Business from technology

Feasibility of Bio-CCS in CHP production - *A Case Study of Biomass Co-firing Plant in Finland*

SECOND INTERNATIONAL WORKSHOP ON BIOMASS & CARBON CAPTURE AND STORAGE

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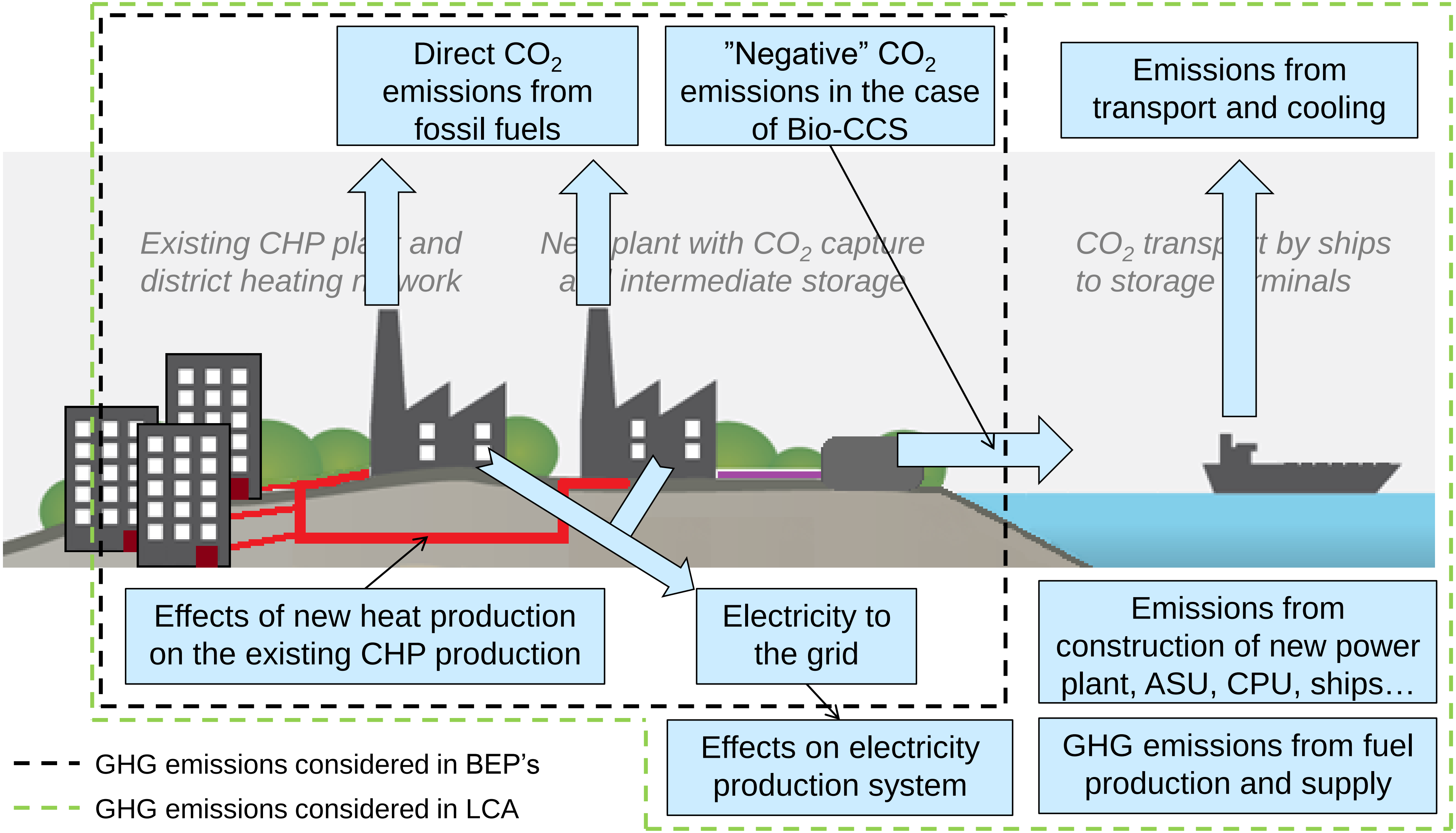
Introduction

