Microturbine Energy Systems

Operational Experiences from Micro-turbine Energy Systems "the OMES project"

presented by:

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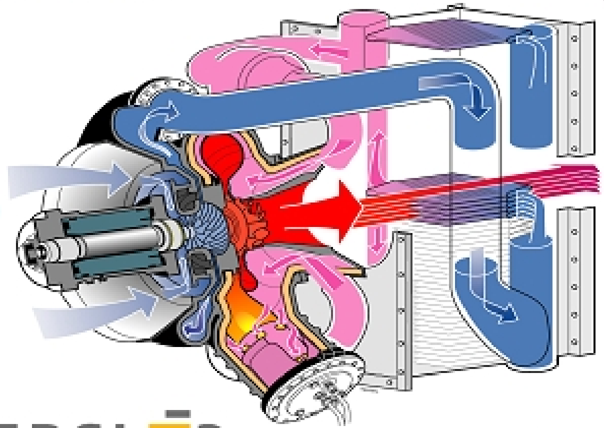
OMES – http://www.omes-eu.com

DONG

Gasum

SGC

turbec



STATOIL

ENERGI E2

VATTENFALL

DONG

OMES - Content

- Demonstration of 18 - 100 kW_e - microturbines in Norway, Sweden, Finland, Denmark, Germany and Ireland. Project period Sept. 2001 – April 2004.
- Development of microturbine solutions for CHP, cooling and industrial processes.
- Development of microturbine solutions for different fuels (natural gas, biogas and methanol)

Different applications

- CHP production
- ”Cluster plant” - power production
- Steam production
- Cooling
- CO_2 in green houses

Alternative fuels (to natural gas)

- Biogas
- Methanol

OMES - Targets

- Energy efficient and flexible microturbine solutions
- Realistic data for efficiency, environmental conditions, O/M conditions etc.
- National-/EU possibilities for CO_2 reduction
- Enforce EU position in the global market for microturbines

Technology Targets

- ➔ Power efficiency from 30 to 33%, and in the long run to 40%
- ➔ Availability > 90%
- ➔ Fuel flexibel (Natural gas, Biogas, LPG, Diesel) and in the long run to handle fuels with heating values down to 25% of the heating value for natural gas.
- ➔ NO_x < 15 ppm at 15% $O_{2,}$.
- ➔ Maintenance costs < 10 Euro/MWh

OMES – demo hosts

DONG

Country	units	Demo host	Responsible
DK	2	Cph Airport	**DONG(DGC)**
DK	5	Diff. Apartment houses, Køge (Cluster)	**Energi E2**
DK	1	M/R station, Lynge	**DONG**
N	1	Statoil, Stavanger (cooling)	**Statoil**
N	1	Fjell Borettslag	**Statoil**
S	1	Mariestads Avl. Rening.	**SGC**
S	1	Klitte & Lundh (Green House – CO_2)	**SGC**
S	1	School at Kävlinge	**SGC**
SF	1	VTT (cooling)	**Gasum**
D	1	Buss. Centre, Hamburg	**Vattenfall**
EI	1	Industry Limerick (steam)	**DONG(SGC)**
EI	1	St. John of God Hosp. Dublin	**SGC**
EI	1	Ht. Oakwood Arms, Shannon	**DONG(SGC)**
TOTAL	**18**		

Project participants

- **Norway - Statoil -** *(NTNU)*
- **Sweden - Vattenfall, Turbec, SGC, (***LTH, Ångpannaföreningen, Hälsingborg Energiverk)*
- **Finland - Gasum OY (***VTT)*
- **Denmark – DONG *), Energi E2 (***DGC, AUC, dk-Teknik)*

*) Overall projectleader

Overall project budget:

4 millions .

