

ENVIRON International Corporation



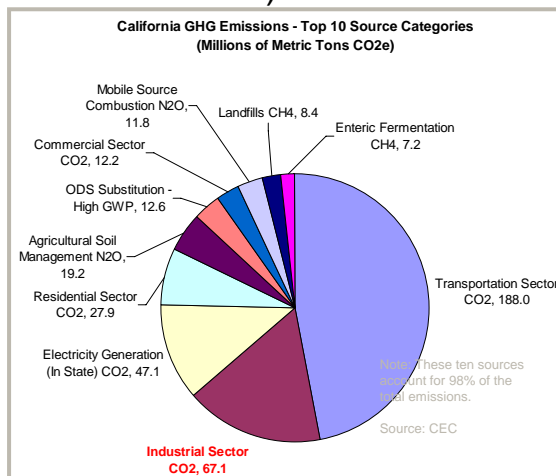
Air & Waste Management Association
 Greenhouse Gas Mitigation Strategies
 Joseph Hower, PE, DEE

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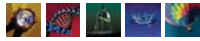


Industrial GHG Emissions

Fossil fuel use in industrial facilities is the second largest contributor to California's total GHG emission (16.4% of total emissions).

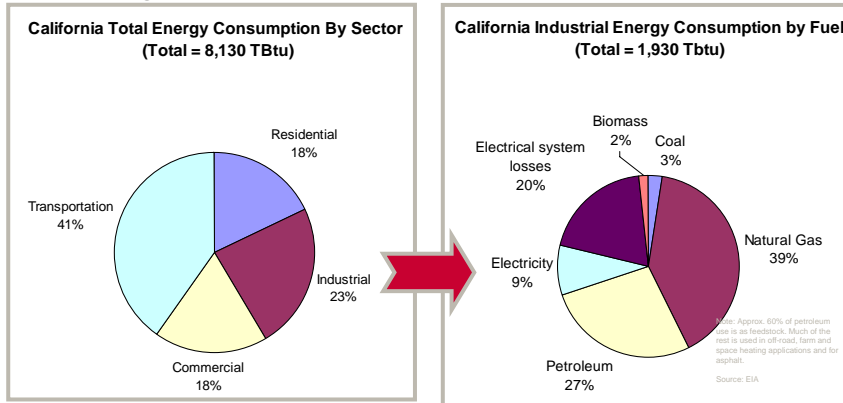


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Industrial Energy Consumption

Industrial energy consumption is approximately one quarter of the state total and is dominated by natural gas use.

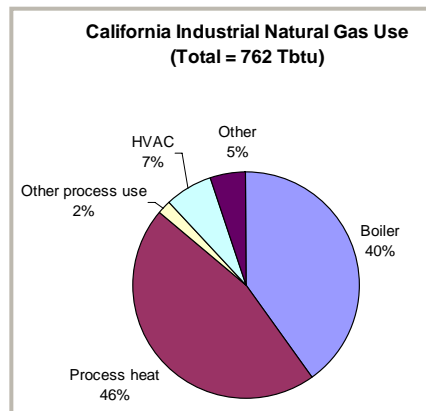


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Industrial Natural Gas Consumption

Natural gas use in industrial facilities is primarily for combustion in boilers and process heaters.



Source: "California Industrial Energy Efficiency Potential," F. Coito, et al. LBNL-59956, 2005

- Industrial boilers generally fall into one of two categories:
 - Firetube boilers: smaller sizes and lower steam pressures, the bulk of the population by number.
 - Water-tube boilers: larger sizes and higher steam pressures, the bulk of the capacity.
- Process heater designs vary widely.

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Process Heater Types

- Process heating operations are extremely diverse and include:
 - Fluid heating
 - Agglomeration and sintering
 - Calcining
 - Drying
 - Smelting
 - Heat treating
 - Metals reheating
 - Melting and refining
 - Curing and forming
 - Incineration
 - Cooking
- Equipment designs vary accordingly:
 - Batch vs continuous
 - Direct vs indirect fired
 - Fluid vs solid heating
 - Designs are often process-specific and even customized to particular facilities

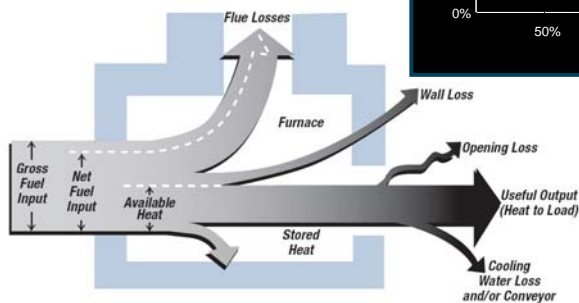
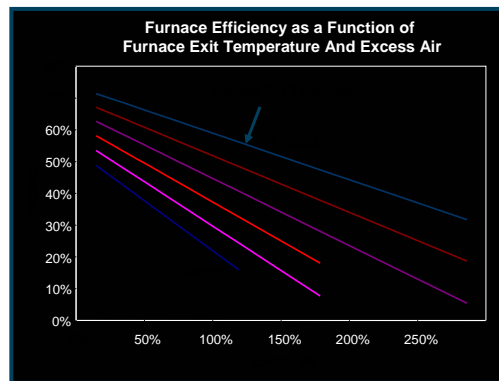


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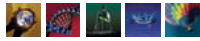


Losses in Process Heaters

- Flue or stack losses can be the most significant loss in high-temperature operations
- Reducing the burner excess air and discharge temperature can significantly increase furnace efficiency.

