

Micro-CHP: Overview of Technologies and Markets

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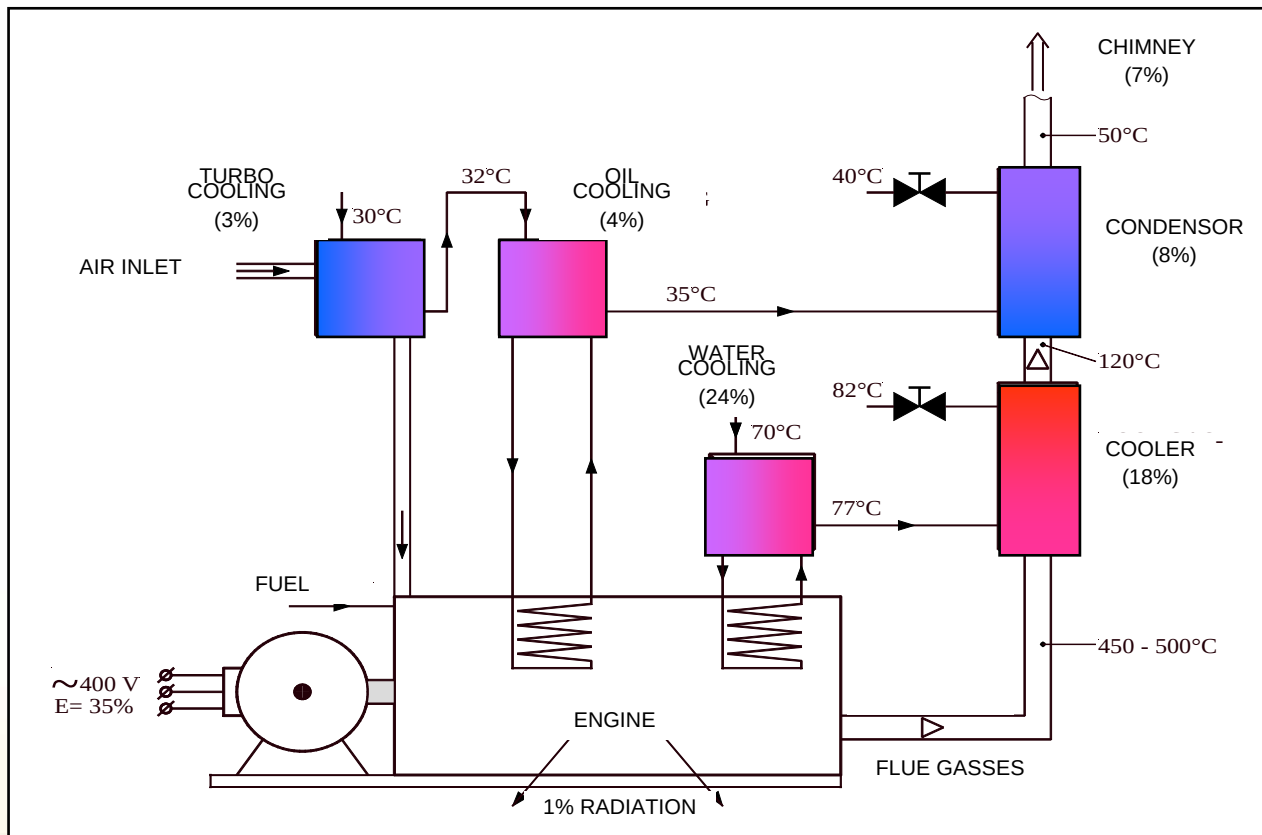


Micro-CHP: Overview of Technologies and Markets

- Technologies:
 - Internal combustion engines
 - Microturbines
 - Stirling engines
 - Fuel cells
- Markets



