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LCA as an ecodesign tool for production of electricity, including carbon capture and storage - a study of a gas power plant case with post-combustion CO2 capture at Tjeldbergodden

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This presentation

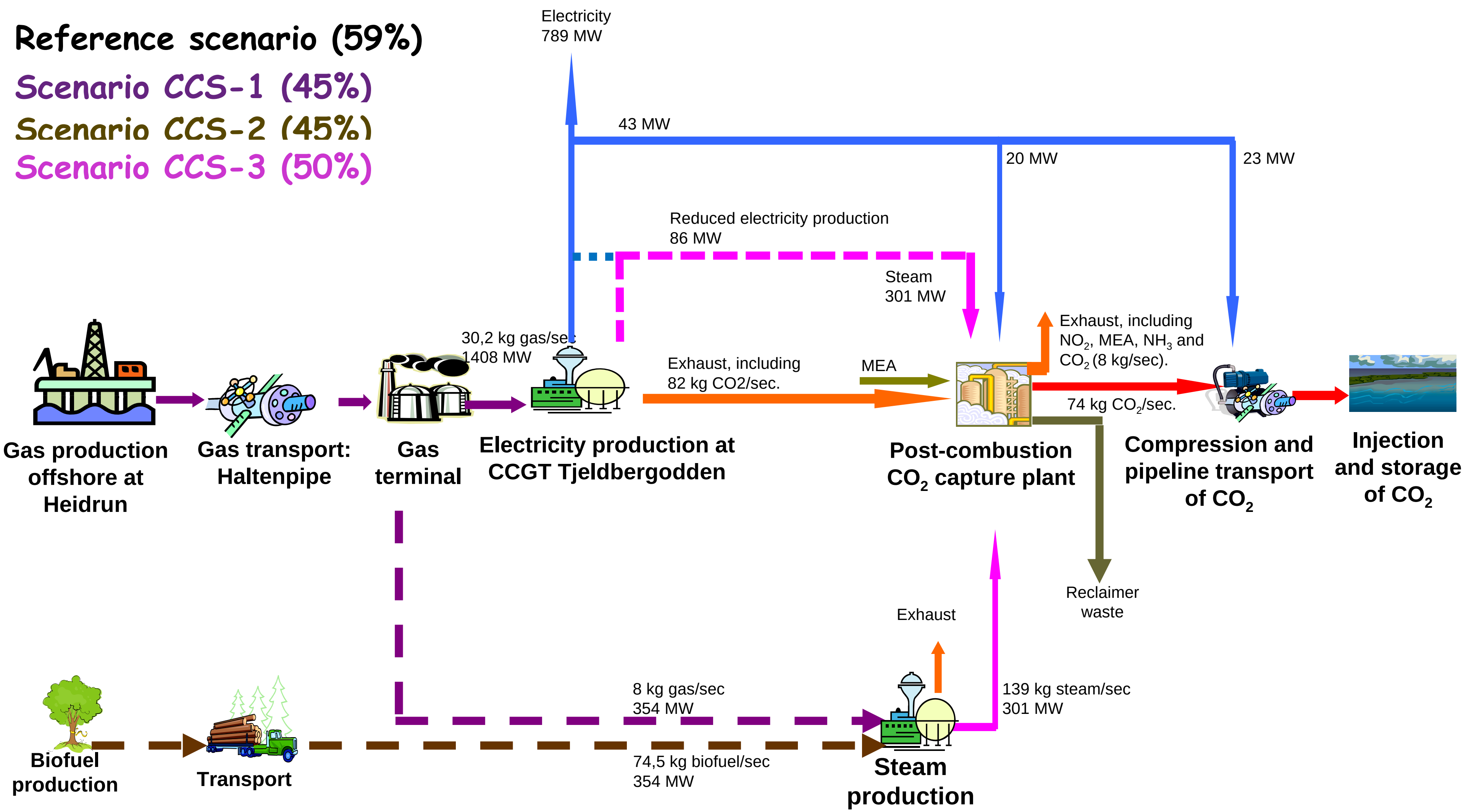
- The EcoDesign Model
- Results
  - Characterisation
  - Relative impacts of the CCS scenarios
  - The study also included normalisation and weighting, but this will not be presented here (time constraints).
- Summary and Conclusions

