

Feasibility of CCS at an integrated steel mill

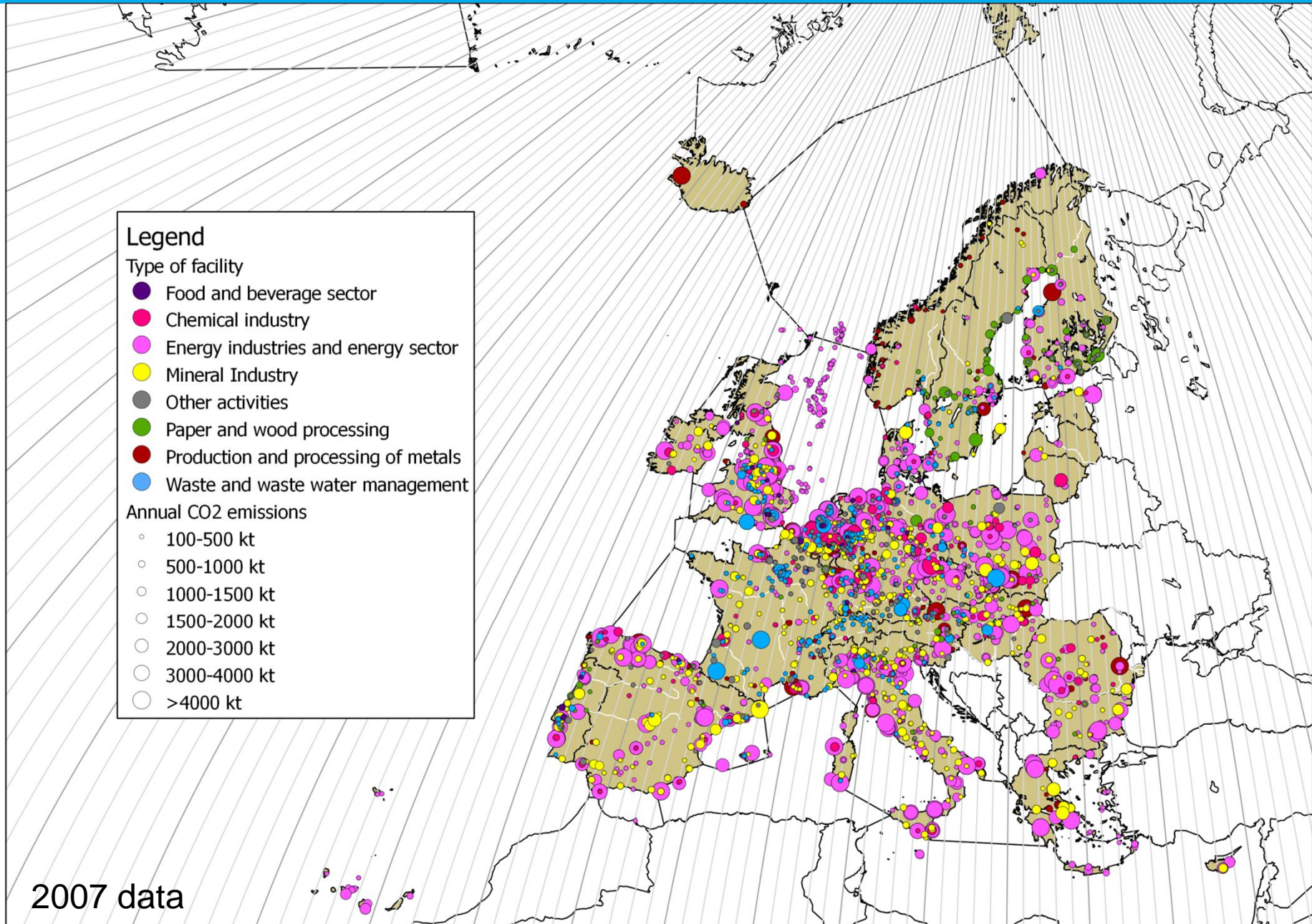
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Scanmet IV