- A study where new (“greenfield”) CHP plant with and without CCS is applied to existing CHP environment
- The study consists of several case studies including different fuel mixes and costs for biofuels
  - Dedicated biomass plant, 50/50 biomass/peat co-firing and dedicated peat plant
- The economics of CCS were evaluated from investor’s (local energy company) point of view including the effects on existing energy system
- Results are presented as company’s profits in different cases with varying prices for electricity and CO_2 emission allowances in EU-ETS. In addition, break even prices (BEP’s) for CO_2 emission allowances where CCS turns feasible over the reference case are presented

Studied system and selected boundaries



Case descriptions

- In the reference case the existing CHP-plant produces district heat and back-pressure electricity with maximum load (utilization rate 6000 h/a) and number of heavy-oil fired district heating plants provide the additional heat needed within the system.
- In other cases existing CHP-plant and the new plant produce district heat and back-pressure electricity with given utilization rates and condensing electricity is produced at the new plant depending on the given utilization rates.
- In every case the existing plant is fired with 50 % peat and 50 % biomass. The heat consumption in the network is 1400 GWh/a.
- The studied fuel-shares with and without CCS for the new plant consisted of pure biomass (consisting of logging residues at average moisture of 50 %), pure peat (at average moisture of 45 %), and biomass-peat co-firing and these options were compared in the same operational environments.

