INTEGRATION OF MICROTURBINE-BOILER

By
CMC-Engineering

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Southern California Gas Co.

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CEC-PIER PROGRAM

INTEGRATE THE CORE COMPONENTS OF A UNRECUPERATED, LOW-NOx ELLIOTT 80 KWe MICROTURBINE WITH A MODIFIED FYR-COMPAK™ WINDBOX OF A COEN ULTRA-LOW NOx DELTA-NOx™ BURNER FOR NEW AND RETROFIT PACKAGED WT/FT INDUSTRIAL AND COMMERCIAL BOILERS OF >5,000 lbsteam/HR

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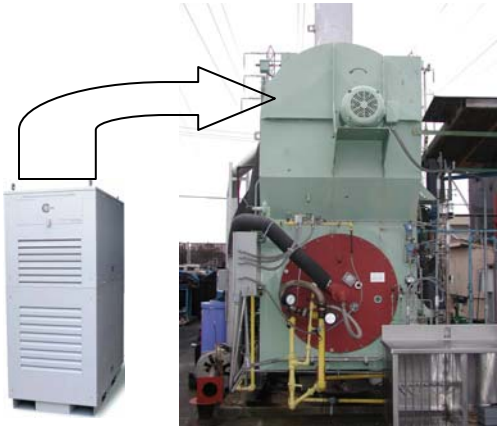
CONVENTIONAL DG/DER OPTIONS

E=30%
FP=17 sft
$/kW=1500

Recuperated
MTG

E=80%
FP=17 sft
$/kW=1800

Hot Water CHP
(ICHP)



E=78%
FP=17 sft
$/kW=1800

Conventional Steam Boiler CHP

E=84%
FP=0 sft
$/kW=700

CEC –PIER Project
Steam Boiler CHP

E= Efficiency; FP = Foot-Print; $/kW= Capital Cost

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KEY SYSTEM COMPONENTS

- COEN FYR-COMPAK™ WINDBOX
  - MODIFIED TO ADAPT CHP-CAPABILITY
  - COMPACTED FOR SEAMLESS OPERATION
- COEN ULTRA LOW-NOx BURNER
  - DUAL-FUEL CAPABLE
  - MAXIMUM 8-9 PPM CAPABLE
  - FLEXIBLE FGR
  - CONTROLS INTEGRATED WITH MICROTURBINE
- ELLIOTT MICROTURBINE GENERATOR
  - MODIFIED FOR <5-PPM NOx WITH LBNL LSB TECHNOLOGY

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COEN FYR-COMPAK™

COEN COMPANY

- Standard Industrial Burner Assembly to 300 MMBtu/hr
- Insulated for Preheat
- Dual Fuel
- FGR-Capable
- Low Pressure Drop
- With Use with All Coen Low NOx Burners

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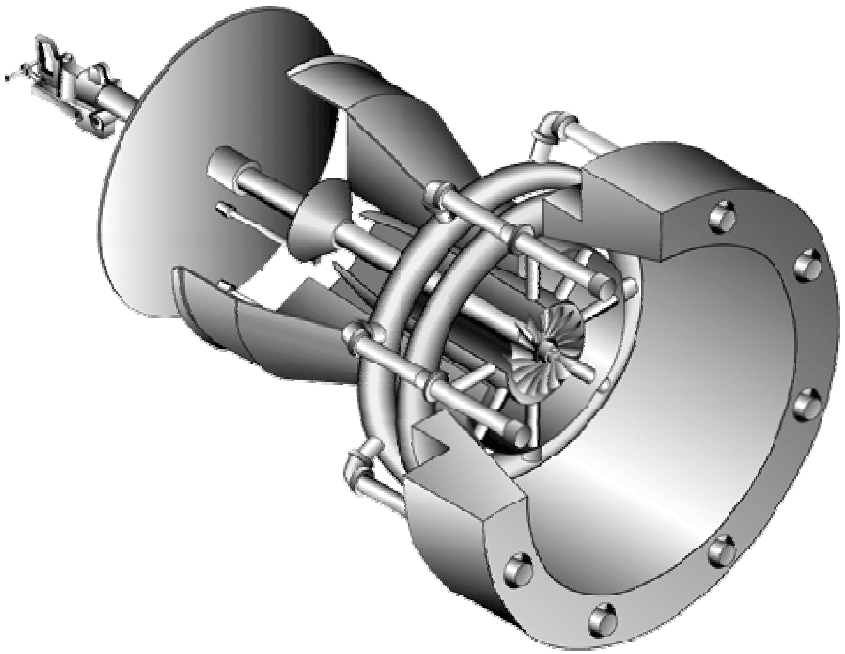
BOILER BURNER



