Boiler Efficiency

CEC Workshop on CHP
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A Sempra Energy utility®

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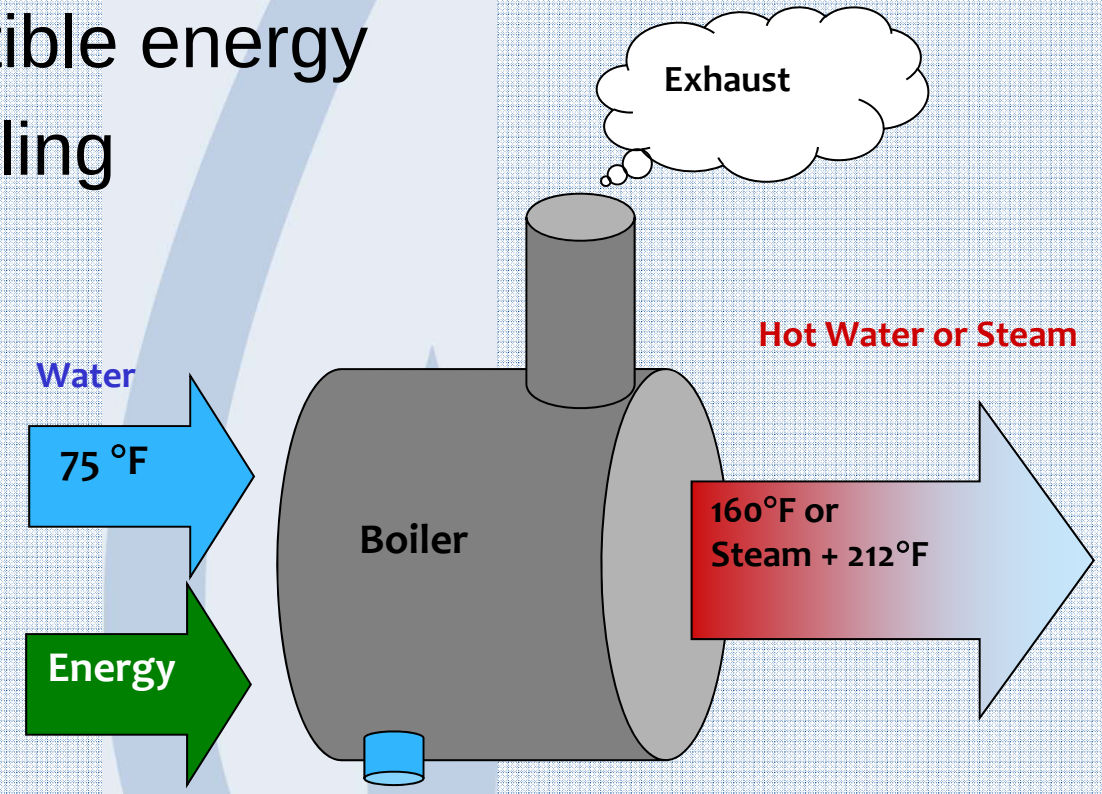
Boiler Efficiency

- Boilers
- Terminology
- Types & Applications
- Efficiency
  - Measurement
  - Components that affect
  - Energy Efficiency Programs
- Conclusion

Boilers

- Primary equipment used for building heat, sterilization, process steam and water heating
- Easily convertible energy source for cooling



Source: ICF Consulting

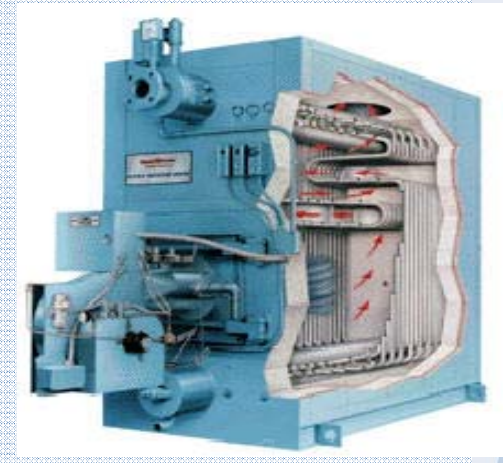
Boiler Terminology

- Horsepower – How a boiler is sized
  - One boiler horsepower equals 33,475 Btu per hour
  - Energy rate required to evaporate 34.5 lb (15.65 kg) of water at 212°F (100°C) in an hour
- Low vs. High – operating pressure
  - Low pressure - below 15 psig or water at 250°F
  - High pressure - above these conditions
- Application
  - Hot Water
  - Steam