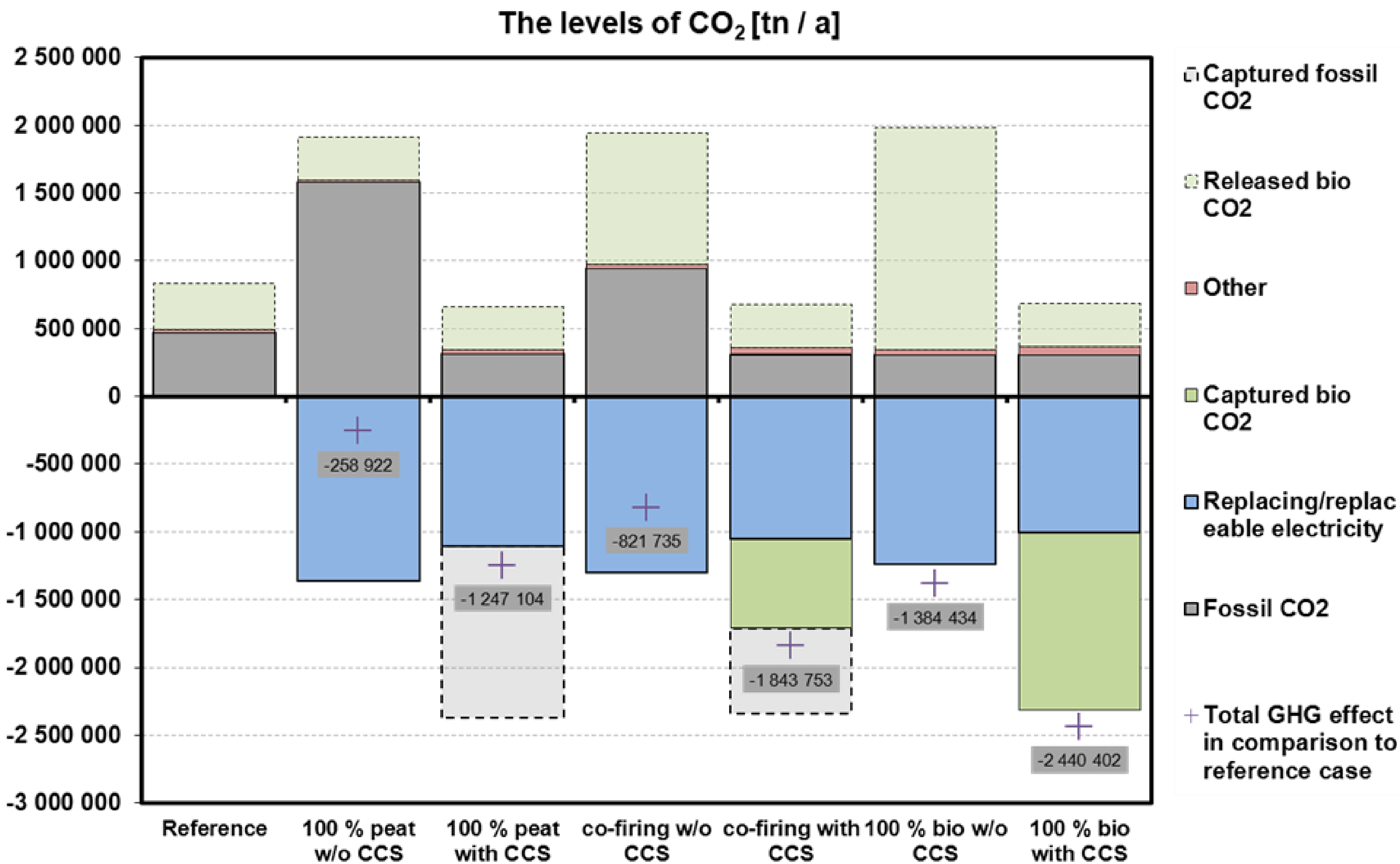
The studied cases are named as follows

1. **Reference**: No new plant.

2. **100 % peat w/o CCS**: The new plant is fired with 100 % peat and it runs without CCS.
3. **100 % peat with CCS**: The new plant is fired with 100 % peat and it runs with CCS.

