

# Presentations 9 February - Plenary

- Henrik Solgaard Andersen, Equinor
- Rikard Kinn, Aker Solutions
- Thomas Reinertsen, Hydrogen Mem-Tech
- John Christopher Knudsen, Aker Carbon Capture

## Longship Sails On

- Kim Hjardar, Illustrert Historie
- Jannicke Gerner Bjerkås, Haslund Oslo Celsio
- Vetle Houg, Brevik CCS
- Christian Buch Andersen, Northern Lights
- Filip Neele, TNO (Netherlands)

# Henrik Solgaard Andersen

VP for Global Hydrogen

Carbon Capture and Storage (CCS)  
scale-up - building on Northern Lights  
and 26 years of CO<sub>2</sub> storage in the  
North Sea

Henrik Solgaard Andersen is a Chemical Engineer from the Danish Technology University and have 30 years of experience from hydrogen, ammonia and CCS R&D, project and business development.

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Carbon Capture and Storage (CCS) scale-up  
- building on Northern Lights and 26 years of CO<sub>2</sub> storage in the North Sea

## CLIMIT Summit 2023

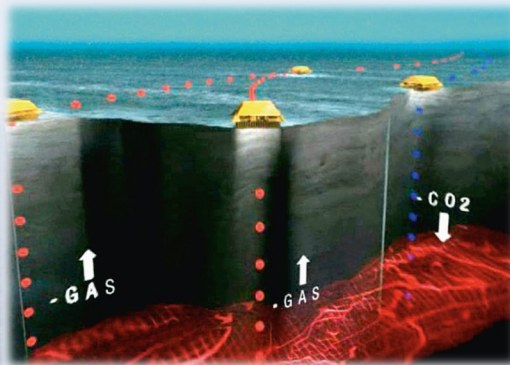
Henrik Solgaard Andersen, VP for Global Hydrogen

# Smeaheia – bringing scale

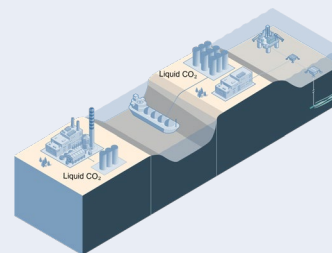
SLEIPNER



SNØHVIT



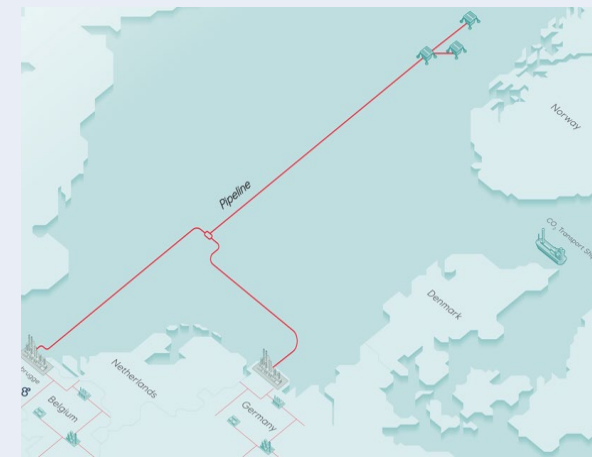
NORTHERN LIGHTS



NORTHERN ENDURANCE PARTNERSHIP



SMEAHEIA



3. Cost down by bringing scale

2. Northern Lights – Market opener

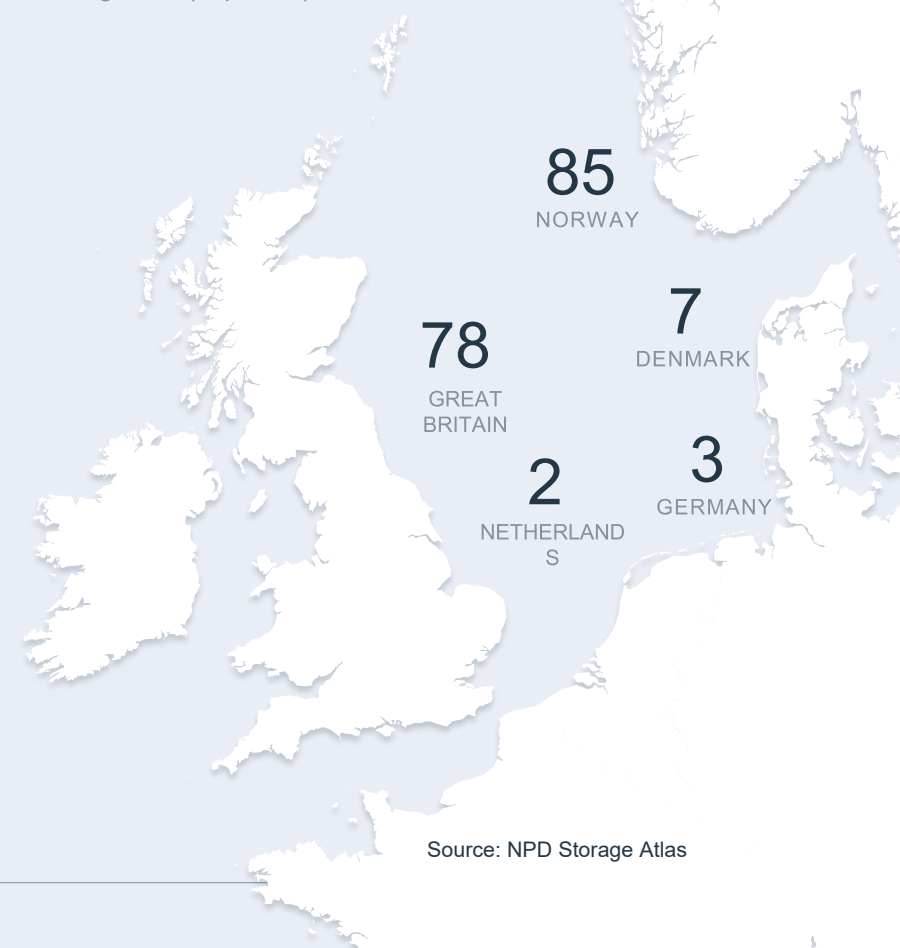
1. Operation experience – technology works!



# European CO<sub>2</sub> pipeline

Connecting large emissions in Europe with storage opportunities in Norway

Large CO<sub>2</sub> storage capacity in the North Sea  
Gigatonn (kapasitet)



Source: NPD Storage Atlas

# Candidate PCI 'EU2NSEA'

## Key highlights

16  
emitters

31  
sites

~34  
CO<sub>2</sub>  
Mtpa

10  
countries

2  
storage sites



# Rikard Kinn

SENIOR MANAGER - PROJECTS

LINCCS; Compact, low OPEX CO<sub>2</sub> capture offshore

26 years' experience from carbon capture & storage, offshore wind and oil & gas industry. Has executed a wide range of tasks and gained a broad commercial and managerial experience and technical knowledge.

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# Compact, low OPEX CO<sub>2</sub> capture offshore

CLIMIT SUMMIT 2023 – BEYOND LONGSHIP  
Larvik - 7-9 February 2023

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# LINCCS LINCCS aims to be a key driver of the green transition

## The challenge

CCS is necessary for reducing CO<sub>2</sub> emissions and ensuring a successful energy transition. However, the current pace of CCS deployment is too slow.

## The solution

Uniting industrial actors and research working across the entire CCS value chain in Norway with common goals.

## Goals by 2030

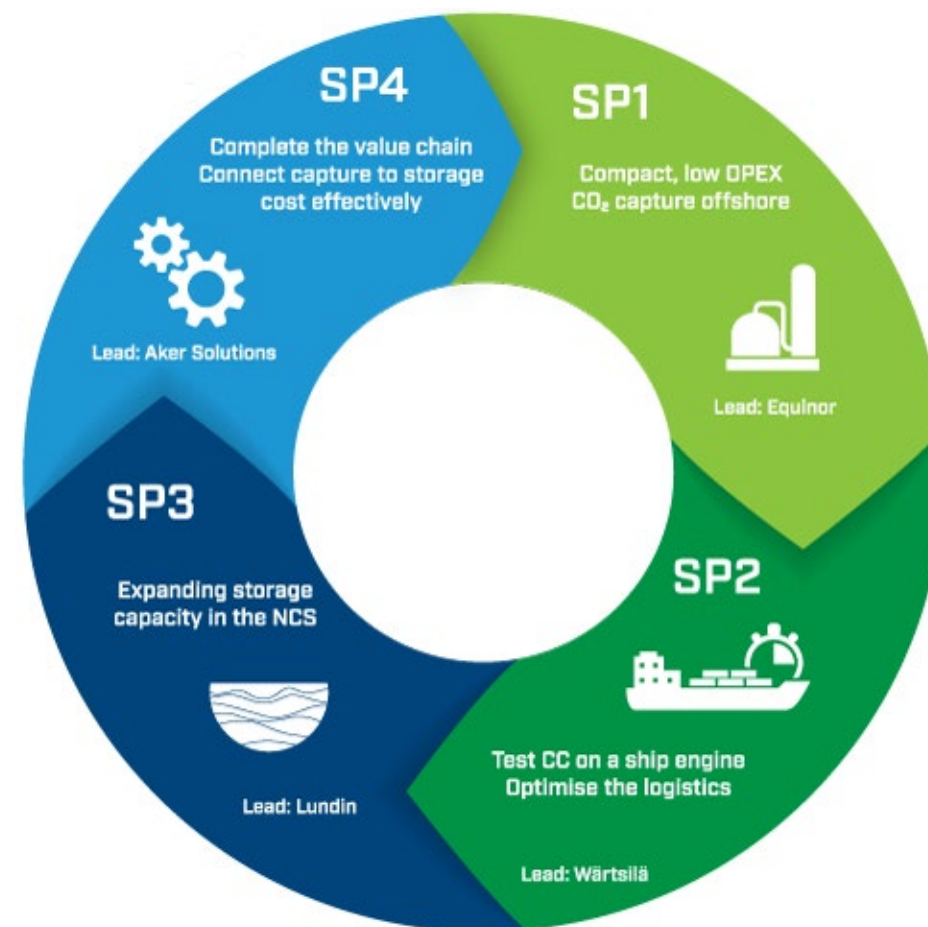
- 70% reduction in CO<sub>2</sub> storage costs,
- 100 million tonnes per year of CO<sub>2</sub> storage unlocked,
- 1000 jobs created, and
- 8 billion NOK revenue/annum

## Partners and funding

- 15 industry and research partners, and 3 governmental funders

## Budget and project period

- 178 MNOK over 2021-2024



## Content



## Today's challenges:

- Electrification of O&G production required, in order to reduce CO<sub>2</sub> emissions
- Green power from shore is a limited resource
- Offshore wind will become available too late

## Viable Solutions:

- Utilize gas resources to produce green, stable power close to consumer
- Carbon capture and permanent storage in close-by reservoir

## Selected concept: Offshore Power Hub

- Floating concept - independent of water depth
- Hub - supplies multiple platforms - reduced LCOE
- Combined Cycle turbines with steam turbine - energy efficient
- Unmanned operations - low OPEX
- Automation / digitalization - low OPEX



### Content

# Thomas Reinertsen

CEO

## Disrupting blue hydrogen production

CEO of HYDROGEN Mem-Tech since June 2017.

