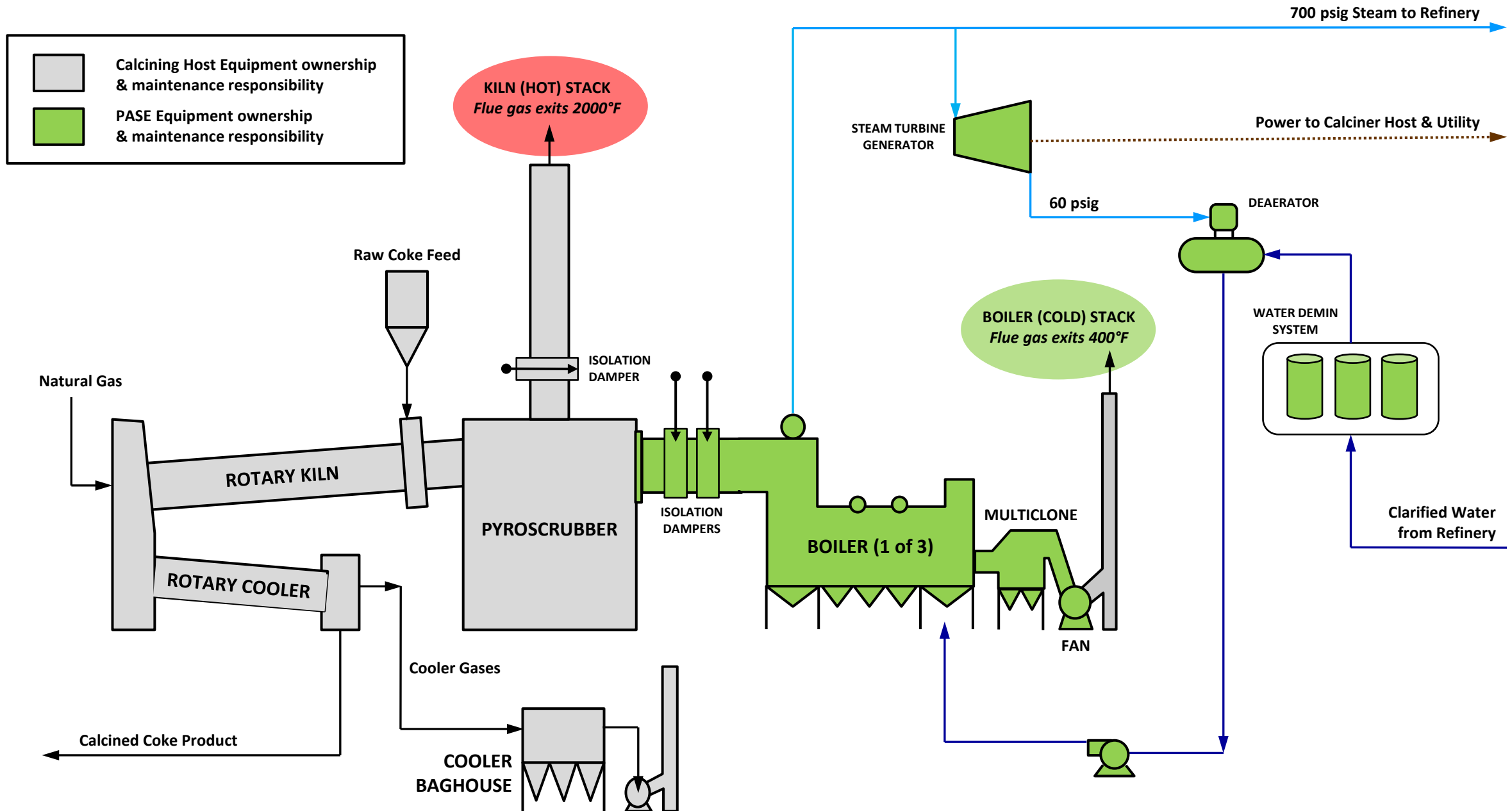
Waste Heat Source: 1800-2000°F Petroleum Coke Calcining Kiln Exhaust Heat