- **Advanced Premix with Flame Stabilizer**
- **9-ppm NOx Capable**
- **Dual-Fuel with Preheat**
- **Low Pressure Drop**
- **Proven Commercial Design**
- **High Turndown**

Delta-NOx is a trademark of COEN Company

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MICROTURBINE

- 80-kW T-80 Elliott
- Unrecuperated
- Oil-cooled
- Simple Cycle Efficiency=14% HHV
- Fuel Heat Input = 2.1 MMBtu/hr
- Exhaust T ~ 1000 F
- Excess O_2 = 16%

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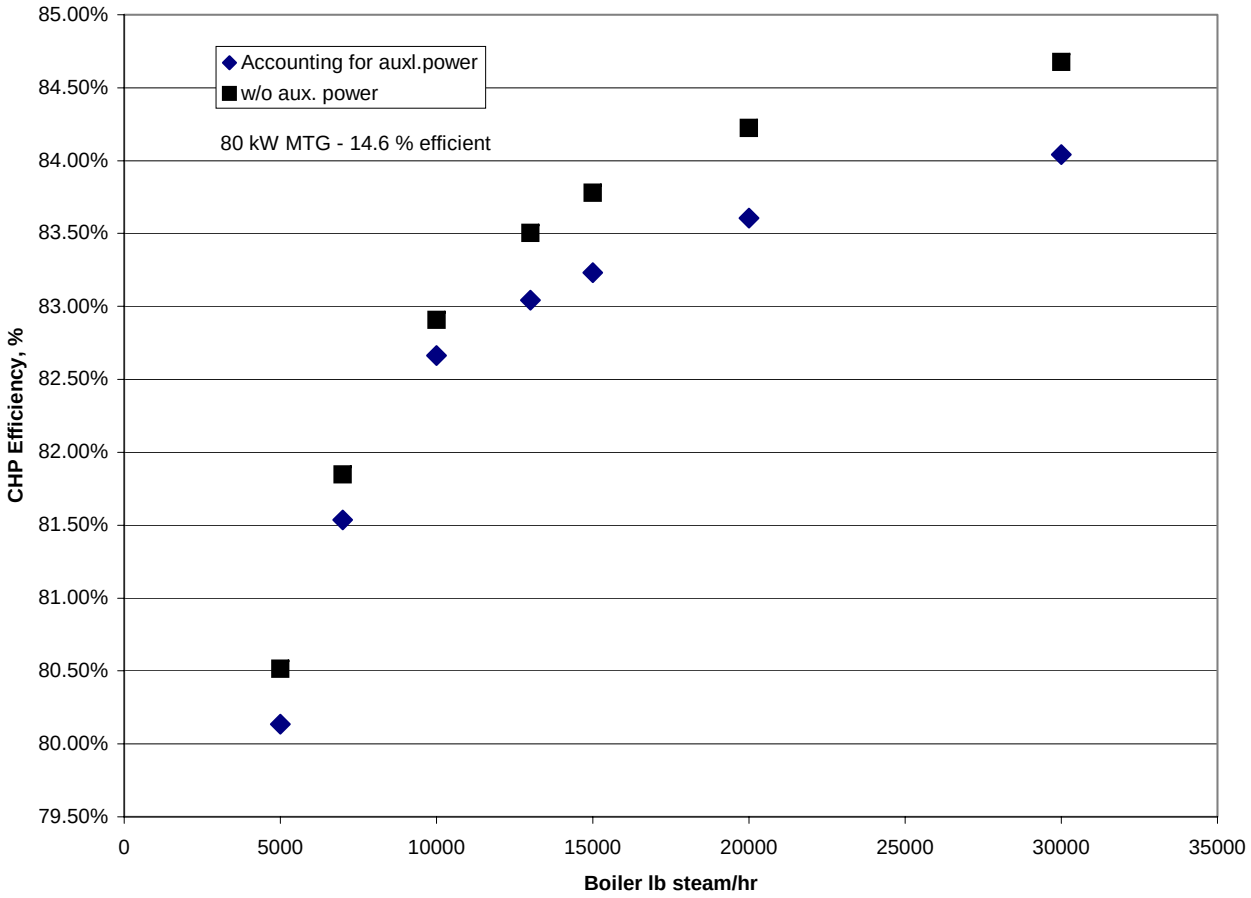
CHP SYSTEM EFFICIENCY