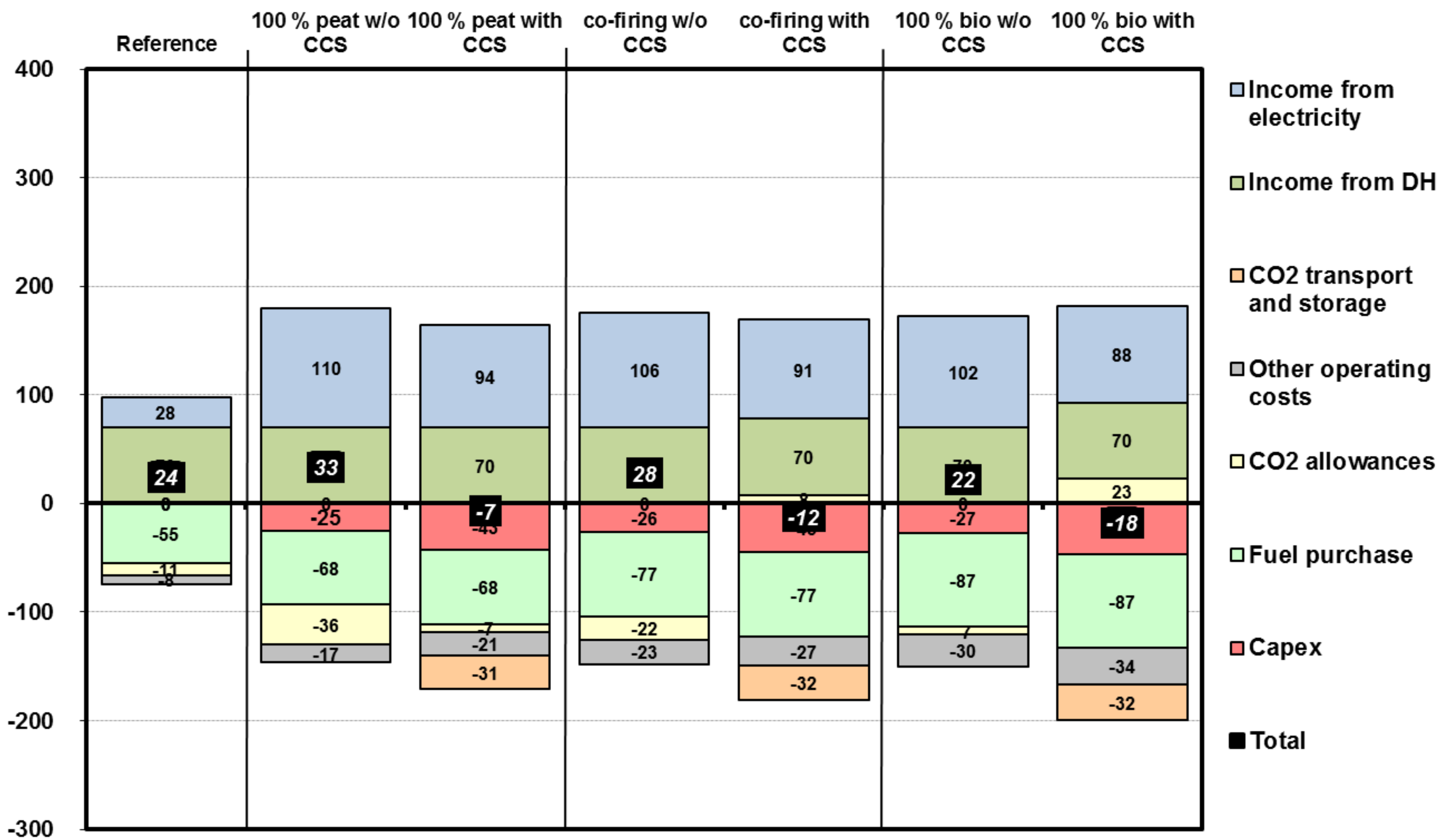
4. **co-firing w/o CCS**: The new plant is fired with 50 % peat and 50 % biomass and it runs without CCS.
5. **co-firing with CCS**: The new plant is fired with 50 % peat and 50 % biomass and it runs with CCS.