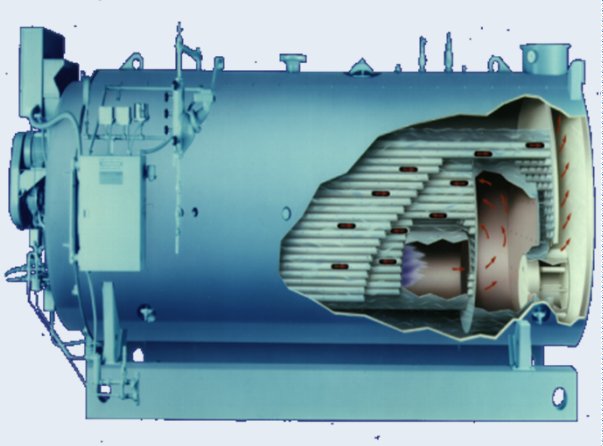
Source: Energy Solutions Center

Boilers – Types & Applications

Water Tube Boiler



Fire Tube Boiler



Water/Fire Tube (Most common)

- Produces hot water, low or high pressure steam
- Small packaged systems up to about 7,500 hp
- Efficiency ranges from 75 to 85%
- Fabricated in large sizes and very high pressures
- Available as packaged systems or can be field erected

Boilers – Types & Applications

- General Applications of Boilers:
  - Space heating
  - Water heating
  - Process steam
  - Cogeneration / Power Generation via steam turbine
- Markets
  - Commercial
  - Industrial
  - Institutional
  - Educational Facilities

Boiler - Efficiency

- Measurement
  - Combustion Efficiency (CE) – measure of the ability of the burner to completely burn the fuel. It is equal to 100 percent of input energy minus the percentage of heat lost up the stack (called "flue loss"). Considered to be the “steady-state” efficiency of a boiler. Value can be determined with a hand held analyzer.
  - Thermal Efficiency (TE) – is equal to the CE minus the jacket (skin of the boiler) and blow-down losses. Generally, 1 - 3% less than the CE. Value must be calculated.
  - Annual Fuel Utilization Efficiency (AFUE) – measure that attempts to represent the actual, season-long, average efficiency of a piece of equipment, including transients

Boiler - Efficiency

- Common components of a boiler that affect efficiency
  - Burner Types
    - Atmospheric
    - Power
      - High efficiency
      - Low NOx
      - Flue exhaust heat recovery (inlet air heating)
  - O_2 Trim
    - Sensor and control (excess air)
  - VFD on combustion air fan
  - Stack Economizer
    - Preheat boiler feed water (fresh water or condensate return)
    - Flue Gas Condensers

Boiler Efficiency

BOILERS	Hot Water Boiler Efficiency			Steam Boiler Efficiency		
	Small <= 300 Mbtuh	Medium 300 to 2,500 Mbtuh	Large > 2,500 Mbtuh	Small <= 300 Mbtuh (9 Hp)	Medium 300 to 2,500 Mbtuh (9 to 75 Hp)	Large > 2,500 Mbtuh (75 Hp)
Source Efficiencies (Manufacturer's)	80 - 87% CE	80 - 87% CE	80 - 87% CE	80 - 83% CE	80 - 83% CE	80 - 83% CE
State Energy Efficiency Rebate and Incentive Program Requirements*	84% AFUE	85% CE	85% CE	82% AFUE	83% CE	83% CE

*Energy efficiency units may have one or more of the following features: high-efficiency/low Nox burners, power burners, water tubes, relatively large heat exchange surfaces, and flue exhaust heat recovery

- To receive a rebate or incentive, measures must be taken to achieve required efficiency as standard units will not qualify
  http://socalgas.com/for-your-business/rebates/general-equipment.shtml
- Efficiency standards are based upon manufacturer's specifications as provided to the CEC(Database), including the following figures

