Demonstration of µCHP Based on Danish Fuel Cells

(Phase 2) – paper # 116

Fuel Cell Seminar 2009,

Palm Springs, US - Nov. 16 – 19, 2009

Presented by Aksel Hauge Pedersen, DONG Energy A/S

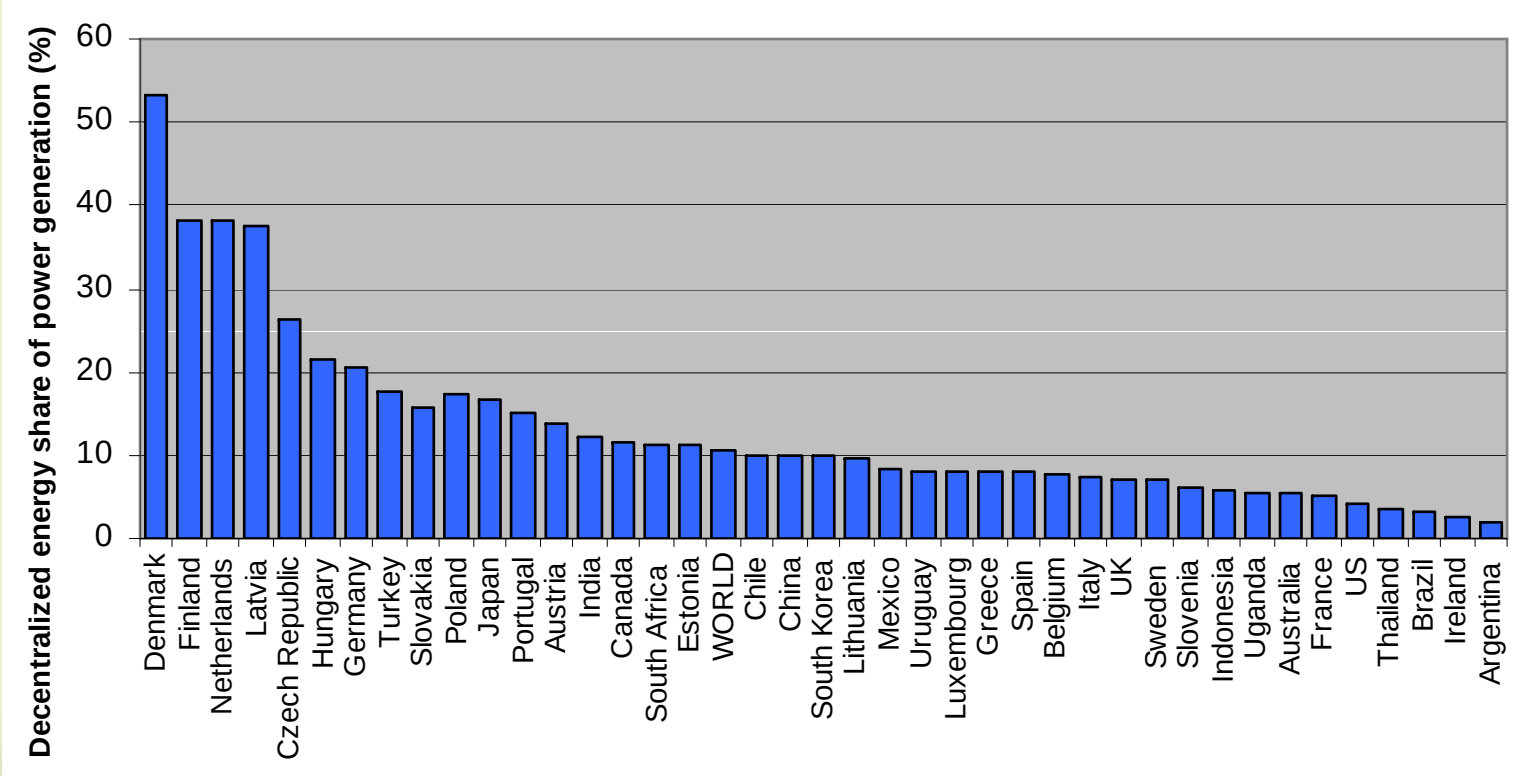
- co author Per Balslev, Danfoss A/S -

DANISH MICRO COMBINED HEAT & POWER

Heat & Power from Fuel Cells

COWI | Danfoss | Dantherm Power | DGC | DONG energy | IRD | seas-nve | SE SYD ENERGI | TOPSOE FUEL CELL