22 years experience from different management positions, incl. building and managing fabrication yards and on-/offshore installation.

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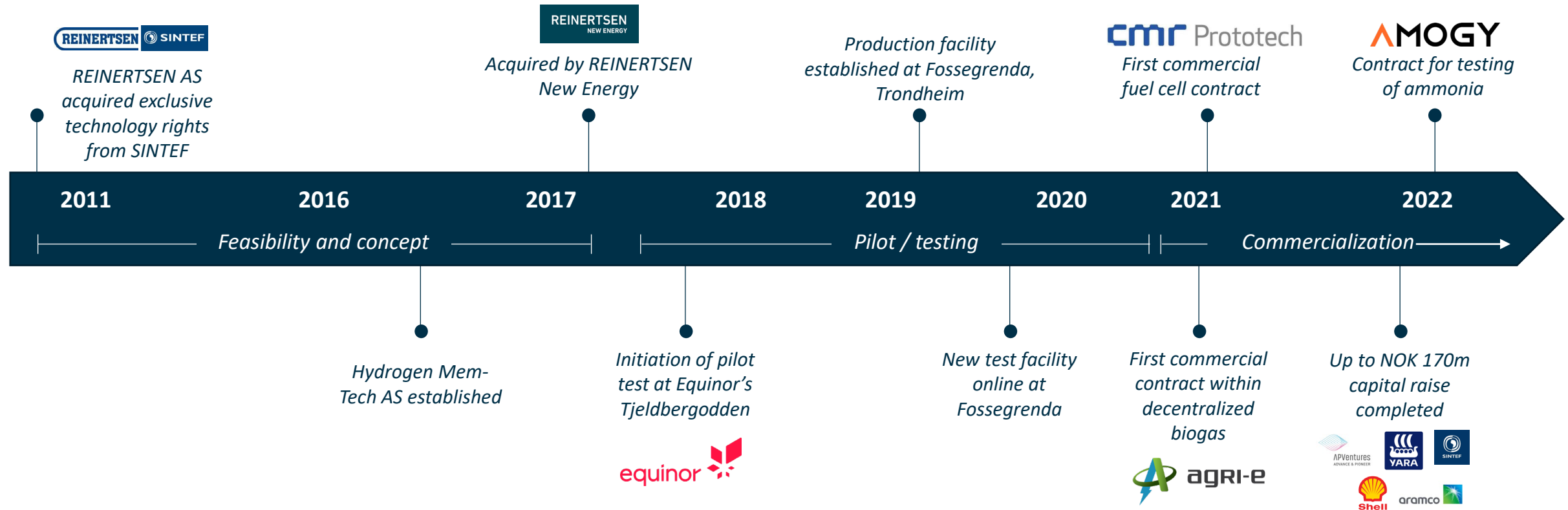
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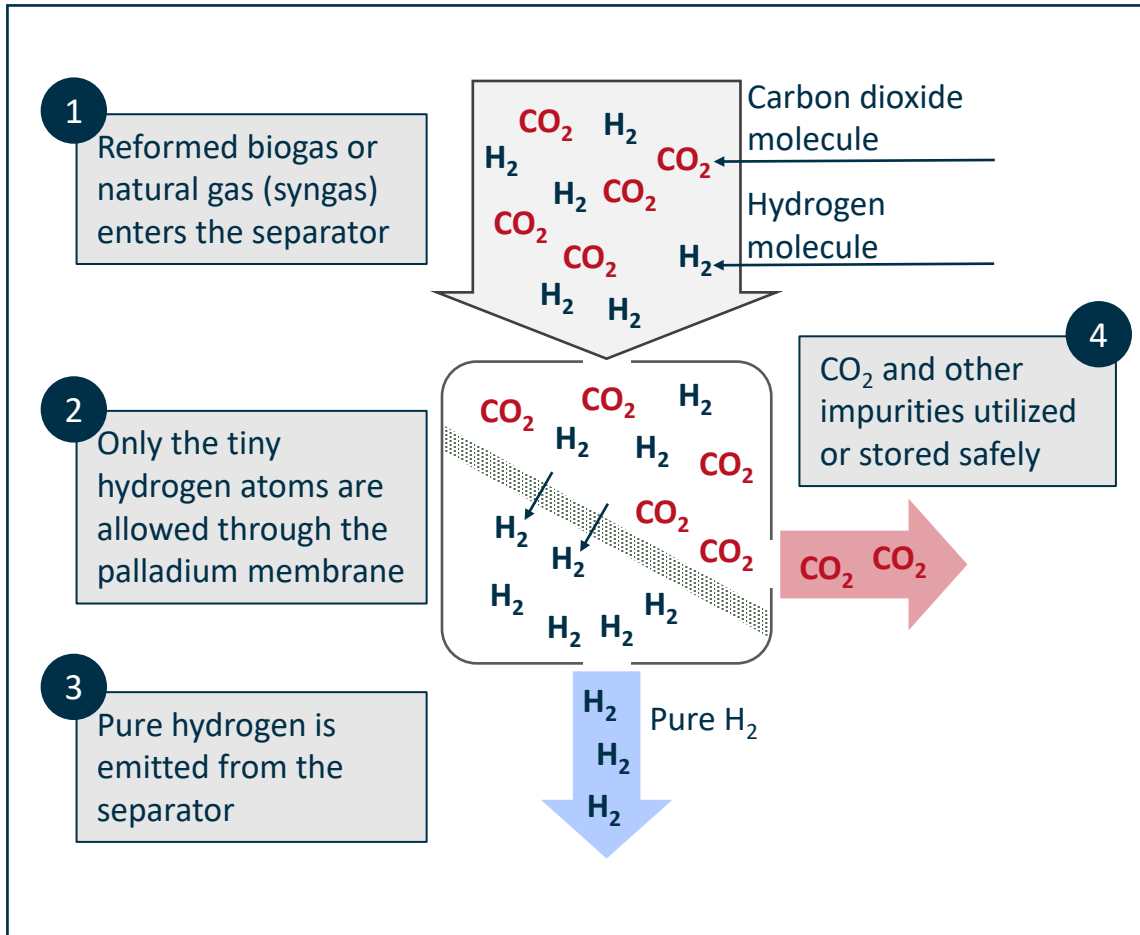
GASSNOVA 

# The story from idea to commercial product







# Disrupt the established

Patented separation using membrane technology

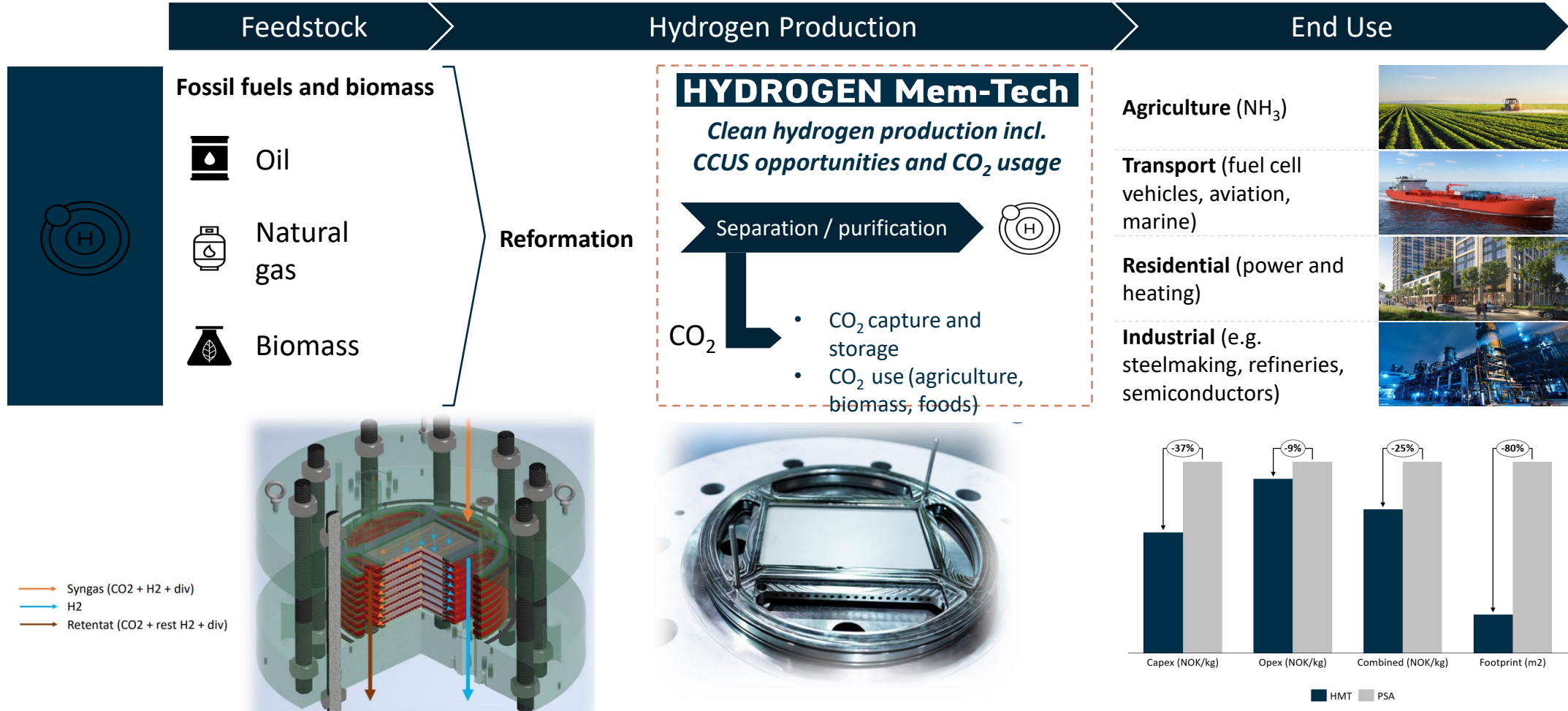


Testing in process to verify long-term performance

	<i>Hydrogen separation from syngas using small frame separator</i>
	<i>Hydrogen recovery from ammonia</i>
	<i>Hydrogen recovery from ammonia using lab scale separators</i>
Confidential company	<i>Hydrogen recovery from cracked ammonia and reformed methanol using lab scale separators</i>
	<i>Hydrogen separation from nitrogen/hydrogen using small frame separator</i>



# Applications and selling points



# Highlights

Item		HMT		Pressure Swing Adsorption (PSA)	
Technology					
Description		Produces clean H <sub>2</sub> and enabling CO <sub>2</sub> capture from natural-, waste-, syn- and biogas		Standard H <sub>2</sub> purification technology	
CAPEX		Low	✓	High	✗
OPEX		Low	✓	High	✗
Footprint / Size		Small	✓	Large	✗
Purity		High	✓	High	✓
CO <sub>2</sub> pressure		High	✓	Low	✗
Scalability		Good (modular)	✓	Limited	✗
Suitability	Small scale	Yes	✓	No	✗
	Large scale	Yes	✓	Yes	✓

## High purity

Up to 99.9%

- Higher value product
- Access to market segments with high purity demands



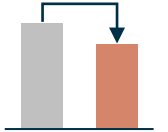
## High recovery factor & yield

- Improves overall production economics
- Higher recovery factor gives higher yield



## Smaller footprint

- Lower CAPEX
- Higher capital efficiency
- Brownfield retrofit/upgrade



## No moving parts

- Lower OPEX (maintenance etc.)
- High uptime



## Modular

- Up to 90% reduced footprint
- Ability to scale as demand changes
- Turndown capability



# Technology and capital

- New-Tech and capital are closely connected
- The Norwegian model and behavior giving advantage wrt. trust
- Soft funding, risk-willing capital, industrial competence and collaboration with universities/R&D
- But, we are slow movers, and time is running out
- Closer collaboration between soft funding and venture capital
  - Demand more!



