Energy Visions for 2050

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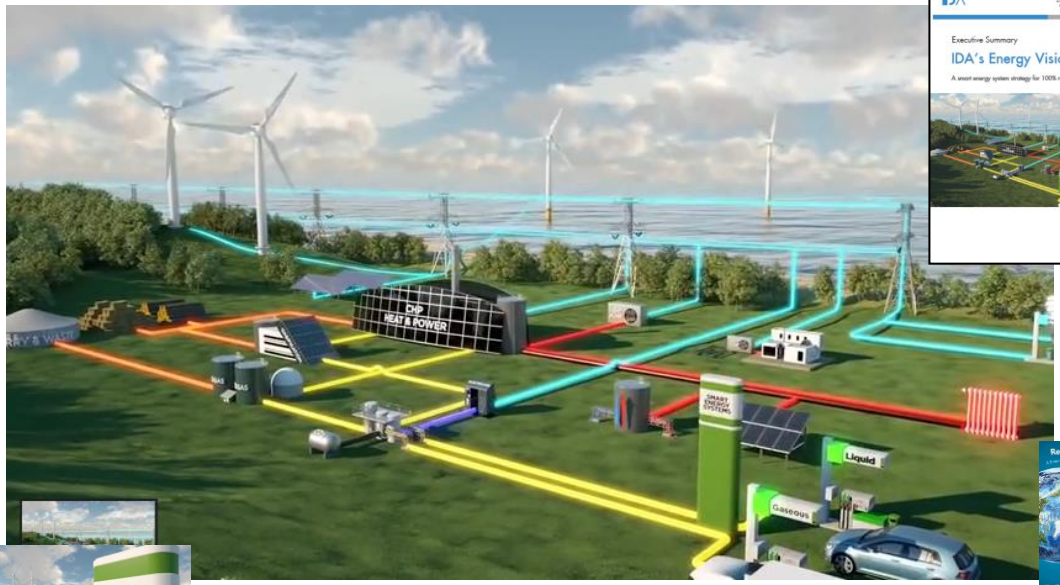
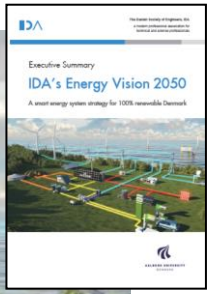
Agenda

Smart Energy System

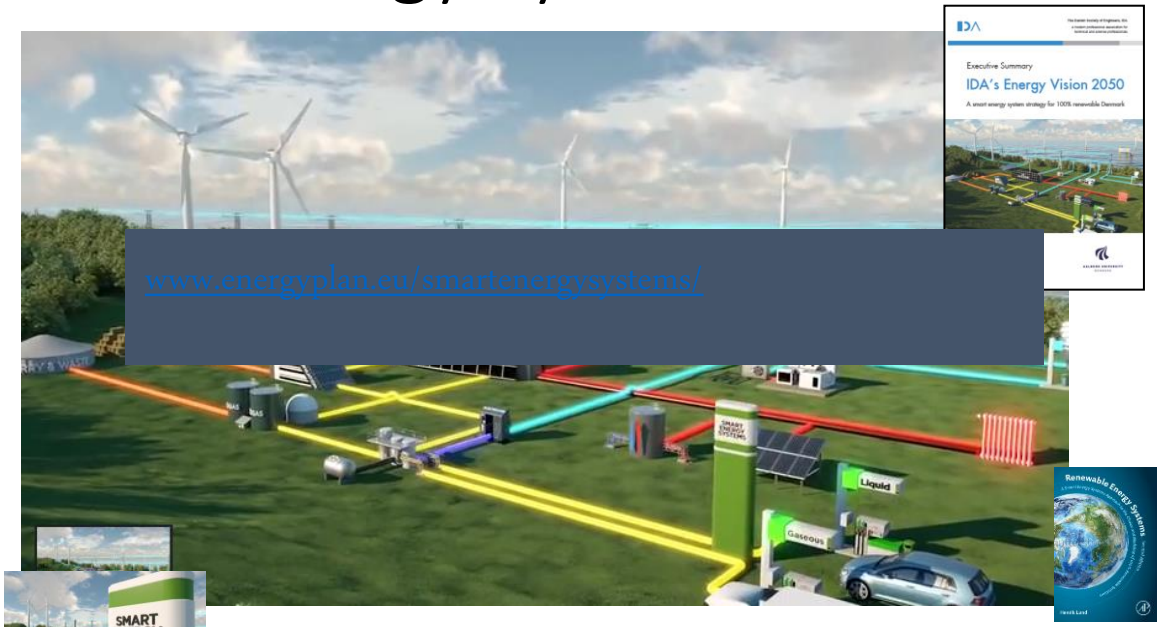
1) System integration
2) Storage
3) Energy savings and heating