Denmark have a tradition for CHP

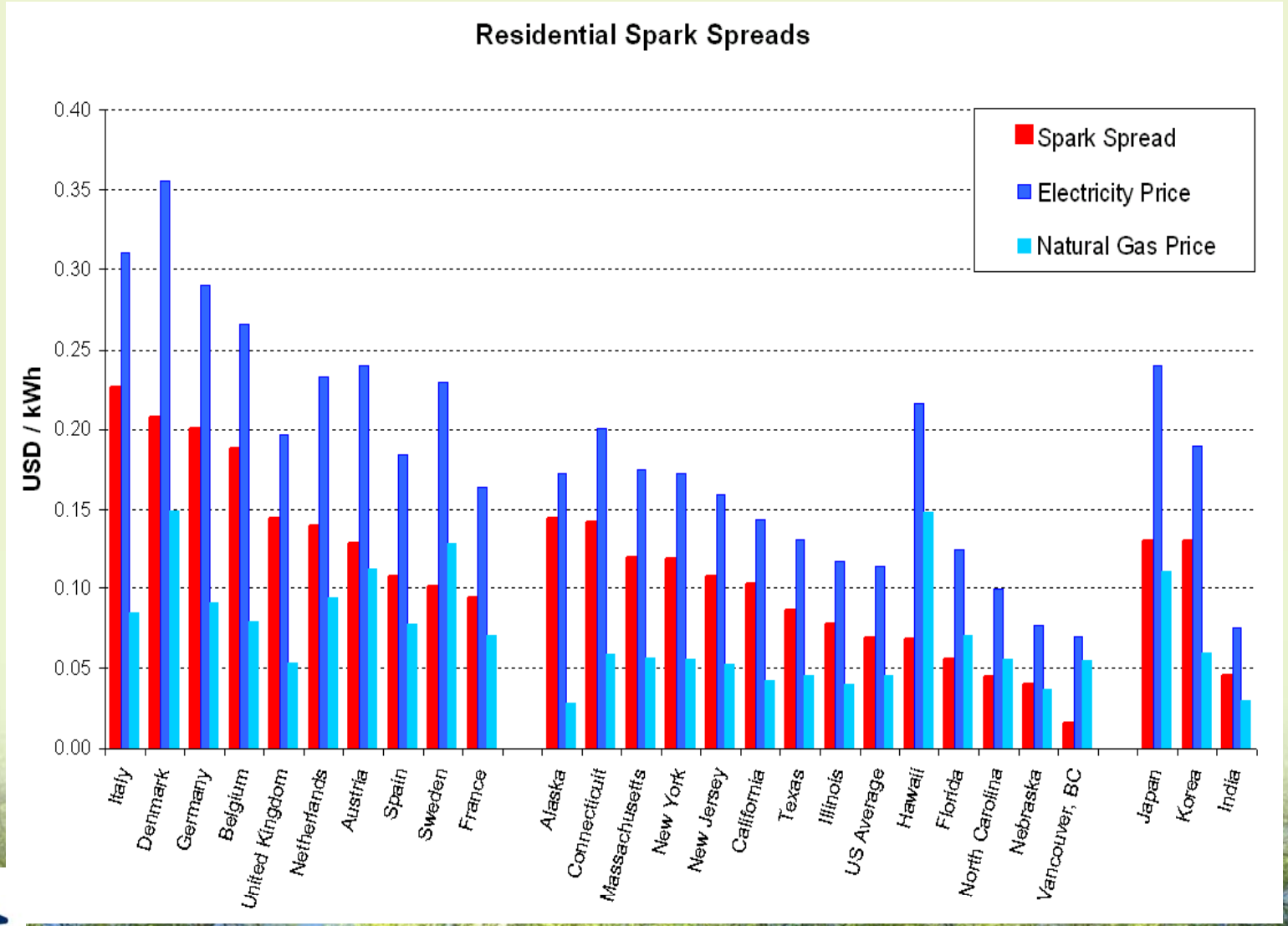


DANISH MICRO COMBINED HEAT & POWER

Heat & Power from Fuel Cells

COWI Danfoss Dantherm Power DGC DONG energy IRD seas nve SE SYD ENERGI TOPSOE FUEL CELL

Why is µCHP interesting in Denmark? - Residential Spark Spreads

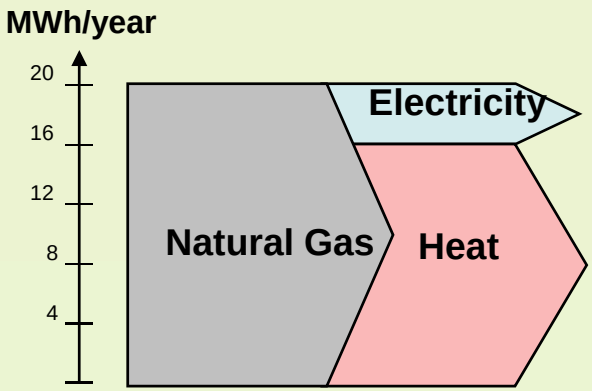


DANISH MICRO COMBINED HEAT & POWER
Heat & Power from Fuel Cells

COWI Danfoss Dantherm Power DGC DONG energy IRD seas nve SE SYD ENERGI TOPSOE FUEL CELL