Micro-CHP: Internal combustion engines



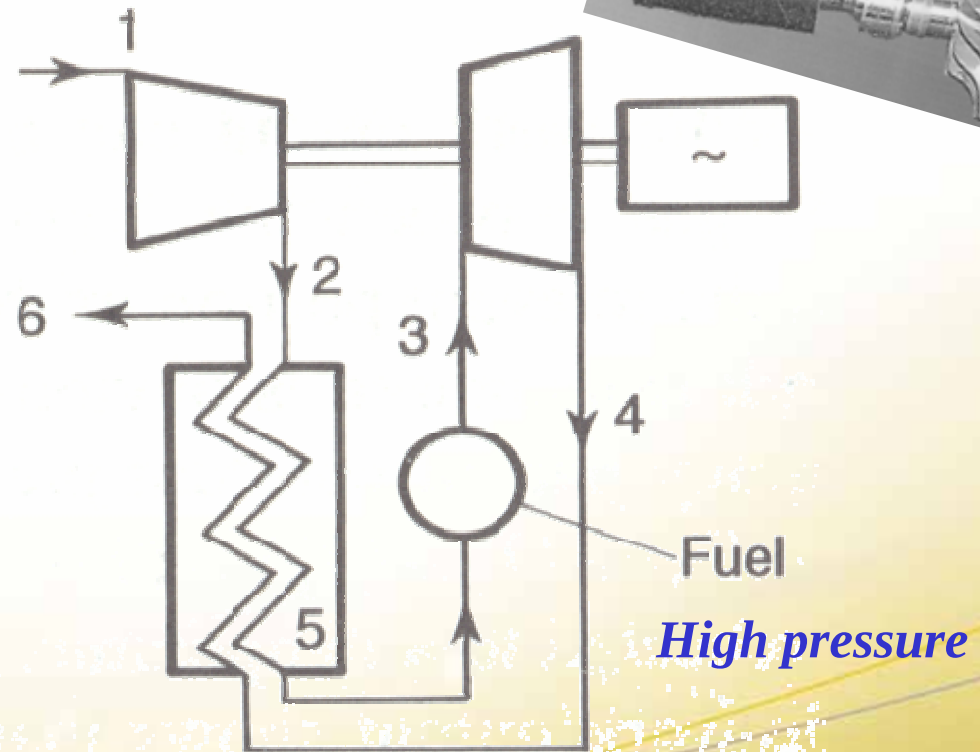
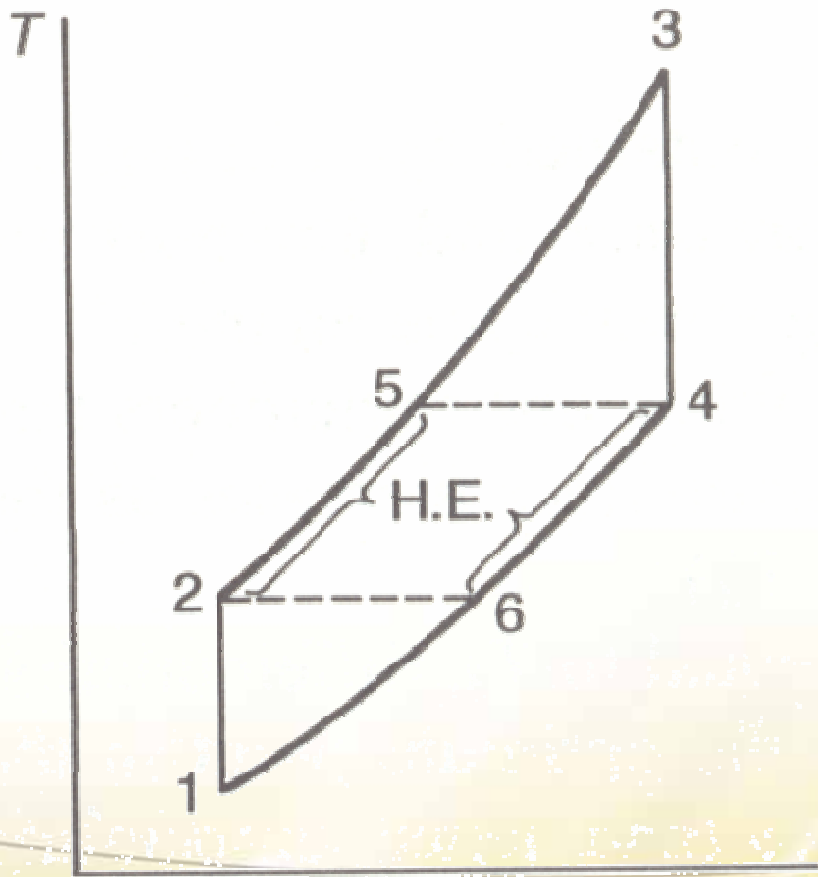
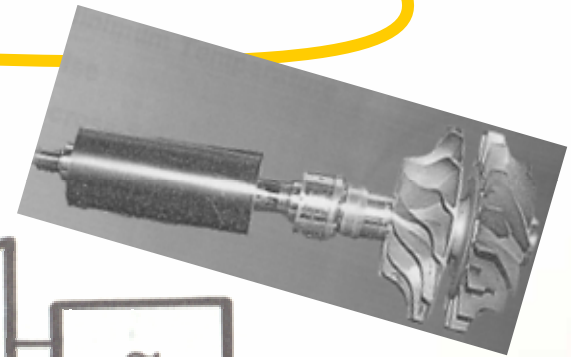
Micro-CHP: Internal combustion engines

