Opportunities for Biofuel-driven Microturbines

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Project Consortium

- **WIP – Munich, Germany**
- **ETA – Florence, Italy**
- **EUBIA –**
  The European Biomass Industry Association
- **Energidalen, Sweden**

Project Start: May 2003

This project is co-financed by the European Commission
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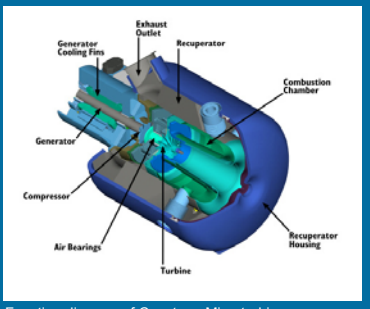
Basic components

- Turbo – Compressor package (compressor, turbine)
- Generator
- Recuperator (heat exchangers)
- Bearings (oil-lubricated, air bearings)
- Power electronics



Function diagram of Capstone Microturbine

Key producers of Microturbines (MT)

- Bowman Power Systems, UK, 80kW
- Capstone Turbine Corporation, USA, 30 & 60kW
- Cummins Power Generation, USA, 60kW
- Elliott Energy Systems, USA, 80kW
- Honeywell Power Systems, USA, 75kW
- IR PowerWorks, USA, 70 & 250kW
- Turbec, SWE, 100kW

Total installed MT systems in 2003: ~ 3000

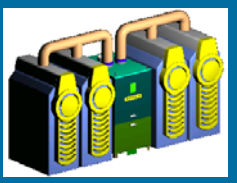
Elliot Energy Systems Inc. (80 kW)

Microturbines (20 – 100 kW) for Distributed Power and Heat Generation

Advantages

- Simple and compact technology
- Modularity
- Low emissions
- Low maintenance requirements
- Reliable provision of electricity and heat for stand-alone and grid-connected applications
- Potential operation on a variety of fuels (natural gas, diesel, gasoline, bio-fuels)

Capstone MT (30 kW)



Heat recovery for MT (microGen™)

Application barriers for Microturbines

- High cost of produced kWh (~ $0.1/ kWh)
- Large investment costs for total MT systems (~ $2000/ kW)
- High internal consumption of produced energy (compressor, cooling of power electronics)
- Large amount of gas required (~ 25kg/h for 100kW power rate)

Biogas and Landfill Gas

Gas composition is highly variable from site to site depending on different factors, such as

- **age of landfill**
- **composition of digested material**
- **type of digestion process**

Table 1. Typical fuel properties

Properties	Landfill gas	Gas from anaerobic digestion
CH_4	45 – 55%	55 – 75%
CO_2	< 40%	Balance
N_2	< 15%	< 0.5%
H_2S	< 50 – 500 ppm	< 10 – 2000 ppm
Water vapour	Saturated at ambient temperature	Saturated at ambient temperature
LHV	4.5 – 5.5 kWh/ Nm^3	5.5 – 7.5 kWh/ Nm^3

Potential problems with Biogas use in MT

- **Condensation of water in the compressor and at valves in the MT burner**
- **Corrosion due to H_2S impurities**
- **Particle formation due to Silane (SiH4) impurities**
- **Flame stability problems due to reduced LHV**

Examples of biofuel-driven Microturbines

- **TURBEC:**
  - **In the framework of the EC co-funded project OMES (Optimised Microturbine Energy Systems) 15 Turbec T100 microturbine are installed,**

    3 installations fuelled with biogas

- **CAPSTONE**
  - **Experimental installation of CAPSTONE C30 microturbine at ISET (Institut für Solare Energieversorgungstechnik), Germany**

    Test runs with reduced LHV gas

Outlook

- **Microturbines provide the electric power industry with opportunities for the deregulated and competitive market**
- **The application of biofuel-driven microturbines are in line with main goals for the energy sector**
  - **Improvement of energy efficiency**
  - **Guarantee of security of supply**
  - **Environmentally friendly power & heat production**

World's largest Microturbine
Tri-generation project (540 kW), USA

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