

PMI Webinar 20 January 2021

The Carbon Capture Project at the Norcem Brevik Cement Plant

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«Langskip»

Government launched «Langskip» on 21 Sept.2020

- Full scale CCS plant at Norcem Brevik
- Northern Lights responsibility:
 - Develop transport solution
 - Intermediate storage at Øygarden (Western coast of Norway)
 - Permanent storage in the Aurora formation in the North Sea
- Partly support of the FOV project in Oslo if EU is contributes through Investment Fund

➔ Total cost 25,1 BNOK (2,5 B€) incl 10 years of operation

- Gov.'s share: 16,8 BNOK (1,7 B€)

«Final decision made by Parliament 14th of December 2020

Project startup January 4th, 2021



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1. Short about cement and concrete
 2. Short about Norcem's Carbon capture project
 3. Project realization
 4. Project management challenges
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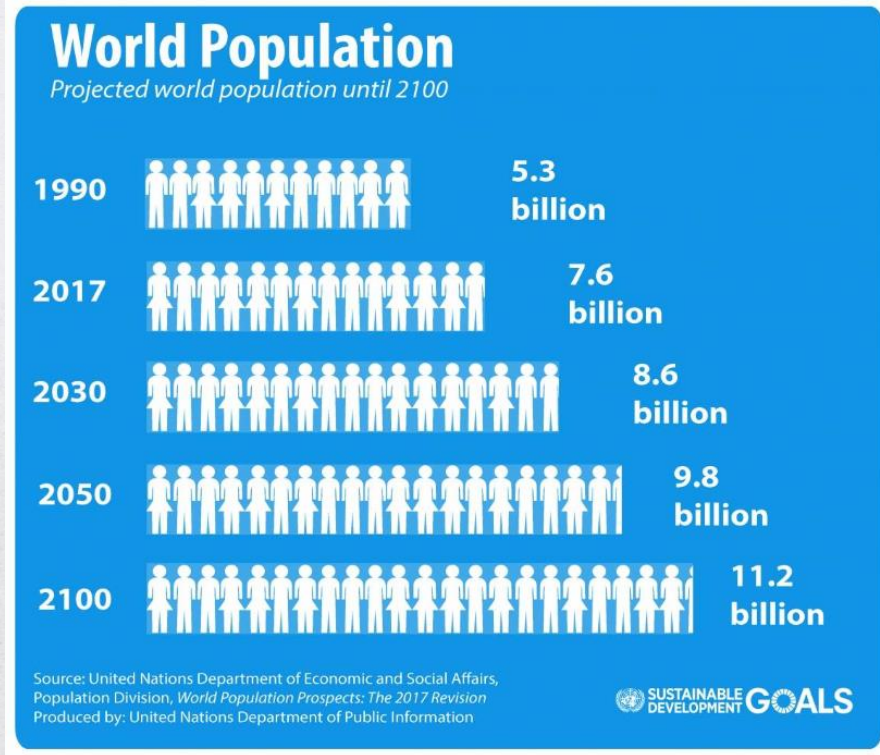
Cement and concrete

- Hard to imagine a future without it
- Lasts for hundreds of years (even thousands)
- The main elements: Limestone, Iron, Aluminium and Silica are the four most dominant elements in the earth's crust. Practically unlimited resources

