Norcem Brevik CO2-capture project; assessment of post-combustion technologies for cement plants

Brussels, 17 October 2018

Per Brevik, Dir. Sustainability and Alternative fuels HC NE
Cement production; two sources of CO2 emissions

CaCO₃ → CaO + CO₂
Our vision: CO₂-neutral concrete products over the product’s life cycle by 2030!
Carbon capture will be the next, and necessary, measure!
CLIMIT–project 2013–2017

Aker Solutions amine technology

Air Products/ NTNU membrane technology

RTI solid sorbent technology

Alstom Power Calcium Looping
Benchmark study

- Capture rate
- Specific regenerator duty
- Specific electricity consumption
- Integration with cement kiln
- Modification of cement kiln
- Complexity
- CAPEX
- OPEX
- Maturity
Testing on 4 capture technologies on real flue gas

Conclusions
1. Technologies are available
2. Technical feasible, but dependent on economic support
3. In a 2020 perspective, Aker Solutions amine technology the only one ready for a full scale project
Chilled Ammonia for Cement
GE Experience from Power application

- Wisconsin Energy a 5000 Nm$^3$/h full process unit capturing gas from a coal fired power plant, in total 7000 h of operation 2008-2009
- American Electric Power, 60 000 Nm$^3$/h slipstream from Mountaineer in WW, in operation 7000 h 2009-10
- Mongstad refinery in Norway, 50 000 Nm$^3$/h from a gas turbine and refinery gas, 2010-2013
- Several test campaign in Växjö lab Synthetic gases 600 Nm$^3$/h 2010-2017
- Enabled us to reach TRL 7

Mountaineer test facility, with a gas flow 25% of CEMCAP standard size
• CAP with utilities in Cement application

- 100 ton/h of CO2 from cement plant
- A biomass boiler at site 90 MW producing steam and electricity for the CAP process
- Capturing 115 ton/h of CO2 meaning 15 t/h negative emissions
- TRL level of 6
The Norwegian full scale CCS demonstration project

**CO₂-STORAGE**
- Planning by Equinor and partners
- Intermediate storage on shore
- Offshore storage in the North Sea
- Huge capacity

**CO₂-TRANSPORT**
- By ship
- Responsibility
- Equinor develop transport and storage

Intermediate storage for CO₂ on shore: «Naturgassparken» in Øygarden

**CO₂-Capture**
- Norcem
- HeidelbergCement
  - Cement production
- Yara Porsgrunn
  - Ammoniakkproduksjon
- Fortum Oslo Varme AS
  - (Klemetsrud)
  - Waste-to-energy plant

Aurora field
**Full scale CO2-capture / Norcem**

<table>
<thead>
<tr>
<th>Technology</th>
<th>Aminsolvent</th>
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<tbody>
<tr>
<td>Technology provider</td>
<td>Aker Solutions</td>
</tr>
<tr>
<td>Capture capacity</td>
<td>400 000 t/ år</td>
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<tr>
<td>Excess heat</td>
<td>46 MW</td>
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<tr>
<td>Intermediate storage CO2</td>
<td>5 300 t</td>
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<tr>
<td>Cost estimates (CAPEX/ OPEX)</td>
<td>± 30 %</td>
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Integration / Layout
Our road to a project realization

- FEED studies ongoing. Deliveries in August 2019

- Gassnova/Ministry process (evaluation/assessment)
  - Included a QA-process

- Negotiations regarding an agreement with Ministry

- Parliament decision (and in parallel internally in HC) regarding realization at the earliest beginning of 2020

- In operation late 2023 (or 2024)!