

Advantages of micro gasturbine based CHP

- Cost effective
- Reliable
- Low maintenance



MTT Introduction



- MTT is an innovative company, active since 2008 on the development and commercialization of micro CHP systems based on its in-house developed micro gas turbine;
- MTT is located in Eindhoven Netherlands, and currently employs 18 highly qualified staff;
- To develop and commercialize its CHP products, MTT has risk sharing contracts with various relevant industrial partners and with knowledge institutes;
- Together with its partners, $\pm$ 45 skilled engineers work on the optimization of the micro CHP system.



Delivering the most cost effective micro CHP



Market assessment:

High investment - and maintenance cost are obstructing fast market introduction of micro CHP

EnerTwin is aiming to be the most cost effective micro CHP system:

- Allowing acceptable pricing at relatively low volumes
- Customer pay back target between 2 and 5 years

MTT's strategy:

- Use Commercial Off The Shelf (COTS) components (automotive)
- Involve business partners and installation companies during development
- Outsource component development & manufacturing to keep costs low and development speed high
- Improve product efficiency once volumes are realized



Micro CHP energy conversion technologies

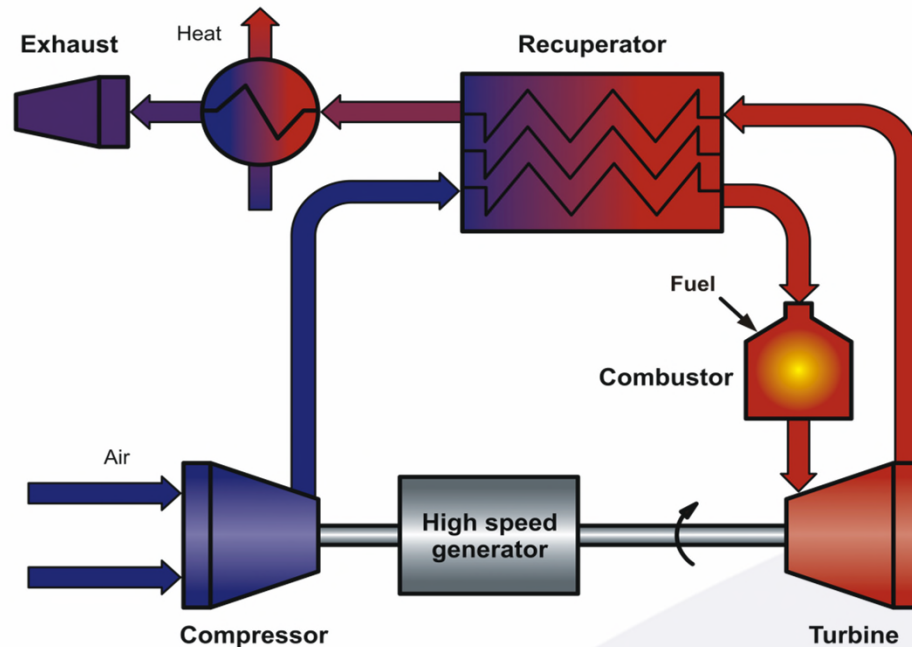


Technologies compared on relevant aspects for micro CHP:

	Cost	Maintenance cost	Pay back time	Fuel flexibility	Reliability	Electrical efficiency	Power 2 weight ratio	Overall score
Stirling engine	high	medium	very long	medium	low	low	very poor	- / -
Rankine cycle (ORC)	high	medium	long	medium	medium	medium	very poor	+ / -
PEM fuel cell	high	low	long	low	high	good	medium (reformer)	+
SOFC fuel cell	very high	low	long	low	high	very good	reasonable	++
Gas engine	medium	medium to high	reasonable	medium	medium	medium	reasonable	+++
Micro gas turbine	low	low	short	very good	high	medium	excellent	++++

**Low cost (investment + maintenance) are essential
for the success of micro CHP !**

Technology: micro gas turbine



MTT 3.8 kWe turbo generator

- **Gas turbines have been used since 1930:**
 - Very reliable & long life: only 1 moving part, moves in only 1 direction
 - Low maintenance costs
 - Highest power to weight ratio / power density → relative low weight
 - High frequency noise: can easily be damped
- **Multi fuel: Natural Gas, Bio Gas, LPG, Heating Oil**
- **Turbochargers are produced in millions → low costs, very reliable**

EnerTwin target specifications

Specifications for the EnerTwin micro CHP system:

- Power (natural gas) input: 20 kW
- Thermal power: 14,4 kW
- Electrical power: 3,0 kW
- Power to Heat ratio: 21 %
- Total efficiency: 87 % *
- Weight: $\pm$ 225 kg
- Clean combustion: < 40 ppm NOx
- Substantial CO2 reductions: 3 - 6 tons per year
- Low noise: < 55 dB(A)



Modulation range:

