

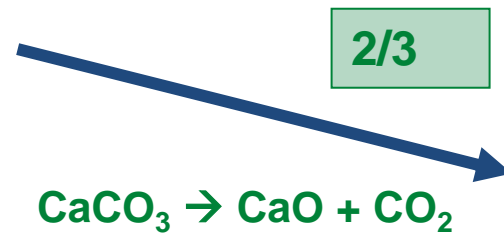


## **Norcem Brevik CO<sub>2</sub>-capture project; assessment of post-combustion technologies for cement plants**

**Brussels, 17 October 2018**

Per Brevik, Dir. Sustainability and Alternative fuels HC NE

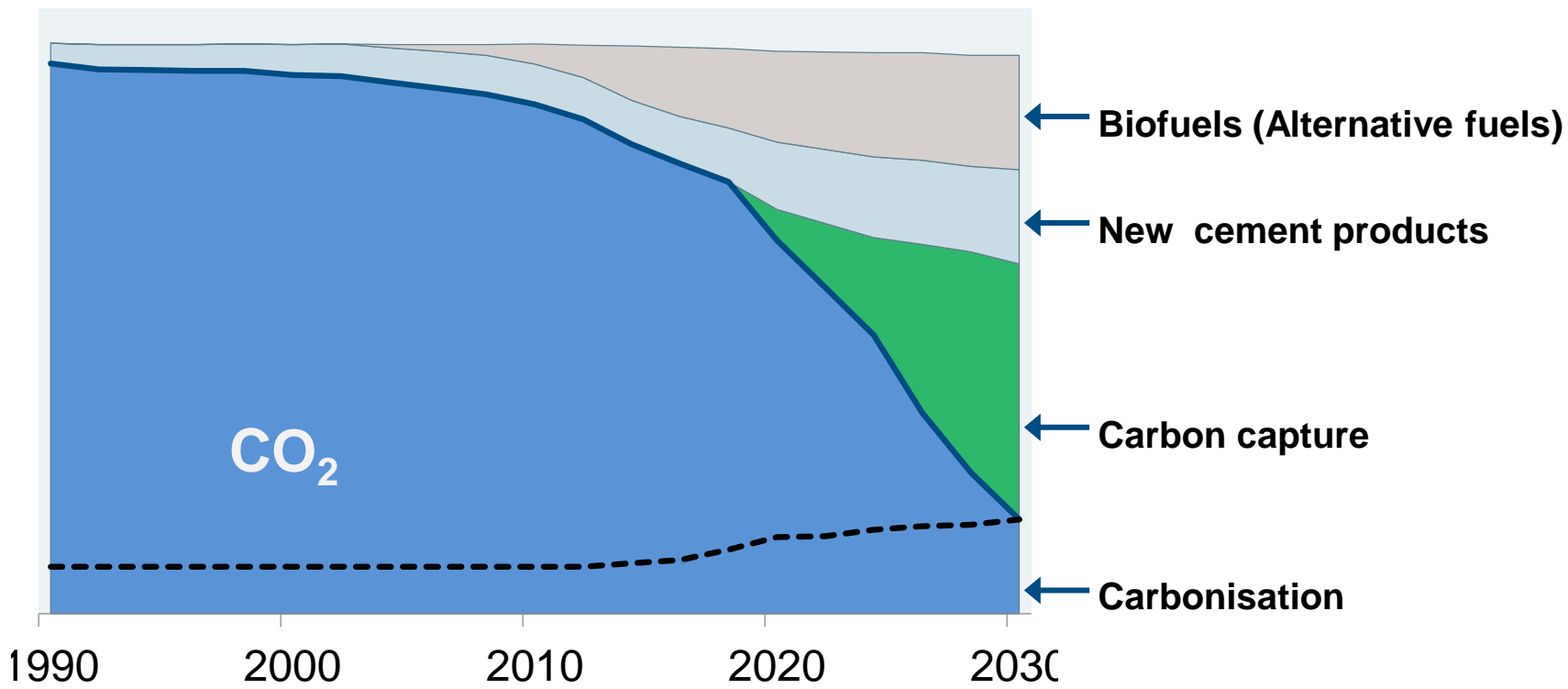
# Cement production; two sources of CO<sub>2</sub> emissions