Functional unit

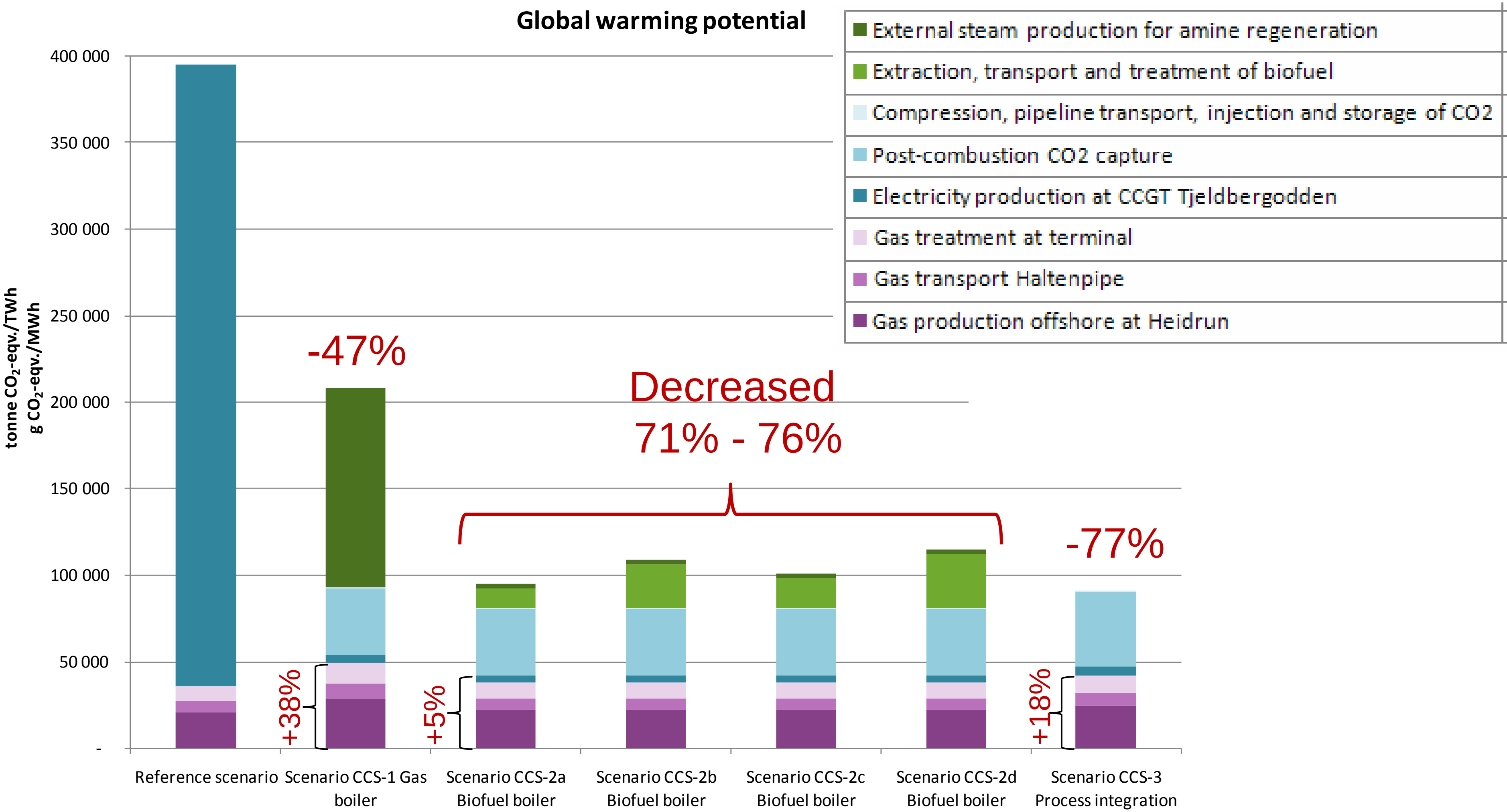
1 TWh electricity generated at Tjeldbergodden gas power plant and delivered to the grid.

