Ramboll Energy

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PROGRAMME

- Introduction
- Smart energy systems
- Low energy district heating
- Low temperature district energy
- Some technical issues
- Questions

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B.Sc Mech. Eng. (Copenhagen Eng. College)
M.Sc. Energy Conservation & the Environment (Cranfield University, UK)

- Energy Consultant in the UK
- Energy Manager in the UK (RAF & Earls Court)
- Project Engineer/Manager in the UK
  - CHP & District Heating

- With Ramboll DK since 2002 working within district energy services:
  - Project Manager
  - Project Director
  - Market Manager – UK & North America
  - Head of Department & Service Line Coordinator – District Energy

Since 2008 Board member of the Combined Heat and Power Association in the UK

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CITIES – A CHALLENGE AND OPPORTUNITIES

- World population is growing
- More people want to live in cities
- It will be a challenge, but also
- An opportunity to create **smart energy solutions**
- The EU has taken the lead in promoting Smart Cities including **smart buildings** and **smart grids** for
  - Electricity
  - District heating
  - District cooling and
  - Gas

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SMART ENERGY SYSTEMS

- National power grid
- City-wide district heating grid
  - storage optimal use of CHP and RES
- City district cooling grid
  - storage and optimal free cooling
- National natural gas - biogas grid
  - gas storage,
  - gas to CHP and small houses
- Buildings
  - Optimized building envelope
  - Low temperature heating
  - High temperature cooling
  - Micro DC grid for micro electronics
  - Adjust consumption to price signals and control (”smart grid”)

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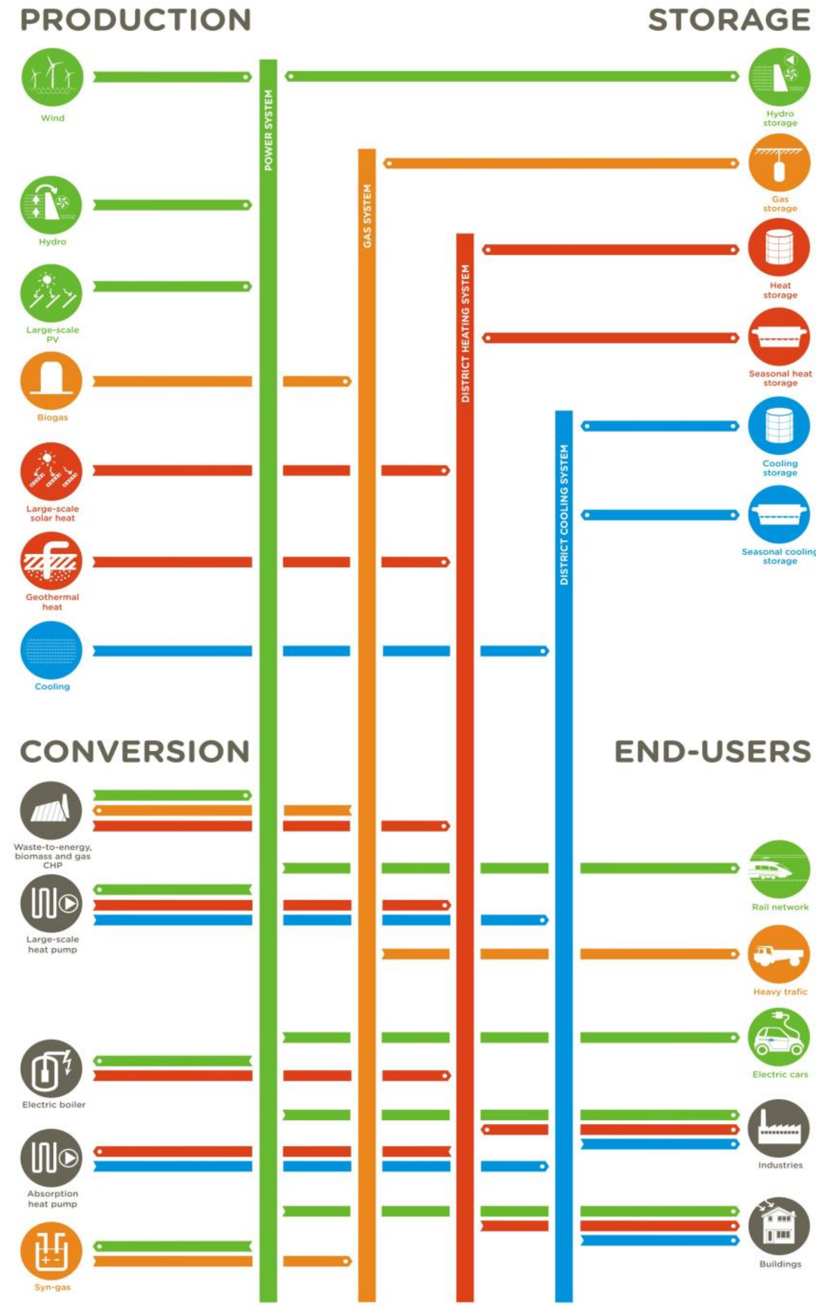
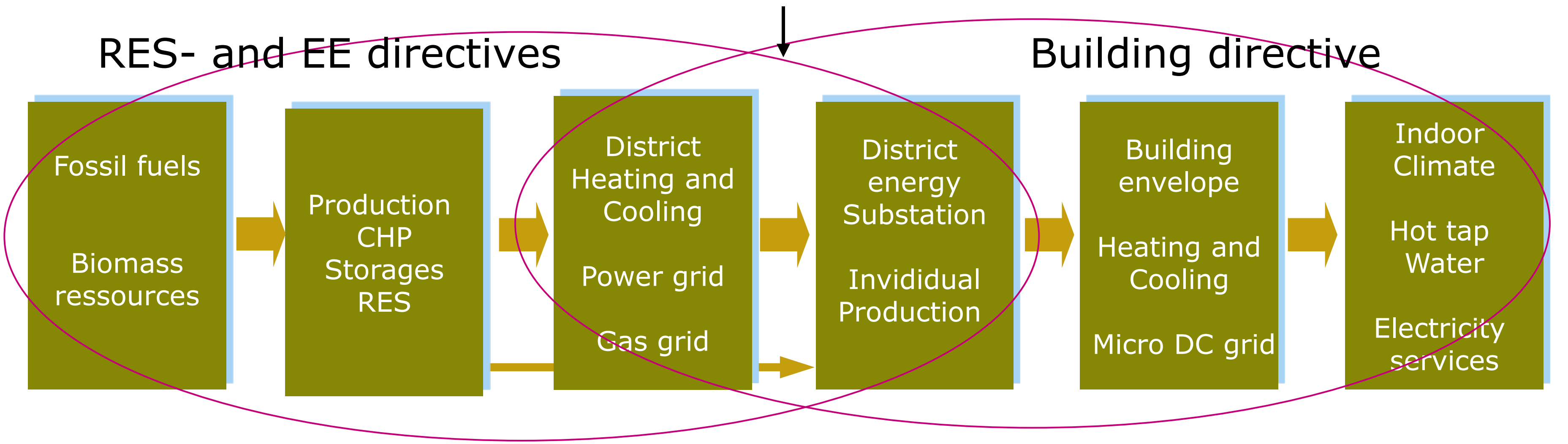