Heat : 7,5 – 14,4 kW
Electricity : 1,0 – 3,0 kW

Additional specifications:

- Able to modulate to ~ 50%
- Maintenance: > 5.000 hrs ($\pm$ 2 years, similar to condensing boilers)
- Lifetime : > 30.000 hrs +
- Remote control / smart grid ready

* At ISA conditions and 30/50: can be improved by adding a condensing unit

Target maintenance cost EnerTwin

- **5.000 hrs (small service):**
 - Replacement of CAP seal, air intake filter, oil filter
 - Check oil level
 - Visual inspection of system + computer read out
 - **Total cost: material Euro 45,- plus ~ 1 hour labor**
- **10.000 hrs (large service):**
 - Similar as 5.000 hrs service, plus:
 - Change fuel compressor head, replacement of UPS battery
 - Replacement of oil (4 liters)
 - **Total cost: material Euro 245,- plus ~ 1,5 hour labor**
- **30.000 hrs (overhaul service):**
 - Similar as 10.000 service, plus:
 - Replacement of micro turbine (~ Euro 750,-)
 - **Total cost: Euro 995,- plus ~ 3 hours labor**
 - Life extension to 45.000 – 50.000 hrs
- Maintenance cost Σ 30.000 hrs: ~ Euro 625 + 6 hrs labor (@ Euro 80) = Euro 1.105,-
- **Per kWh electricity: 1,3 Eurocent (@ 85.000 kWh)**



Best use cases EnerTwin

- EnerTwin can best be used in situations where many running hours are possible;
- Aiming at annual heat demand of $> \sim 3.500 \text{ m}^3$ of natural gas;
- Combination with a heat buffer is advised to enable long running periods;
- Systems can be placed in cascade when higher heat demand is required;
- Examples: large houses, houses with pool, family hotels, fitness centers, schools, elderly homes, multi family homes, restoration projects, municipality buildings etc.



