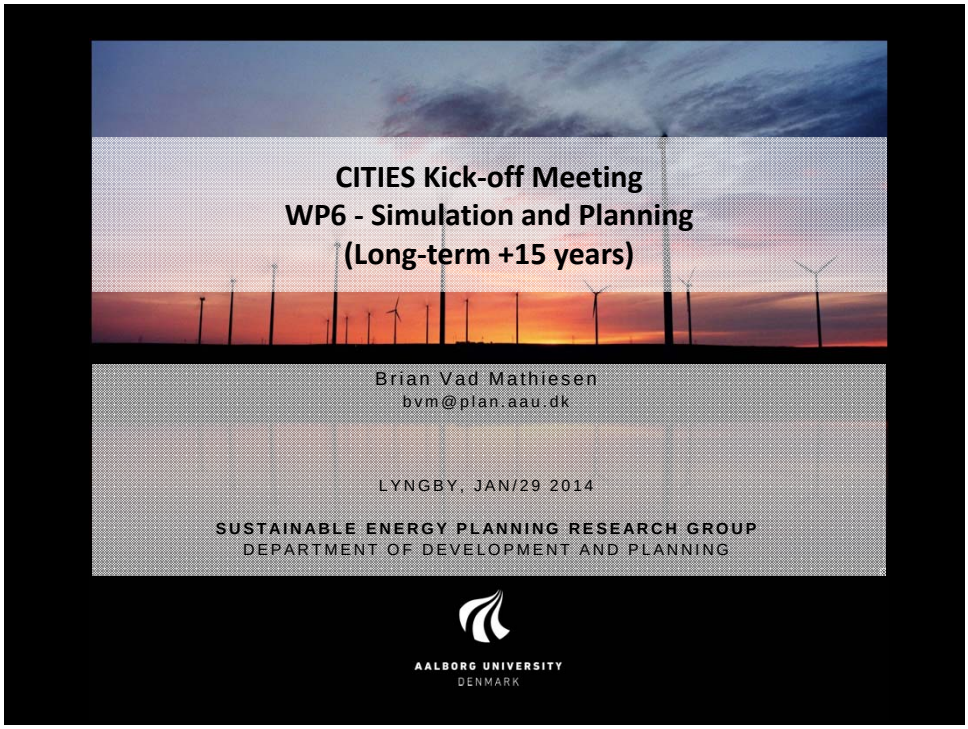


Scientific Objectives in WP6

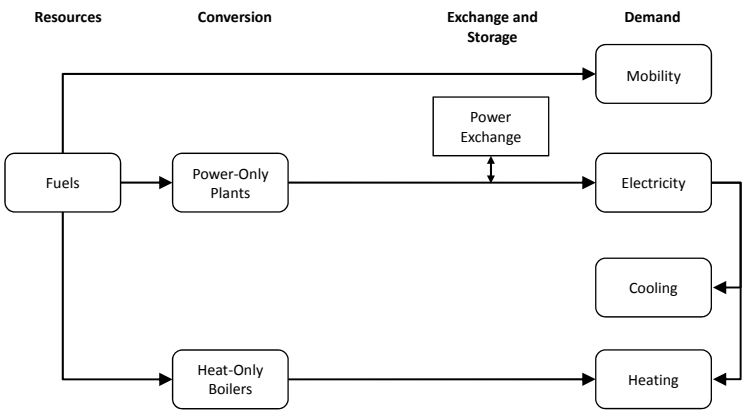
- Longer term energy planning scenarios and methodologies (+15 years) for identifying city challenges
- Development of an integrated energy system modelling platform
- Focus particularly on the role of the city level compared to a regional, national or international level
- Information from other WPs will be used to describe the resources within the system on a range of scales (geographic/temporal/complexity)

1/30/2014

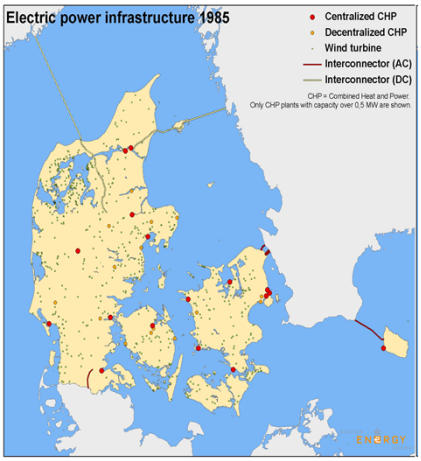
Scientific Objectives in WP6

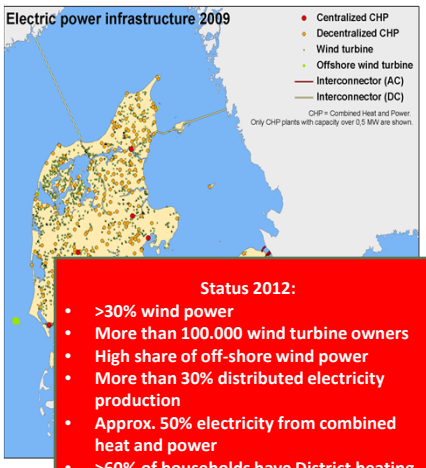
- WP6 creates holistic CITIES implementation scenarios and suggestions for potential future market and regulation structures for policy priorities
- These are based on the technical scenarios and other WPs the institutional challenges and barriers are identified and new proposals for public regulation to overcome these are provided.