Why is µCHP interesting in Denmark? – CO2 economics

CO_2 footprint: Fuel Cell based µCHP fueled by natural gas



Electricity consumption 4 000 kWh/year

Heat consumption 16 000 kWh/year

CO_2 footprint per household: (20 000*0,21) = 4 200 kg CO_2/year

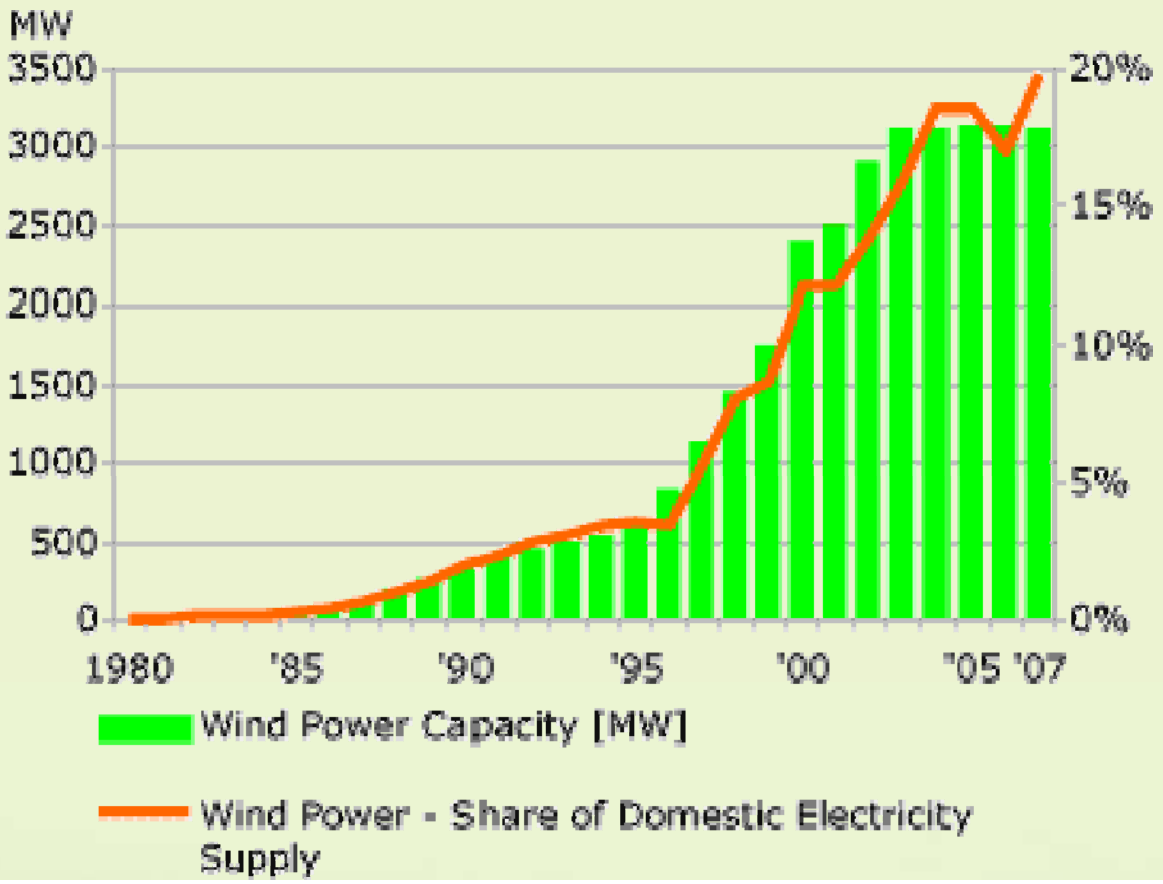
(NG reference 5 560 kg CO_2/year) **Saving: 1 360 kg CO_2/year or 24%**

CO_2 footprint per kWh: from grid 0,55 kg CO_2 or from natural gas 0,21 kg CO_2

DANISH MICRO COMBINED HEAT & POWER
Heat & Power from Fuel Cells

COWI Danfoss Dantherm Power DGC DONG energy IRD seas-nve SE SYD ENERGI TOPSOE FUEL CELL