Model	Power [kW _e]	Power [kW _{th}]
SenerTec Dachs	5,5	12,5
Ecopower	1,3 – 4,7	4 – 12,5
EC Power	4 - 13	17 - 29
Ecowill	1	3,25

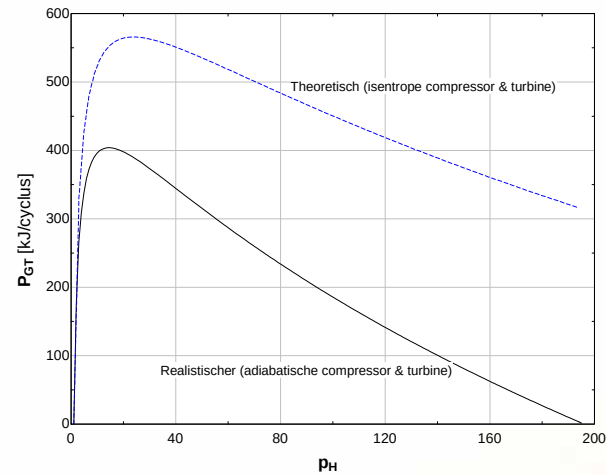
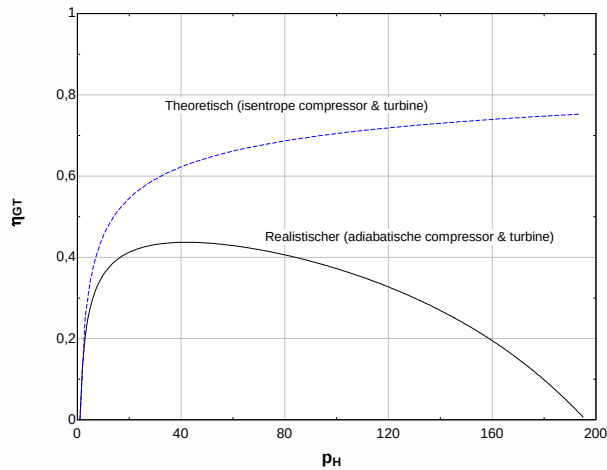
Price: 3000 - 10000 €/kW_e



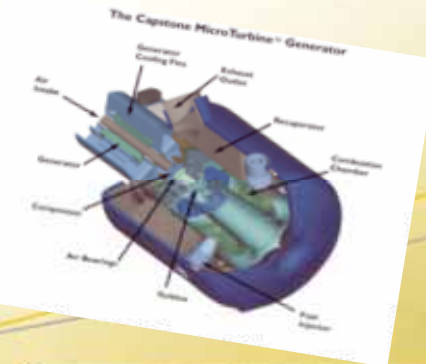
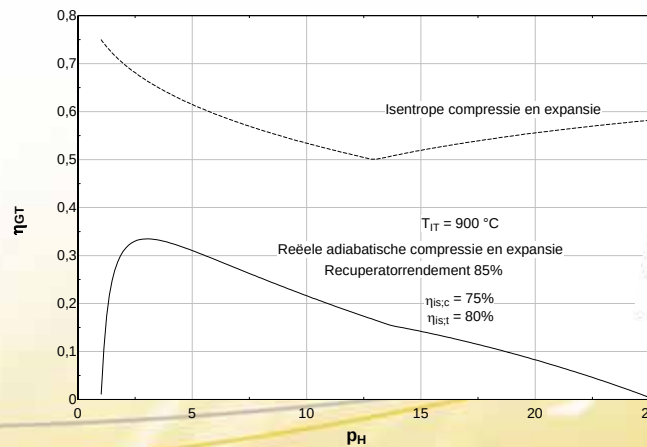
Micro-CHP: Microturbines