Energy System 1.0



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





Status 2012:

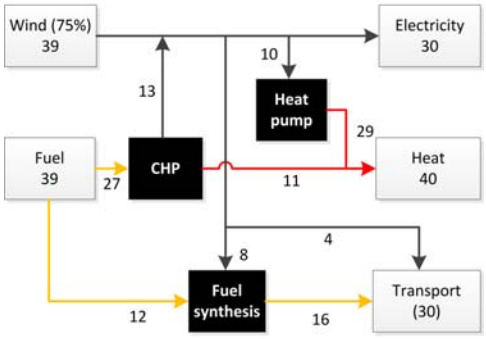
- **>30% wind power**
- **More than 100.000 wind turbine owners**
- **High share of off-shore wind power**
- **More than 30% distributed electricity production**
- **Approx. 50% electricity from combined heat and power**
- **>60% of households have District heating**
- **Large heat savings**
- **Constant Primary energy supply**

Technical and institutional 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 handle fluctuations and power 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.

BUT…..
What are the technical and public regulation challenges in a 100% renewable energy system?

Smart energy system with 75 % wind and syn-fuels

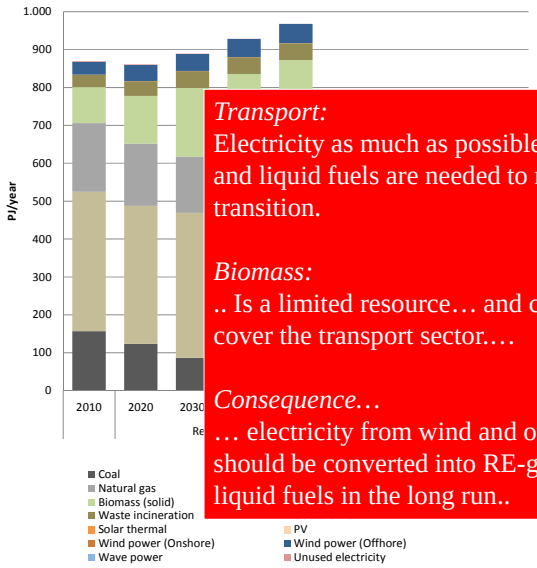


We want to decrease the use of fossil fuels but:

1. *The current system is extremely flexible…*
2. *We cannot replace these with biomass only (in e.g. transport)…*
3. *We need to use intermittent renewable ressources!*

7

Primary energy consumption in CEESA



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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Solution

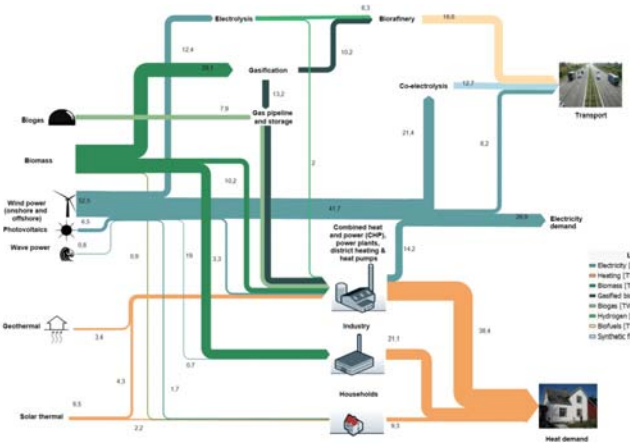
Smart energy systems are crucial in 100% renewable energy systems

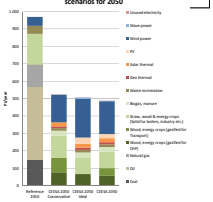
A cross-sectoral and coherent energy system solution

- **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.