$1/3$

**Our vision:  
CO<sub>2</sub>-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

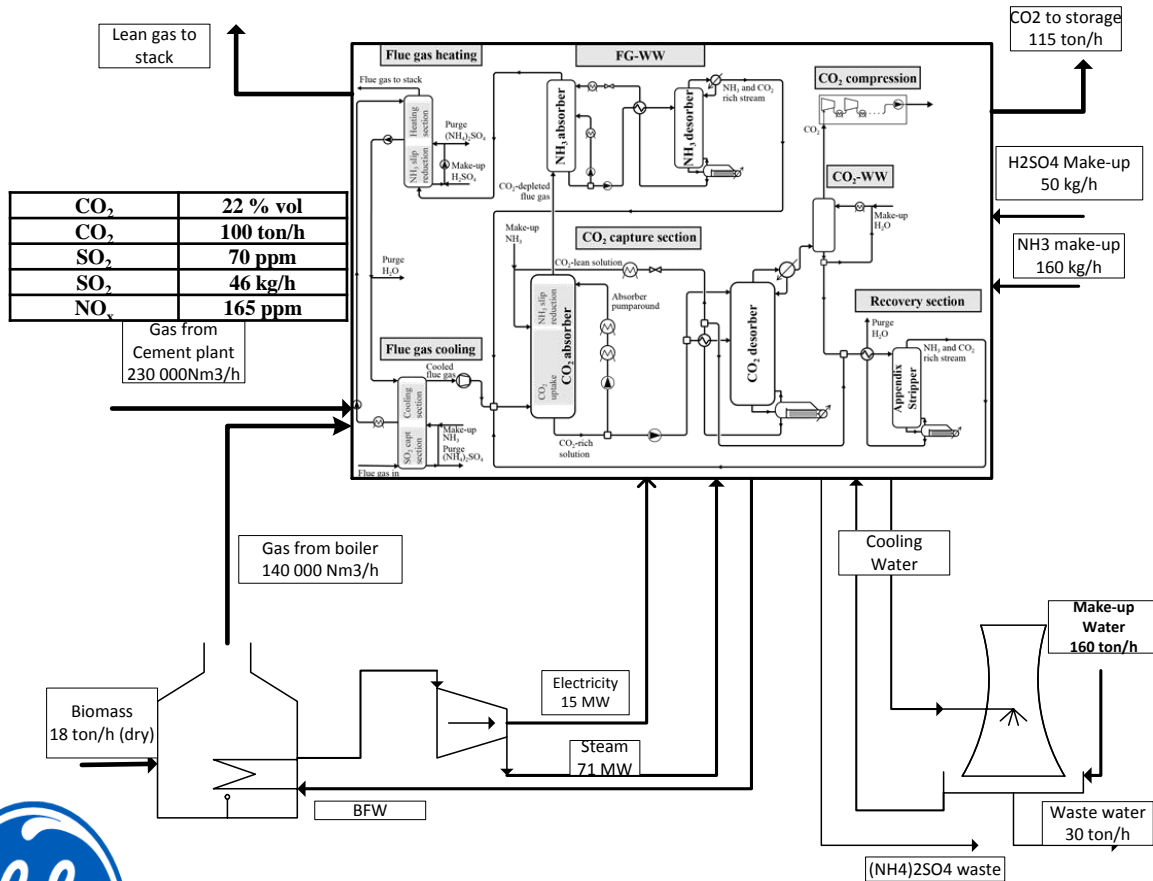


**Mountaineer test facility, with a gas flow 25% of CEMCAP standard size**

- Wisconsin Energy a 5000 Nm<sup>3</sup>/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<sup>3</sup>/h slipstream from Mountaineer in WW, in operation 7000 h 2009-10
- Mongstad refinery in Norway, 50 000 Nm<sup>3</sup>/h from a gas turbine and refinery gas, 2010-2013
- Several test campaign in Växjö lab Synthetic gases 600 Nm<sup>3</sup>/h 2010-2017
- Enabled us to reach TRL 7



# CAP with utilities in Cement application



- 100 ton/h of CO<sub>2</sub> from cement plant
- A biomass boiler at site 90 MW producing steam and electricity for the CAP process
- Capturing 115 ton/h of CO<sub>2</sub> meaning 15 t/h negative emissions
- TRL level of 6



October 18, 2018

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# The Norwegian full scale CCS demonstration project