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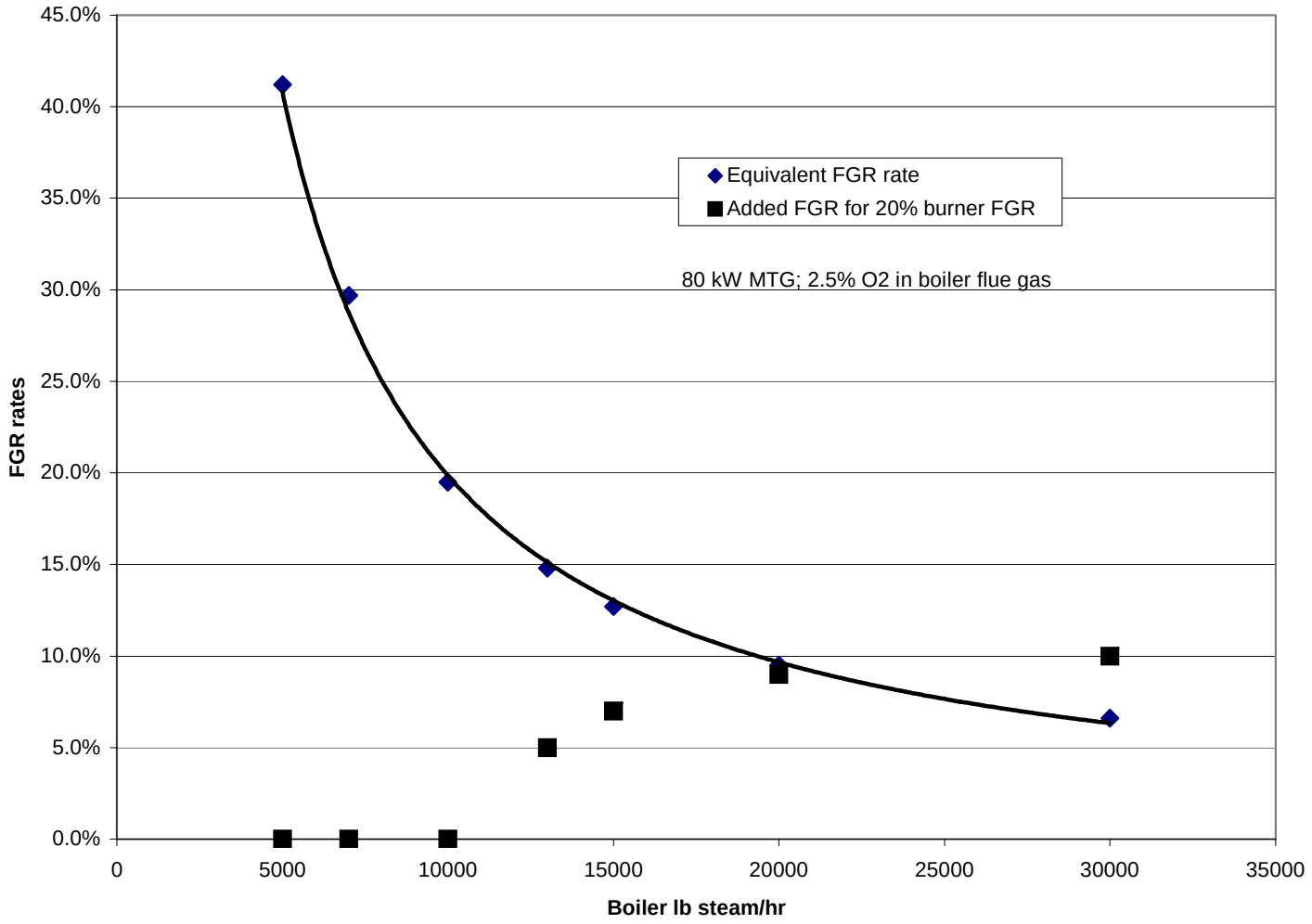
EQUIVALENT FGR RATE TO BOILER BURNER