Project period:

September 2001 – April 2004

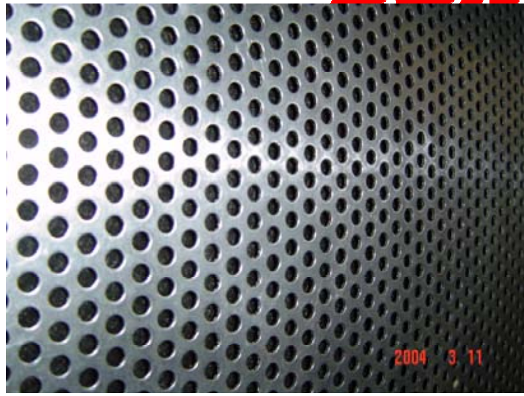
Methanol fired installation at Statoil, Stavanger (with cooling)

Installation of methanol fuel tank at Forus.Photo: Tor Berquist, Statoil

Turbec T100 at Statoil, Forus, Stavanger. Photo: Roar Stokholm, Statoil

Broad Chiller at Statoil, Forus, Stavanger.
Photo: Roar Stokholm, Statoil

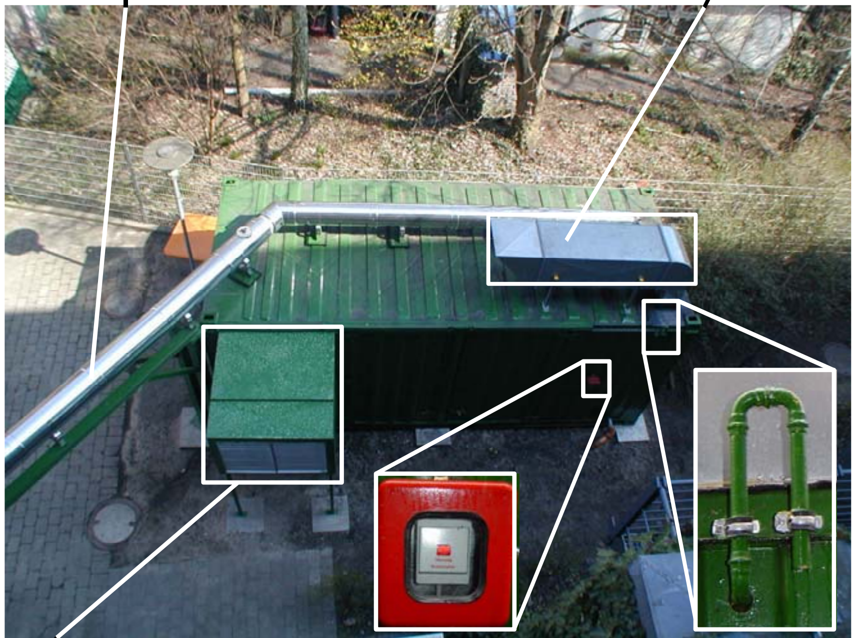
"Container" installation at Hamburg



Noise lewel outside container < 45 dbA

Chimney

Container ventilation



Silencer

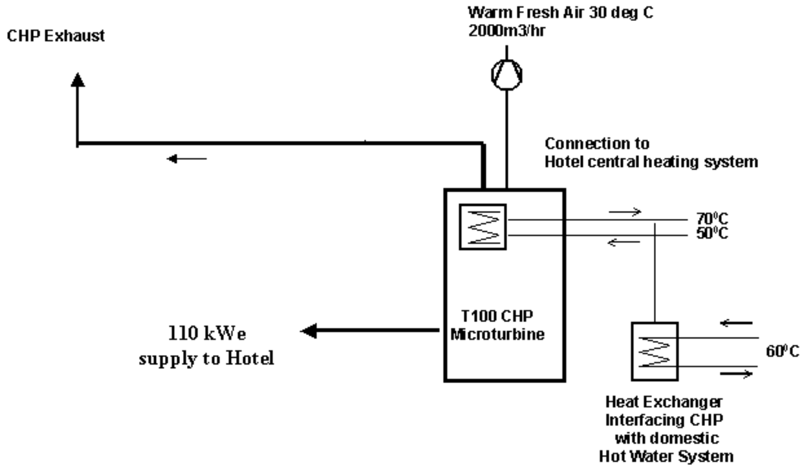
Safety stop

Gas safety outlet pipe

Installation af Ht. Radisson, Eireland

Figure Pre-installation image

Figure Image after installation



Biogas in the OMES project (1)