Micro-CHP: Microturbines



$p_L = 1$
 $T_1 = 20$
 $T_{Max} = 1300$
 $\eta_{isc} = 0,85$
 $\eta_{ist} = 0,9$



Micro-CHP: Microturbines

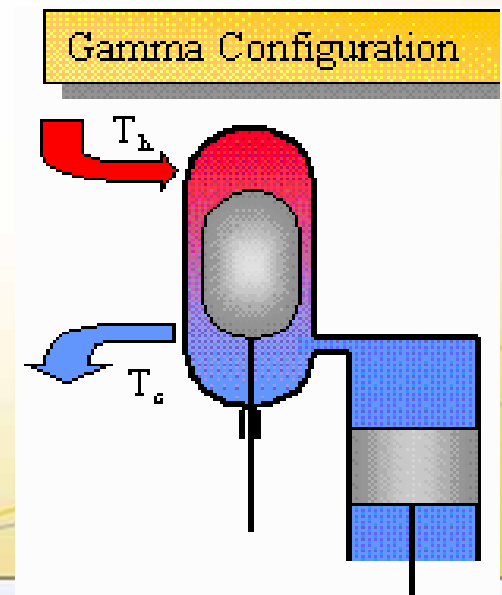
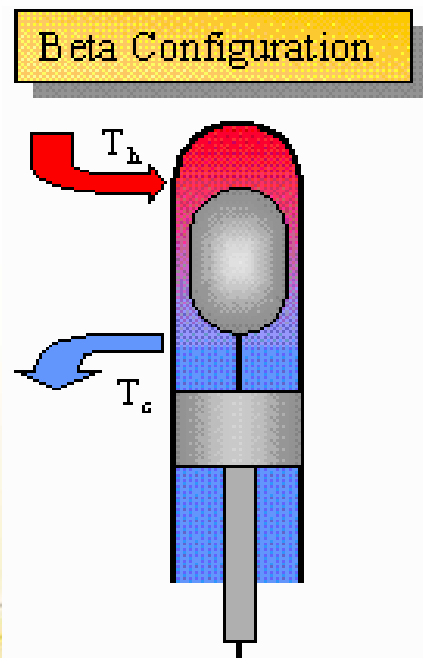
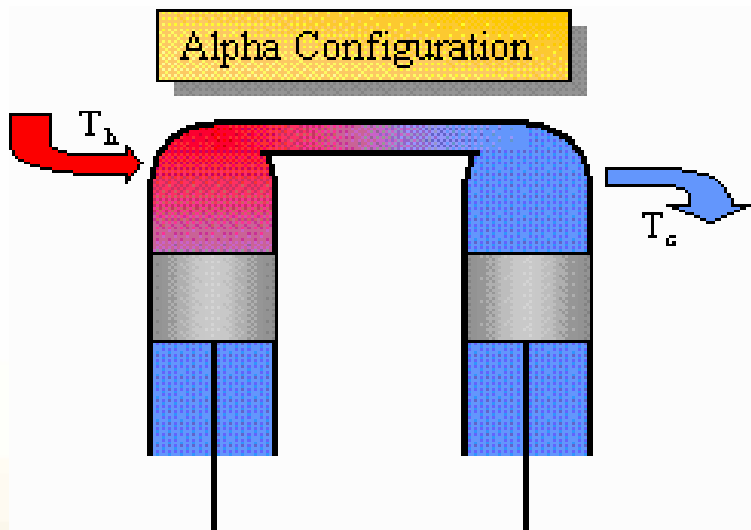
Model	Power [kW]	Electrical efficiency [%]
Capstone	28 / 60 / 200	26 / 28
Elliott/Bowman	35 / 80 / 100	14 / 30
IR Power Works	70 / 250	27 / 33
Turbec	100	30

Price: 1200 – 1900 €/kWe



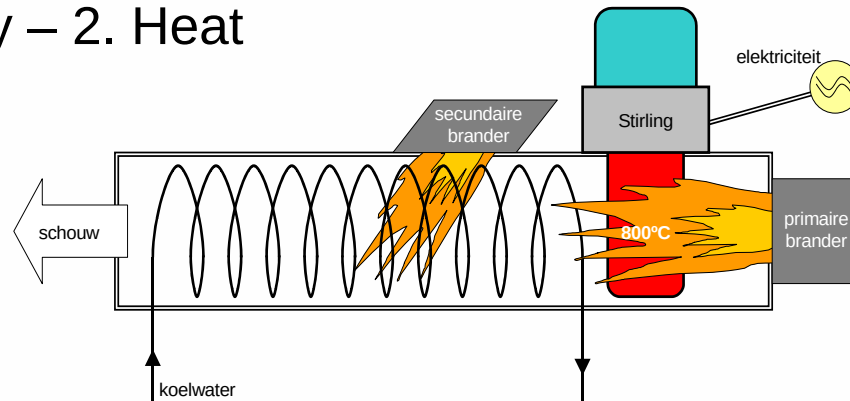
Micro-CHP: Stirling engines

- Exists sinds 19th century
- External combustion engine
- Closed cycle hot air engine with internal heat exchanger

