District heating network savings from building retrofit

Building retrofit to capacity problems

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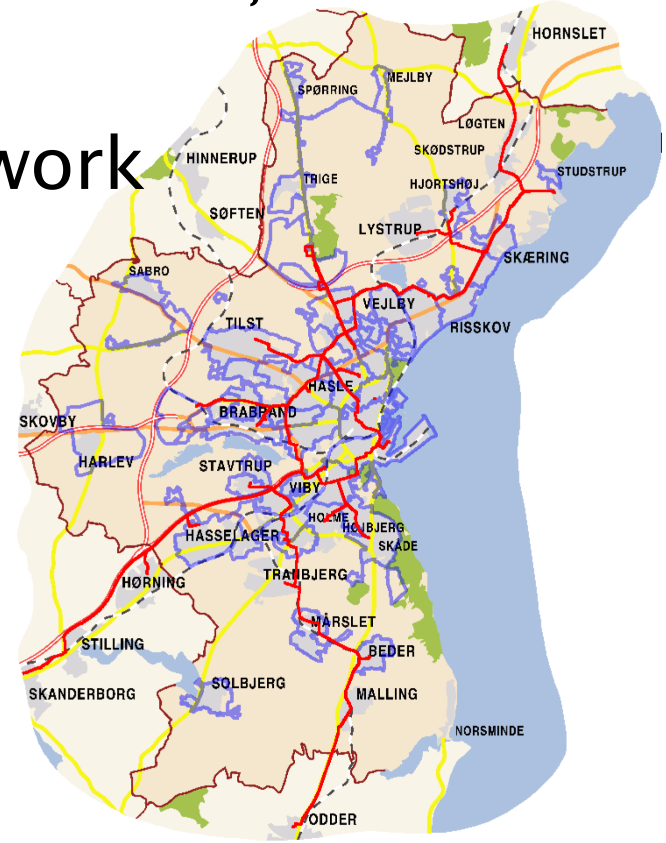
AffaldVarme Aarhus

- District heating company of Aarhus, Denmark
- Part of Varmeplan Aarhus
- 130 km of transmission network
- 50 area substations
- 55,000 costumers
- 3,000,000 MWh/year
- 1,000 MW peak load



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Why use District Heating?

- District heating is essential in the future energy system [1]
- Sharing excess heat
- Renewable heat sources
- Cheapest in dense areas [2]
- Already functioning in many locations

[1] H. Lund, B. Möller, B. V. Mathiesen, and A. Dyrelund, "The role of district heating in future renewable energy systems," *Energy*, vol. 35, no. 3, pp. 1381–1390, Mar. 2010.
[2] C. Reidhav and S. Werner, "Profitability of sparse district heating," *Appl. Energy*, vol. 85, no. 9, pp. 867–877, 2008.

