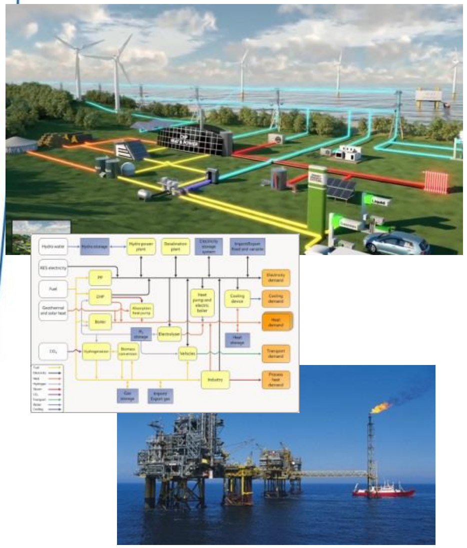
BLIV MEDLEM AF IDA

IDA UNIVERSE

VIDEN & TEKNOLOGI

BRINT FREM FOR BIOMASSE I ENERGISYSTEMET?

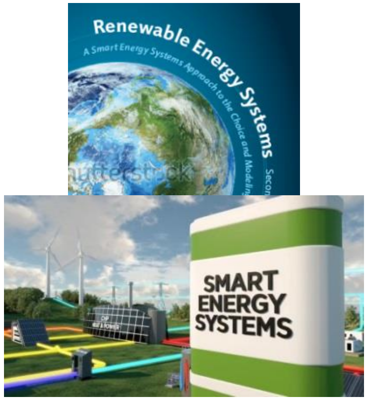
Christiansborg 5. februar 2018



4DH
4th Generation District Heating Technologies and Systems

Hvordan kan brint reducere behovet for biomasse i fremtidens energisystem?

Henrik Lund
Professor i Energiplanlægning
Aalborg Universitet



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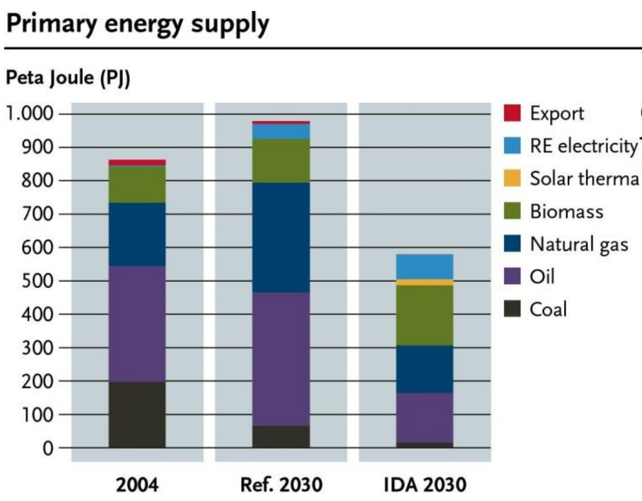
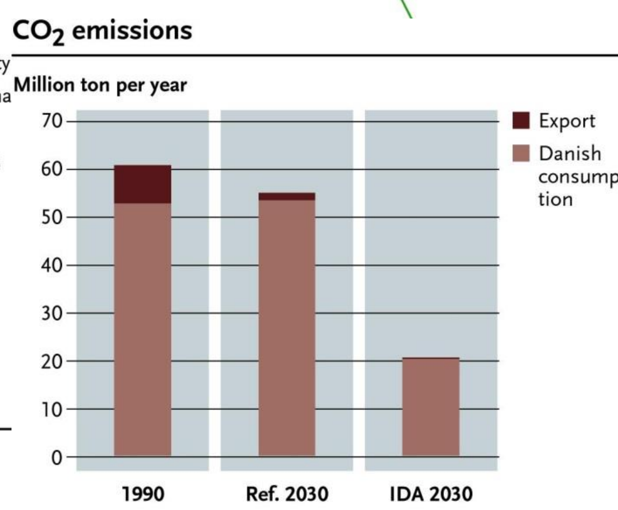
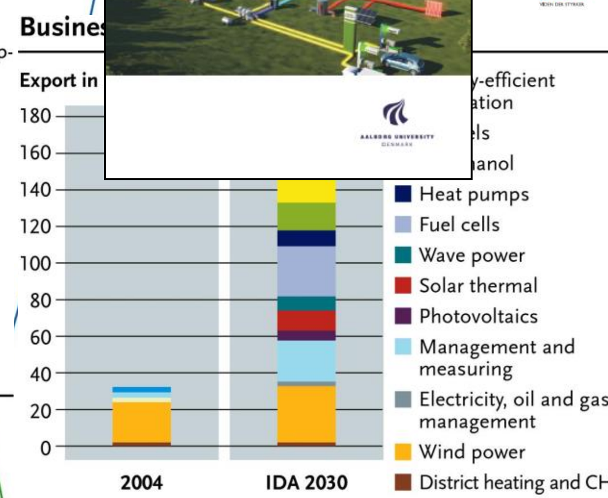
reINVEST

CITIES
Centre for IT Intelligent Energy Systems

IDA Energiplan 2030







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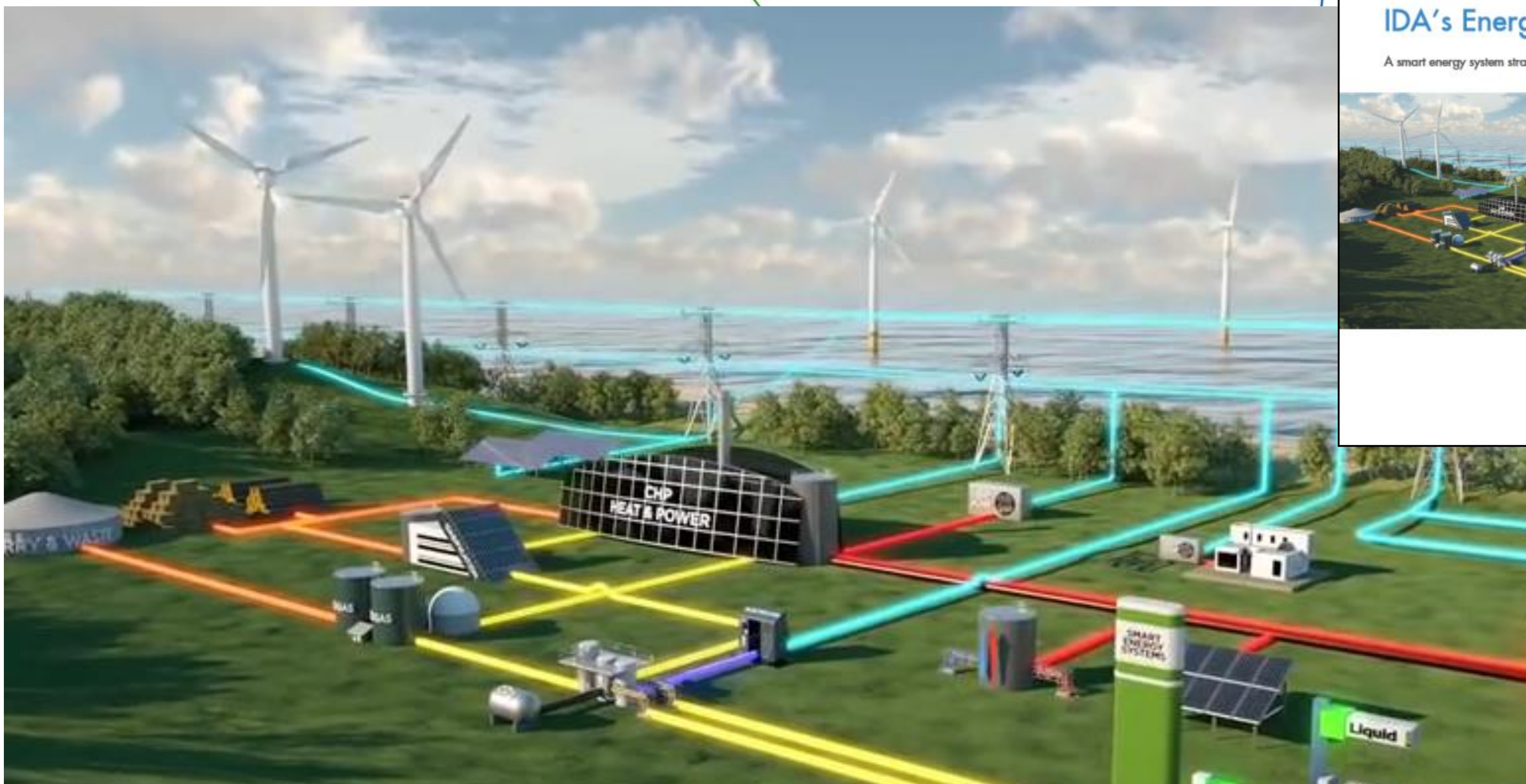
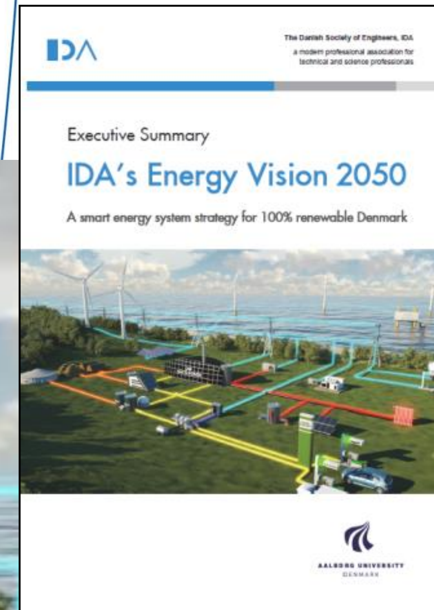
DENMARK