Source: Workpaper SCG, Process Boilers

Boiler Efficiency

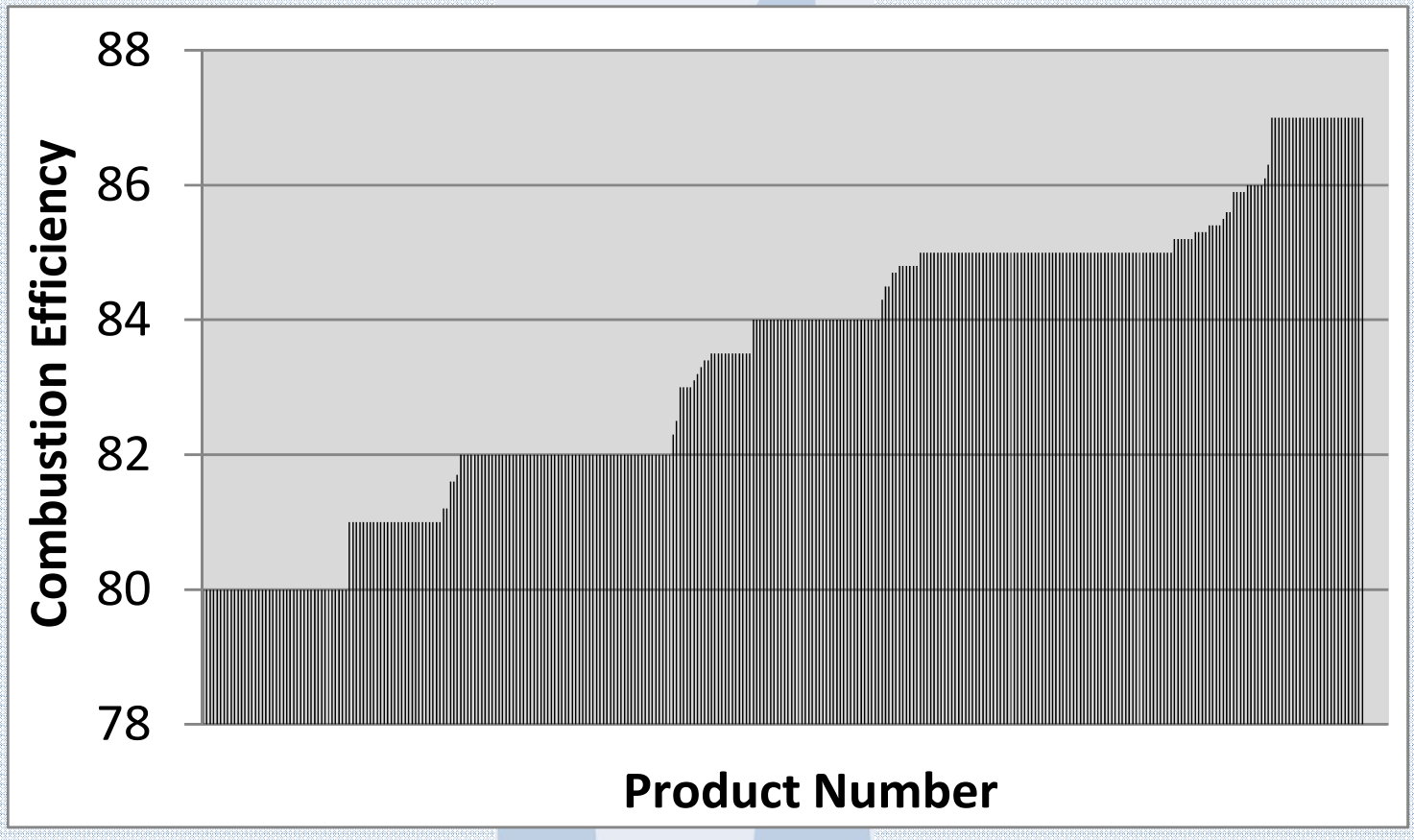


Figure 1 – CEC Efficiency Data (Hot Water Boilers <= 200 Mbtuh)

Source: Work paper SCG, Process Boilers Efficiency standards are based upon manufacturer's specifications as provided to the CEC(Database),