Smart Energy Systems





Smart Energy Systems



www.energyplan.eu/smartenergysystems/

Smart Energy Systems

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

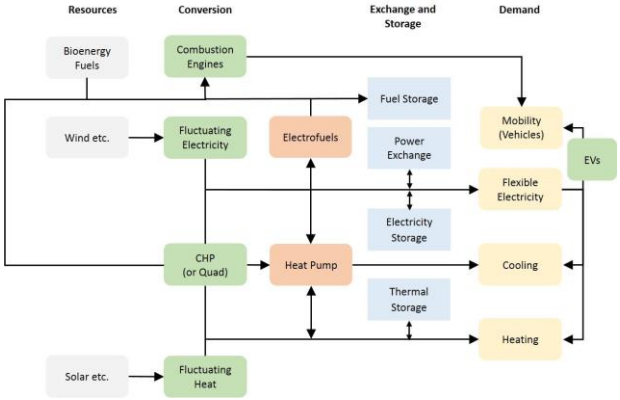
- Looking at renewable electricity as a part smart energy systems including heating, industry, gas and transportation opens for cheaper and better solutions…

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



Electrificiation without system integration

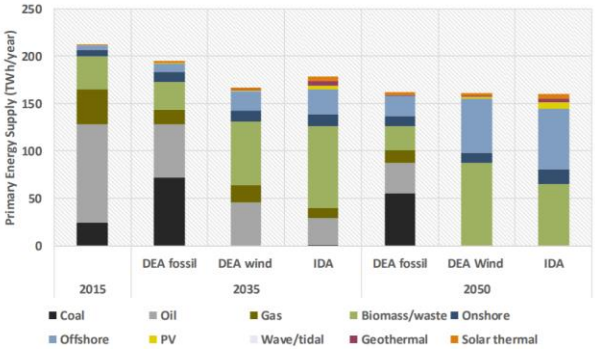
Without savings, individual electric heating

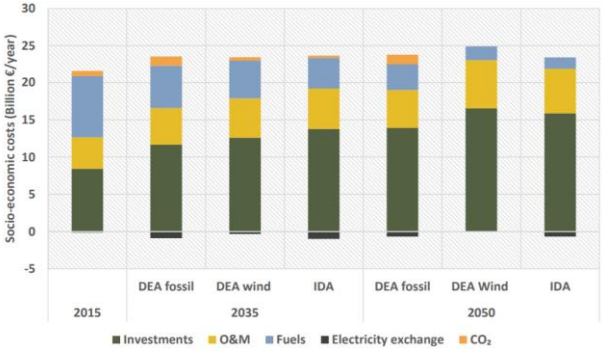
12,500 MW vind (180 B DKK)
Quadroupling of electric grid (300 B DKK)
10 TWh electric storage (12.000 B DKK)

Integrated system with district heating and savings

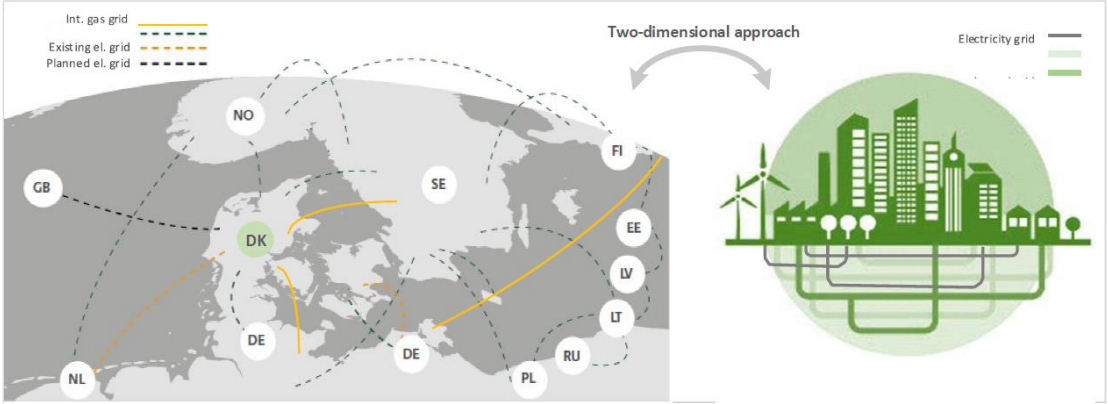
1500 MW Wind
Same grid as today
Heat storages < 7 B DKK