RENOVERING PÅ DAGSORDENEN

Smart Energy Systems





Smart Energy Systems

www.energyplan.eu/smartenergysystems/

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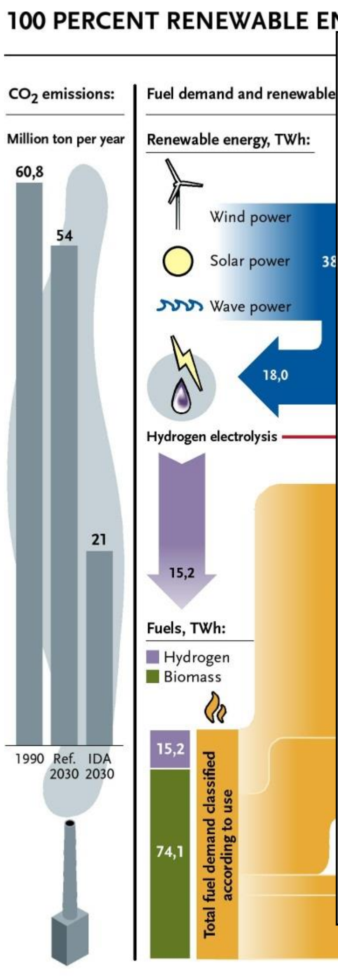
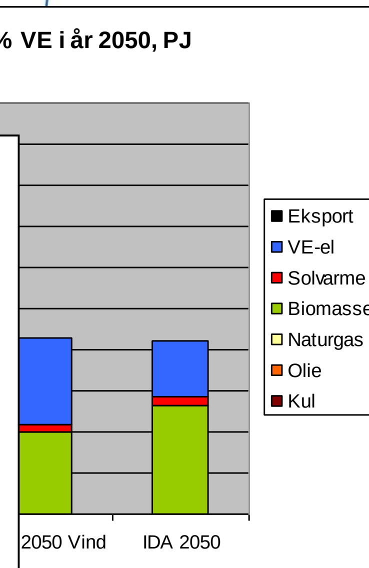
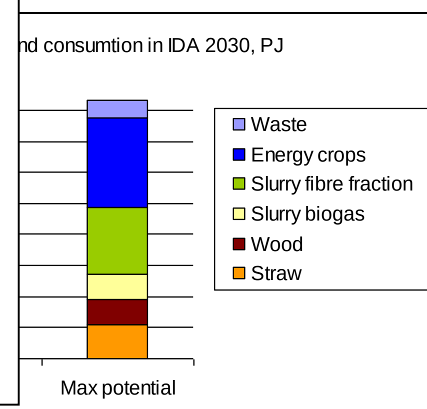
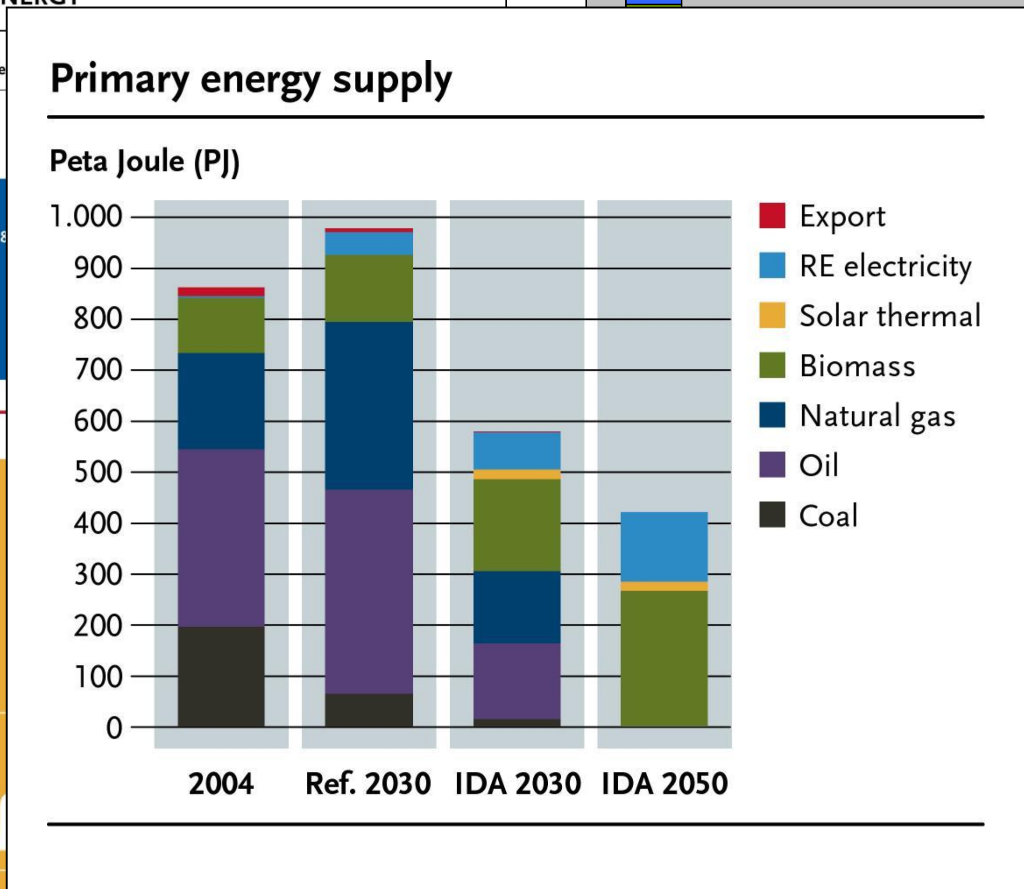
100% VE i 2050


100 PERCENT RENEWABLE ENERGY
CO2 emissions:
Million ton per year
60,8
54
21
1990
Ref. 2030
IDA 2030
Fuel demand and renewable
Renewable energy, TWh:
Wind power
Solar power
Wave power
18,0
Hydrogen electrolysis
15,2
Fuels, TWh:
Hydrogen
Biomass
15,2
74,1
Total fuel demand classified according to use

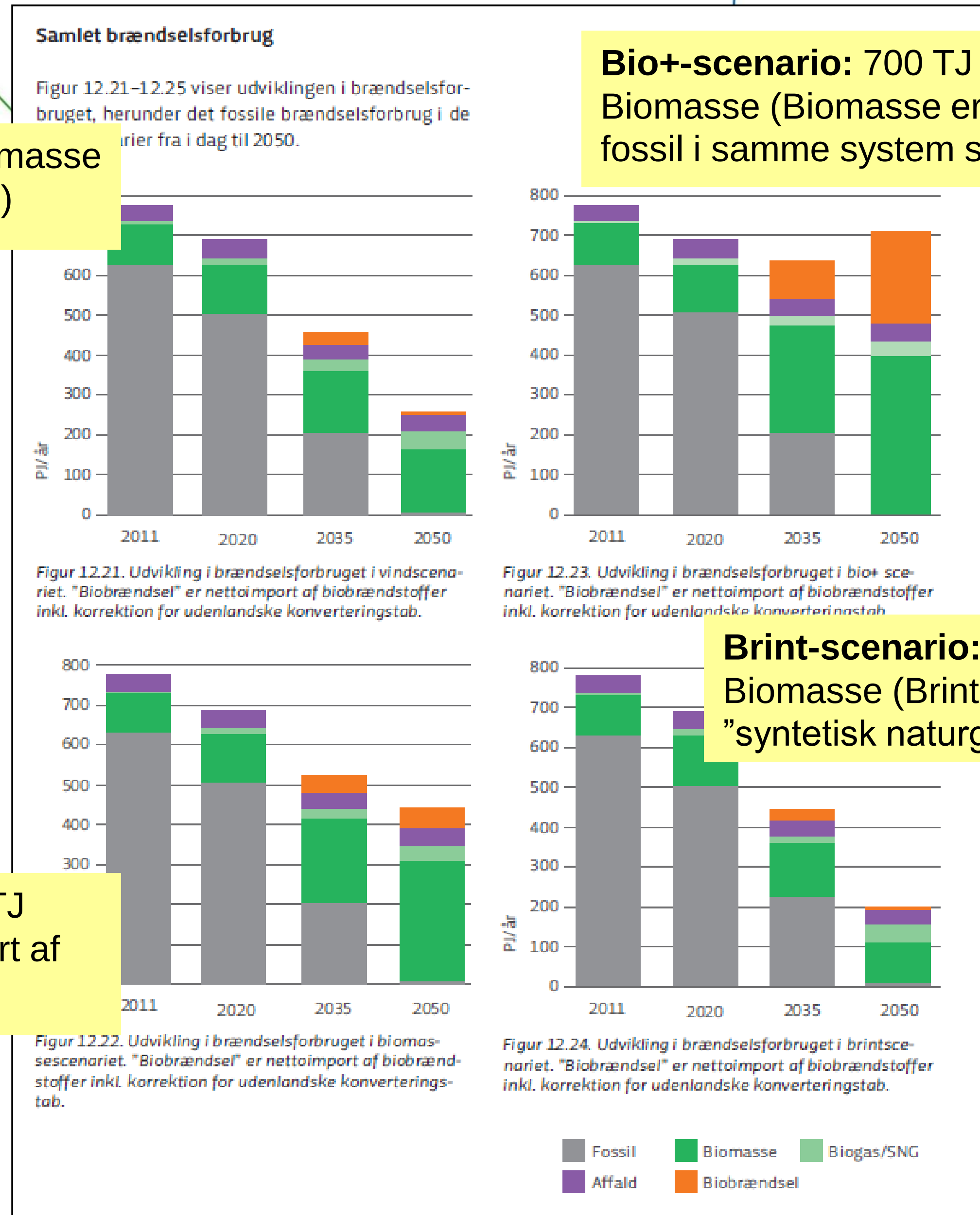

Primær energiforsyning 100% VE i år 2050, PJ
1,000
2050 Vind
IDA 2050
Eksport
VE-el
Solvarme
Biomasse
Naturgas
Olie
Kul


nd consumtion in IDA 2030, PJ
Max potential
Waste
Energy crops
Slurry fibre fraction
Slurry biogas
Wood
Straw


Primary energy supply
Peta Joule (PJ)
1.000
900
800
700
600
500
400
300
200
100
0
2004
Ref. 2030
IDA 2030
IDA 2050
Export
RE electricity
Solar thermal
Biomass
Natural gas
Oil
Coal

Vind-scenario: 250 TJ Biomasse (Svarer til Dansk Potentiale)

Bio+-scenario: 700 TJ Biomasse (Biomasse erstatter fossil i samme system som nu)



Samlet brændselsforbrug

Figur 12.21–12.25 viser udviklingen i brændselsforbruget, herunder det fossile brændselsforbrug i de ... rier fra i dag til 2050.

Figur 12.21. Udvikling i brændselsforbruget i vindscenariet. "Biobrændsel" er nettoimport af biobrændstoffer inkl. korrektion for udenlandske konverteringstab.

Figur 12.23. Udvikling i brændselsforbruget i bio+ scenariet. "Biobrændsel" er nettoimport af biobrændstoffer inkl. korrektion for udenlandske konverteringstab.

Figur 12.22. Udvikling i brændselsforbruget i biomassescenariet. "Biobrændsel" er nettoimport af biobrændstoffer inkl. korrektion for udenlandske konverteringstab.

