The role of CHP and power plants in 100% RES systems and smart energy systems

4DH
4th Generation District Heating Technologies and Systems

4th Generation District Heating Technologies and Systems,
Second Annual Conference 21-22 August 2013

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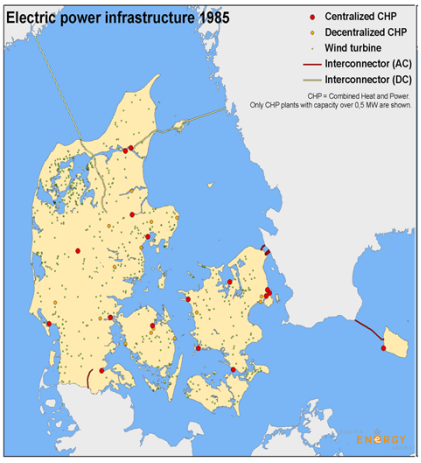
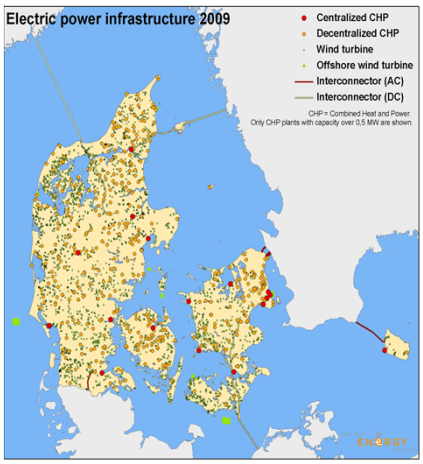
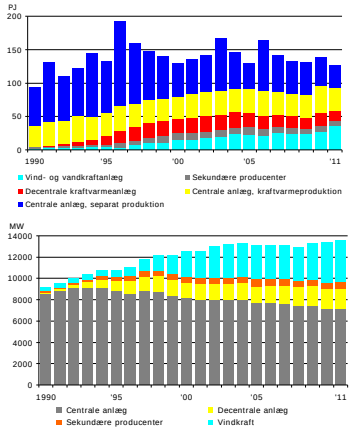
Transition from a hierarchal centralised to a semi-decentralised energy system – Status





Past trends for district heat production and CHP plants

- More wind power – now +30%
- ➢ Less fuel for electricity production
- ➢ Less opportunities for CHP plants
- ➢ Still the same capacities in the energy system



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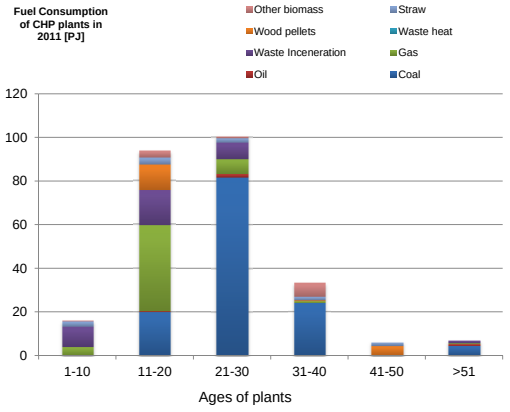
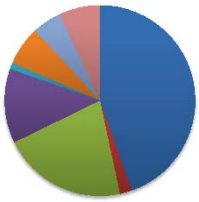
Ages and current plans for new capacities in CHP production





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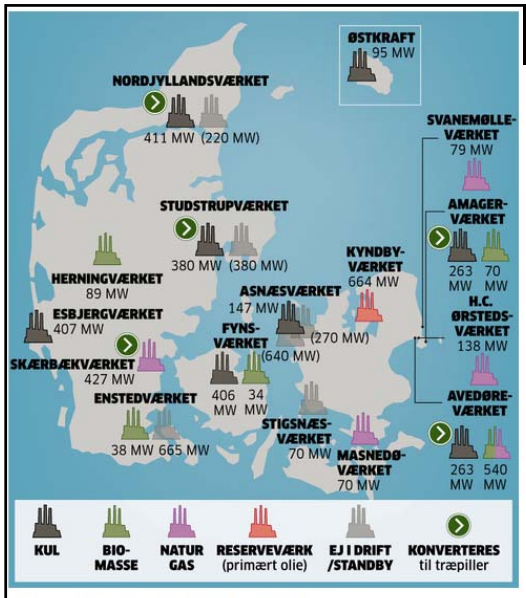