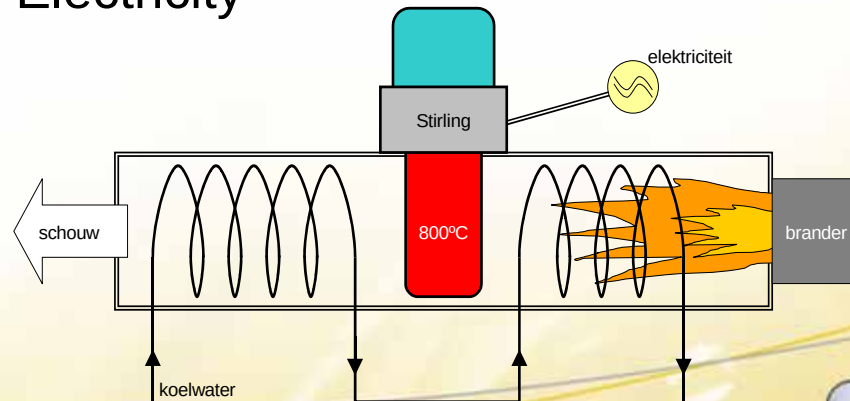


Micro-CHP: Stirling engines

- 1. Electricity – 2. Heat



- 1. Heat – 2. Electricity



Micro-CHP: Stirling engines

- Efficiency:
 - Almost independent of size
 - Very small engines possible
 - Total efficiency : >90%
 - Electrical efficiency: 10 – 35%
 - aE/aQ variable
- Power range: 1-60 kWe
- Investment cost high



Micro-CHP: Stirling engines

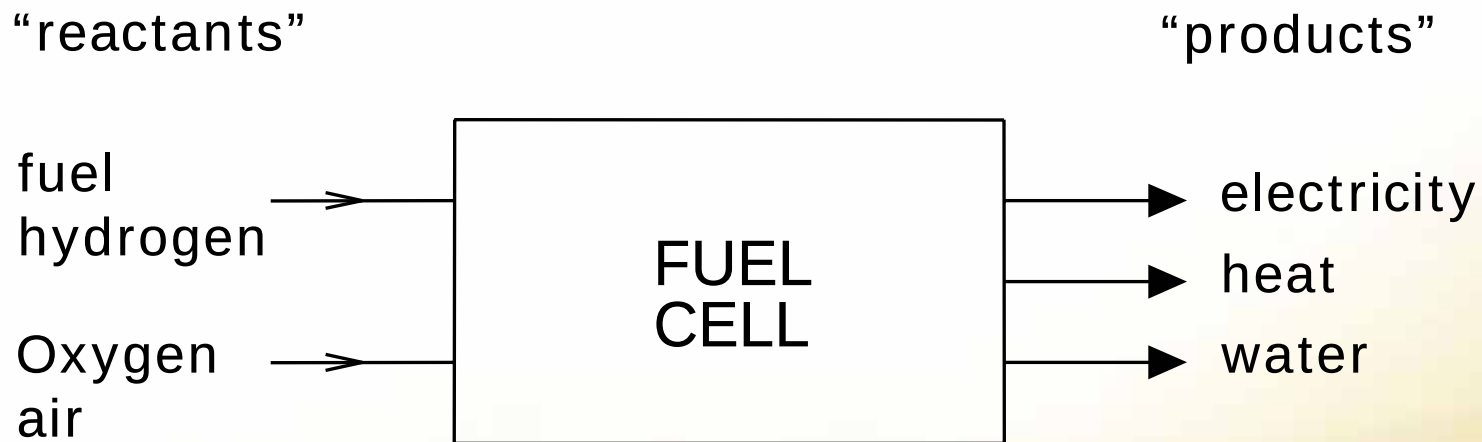
Model	Power		Efficiency	
	Electrical kWe	Thermal kWth	Electrical	Total
WhisperGen	Maximum 1	5,5 / 12	12	>90%
SOLO	2 - 9	8 - 26	22..24%	92-96%
Sunmachine	1,5 - 3	4,5 – 10,5	20 - 25%	90%
<i>MTS – Bosch - Enatec</i>	<i>1</i>	<i>4-9 (Stirling engine) 6 tot 35 (Peak burner)</i>		>98%
<i>Vaillant, Viessmann, Baxi and Remeha</i>	<i>1</i>	<i>4 to 40</i>		



