



An Energy-Efficiency Workshop and Exposition
Orlando, Florida

The Nitty Gritty Numbers: Engines and Gas Turbines

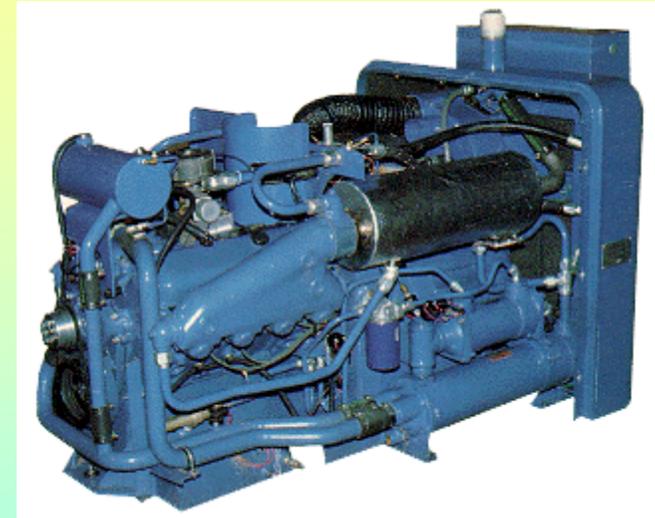
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Tuesday, August 19th 2003

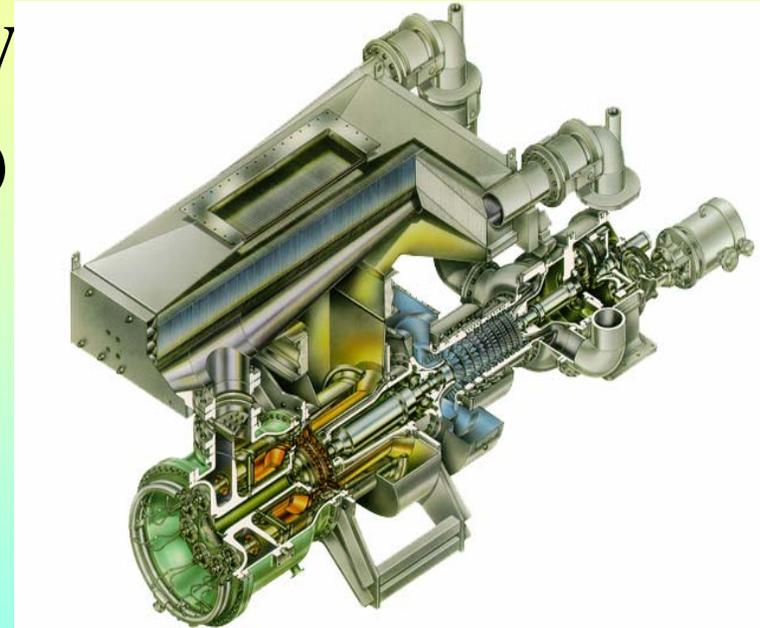
Reciprocating Engines

- Size Range: 30 - 6,000 kW
- Electric efficiency: 28 - 38%
- Fast startup (10 secs) capability allows for use as standby
- Thermal energy in the form of hot water or low pressure steam
- Mature commercial business with established sales and service networks
- Perception of high maintenance requirements (lots of moving parts)
- Emissions can be an issue



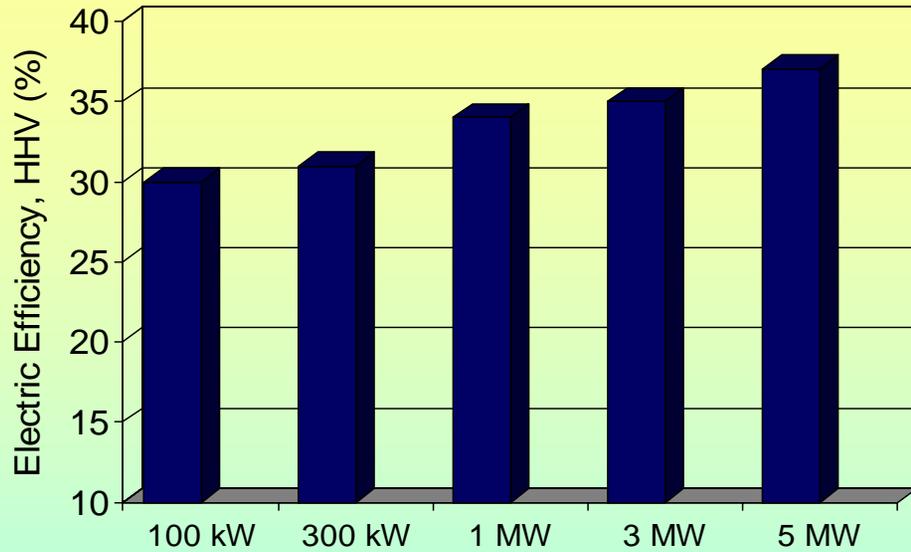
Industrial Gas Turbines

- Size range: 500 kW - 50 MW
- Electric efficiency (22-40%)
- Start-up time: 10min - 1hr
- Established technology for many power and direct drive applications
- Multi-fuel capable, but economics and emissions favor natural gas
- High pressure steam or high temperature direct heat