# Highlights

**Unique, validated,  
and patented  
technology superior  
to existing  
solutions**

Commercially ready after  
10 years of development  
and successful testing

**Massive market  
opportunity forming  
an integral part of  
the energy  
transition**

Vast range of potential use  
cases - initial focus will be  
on decentralized and large-  
scale production

**Initial commercial  
contracts already  
delivered**

Currently ramping up  
production capacity to  
enable execution on an  
attractive pipeline of new  
potential opportunities

**High credibility in  
execution**

Highly experienced team  
with decades of industrial  
competence backed by a  
strong shareholder base

**Enabler for clean and competitive hydrogen production**

# Jon Christopher Knudsen

CHIEF COMMERCIAL OFFICER

Building commerciality for CCUS - the road from Longship to full European deployment

Jon Christopher Knudsen is Chief Commercial Officer (CCO) in Aker Carbon Capture. With nearly 20 years in the oil and energy sector, Knudsen has held several leadership positions in digitalization, customer experience, strategy and HR in the Aker Solutions group.

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Longship Sails on

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# Kim Hjarðar

LECTURER

## The Longships

Kim Hjarðar has an MPhil in Nordic Viking and Medieval Culture studies from the University of Oslo and works as a Lector of History at St. Hallvard College. Hjarðar has published many books about the Vikings.

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# Jannicke Gerner Bjerkås

DIRECTOR CCS

World's first full-scale CCS on waste incineration under construction!

Jannicke Gerner Bjerkås is the CCS Director in Hafslund Oslo Celsio, leading the carbon capture project at their Waste-to-Energy plant. She has various experience from managing positions. Bjerkås is a former officer with education from the Norwegian Air Force Academy (RNoAF).

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## Energy sources:



EXCESS  
WASTE HEAT



ELECTRICITY



HEATPUMP/  
SEWER



DATACENTER



WOOD PELLET



BIOFUEL

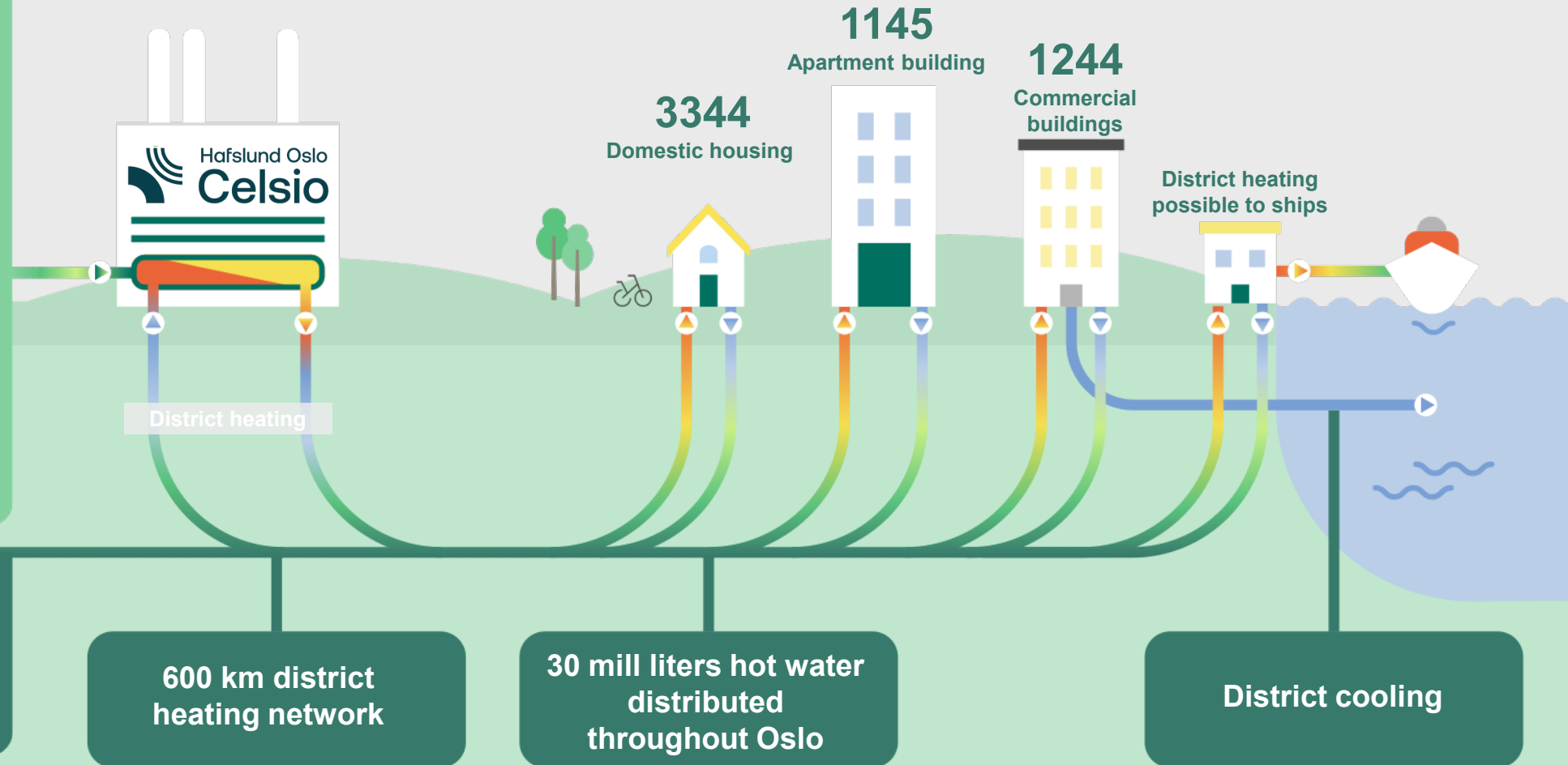


FOSSIL OIL



LNG

# Celsio



ENERGY RECOVERY  
FROM 400.000 TONNES  
WASTE/ YEAR

Production approx  
**152 GWh**  
electricity (est. 200)



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# Celsio with new owners



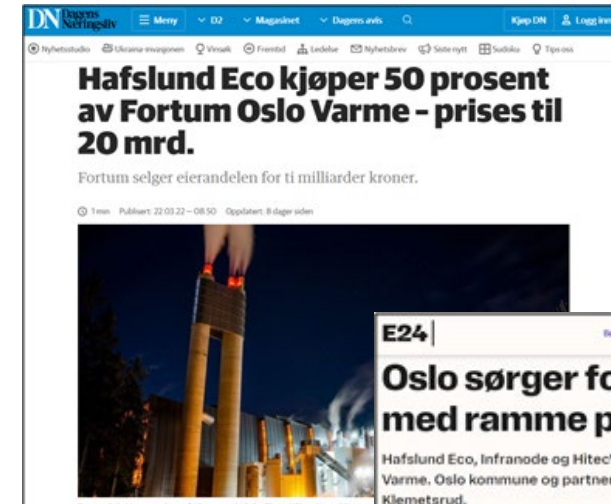
**HITECVISION**

(20 %)



(20 %)

- Agreement signed 22. mars 2022
- Transaction completed 19. mai 2022
- FID 28. juni 2022, start 1. July 2022
- CCS financing secured with contributions from State, City of Oslo and Celsio



## De vil satse milliarder på å kjøle ned folk i Oslo

De nye eierne av Fortum Oslo Varme har planer som går langt utover fangst av CO<sub>2</sub>. De lover å investere nær 10 milliarder kroner i både fjernvarme og fjernkjøling i Oslo de neste årene.



# World's first full-scale CCS project on Waste-to-Energy from 2026

- Part of **Longship** CCS project; permanent geological storage below seabed
- 400 000 tons CO<sub>2</sub> /year, 90% CO<sub>2</sub> capture
- CCS on Waste-to-Energy provides 50 % CDR
- Studies completed 2015-2021
- Demonstrates truck transport of CO<sub>2</sub> to port
- Successful testing on real flue gas 2018, new test period with modified amine Fall 2021
- Technology supplier Shell with full-scale experience, EPC contractor TechnipEnergies



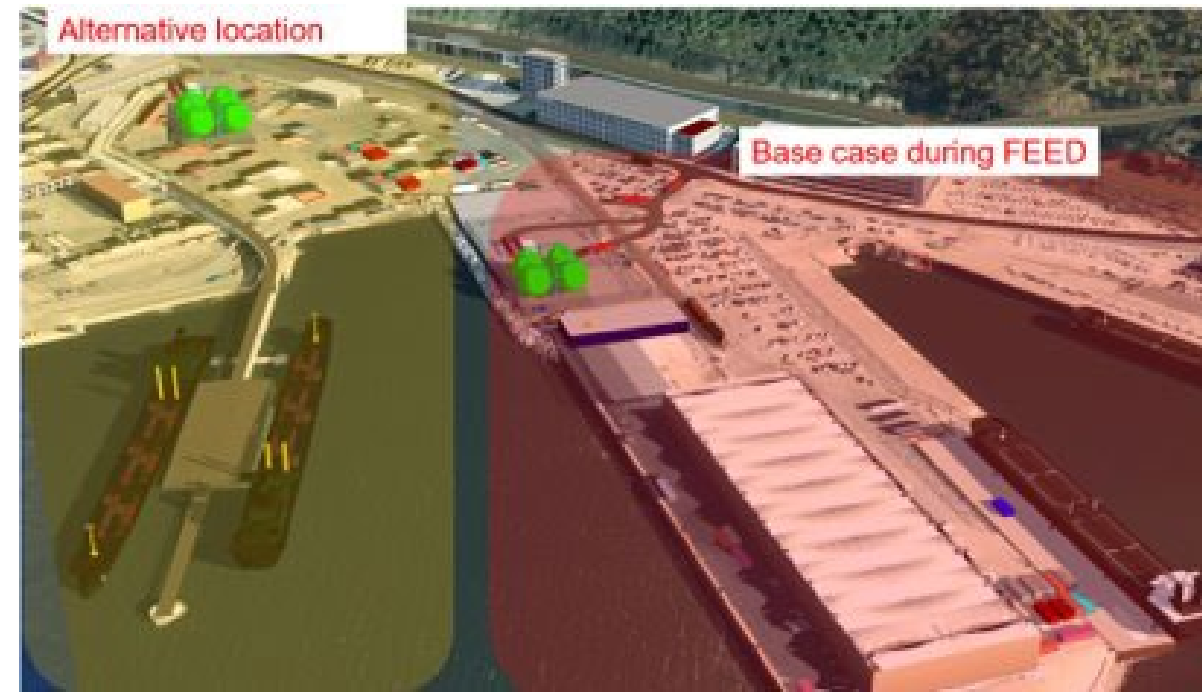






# Challenges and main risks

- 1) Organization – necessary with more resources and different organisation structure than anticipated
- 2) Area demand
  - a) Logistics and rig areas
  - b) Temporary solutions for parking, admin etc.
  - c) New entrance to incineration plant
- 3) Final location at Port of Oslo changed
- 4) Civil works, infrastructure and plans for building and operations simultaneously
- 5) Local power demand and timeline for new transformer station



