Energy Visions for 2050

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Agenda

Smart Energy System

1) System integration
2) Storage
3) Energy savings and heating
Smart Energy Systems
Smart Energy Systems

[Link to Smart Energy Systems: www.energyplan.eu/smartenergysystems/]
Smart Energy Systems

• A sole focus on renewable electricity (smart grid) production leads to electricity storage and flexible demand solutions!

• Looking at renewable electricity as a part smart energy systems including heating, industry, gas and transportation opens for cheaper and better solutions...
Smart Energy Systems

• We need to limit the use of biomass, so we only use what we sustainably can produce
• Electrification only to increase the demand is problematic
• We get the cheapest, most efficient system by integrating the sectors (limits biomass use and increases VRES utilisation)
System Integration

- Connect the gas grids, electricity grids and thermal grids
- Make them work together
- Utilise storages
Electrification without system integration

Without savings, individual electric heating

12,500 MW vind (180 B DKK)
Quadroupling of electric grid (300 B DKK)
10 TWh electric storage (12,000 B DKK)

Integrated system with district heating and savings

1500 MW Wind
Same grid as today
Heat storages < 7 B DKK
Results of a Smart Energy System
Interconnection or Integration
Energy storage

• Fluctuating demand and fluctuating production

• With system integration more technologies become available

• All these can be used to handle variable renewable energy
Energy Storage

Pump Hydro Storage
175 €/kWh

Natural Gas Underground Storage
0.05 €/kWh

Thermal Storage
1-4 €/kWh
(Source: Danish Technology Catalogue, 2012)

Oil Tank
0.02 €/kWh
(Source: Dahl KH, Oil tanking Copenhagen A/S, 2013: Oil Storage Tank. 2013)
Energy Storage Capacities in Denmark

Danish Oil Storage
~50 TWh

Danish Gas Storage
~11 TWh

Danish Thermal Storage
~0.050 TWh
Energy Storage Capacities in 100 % RES Denmark 2050 (IDA)

Danish Oil Storage
~50 TWh

Danish Gas Storage
~11 TWh

Danish H₂ Storage
~0.550 TWh

Danish Thermal Storage
~0.200 TWh

Danish Electricity Storage
~0.015 TWh
Energy Storage and Smart Energy Systems

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Figure 1: Investment cost and cycle efficiency comparison of electricity, thermal, gas and liquid fuel storage technologies. See assumptions, details and references in Appendix 1.

Figure 2: Annualized investment cost per use-cycle vs annual numbers of use-cycles. In the diagram the cost is also benchmarked against the cost of producing renewable energy, here shown for a wide cost span by grey (extension along horizontal axis is for presentation only; there is no cycle dependence for renewable energy production). See assumptions, details and references in Appendix 1.

Figure 3: Investment cost comparison of different sizes of thermal energy storage technologies. The sizes correspond to storages for a dwelling, a larger building, a CHP plant and a solar DH system (see Footnote 2). See assumptions, details and references in Appendix 1.
Energy savings and heat supply

• Energy savings is a key solution for future energy systems

• We need to find the balance between production and savings

• The goal is the most efficient energy system
Heat savings

- ~40% heat saved
- Cost per kWh of heat supply (with 66% district heating) when heat demand of buildings decreases
- Marginal cost per kWh heat saved in new buildings
- Marginal cost per kWh heat saved in existing buildings

Graph: Cost of Heat Savings (€/kWh) vs. Amount of Savings (TWh)
Heat savings and district heating
Renewables in the heat supply
Thank you for your attention

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