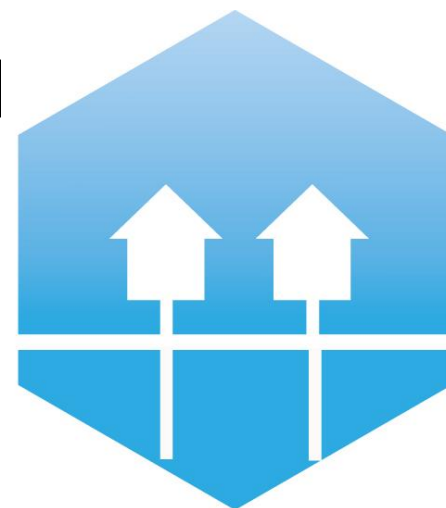
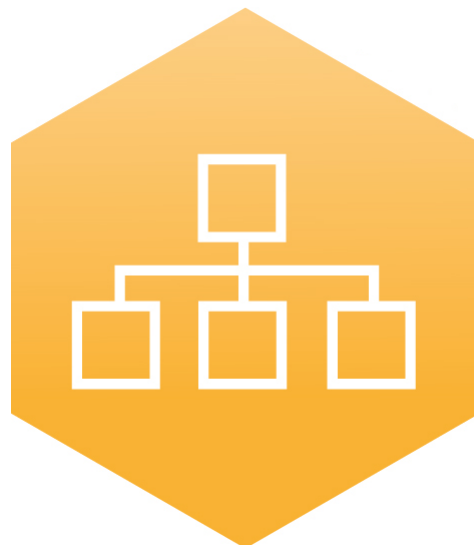


4 GDH and HVAC - a virtual electricity storage

Anders Dyrelund Ramboll



4DH

4th Generation District Heating
Technologies and Systems

Cities – an opportunity for cost effective EE and RES solutions

- Cities are growing
- An opportunity for DH&C
- DH&C is a precondition for EE and cost effective integration of RES from wind, solar, biomass, geothermal
- Efficient integrated low temperature HVAC in Buildings is an important part of the urban DH&C infrastructure

4DH&C and efficient HVAC- the Hidden back bone of the liveable city



International Conference on Smart Energy Systems and
4th Generation District Heating, Copenhagen, 25-26 August 2015

EU-energy legislation

Buildings

Energy Performance of Buildings Directive

- Good indoor climate
- Cost effectiveness
- Local conditions
- **Low carbon (nearly zero), taking into account**
 - RES via District heating and cooling, DH&C
 - CHP via District heating and cooling, DH&C
 - Heat pumps
 - Local RES

HVAC installations in buildings should therefore be an integrated part of the DH&C system

EU-energy legislation

RES and Efficiency



Renewable Energy Directive

- Urban planning of heating and cooling infrastructure
- Nearly Zero buildings taking into account RES via DH&C

Energy Efficiency Directive approved 25.10.2012

- New power plants to be CHP located near heat markets
- Urban planning of heating and cooling infrastructure
- Nearly Zero buildings taking into account CHP via DH&C