Why is µCHP interesting in Denmark? – Balancing of Wind Power



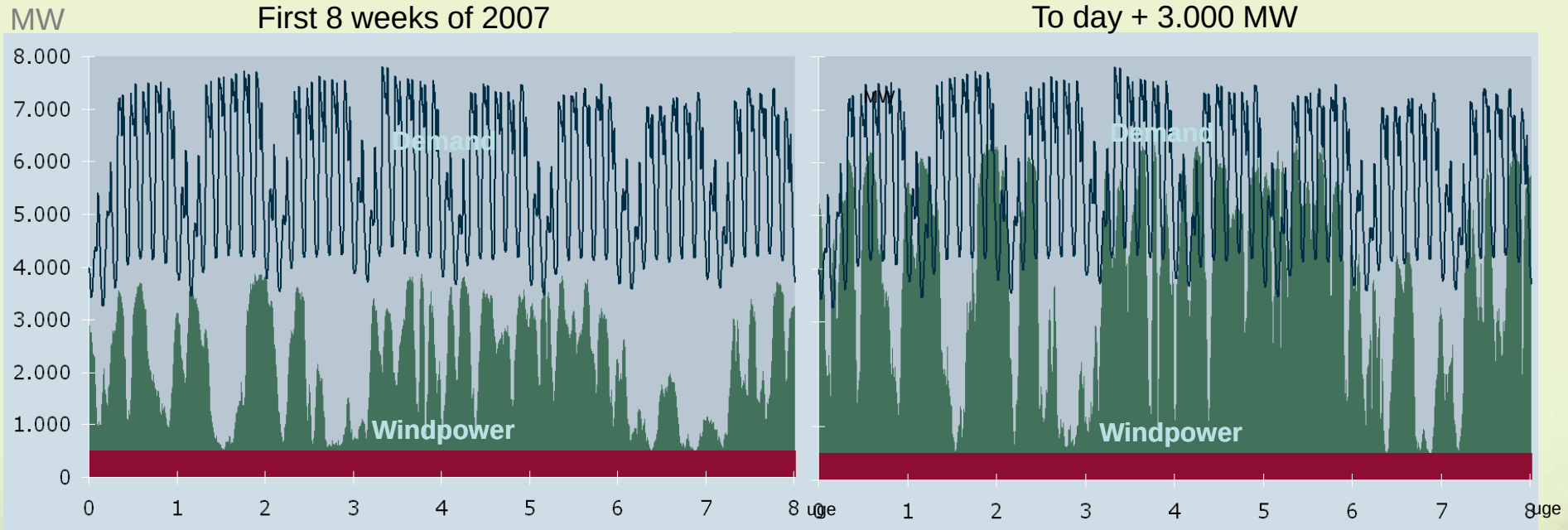
Fluctuating wind power in Denmark will increase to around 50% in 2020

DANISH MICRO COMBINED HEAT & POWER
Heat & Power from Fuel Cells

COWI | Danfoss | Dantherm Power | DGC | DONG energy | IRD | seas-nve | SE SYD ENERGI | TOPSOE FUEL CELL

Wind Power in Denmark

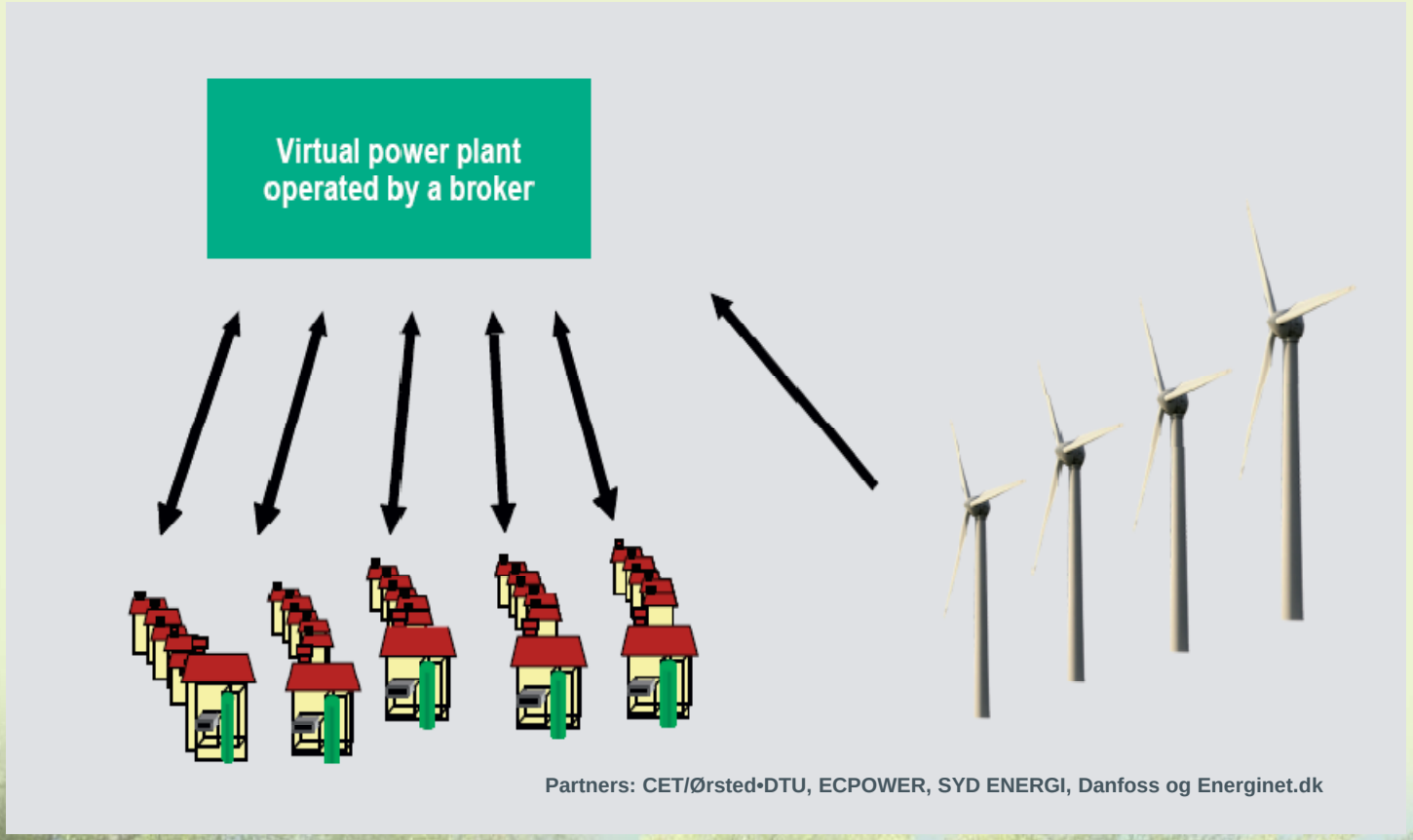
Integration of extra 3 000 MW wind power?