**Europe will need 100 more WtE plants  
like Celsio's to deal with residual waste,  
even after reaching goals for increased  
recycling and reduced landfilling**

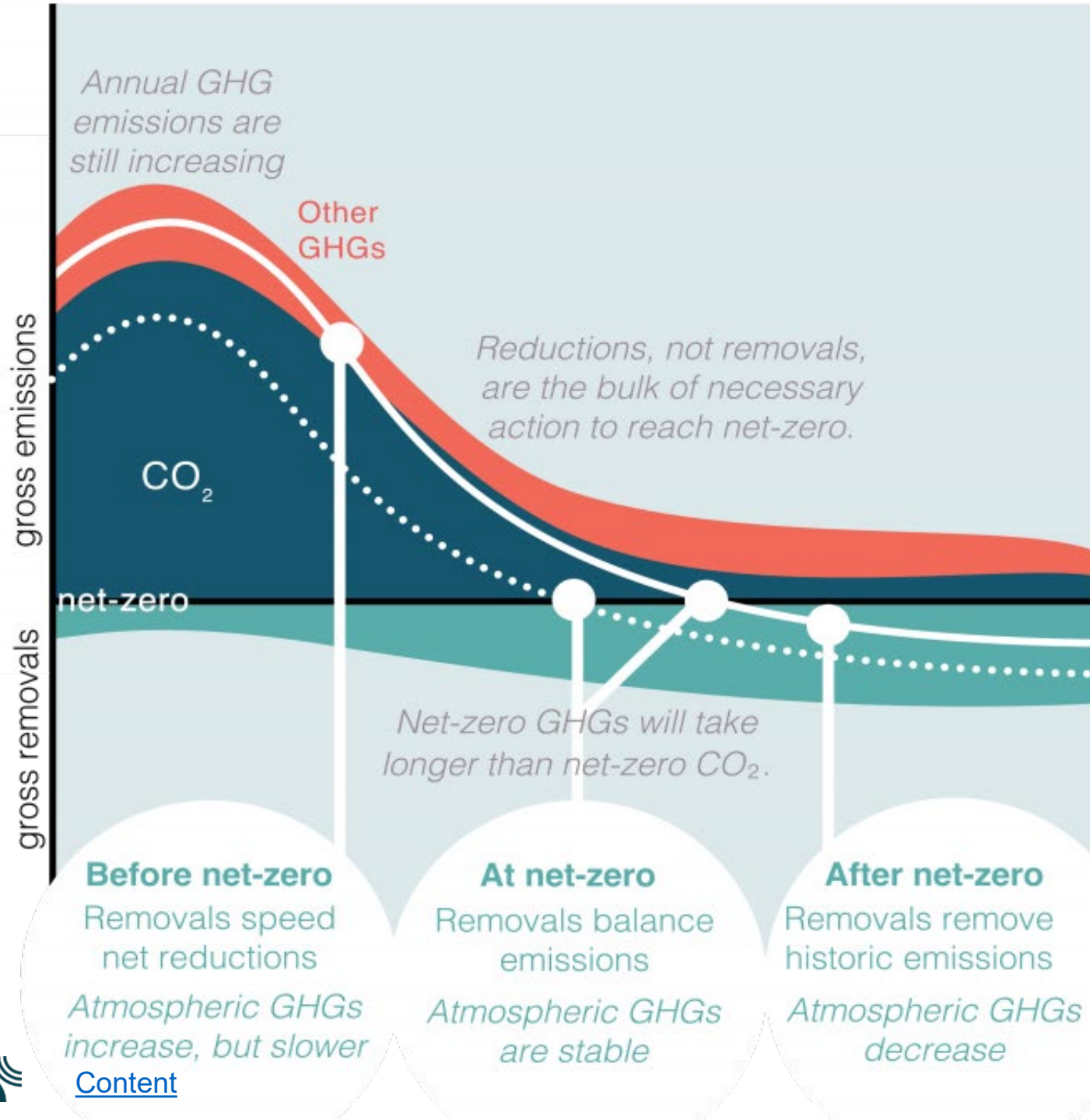


# Potential future revenues

- **Avoided costs (fossil part of emissions)**
  1. **Carbon removal (CDR) certificates**
  2. Net Zero Plastic certificates
  3. Increased gate fee for carbon neutral waste services
  4. Improved standing for district heating
  5. CCS business development





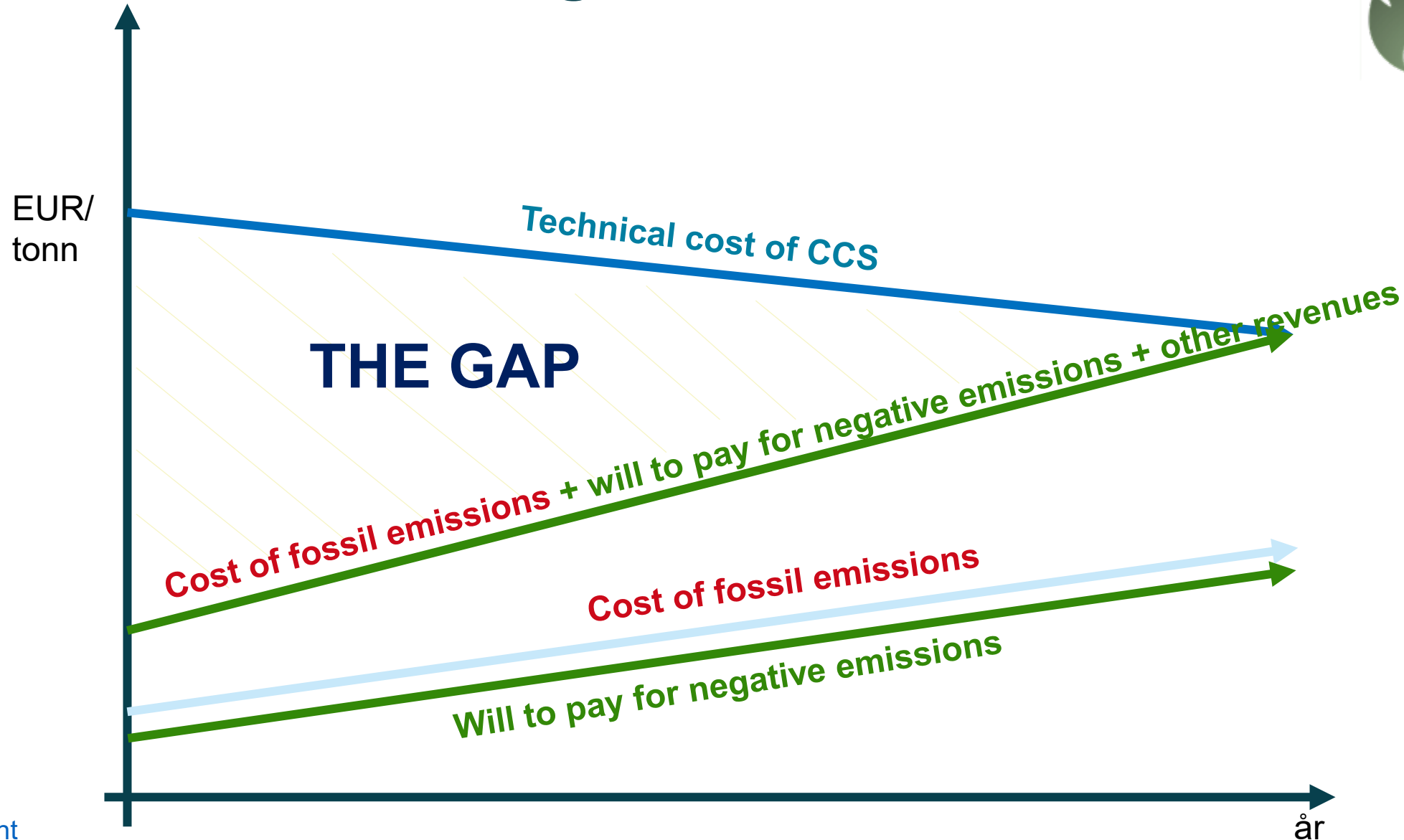


# The potential of Carbon removals

- **Net zero** by 2050
- EU legislation/framework
  - Permanence
  - Sustainability
  - Single counting of removal
  - Additionality

**Bellona:** "The three sequential roles of carbon dioxide removal in mitigating catastrophic climate change (Stylized rendering; adapted from IPCC 2022)"

# Need for public funding of THE GAP, but for how long?



# Vetle Houg

SUSTAINABILITY MANAGER

We are doing it – the cut that matters

Has been working within the cement and concrete industry since 2001.  
Communication Manager in HeidelbergCement Norway 2008-2018,  
manager of Brilliant Buildings, later Betongfokus 2018-2022.  
Sustainability manager in Heidelberg Materials Norway since 2022.

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An aerial night photograph of a city, likely Berlin, showing the Spree river winding through the urban landscape. The city lights are visible, and the river reflects the surrounding lights. A large green semi-transparent shape is overlaid on the left side of the image, containing the main text.

