Proe HRPG™ Heat Recovery Power Generator for 15-20% 
Additional Electric Power From Existing Reciprocating 
and Gas Turbine Gensets – WITHOUT STEAM

Proe HRPG™ Heat Recovery Power Generator

Combined Spark Ignition/Bottom Cycle
Bottom Cycle Pressure Ratio = 6.8:1

For Additional Information Contact Richard Proeschel
at (800)315-0084 or (330)723-4469
raproe@proepowersystems.com

Proe HRPG™ US Patent #6,672,063
Afterburning Ericsson Cycle Engine, Proe 90™ Recuperator, and 
Proe Afterburning™ Cycle Engine are protected by
US Patents Number: 5,894,729; 6,390,185 and 7,028,476

Proe Power Systems, LLC
Why Did Proe Power Invent Two Types of Engines?

... for Two Applications:

1) Proe Afterburning™ Cycle Engine:
   - Purpose: Produce the maximum amount of mechanical energy from a combustion process of a liquid, gaseous, or solid fuel
     - Combustion process can be dedicated combustor or integrated with an existing furnace process
     - Increases combustion efficiency of industrial furnaces by providing a forced blast of clean hot air while simultaneously producing power
     - Provides Clean and Efficient Combustion of Solid Fuels for Village Power & Waste Heat Recovery from trash or bio-waste Incinerators
     - Clean exhaust meets 21st Century environmental requirements
     - Ideal for alternative fuels: CNG, propane, hydrogen, methanol, ethanol, bio-waste (solid, liquid or gas) etc
     - `40% Shaft efficiency/ `36% Electrical Efficiency + Potential CHP

2) Proe HRPG™ Heat Recovery Power Generator:
   - Purpose: Recover the maximum amount of mechanical energy from the exhaust of an existing top cycle engine (gas turbine, internal combustion etc)
     - “Bolt-on” means for increasing fuel efficiency of existing engines by 15-20%
     - Clean hot air exhaust can be used for direct CHP
Objectives of HRPG™ Bottom Cycle

- Utilize high temperature exhaust from existing reciprocating engine, turbine engine or SOFC to:
  1. Generate additional electrical power (primary objective)
  2. Recover heat for CHP (secondary objective)
- Maximum electrical power augmentation requires a bottom cycle that makes the best use of the topping cycle exhaust heat
  1. Topping cycle exhaust temperature reduced as close to ambient as possible
  2. HRPG™ exhaust temperature is also as low as possible
Combined Cycle Engine with IC Top Cycle and Proe Power HRPG™ Bottom Cycle

1-2: Topping Cycle
2-3: Exhaust Adjusts to Backpressure
3-4: Exhaust Cooled in Recuperator
A-B: Cooled Compressor
B-C: Compressed Air Heated in Recuperator
C-D: Expansion in Insulated Expander

Legend
-→ Low Pressure Gas
—→ High Pressure Gas
≜ Heat Transfer

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Proe Power Systems, LLC
HRPG™ Easily Integrated with Top Cycle Engine Exhaust

Hot Exhaust from Top Engine (1100-1300F)

Up to 15-20% of Hot Exhaust Energy Converted to Shaft Power

Up to 50% of Hot Exhaust Converted to Warm, Clean Air for CHP (300-500F)
Simple/Effective Route to High Efficiency CHP

Typical I/C Genset Power Balance
No HRPG™

Electric Power (34.0%)
Exhaust Losses (47.7%)
Other Losses (18.3%)
Heated Clean Air (0.0%)
34% Efficient

Typical I/C Genset Power Balance
With Proe HRPG™

Electric Power (40.4%)
Exhaust Losses (13.9%)
Heated Clean Air (23.5%)
Other Losses (22.1%)
64% Efficient

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The Simplest & Most Effective Bottom Cycle Available

Bottom Cycle Comparison

- Proe HRPG™
- Stirling
- Steam
- Toluene ORC

Bottom Cycle Power/Top C. Exhaust Heat

Top Cycle Exhaust Temperature (F)

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Hot Exhaust from Top Cycle

Cold Exhaust from Top Cycle

Proe 90™ Recuperator

Water Cooled Compressor

Shaft Power

Warm Air Exhaust for CHP

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