System descripton; flowsheet

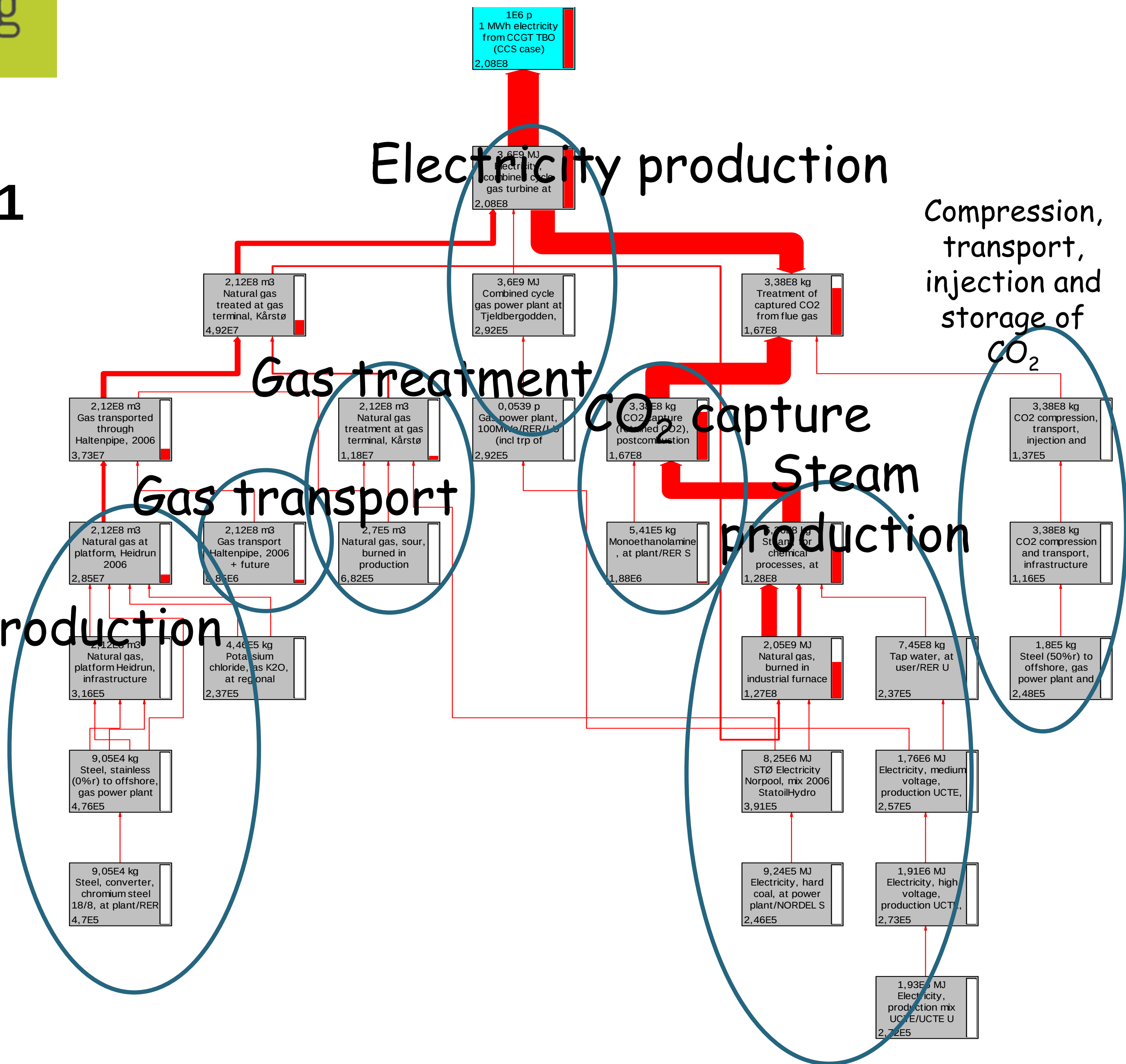
Reference scenario (59%)
Scenario CCS-1 (45%)
Scenario CCS-2 (45%)
Scenario CCS-3 (50%)