Figur 12.24. Udvikling i brændselsforbruget i brintscenariet. "Biobrændsel" er nettoimport af biobrændstoffer inkl. korrektion for udenlandske konverteringstab.

Biomasse-scenario: 450 TJ Biomasse (Indebærer import af netto biomasse)

Brint-scenario: 200 TJ Biomasse (Brint til ”syntetisk naturgas”)

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DTU Danmarks Tekniske Universitet

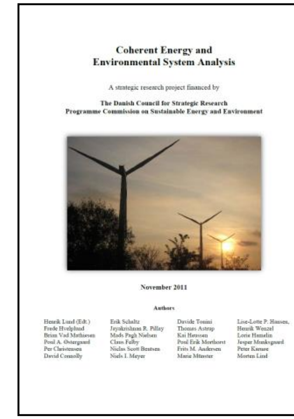
CBS COPENHAGEN BUSINESS SCHOOL HANDELSHØJSKOLEN

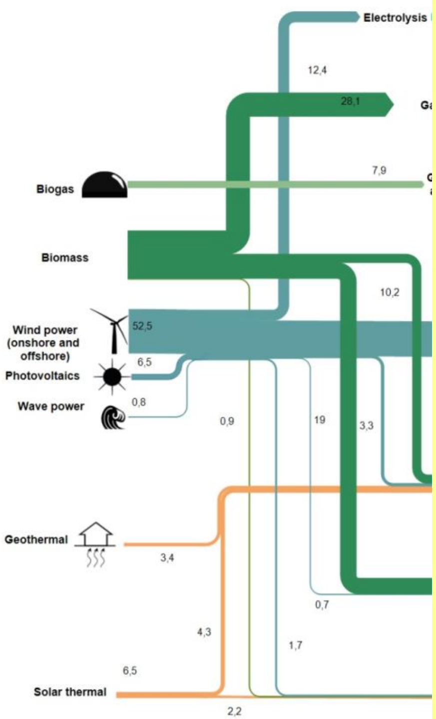
AALBORG UNIVERSITY DENMARK

KØBENHAVNS UNIVERSITET

SYDDANSK UNIVERSITET

CEESA Project 2011/2012





Transport:

El biler er bedst set fra et energi system synspunkt. Men gas og flydende brændsler behøves for at håndtere hele transport sektoren.

Biomasse:

.. er en begrænset ressource og der er ikke nok til at tilfredsstille hele transportsektoren…

Konsekvensen…

… el fra vindkraft (og tilsvarende) skal konverteres til VE-gasser og flydende brændsler på langt sigt…

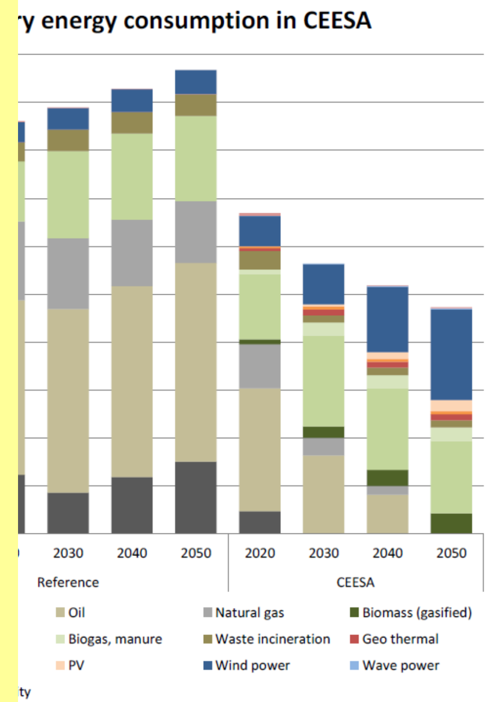
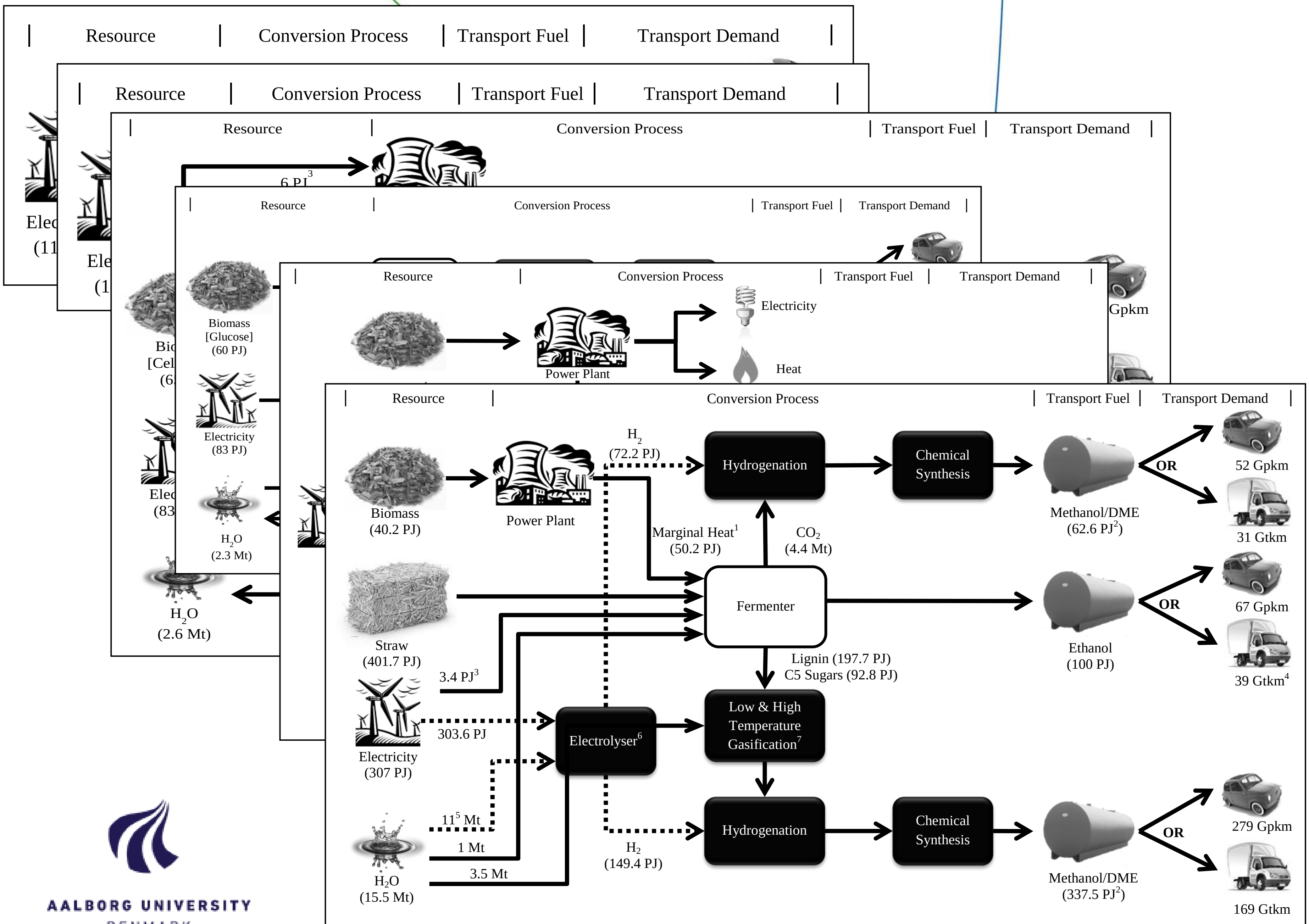


Figure 2: Primary Energy Supply in CEESA.



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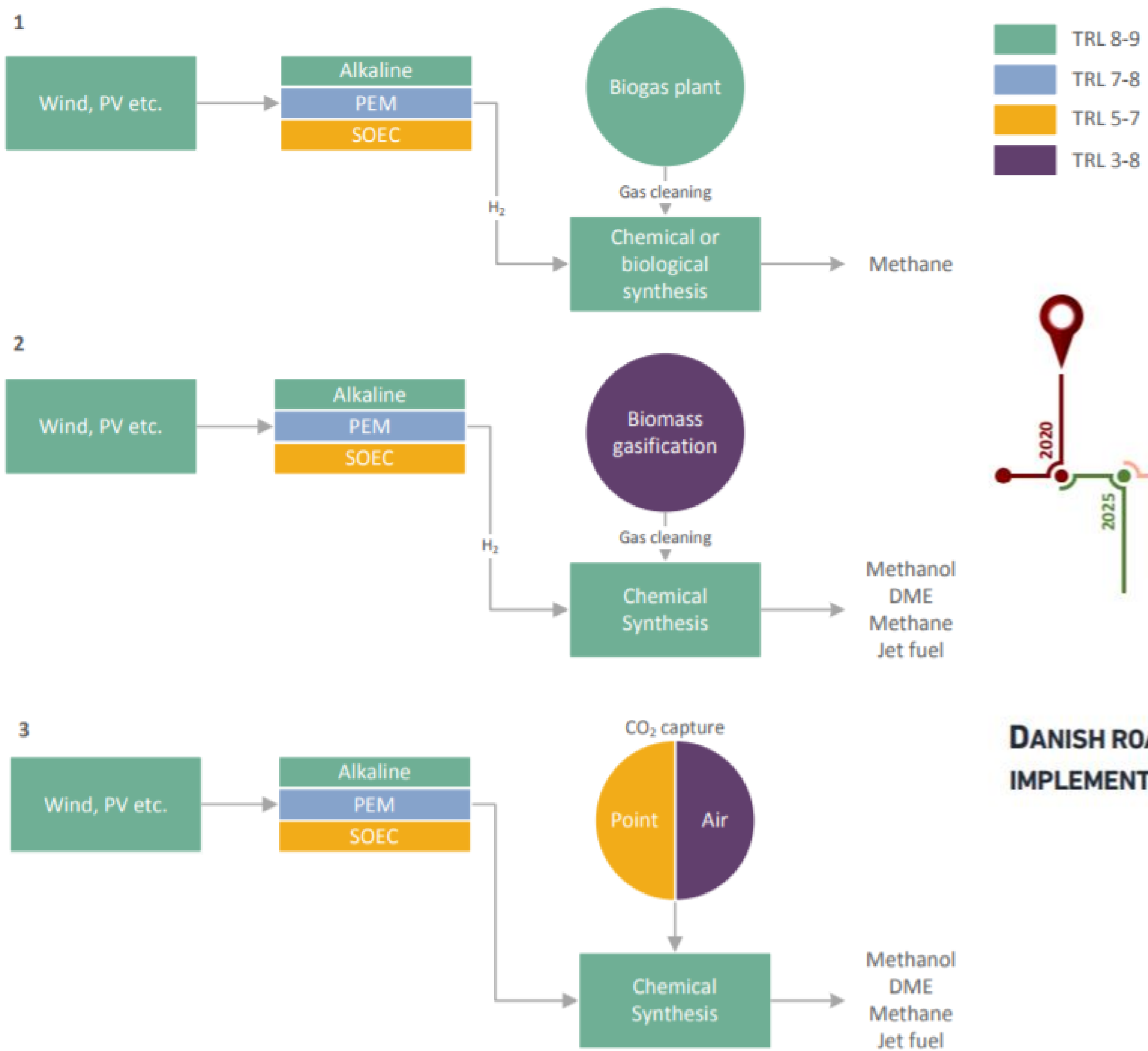


