

Mid-Range Combustion Turbines

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TEXAS COMBINED HEAT & POWER INITIATIVE

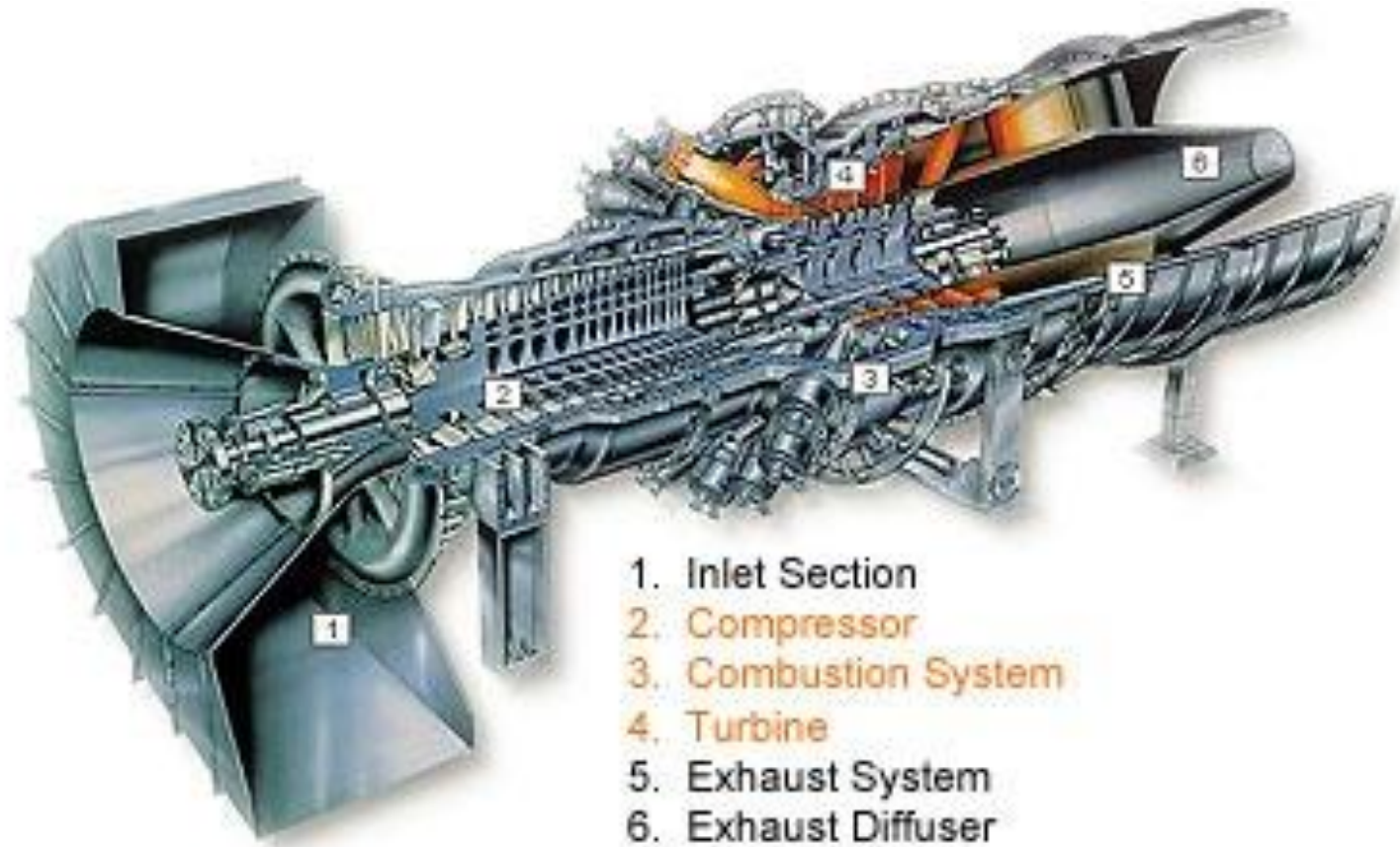
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Clean, Efficient, and Reliable Energy to Power Texas

Mid-Range Combustion Turbines

Characteristics of Mid-Range Turbines

- 1 to 20 MW Power Range (nominal)
- Uses Gas and/or Liquid Fuels
- Achieves Best CHP System Efficiency
- Low Operating Costs
- Performance Impacted by:
 - Combustion Air Temperatures
 - Elevations

