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Micro-CHP in Denmark?

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Why this interest in micro-CHP?

Cogeneration is widely used in Denmark: more than 50 % of the electricity production is based on cogeneration. Electricity based on wind turbines accounts for another 20 %.

More than 80 % of the heat supplied via district heating (the dominant heat supply for heating of houses) derives from cogeneration.

The EU Cogeneration Directive obliged the member states to search for further CHP potentials. In Denmark remaining CHP potentials can be found in industry and the domestic sector represented by houses individually heated via oil or gas fired boilers.

An analysis was made in 2006 regarding space heating CHP potential in the domestic/light commercial/institutional sector, taking into account:

- only houses within the domestic sector and/or light industry
 - with full-year occupation
- houses placed outside the existing district heating supply grid
- houses with water based heating systems
- a heat to power ratio of 2:1
- micro-CHP sizing so that > 4000 annual operation hours are obtained.

The analysis showed a technical potential of up to approx. 600,000 units with the power range of 0.7-3.5 kW_e. In the natural gas fired sector alone there is a technical potential of some 200,000 units with an average power output of between 0.8-1.8 kW_e.

The national micro-CHP demonstration programme

A large national development and demonstration programme was initiated in 2007 focussing on micro-CHP based on fuel cells. Various fuel-cell technologies (LT-PEM, HT-PEM, SOFC) are being tested, demonstrated and evaluated. Both units operating on natural gas and units for hydrogen are being tested/demonstrated. The micro-CHP units are designed for single-family houses. Based on energy consumption statistics and analysis a net electrical output of some 1.2-1.5 kW_e seems to give the best operation conditions for the units. All units are connected to the heating systems via heat storage.

A number of hydrogen fuelled micro-CHP units are now in operation in the town of Vestenskov. Other units are natural-gas fuelled; the first units are now installed and commissioned in the Southern Jutland region.

Smart Grid

Micro-CHP is also part of other demonstration projects. A large joint European demonstration project, EcoGrid (www.eu-ecogrid.net), includes micro-CHP as one of the tools for smart grid operation/demonstration.

Early product introduction

The first presentations of the BaxiStirling engine-based micro-CHP product have been made in technical magazines. The product has also been shown at technical exhibitions.

Arguments/Drivers for micro-CHP in Denmark

- Boilers have reached their efficiency limit; new technologies should be introduced in this market.
- Micro-CHP can be valuable for power balancing issues.
- On-site production saves transmission losses and saves primary fuel elsewhere (fossil-based power-only production).
- Micro-CHP with intelligent control systems can be valuable in smart grid networks.
- The gas system is important in the future energy system; introduction of micro-CHP secures the return of investment for connections to individual consumers with decreasing heating energy needs.
- Micro-CHP paves the way for interesting ownership and operational models.
- Micro-CHP supports the EU Cogeneration Directive, the Energy Service Directive and more.
- Improves security of supply along with other local producers, cell test/demo projects (e.g. www.eu-ecogrid.net).

PowerPoint presentation



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Micro-CHP...in Denmark..?

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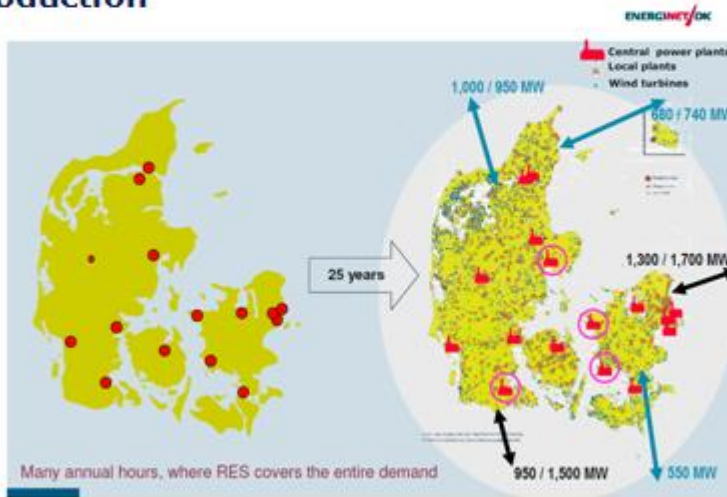
Presentation outline

- The CHP situation
- Mini-/micro-CHP potential?
- The market situation for mini-/micro-CHP
- The Danish Micro-CHP Fuel Cell Project
- Conclusion