DANISH ROADMAP FOR LARGE-SCALE IMPLEMENTATION OF ELECTROLYSERS

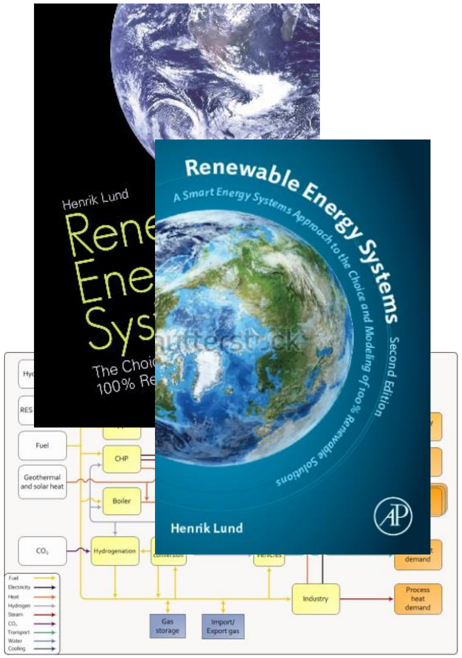
DENMARK

Smart Energy Systems

The key to cost-efficient 100% Renewable Energy

- 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…



Power-to-Heat

Power-to-Gas
Power-to-Transport

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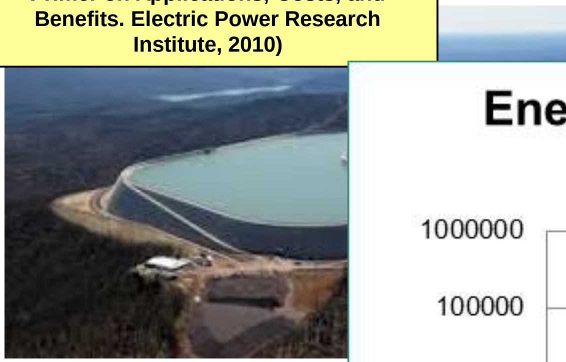
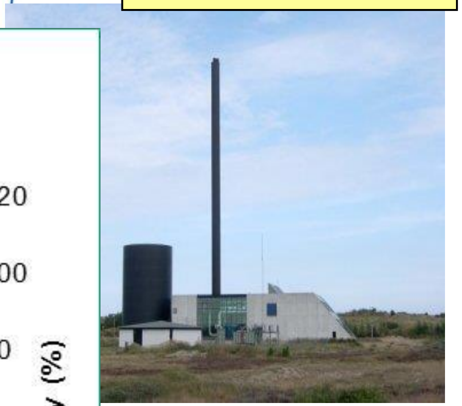
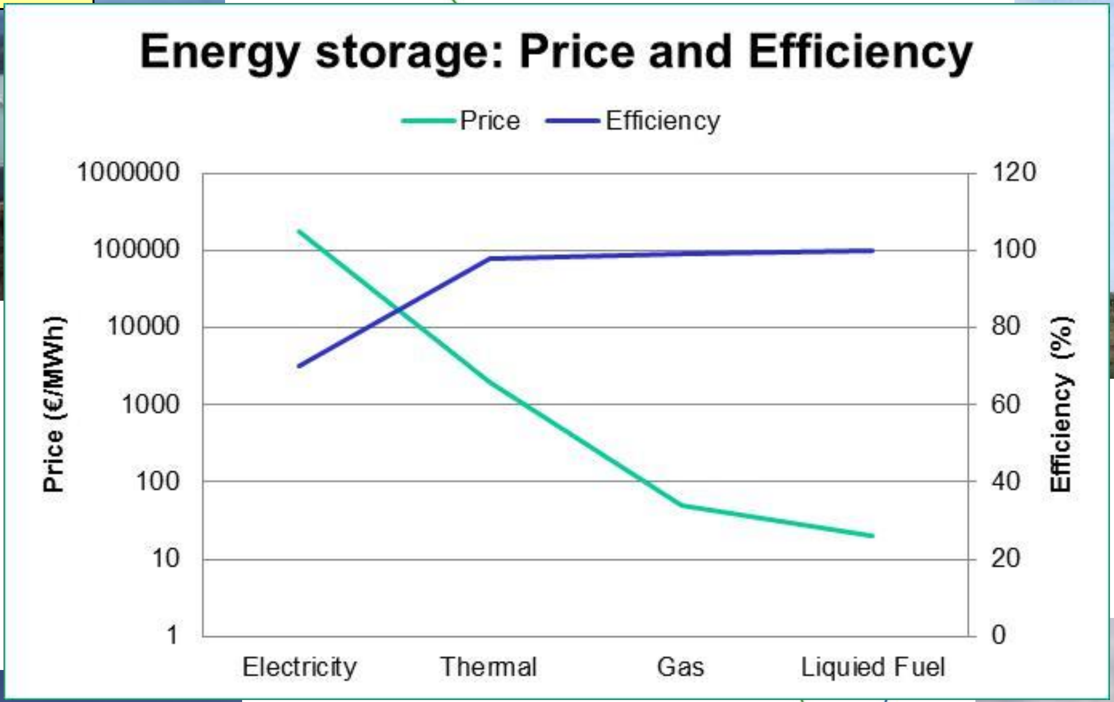
Energilagre

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)



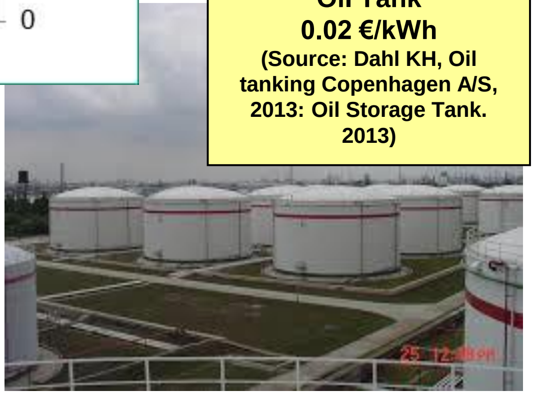
Thermal Storage
1-4 €/kWh
(Source: Danish Technology Catalogue, 2012)





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

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

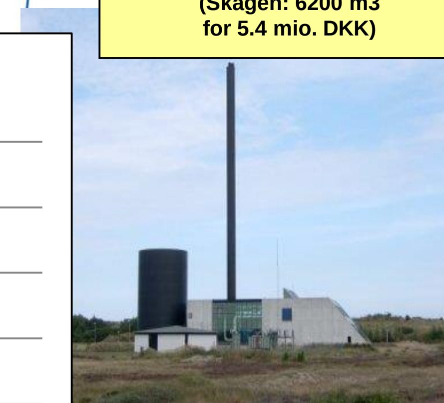


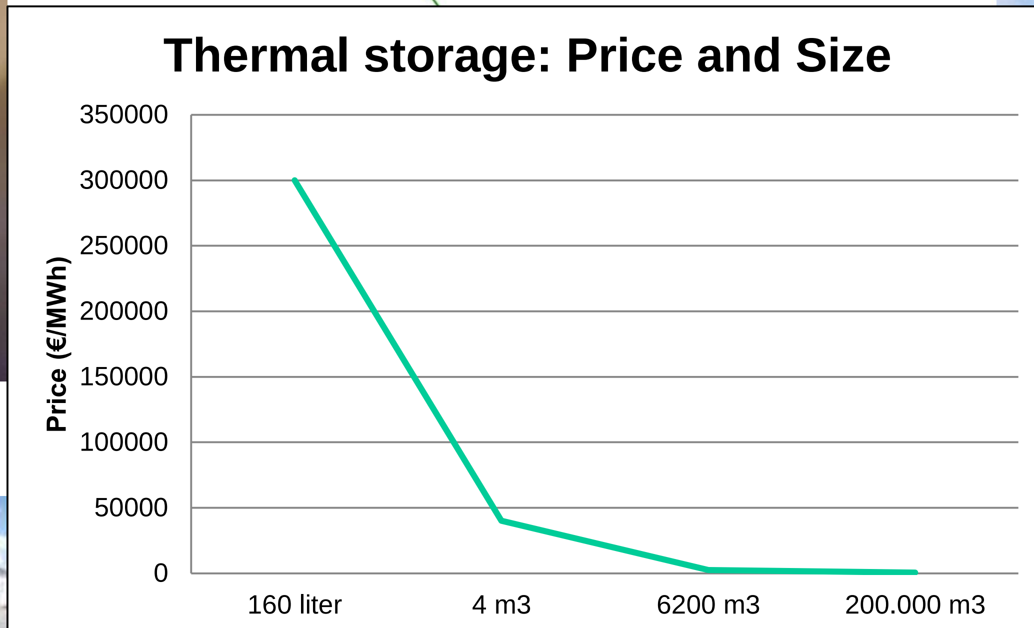
RENOVERING PÅ DAGSORDENEN

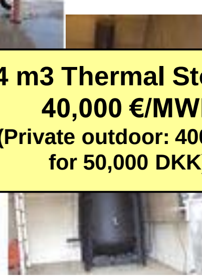
Varmelagre

0.16 m3 Thermal Storage
300.000 €/MWh
(Private house: 160 liter for 15000 DKK)