# We are doing it! – the cut that matters

Climit Summit | Vetle Houg  
2/12/2023



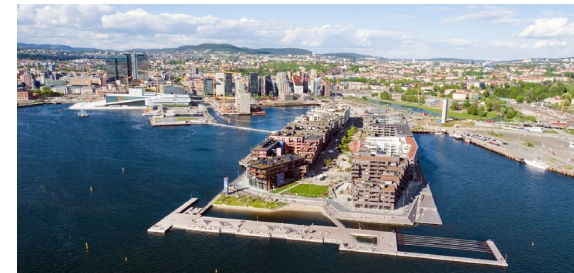


# Concrete is the foundation of our society





# Concrete is the foundation of our society

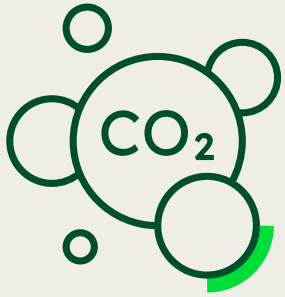




# Concrete is the foundation of our society



# The downside is large CO<sub>2</sub> emissions ...

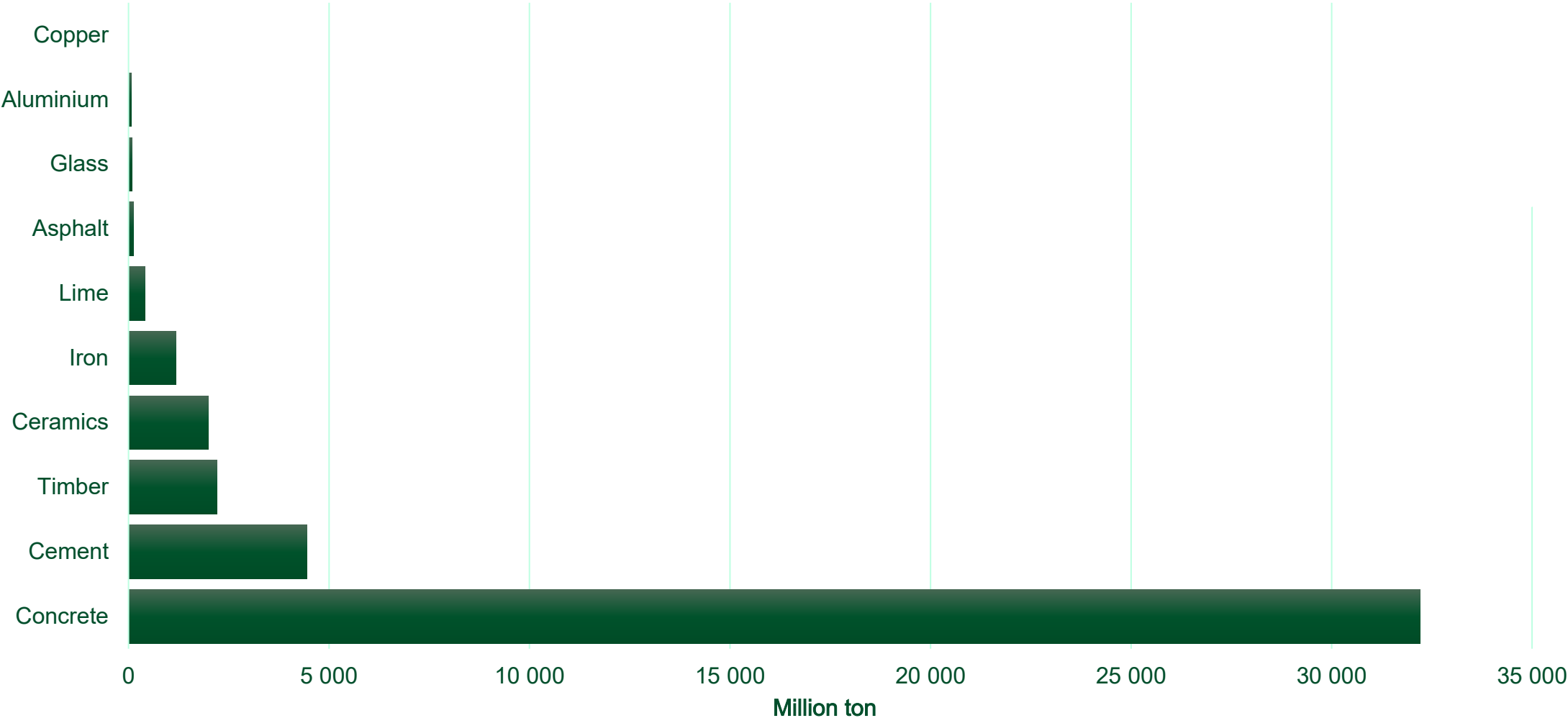


5-7 % of global CO<sub>2</sub> emissions

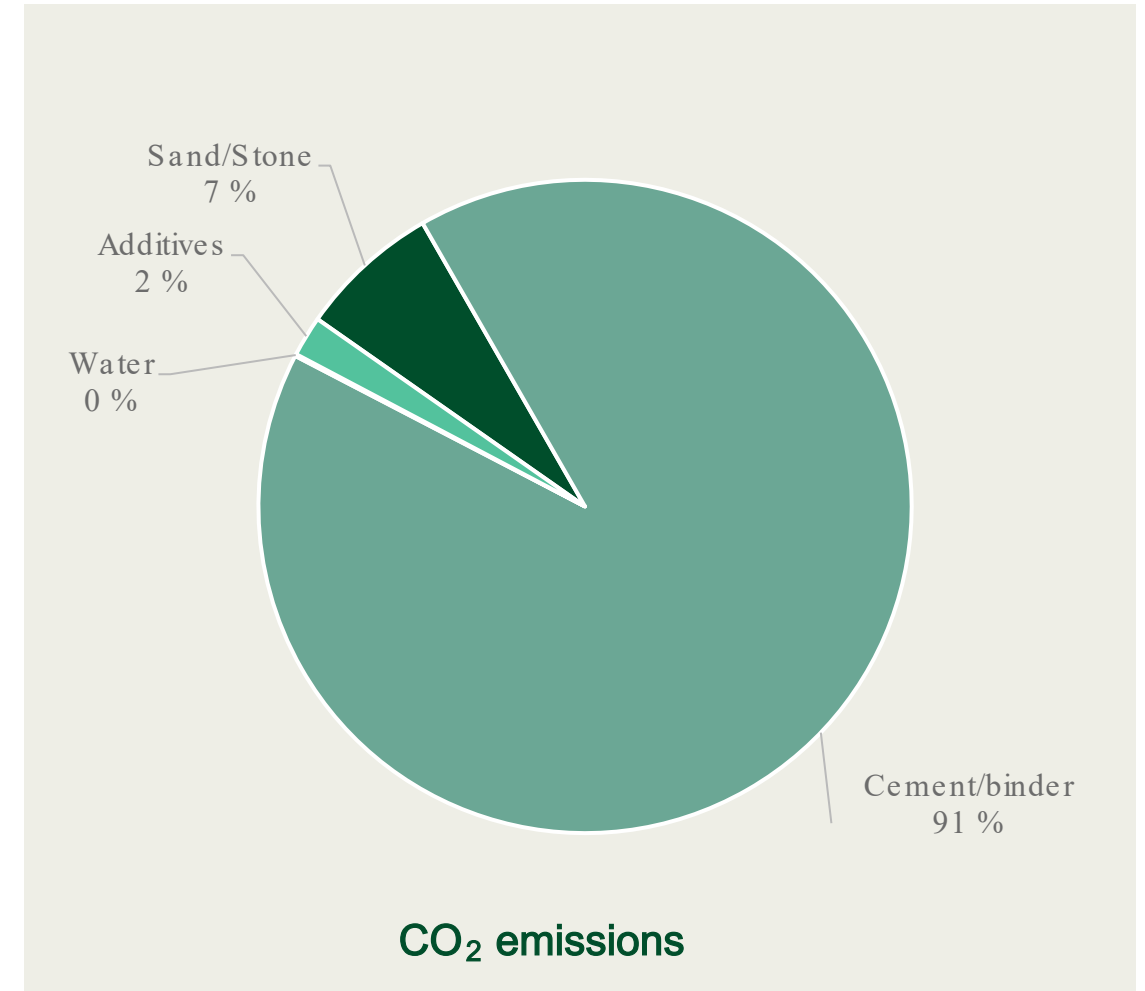
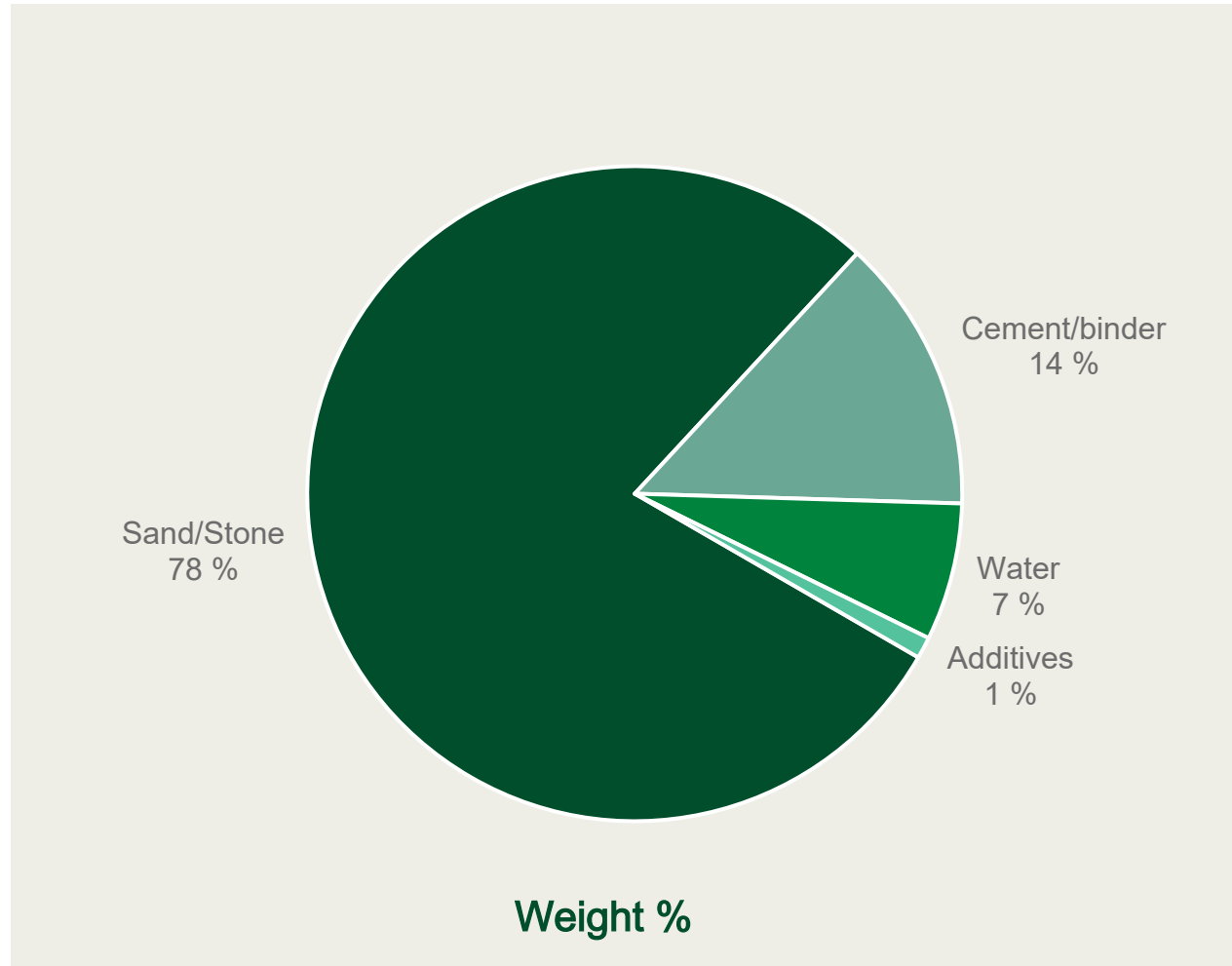
But you get a durable, flexible and recyclable material!