Results of a Smart Energy System





Interconnection or Integration



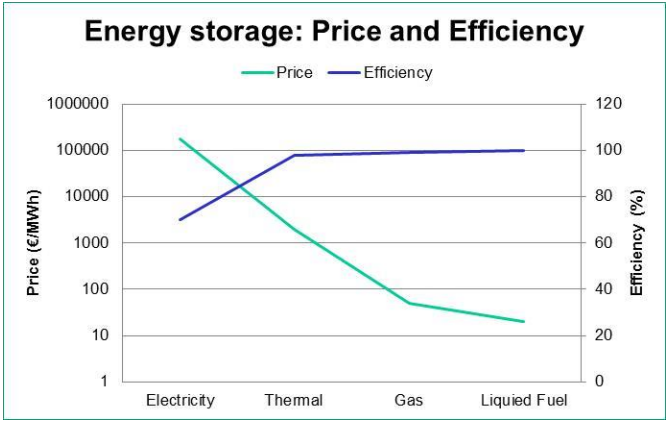
Energy storage

- Fluctuating demand and fluctuating production
- With system integration more technologies become available
- All these can be used to handle variable renewable energy

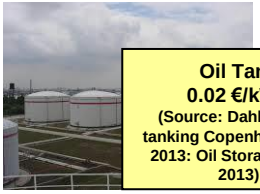
Energy Storage

Pump Hydro Storage
175 €/kWh
(Source: Electricity Energy Storage Technology Options: A White Paper Primer on Applications, Costs, and Benefits. Electric Power Research Institute, 2010)

Natural Gas Underground Storage
0.05 €/kWh
(Source: Current State Of and Issues Concerning Underground Natural Gas Storage. Federal Energy Regulatory Commission, 2004)

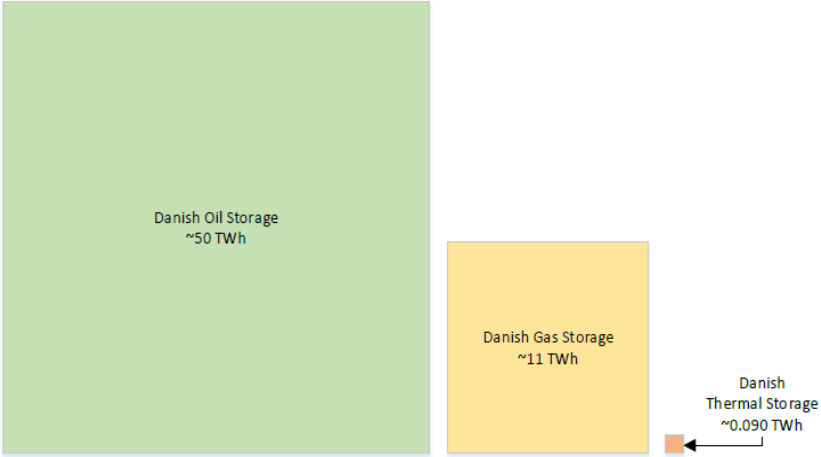


Thermal Storage
1-4 €/kWh
(Source: Danish Technology Catalogue, 2012)



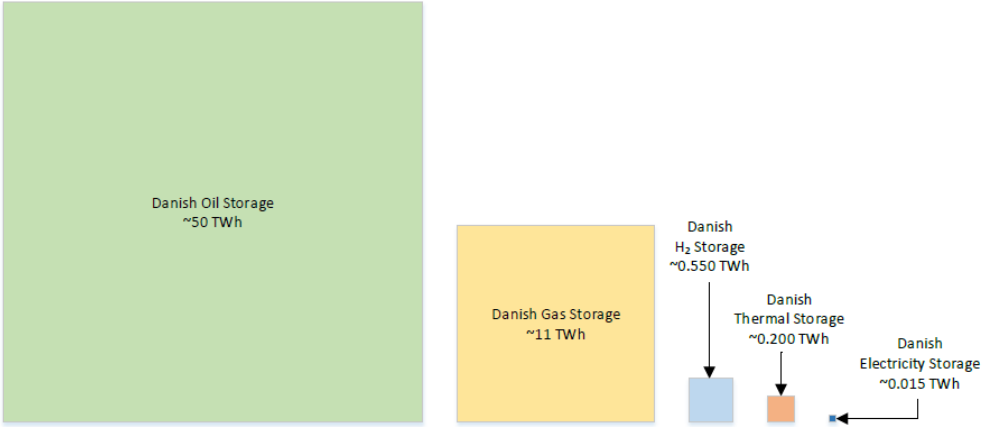
Oil Tank
0.02 €/kWh
(Source: Dahl KH, Oil tanking Copenhagen A/S, 2013: Oil Storage Tank. 2013)