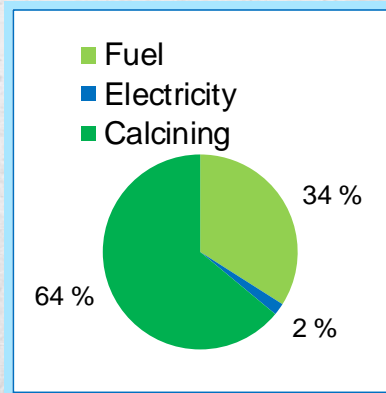
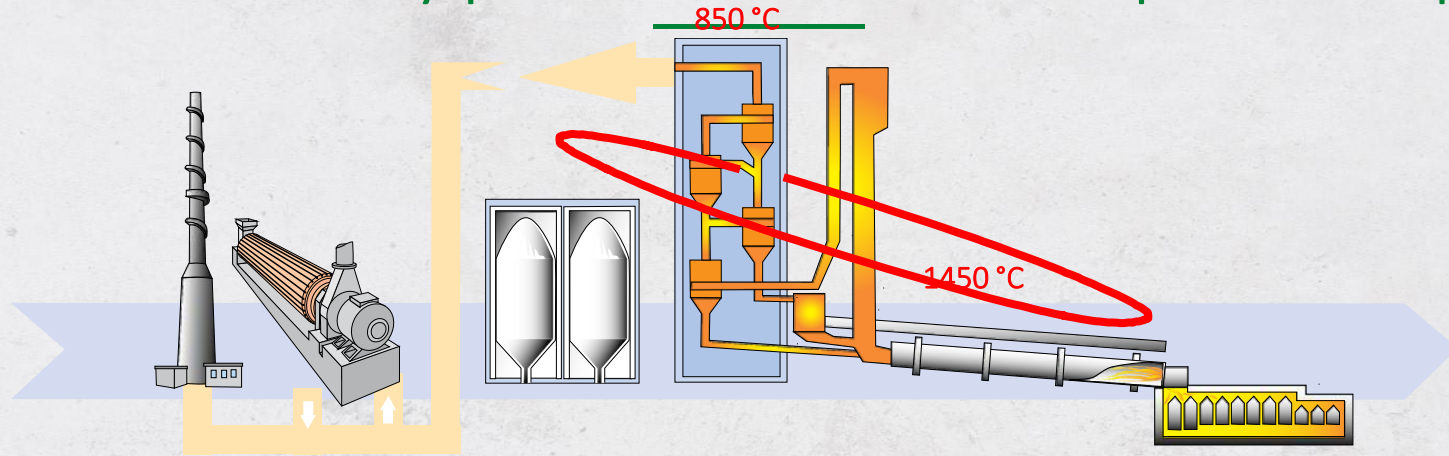


The challenge

The population increase demands more cement and concrete



CO₂ – Unavoidable by-product from the cement production process



Two main CO₂ sources:

- 1) 64 %: Raw Materials ($\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2 \uparrow$)
- 2) 34 %: Fuels (Cyclone Tower & Kiln System)

CO₂ emissions from cement industry:

Globally: 7 % (2,5 Gt CO₂ annually)
Of which Europe: 20 % (2011)

