



A GLOBAL SMART ENERGY SYSTEM APPROACH FOR LONG-TERM SUSTAINABLE BIOMASS CONSUMPTION

BRIAN VAD MATHIESEN
bvm@plan.aau.dk

GSAIS International Symposiums on Human Survivability
Kyoto, JAPAN, NOV/19 2015

SUSTAINABLE ENERGY PLANNING RESEARCH GROUP
AALBORG UNIVERSITY



CONTENT



- The challenge – current and future
- The Smart Energy System Concept research and (district) heating Research
- Perspectives on key strategic research objectives



CHALLENGES FOR THE ENERGY SECTOR

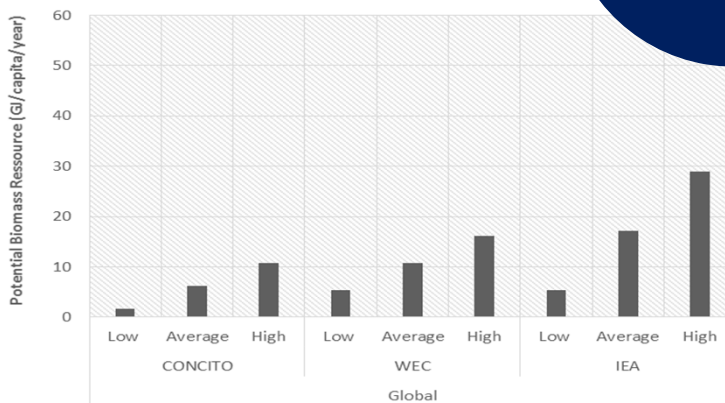


- We want to decrease the use of fossil fuels but:
 - The current system is extremely flexible...
 - We cannot replace these with biomass only...
 - We need to use intermittent renewable resources!

3

CHALLENGES USING BIOENERGY

Denmark: 0,05-0,3 EJ
 EU: 4,2-25 EJ
 Japan: 1,1 – 6,1 EJ
 Germany: 0,7 – 4,3 EJ

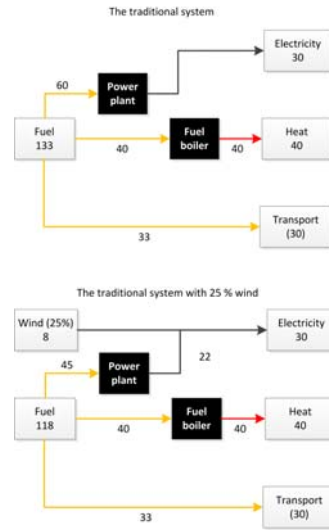


4

CHALLENGES FOR THE ENERGY SECTOR



- We can increase wind power but..
 - There is a limit with the current energy system design
 - ... a need for a new system design?



5

100% RENEWABLE ENERGY IN 2050

State-of-the-art-knowledge:

- System dynamics and components in sectors
- Feasibility studies and implementation barriers



RENEWABLE ENERGY STRATEGIES FOR SUSTAINABLE DEVELOPMENT

FLEXIBLE TECHNOLOGIES

INTEGRATED ENERGY SYSTEMS

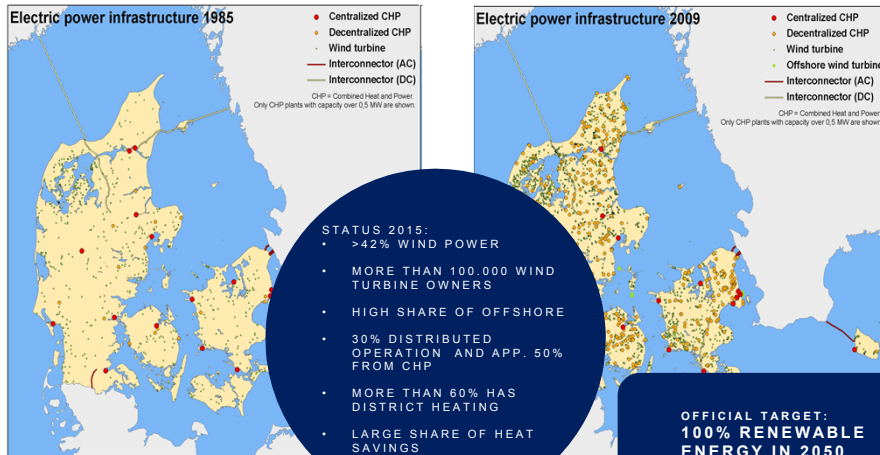
TRANSITION FROM A CENTRALISED ENERGY SYSTEM TO A PARTLY DE-CENTRALISED SYSTEM BASED ON RENEWABLE ENERGY