Energy Storage Capacities in Denmark






Energy Storage Capacities in 100 % RES Denmark 2050 (IDA)



International Journal of Sustainable Energy Planning and Management Vol. 11 2016 3-14

International Journal of
Sustainable Energy Planning and Management

Energy Storage and Smart Energy Systems

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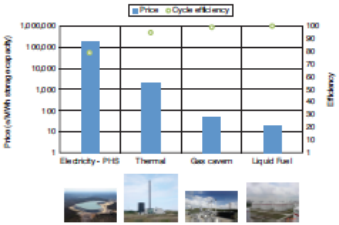


Figure 1: Investment cost and cycle efficiency comparison of electricity, thermal, gas and liquid fuel storage technologies. See assumptions, details and references in Appendix 1.

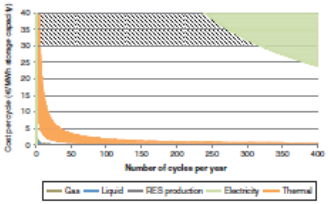


Figure 2: Annualized investment cost per use-cycle vs annual numbers of use-cycles. In the diagram the cost is also benchmarked against the cost of producing renewable energy, here shown for a wide cost span by grey (extension along horizontal axis is for presentation only; there is no cyclic dependence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

Energy Storage and Smart Energy Systems

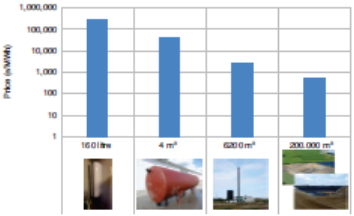
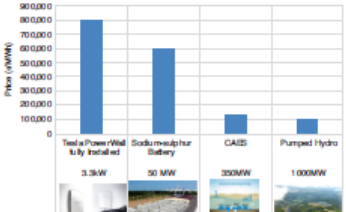


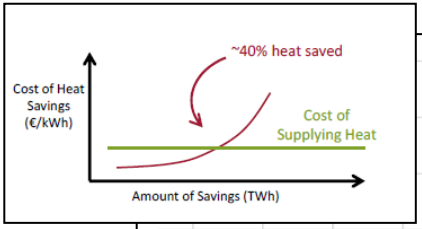
Figure 3: Investment cost comparison of different sizes of thermal energy storage technologies. The sizes correspond to storages for a dwelling, a larger building, a CHP plant and a solar DH system (see Footnote 2). See assumptions, details and references in Appendix 1.