HeidelbergCement: ~ 70 million t/y

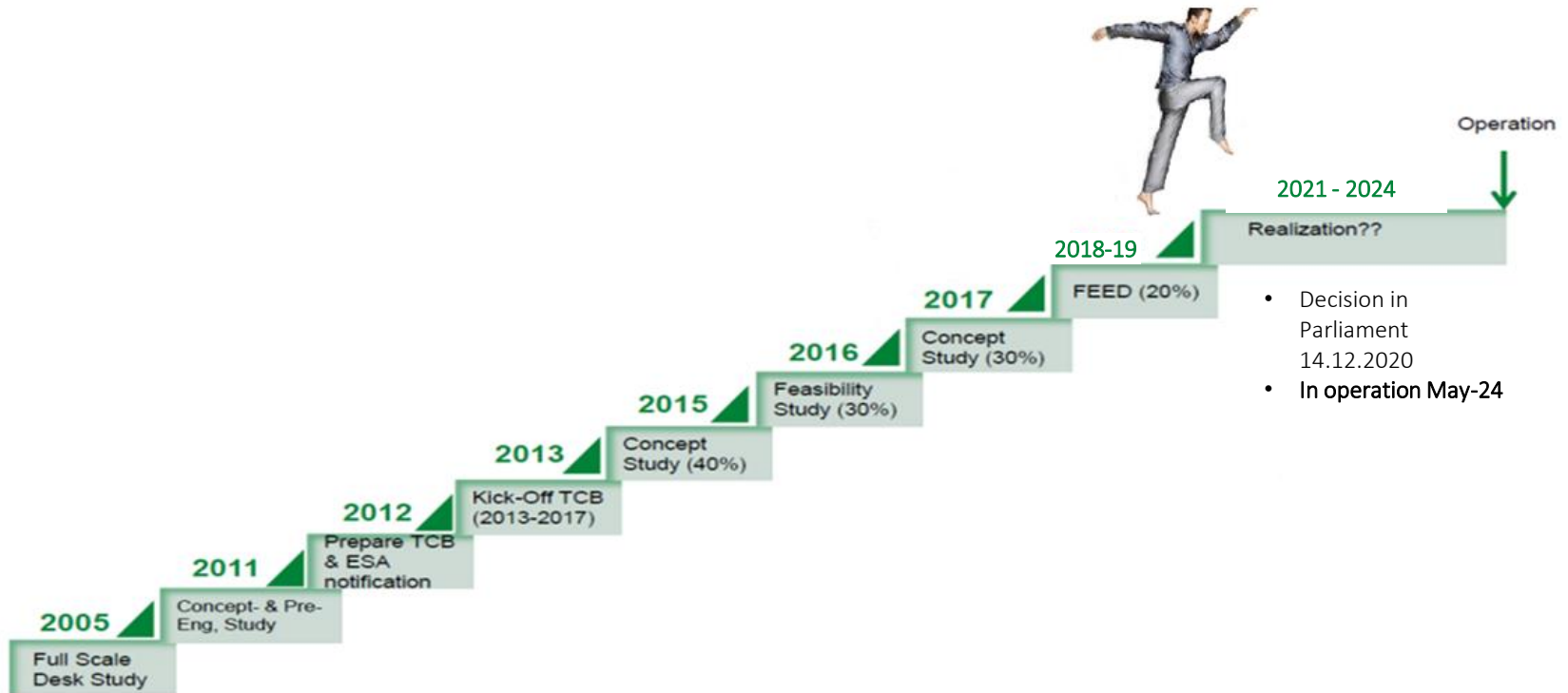
Norcem Brevik: ~ 1 million t/y

Cement industry well suited for carbon capture

- **Large, stationary units**
 - Typically 500.000 – 2.000.000 tons CO₂ per year
- **Often located close to sea**
- **Process emissions represents 2/3 of the CO₂ emissions; fuels only 1/3**
- **High concentration of CO₂ in flue gas (22-24% CO₂)**



A long and winding road towards CCS in Brevik ...