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Installation – Mariestad Sewage plant, Sweden

Fuel Properties

CH_4 45 - 55 %, CO_2 < 40 %, N_2 < 15 %, H_2S < 50-500 ppm

Water vapor satured at ambient temperature

LHV 4,5-5,5 kWh/Nm^3

Biogas in the OMES project (2)

Raw biogas is dried to a dew point of about 5°C (ambient pressure) and then compressed and fed to the T100. Promised gas production was initially exceeding 800 Nm^3/day but actual production was less than 200-250 Nm^3/day. This equals a gas input of 50-60 kW, i.e. very much below the T100 rated gas input of 333 kW.

1 Digestion chamber

2 T100

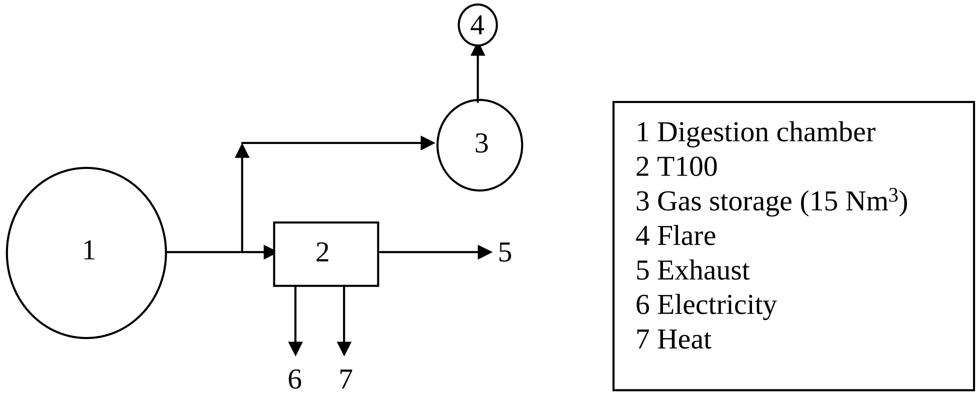
3 Gas storage (15 Nm^3)

4 Flare

5 Exhaust

6 Electricity

7 Heat



Schematic installation of the Mariestad site.

Problems with moisture in the gas was solved with an additional water separator. Several measures were tried in order to raise the gas production, including emptying the digestion chamber several times. Unfortunately, none of these measures proved successful.The unit has only been in operation for about 200 hours and the typical running cycle is less than an hour per start at 20-25 kW_e. This makes it almost impossible to draw any conclusions of the installation, though one major conclusion can be drawn. The fact that the T100 could operate under such poor conditions indicates a great strength of the technology.