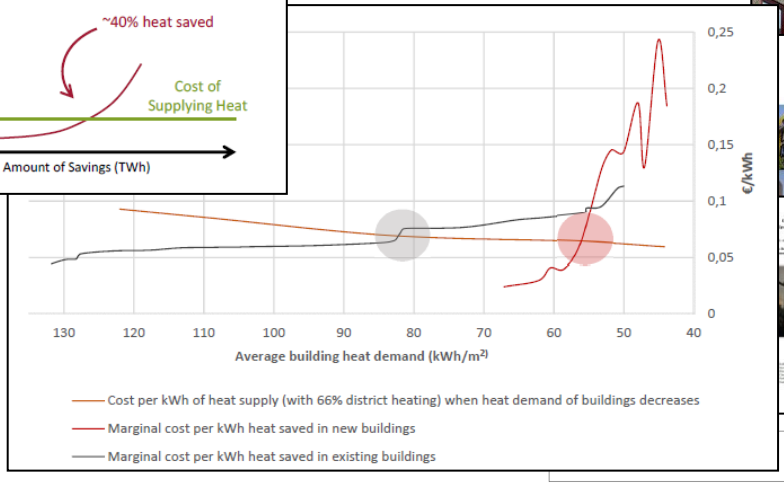


Energy savings and heat supply

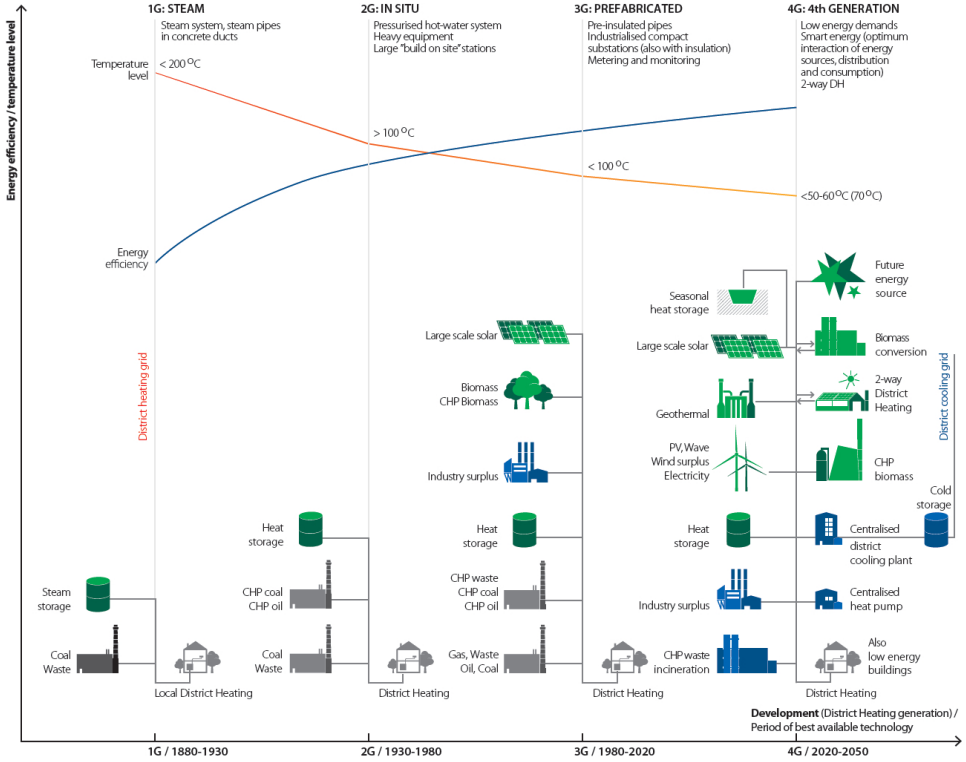
- Energy savings is a key solution for future energy systems
- We need to find the balance between production and savings
- The goal is the most efficient energy system

Heat savings

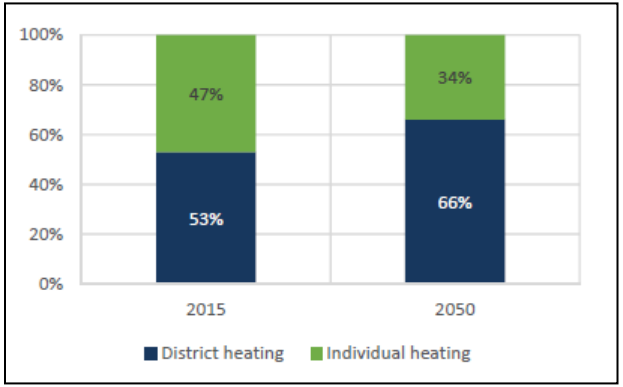


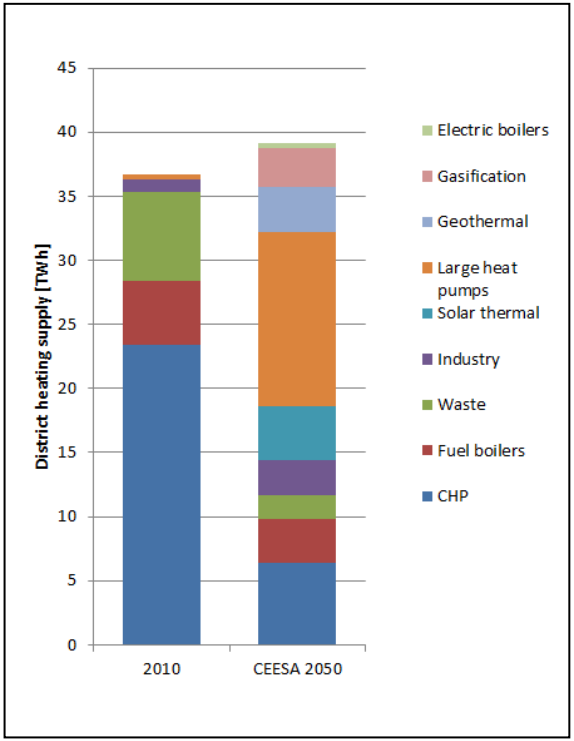


Heat savings and district heating



Renewables in the heat supply





Thank you for your attention

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