Electric power infrastructure 1985

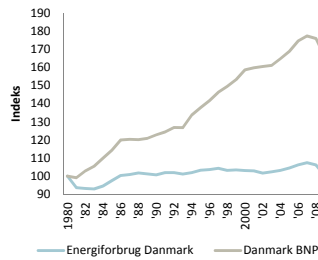
Electric power infrastructure 2009

8

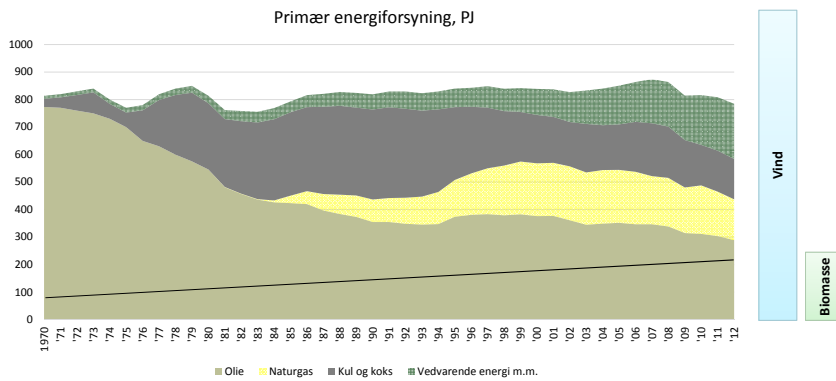
TRANSITION FROM A CENTRALISED ENERGY SYSTEM TO A PARTLY DE-CENTRALISED SYSTEM BASED ON RENEWABLE ENERGY

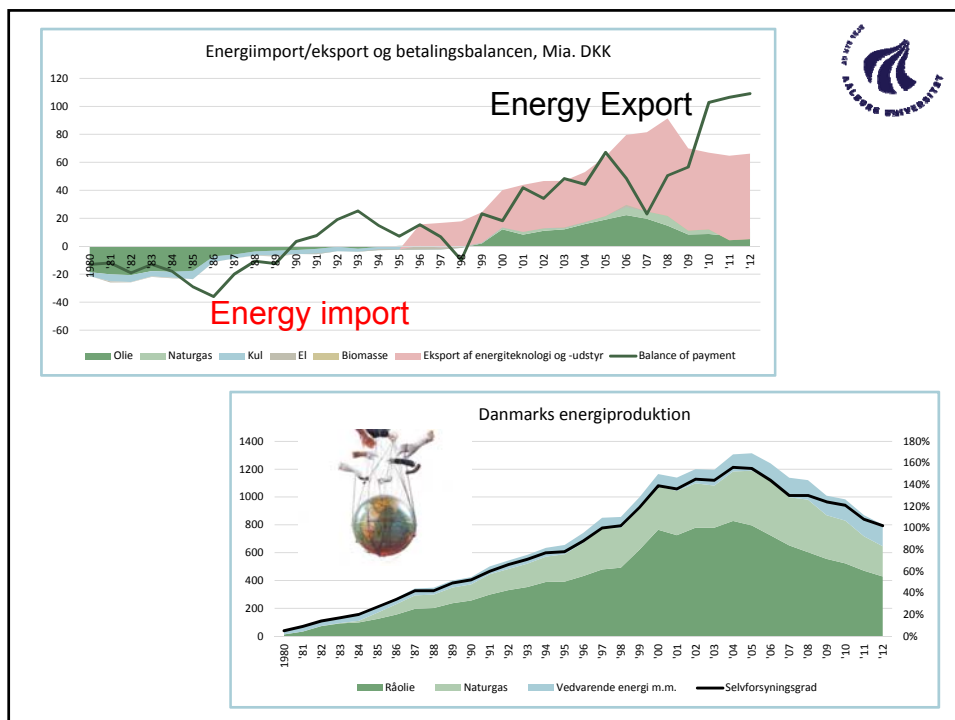


40 YEARS =
 LOW CONSUMPTION
 LOW COSTS
 SECURITY OF SUPPLY
 LOW CO₂-EMISSIONS



Primær energiforsyning, PJ





Why this study?