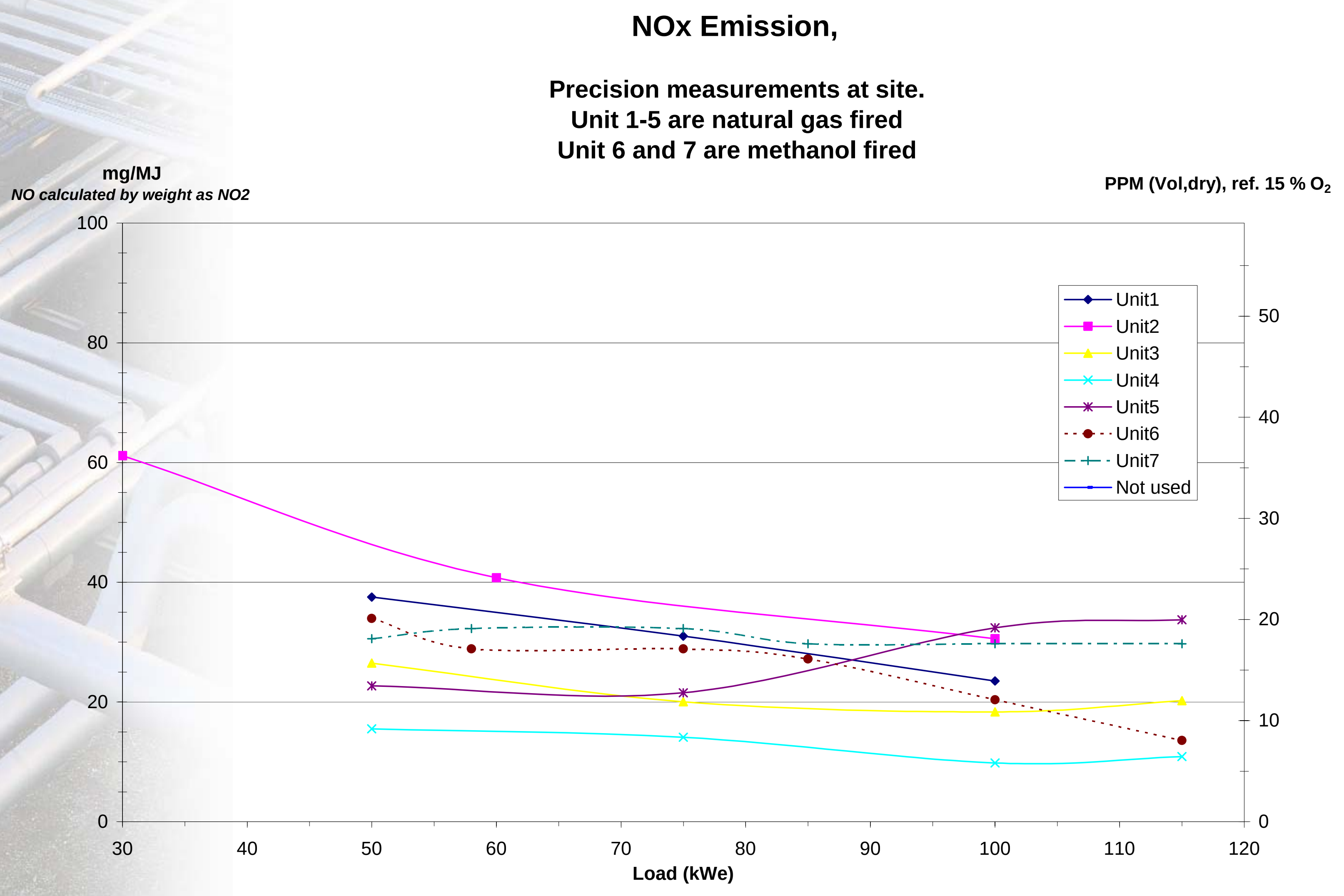
Operation data from 2 OMES installations (Torpgården)

Plant	**Torpgården unit 1**	**Torpgården unit 2**	
Plant owner	Energi E2	Energi E2	
Installed	April 2003	April 2003	
Running hours by 040317	6.041 hours	6.294 hours	
Fuel	Natural gas	Natural gas	
Function	Heating of houses and production of hot water		
Power production, kWh (accumulated by 040317)	540.000	553.000	
Heat production, kWh (accumulated by 040301)	750.000	744.000	
	factory test	factory test	8/3 2004
$\eta_{\text{power gross (excl. pressuration of gas)}}$ %	30,35	30,75	32,4
$\eta_{\text{power net}}$ %	28,98	29,41	30,5
$\eta_{\text{total gross (excl. pressuration of gas)}}$ %	75,22	76,11	80,7
$\eta_{\text{total net}}$ %	73,85	74,77	78,8
Water temp. out deg. C	90	90	
Water temp. in deg C	50	50	