Characterisation results



LCA tree for scenario CCS-1 Gas boiler



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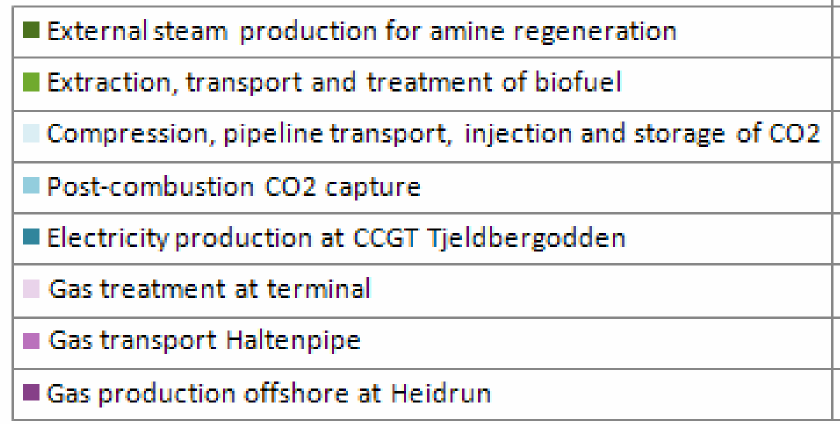
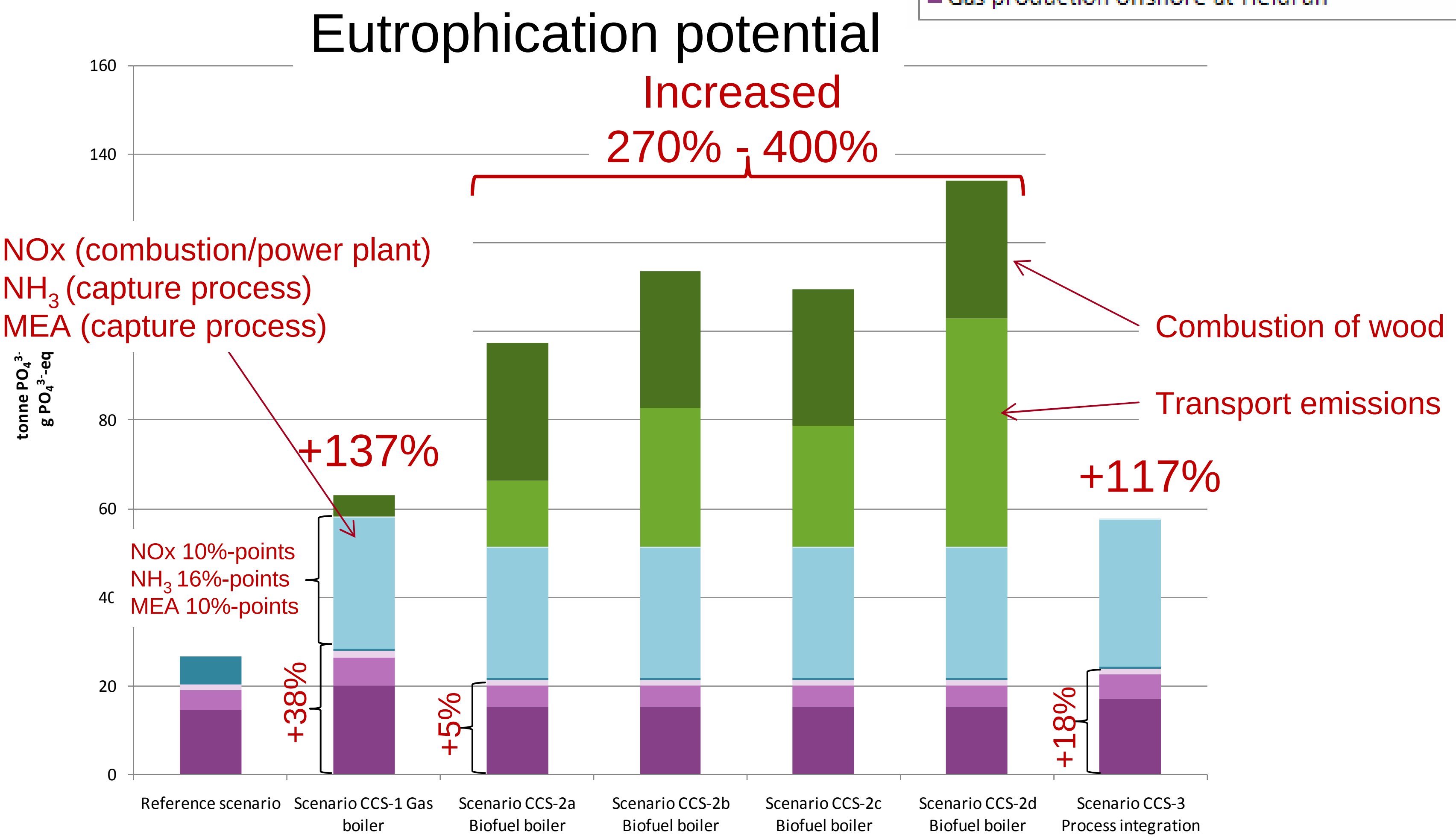
Characterisation results, *cont.*