- The **heating and cooling sector has largely been overlooked** in all scenarios exploring the energy future towards 2050.
- This study focuses on the future European heat and cooling market and its importance in terms of cost-savings, job creation, investments, and a **smarter energy system**
- **>70 % of Europeans live in cities..**





STUDY FOR THE EU27

by



Aalborg University
David Connolly
Brian Vad Mathiesen
Poul Alberg Østergaard
Bernd Möller
Steffen Nielsen
Henrik Lund



Ecofys Germany GmbH
Jan Grözinger
Thosmas Boersmans
Michelle Bosquet



PlanEnergi
Daniel Trier



Halmstad University
Urban Persson
Daniel Nilsson
Sven Werner



HEAT ROADMAP CHINA
- NEW HEAT STRATEGY TO REDUCE ENERGY CONSUMPTION TOWARDS 2030



Tsinghua University
Weiming Xiong
Yu Wang
Xiliang Zhang

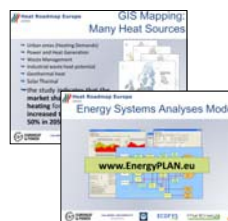


Aalborg University
Brian Vad Mathiesen
Henrik Lund
David Connolly

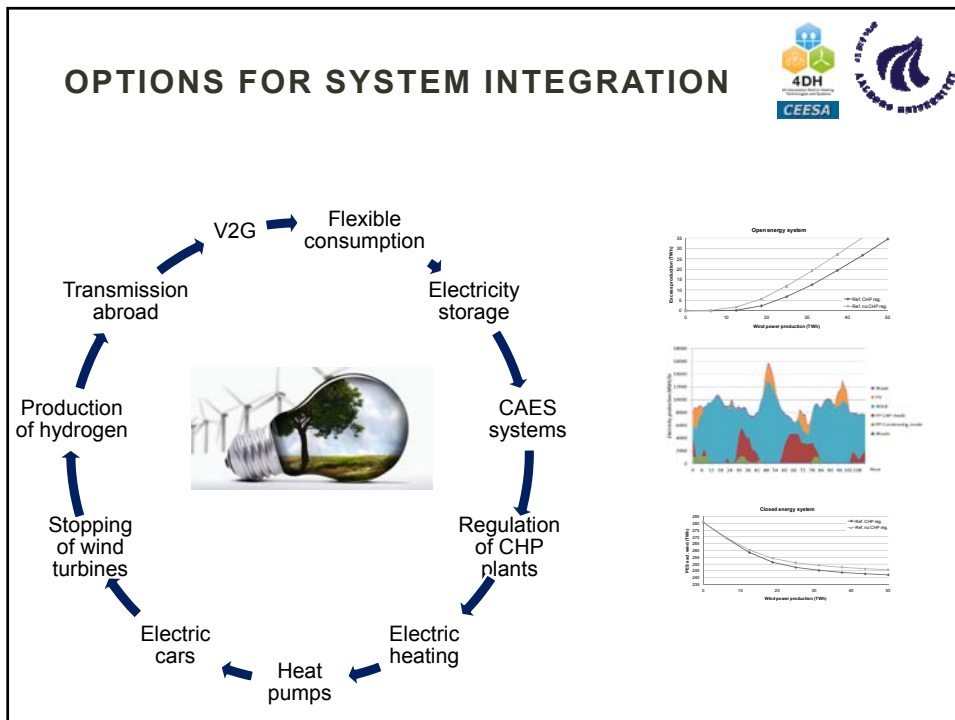
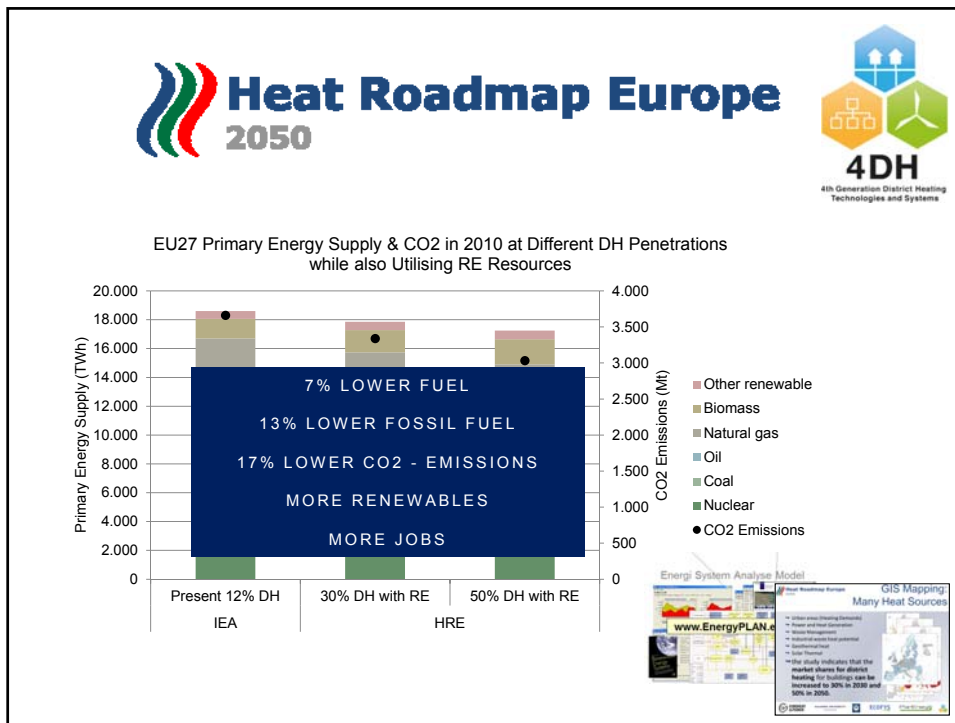