DANISH MICRO COMBINED HEAT & POWER
Heat & Power from Fuel Cells

COWI Danfoss Dantherm Power DGC DONG energy IRD seas nve SE SYD ENERGI ENERGINET.DK

Why is µCHP interesting in Denmark? – Virtual Power Plant



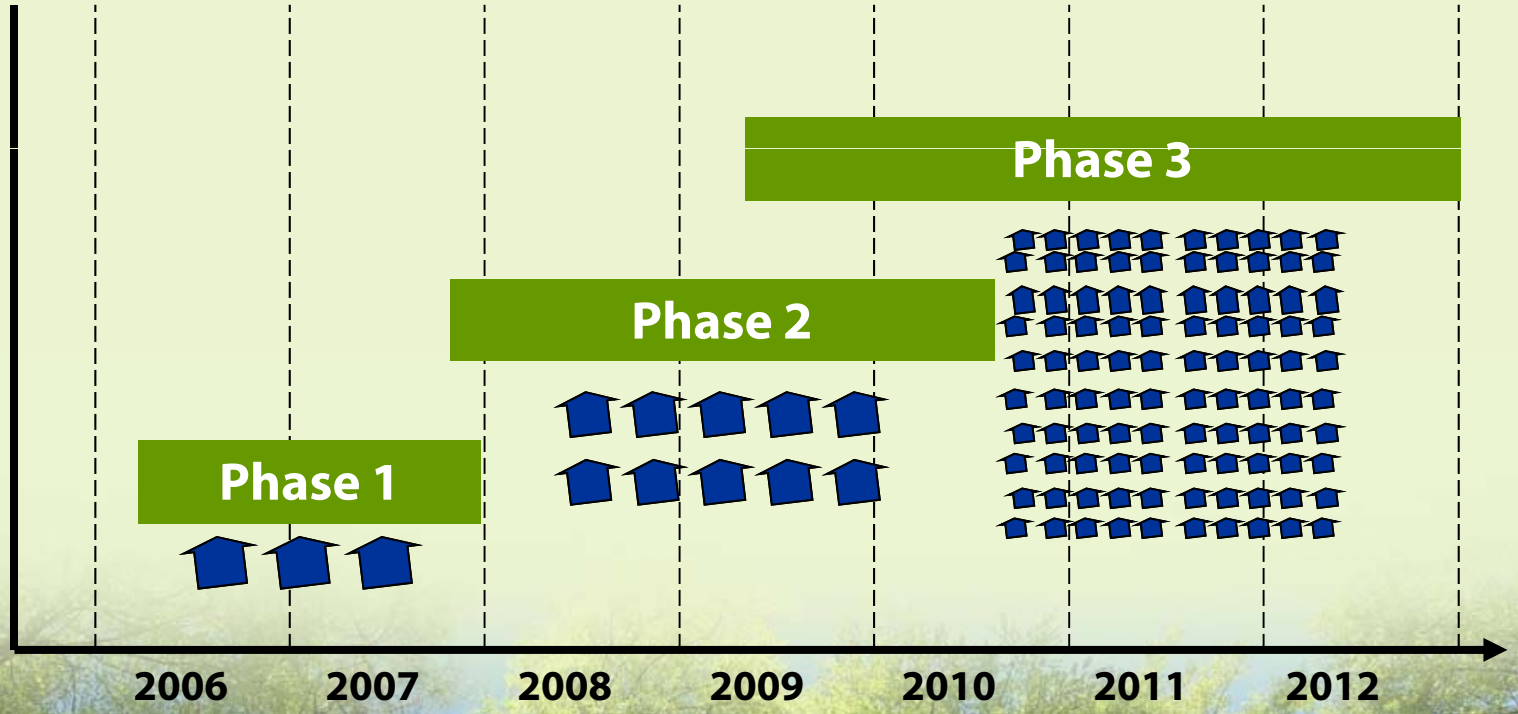
Partners: CET/Ørsted•DTU, ECPOWER, SYD ENERGI, Danfoss og Energinet.dk

Virtual Power Plant: Power from µCHP can supplement wind turbines in periods with little wind.

DANISH MICRO COMBINED HEAT & POWER
Heat & Power from Fuel Cells

A Danish demonstrations project on fuel cell based micro CHP

The Danish µCHP is a corporation between 9 Danish companies on development and demonstration of fuel cell based micro combined heat and power for private homes. The project includes Danish fuel cell stacks of low and high temperature PEM and SOFC fueled by natural gas or hydrogen.