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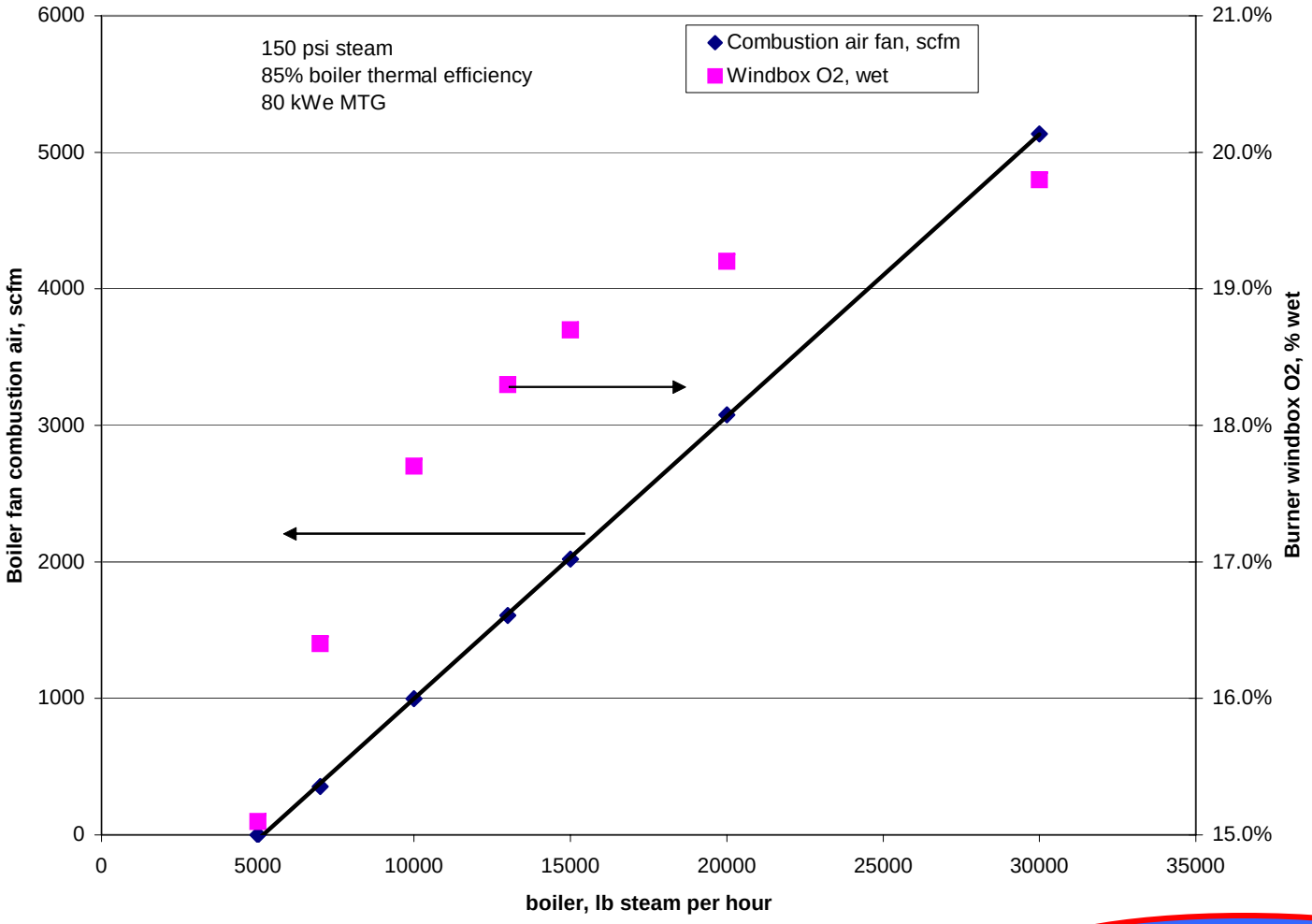
MTG-SUPPLIED COMBUSTION AIR TO BOILER BURNER