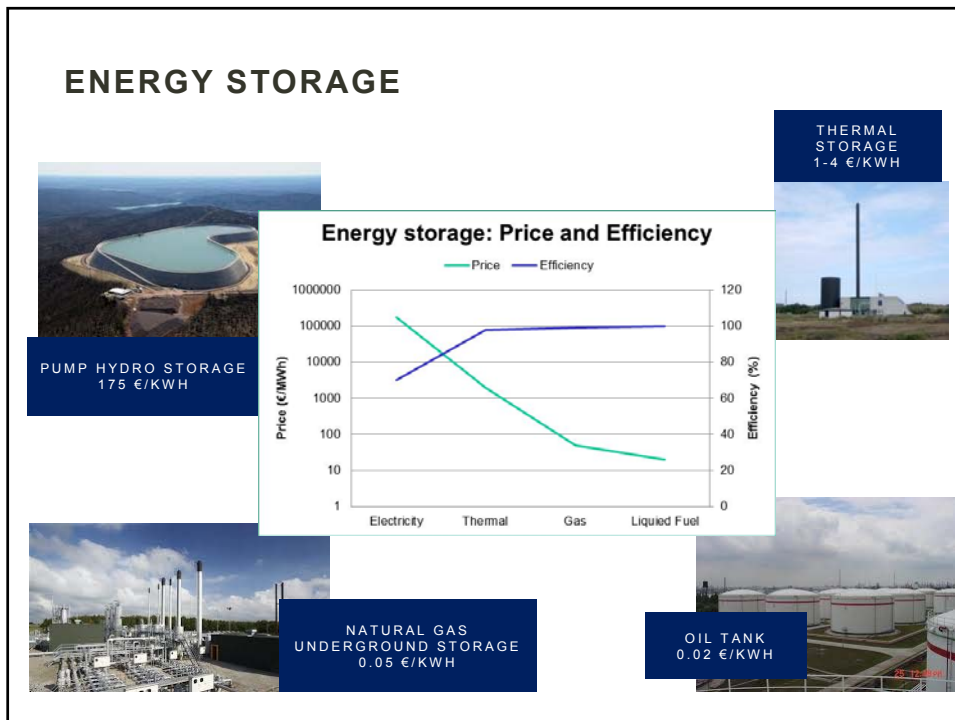
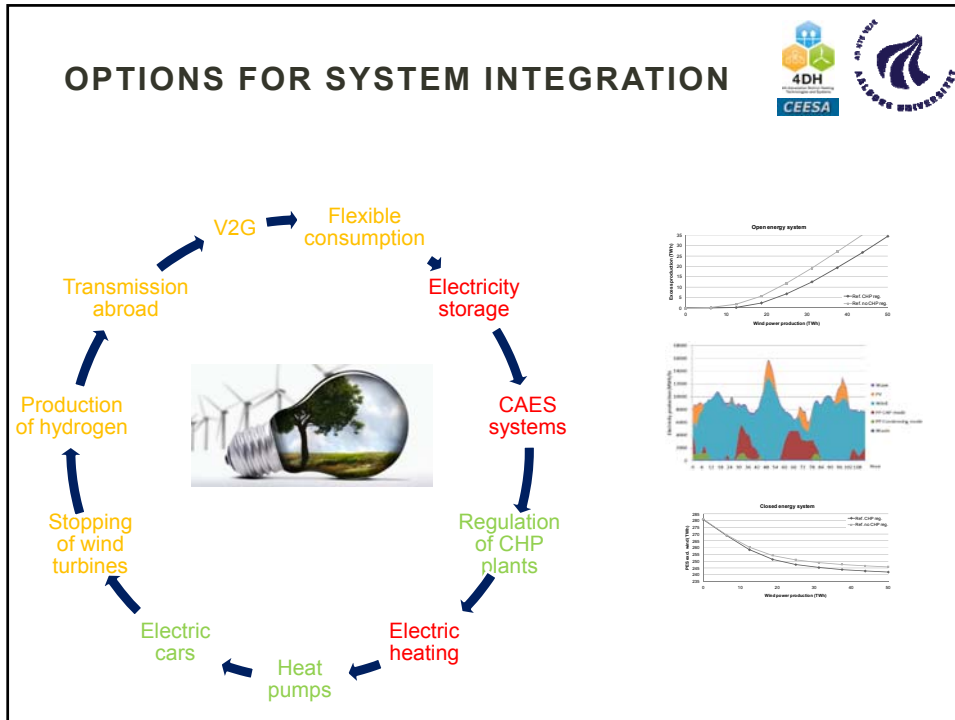
HRE: Key Conclusion