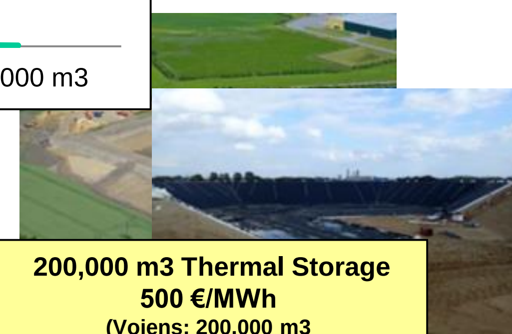
6200 m3 Thermal Storage
2500 €/MWh
(Skagen: 6200 m3 for 5.4 mio. DKK)







4 m3 Thermal Storage
40,000 €/MWh
(Private outdoor: 4000 m3 for 50,000 DKK)



200,000 m3 Thermal Storage
500 €/MWh
(Vojens: 200,000 m3 for 30 mio. DKK)

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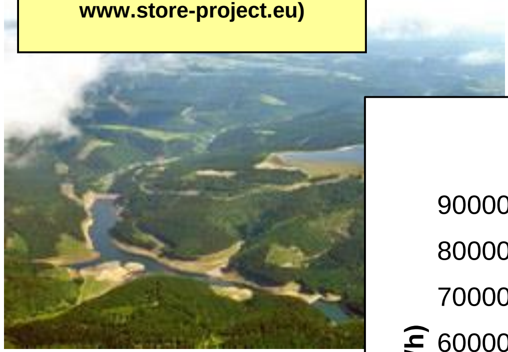
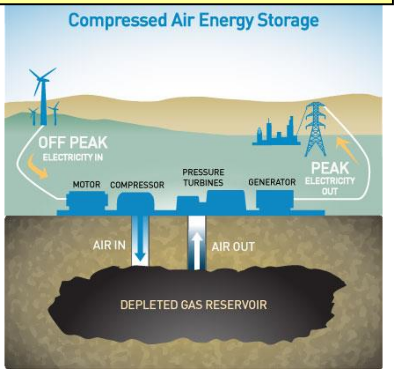
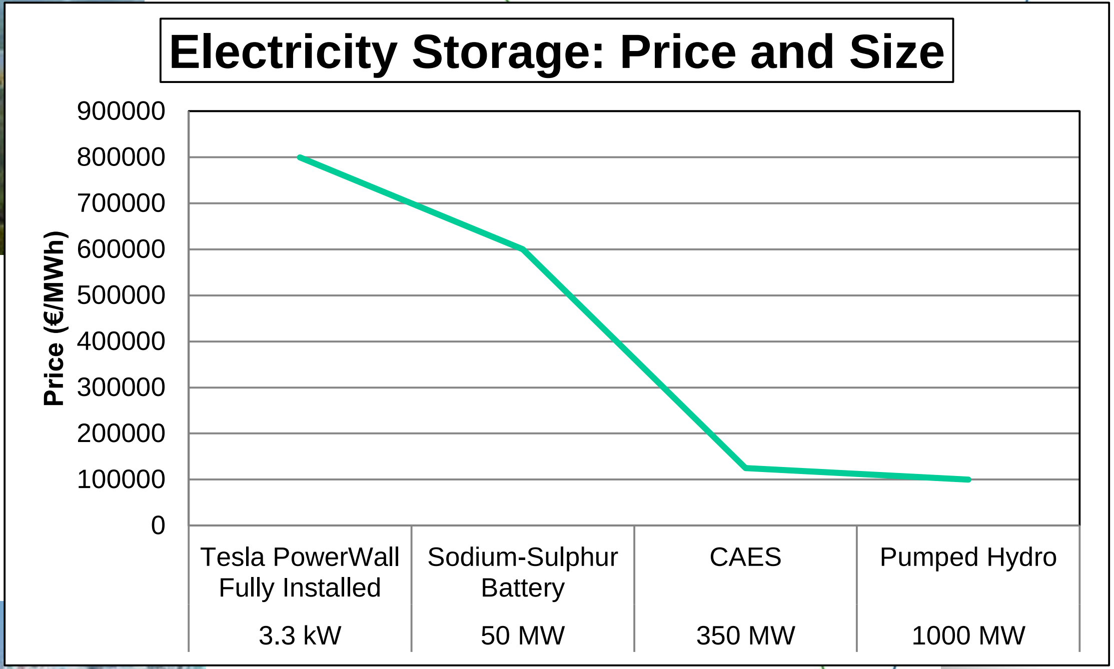
El-lagre

Pump Hydro Storage
100 €/kWh
(Source: Goldisthal Pumped Storage Station, Germany, www.store-project.eu)



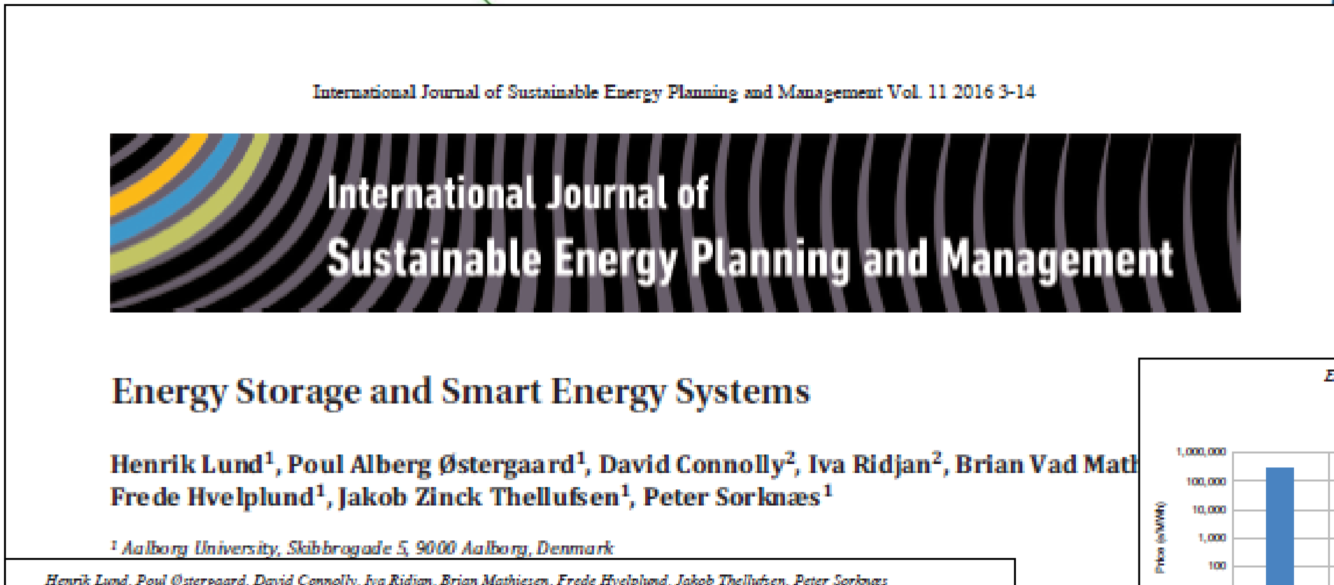
Compressed Air Energy Storage
125 €/kWh
(Source: http://www.sciencedirect.com/science/article/pii/S0196890409000429)





Tesla PowerWall
800 €/kWh
(Source: http://solarlove.org/solarcity-tesla-battery-create-turnkey-systems-depth/

Sodium-Sulphur Battery
600 €/kWh
(Source: Table 4: http://large.stanford.edu/courses/2012/ph240/doshay1/docs/EPRI.pdf)



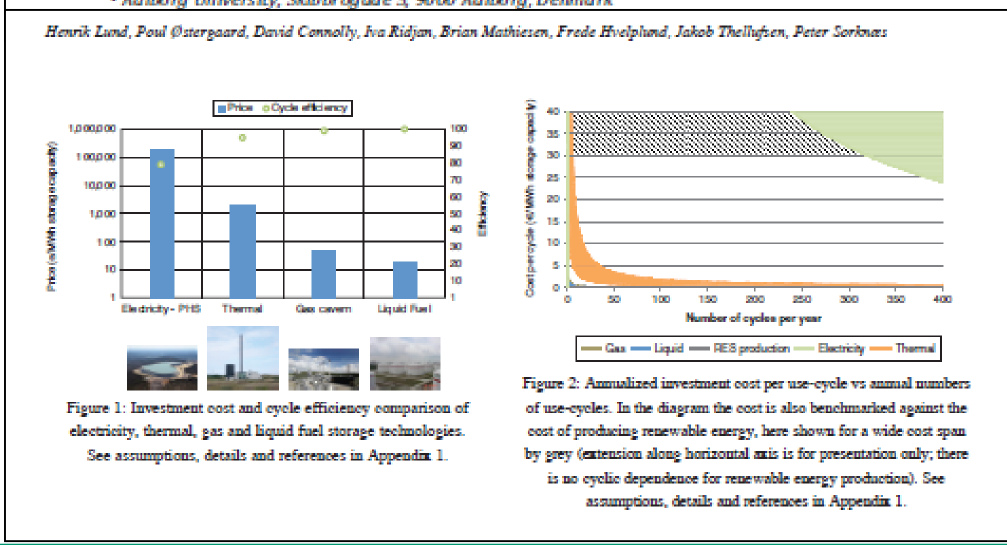
International Journal of Sustainable Energy Planning and Management Vol. 11 2016 3-14

International Journal of
Sustainable Energy Planning and Management

Energy Storage and Smart Energy Systems

Henrik Lund[1], Poul Alberg Østergaard[1], David Connolly[2], Iva Ridjan[2], Brian Vad Math
Frede Hvelplund[1], Jakob Zinck Thellufsen[1], Peter Sorknæs[1]

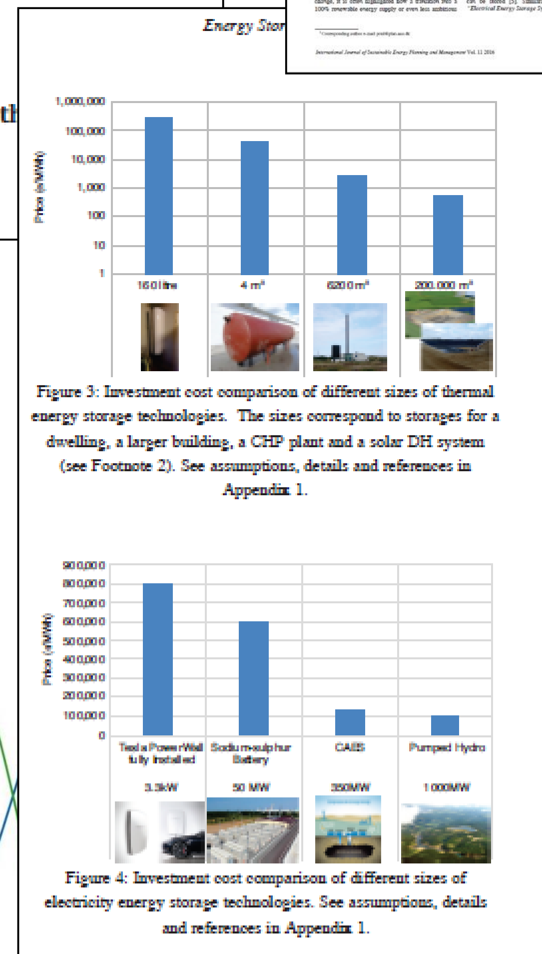
[1] Aalborg University, Skibbrogade 5, 9000 Aalborg, Denmark



Henrik Lund, Poul Østergaard, David Connolly, Iva Ridjan, Brian Mathiesen, Frede Hvelplund, Jakob Thellufsen, Peter Sorknæs

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.