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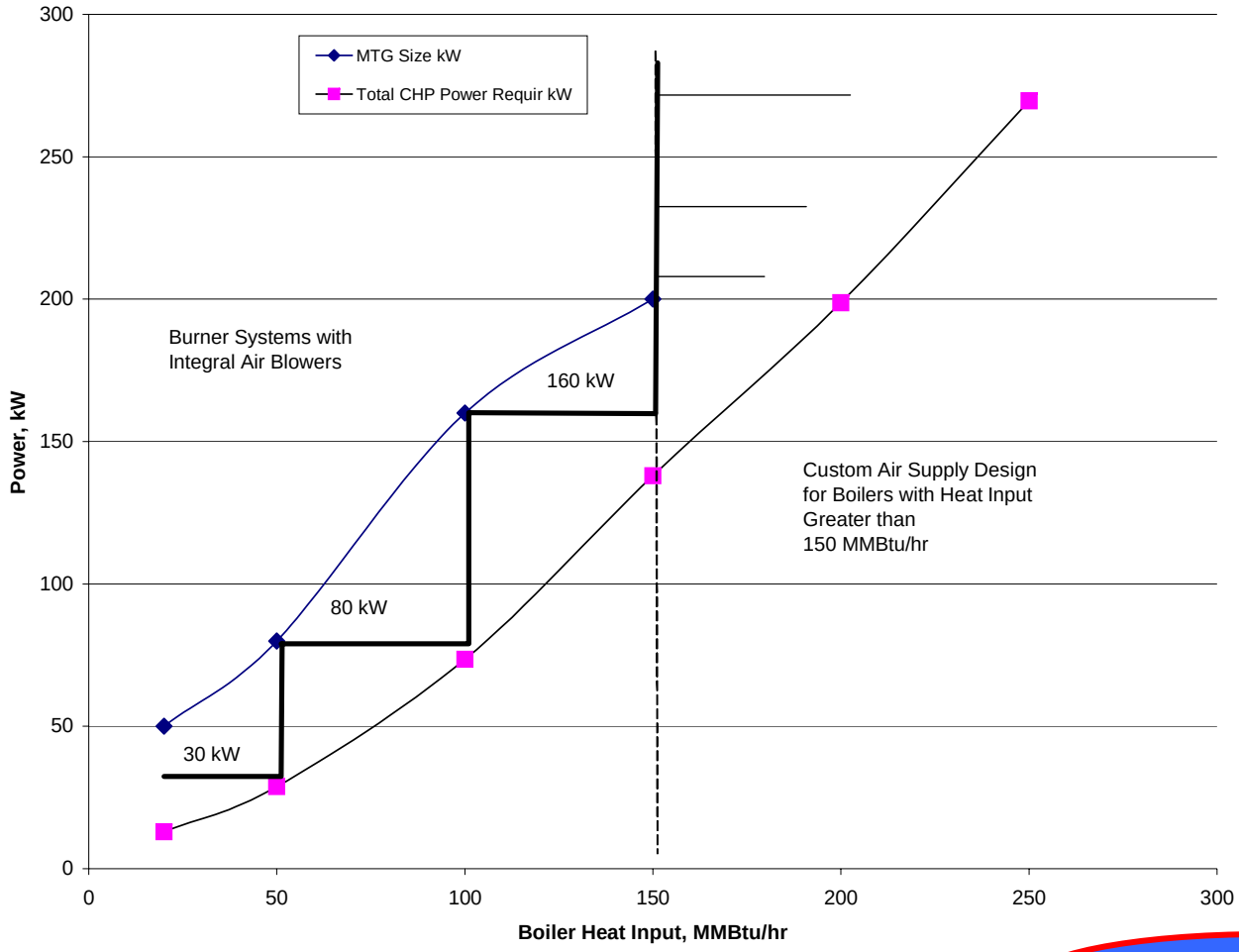
MATCHING MTG AND BOILER SIZES