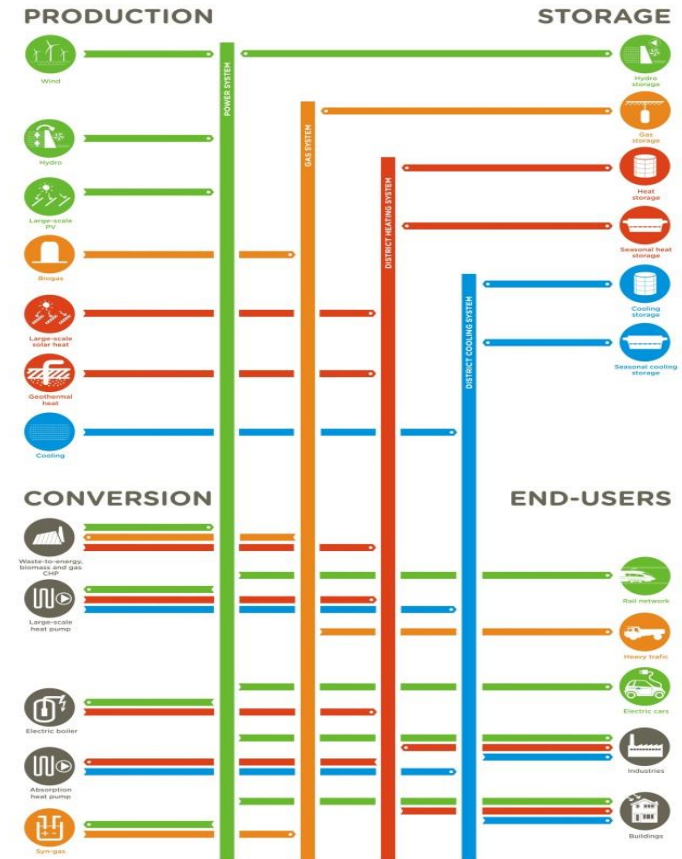
ECO Directive

- to stimulate energy efficient appliances, e.g. hot tap water to laundry and dish washing machines



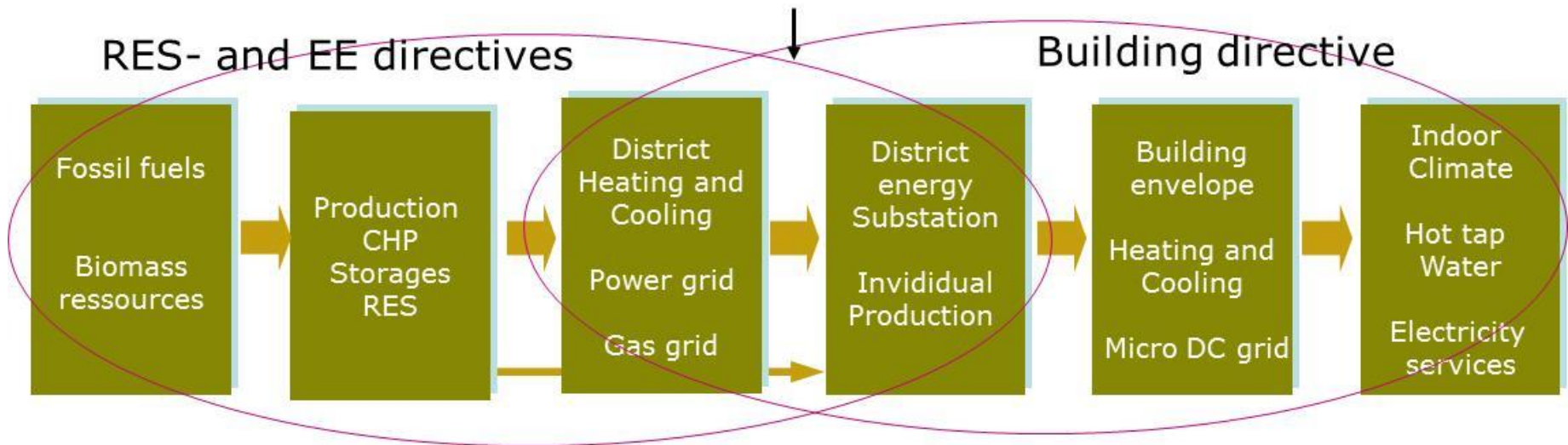
Smarter energy systems include the building installations

- International power grid
- International gas grid
- City-wide district heating grid
- Local district cooling grids
- 100% connection to DH&C
- Integrated building HVAC system
 - **Low temperature heating**
 - **High temperature cooling**



Energy is quality and time

- **Same criteria for cost effectiveness** for all investments
- Interaction between **smart grids, buildings and end-use**
- Energy depends on **time and quality**



Optimal low-temperature heating and high-temperature cooling ?