Boiler Efficiency

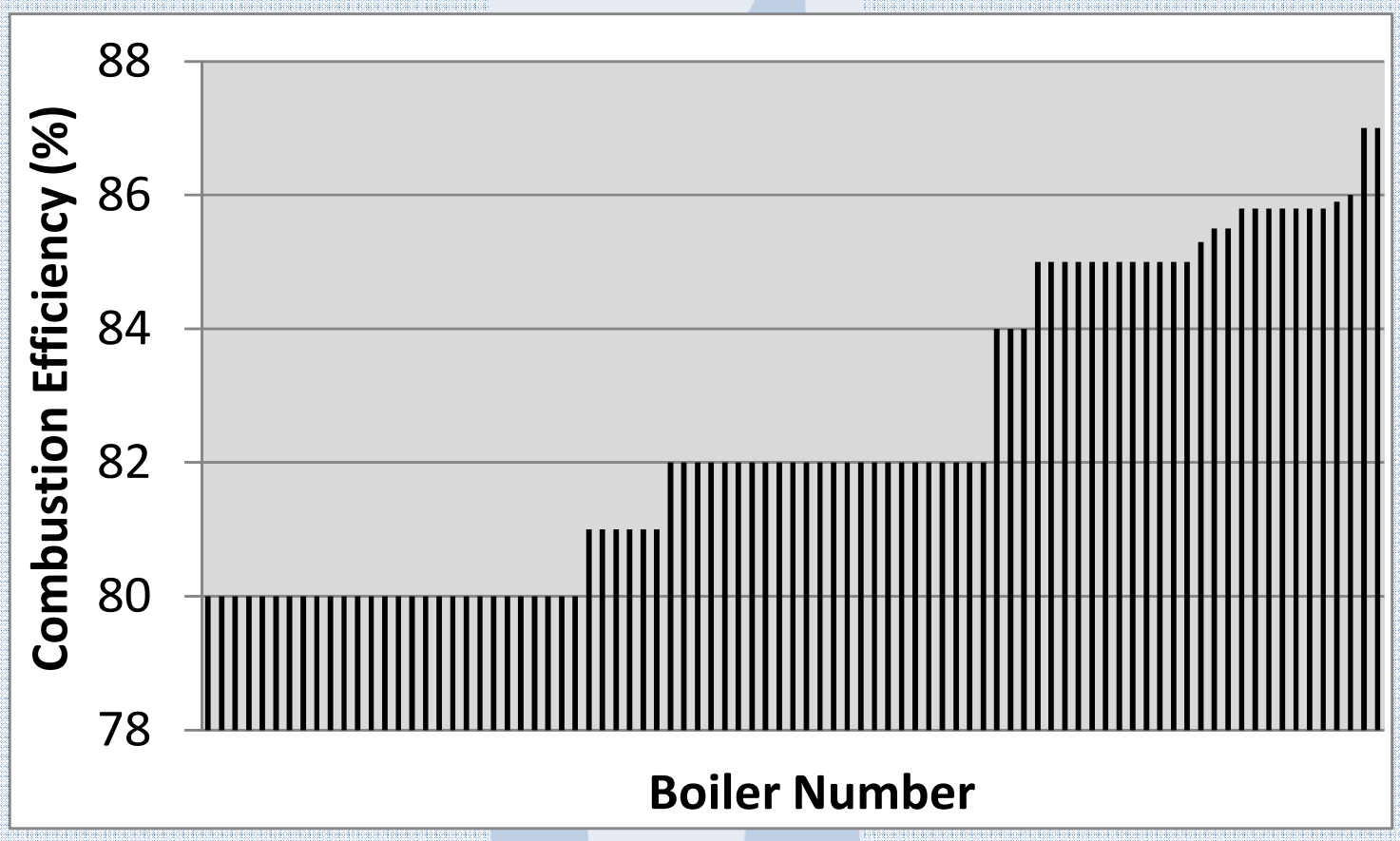


Figure 2 – CEC Efficiency Data (Hot Water Boilers 200 – 1000 Mbtuh)

Source: Work paper SCG, Process Boilers Efficiency standards are based upon manufacturer's specifications as provided to the CEC(Database)