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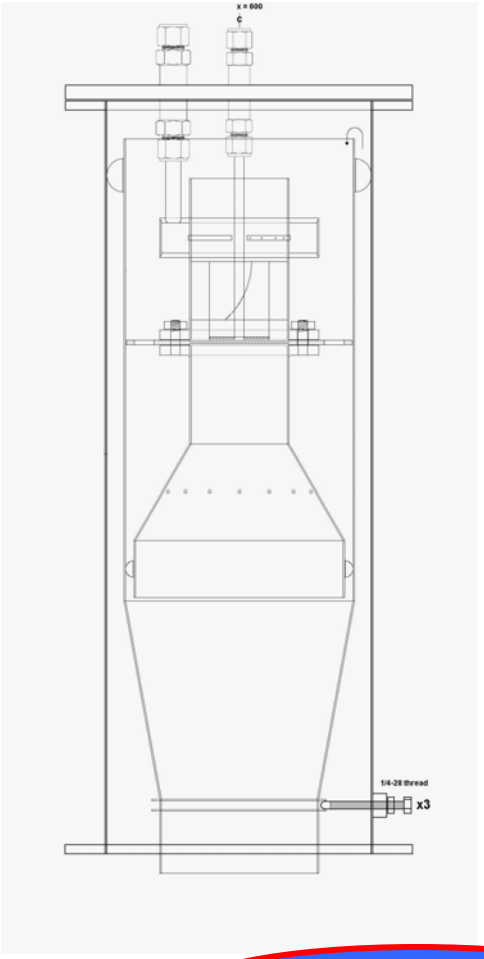
SILO COMBUSTOR RETROFIT FOR MTG

- Convert Elliott Annular Fuel Combustor to Silo Combustor Design
- Adapt LBNL LSB™ Gas Turbine Nozzle to Elliott 80-kW MTG
- Demonstrate <5ppm NOx for Compliance with Current Emissions Standards
- Maintain Overall CHP Emissions <5-ppm



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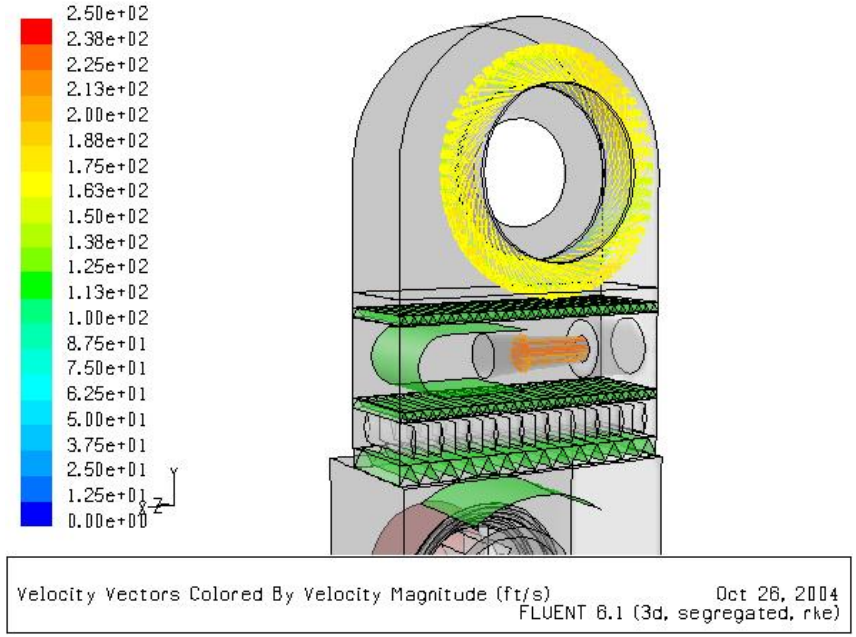
INTEGRATED SYSTEM ASSEMBLY