6. **100 % bio w/o CCS**: The new plant is fired with 100 % biomass and it runs w/o CCS.
7. **100 % bio with CCS**: The new plant is fired with 100 % biomass and it runs with CCS.

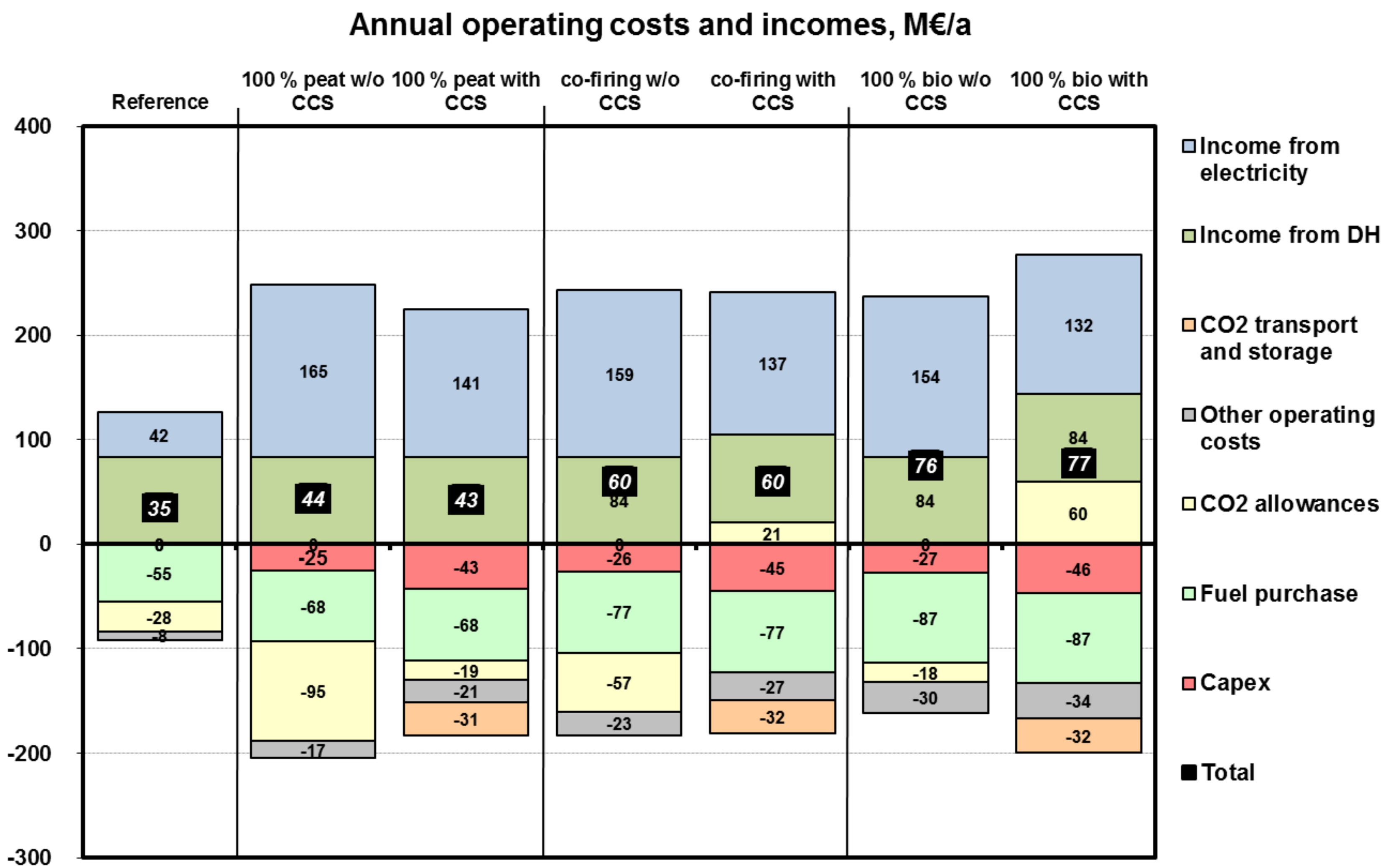


Peak load utilisation rate of new plant 7000 h/a and existing plant 5500 h/a. Replaced fuel in electricity generation system (marginal production) is assumed to be coal.