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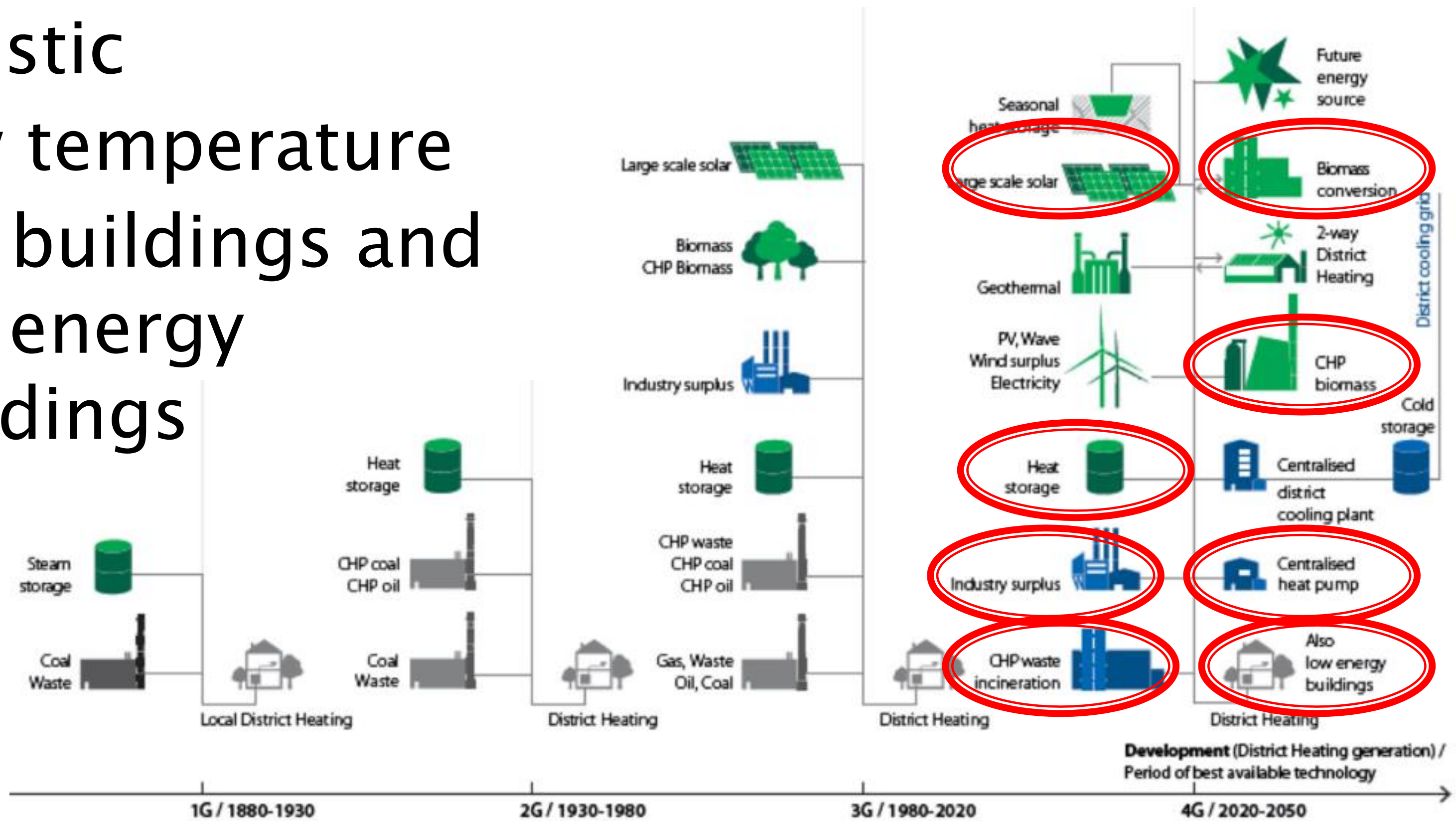
What is 4GDH[3]?

- Holistic
- Low temperature
- Old buildings and low energy buildings



[3] H. Lund, S. Werner, R. Wiltshire, S. Svendsen, J. E. Thorsen, F. Hvelplund, and B. V. Mathiesen, "4th Generation District Heating (4GDH)," *Energy*, vol. 68, pp. 1–11, Apr. 2014.

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How do we get there?

- What is the best operational strategy, using the existing network setup?

- Investment costs in DH are more than half the total distribution costs[4]
  - Investment could also be placed in building renovations

[4] U. Persson and S. Werner, "Heat distribution and the future competitiveness of district heating," *Appl. Energy*, vol. 88, no. 3, pp. 568–576, 2011.

Network or building renovation

What should we do first?
eg. Capacity problems

Networks

- Capacity design
- Common practis
- Better pipes

Buildings

- Capacity limits
- Building renovation also works as low temperature preparation [5]
- Better design of the network

[5] M. Brand and S. Svendsen, "Renewable-based low-temperature district heating for existing buildings in various stages of refurbishment," *Energy*, vol. 62, pp. 311-319, 2013.

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Example: Aarhus City center

- 50 km DH network
- 2,500,000 m^2 buildings
- Energy consumption at area substation: 260,000 MWh
- Total energy consumption in buildings: 230,000 MWh

12 % grid loss
19 GJ/m linear heat density
92 kWh/m^2 (BR15 = 30–41)

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Example: Aarhus City center

- Capacity issues due to urban densification
  - Action is needed

Network renovation

- At least 1,000 mio DKK
- Up to 75 %[6] (~6 mio DKK) saved from grid losses

Building renovation

- 2,500 – ? mio DKK
- Lower energy use
  - Direct benefits
  - Indirect benefits
- Peak load reduction [5]

[5] M. Brand and S. Svendsen, "Renewable-based low-temperature district heating for existing buildings in various stages of refurbishment," *Energy*, vol. 62, pp. 311-319, 2013.
[6] H. Li and S. J. Wang, "Challenges in Smart Low-temperature District Heating Development," *Energy Procedia*, vol. 61, pp. 1472-1475, 2014.

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Benefits of building renovation

Direct

- Lower energy demand

Aarhus City

- Direct saving: 150,000 MWh (30 mio DKK)

Indirect

- Grid losses due to temperature reduction
- Peak shaving
- Postponing renovation
- Extension planning

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Future work

- Using all 50 networks in Aarhus
- Considering
  - Energy
  - Economy
  - CO_2
  - Security of supply
- Building changes
  - Retrofit
  - Demand Side Management

Thank you!
Questions?

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