## CO<sub>2</sub>-STORAGE

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

**Aurora field**

**Intermediate storage for CO<sub>2</sub> on shore:  
«Naturgassparken» in Øygarden**

## CO<sub>2</sub>-TRANSPORT

- By ship
- Responsibility

**Equinor develop transport and storage**

## CO<sub>2</sub>-Capture



**Norcem HeidelbergCement**  
Cement production



~~**Yara Porsgrunn**  
Ammoniakkproduksjon~~



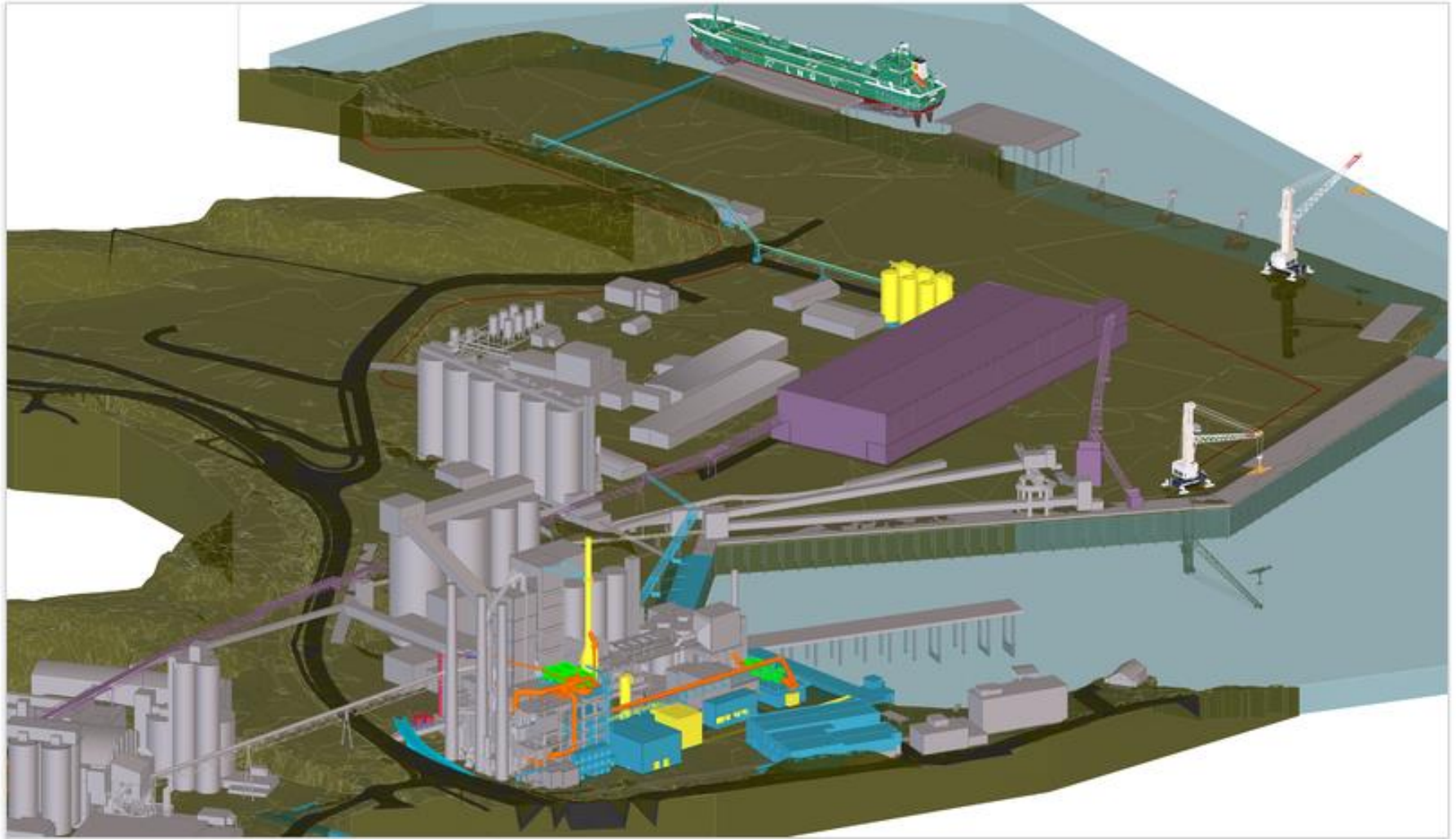
**Fortum Oslo Varme AS (Klemetsrud)**  
Waste-to-energy plant

# Full scale CO2-capture / Norcem

<b>Technology</b>	<b>Aminsolvent</b>
<b>Technology provider</b>	<b>Aker Solutions</b>
<b>Capture capacity</b>	<b>400 000 t/ år</b>
<b>Excess heat</b>	<b>46 MW</b>
<b>Intermediate storage CO2</b>	<b>5 300 t</b>
<b>Cost estimates (CAPEX/ OPEX)</b>	<b>± 30 %</b>



# 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)!**