CLIMIT–project 2013–2017

Aker Solutions amine technology – TRL 9



Air Products/ NTNU membrane technology – TRL 5



RTI solid sorbent technology – TRL 4



Testing of 4 capture technologies on real flue gas

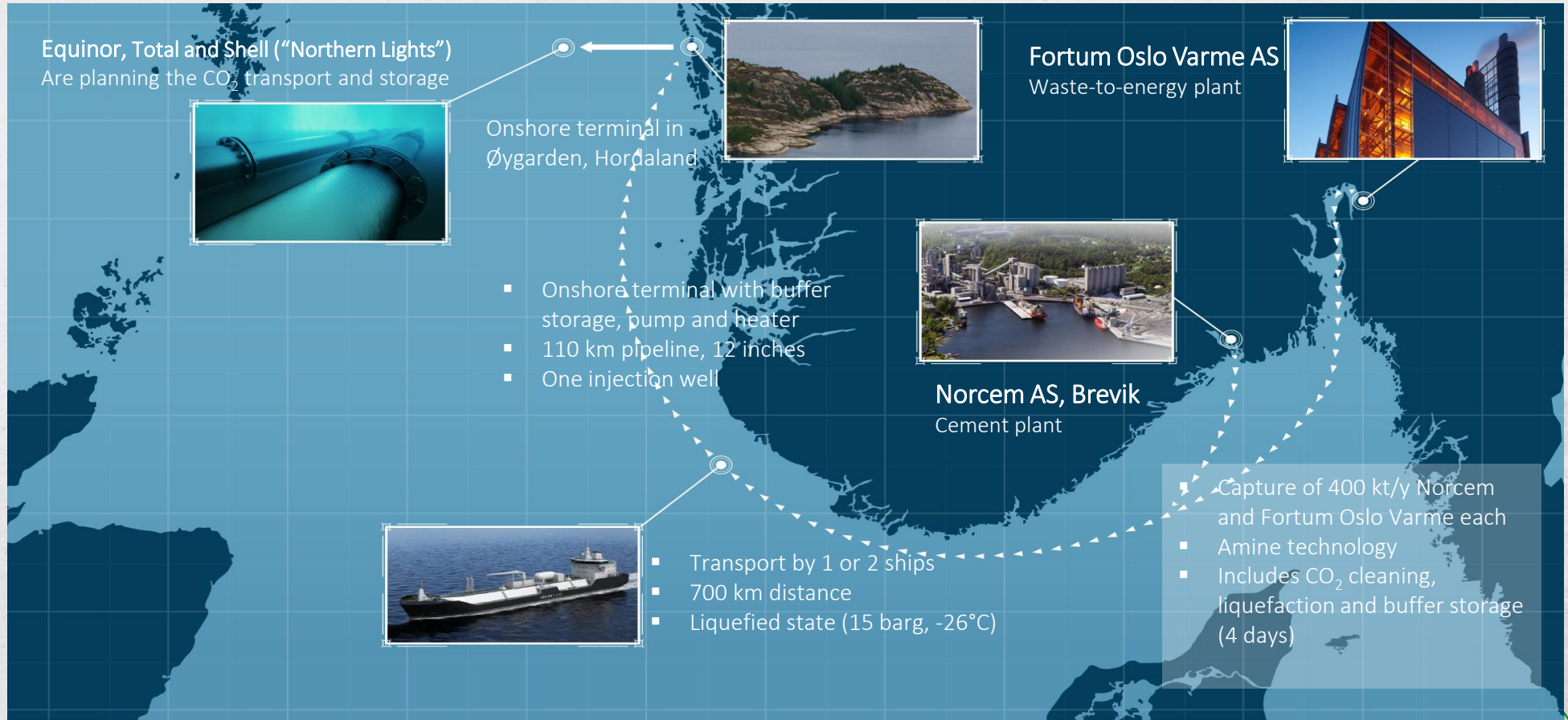
Conclusions

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

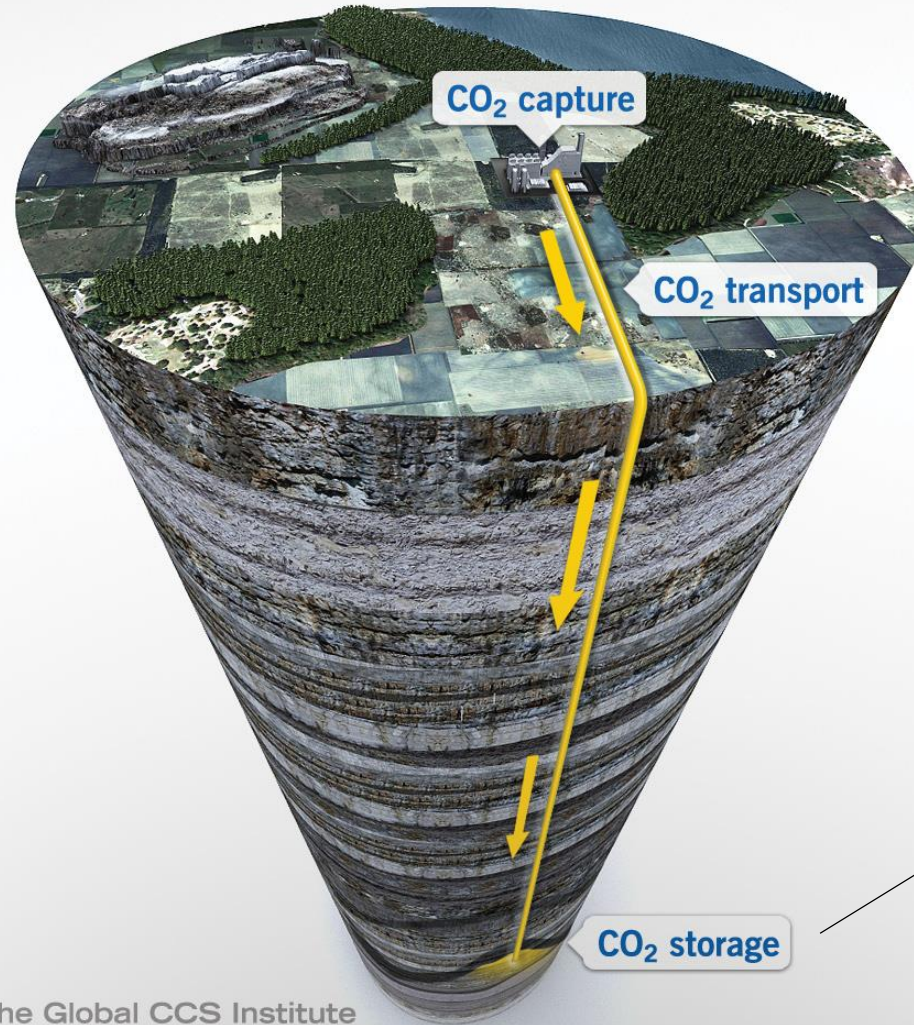
Alstom Power Calcium Looping – TRL 3



The Norwegian Carbon capture Demonstration project



THE CARBON CAPTURE AND STORAGE PROCESS



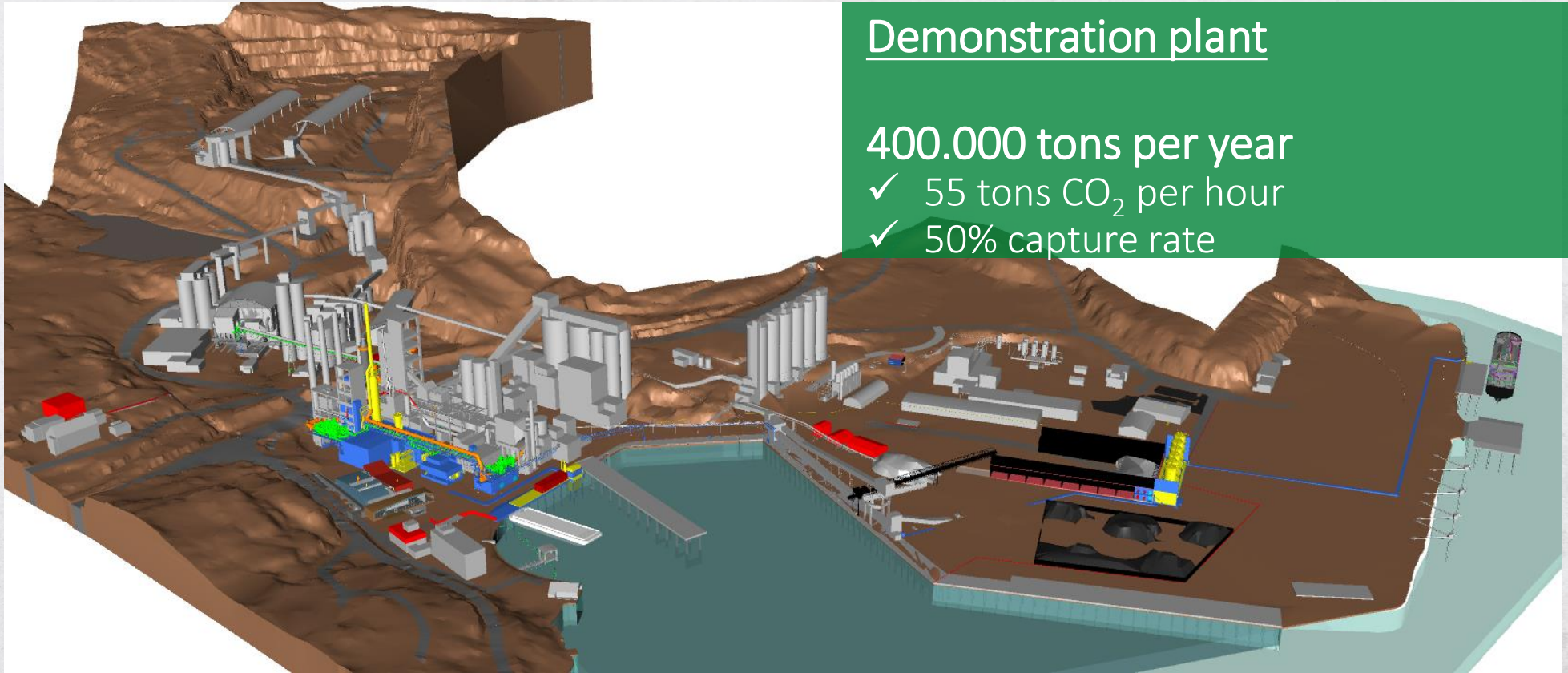
2600m below seabed. Well drilling completed 15/1-20

CO₂ capture Brevik

Demonstration plant

400.000 tons per year