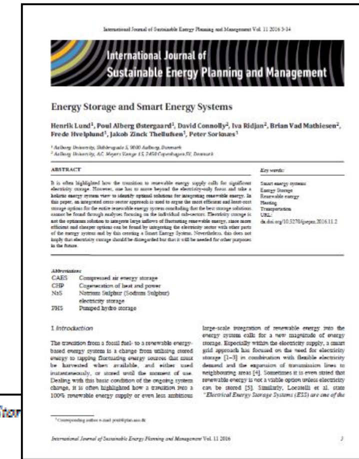
Figure 2: Annualized investment cost per use-cycle vs annual numbers of use-cycles. In the diagram the cost is also benchmarked against the cost of producing renewable energy, here shown for a wide cost span by grey (extension along horizontal axis is for presentation only; there is no cyclic dependence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



Energy Stor

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.

Figure 4: Investment cost comparison of different sizes of electricity energy storage technologies. See assumptions, details and references in Appendix 1.



International Journal of
Sustainable Energy Planning and Management

Energy Storage and Smart Energy Systems

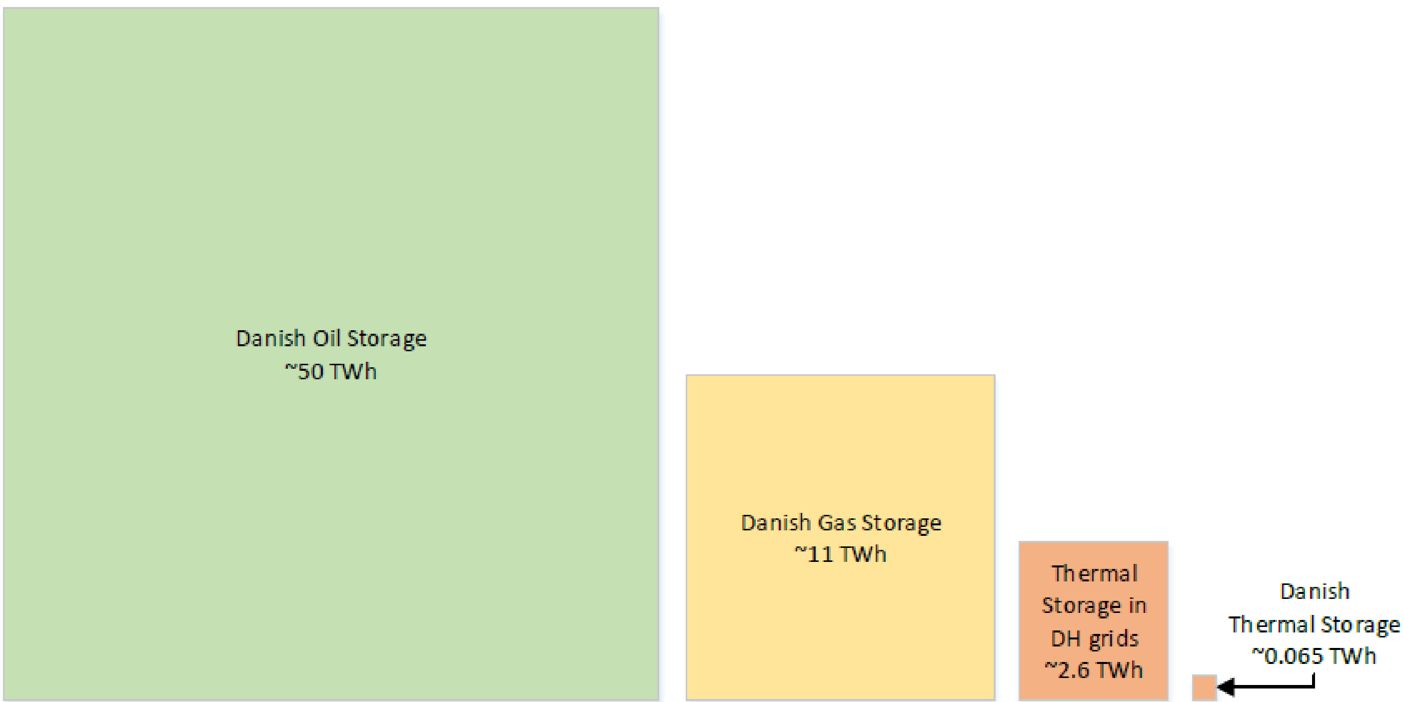
www.journals.aau.dk/index.php/sepm

4DH

reINVEST

Innovation Fund Denmark

Energy Storage Capacities in Denmark



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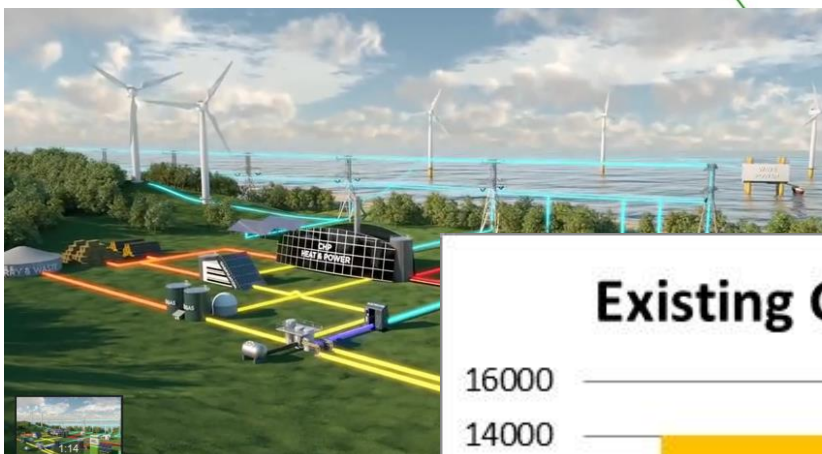
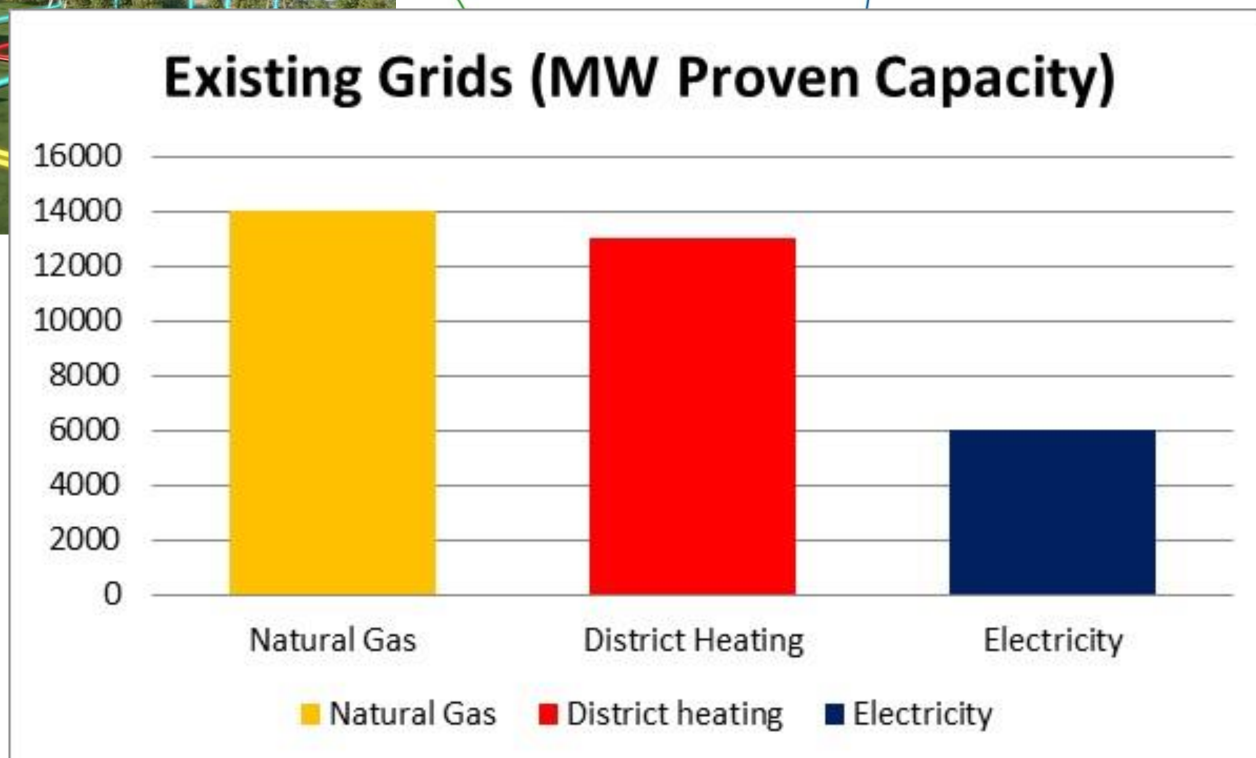
Eksisterende distributionsnet





