

THE ROLE OF LARGE POWER PLANTS IN RENEWABLE ENERGY SYSTEMS

4DH SEMINAR - 13TH MARCH 2014

RASMUS LUND – DEPARTMENT OF DEVELOPMENT AND PLANNING



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Purpose of the study

- Part of a project in cooperation with Copenhagen Municipality
- To give perspectives on the CPH 2025 Climate Plan towards 2050
- The purpose of power plant analysis to assess the role of large CHP-plants in renewable energy systems
- To give decision support for the energy planning in the municipality for future choice of power plants

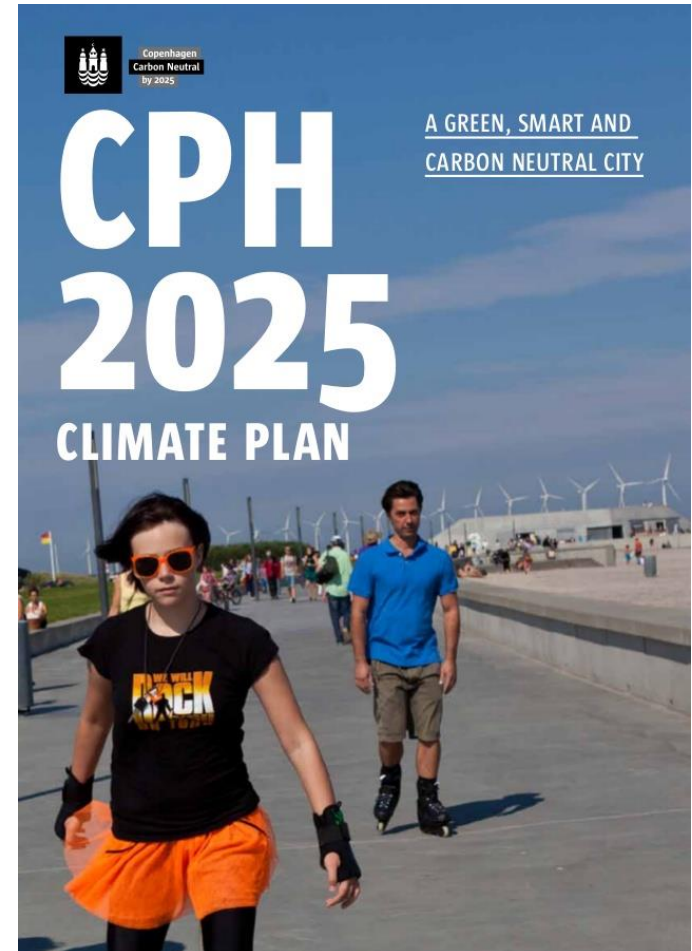
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CPH 2025 - The Climate Plan

- Goal of being CO₂-neutral in 2025
- Excess wind production to compensate for fossil fuel use in transport
- Heat and power production on biomass
- Electric vehicles, hydrogen and use of biofuels in transport
- Development of a long term strategy for 100% RE in 2050



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Methodology

- The analysis is taking its point of departure in the CEESA 2050 Recommendable scenario
- A 100% renewable energy scenario for Denmark
- Biomass fired power plants is suggested in the CPH 2025 Climate Plan
- Analysis of different scenarios in EnergyPLAN
- Comparison of CHP plant types:
 1. Combined Cycle Gas Turbine
 2. Circulating Fluidized Bed
 3. Advanced Pulverized Fuel
- Change of the type of power plant in central CHP areas