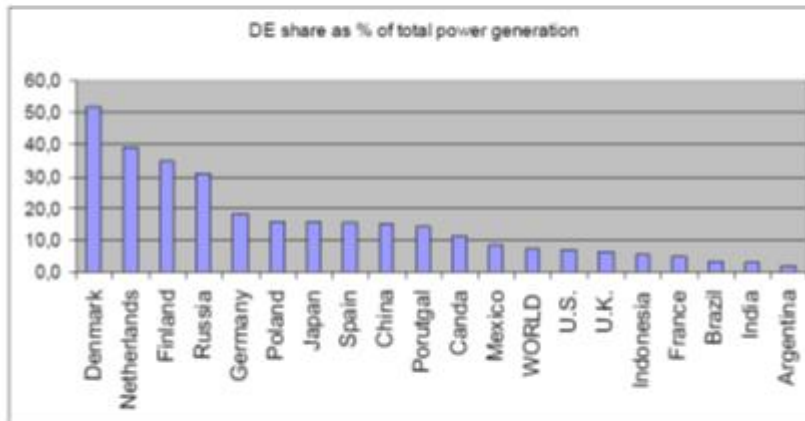
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From centralised to decentralised power production

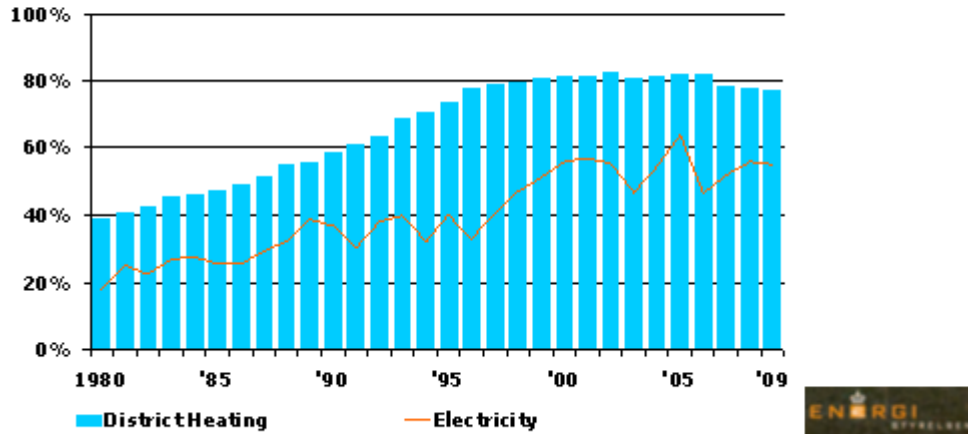


CHP overview

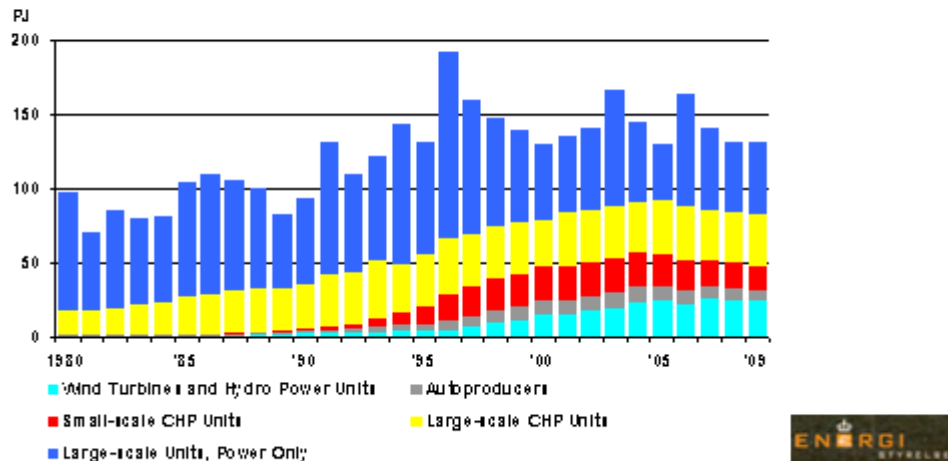




CHP share of electricity and district heating production



Room for μ CHP ...as some 35 % power production is still fossil fuel based power only





Heating.....how..?

Statistical Yearbook 2009

	Number of dwellings
District heating	1.550.000
Individual oil firing	375.000
Individual gas boilers	380.000
Electrically heated	125.000 ¹⁾
Other	100.000
Total	2.530.000

¹⁾ Estimate



Where to install mini- or micro-CHP units – Analysis of the technical potential (Denmark)

Foundation for the analysis

- The energy consumption database for houses, Danish Energy Agency
- Only all-year houses
- Outside the district heating areas
- Only dwellings with hydronic heating
- CHP based on at least 4500 annual operation hours



Mini- or micro-CHP, technical potential

Gas area

CHP plant size, avg. (kW _e)	CHP potential (MW _e)	Number of plants
0.8	2	2500
1.8	365	203.000
3.1	466	150.000
20	254 ^{*)}	12.700 ^{*)}
<i>Total</i>	<i>Approx. 1100</i>	<i>368.000</i>
^{*)} Only half of the potential is included, as the average is larger than 15 kW _e		