SMART CITIES AND GRIDS FOR THE SOCIETY

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



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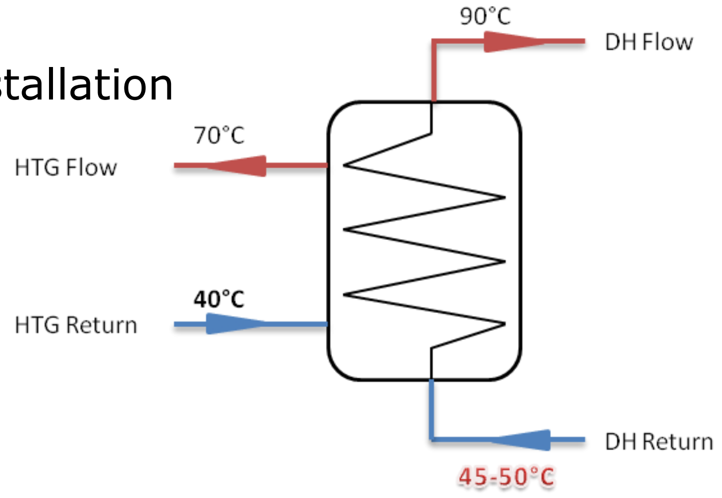
NETWORK TEMPERATURE

- Steam system
- Super-heated system: water > 120ºC (High temperature hot water)
- Normal hot water system: water < 120ºC
- Low temperature system:
  - Supply temperature (summer): 75-65ºC
  - Supply temperature (winter): 90-75ºC

- Cooling of district heating water at user installation
  - Low return temperature



SYSTEM TEMPERATURE

The DH flow temperature influences the building heating system flow temperature.

but the building heating system return water temperature influences the DH return water temperature and the efficient operation of the DH system.

Older existing buildings system temperatures e.g. 82°C flow and 71°C return.
More recent buildings will have been designed with system temperatures of e.g. 80°C flow and 60°C return.