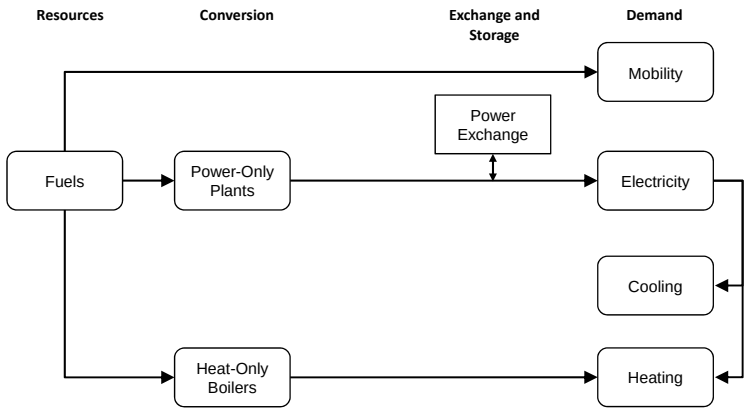
Fem store kraftværksblokke i drift skal konverteres helt eller delvis til træpiller over de næste fem-seks år. Samtidig lægger selskaberne en række blokke i mølpose eller sætter dem på standby, hvilket kan betyde, at der måske bare vil være tre deciderede kulkraftværker i regelmæssig drift i Danmark i 2020. Det er Enstedværkets store blok samt Stigsnæsværkets blok 2, som lægges i mølpose pr. 1. januar 2013. (Kilde: Dong Energy, Vattenfall og Energistyrelsen)

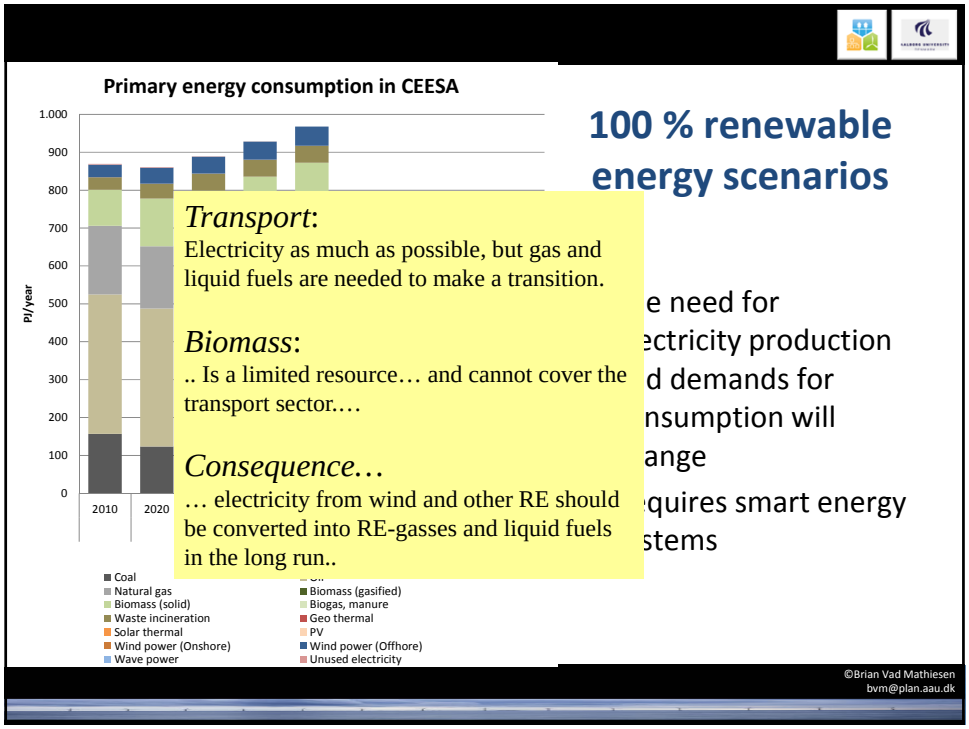
Reference:
Ingeniøren 12/6-2012

Plans for new power plants and CHP plants

- From coal steam CHP plants to biomass steam CHP plants?