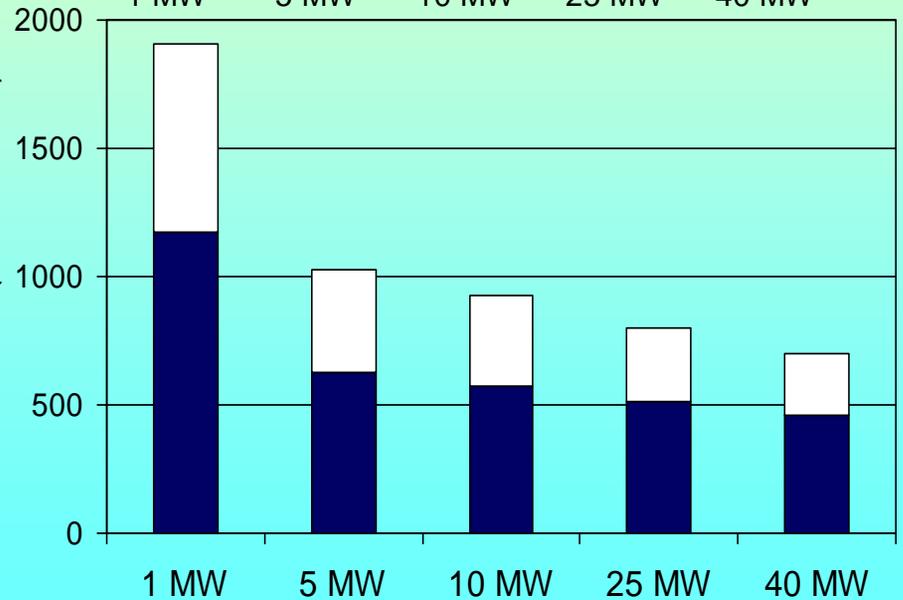
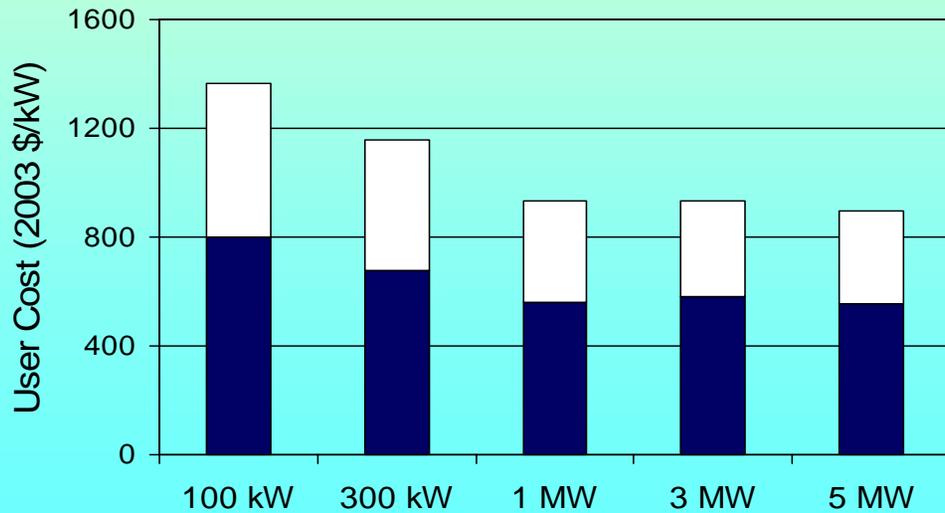
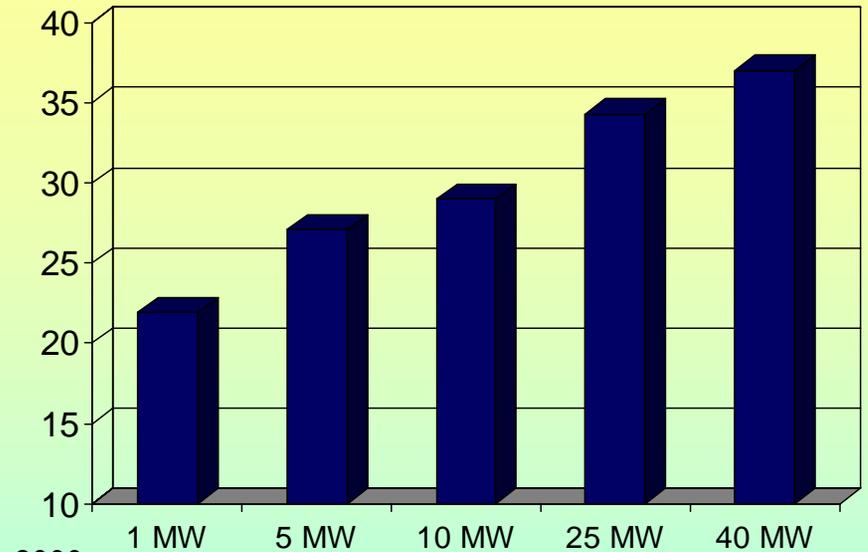


Current Status

Reciprocating Engines



Industrial Gas Turbines



■ Equipment □ Installation

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Reciprocating Engine Emissions

- Lean burn gas with electronic air/fuel ratio control - 0.5 - 2 gm NO_x/bhp-hr (1.5 - 6 lb/MWh)
- Rich burn gas with three-way catalyst
- 0.15 gm NO_x/bhp-hr (0.47 lb/MWh)
- Diesel engine - 4.5 to 7 gm/bhp-hr (14 - 21 lb/MWh)



Gas Turbine Emissions

- Water/steam injection (42 ppm NO_x - 1.8 lb/MWh)
- Lean-premix, dry low NO_x (15 - 25 ppm NO_x - 0.6 - 1 lb/MWh)
- Selective catalytic reduction (3 - 9 ppm NO_x - 0.1 - 0.4 lb/MWh)
- Control technologies can be used in series (3 ppm NO_x - 0.1 lb/MWh)
- Emerging technologies: catalytic combustion - 3 ppm; SCONOXTM -2 ppm; lean pre-mix <15 ppm