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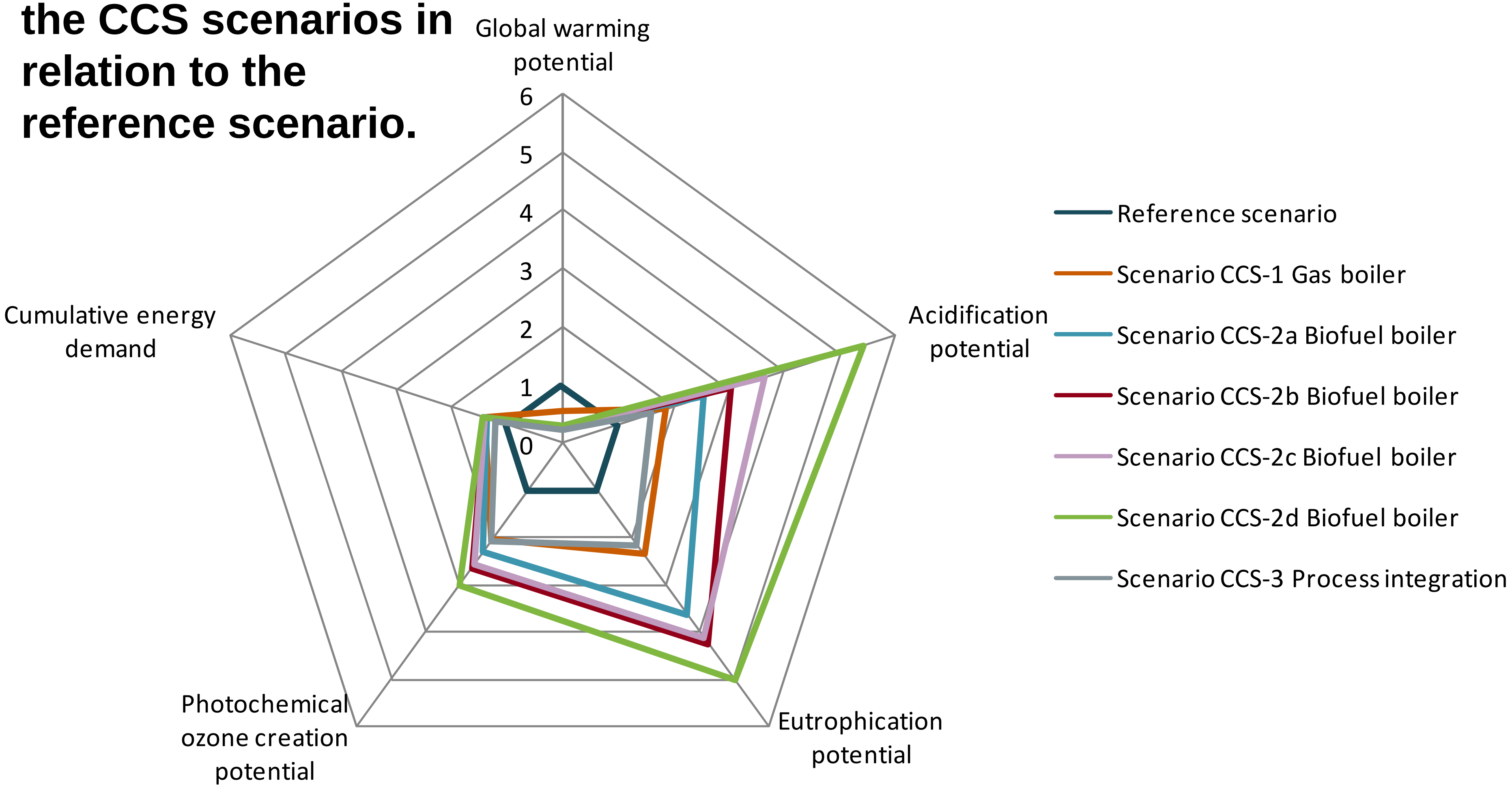
Summary of the characterisation results