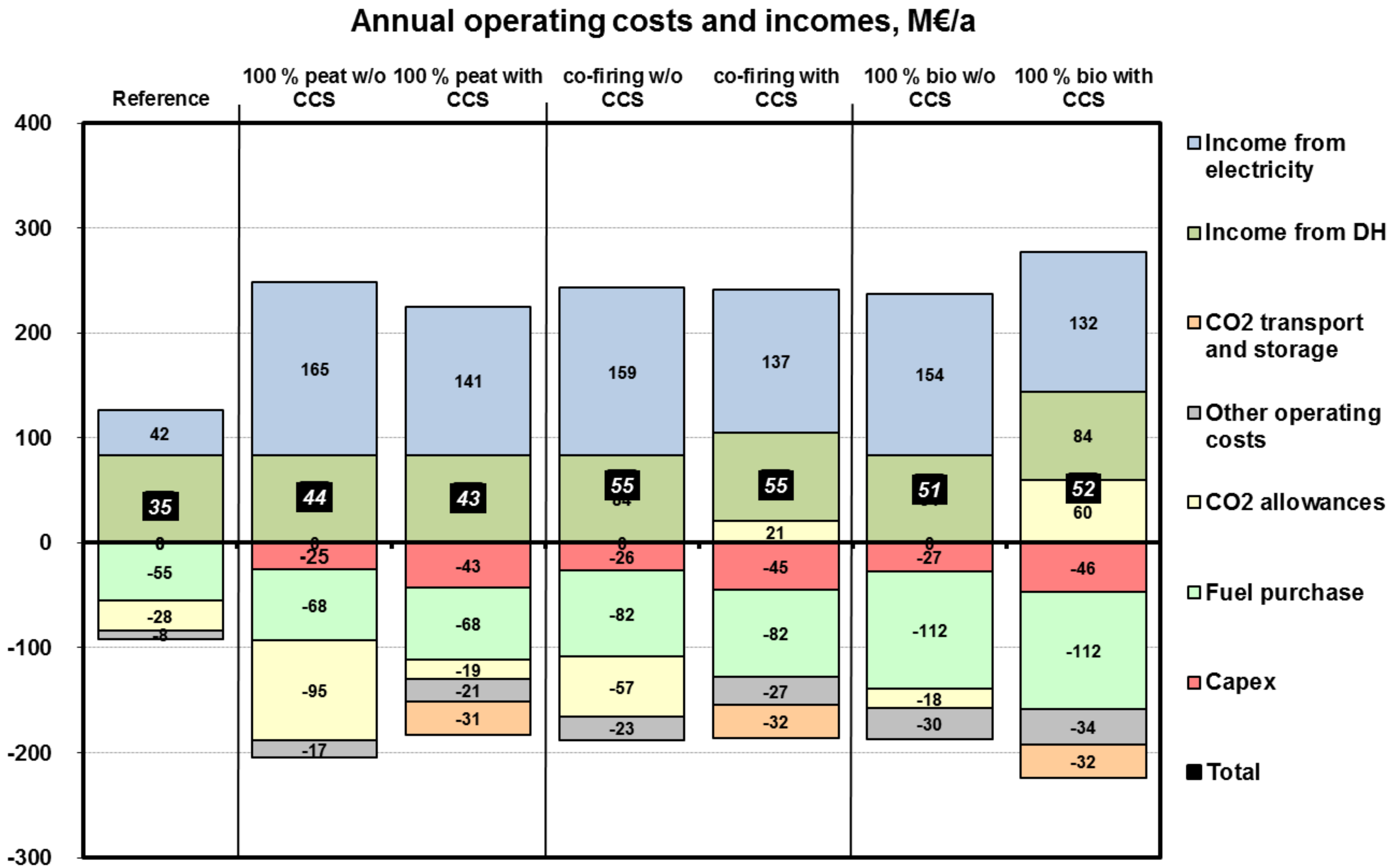
Annual operating costs and incomes, M€/a



EU-ETS price 23 €/tn,CO_2, electricity 60 €/MWh, DH 50 €/MWh, peat 12 €/MWh and biomass 18 €/MWh