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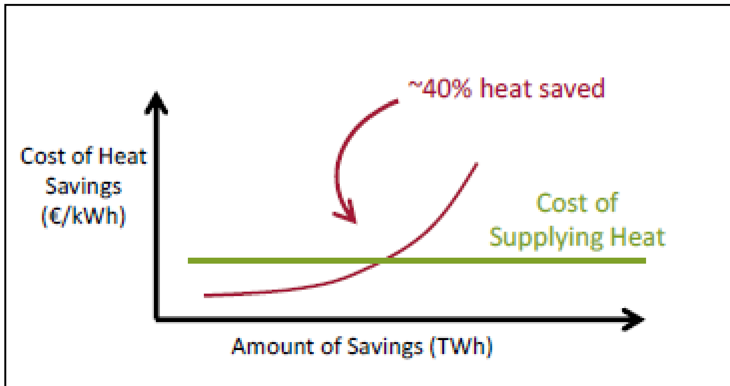
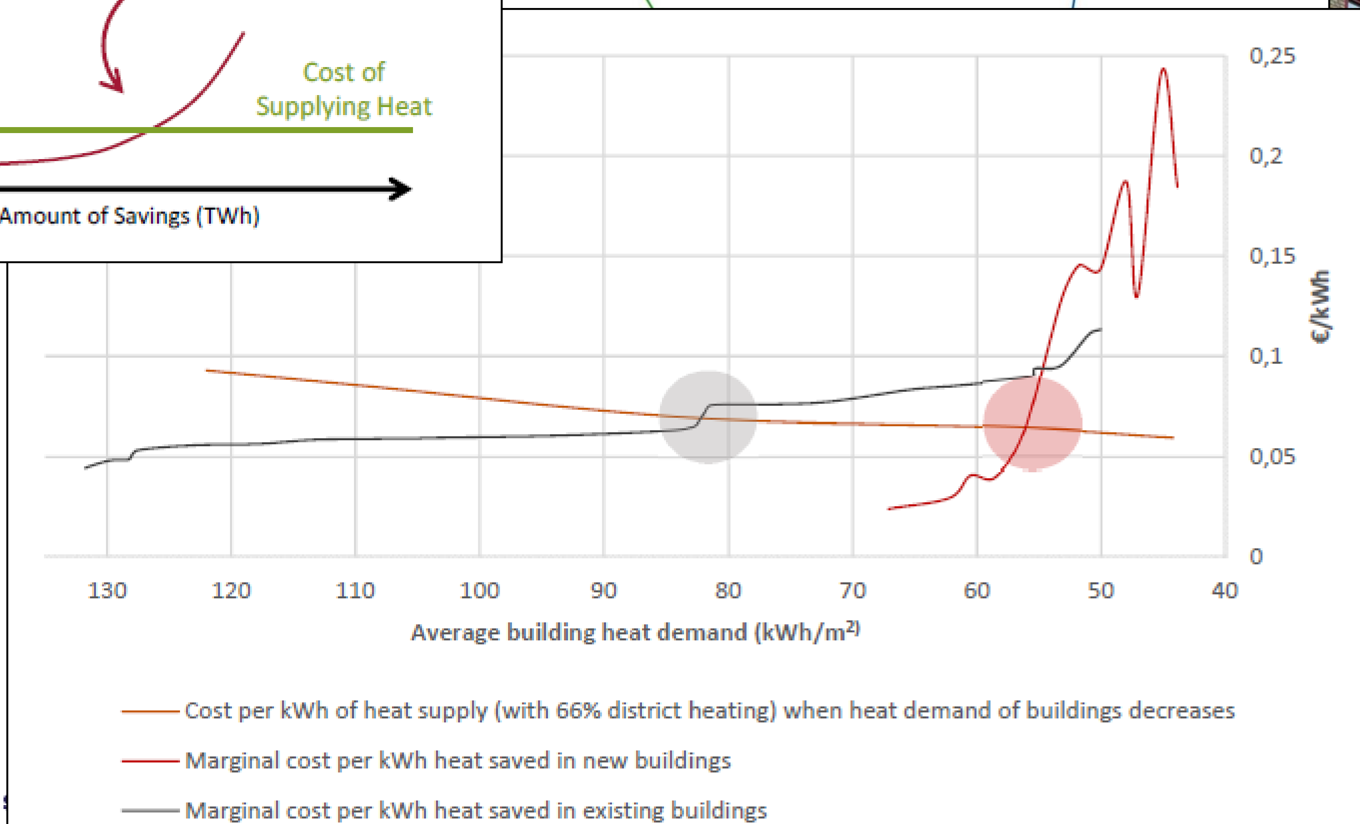
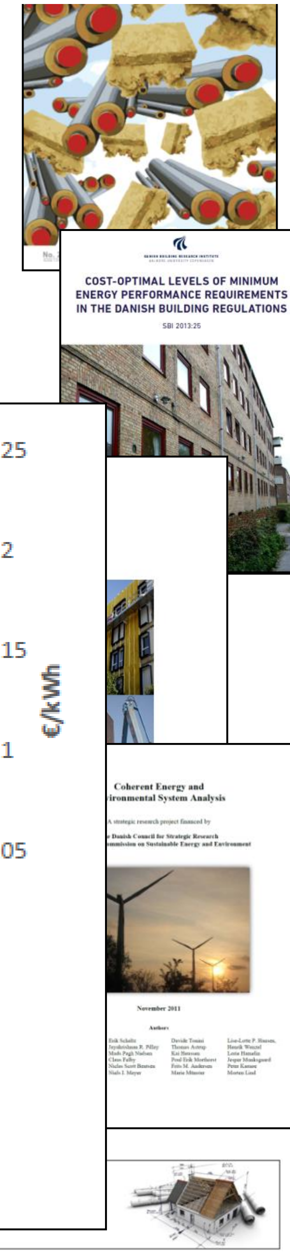
RENOVERING PÅ DAGSORDENEN

Hvor meget skal varmeforbruget reduceres før 2050?







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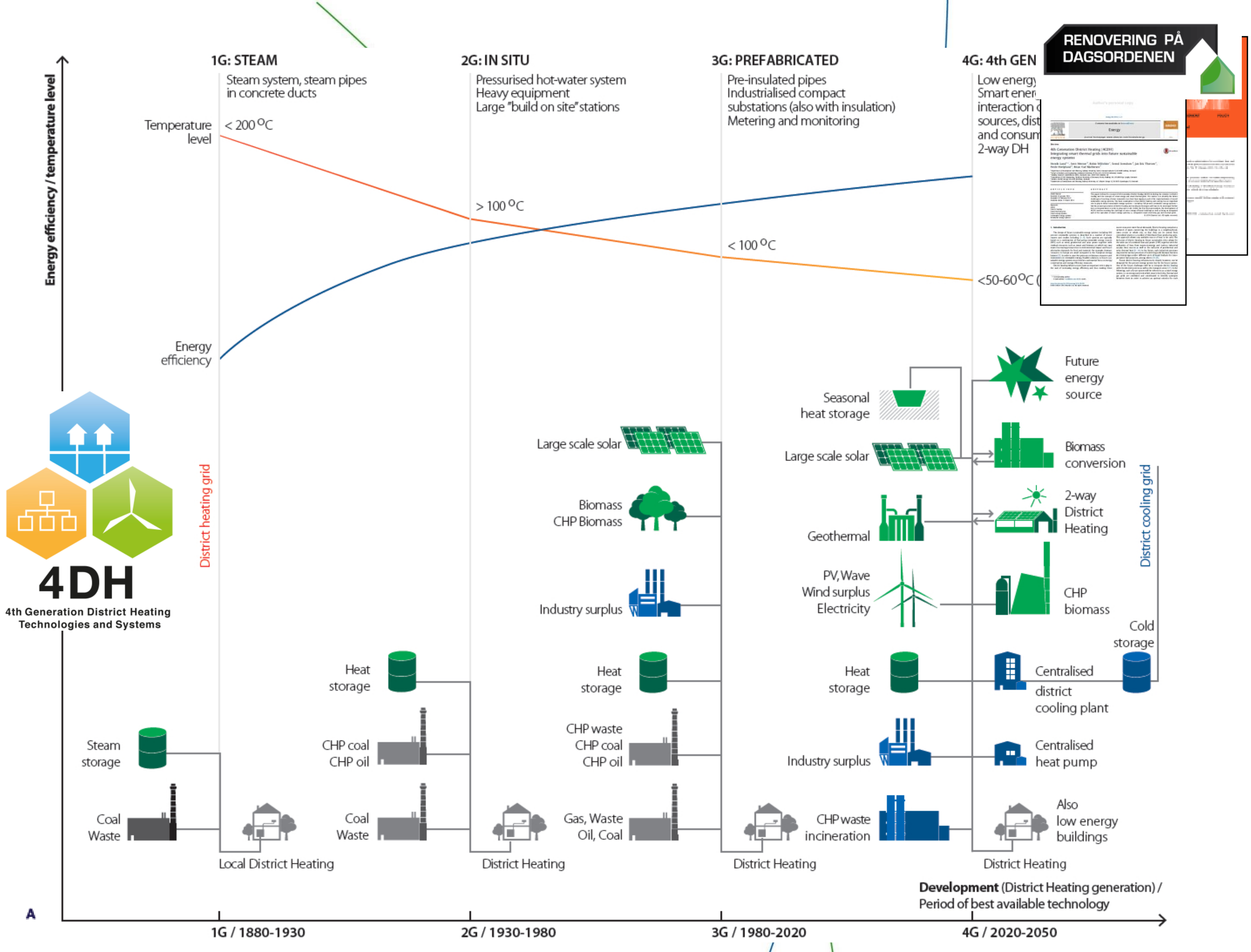

1G: STEAM
Steam system, steam pipes in concrete ducts
2G: IN SITU
Pressurised hot-water system
Heavy equipment
Large "build on site" stations
3G: PREFABRICATED
Pre-insulated pipes
Industrialised compact substations (also with insulation)
Metering and monitoring
4G: 4th GEN
Low energy
Smart ener
interaction
sources, dist
and consum
2-way DH
RENOVERING PÅ DAGSORDENEN
Energy efficiency / temperature level
Temperature level
< 200 °C
> 100 °C
< 100 °C
<50-60 °C
Energy efficiency
4DH
4th Generation District Heating Technologies and Systems
District heating grid
District cooling grid
Steam storage
Coal
Waste
Local District Heating
Heat storage
CHP coal
CHP oil
Coal
Waste
District Heating
Large scale solar
Biomass
CHP Biomass
Industry surplus
Heat storage
CHP waste
CHP coal
CHP oil
Gas, Waste
Oil, Coal
District Heating
Seasonal heat storage
Large scale solar
Geothermal
PV, Wave
Wind surplus
Electricity
Heat storage
Industry surplus
CHP waste incineration
District Heating
Future energy source
Biomass conversion
2-way District Heating
CHP biomass
Cold storage
Centralised district cooling plant
Centralised heat pump
Also low energy buildings
District Heating
Development (District Heating generation) / Period of best available technology
A
1G / 1880-1930
2G / 1930-1980
3G / 1980-2020
4G / 2020-2050