Relative impacts of the CCS scenarios in relation to the reference scenario.



Summary and Conclusions

- The CCS scenarios have reduced impacts for the global warming potential category only. However, CCS-3 has the best weighting result of all the scenarios analysed (EDIP/UMIP, EPS 2000 and IMPACT 2002+ methods)
- Storing one tonne of CO_2 does not equal one tonne of CO_2 avoided (CO_2 avoidance efficiency 55% - 89%).
- Regarding GWP: The best CCS scenario is CCS-3 (process integration).
- For the other impact categories: The 'least bad' CCS-scenario is scenario CCS-3 (process integration).
- Infrastructure is generally insignificant for all scenarios. Compression, pipeline transport, injection and storage of CO_2 has also almost negligible impacts for all of the impact categories analysed.

EcoDesign Conclusions

- One obvious way to reduce the environmental effects from the CCS system is to reduce:
  - the efficiency penalty by reducing the energy consumption of CO_2 capture,
  - the emissions of MEA, ammonia and acetaldehyde.
- It is still important to find more optimal design options. For the MEA process focus should be on the CCS-3 scenario, since this scenario has proved to be the best of the CCS scenarios analysed.
- This study has chosen not to include impact categories concerning toxic effects due to the large uncertainties in the input data material. The weighting results and the fact that the degradation products from MEA are not yet fully known, except that they could have toxic effects, indicate that toxicity should be stronger focused in the data gathering of future analysis of CCS systems.