Capacity: 450,000 pph Process Steam + 5MW Electricity

Commercial Operation: Original Plant 1983, PASE reboot 2005

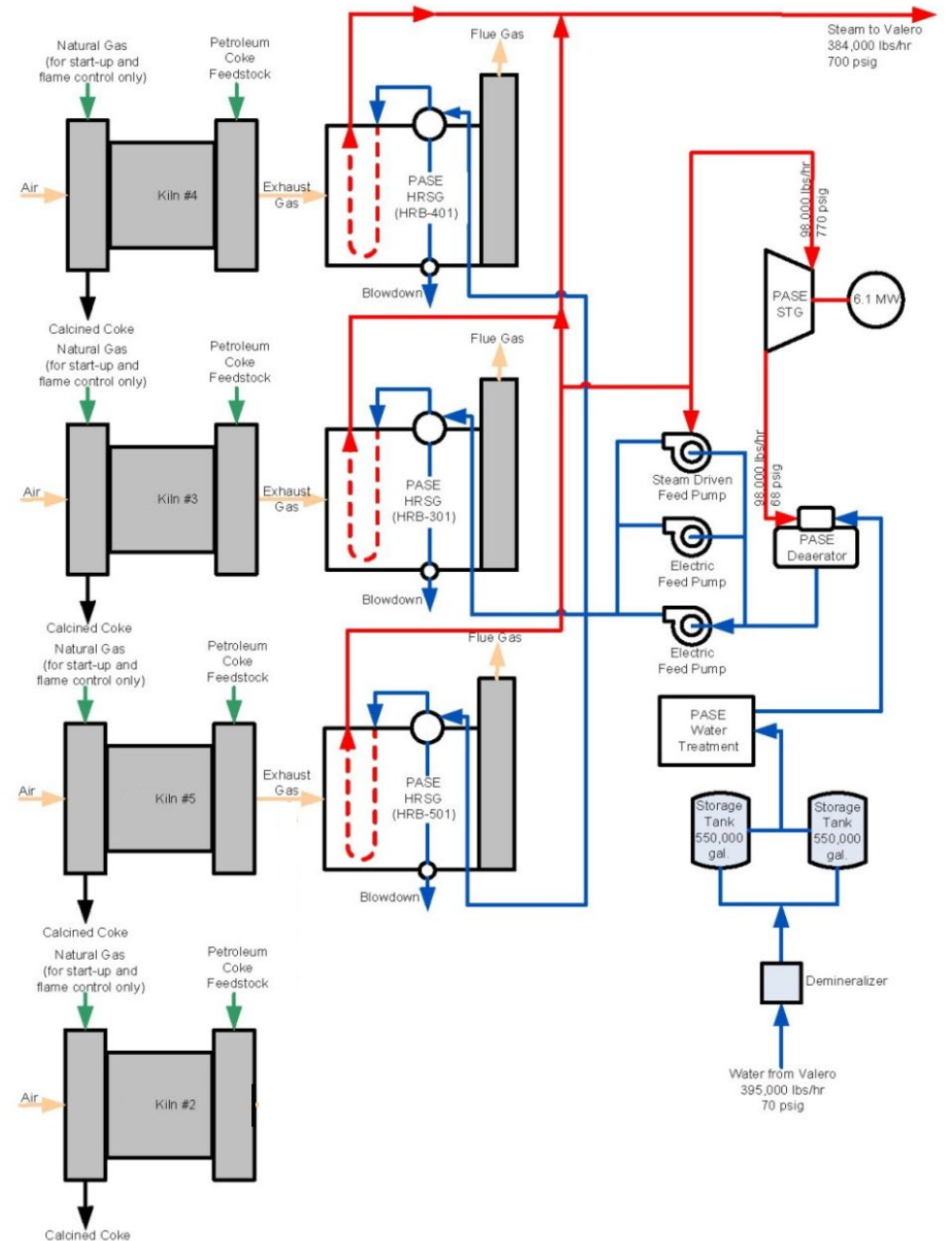


General Equipment Configuration



Major Equipment

- ✓ 490 kpph (770 psig) Total Waste Heat Boiler Capacity
- ✓ Each of 3 Boilers includes:
 - *Refractory lined inlet ducts*
 - *Magnesium Hydroxide Injection*
 - *Double Isolation Dampers*
 - *Radiant, Superheater, Evaporator, Economizer*
 - *Multiclone*
 - *Induced Draft Fan*
 - *Acoustic Sootblower*
- ✓ 6.5 MW / 4160V Steam Turbine-Generator
- ✓ Deaerator
- ✓ Electric & Steam (backup) Boiler Feed Pumps
- ✓ 1,000 gpm Water Demineralization System
- ✓ 2 x 500,000 gal Demin Water Storage Tanks
- ✓ 2.5 mile, 20" Steam Pipeline to Refinery