Energy System 1.0





100 % renewable energy scenarios

Transport:
Electricity as much as possible, but gas and liquid fuels are needed to make a transition.

Biomass:
.. Is a limited resource… and cannot cover the transport sector.…

Consequence…
… electricity from wind and other RE should be converted into RE-gasses and liquid fuels in the long run..

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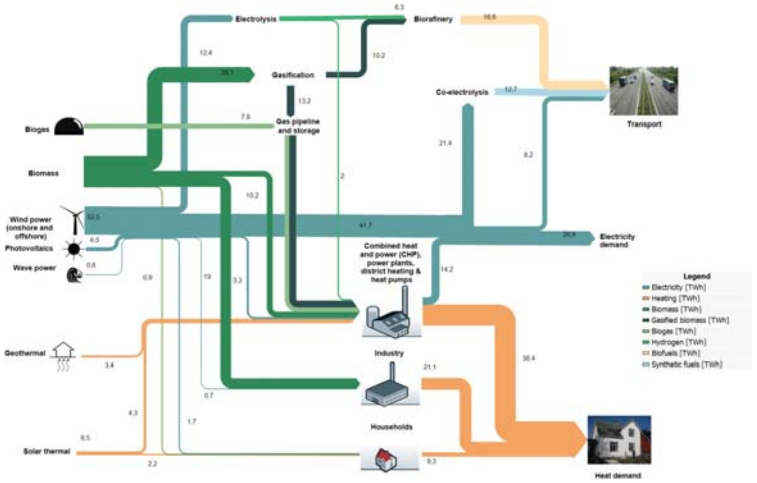
CEESA – smart energy system



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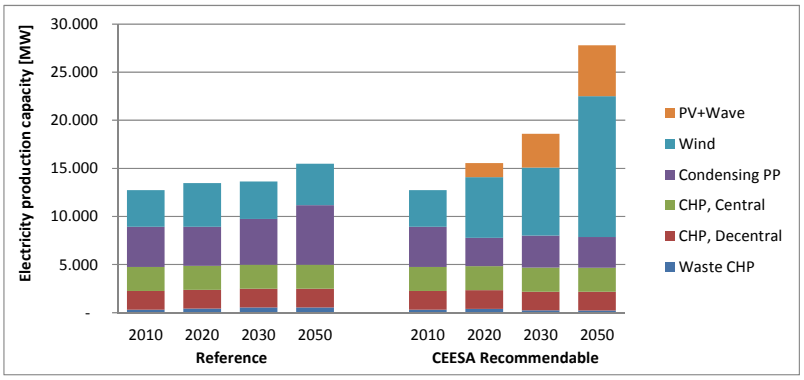
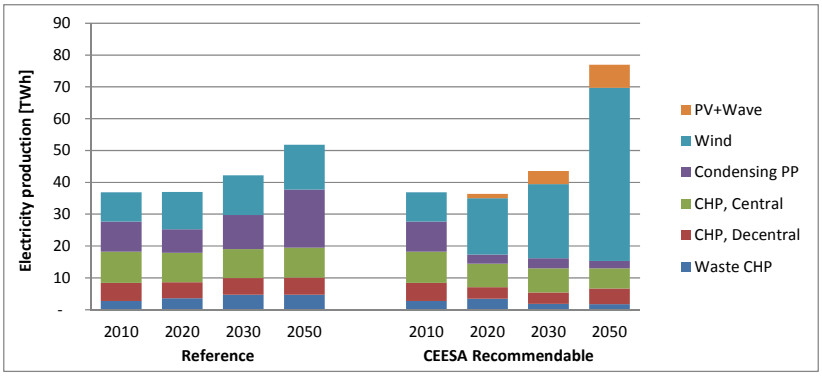
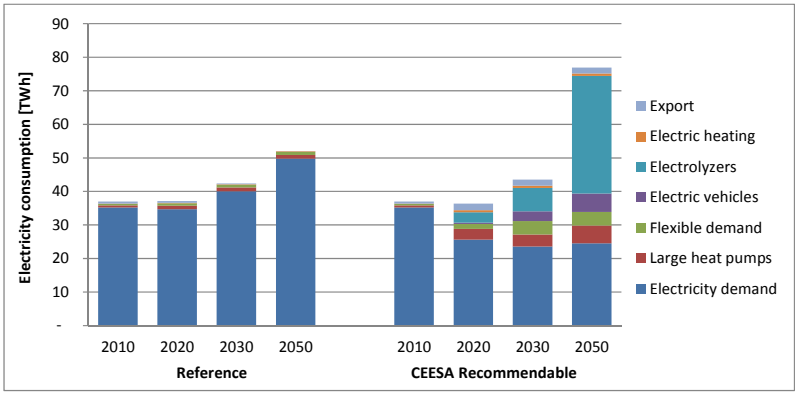
Potential development in electricity capacity