- For EU a combination of:
 - 50% District Heating (*Cities*)
 - 50% Heat Pumps (*Rural Areas*)
 - 35% Energy Savings (*Everywhere*)



Can enable the EU to reach its CO2 target in 2050 for **€100 billion/year less** than energy savings on their own.






SMART ENERGY SYSTEMS

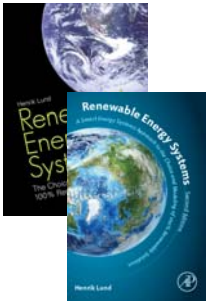
- THE KEY TO COST-EFFICIENT 100% RENEWABLE ENERGY

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



LEADS TO:

- ELECTRICITY STORAGE,
- FLEXIBLE DEMANDS




- 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





SMART ENERGY SYSTEMS


- ARE CRUCIAL IN 100% RENEWABLE ENERGY SYSTEMS




A cross-sectoral and coherent energy system solution

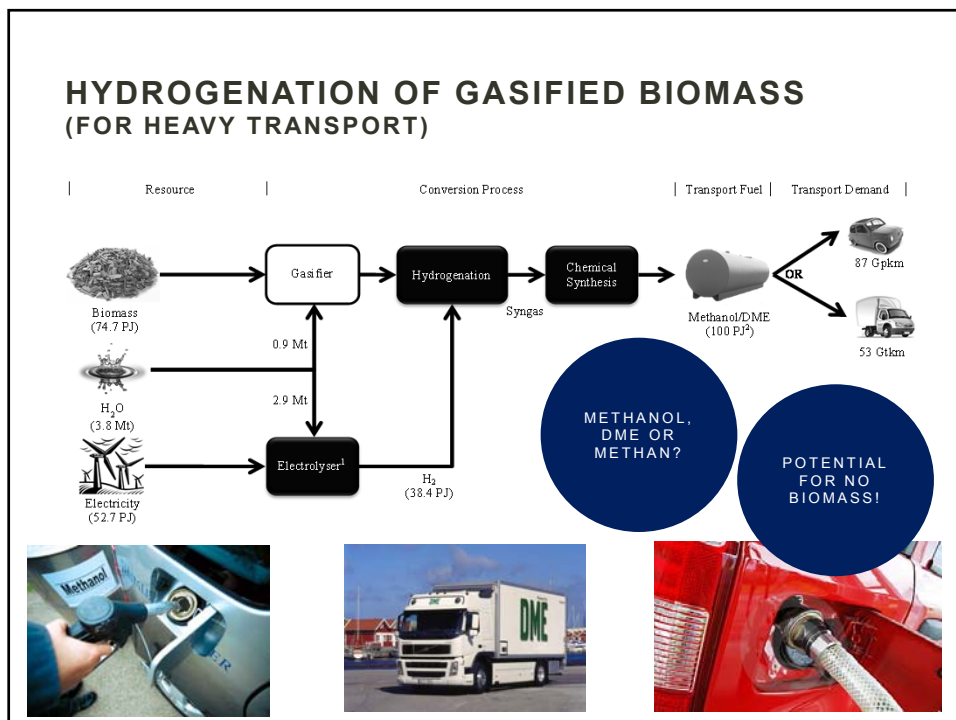