Boiler Efficiency

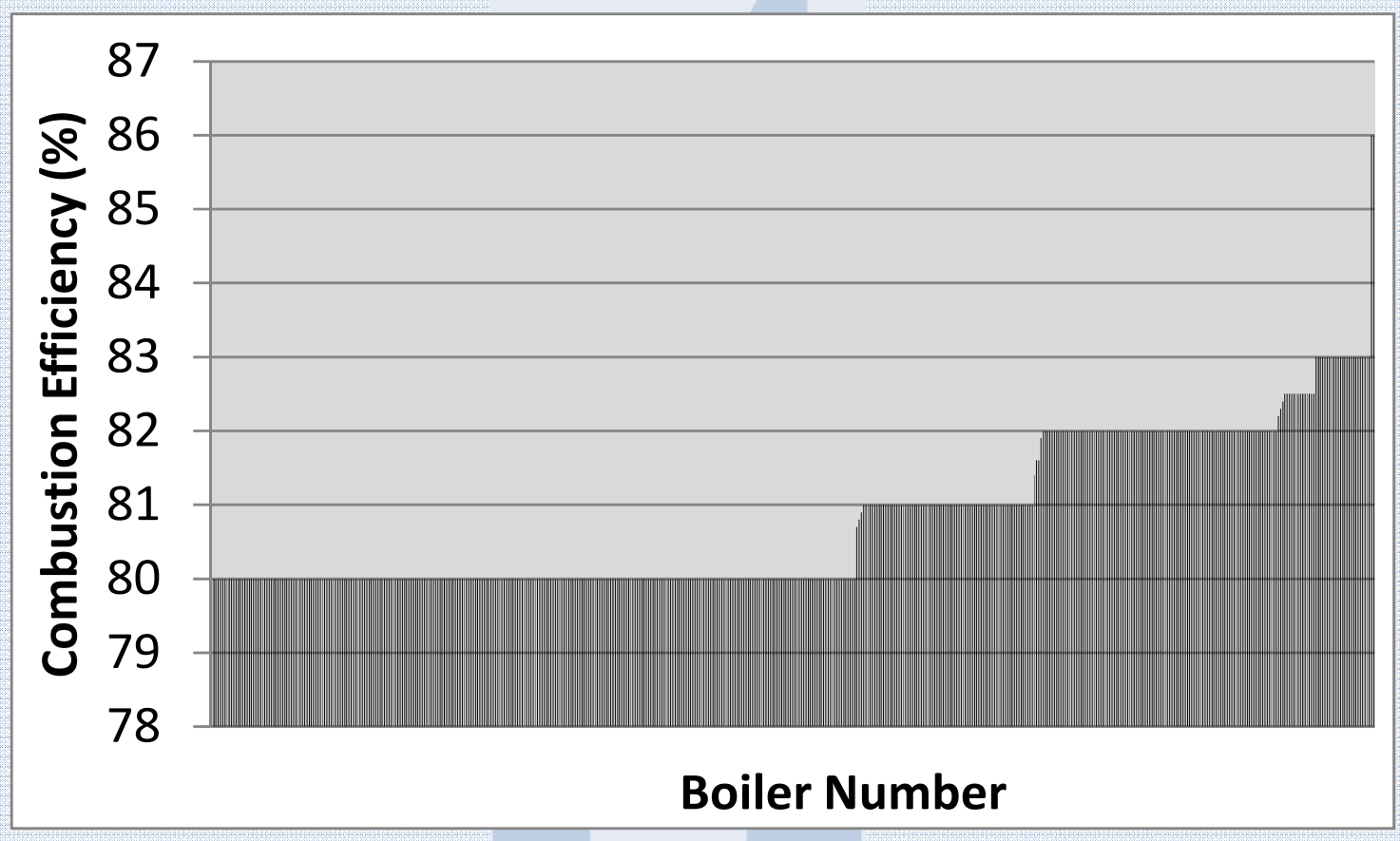


Figure 3 – CEC Efficiency Data (Steam Boilers <= 200 Mbtuh (50 Hp))

Source: Work paper SCG, Process Boilers Efficiency standards are based upon manufacturer's specifications as provided to the CEC(Database)