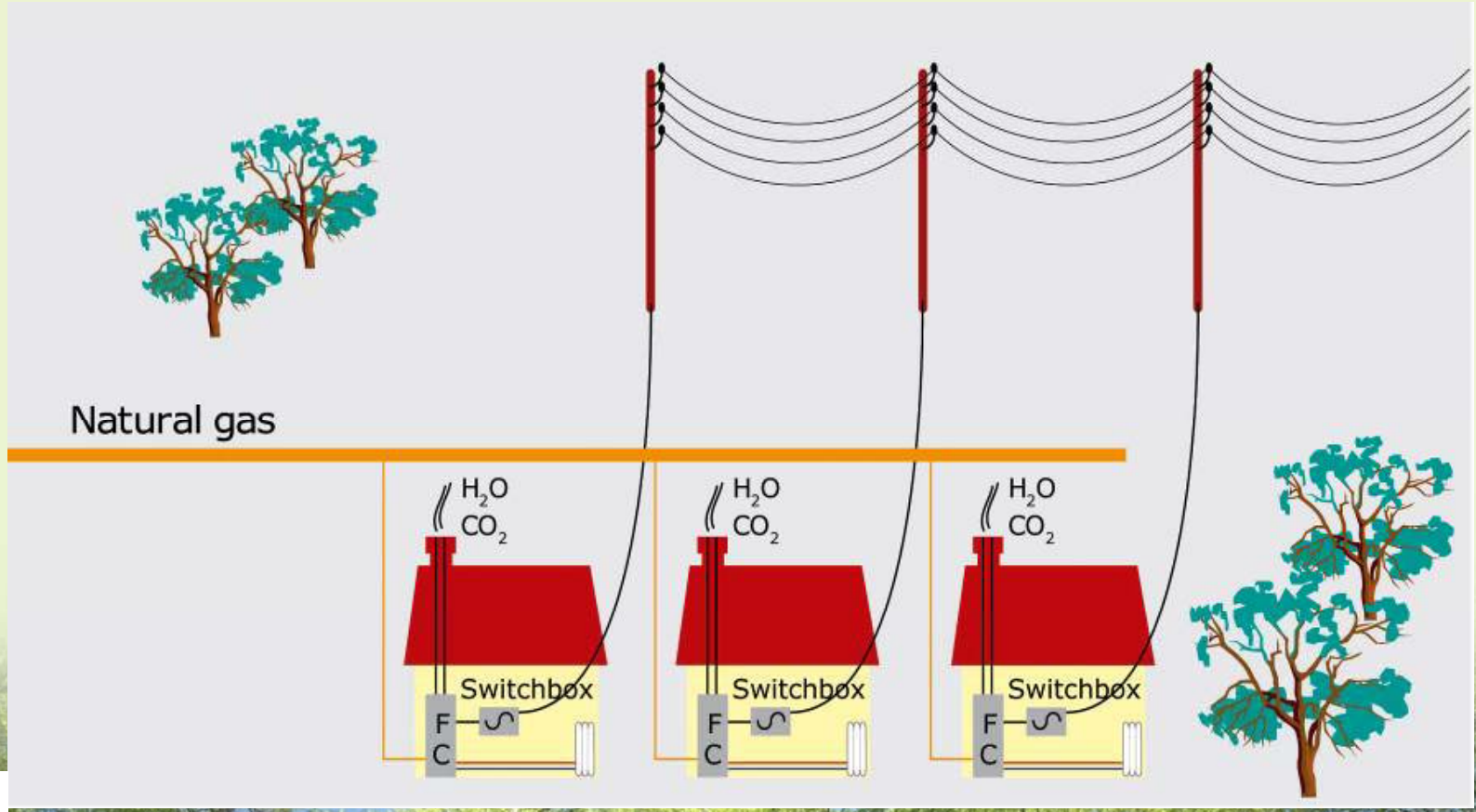


DANISH MICRO COMBINED HEAT & POWER
Heat & Power from Fuel Cells

COWI | Danfoss | Dantherm Power | DGC | DONG energy | IRD Fuel Cell Technologies | seas-nve | SE SYD ENERGI | TOPSOE FUEL CELL

A Danish demonstration project on fuel cell based micro CHP

Demonstration of Fuel cell micro CHP fueled by natural gas based on HT-PEM and SOFC



DANISH MICRO COMBINED HEAT & POWER
Heat & Power from Fuel Cells

COWI | Danfoss | Dantherm Power | DGC | DONG energy | IRD | seas-nve | SE SYD ENERGI | TOPSOE FUEL CELL