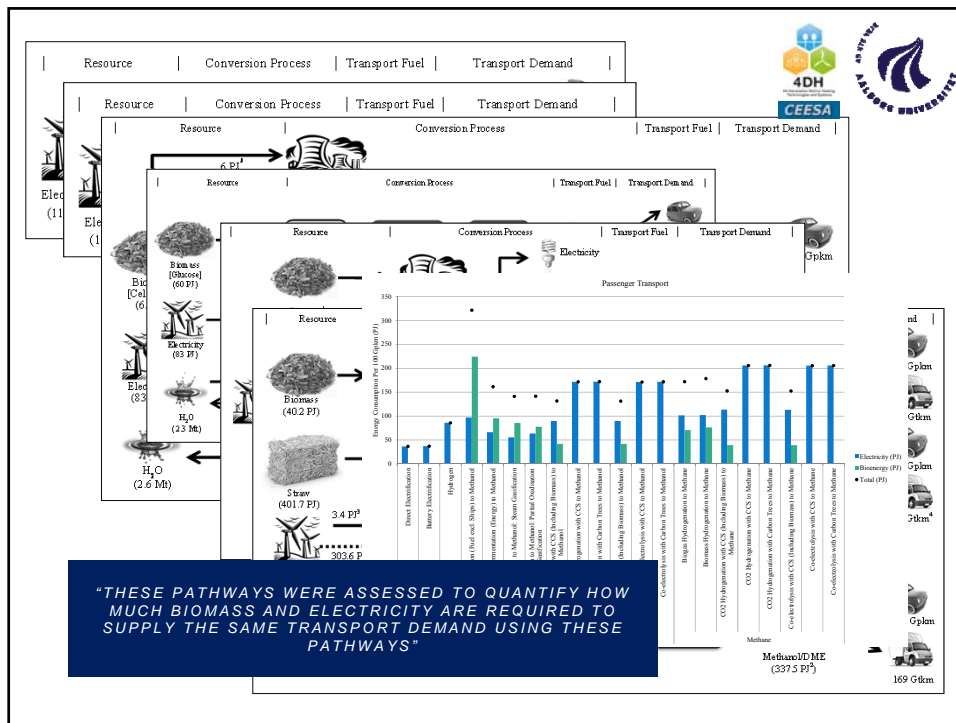
- **Smart Electricity Grids** to connect flexible electricity demands such as heat pumps and electric vehicles to the intermittent renewable resources such as wind and solar power.
- **Smart Thermal Grids** (District Heating and Cooling) to connect the electricity and heating sectors. This enables thermal storage to be utilised for creating additional flexibility and heat losses in the energy system to be recycled.
- **Smart Gas Grids** to connect the electricity, heating, and transport sectors. This enables gas storage to be utilised for creating additional flexibility. If the gas is refined to a liquid fuel, then liquid fuel storages can also be utilised.