Underfloor heating is ideal for low temperature district heating:

Flow temperatures at 40° C - 50° C and with a temperature drop of 5° C - 10° C which means return temperatures can be very low which as explained is ideal for DH.

		Flow Temperature								
		85	80	75	70	65	60	55	50	
Return Temperature	60	91%	85%	80%	74%	69%				
	55	85%	80%	74%	69%	64%	59%			
	50	80%	74%	69%	64%	59%	54%	49%		
	45	74%	69%	64%	59%	54%	49%	44%	39%	
	40	69%	64%	59%	54%	49%	44%	39%	35%	
	35	64%	59%	54%	49%	44%	39%	35%	30%	
	30	59%	54%	49%	44%	39%	35%	30%	26%	

Effect of changes in radiator output with differing flow and return temperatures

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NETWORK TEMPERATURE RELATED DRIVERS IN HEAT NETWORK ECONOMICS

Temperature difference across network drives investment costs and capacity of system

$$\Delta T = Tflow - Treturn$$

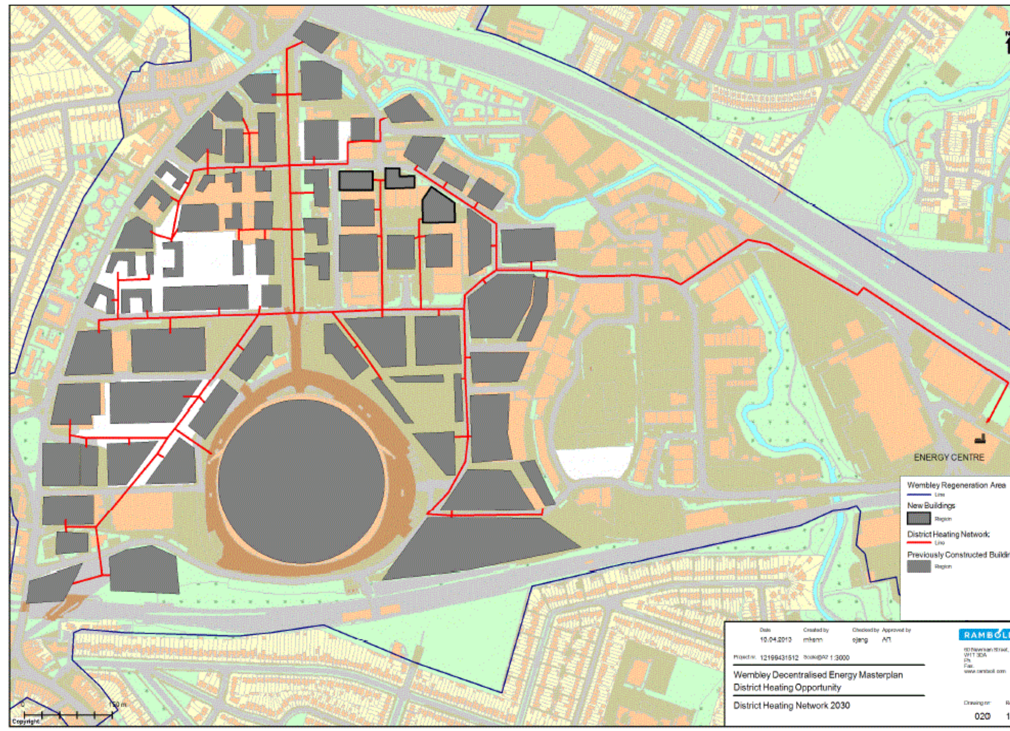
$$Heat\ Capacity = mCp\Delta T$$

Temperature difference across network drives pumping energy costs

$$P \propto HQ \propto kQ^3$$

Average network temperature affects heat losses

$$HeatLoss \propto \frac{T_{flow} + T_{return}}{2} - T_{ambient}$$



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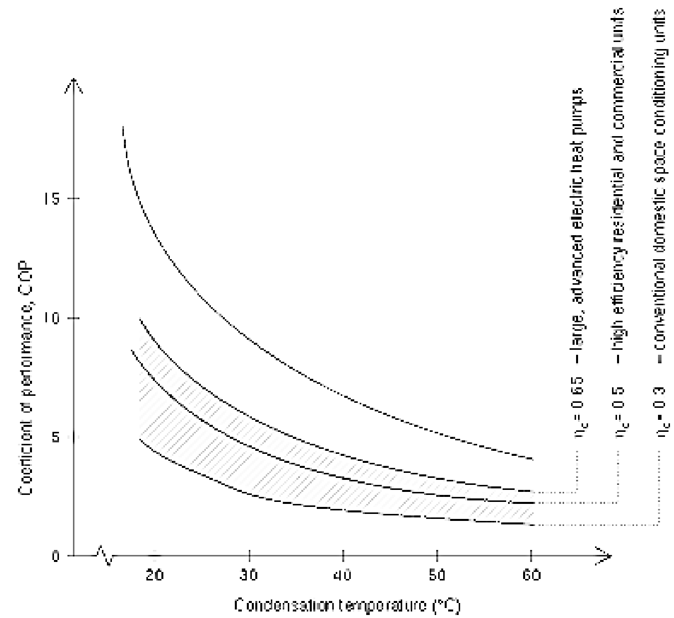
BENEFITS OF LOW TEMPERATURE RETURN SYSTEMS IN RELATION TO HEAT NETWORKS