Investment cost: 9000...15000 €/kWe

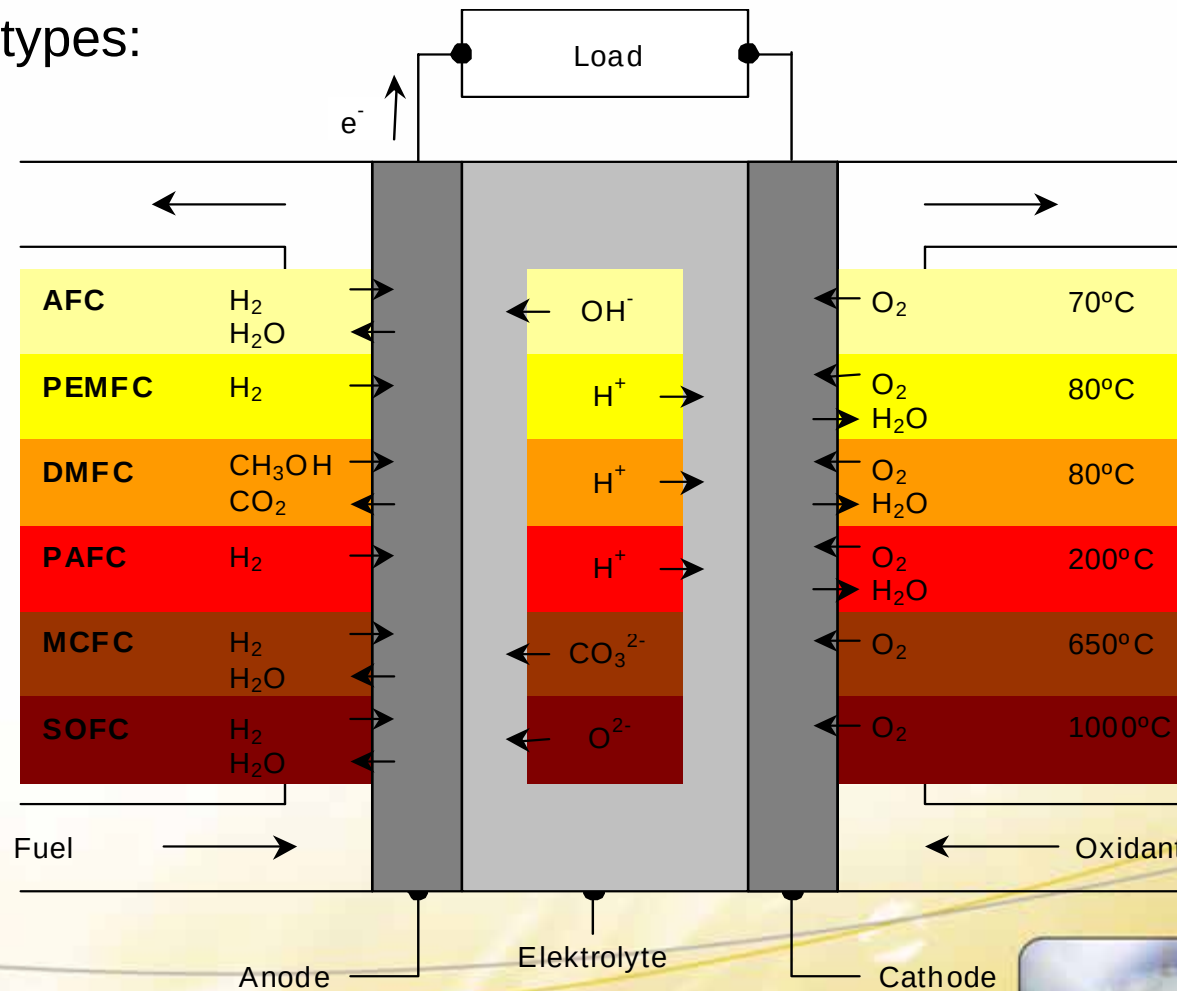
Micro-CHP: Fuel cells

In- and outputs of a simple fuel cell system:



Micro-CHP: Fuel cells

Different types:



Micro-CHP: Fuel cells

- Efficiency:
 - High electrical efficiency possible, even increasing at partial load: 25%...60%...??? (high values for high temperature fuel cells)
 - Thermal efficiency: 30%...60%
 - Total efficiency: ~80-85%
- Power range: few W tot MW
- DC current: power inverter
- Investment costs high



Micro-CHP: Fuel cells

1 – 5 kWe micro-WKK:



**Viessman,
Vaillant, Buderus,
De Dietrich, ...**



**Sanyo, Toyota,
Ebara Ballard,
Panasonic,
Toshiba,**



Micro-CHP: Markets

- Market potential by country uncertain:
 - Dependant of technological and economical evolutions
 - UK: estimates between 1 and 18 million households
- General barriers:
 - High investment costs
 - Limited product availability
 - Regulatory barriers
 - Uncertainties about consequences for different market actors
- Field tests are being executed
 - UK, Carbon trust field trials
 - The Netherlands
 - Germany
 - Japan

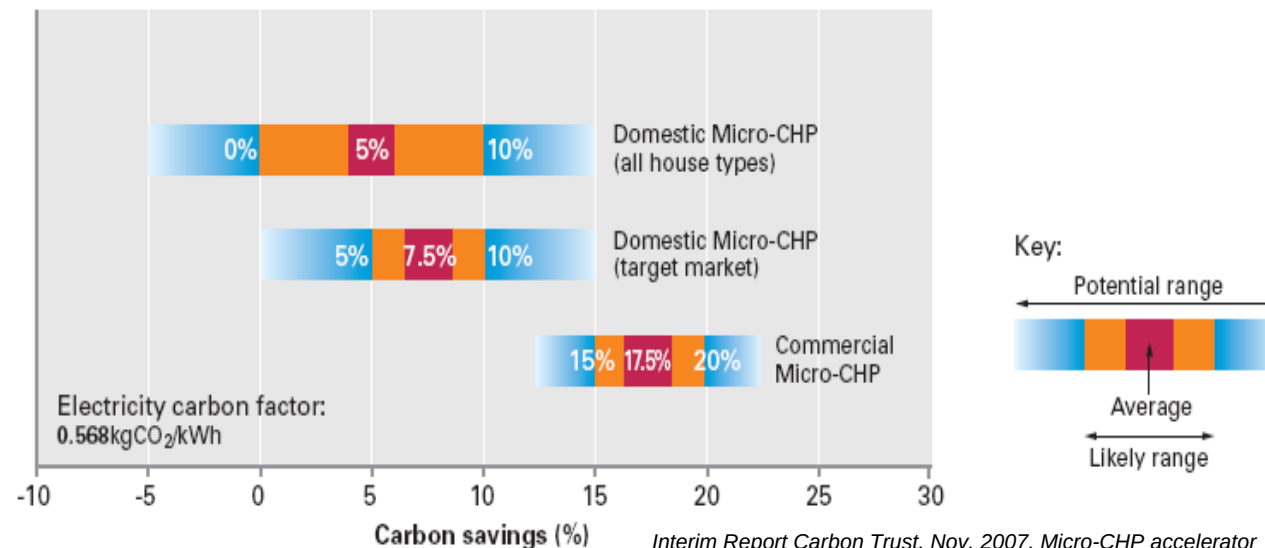


Micro-CHP: Markets

Carbon trust field trials:

- Field test with 87 μ -CHP units:
 - ICE for small commercial
 - Stirling for domestic
- Carbon and cost savings better for buildings where they can operate for long and consistent heating