A Danish demonstration project on fuel cell based micro CHP

Demonstration of Fuel cell micro CHP fueled by Hydrogen – based upon LT - PEM

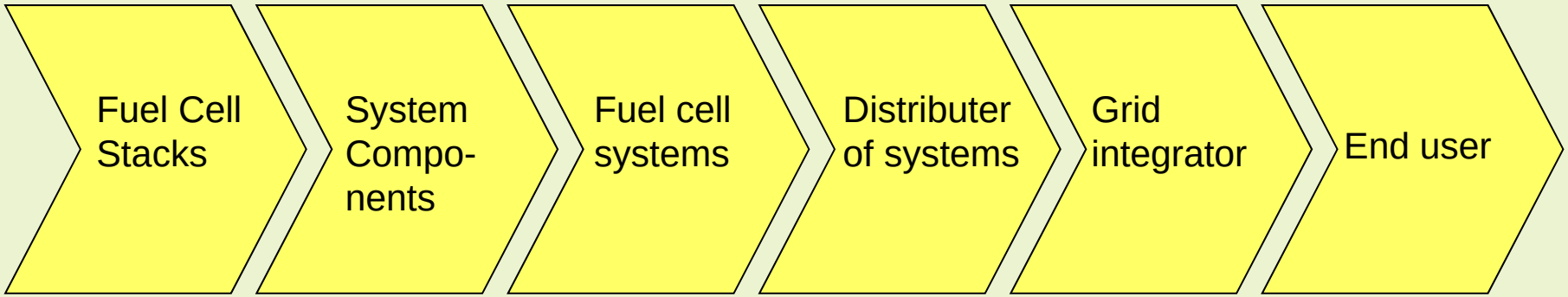
DANISH MICRO COMBINED HEAT & POWER

Heat & Power from Fuel Cells

COWI | Danfoss | Dantherm Power | DGC | DONG energy | IRD | seas-nve | SE SYD ENERGI | TOPSOE FUEL CELL

A Danish demonstration project on fuel cell based micro CHP

The Value Chain for microCHP



TOPSOE FUEL CELL

Dantherm Power

seasonve

IRD Fuel Cell Technology

SYD ENERGI

Danfoss

DONG energy Gas

DANISH MICRO COMBINED HEAT & POWER

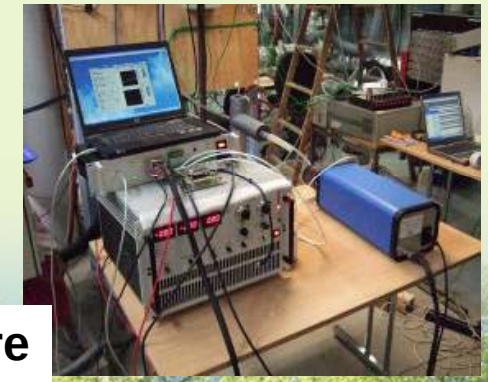
Heat & Power from Fuel Cells

COWI | Danfoss | Dantherm Power | DGC | DONG energy | IRD Fuel Cell Technology | seasonve | SYD ENERGI | TOPSOE FUEL CELL