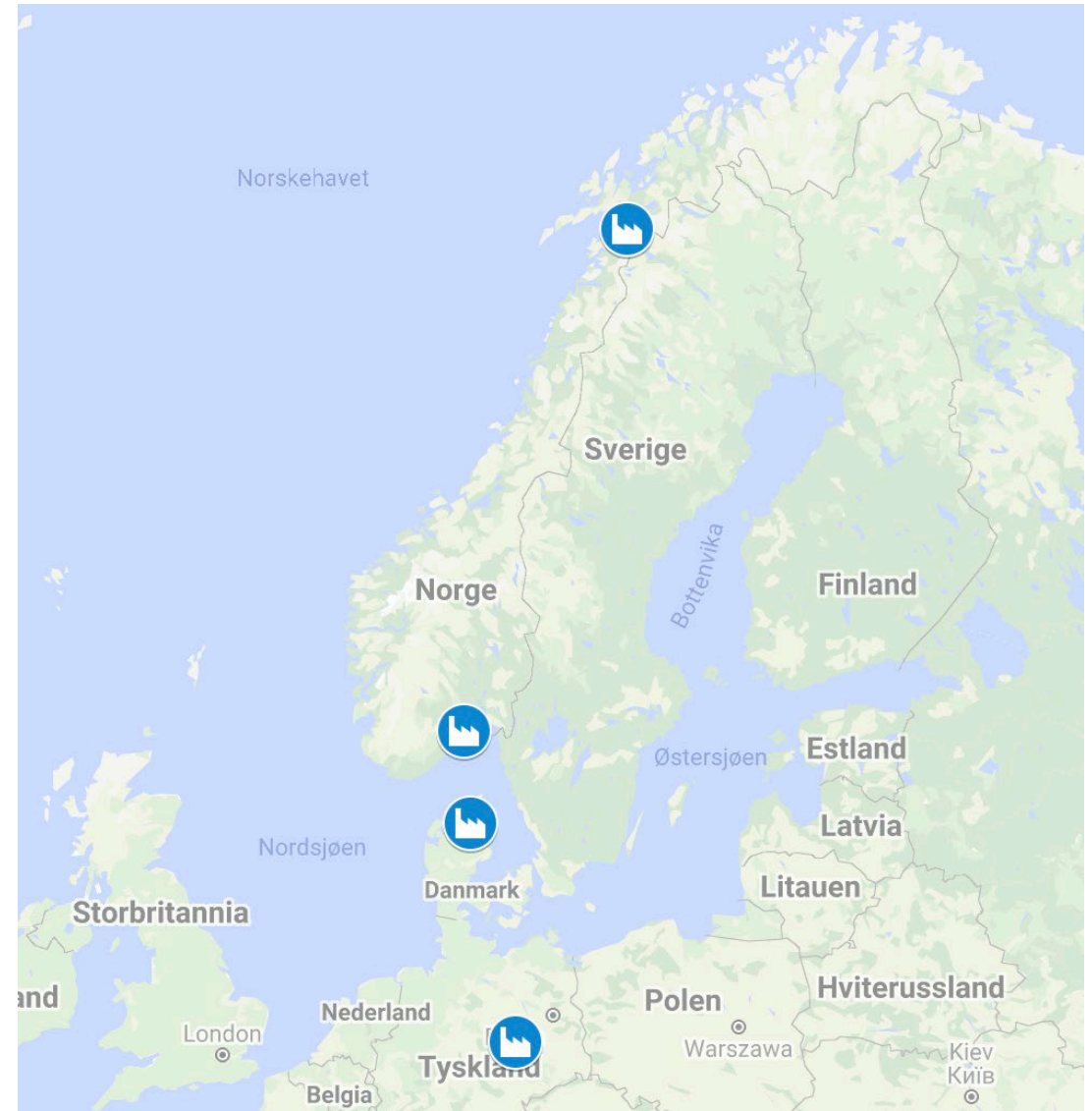
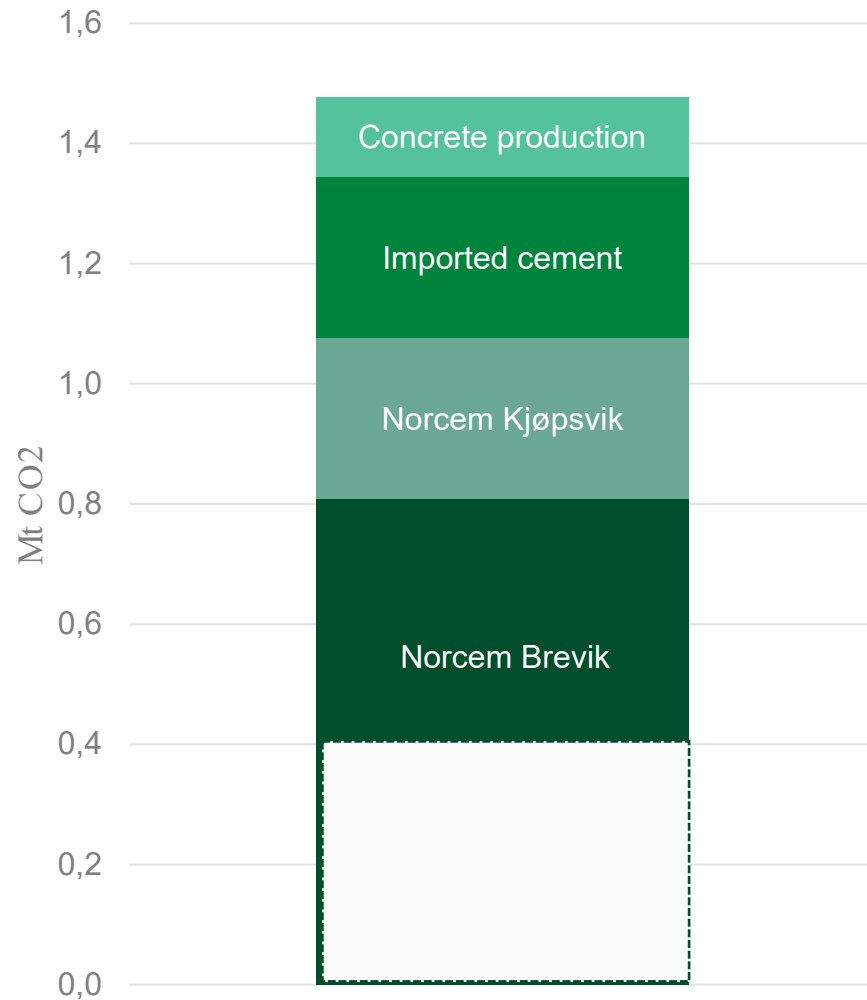
# Global production volume of concrete is enormous!



