



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

Brussels, 17 October 2018

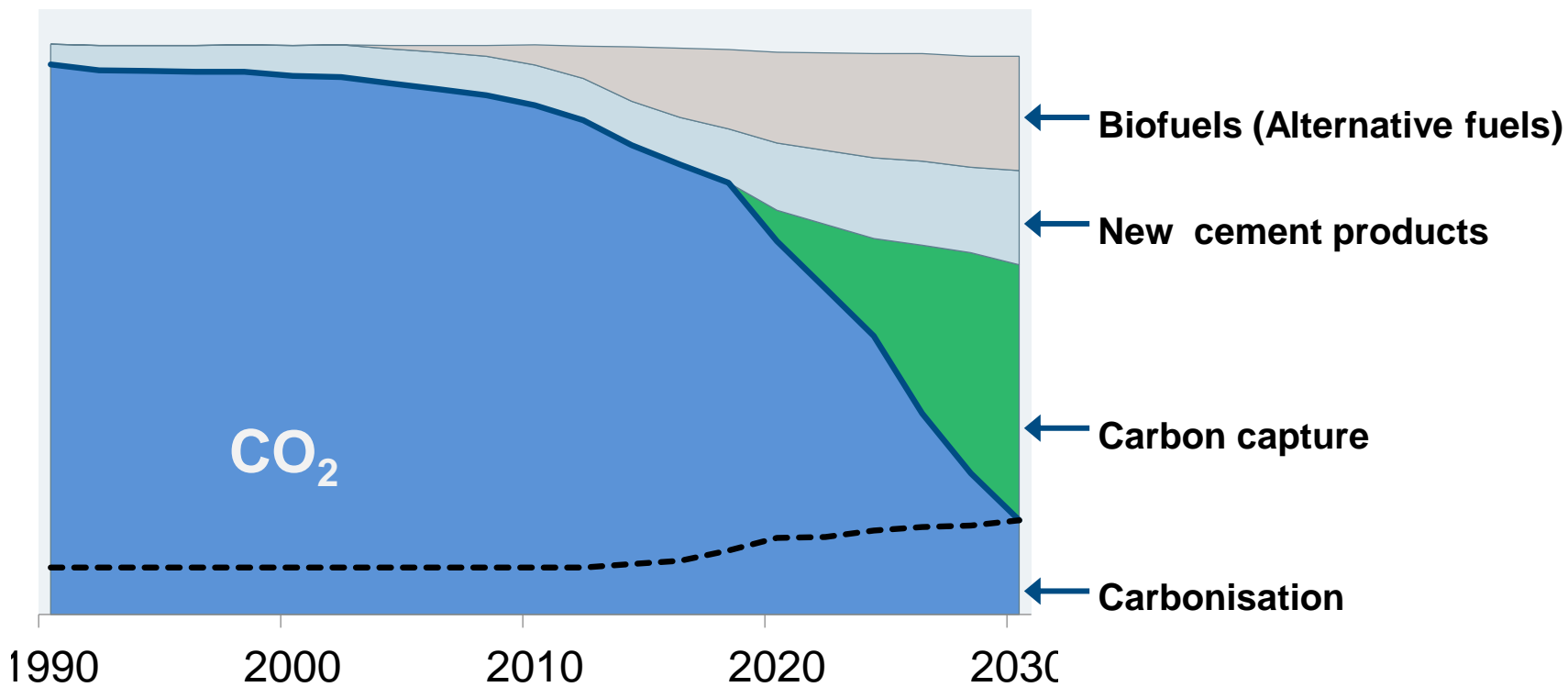
Per Brevik, Dir. Sustainability and Alternative fuels HC NE

Cement production; two sources of CO₂ emissions



**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**

CLIMIT–project 2013–2017

Aker Solutions amine technology – TRL 9



Air Products/ NTNU membrane techn – TRL 5



RTI solid sorbent technology - TRL 4



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

Alstom Power Calcium Looping – TRL 3





Chilled Ammonia for Cement

GE Confidential – GE Internal use only

GE Experience from Power application



- Wisconsin Energy a 5000 Nm³/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 Nm³/h slipstream from Mountaineer in WW, in operation 7000 h 2009-10
- Mongstad refinery in Norway, 50 000 Nm³/h from a gas turbine and refinery gas, 2010-2013
- Several test campaign in Växjö lab Synthetic gases 600 Nm³/h 2010-2017
- Enabled us to reach TRL 7