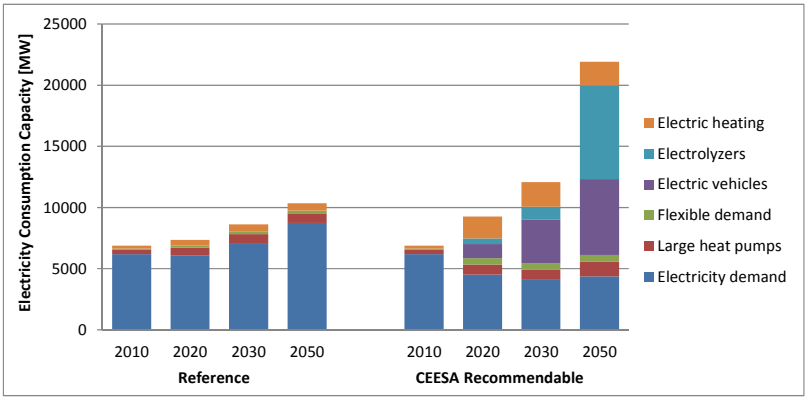
Potential development in electricity production



Potential development in electricity consumption



Potential development in electricity consumption capacity



What can we do on the production side?

- Larger gas turbines
  - 10% of full load pr. min
  - Good load efficiencies
  - Best efficiencies in base load
  - Quick start-up
  - From Natural gas to biogas and gasified biomass
  - Low investment costs
  - Fuel cells may eventually perform better.
- New demands for wind turbines
  - Can be used in the regulation power markets
  - +5MW/min/200MW or 2,5% incr./min of full load

Smart energy systems are crucial in 100% renewable energy systems

Electricity smart grids are only one part of this system. The scenarios rely on a holistic *smart energy system* including the use of:

- ***Heat storages*** *and district heating with CHP plants and large heat pumps.*
- ***New electricity*** *demands from large heat pumps and electric vehicles as storage options.*
- ***Electrolysers and synthetic liquid fuel*** for the transport sector, enabling energy storage in a dense liquid form;
- ***The use of gas storage and gas grids*** for biogas and syngas/methane

Flexible integration of electricity, heat, gas and transport
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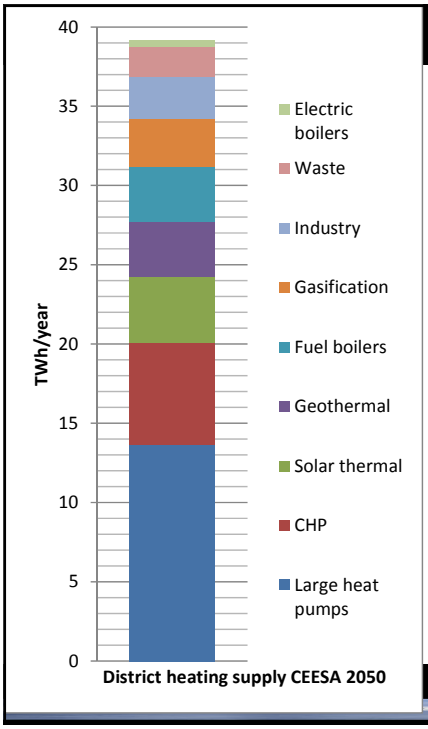
What can we do on the demand side?

