Use of biomass in partial CO₂ capture systems in the process industry

Hans Aksel Haugen¹ Jon Hovland¹ Ragnhild Skagestad¹ Tonje Warholm Thomassen¹

¹SINTEF Industry, Porsgrunn, Norway

Abstract

Background and rationale

The CO2stCap project basically studies how partial capture of CO₂ can make CCS an attractive option for CO₂ mitigation in the process industry. The CO2stCap project has been described in [1] and [2], and will also be presented at GHGT-14, see XX and YY. One partial capture option of interest to different process industries is the use of surplus (waste) heat as energy supply for the CO₂ capture process. Results from [2] show that partial capture of CO₂ could lower the specific capture cost (€/ton CO₂) and that the relation between capital expenditure and lowered energy demand should be reconsidered for cases with access to low-cost heat.

Process industry sectors studied in the CO2stCap project include cement, pulp and paper, steel, industrial gases and ferro alloys. Also, silicon production for solar panels has been part of the study. The industry partners are Norcem which is part of the HeidelbergCement group, SSAB (steel), Aga Gas AB Sweden and Elkem (ferro alloys, solar silicon). Pulp and paper is covered through the consortium partner RISE Bioeconomy (formerly Innventia). CCS may form one out of several possible technologies for reducing the CO₂ footprint in these industries.

The main question to be addressed in work package 2 of the CO2stCap project is how does CCS fit into an overall mitigation portfolio to optimize emissions reductions. That is to put CCS into an overall survey of CO₂ mitigation options in order to achieve the most cost efficient overall CO₂ reductions in these industries. For instance, Elkem may use biocarbon (charcoal) as reduction agent in their metal production. Elkem, like other industries, has also considered growing algae. When producing silicon for solar panels, the CO₂ concentration in the flue gas is very low, approximately only 1 %, which makes capturing a particular challenge. Other options to reduce the CO₂ footprint may therefore be attractive.

The work package is divided into three tasks:

1) Literature survey on how mitigation options other than CCS could be utilised at a site, which was completed in 2017
2) Develop concepts for how biomass could be used in partial carbon capture schemes for efficient use of the biomass resources and efficient reduction of CO₂ emissions while minimizing CO₂ reduction cost
3) Evaluation of use of biomass for external energy supply to capture plant
Tasks 2 and 3 will be addressed during first quarter of 2018.

Main findings from literature survey

For each of the industries cement, pulp and paper, solar silicon and steel, the following alternatives to CCS appeared to be most relevant, according to the literature study:

- Change of raw material, for example to increase use of fly ash to replace part of the clinker (limestone derived) in cement production
- Changing electricity or other energy consumption from fossil to renewables (buying "guarantees of origin")
- Increase the use of biomass to replace especially coal, including co-firing. Also, the cultivation of algae to capture CO₂ and/or to be used as for instance fuel was evaluated.
- CO₂ capture and utilization (CCU)
- CO₂ capture and storage (CCS)

The literature survey did not go into details about increasing energy efficiency, as this option can be regarded as part of normal industry operations independent of the need for CO₂-reductions.

The overall conclusions were as follows:

The literature survey suggests that use of biomass as an energy source/reduction agent/raw material instead of fossil sources may be an attractive option for all the studied industries. However, there are several pitfalls associated with the extensive use of biomass, such as:

- Increased cost of energy/raw material
  - Competition for biomass will increase, and thus most likely cost
- Sourcing sustainable biomass
  - Possibly more variation in quality compared to coal / oil / natural gas
- Changes in equipment and process may be necessary

CCS also seems to be a good option for all the industries: Cement, pulp and paper, silicon, and steel. CCU(S) may be of interest to specific plants or maybe industries, but most likely on a small scale and in cases where there are obvious economic benefits involved.

Next step

Tasks 2 and 3 mentioned above will be addressed during first quarter of 2018 and results will be available for the full paper. Cost efficient use of biomass resources in the different industries in the context of partial capture will be the main focus of these tasks, including how biomass can be used as energy supply to a capture plant. The tasks will be performed in close contact with industry partners to assure high industrial relevance.

Acknowledgements

SINTEF will like to thank our project partners:
The CLIMIT programme/Gassnova, Energimyndigheten, Aga Gas AB, Elkem, Norcem Brevik AS, Chalmers Technical University AB, RISE Bioeconomy (formerly Innventia AB), Swerea MEFOS, SSAB EMEA AB, Global CCS Institute, IEA Environmental Projects Ltd. (IEAEPL), duly represented by IEA Greenhouse Gas Programme, University College of South East Norway.
Literature