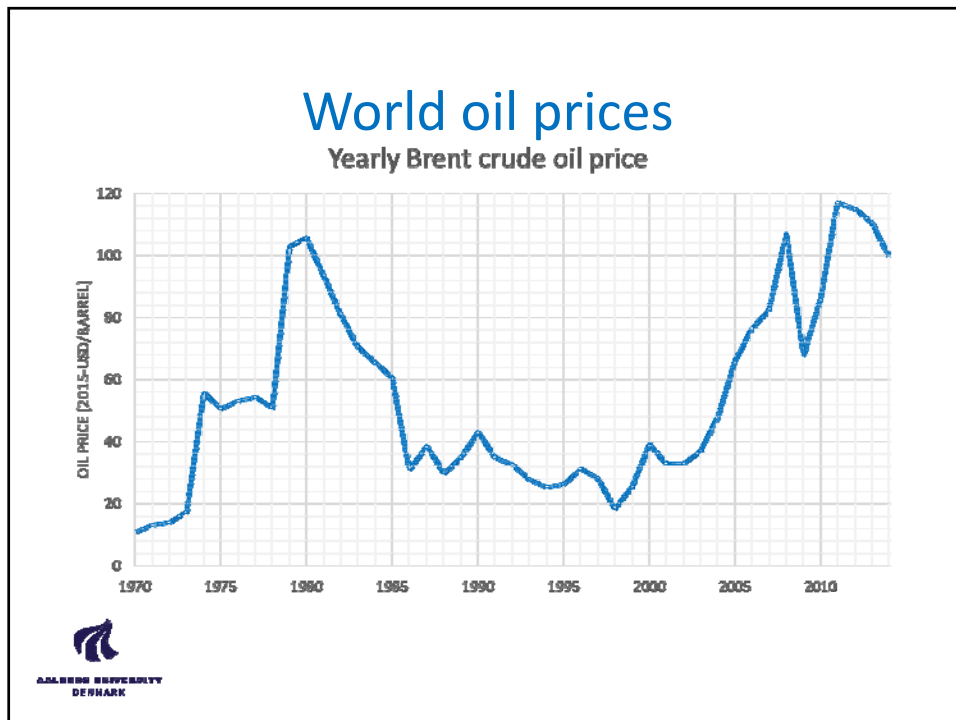
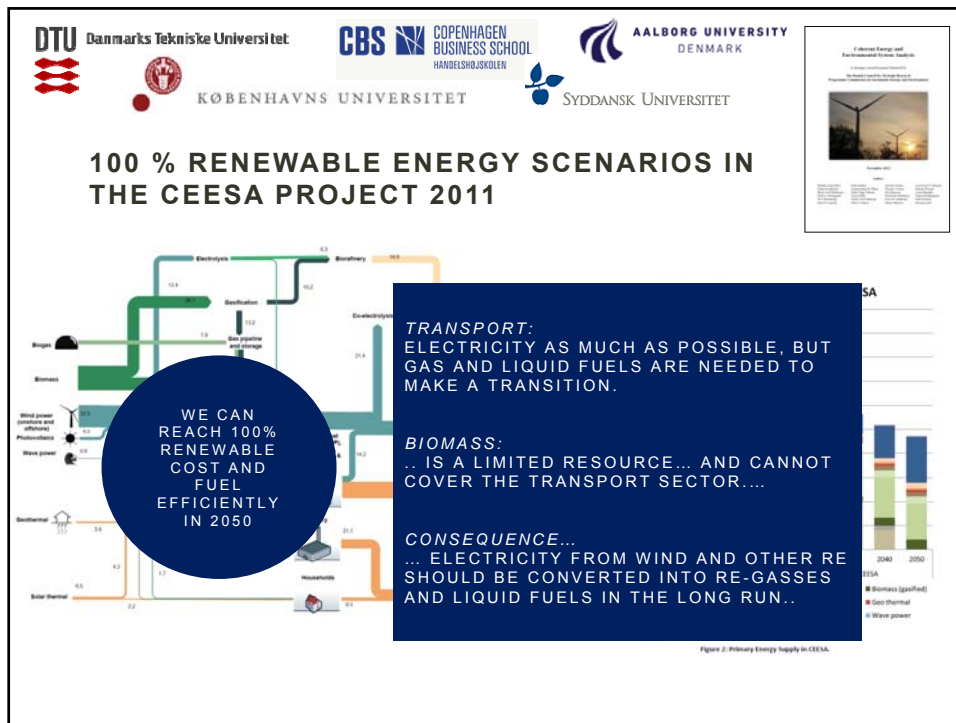