Mid-Range Combustion Turbines



Mid-Range Combustion Turbines

Fuel Awareness

- Turbine Fuel Requirements are Based on LHV
- Natural Gas, 1000 BTU/SCF (nominal)
- Low BTU, 400 BTU/SCF (nominal)
 - Ex: Hydrogen Mix, Off-gas, Landfill,
- Wobbe Index
- Affects of Fuels on Unabated Emissions
 - NO_x Large Variances
 - CO₂ Minor
- Pressure Requirements Due to Fuels

Mid-Range Combustion Turbines

Exhaust Awareness

- Thermal Output Drives CHP
 - Impact Varies by US Region
- Exhaust Impacts On CHP
 - Low Combustion Air Temperature Causes Lower Exhaust Temperature
 - Elevation Reduces Mass Flow (no impact in Gulf Coast)
 - Results from Emission Abatement Method
- Excess Oxygen
 - Allows for Effective Duct Firing in CHP

Mid-Range Combustion Turbines Emission Ranges – Un-abated

– NO_x

- Natural gas – 2.5 ppmV to 25 ppmV
- Convenience Gas Fuels – 50 ppmV to +200ppmV
 - (Syngas, Biogas, Plant Waste Gases)
- Liquids – 100 ppmV to +400 ppmV

– CO; Typically 50 ppmV with Minor Variance Based on Fuels

– CO₂; 115 lb to 200 lb/MMBtu

Mid-Range Combustion Turbines

Efficiencies

- Gas Turbine (simple cycle)
 - 20% to 38% (Heat Rate - LHV – 17,060 to 8,863)
 - Typically the Smaller Turbines are Less Efficient
 - Fuels Utilized Will Affect Efficiency

- CHP System
 - 60% to +90% (based on LHV)
 - Dependent on Thermal Application
 - Highest Efficiency is Based on Direct Heat Use (Dryer)
 - Stand Alone Boiler Efficiency is HHV When Comparing

Mid-Range Combustion Turbines

Multiple Providers of Systems (partial list)

- Solar Turbines
- Siemens Gas Turbines
- Rolls-Royce Energy
- Pratt & Whitney Power Systems
- Orenda Gas Turbines
- Kawasaki Gas Turbines
- GE Power

Mid-Range Combustion Turbines

Permitting

- Typical NO_x, Sox, CO, UHC Impacts
- CHP \leq 10 MW System Unique Process in Texas
 - Standard Permit
 - Based on Adjusted NO_x Emissions
 - Takes Thermal Energy Into Account
 - Can Avoid Needing SCR Installation
 - Expedited Permitting Process
- Potential Future Impacts
 - CO₂/GHG Emissions
 - SO₂ Emissions

Mid-Range Combustion Turbines

Abatement Nox

- Special Combustors (Dry Low NO_x – DLN)
- Catalytic Combustors
- Water/Steam Injection
- Selective Catalytic Reduction (SCR – Urea/Ammonia)

Abatement CO

- CO Catalyst

Mid-Range Combustion Turbines

Fuel System

- Gas
 - Natural gas – 160 to 500 psig
 - Convenience gas – 200 to 700 psig
 - Water and Hydrocarbon Dew Point Controls
- Liquid
 - 200 to 700 psig (pumps on some packages)
 - Compressed Air Typical Mixing for Startup
 - Fuel Cleaning System

Mid-Range Combustion Turbines



Un-enclosed

- Indoor Locations
- Ease of Maintenance
- Typically Less Cost if Looking at Putting ≥ 4 in Building

Enclosed

- Outdoor Locations
- Indoor Noise Control
- Typically Less Cost if Looking at Putting < 4 in Building
- Integral Fire Suppression



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Mid-Range Combustion Turbines

Applications in CHP Projects

- Refining/Petrochemical
- Oil Gas
- Waste to Energy
- Manufacturing Direct Drying (Rice, Ceramics)
- Institutional Facilities
- Food Processing
- Mining/Minerals
- Pulp/Paper
- Brewery

CHP Does Not Always Mean Steam

Mid-Range Combustion Turbines

Examples of Application in CHP



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Mid-Range Combustion Turbines

Examples of Application in CHP



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Examples of Application in CHP



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Examples of Application in CHP



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