THE SMART ELECTRICITY STORAGE
DISTRICT HEATING AND
COOLING WITH THERMAL
STORAGES
OUR VISION

Creating liveable cities – smart solutions for the citizens
STRUCTURE OF THE PRESENTATION

• Today’s energy system
• The future smart energy system
• Virtual battery
• Case study: Gram Fjernvarme
• Case study: Favrholm
• Final remarks
TODAYS ENERGY SYSTEM

- Starting point in DK1 (Western part of Denmark)
PRODUCTION DISTRIBUTION (2010 – 2016)
ELECTRICITY PRICE 2016

Day – ahead market electricity price daily average 2016 (DK1)
MARKET VALUE OF ELECTRICITY
ELECTRICITY PRICE AND WIND PENETRATION

Day – Ahead Price vs. Wind Penetration (DK1)
THE FUTURE SMART ENERGY SYSTEM

• Based on the Smart Energy Barrier and Solution Catalogue
STRUCTURE OF SMART ENERGY SYSTEMS

- *Smart Energy Barrier and Solution Catalogue* outlines the benefits and roadmap towards a renewable energy system
  - Integration between sectors
  - Sectoral suboptimal planning must be avoided
  - 4th generation district heating
  - Thermal storages
"Thermal storages with electricity producing/consuming units can provide the same flexibility as electric batteries, but at a much lower cost"
CASE STUDIES

- Gram Fjernvarme
- Favrholm
**GRAM FJERNVARME**

- Multiple production units
- Thermal storage
HEAT PRODUCTION COST

![Graph showing heat production cost vs. electricity price for different technologies: Gas Engine, Heat Pump, Gas Boiler, Electric Boiler.](image)
DISTRICT HEATING PRODUCTION DISTRIBUTION

- Demand
- Heat Pump
- Gas Engine
- Gas Boiler
- Electric Boiler
- Solar
- Storage Content

Heat Production (MWh)
NET ELECTRICITY PRODUCTION

- Net Electricity Production
- Electricity Price

Time (h)

Electricity Price (€/MWh)

Net Electricity Production (kWh/h)
FAVRHOLM (HILLERØD)

- Development area
- DH&C a profitable option
  - 660,000 m² heated floor area
    - 13 MW peak
  - 470,000 m² cooled floor area
    - 9 MW peak

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<th>Projektscenarie</th>
<th>Lokalsamfund</th>
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<td>Fjernvarme ved 100 % tilslutning</td>
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![Graph showing heat production cost vs. electricity price](image-url)
THE DH&C SYSTEM

DH&C SYSTEM:

- ATES
- Heat Pumps
- Thermal Storage
FINAL REMARKS

• The virtual battery is available for free

• DH&C systems provides great flexibility to the electricity system (demand response)

• Variable electricity prices (and tariffs) favours flexible operation

• District cooling holds great future potential for development

“Common solutions provides cheaper energy to the local community, and additional benefits to all of society”
THANKS FOR YOUR ATTENTION!

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