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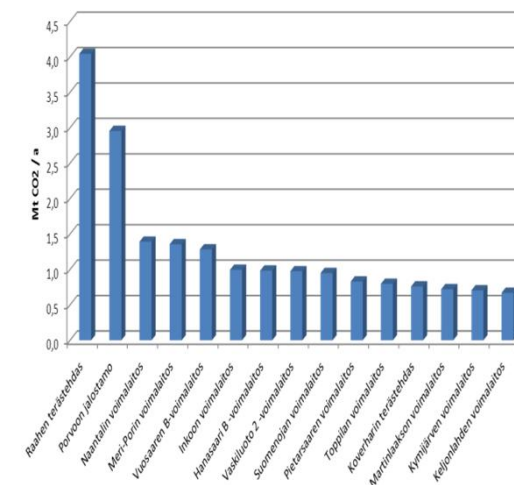
Roadmap Milestones

- ★ **Not about targets, but identifying cost-efficient trajectory**
- ★ **Gradual emission reductions:**
 - ↳ -1.0% per year 2010-2020 vs 1990
 - ↳ -1.5% per year 2020-2030 vs 1990
 - ↳ -2.0% per year 2030-2050 vs 1990
- ★ **Sectoral milestones: all sectors contribute in different manner**

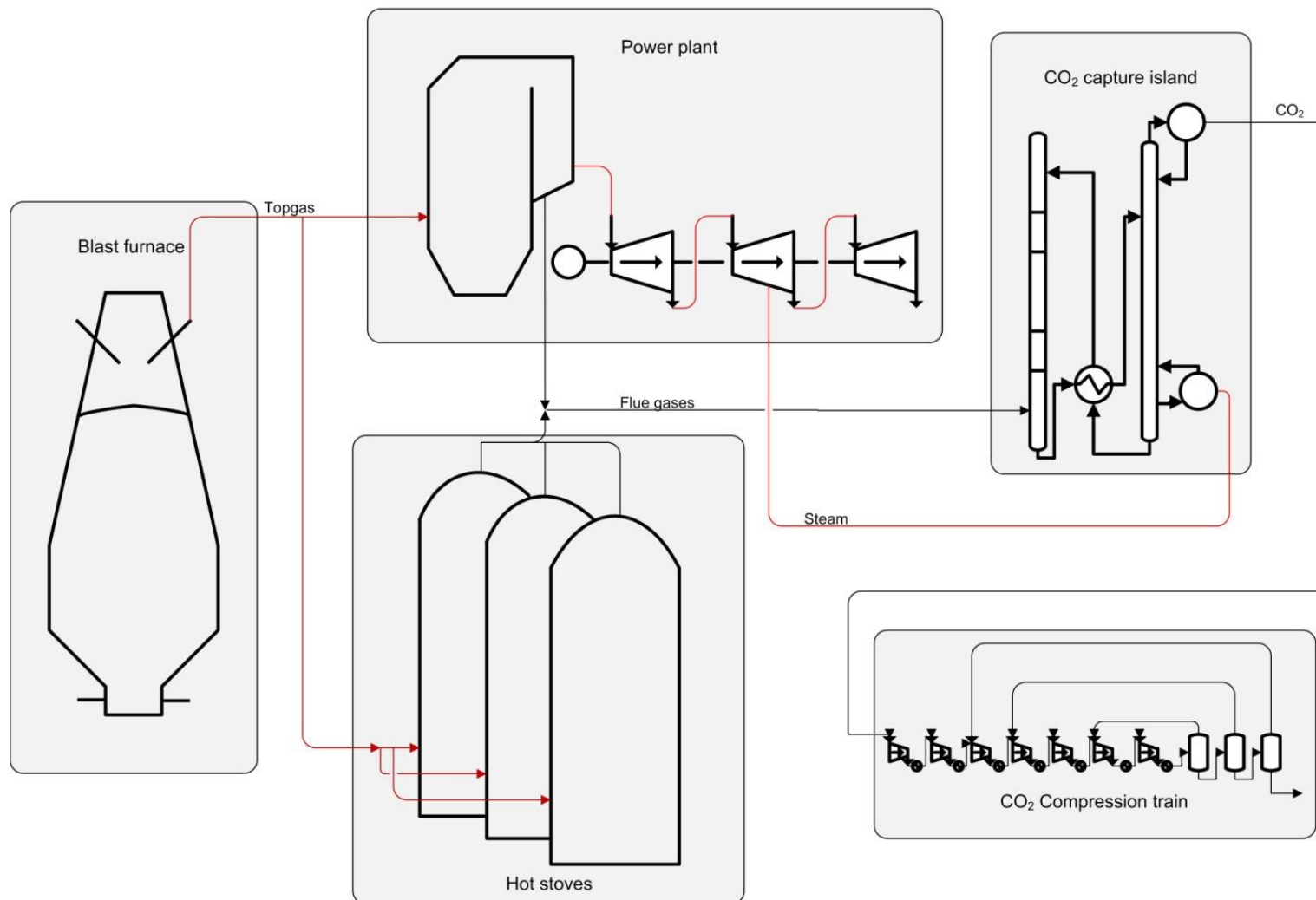
GHG reductions compared to 1990	2005	2030	2050
Power (CO ₂)	-7%	-54 to -68%	-93 to -99%
Industry (CO ₂)	-20%	-34 to -40%	-83 to -87%
Transport (incl. CO ₂ aviation, excl. maritime)	+30%	+20 to -9%	-54 to -67%
Residential and services (CO ₂)	-12%	-37 to -53%	-88 to -91%
Agriculture (non-CO ₂)	-20%	-36 to -37%	-42 to -49%
Other non-CO ₂ emissions	-30%	-72 to -73%	-70 to -78%