PASE Equipment Highlights



Multiclone & Induced Draft Fan



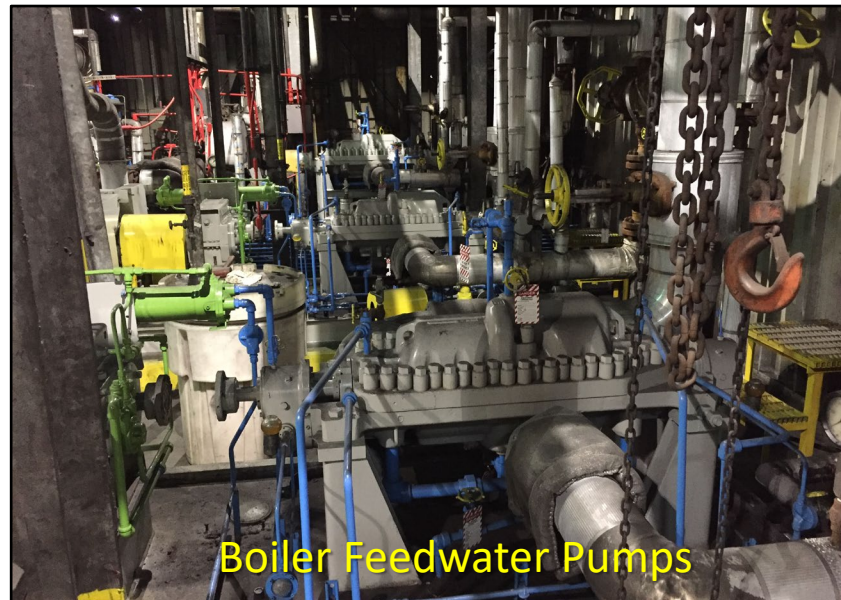
Deltak Waste Heat Boiler



Admin & Electrical Building



Emerson Delta-V Control System



Boiler Feedwater Pumps



GE Steam Turbine-Generator

Unique Challenges & Solutions – Isolation Dampers

CHALLENGE: Each upstream kiln system needed to be able to operate with its respective boiler down, and personnel protection requires double isolation to work in the boiler if the kiln is operating.

Kiln Stack “Cap” Exhaust Diverter



SOLUTION: Each kiln includes an “A” damper to isolate the kiln stack and direct the flue gas through the boiler, and also “B” and “C” isolation dampers to allow for double isolation of the boiler for periods when the boiler is down while the kiln is up.

Vertical Duct Diverter Systems



Unique Challenges & Solutions – Magnesium Hydroxide Injection

CHALLENGE: Petroleum coke calcining exhaust contains SO_2 and SO_3 , which leads to sulfur dewpoint corrosion on boiler surfaces at lower temperatures, affecting the cold end and especially during start-ups.



On-site Magnesium Hydroxide
Mixing System

SOLUTION: Magnesium Hydroxide (~60% slurry) is injected into the duct upstream of each boiler to neutralize SO_3 and lower the acid dewpoint of the flue gas, protecting cold end equipment from sulfuric acid corrosion.

Injection point in boiler inlet duct

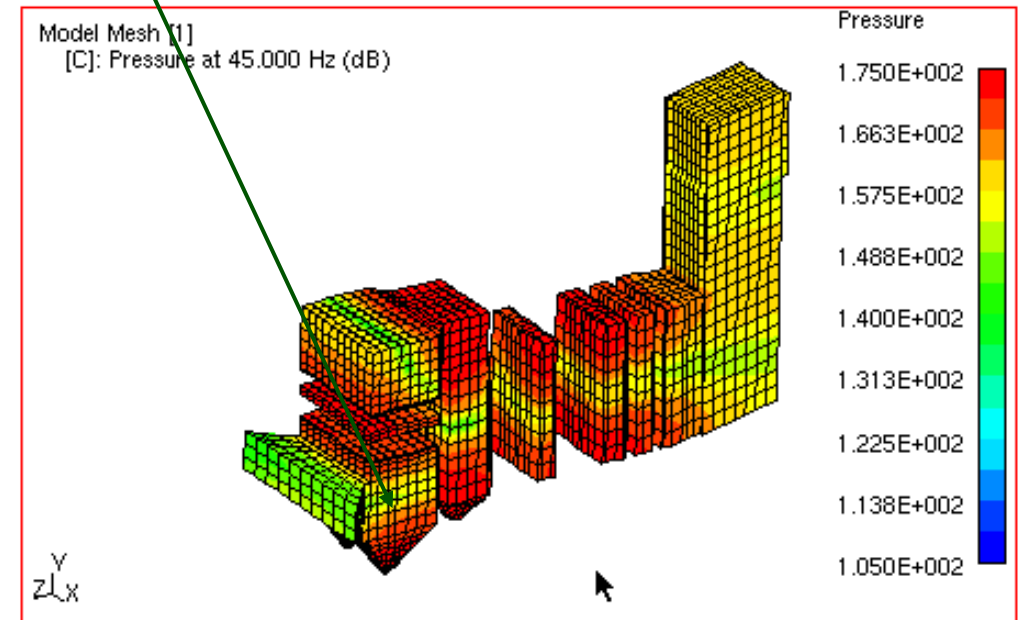


Unique Challenges & Solutions – Acoustic Sootblowers

CHALLENGE: Petroleum coke calcining exhaust contains entrained particulate, which builds up on boiler tube surfaces over time, increasing pressure drop and decreasing heat transfer.