CEESA

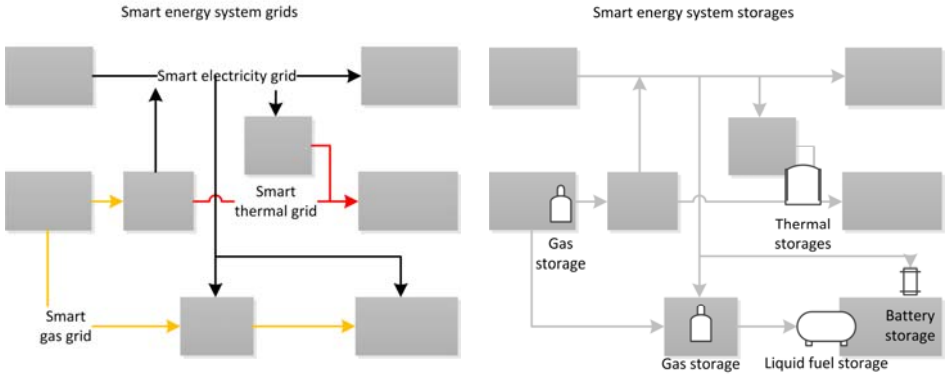
CEESA – smart energy system



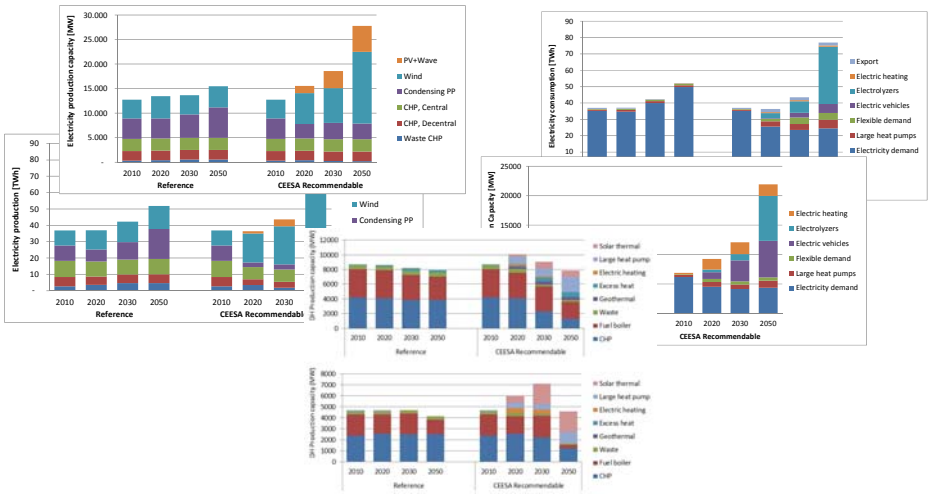


CEESA

Grids and storages in Smart Energy Systems



The system capacities and production for electricity and heat is significantly different than today – and transport is included (Electric Vehicles and synthetic fuels)



Challenges

- What are the role of Cities?
- How do we ensure a holistic coherent energy system focusing on all sectors?
- What are the long term options for public regulation focusing on all sectors of the energy systems?

Decision support tools that enable long term 100% renewable energy and short-term decision support

Activities in WP6

- **WP6.1:** Develop a simulation platform to support decision support at the city level enabling modelling from the city level to the national level. This requires tool development to identify the impact of aggregation on planning outcomes form the city level to the national or EU-level (Resources: AAU-VIP, AAU-PhD1).
- **WP6.2:** Using the simulation platform to investigate the differences in outcomes when the system is modelled at the aggregate and detailed levels (considering geographic, temporal and complexity scales) different long term energy system scenarios for cities and at levels above will be created.
  (Resources: AAU-VIP, AAU-PhD1, DTU-Man-VIP, inputs from other WPs)
- **WP6.3:** Creation of public regulation scenarios for long-term holistic markets, aggregating cross-sectorally solutions in cities (transportation, electricity, gas, heating, cooling, savings) calls for the identification of new institutional, organizational and market implementation strategies. Such scenarios are based on the technical scenarios (WP6.1) and inputs from other WPs
  (Resources: AAU-VIP AAU-PhD2 in WP4, DTU-Man-PhD)

PhDs in WP6 (and links)

AAU-PhD1-project: Establishment of modeling platform based on the EnergyPLAN model (Supervisor Henrik Lund, EMD International as co-supervisor)

The implementation of input from the previous WPs in order to design long-term scenarios based on detailed energy systems analyses calls for further developments of existing tools and methodologies. This PhD project will create a modeling platform for such activities based on the use of the EnergyPLAN model. Moreover the project will further de the development of theories and methodologies aligned with the use of models such as EnergyPLAN. The modeling platform will be designed as a help-tool which will be able to execute multiple analyses of individual cities in a coherency in which such cities is analyses as part of the overall national system. The complete energy system, including all grid infrastructures (electricity, heating/cooling, gas and various biomass and hydrogen conversions) as well as all sectors such as heating, electricity, transport, industry etc. is in focus.

DTU-Man-PhD1: Methodologies and tools for long term energy planning in cities (Supervisor Kirsten Halsnæs, Henrik Lund as Co-supervisor)

Development of a city based long term planning model for smart energy systems reflecting scenarios for strategic smart energy city development and for private energy market actors. The model will be developed based on state of the art existing energy systems models, but new elements and methodologies will be developed to reflect short- and medium modelling of intelligent energy systems in other CITIES WP's. Alternative city development and policy priorities will be assessed and tools for scaling and visualization and associated user interfaces to aid integrated system optimization in time and space and across different energy suppliers and consumer groups will be developed and coordinated with WP7.

WP4 - AAU-PhD-project: Institutional strategies for holistic CITIES scenario implementation (Supervisor Frede Hvelplund)

The implementation of long-term holistic solutions in cities including transportation, electricity, gas and heating and cooling calls for the identification of new institutional and organizational implementation strategies. Based on the technical scenarios performed in WP6 and in other part of the project this PhD will focus on the institutional challenges and barrier as well as the identification of proposals to overcome these. This involve cross-sectoral organization between different supply systems as well as institutional set-ups to overcome the barriers to implement suitable balances between on the one hand implementation of demand site reductions and management and on the other side production management. One important aspect will be the participation of City production and consumption units in the coherent energy markets.