- ✓ 55 tons CO₂ per hour
- ✓ 50% capture rate



Carbon capture at Norcem Brevik – the first global CCS project in Cement

CO₂ capture



- Aker Carbon Capture’s technology (more than 7,500 hours of testing at Brevik completed)

CO₂ transport



- By ship
- Responsibility – Northern Lights

CO₂ storage



- Offshore storage in the North Sea
- Planning by Equinor and partners

Facts

Technology:

Amine - Post combustion capture

Scope:

Capture, liquefaction, pipe transfer, storage on quay

Strategic Partners:

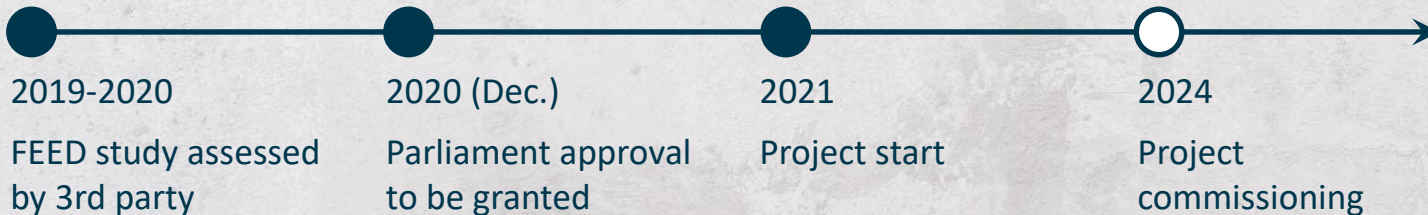
Aker Carbon Capture’s (capture technology), Northern Lights (Equinor, Shell and Total) (transport & storage)