Steam → Super heated water 160 → Water 110 → Water 95

Ice → Cold water 4 → Cold water 10 → Cold water 20

Maximal building supply temperature for heating 60 °C

Maximal building return temperature at max 35 °C

Minimal building supply temperature for cooling 10 °C

Minimal building supply temperature for cooling 20 °C

Maximal DH design supply temperature 95 °C

Normal DH operation temperature 65 °C- 80 °C

Normal DC operation temperature 4 °C - 10 °C

Heating and cooling directly to each section or apartment in the building



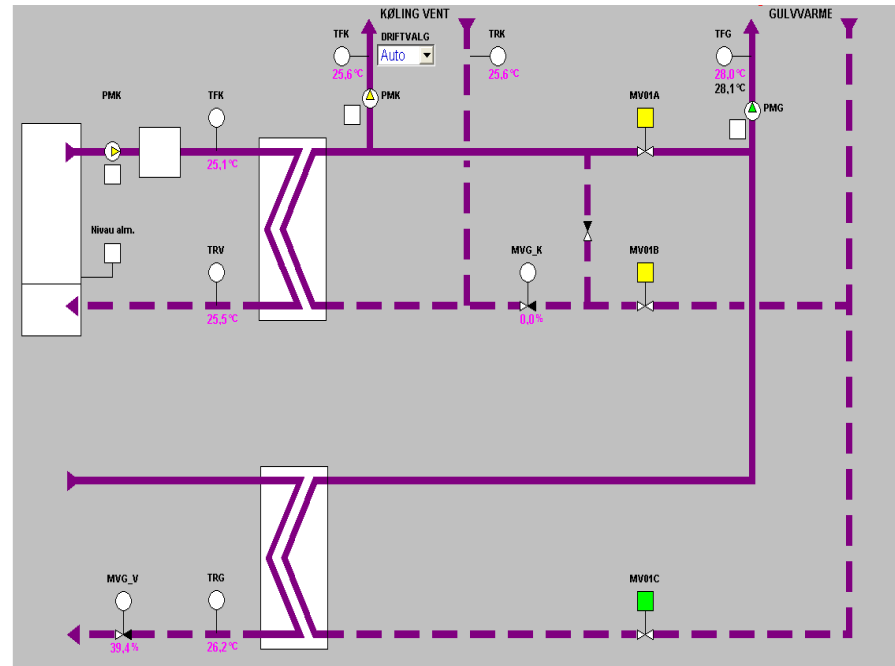
Central heating network

- Ventilation coil
- Floor tubes
- Radiators
- Hot tap water

Central cooling network

- Ventilation coil
- Floor tubes

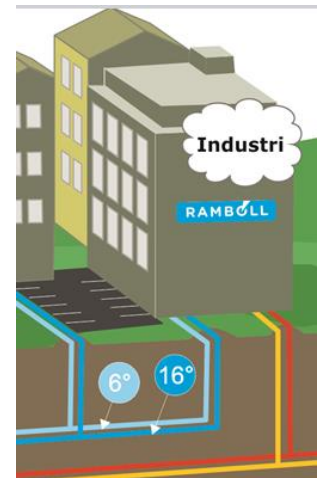
DH&C can be measured and delivered directly to each unit



Modern buildings can have many individual heating/cooling units



- All units are supplied with central hot water in winter
- All units are supplied with central cold water in summer
- Hot tap water is available from hot water all year
- Hot water for dehumidiation if necessary
- Central production of hot and cold water by:
 - DH&C grids, directly or via heat exchangers
 - DH grid /local cooling (ATES with optimal DH prod.) or
 - Building level ATES (outside DH&C districts)

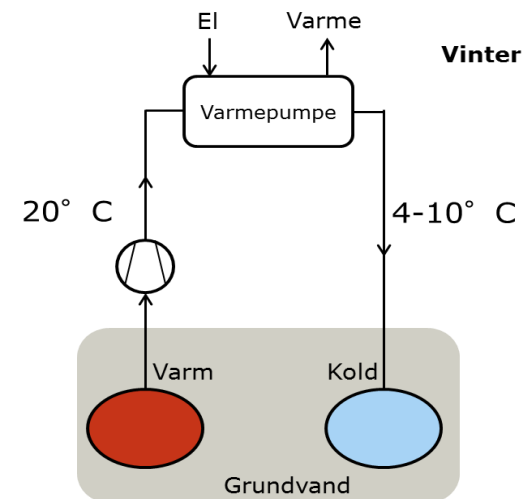
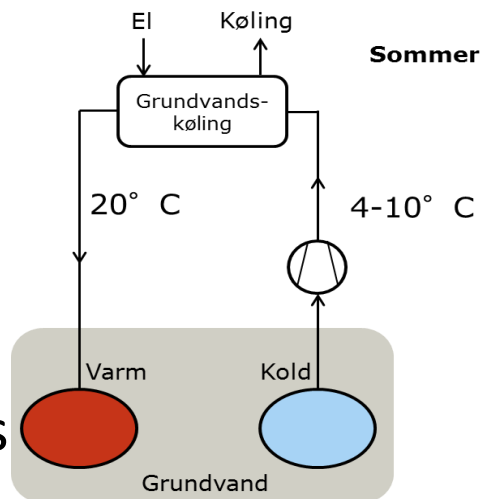


- The same HVAC for 4GDH and building level supply !