A Danish demonstration project on fuel cell based micro CHP

SOFC unit

LT-PEMFC unit



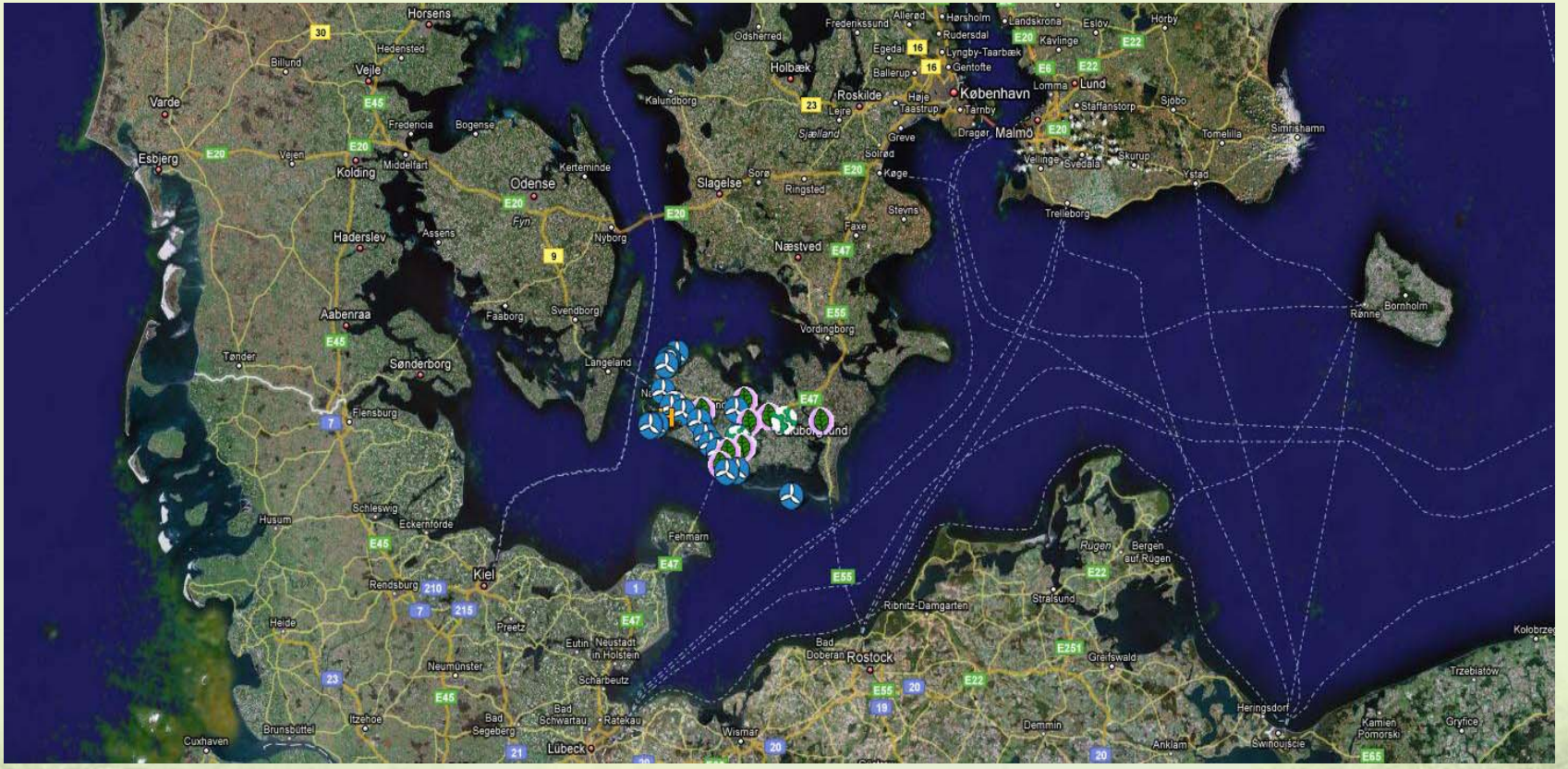
HT-PEMFC core

DANISH MICRO COMBINED HEAT & POWER

Heat & Power from Fuel Cells

COWI | Danfoss | Dantherm Power | DGC | DONG energy | IRD Fuel Cell Technology | seas-nve | SE SYD ENERGI | TOPSOE FUEL CELL clean, efficient and reliable

A Danish demonstration project on fuel cell based micro CHP

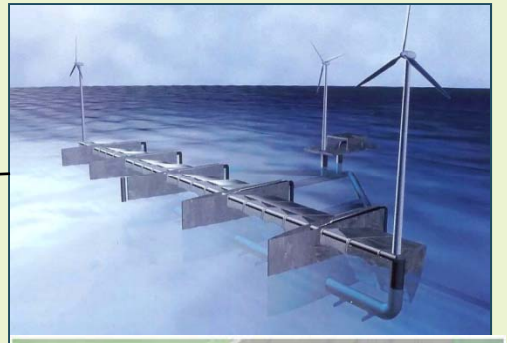


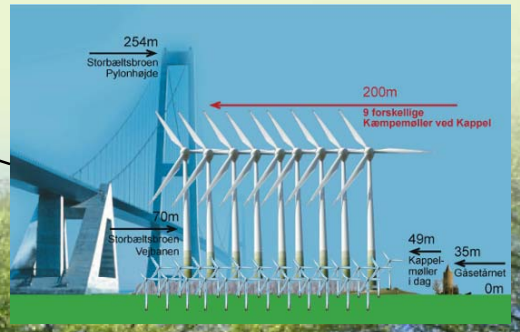
DANISH MICRO COMBINED HEAT & POWER

Heat & Power from Fuel Cells

COWI | Danfoss | Dantherm Power | DGC | DONG energy | IRD Fuel Cell Technology | seas-nve | SE SYD ENERGI | TOPSOE FUEL CELL clean, efficient and reliable

Lolland Commmunity - Demonstration of sustainable Energy





DANISH MICRO COMBINED HEAT & POWER
Heat & Power from Fuel Cells

COWI | Danfoss | Dantherm Power | DGC | DONG energy | IRD Fuel Cell Technology | seas nve | SE SYD ENERGI | TOPSOE FUEL CELL

Royal opening of the first field test plant ! – Sept. 2008

DANISH MICRO COMBINED HEAT & POWER

Heat & Power from Fuel Cells

COWI | Danfoss | Dantherm Power | DGC | DONG energy | IRD Fuel Cell Technology | seas-nve | SE SYD ENERGI | TOPSOE FUEL CELL clean, efficient and reliable

Status November 2009

- LT PEM – field test running – 5 installations feed with Hydrogen
- HT PEM – field test model developed. First field installation will be made December 2009
- SOFC – field test model developed. First field installation will be made December 2009.

DANISH MICRO COMBINED HEAT & POWER
Heat & Power from Fuel Cells

COWI | Danfoss | Dantherm Power | DGC | DONG energy | IRD Fuel Cell Technology | seas-nve | SE SYD ENERGI | TOPSOE FUEL CELL clean, efficient and reliable

Demonstration of micro CHP based on Danish fuel cells

Thank you – for your attention

DANISH MICRO COMBINED HEAT & POWER

Heat & Power from Fuel Cells

COWI | Danfoss | Dantherm Power | DGC | DONG energy | IRD | seas-nve | SE SYD ENERGI | TOPSOE FUEL CELL