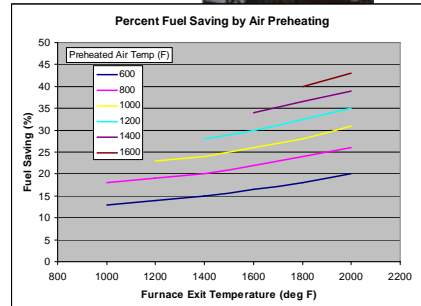


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Process Heater GHG Emissions Reductions

- Heat Generation
 - Optimize excess air level (5 to 25% potential savings)
 - Preheat combustion air (10 to 35%)
 - Use oxygen enrichment (5 to 25%)
- Heat Containment
 - Reduce wall heat losses (2 to 5%)
 - Eliminate air infiltration (5 to 10%)
 - Maintain door and tube seals (up to 5%)
- Heat Recovery
 - Feed preheating (5 to 20%)
 - Condensing heat exchangers (5 to 10%)
- Implementing fuel-switching or co-firing:
 - Biomass
 - Bio-gas
 - Ethanol
 - Bio-diesel



Source: "Improving Process Heating System Performance," US DOE, 2005

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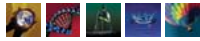


Boiler GHG Emissions Reductions

- Many options apply equally to boilers as well as process heaters.
- Improved air-fuel ratio control:
 - O₂ measurement
 - O₂ measurement with closed loop control
 - O₂ closed loop with CO constraint
- Optimizing performance of existing steam systems (load-matching, insulation, leaks, steam traps).
- Installing additional heat recovery equipment (economizers, air preheaters, condensing heat exchangers).
- Moving to on-site cogeneration or trigeneration – first step: consider a back-pressure turbine-generator.
- Implementing fuel-switching or co-firing



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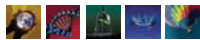


Low-cost Emissions Reductions

- Lawrence Berkeley Labs¹ have estimated economically viable fuel savings in Californian industrial boilers at ~28 TBtu (~10% saving) and in process heaters at ~19 TBtu (~5% saving). Measures included were low cost:
 - Air/fuel ratio optimization
 - Economizer installation
 - Improved insulation
 - Improved process control
 - Load matching
 - Steam trap maintenance
 - Leak repair
- These estimates do not incorporate potential GHG benefits from more costly modifications.
 - Installation of air preheaters or condensing heat exchangers
 - Use of oxygen enrichment
 - Feed preheating
 - Fuel switching

1. "California Industrial Energy Efficiency Potential," F. Coito, et al. LBNL-59956, 2005

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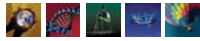


Economics

In a high oil-price world, many of these investments will pay back in 2 years or less.

- Options with payback less than 6 – 12 months
 - Heat containment improvement
 - Air-fuel ratio optimization
 - Load matching
 - Improved controls
 - Steam system optimization/maintenance
- Options with payback greater than 1 year
 - Installation of heat recovery equipment (air preheater, economizer, condensing heat exchanger)
- Options with payback greater than 2 - 3 years
 - Cogeneration or trigeneration

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Advanced Technologies

Next generation, higher efficiency, lower emissions systems are also becoming available for new installations. Recent DOE developments include:



Advanced Process Heater

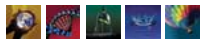
- Integrated design of combustion, heat transfer and heat recovery
- Very high efficiency (~95%)
- Very low emissions (~5 ppm NOx)
- Lower cost than conventional technology



Superboiler

- Deep staged combustion – less than 5 ppm NOx
- Ultra-high-surface heat exchangers
- An advanced heat recovery system using a patented transport membrane condenser (TMC).
- Greater than 94% thermal efficiency

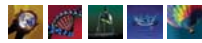
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Other Energy Reduction Options

- Lighting Retrofits
- Replacing thermal oxidizers with regenerative units
- Install submeters on power, fuel, compressed air
- More effective control systems
 - Smart thermostats
 - Energy management systems
- Process optimization

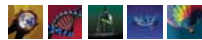
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Other GHG Reduction Options

- Scrubbers
- Fuel switching
- Fleet vehicle fuel efficiency improvements
 - Aerodynamics
 - Engine modifications
- Landfill gas energy production
- Digester gas energy production
- Cold Ironing
- Product changes
- Carbon capture and sequestration
- Nuclear Power or renewables

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Or Perhaps, We Will Adapt



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Questions or Comments

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