Smart Energy Europe

Renewable and Sustainable Energy Reviews 60 (2016) 1634–1653

Contents lists available at ScienceDirect

Renewable and Sustainable Energy Reviews

journal homepage: www.elsevier.com/locate/rser

ELSEVIER

Smart Energy Europe: The technical and economic impact of one potential 100% renewable energy scenario for the European Union

CrossMark

D. Connolly [a,*], H. Lund [b], B.V. Mathiesen [a]

[a] Department of Development and Planning, Aalborg University, A.C. Meyers Vænge 15, 2450 Copenhagen SV, Denmark
[b] Department of Development and Planning, Aalborg University, Vestre Havnepromenade 9, 9000 Aalborg, Denmark

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ABSTRACT

www.EnergyPLAN.eu/SmartEnergyEurope

- Report Online
- Paper Published

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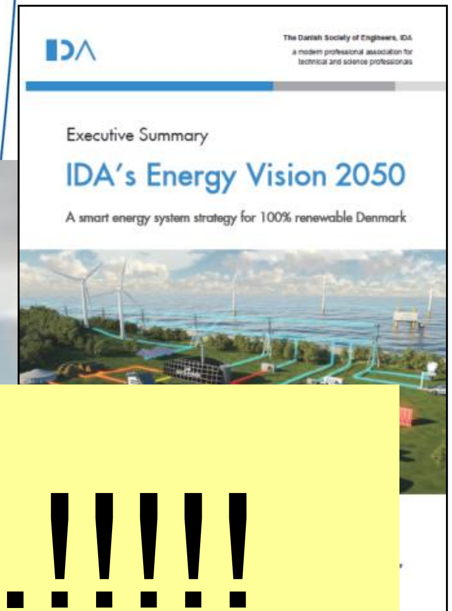
RENOVERING PÅ DAGSORDENEN

Smart Energy Systems



Elektrificeringen….!!!!!

A: energi og klima

De Økonomiske Vismænd: Hvorfor skal vi spare på energien?

DEBAT

"…Det er svært at se fornuften bag et sådant mål, for hvad er miljøgevinsten ved at reducere den grønne energiproduktion?

Jyllands-Posten Politik

Dansk Energi: Næste energifor… tage opgøret med elafgiften

DEBAT 31. maj 2017 kl. 4:00 | 0 kommentarer

Print

"Jeg har kun set opbakning til Energikommissionens anbefaling om at adressere den høje danske afgift på el.

–

Lars Aagaard
Adm. direktør i Dansk Energi

JOBANNONCER Se alle »

POLITIK 24.04.2017 KL. 11:15

Dansk Energi efter rapport: Tid… til at droppe elafgift

Brancheforeninger mener, at det er på tide at få gjort noget ved den høje danske elafgift.

BØRSEN.

TORSDAG 8. JUNI 2017 - ÅRGANG 121 - PRIS 30,00 KR.

Lilleholt vil fjerne elafgift – men skal finde 11 mia

En afskaffelse af elafgiften, der udgør knap halvdelen af danskernes elregning, står allerøverst på energi- og klimaminister Lars Christian Lilleholts (V) ønskeliste. "Men det er ikke bare lige et greb i lommen at finde de 11 mia. kr., som det koster," siger han.

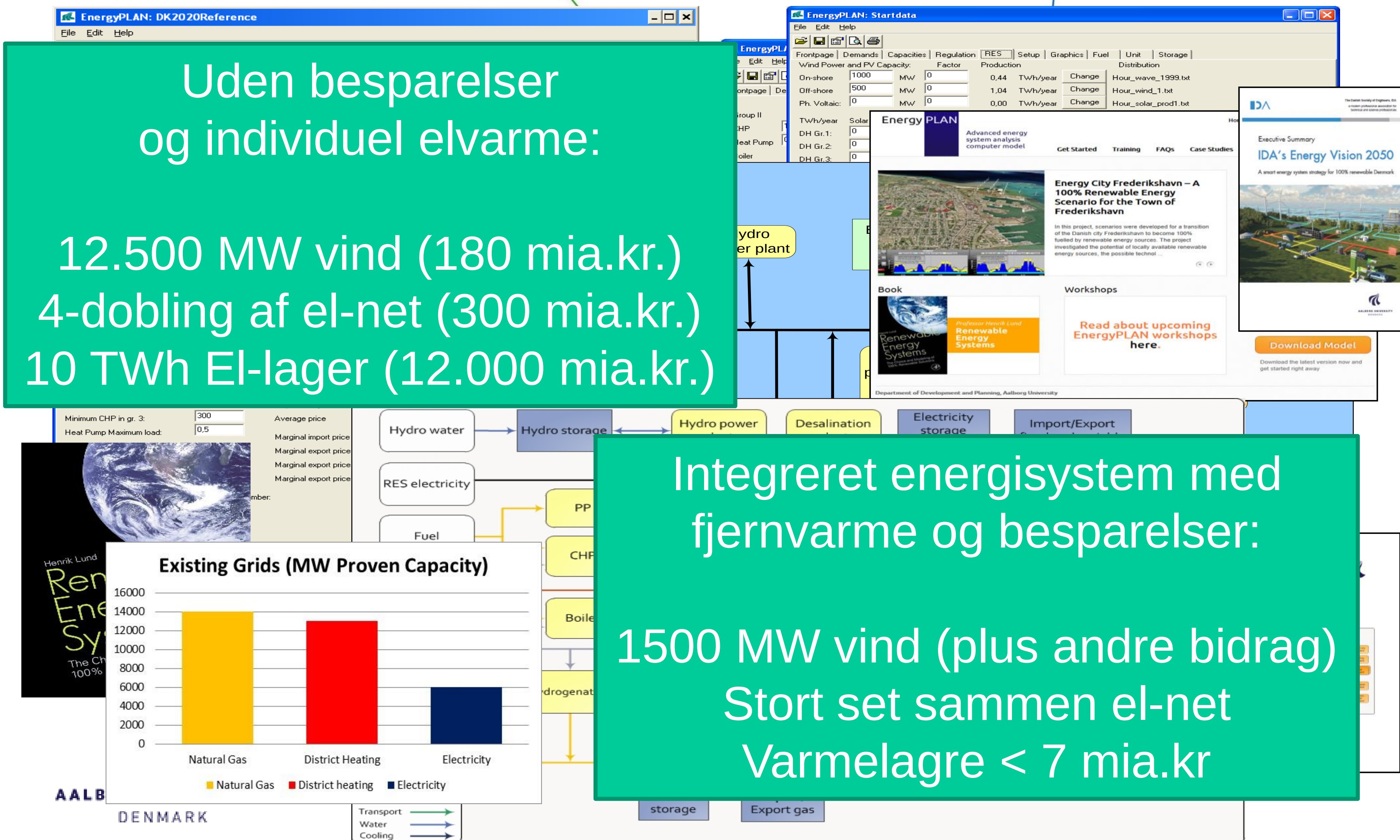
■ Dansk Energi: Skrot elafgiften og skab 3400 job

Dansk Energi roser topskat-retr… skal fokus på elafgiften

AALBORG UNIVERSITY DENMARK

Altinget

Hvad nu hvis….!!!?



Uden besparelser
og individuel elvarme:

12.500 MW vind (180 mia.kr.)
4-dobling af el-net (300 mia.kr.)
10 TWh El-lager (12.000 mia.kr.)

Integreret energisystem med
fjernvarme og besparelser:

1500 MW vind (plus andre bidrag)
Stort set sammen el-net
Varmelagre < 7 mia.kr

Hovedpointer

- Vi skal begrænse brugen af Biomasse til et niveau, der er bæredygtigt
- Den "elektrificering" som blot øger elforbruget er problematisk… (øger presset på biomasse og vind)
- Det er når alle sektorer spiller sammen i et smart energi system, at vi opnår den bedste og den billigste løsning (mindsker presset på biomasse og integrerer vind):
  - Elektrolyseanlæg (produktion af Brint) er en central teknologi
  - Besparelser, fjernvarme (store varmepumper) er andre centrale tiltag

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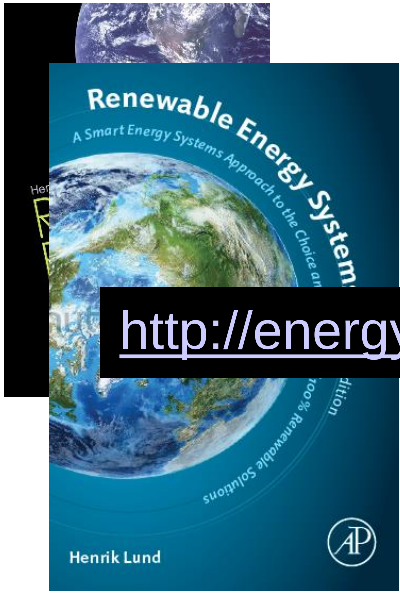
More information:

www.henriklund.eu

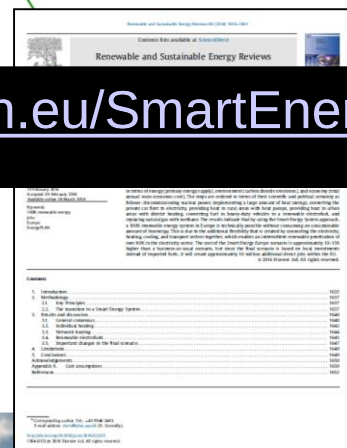
www.4DH.dk

4DH

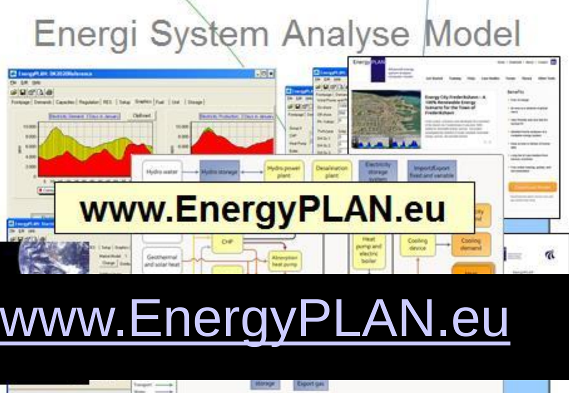
4th Generation District Heating Technologies and Systems



http://energy.plan.aau.dk/book.php



www.energyplan.eu/SmartEnergyEurope



www.heatroadmap.eu

www.EnergyPLAN.eu

www.energyplan.eu/smartenergysystems/

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