Boiler Efficiency

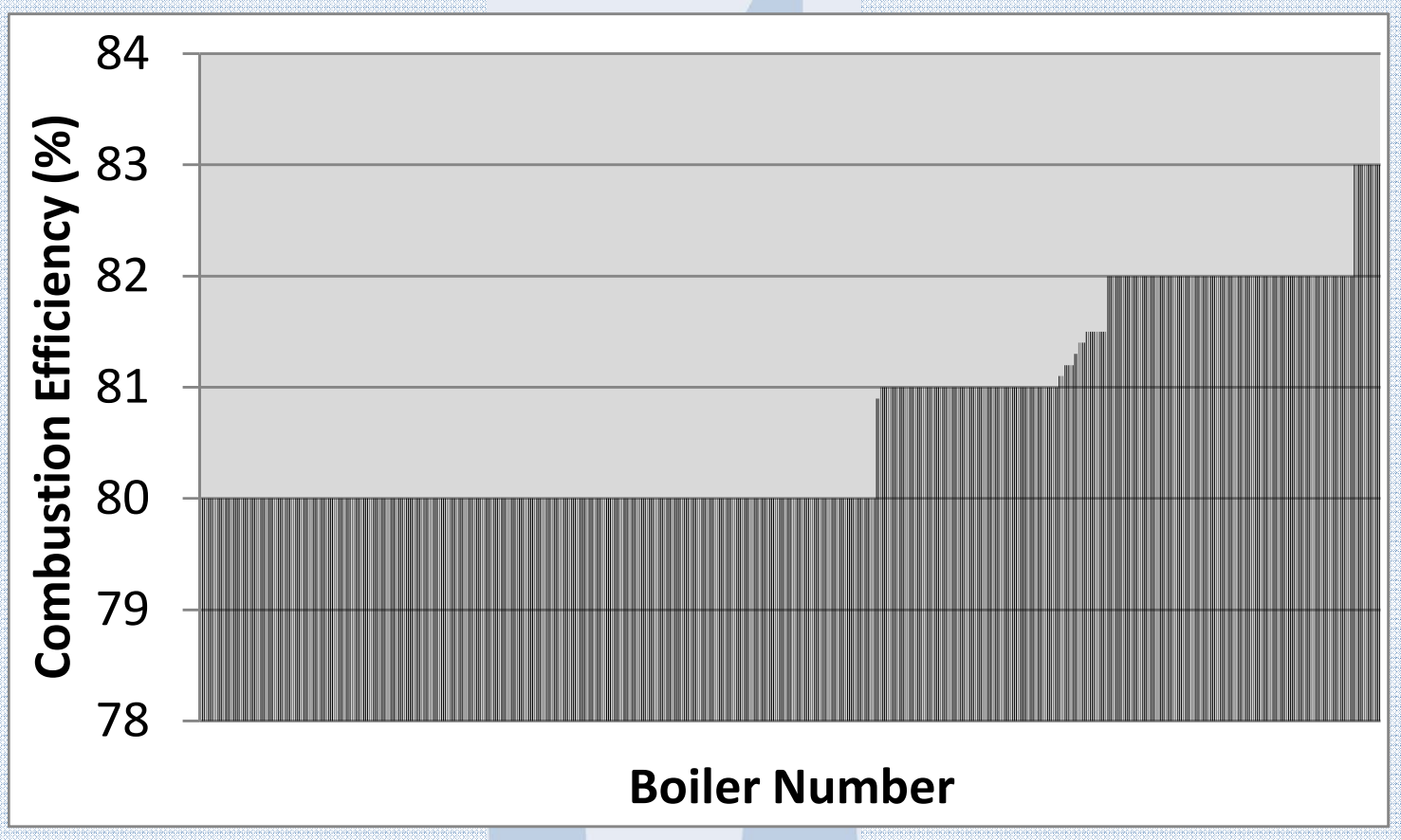


Figure 4 – CEC Efficiency Data (Steam Boilers 200 – 1000 Mbtuh (50 – 300 Hp))

Source: Work paper SCG, Process Boilers Efficiency standards are based upon manufacturer's specifications as provided to the CEC(Database)

Boiler Efficiency

» Conclusion

- Most existing boilers in California do not achieve 85% combustion efficiency, especially steam boilers.
- 83% for steam boilers and 85% for hot water boilers is the efficiency for which EE monies are provided, the goal.
- Achieving 85% efficiency requires the addition of components that add cost to a boiler system
  - O_2 Trim
  - VFD on combustion air fan
  - Economizers
  - Flue gas condensers