Raahe steel mill

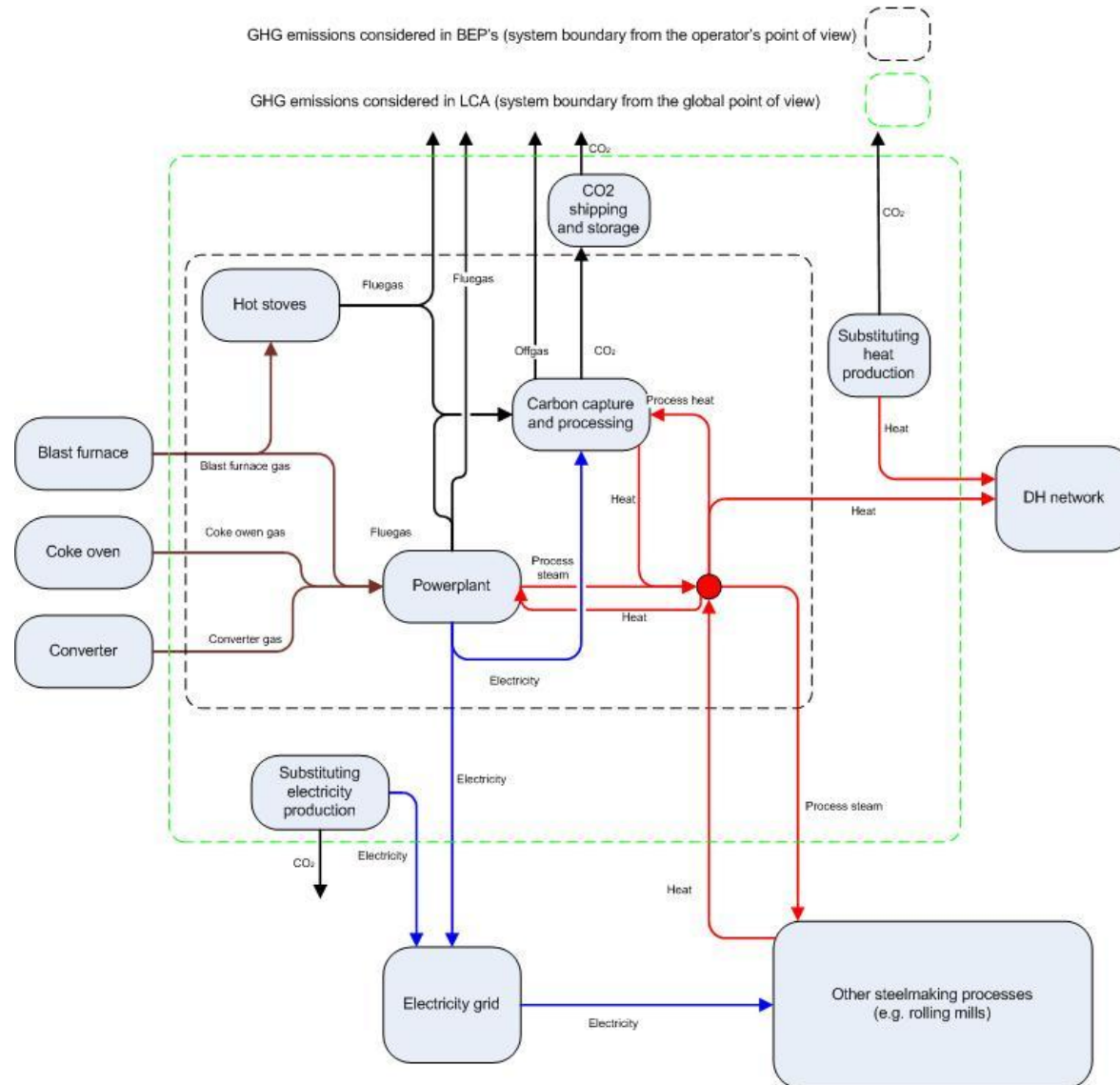
- Case study is based on Ruukki Metals Oy's Raahe steel mill that is situated on the coast of the Gulf of Bothnia
- It is the largest integrated steel mill in the Nordic countries producing hot rolled steel plates and coils.
- It is also the largest CO₂ point source in Finland emitting approximately 4 Mton / year (in 2011).



