ccsp
Carbon Capture and Storage Program

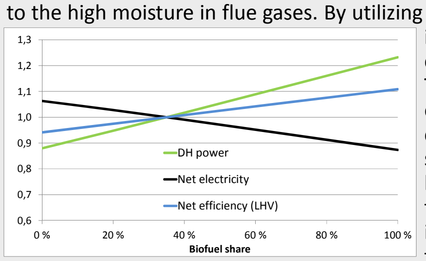
Oxy combustion based CCS for CHP, case study

Preliminary feasibility estimations showed that the operation costs of this oxy combustion concept vs. air combustion are equally economical when CO_2 emissions are on the level of ca. 5-6 €/t_{CO2} (no investments or other variable costs than energy included).

Summary

Case study of a CHP plant concept utilizing oxy combustion and biofuels has pointed out the technology's key advantages and a list of critical issues to be clarified in the future. Downside of the technology is the high auxiliary power of some new key components, consuming around 30% of plant's gross output.

Oxy combustion in biofuel CHP production seems to be beneficial due to the high moisture in flue gases. By utilizing flue gas condenser 15 % increase in DH power could be achieved. The biofuel share's effect to plant characteristics was also studied. Increase of the biofuel share decreases the power output but increases DH power and the plant efficiency.

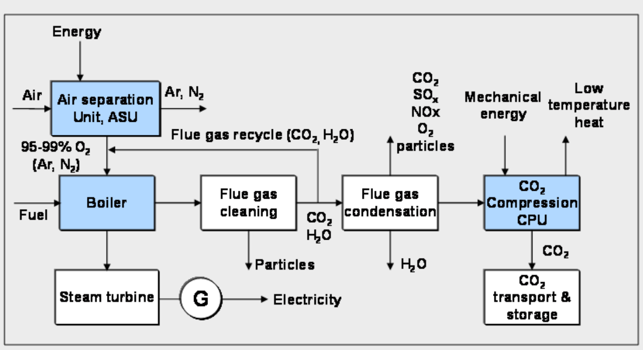


Impact of biofuel share. Reference point at 35% biofuel share.

Background

In oxy combustion processes almost pure oxygen mixed with recycled flue gases is used as an oxidant instead of air. This excludes nitrogen out of the process and the flue gases consist mainly of CO_2. The advantage of using oxy combustion is the less energy requiring removal of other components when CO_2 is separated.

In comparison to conventional power plant the oxy combustion process requires two essential large scale components; ASU – Air separation unit for producing pure oxygen and CPU - CO_2 compression and purification unit for converting CO_2 to storable form. Adapting this technology to CHP plant using biofuels is an uncharted concept with a lot of unknown aspects but several opportunities for process integrations.



Basic description of oxy combustion process.

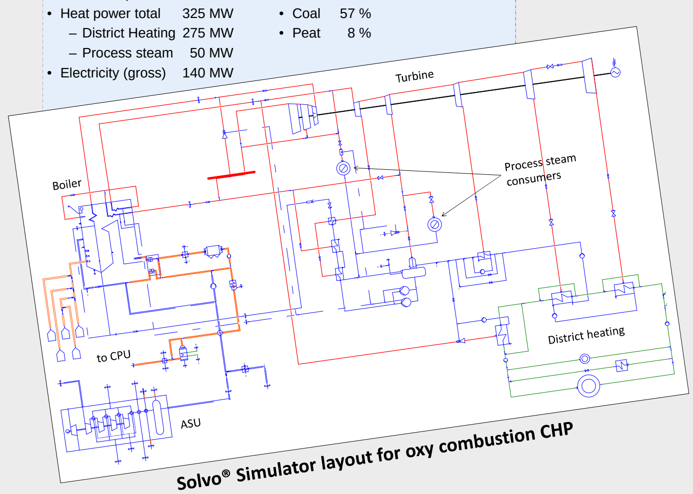
Solution description

Case study analyses were carried out with Fortum's power plant simulator Solvo®. Plant layout, capacities and fuel distributions were modelled according to the study design figures. Solvo® model calculations included also CO_2 capture components. Heat from flue gas condenser was utilized in the DH network.

After Solvo® model was done and tuned the following studies were carried out and analyzed:

- Biofuel shares (min and max)
- Biofuel moisture levels
- Different DH and process steam loads (winter and summer)

Design capacities		Fuels	
• Boiler fuel power	425 MW	• Bio	35 %
• Heat power total	325 MW	• Coal	57 %
– District Heating	275 MW	• Peat	8 %
– Process steam	50 MW		
• Electricity (gross)	140 MW		



Solvo® Simulator layout for oxy combustion CHP

Collaboration and continuation

In the next phase boiler supplier Foster Wheeler Energia Oy will be consulted to get the manufacturer aspect to the oxy firing boiler design and to prepare complete process integrations.

Following process alternatives will be considered in the future: fuel drying, condensing turbine, heat recovery systems, alternative technologies for air purification and even supercritical steam parameters. After finishing the design it is possible to compare oxy combustion CHP plant with CCS to other CCS technologies.

More Information

Kalevi Kankkunen, Fortum (kalevi.kankkunen@fortum.com)
Ilkka Salmensaari, Fortum (ilkka.salmensaari@fortum.com)
Sari Hujanen, Fortum (sari.hujanen@fortum.com)
Risto Sormunen, Fortum (risto.sormunen@fortum.com)

Next generation energy company Fortum

CLEEN
Cluster for Energy and Environment