- **Smart Electricity Grids** and infrastructure
  - Connects to storage with 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 infrastructure
  - connects electricity & heating sectors.
  - Enables thermal storage and heat losses in the energy system to be used.
- **Smart Gas Grids** and infrastructures
  - Connects the electricity, heating, and transport sectors. This enables gas storage to be utilised for creating additional flexibility. (Liquid fuel storages can also be utilised)



District heating supply in CEESA 2050

Conclusions

- Power plants and CPH plants need to change – but we need the same capacity
  - No need for base load plants
  - Flexibility is a key characteristic
  - Gas should be the focus
- Decisions made within the sector has implications 30-40 years into the future
- The consumption side will change and needs to be more flexible with twice todays electricity demand
- We need smart energy systems
- If district heating is not there in the future we need much more biomass (up to 30%)
- *Urgent need for investing in large scale heat pumps and flexible power plants*

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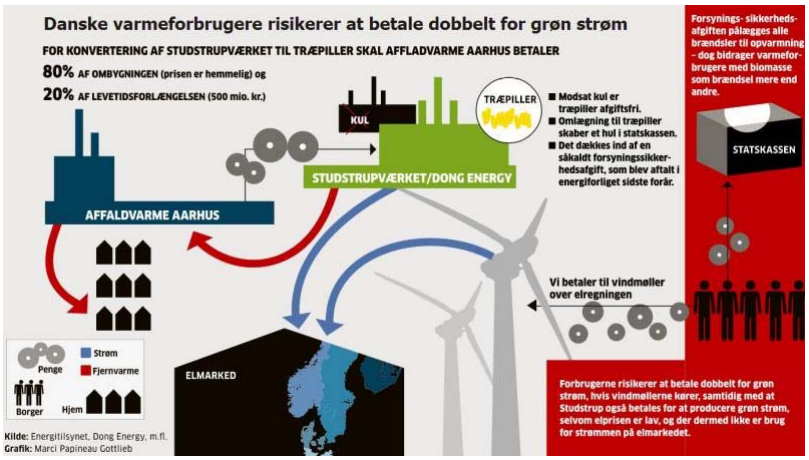


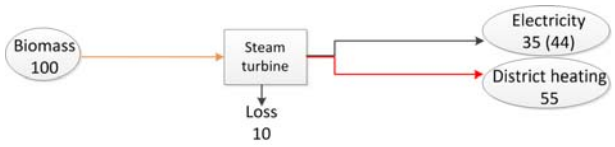
Challenges for the electricity supply

- **The long term - Security of supply:**
  - More renewable energy sources – less fossil fuels and biomass demand
  - The integration of the heat sector and the transportation sector increases the efficiency and the options to for storage and flexibilty
  - Between years and seasons
- **Medium to short timescale - Grid stability:**
  - Regulation power needs to be supplied from the demand and production side
  - Options to store and handle fluctuations has to be established
  - Demands should be flexible enough to hand fluctuations and plants should be able to handle changes in demands and in intermittent resources
  - From seconds to hours and over a few weeks
- **Short timescale - Emergency:**
  - Ensure short term power quality with fall outs and start up after fall-outs.

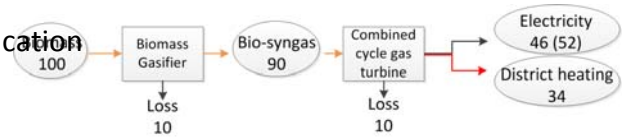
What can we do on the production side?

- Centrale dampkraftværker kan regulere 20-100% uden varmeproduktion og
  - Fra 50 til 90% kan der reguleres 4% af fuldlast pr. min. og
  - <50% og >90% kun 2% af fuldlast pr. min.
  - Slow start from cold
  - Traditionally for base load

1. Biomass CHP



2. Biomass gasification



3. Natural gas combined cycle