Mini- or micro-CHP - Analysis of technical potential

Gas area

	Potential (MW _e)	Avg. CHP installed power (kW _e)
Detached houses	731	2.4
Terraced houses	126	3
Business/Industry	109 ^{*)}	19.4
Blocks of flats	62 ^{*)}	17.1
Farmhouses	23	4.4
Hotels and service	18	12.3
24-hour care centres	11	8.5
Cultural centres	10	8.9
<i>Total</i>	<i>Approx. 1100</i>	
^{*)} Only half of the potential is included, as the average is larger than 15 kW _e		
The table shows that single-family houses offer a significant CHP installation potential		



Mini-CHP (5-15kW_e): On the market

micro-CHP...marketing initiated....



EC-Power



Micro-CHP...

..now included in the Building Regulations 2010
..as an accepted heating appliance



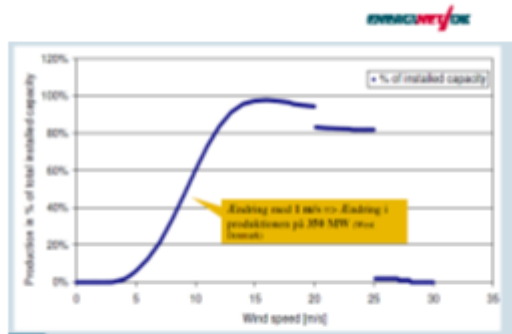


Micro-CHP...

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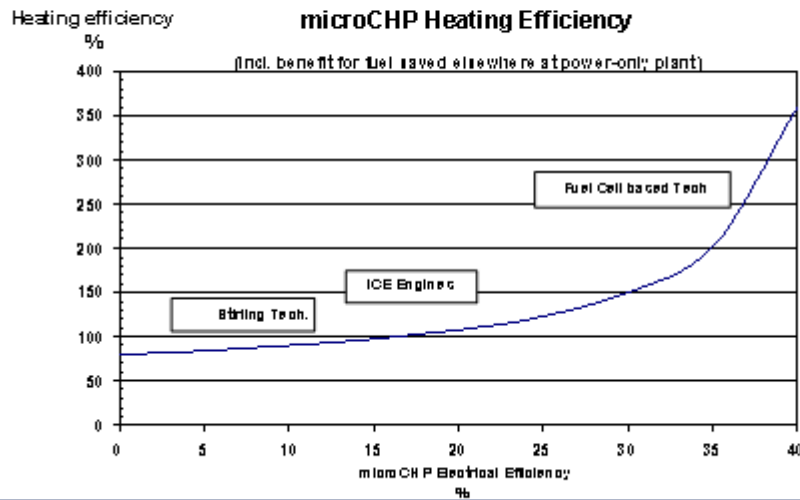
A wind speed change of 1 m/s means a power change of some 350 MW_e in western DK



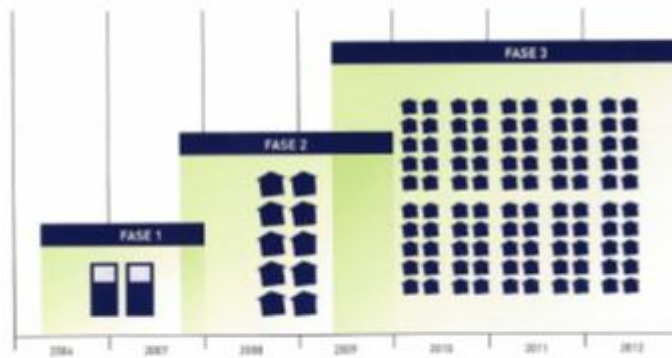
When a storm forces the wind turbines to stop there is a sudden tremendous need for alternative power production.



Why this focus on fuel cells?

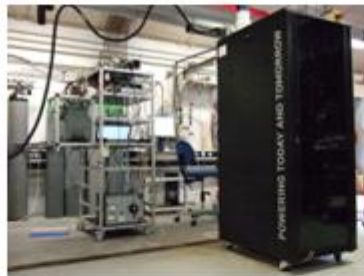


Time table "Danish Micro-CHP Project" Micro-CHP based on fuel cells (3-5 FC types, 2 fuels)

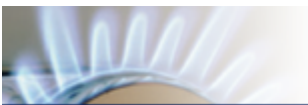




First-, second- and third-generation IRD μ CHP (FC based)



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Micro-CHP in Denmark, Conclusion

- Legislative initiatives taken (Building Codes, grid connection)
 - R&D and demonstration on-going, R&D with fuel-cell focus
 - Marketing initiated (boiler companies)
 - Seen as next-generation boiler, competing with heat pumps etc.

Even in Denmark there is a significant technical potential for efficient μ CHP!

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Micro-CHP is part of the EcoGrid EU smart grid demo project