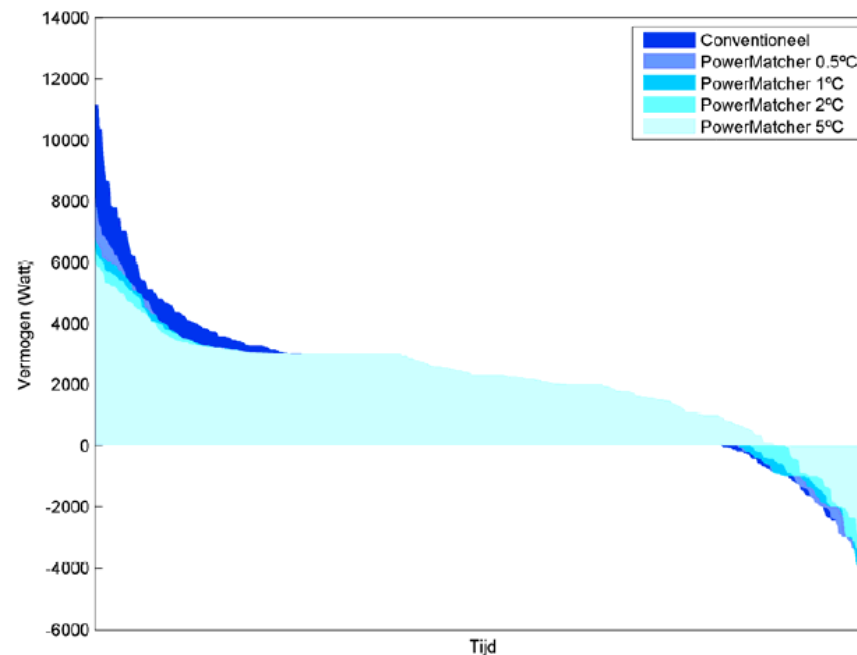
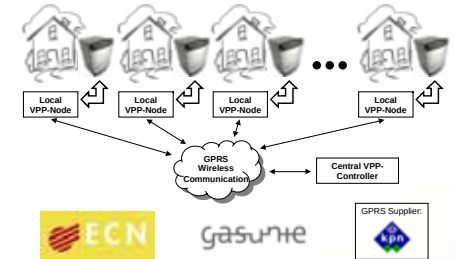
Range of carbon savings expected for domestic and commercial Micro-CHP (relative to a typical A-rated condensing system boiler and based on carbon emissions factor of 0.568kgCO₂/kWh for displaced electricity)



Micro-CHP: Markets

The Netherlands: Virtual power plant field test

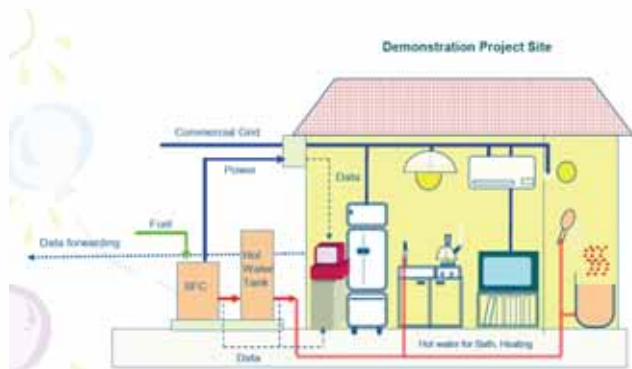
- Goal: reduce local peak demand of low-voltage grid
- High electricity prices: trigger to produce electricity
- Production only in case of heat demand
- Significant drop in peak load possible:
 - Summer: 30%
 - Winter: 50%



ECN Rapport: Aggregatie van micro-WKK's in een virtuele centrale

Micro-CHP: Markets

Large scale stationary fuel cell demonstration project in Japan:
Demonstration project with 2187 μ -CHP units (SFCs) (2005 – 2007)



Item	Result
Total Power Generated	555,152 kWh
Total Generation Hours	954,371hrs
Total Power Generated (per Site)	3,172kWh (8.7kWh/day)
Total Generation Hours (per Site)	5,454 hrs (14.9hrs/day)
Average Power Output	582W
Average Electrical Efficiency	29.1% (HHV)
Average Electrical Utilization Efficiency	26.0% (HHV)
Average Heat Recovery Efficiency	40.7% (HHV)
Average Heat Utilization Efficiency	37.1% (HHV)
Primary Energy Reduction Amount (per Site)	7215MJ/year
Primary Energy Reduction Rate	15.3%
CO ₂ Reduction Amount (Based on Thermal Power Plant ; per Site)	846kg-CO ₂ /year
CO ₂ Reduction Rate (Based on Thermal Power Plant)	28.0%

The total operational records as of July, 2007, including the data of FY2005-2nd stage and FY2006 stage;

Total Power Generated : 3,642,633 kWh

Total Generation Hours : 6,434,840 hrs

Presentation New Energy Foundation, Fuel Cell Seminar, Oct. 2007

Micro-CHP: Overview of Technologies and Markets

Conclusions:

- Different technologies exist
- Varying aE/aQ
- Market barriers
- Field test are going on



Thank you!

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