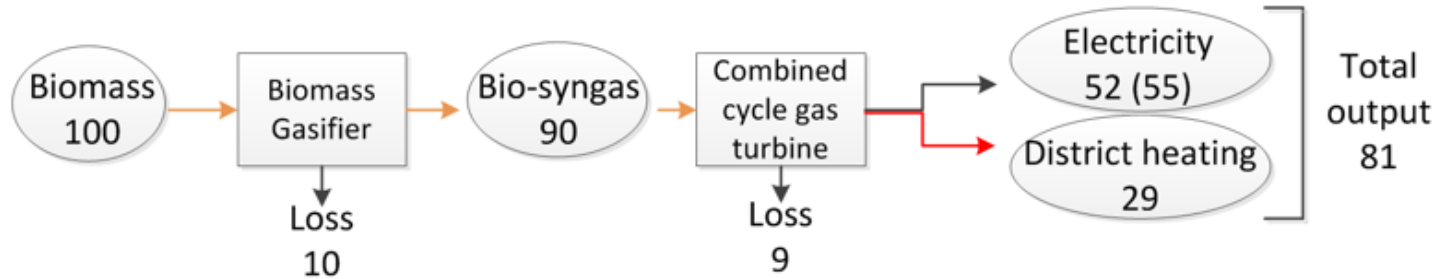
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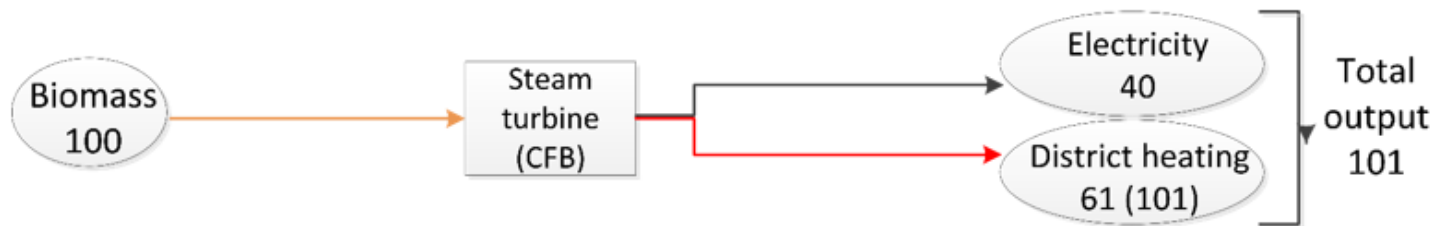
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Scenarios

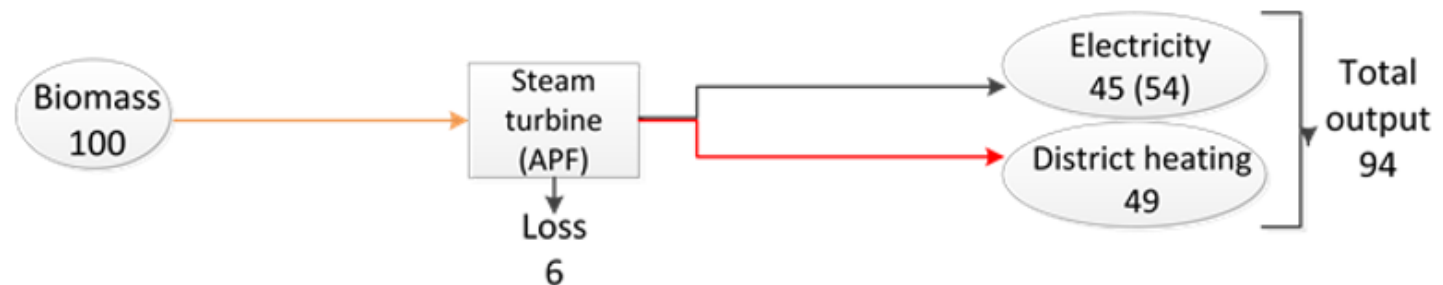
Biomass which is Gasified and then used in a Gas Turbine



Biomass fired CFB boiler driving a steam turbine



Biomass fired APF boiler driving a steam turbine



Technology Assumptions

Combined cycle gas turbine plant

- Reference
- Fully flexible operation in hourly resolution

Circulating Fluidized Bed plant

- Assumed to operate base load in heating season
- For condensing power production CCGT's are applied

Advanced Pulverized Fuel plant

- Fully flexible operation in hourly resolution
- Minimum load: 20% of total capacity

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Results

| Annual values | Combined cycle gas turbine | Steam turbine (CFB) | Steam turbine (APF) |
|-------------------------------------|-------------------------------|------------------------|------------------------|
| Total scenario costs (BDKK) | 147 | 148 | 156 |
| Biomass consumption (TWh) | 67 | 75 | 68 |
| Excess electricity production (TWh) | 1.75 | 4.41 | 2.75 |

- Both CFB and APF plants utilises less production from large heat pumps because of the higher heat production and lower flexibility
- Both alternatives uses more biomass on annual basis
- CCGT is lowest on the three main parameters

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Conclusions

- In renewable energy systems large power plants should have high flexibility of electricity and heat production
- Utilisation of gaseous fuel for power plants allow for increased flexibility in the CHP unit and in the fuel production
- Application of biomass fired CFB or APF CHP units will increase the annual
 1. total energy system costs,
 2. biomass consumption and
 3. excess electricity

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QUESTIONS

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