SOLUTION: Traditional steam sootblowers from the prior (1983) installation were replaced with acoustic sootblowing horns, which were installed downstream of the economizers and tuned to affect all upstream boiler surfaces.



Key Drivers and Benefits

- ✓ Improves on-site energy efficiency, plant economics and carbon footprint.
- ✓ Capable of operating in “island mode” when the incoming utility power is interrupted, saving the host plant from power outages.

When operating at capacity:

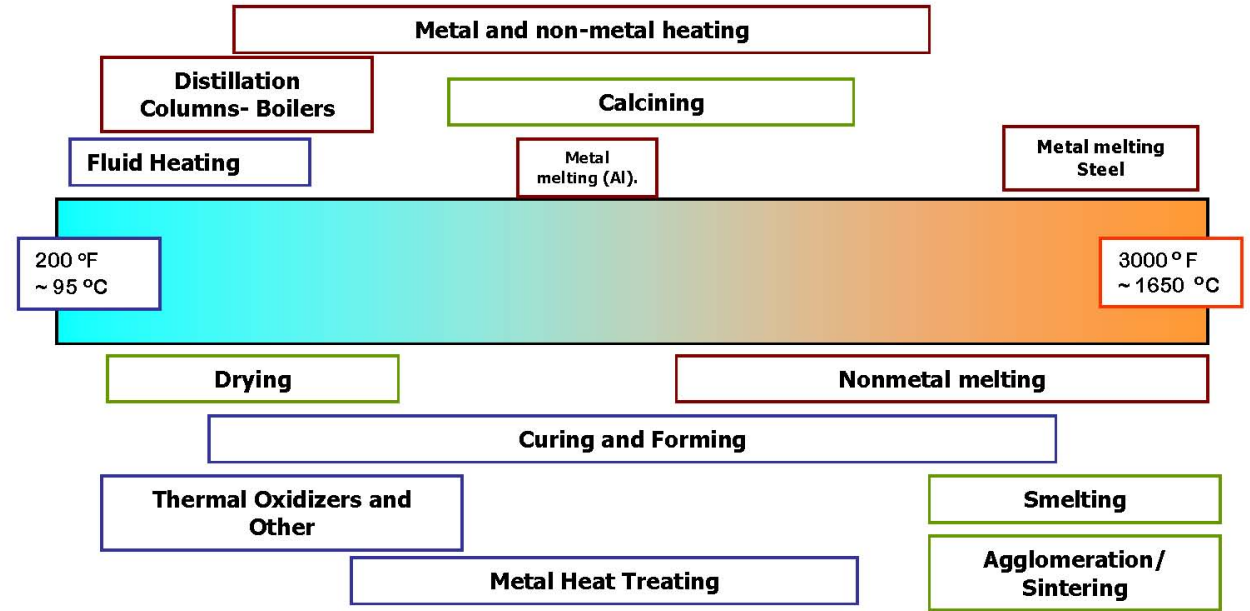
- ✓ Saves up to \$5 million per year in electric and natural gas costs.
- ✓ Avoids the burning of 36,422,400 therms of natural gas per year (~3.6 trillion BTUs per year).
- ✓ Reduces CO₂ emissions by an EPA estimated 159,000 tons per year, equivalent to the emissions from more than 27,000 passenger vehicles.



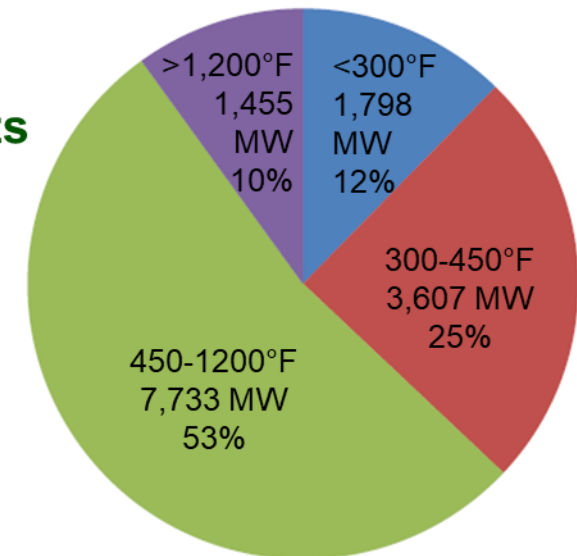
Other Applications

Lessons learned from the PASE Project ~~could~~ should be applied to recovering the waste heat from ...

- Other Calcining Facilities
- Cement Plants
- Lime Plants
- Carbon Black Plants
- Steel Manufacturing
- Waste Incineration Plants



**Potential for
Additional Projects
14,594 MW**



Source: ICF Waste Heat to Power
Market Assessment March 2015



THANK YOU!

Raymond Deyoe
Managing Director
Integral Power, LLC
Tel: 713-824-6851
rdeyoe@integralpower.com