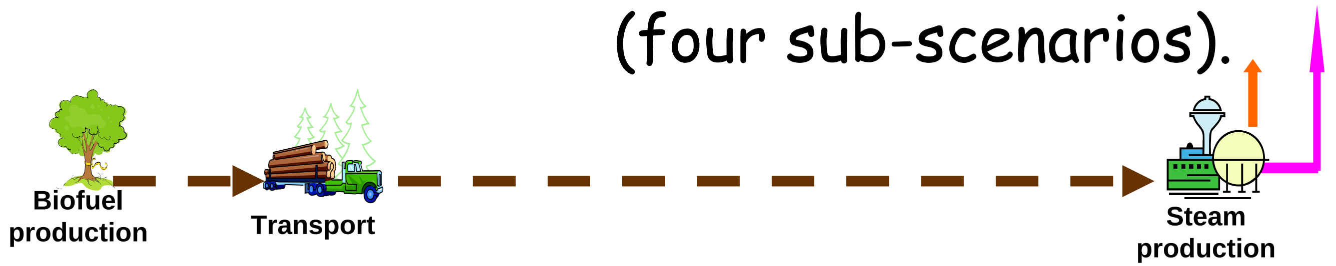
Thank you for your attention!

Further information if needed for questions

System descripton; scenarios

Reference scenario	Gas power plant without CCS.
Scenario CCS-1	Gas power plant with CCS based on post-combustion CO_2 capture using MEA absorbtion, with a **separate gas fuelled steam boiler** for amine regeneration.

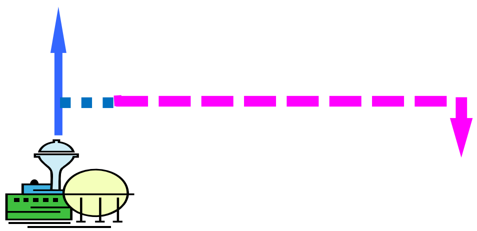
- Scenario CCS-2 Gas power plant with CCS based on post-combustion CO_2 capture using MEA absorbtion, with a **separate biofuelled steam boiler** for amine regeneration (four sub-scenarios).



Scenario	Country	Transport mode and distance	Reference/comment
CCS-2a	Norway (100% collection rate)	Lorry 96 km	Distance from forest to port/reloading in Norway. Calculated for alternative 5 (Skogn) by Brekke et al. (2008).
		0 km	Distance from port/reloading in Norway to biofuel boiler at Tjeldbergodden. Calculated for alternative 5 (Skogn) by Brekke et al. (2008).
CCS-2b	Norway (50% collection rate)	Lorry 303 km	Distance from forest to port/reloading in Norway. Calculated for alternative 5 (Skogn) by Brekke et al. (2008).
		0 km	Distance from port/reloading in Norway to biofuel boiler at Tjeldbergodden. Calculated for alternative 5 (Skogn) by Brekke et al. (2008).
CCS-2c	The Baltic states	Lorry 60 km	Distance from forest to port/reloading in the Baltic states. Calculated for alternative 5 (Skogn) by Brekke et al. (2008).
		Ship 2210 km	Distance from port/reloading in the Baltic states to biofuel boiler at Tjeldbergodden. Calculated for alternative 5 (Skogn) by Brekke et al. (2008).
CCS-2d	Canada	Lorry 100 km	Distance from forest to port/reloading in Canada/Halifax. Calculated for alternative 5 (Skogn) by Brekke et al. (2008).
		Ship 5320 km	Distance from port/reloading in Canada/Halifax to biofuel boiler at Tjeldbergodden. Calculated for alternative 5 (Skogn) by Brekke et al. (2008).

- Scenario CCS-3

Steam for amine regeneration is delivered from the low-pressure steam turbine in the power plant (**process integration**).



Electricity production at CCGT Tjeldbergodden

The thermal work of the power plant is reduced when low pressure steam is withdrawn.

Total amount of steam needed to regenerate amines: 301 MW.

Reduction of electricity delivered to the grid: 86 MW (from 789 MW to 703 MW).