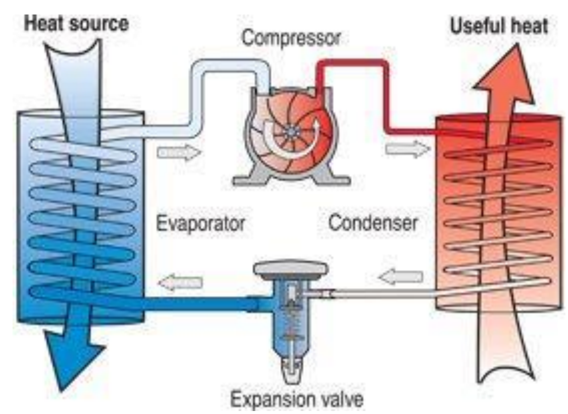
Flexibility to integrate low grade heat more efficiently:-

- industrial waste heat (data centres, tunnel cooling, transformer cooling, process waste heat, treated sewage
- Large scale solar thermal collectors with inter seasonal heat stores
- Geothermal energy

Lower network return temperatures also:-

- reduce temperature lift and increase Heat pump efficiency
- reduce losses (unwanted heat gains) in buildings
- Lower space and investment costs in heat exchanger stations (larger Delta T)
- Allow for gas condensation heat recovery in power plant and energy centres with communal boilers and gas fired CHP





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Source: heatpumpcentre.org

ALL HEATING FORMS BENEFIT FROM LOW RETURN TEMPERATURE

Supply temperature e.g. max. 90 degree C

Benefits reducing return temperature from e.g. 60 to 30 degree C

- Circulated water reduced to 50%
- Heat accumulator capacity increased by 100%
- Investment reduced roughly by 20%
- Heat losses in network reduced roughly by 25%
- Use low temperature heat sources to pre-heat the water, e.g.
  - CHP condenser at 60 degree C to preheat from 30 to 60 degree C at a very high Z-factor
  - Greater flue gas condensation
  - Solar water panels more efficient
  - Geothermal heat more efficient
  - Large heat pumps more efficient
  - Access to more industrial low temperature surplus heat

= lower cost of heat to customer

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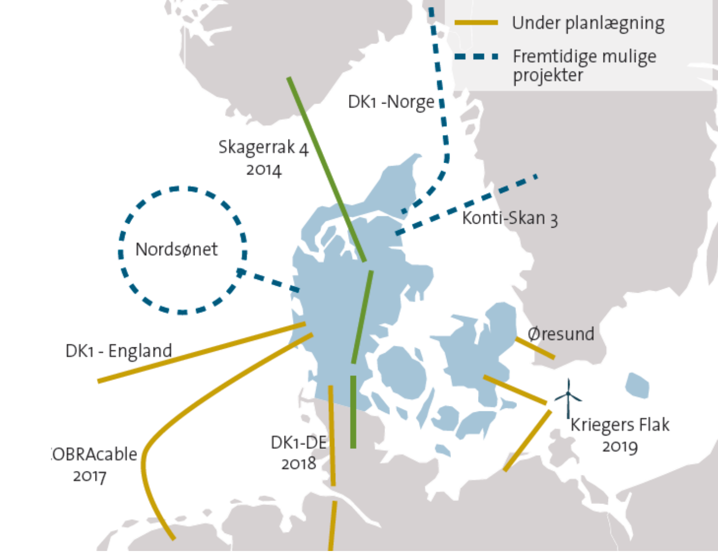
ENERGY INFRASTRUCTURE IN DENMARK
TECHNICAL DH&C DEVELOPMENT 2010-

- District cooling in city centers
- Lower temperatures in consumers installations paves the way for more low-temperature DH
- Large heat pumps and electric boilers to use surplus wind
- Large efficient heat pumps to upgrade low quality heat
- Larger storages to use available heat
- More shift from gas to DH
- More integrated markets



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