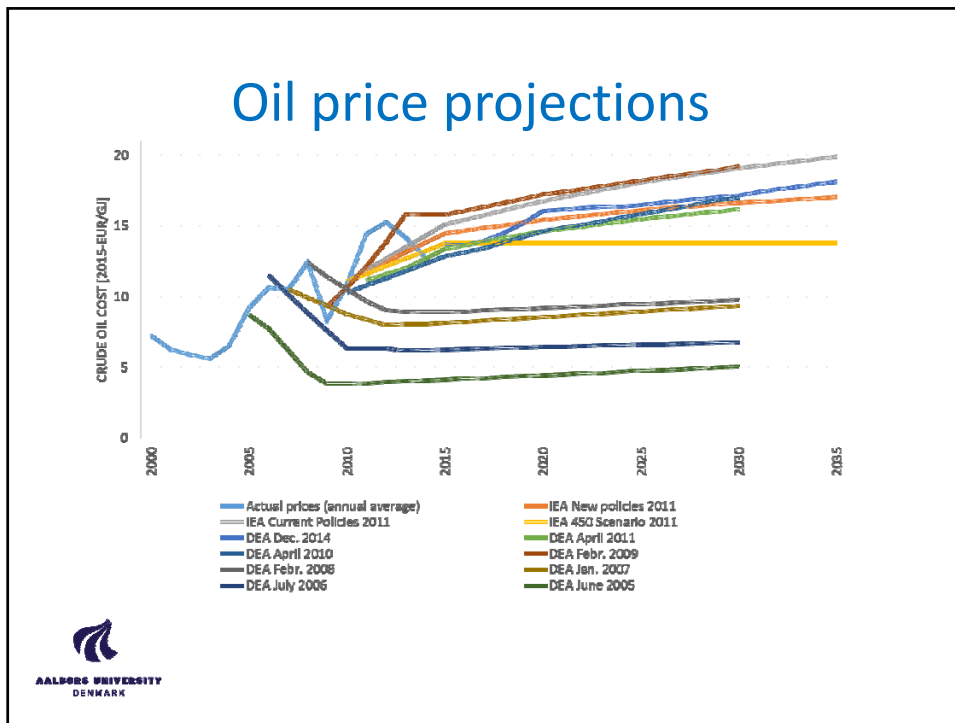


4DH
4th Generation District Heating
Technologies and Systems



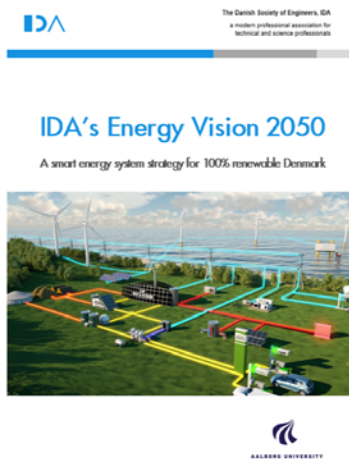






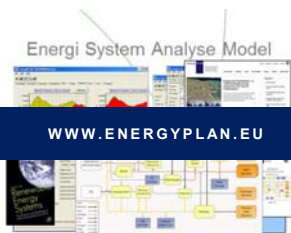
NEW STUDY OUT

- 100% is possible ecnically and feasible
- A fleksible system is robust with regards to costs and biomass consumption
- It provides more jobs and lower health costs than fossil fuel systems





WWW.SMARTENERGYSYSTEMS.EU



WWW.ENERGYPLAN.EU



WWW.4DH.DK



WWW.HEATROADMAP.EU