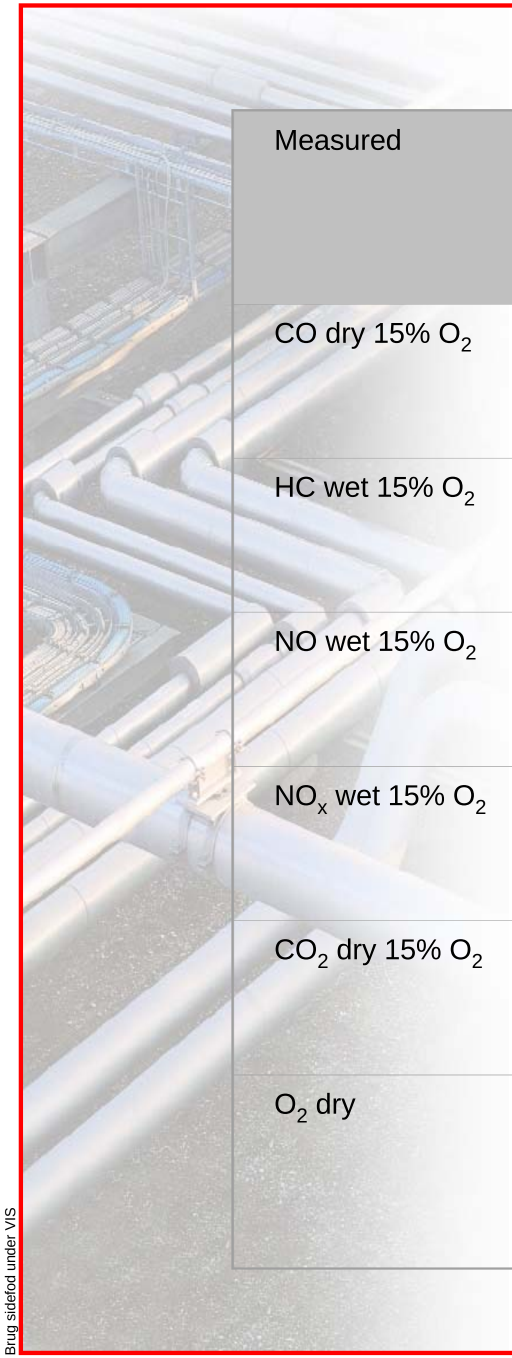
Did we reach the success criteria for the OMES project?

Success Criteria for the OMES project	Achivements
Power Efficiency ≥ 30 % during full load operation (ref. LCV)	OK for the newest versions installed. The first installations had power efficiencies between 29- and 30%.
Overall efficiency ≥ 85 % (ref. LCV)	Not achieved. The major problems seems to be heat loos through ventilation air, and to high inlet water temp. Observed interval for for overall efficiency 60 - 80%, primarily depending of inlet water temperature.
Availability ≥ 90 %	OK for most installations
O/M Costs < 10 Euro/MWh_e.	Not achieved. Observed results 13 - 15 €/MWh
Unit Cost < 800 Euro/kW_e	OK? Observed result: 800 - 860 /kW
Emission levels < 15 ppm NO_x, @ 15% O	OK at all sites at full load and part load. For CO and UHC levels < 10 ppm @ 15% O_2 were achieved at full load, but raising levels found at low load conditions.

Measured NOx emission



Environmental measurements – VTT unit



Measured	Unit	115 kWe	100 kWe	86.3 kWe	75 kWe	57.5 kWe	50 kWe
CO dry 15% O_2	Ppm	3.3	0	393	568	1074	1083
HC wet 15% O_2	Ppm	3.6	0.1	227	389	1164	1128
NO wet 15% O_2	Ppm	10.2	9.6	7.3	9.1	10.5	12
NO_x wet 15% O_2	Ppm	11.4	10.4	9.9	11.3	13.9	15
CO_2 dry 15% O_2	%	3.4	3.3	3.2	3.2	3.2	3
O_2 dry	%	18.05	18.09	18.29	18.34	18.61	18.64

Conclusions from the OMES project

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⌘ Most technical and environmental goals were achieved, and unit cost seems OK

⌘ Remaining problems with economic parameters like overall efficiency, O/M costs - and installation costs:

- ✓ Overall efficiency is very dependent of inlet water temperature, which carefully must be taken into account by planning new installations.
- ✓ O/M costs are likely to be reduced as the number of micro turbines increase.
- ✓ Installation costs variation 640 - 1620   /kW. 100 - 300   /kW, was OMES specific costs (measurement, data transmission etc.). The observed level will be reduced when "plug and play" micro turbine installations can be made, and/or authorities will be accustomed to the micro turbine installations.

The OMES project showed that the micro turbine technology is reliable and working satisfactory.
Installation costs must be reduced to give the micro turbine a commercial break through.