# What makes up concrete and its emissions?

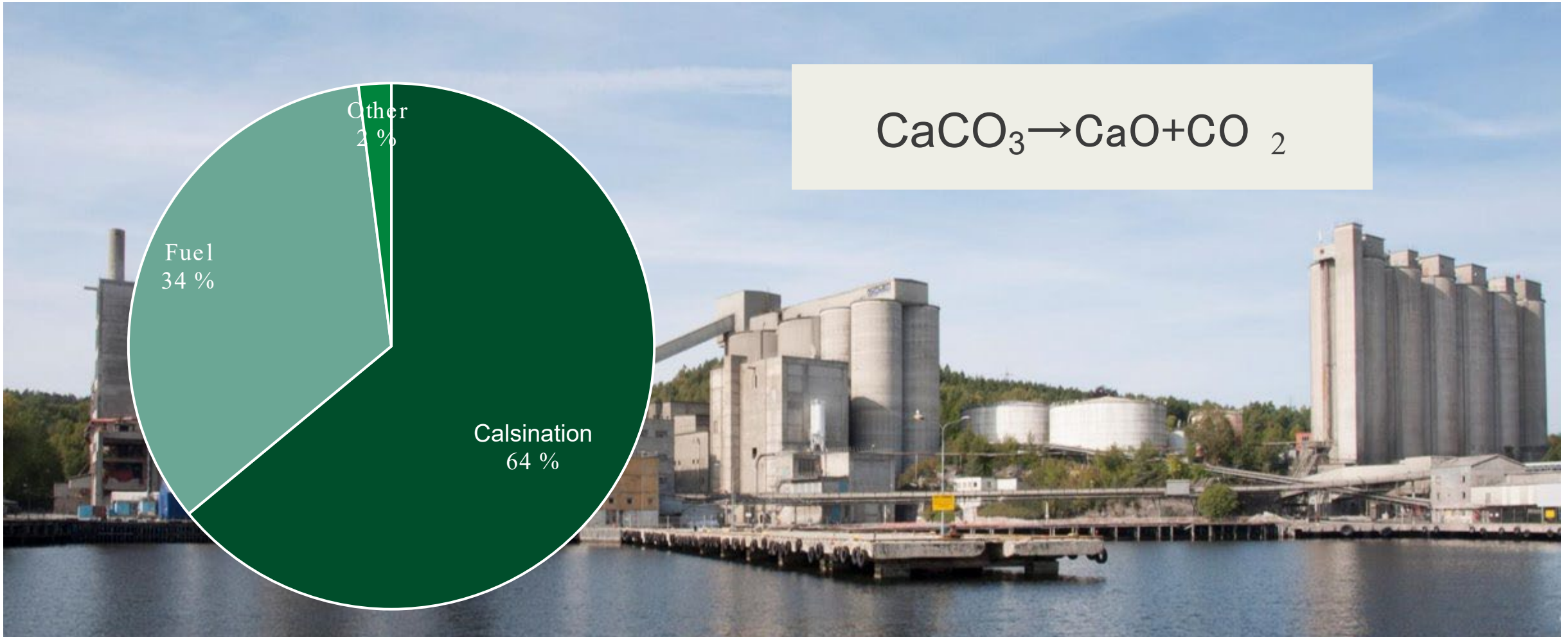


# Emission sources for concrete in Norway



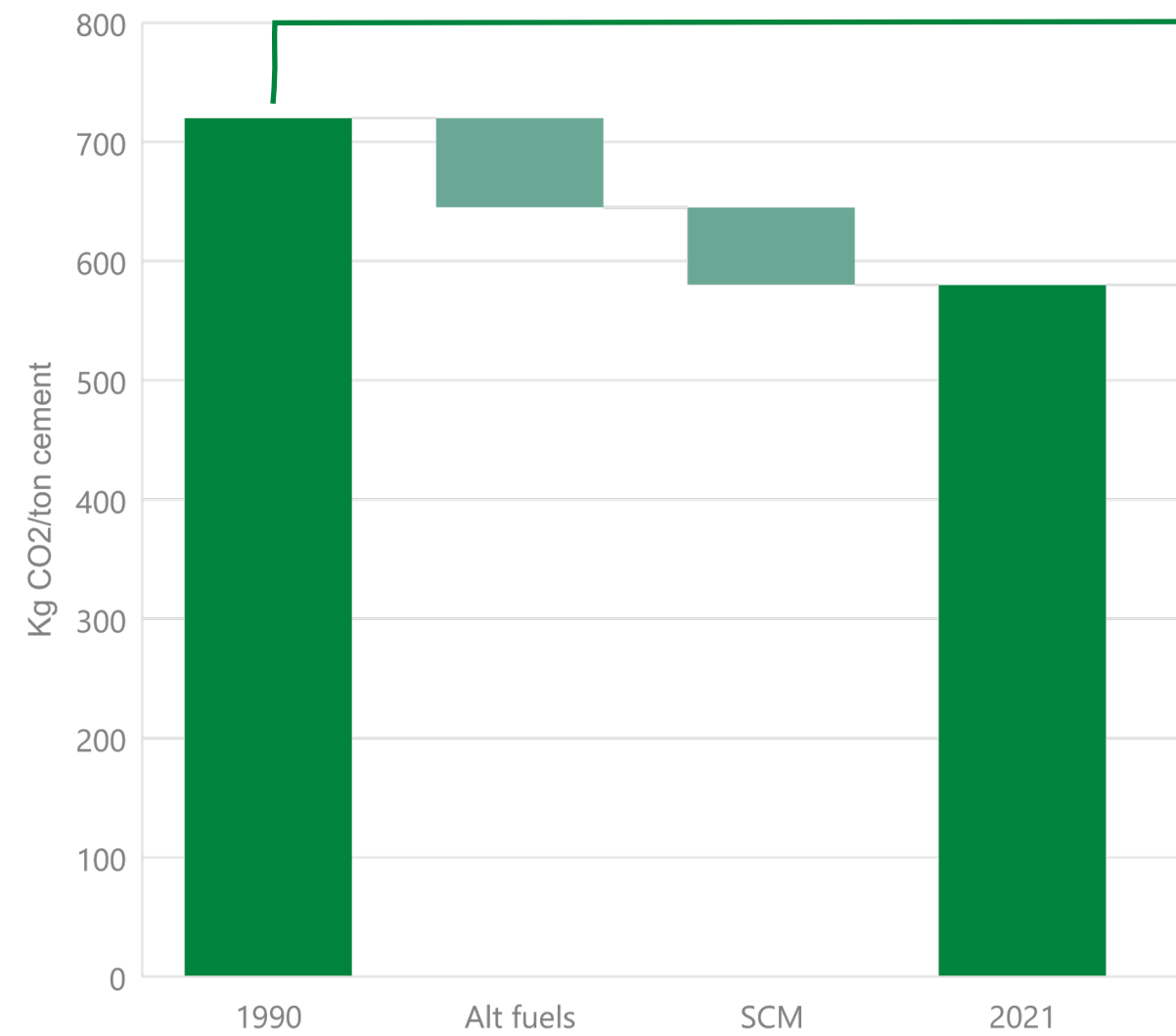


# Why cement production emits CO<sub>2</sub>





# Em ission development towards 2025, Brevik plant

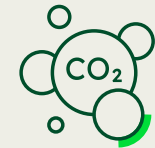


# Our bold project: Brevik CCS – the world's first in the cement industry!



When all traditional levers  
are fully utilized, what's next?

Capturing CO<sub>2</sub> !



## 400 kt

CO<sub>2</sub> capture per year



Demonstrate that **it is possible to decarbonize** a hard to abate sector





And now: Construction!





And now: Construction!