Fluent™ Modeling

- Microturbine in Windbox
- Oil Cooler, Air Filter out of W/B
- Power Generation Efficiency Approaching Boiler Efficiency
- All recoverable waste heat from microturbine, recovered
- CHP Fuel Utilization 84-86% with Natural Gas at Full Load
- 20/1 Thermal/Power Fuel Split at Full Loads
- Integrated Controls
- Lowest Cap/Recurring Costs

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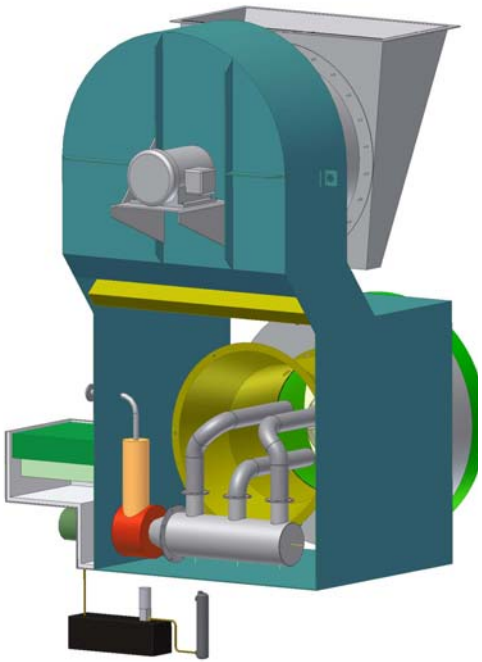
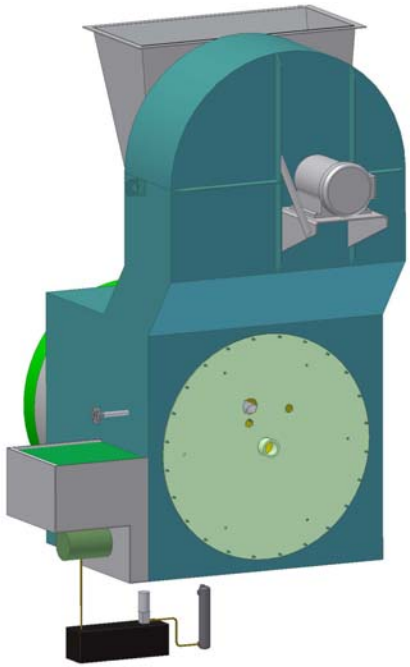
PRELIMINARY BETA-TEST ARRANGEMENT





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TARGET CHP NOx EMISSIONS

	Lb/MWh	Lb/hr	Lb/MMBtu	ppm@ actual
From MTG	0.01	0.0004	0.0003	1.7
From Boiler	3.65	0.292	0.015	7.1
Total	3.65	0.292	0.014	8.3

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SYSTEM ADVANTAGES

- ONE PACKAGED/INTEGRATED BURNER-CHP SYSTEM
- REDUCED COST OF GENERATOR W/O RECUPERATOR
- ELIMINATE MOST OF CONVENTIONAL CHP INSTALLATION COST
- REDUCE MAINTENANCE COST
- MAXIMUM MTG WASTE HEAT RECOVERY
- EXISTING BOILER COMBUSTION AIR FAN CAPABLE OF VARIABLE SPEED FOR BETTER BOILER TURNDOWN EFFICIENCY
- INCREASED HEAT LOAD TO BOILER FOR STEAM RAISING
- GRID-INDEPENDENT PACKAGED STEAM GENERATION
- NO INCREASE IN BURNER/BOILER FOOTPRINT
- IMPROVED COMBUSTION STABILITY OF BOILER LEAN PREMIX BURNER WITH PREHEAT
- REDUCED/ELIMINATED FGR REQUIREMENTS DEPENDING ON LOAD AND BOILER CAPACITY
- MORE RAPID WARM START-UP FOR BOILER