Annual CO₂ captured:

approx. 400,000 t per year (approx. 50 % of plant emission)

External funding:

>80%



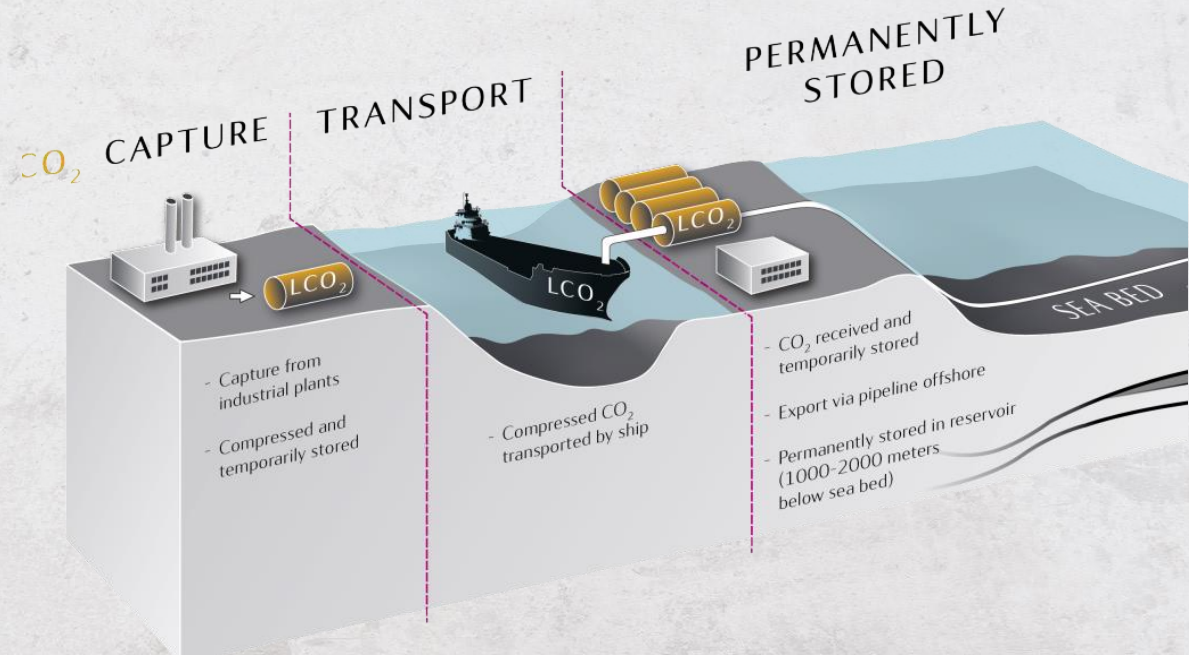
The unique elements of «Langskip»

The worlds first CCS complete value chain

The worlds first full scale CO₂-capture plant from cement- and waste industry

The worlds first network for shipment transport of CO₂

Establishment of centralized storage for CO₂ at Norwegian shelf



INFRASTRUCTURE

will be the most important
«take away» from the
Norwegian project



Brevik can be the first in a row of HC-projects ...

Three HeidelbergCement plants have launched CCS-development projects



Lixhe, Belgium.

LEILAC-project. Funded through H2020
Building pilot for Phase 2 test.
Potential: 1,2 mill. tonnes/year