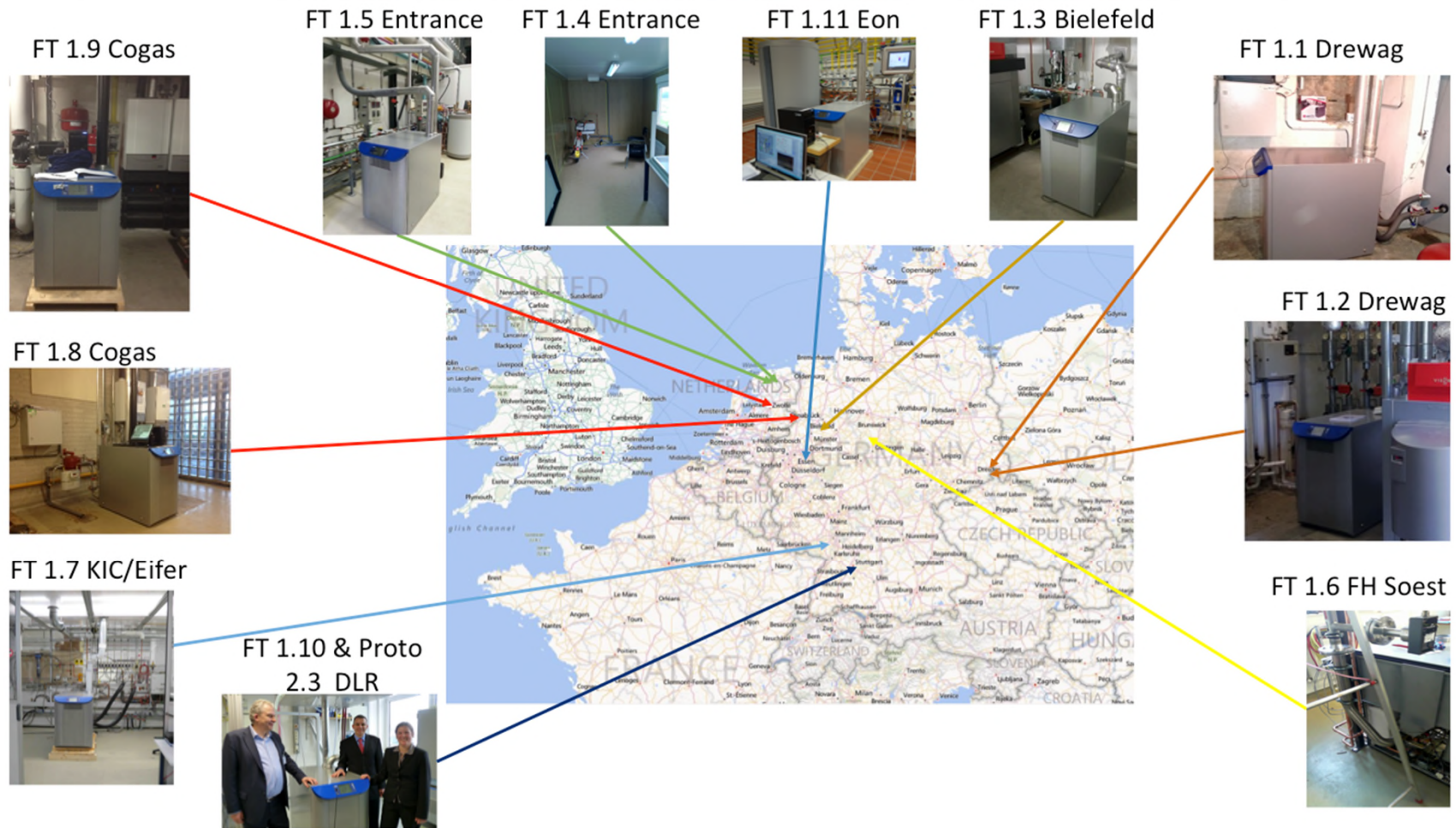
EnerTwin in Field Test



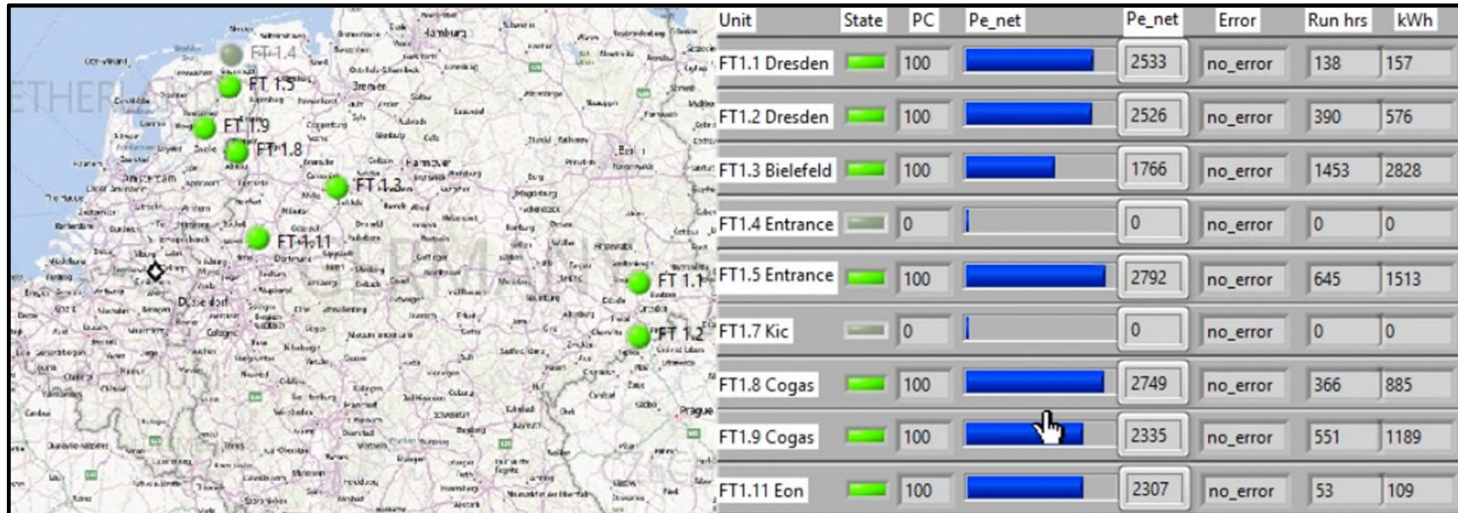
- Certification for field test Q1 2013;
- Field tests started July 2013 (Phase 1):
 - Initially 12 systems
 - Lab endurance testing partly in parallel
 - Main objective: reliability
- Field Test Phase 2:
 - Planned to start Q2, 2014
 - Up to 50 systems
 - Main objective: use cases
- Commercialization planned for mid 2015



Field test locations in NL and DE (phase 1)



Remote monitoring FT units



- Continuous on-line monitoring on key parameters by MTT team (PC and mobile phone)
- FT units are equipped with local PC for detailed data logging
- Data is transferred to MTT database every minute for analyses, extra loggings in case of errors (1 sec)
- Weekly update report to partners
- FT units for supporting R&D (DLR, KIC-Eifer, KIC-IREC, FH Soest) are locally monitored, independent test results are shared with MTT

USP's



- Pay back of investment 2 - 5 years;
- Low investment cost (3 kWe micro CHP system);
- High reliability - low maintenance costs;
- Able to modulate while retaining high electrical efficiency;
- Substantial CO2 reduction (3 – 6 tons per unit per year);
- Multi fuel: Natural Gas, Bio Gas, LPG, Heating Oil;
- Low weight, low noise and easy installation – plug & play;
- Allows new business models for energy distribution companies & -utilities.



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