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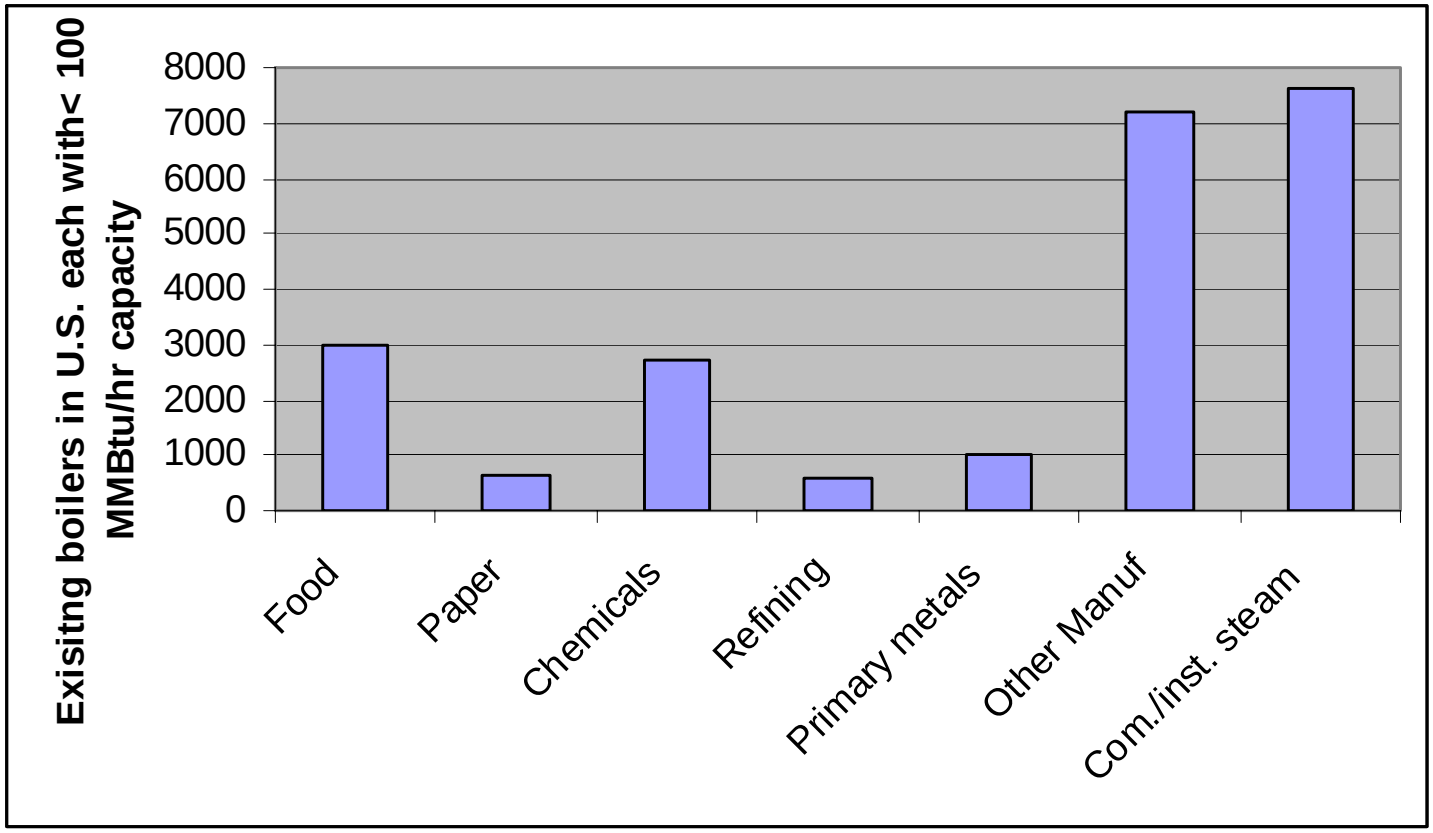
NATIONWIDE TARGET BOILERS FOR CHP CAPABLE BURNERS



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