Slite, Gotland, Sweden

Feasibility study ongoing
Potential: 1,5 mill. tonnes /year



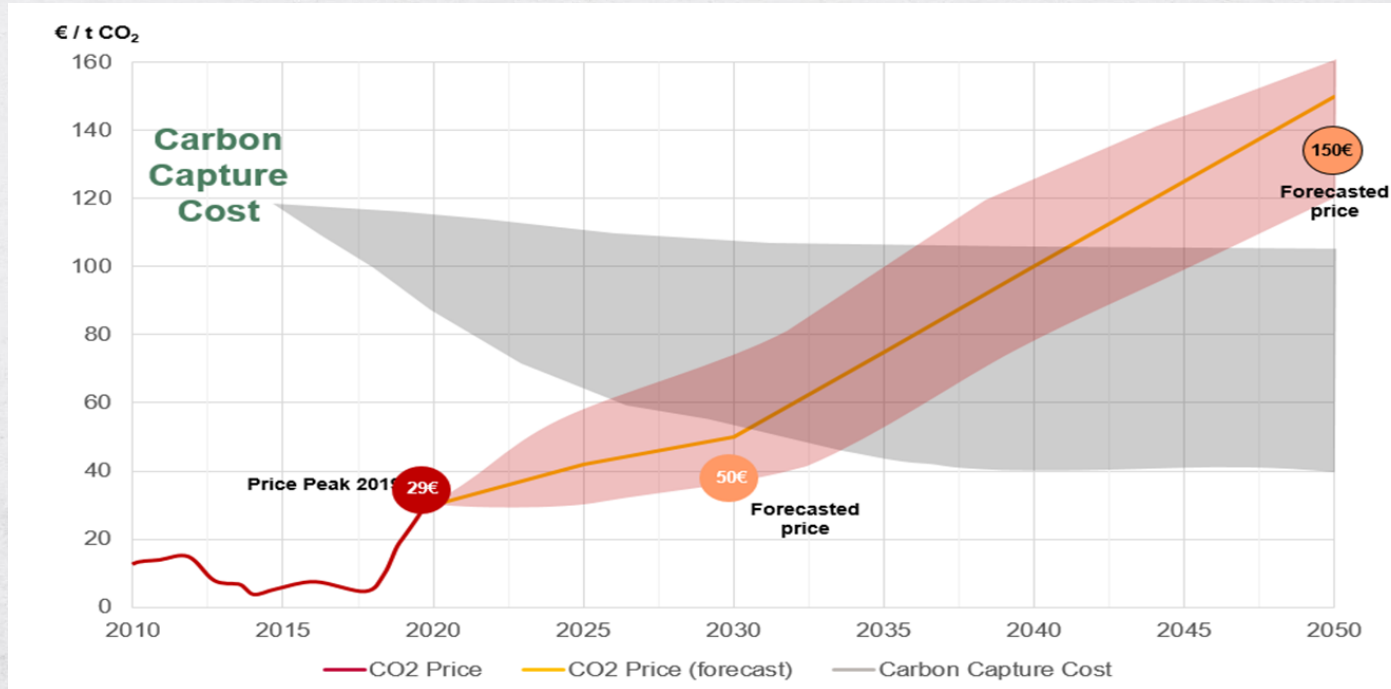
Hannover, Germany

Involved in the CEMCAP-project (H2020)
Potential: 0,65 mill. tonnes/year

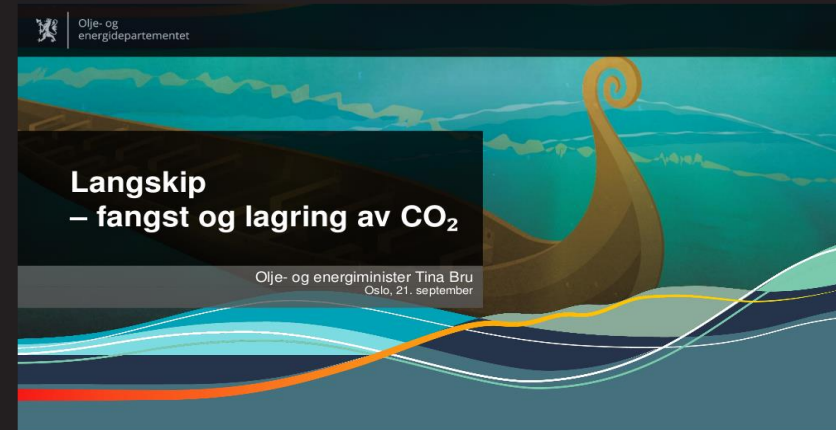
HC- involvement in CCS
for many years already:

- ECRA
- CEMCAP
- Oxyfuel-pilot
through consortium
for full-scale test

Cost development / Can CCS be economically sound in the near future?



Project «Langskip» launched 21 September 2020



«The biggest climate project in Norwegian industry ever!»

Tina Bru, Minister of Petrol and Energy

Political project

High number of Stakeholders

- Politicians
- Ministry/Gassnova
- Norcem/HeidelbergCement
- EU / EEA
- Academia – R&D
- Technology providers

Realistic technical solutions

- Alternatives
- Maturity level
- Testing on real flue gas a necessary step
- Long term plan (timing internally and externally)



Prime minister Erna Solberg. With two fellow cabinet members visiting Norcem in Oct. 2020