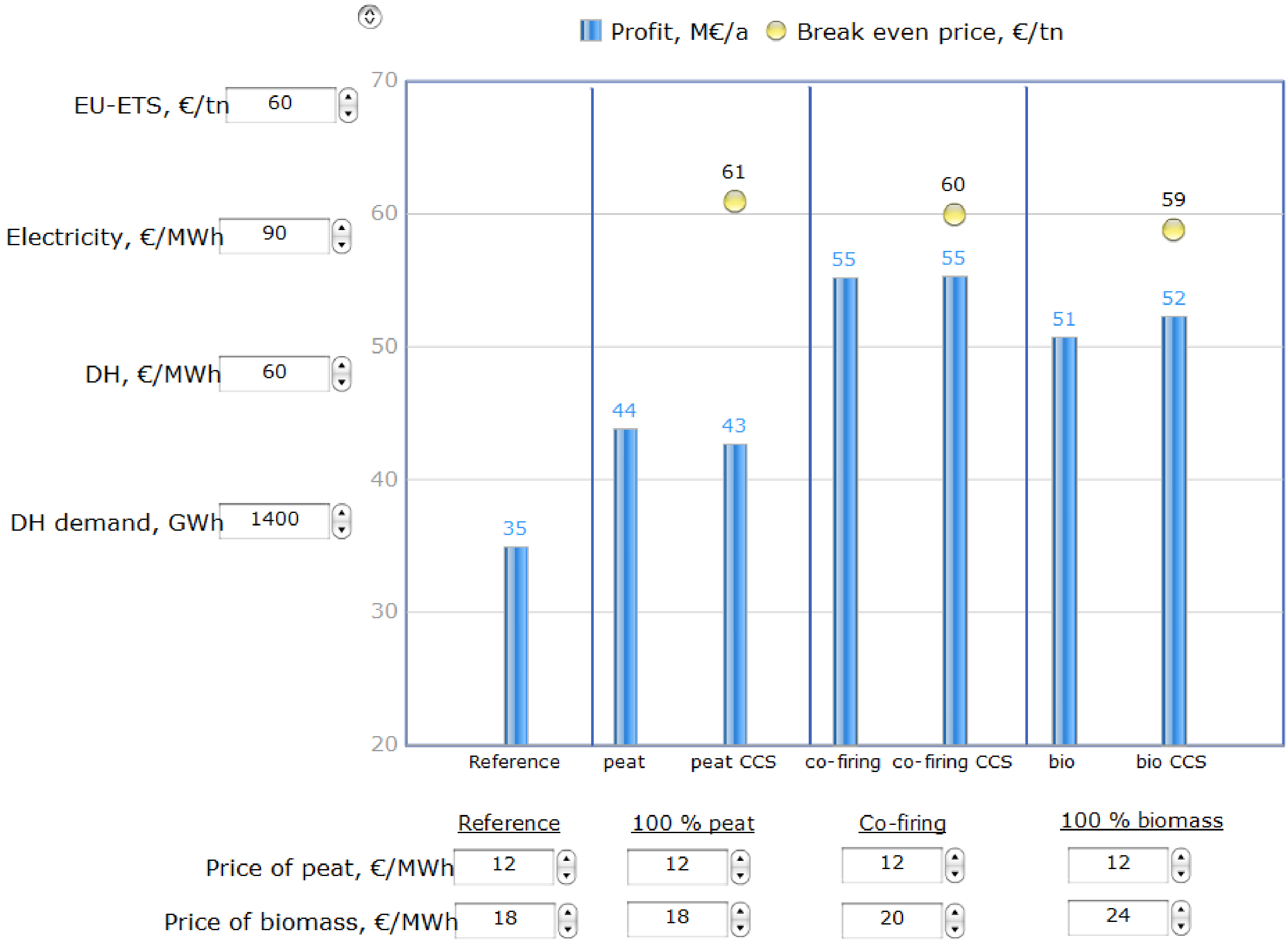


EU-ETS price 60 €/tn,CO_2, electricity 90 €/MWh, DH 60 €/MWh, peat 12 €/MWh and biomass 18 €/MWh



Prices as previous, but biomass prices increase as a function of demand from 18 to 20 (co-firing) and 24 (100% biomass) €/MWh

Profit and break even prices (BEPs)



Conclusions (1/2)

- The results showed that the costs for CCS are heavily dependent not only on the characteristics of the facility and the operational environment but also on the chosen system boundaries and assumptions.
  - Significant improvements can be achieved by CHP, especially if condensing mode operation to achieve high peak load hours during low heat demand is possible.

- In the case of Bio-CCS the investment and operational costs (excluding CO_2 emission allowances) are probably higher than in the case of fossil fuels. However, increasing CO_2 prices benefit Bio-CCS faster than other CCS options.

- Feasibility of Bio-CCS is strongly dependent on the CO_2 allowance price level shift into biomass prices. In general, feasibility of CCS is also dependent significantly on the CO_2 allowance price level shift into electricity price.

Conclusions (2/2)

- The current EU ETS do not recognize negative emissions, and thus no economical incentive exist for capturing CO_2 from biomass installations.
- In Finland, as far as biomass and biogenic emissions are concerned in power plants, most potential and straight forward applications would be in facilities co-firing biomass with peat.
- Biomass firing plants are generally of moderate size and often situated in central Finland, which makes them less attractive due to large distances to potential ship terminals.
- In the near future particularly large, new and flexible combined heat and power (CHP) plants, which can burn coal, biomass or peat, are seen as promising candidates for CCS in Finland.

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