Process integration post combustion carbon capture to the steel mill

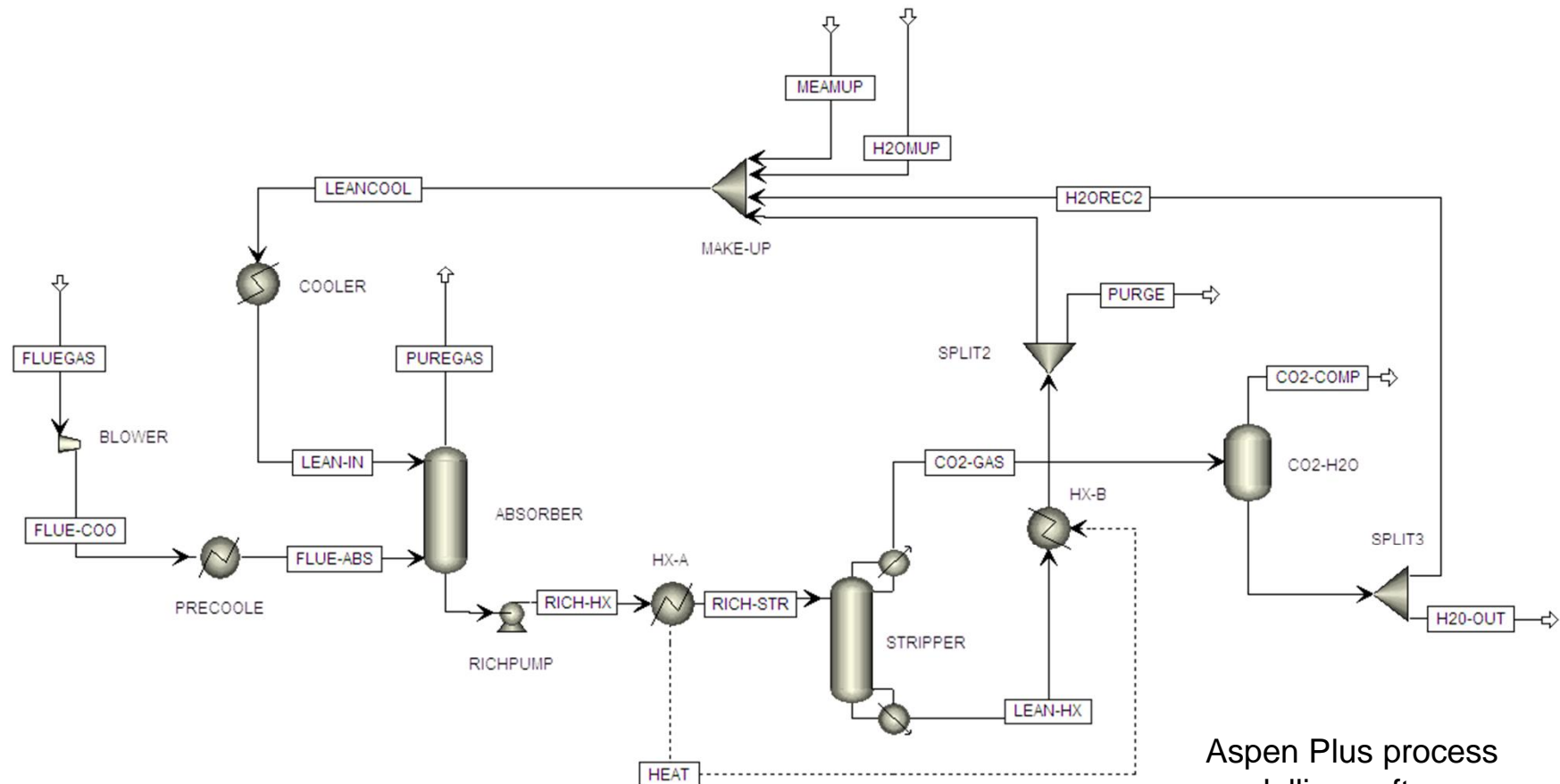


Boundaries of evaluation



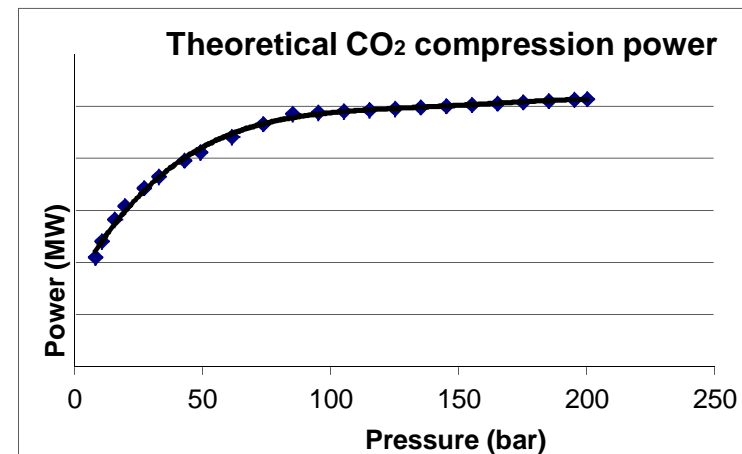
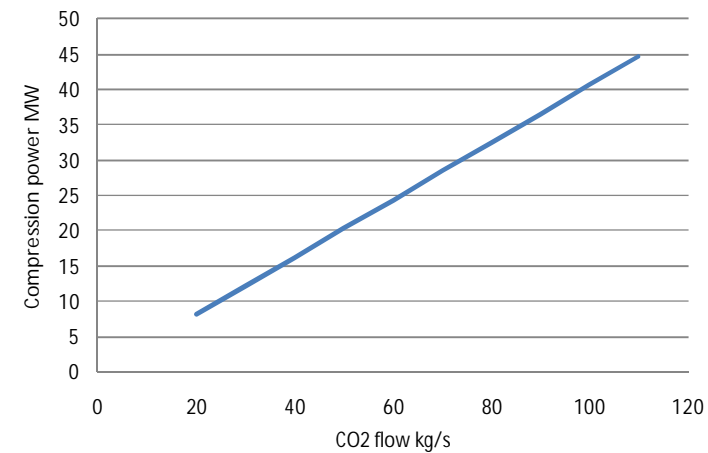
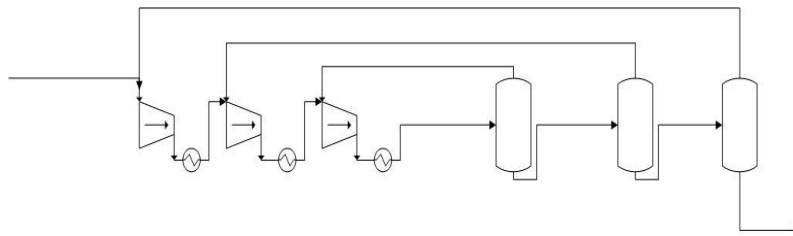
Modelling of processes

Three different solvents considered: MEA, Siemens amino acid salt and a low temperature solvent



CO₂ transportation and processing

- Ship transportation (6,5 bar ja -52°C)
- Intermediate storage 1,5 x ship capacity
- Ship capacity ~10 000 t.