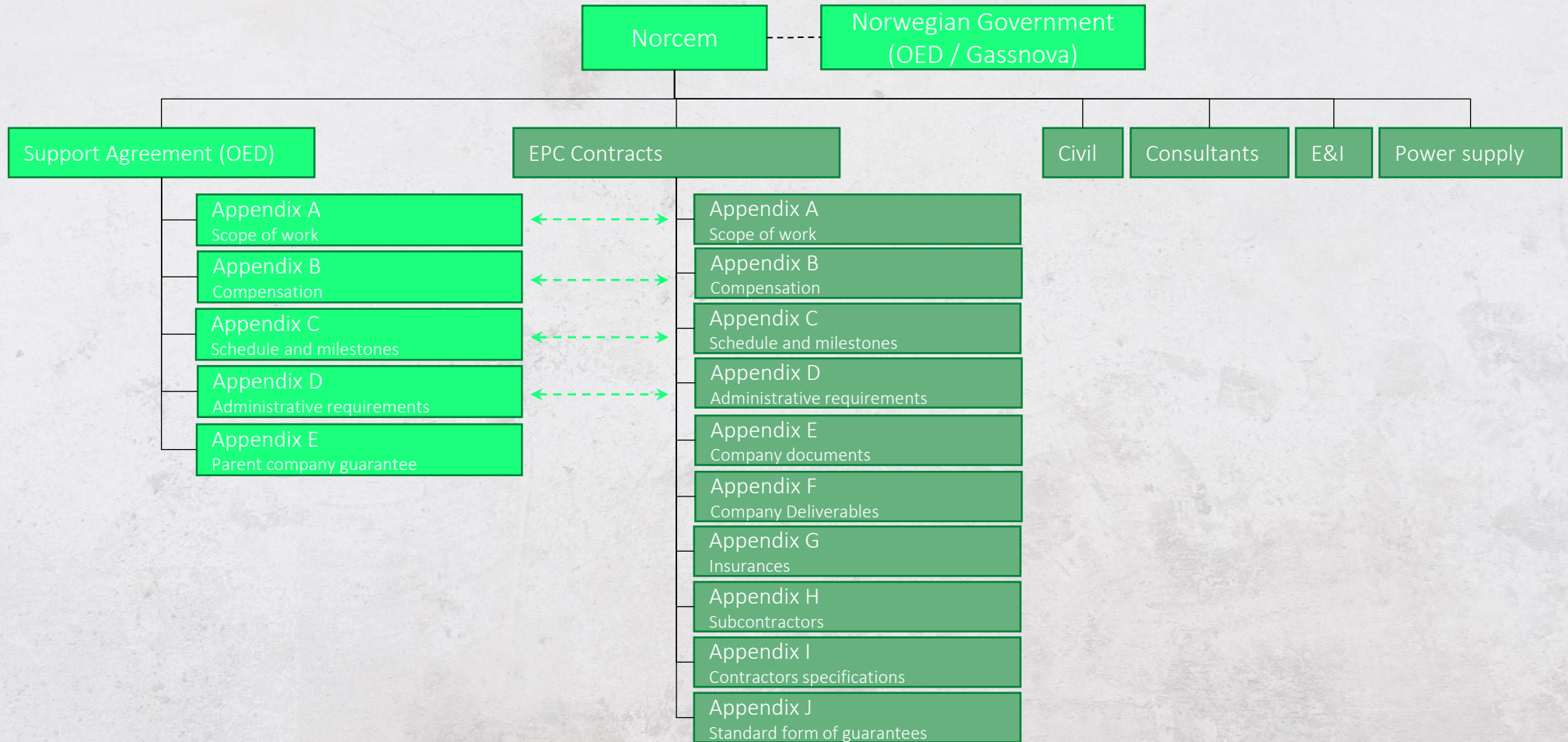
Project execution

Competence

- We are cement producers
- Capture technology and technical requirements
- Building and integrating the capture plant while the cement production is on «full speed»
- Management assistance
 - ✓ Concept study
 - ✓ FEED-study
 - ✓ Realization



Agreement structure



The biggest climate project in Norwegian industry ever!

We have a huge responsibility!

- The size of the project itself!
- «Tax payers money»
- Public procurement
- Progress
- Follow-up from Ministry/Gassnova
- Communication a must!
- Media



Cultural challenges

- Operations vs Project
 - ✓ Norcem (and HeidelbergCement) is an operating unit. Do not have the project experience and competence in-house
- Public project vs industry
 - ✓ Understand the political element
- Offshore vs onshore
 - ✓ Number of Specialists meet generalists
 - ✓ Variation orders vs Fixed prices
- A Norwegian project
 - ✓ Knowledge about Norwegian culture



In a nutshell

We are ready to realize carbon capture in Brevik!

- The cement industry; one of the big emitters!
- Our challenge is to execute the Brevik project within the defined frames regarding progress and cost control!
- Experience / «Lessons learnt» from realization and operation will be valuable for the Group and our industry!
- It's a political project; but realizing the first full scale carbon capture project in Cement within budget and time will be the best argument for launching the next projects!

Thank you for your attention!