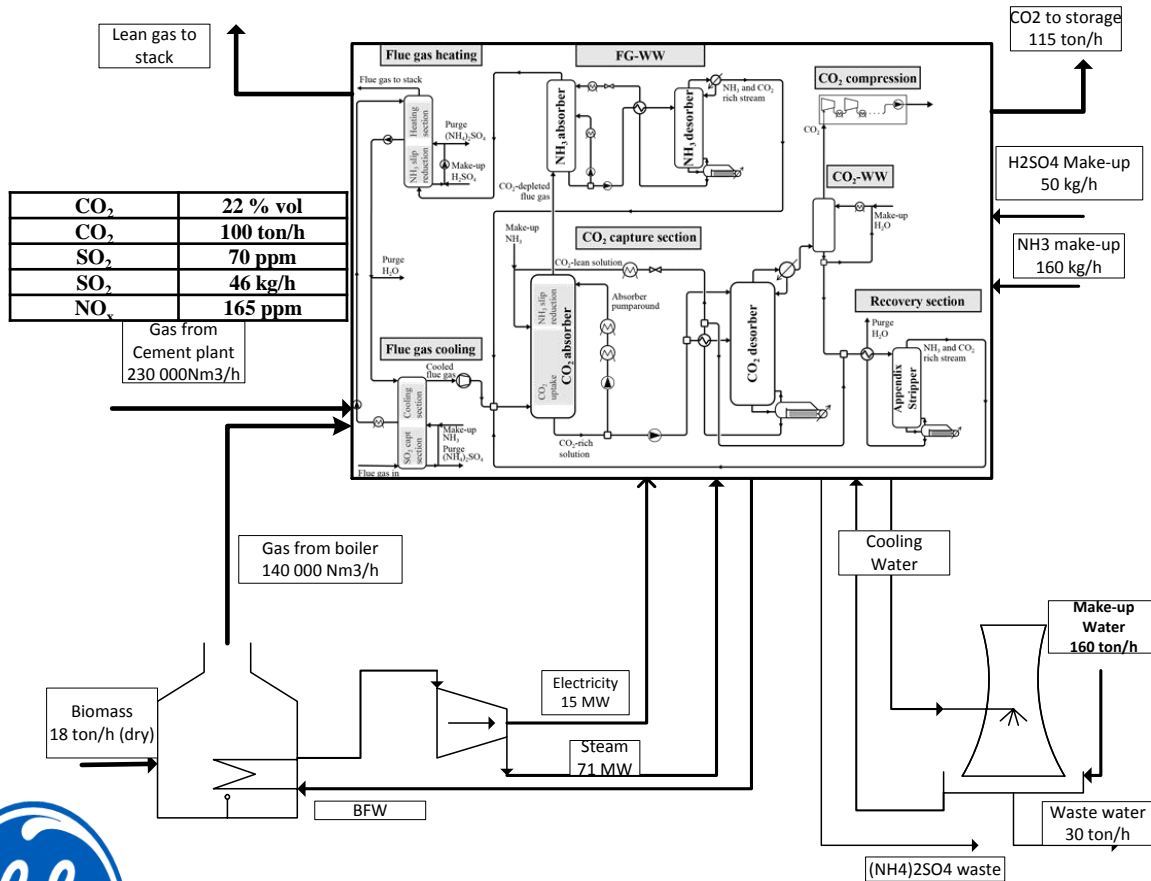
Mountaineer test facility, with a gas flow 25% of CEMCAP standard size



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• 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



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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