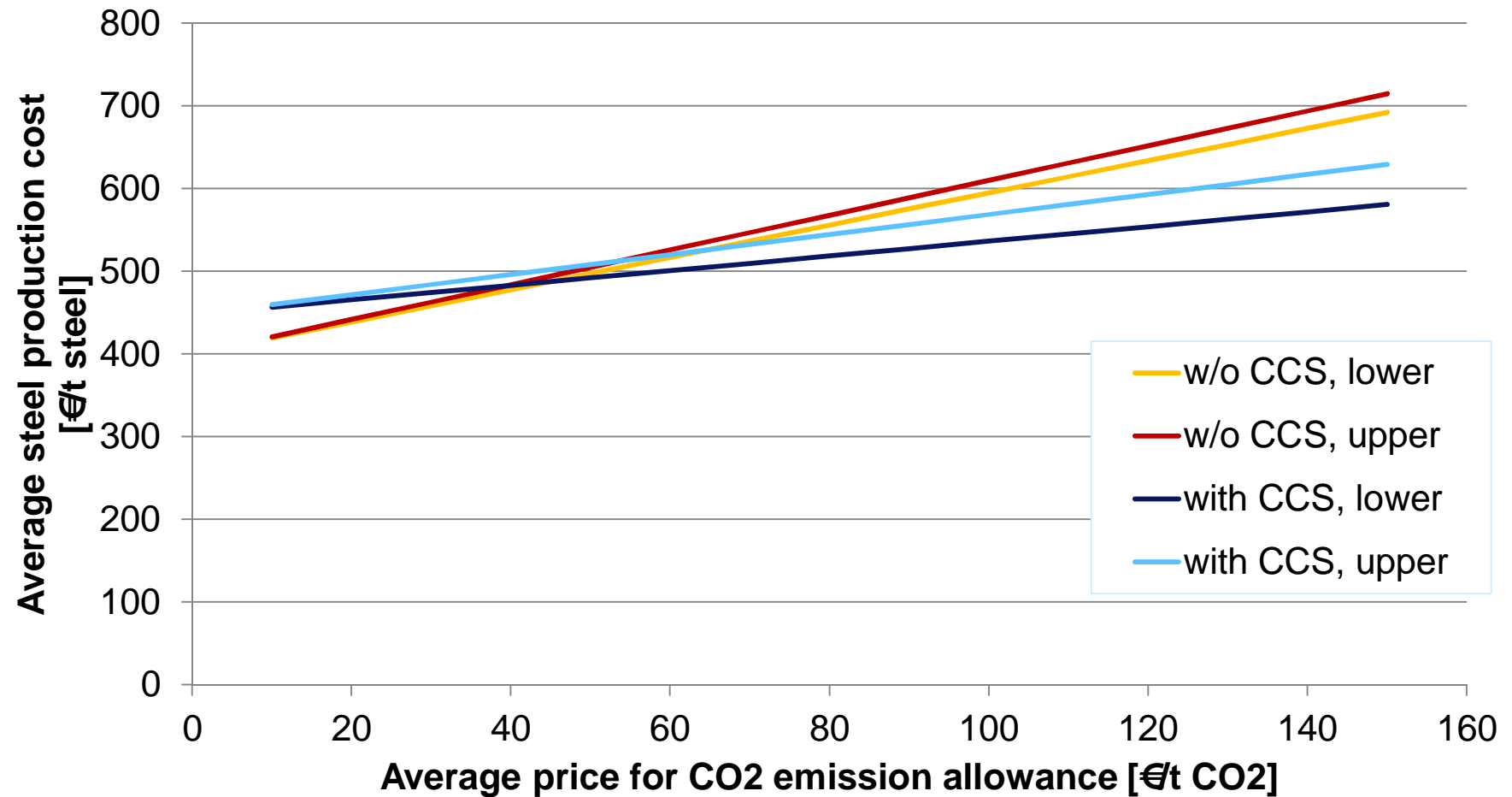


Case descriptions

Case no	Case description
0	The reference case without CCS for to which the CCS cases are compared
1	Small scale CCS application, regeneration heat for solvent from heat recovery only
2	Back pressure turbine operation
3	Combination of Case 1 and Case 2.
4	No electricity production
5	Combination of Case 1 and Case 4



Effect of carbon prices to the production cost of steel



Conclusions

- Possibility of significant CO₂ reductions with CCS (**2-3 Mt CO₂/a, 50 – 75 % of the site emissions**)
- Smaller amounts (in the range of 0.3 Mt CO₂/a), with very low operational costs, due to the waste heat available at the site of the steel mill
- Avoided CO₂ emissions and the costs strongly effected by electricity production
- **58– 78 €/t CO₂** (with electricity prices in the range of 80 - 150 €/MWh)
84 – 114 €/t CO₂ Globally avoided (replacing electricity coal)
- Even if CCS would become more feasible than (over the operation without CCS) in the steel industry with realistically assumed future EUA prices, the production costs of steel would rise drastically in the EU member states
- Work continues in CCSP, the national CCS program of Cleen Oy, funded by Tekes



Business from technology

Thank you for your attention!

Antti Arasto

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More information:

http://www.cleen.fi/en/program_overviews/ccsp_carbon_capture_and_storage_program

<http://www.vtt.fi/proj/ccsfinland/>