Aquifer Thermal Energy Storage

ATES for DH&C and for buildings

- Seasonal cold storage
- Seasonal hot storage
- Heat pump back-up and peak for cooling in summer
- Heat pump generates heat in winter



Large hot water tanks and thermal storage pits

Largest storages in Denmark:

70,000 m³ 95 °C water in Odense

3 x 24,000 m³ 120 °C in Copenhagen

200,000 m³ 85 °C in Vojens (sand pit)

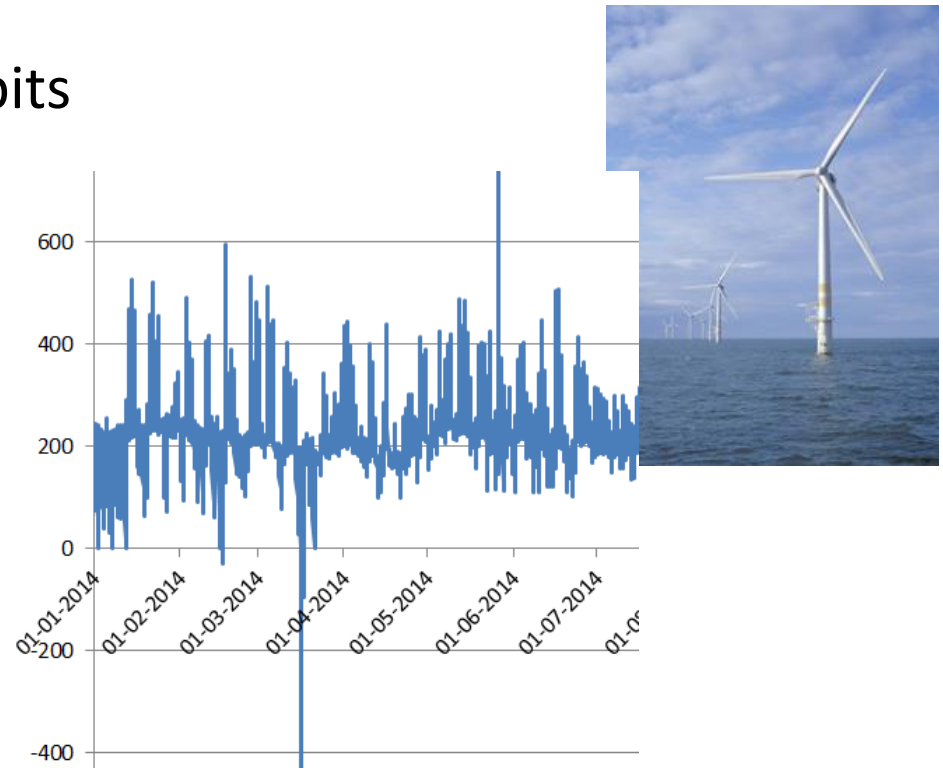
120,000 m³ 85 °C in Gram (clay)

Many more in the pipe line



The virtual electricity storage optimizes electricity consumption

- 4DH&C grids in city and integrated HVAC in buildings
- Hot/cold water tanks
- Seasonal hot/cold storage pits
- ATEs
- Large electric heat pump
- CHP
- Electric boiler
- Absorption heat pump
- Boilers



Measures to implement cost effective 4DH&C

- Implement EE directive for buildings correctly in the national building codes
- HVAC codes in accordance with EE directive
- Implement planning of DH&C as a part of the urban infrastructure (like sewage and water)
- Regulatory framework, which promotes long-term investments to the benefit of society and consumers
- Tax incentives to implement cost effective solutions



Thank you for your attention

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See our climate solutions at

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