Aurora field

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

CO₂-TRANSPORT

- By ship
- Responsibility

Equinor develop transport and storage

CO₂-Capture



Norcem
HeidelbergCement
Cement production



~~Yara Porsgrunn
Ammoniakkproduksjon~~



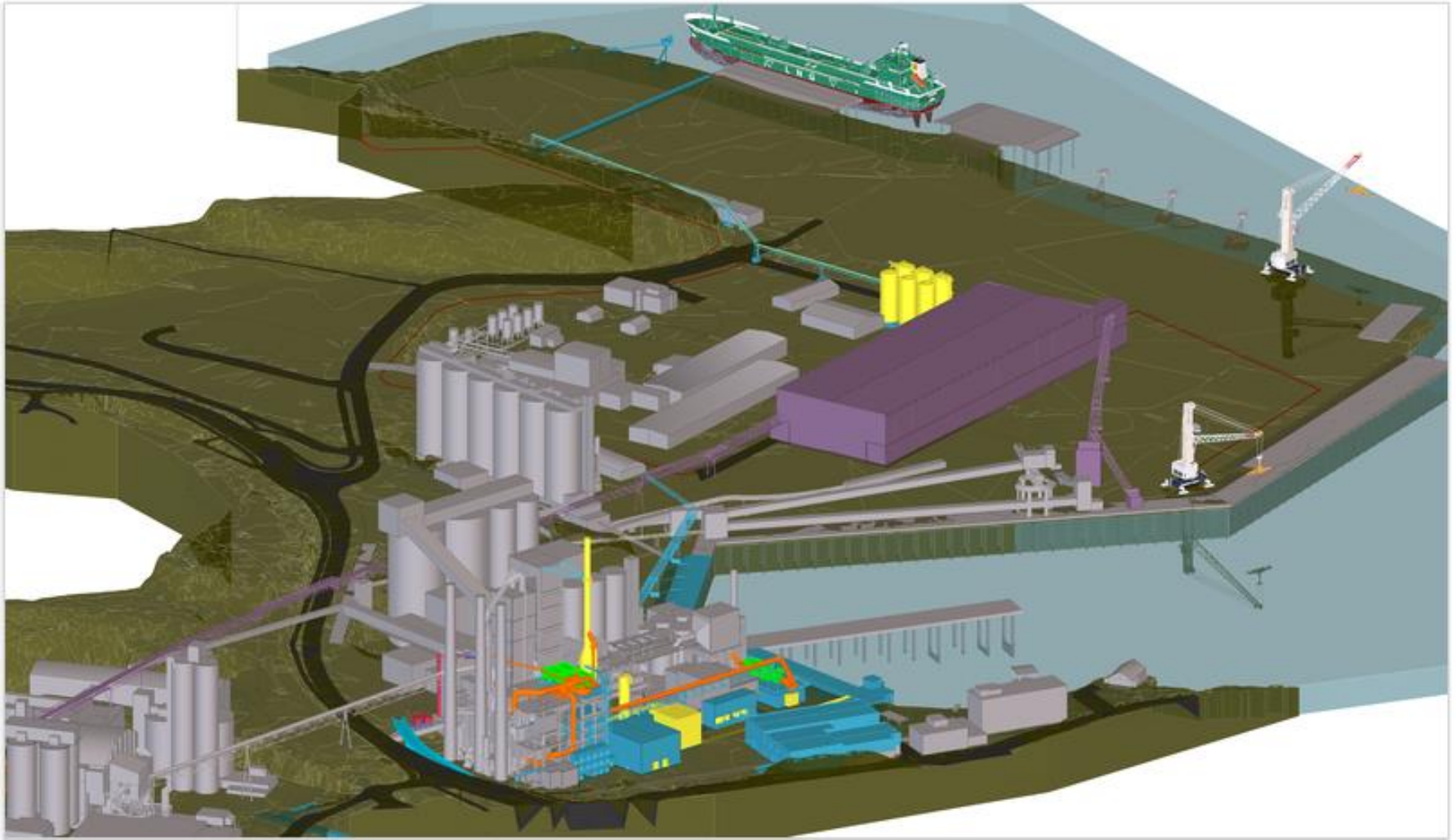
Fortum Oslo Varme AS
(Klemetsrud)
Waste-to-energy plant

Full scale CO₂-capture / Norcem

Technology	Aminsolvent
Technology provider	Aker Solutions
Capture capacity	400 000 t/ år
Excess heat	46 MW
Intermediate storage CO ₂	5 300 t
Cost estimates (CAPEX/ OPEX)	± 30 %



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)!**