2/12/2025 Climate Summit, Vettel House



Heavy lifting – large major parts will be installed





# Major parts (soon) ready for assembly



Absorber photographed at construction site in Holland



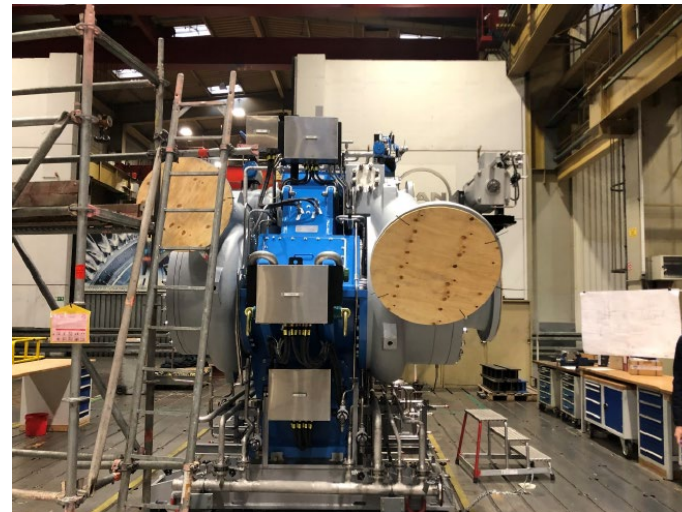
Module preassembled in Lithuania



Desorber



Oil lube unit



CO<sub>2</sub> compressor



DCC



### Project facts:

Capture capacity: 400,000 t/y

Heat recovery: 46 MW

Operational: H2, 2024

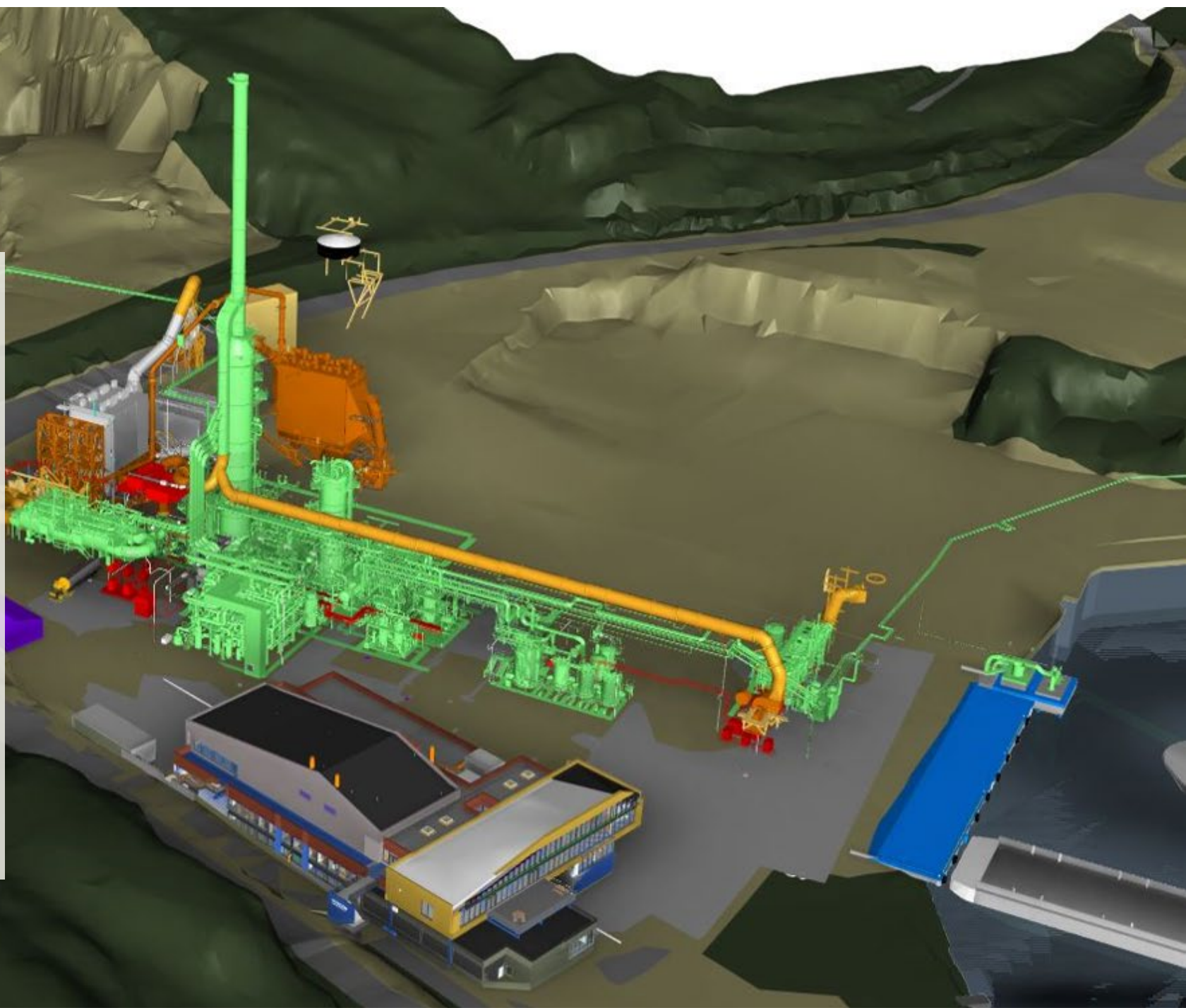
Concrete: 9,800 m<sup>3</sup>

Rebar: 1,500 t

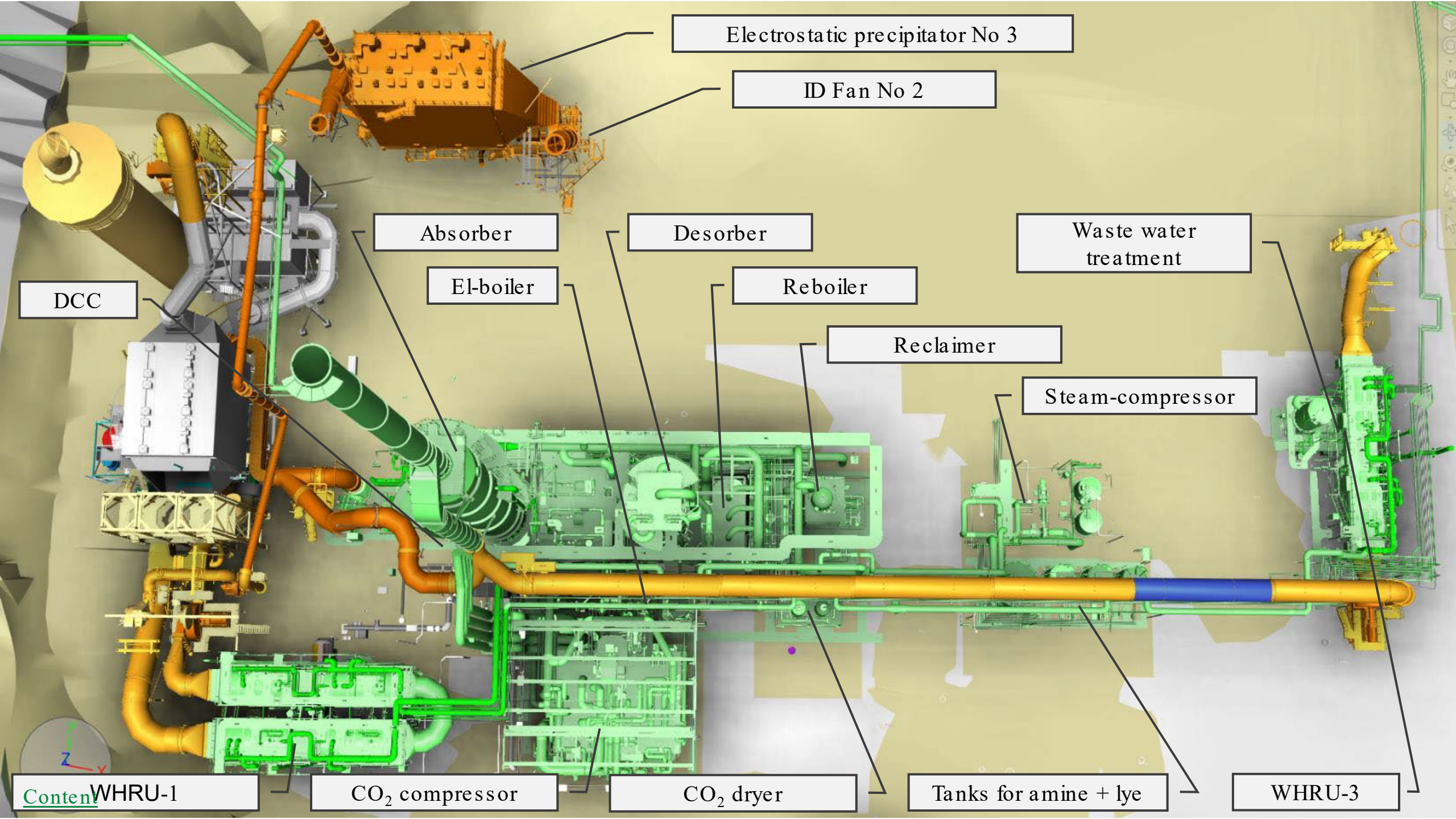
Piles: 12.5 km

Steel structure: 1,650 t

Hight, absorber 103 m







Electrostatic precipitator No 3

ID Fan No 2

Absorber

Desorber

Waste water  
treatment

E1-boiler

Reboiler

DCC

Reclaimer

Steam-compressor

[Content](#) WHRU-1

CO<sub>2</sub> compressor

CO<sub>2</sub> dryer

Tanks for amine + lye

WHRU-3

# Storing and ship loading

**Storage capacity:** 5,000 m<sup>3</sup>

4 days of production

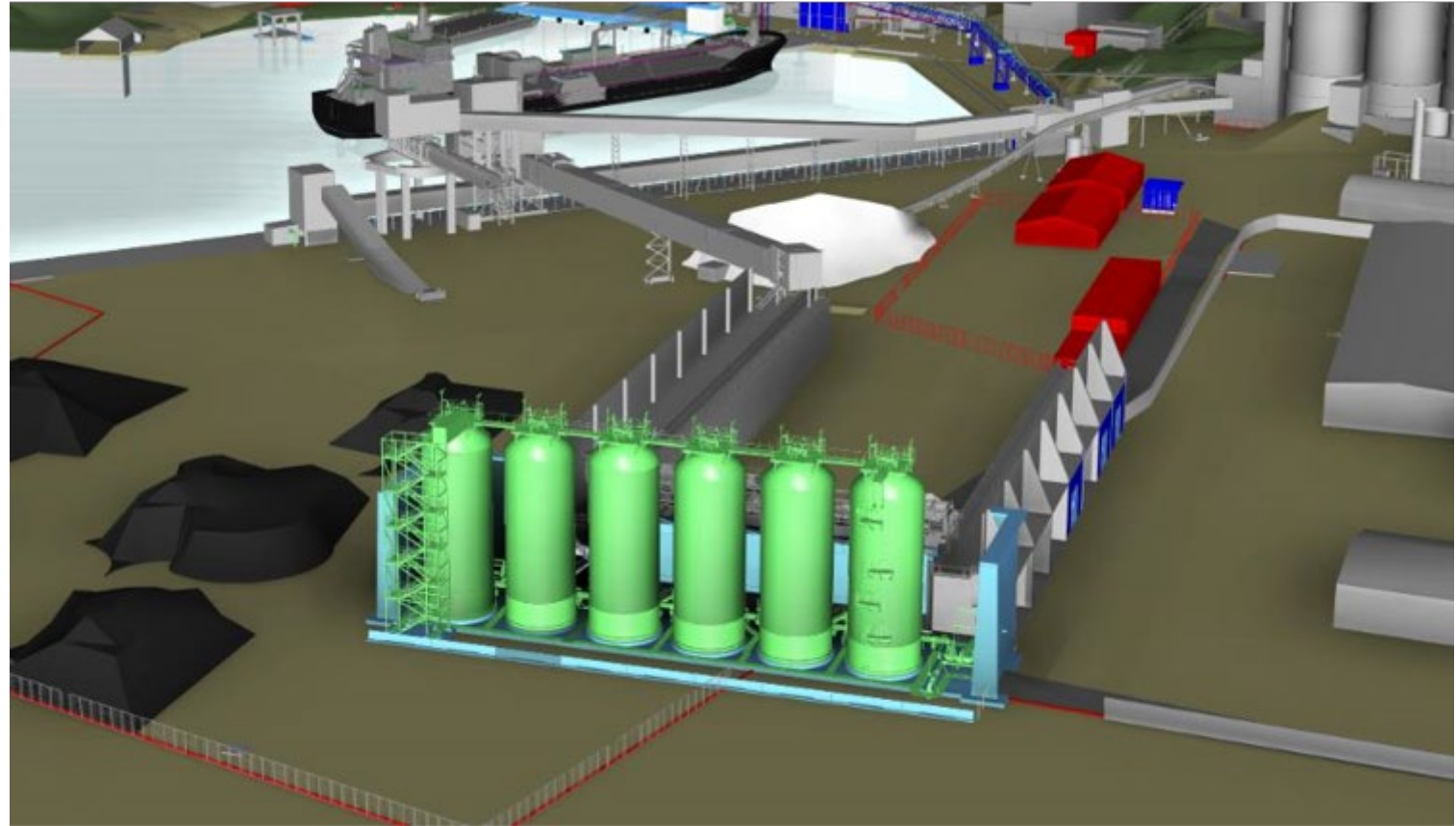
**State of CO<sub>2</sub>**

Liquid, - 26° C, 16 bar

**6 Insulated tanks**

- No active cooling
- Natural evaporation  
(return to capture plant)

**Return of displaced gas from ship back to capture plant during ship loading**









# Cooperation, support and public acceptance: key pre-requisites



Interest for the project has been overwhelming

From students to royalty



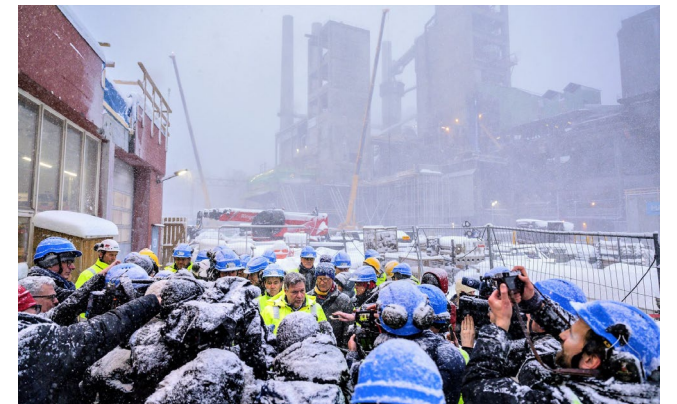
Support from authorities and government

Every step of the way



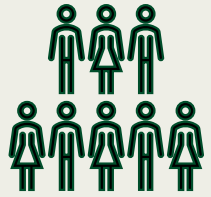
Industrial partnerships along a value chain

Aim for replicability





## Positive and inspiring media attention!



Interest for the project  
has been overwhelming

From students to royalty –  
and a German vice  
chancellor!



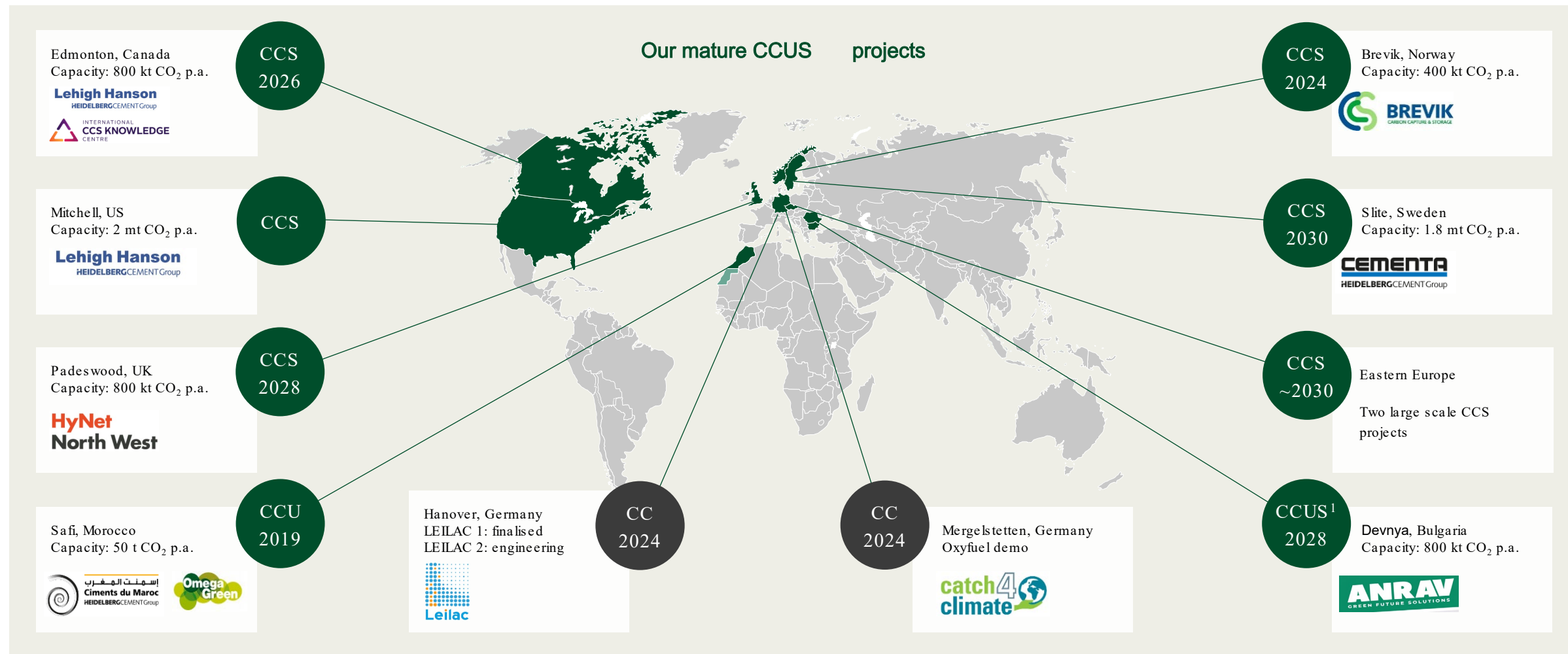








# The snowball is now rolling!



We target to cumulatively capture 10 Mt CO<sub>2</sub> by 2030!







Heidelberg  
Materials

# Christian Buch Hansen

SUSTAINABILITY MANAGER

## Northern Lights: Delivering on our Commitments

Christian Buch Hansen recently joined Northern Lights JV as Communication & Government relations Director. Buch Hansen has solid experience from Communication within both public and private sectors.

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# Northern Lights – Delivering on our commitments

Climit Summit 9.2.2023

Christian Buch Hansen, Communication & Government Relations director Northern Lights JV

# Longship value chain



## LONGSHIP

### CO<sub>2</sub> capture

Capture from industrial plants.  
Liquefaction and temporary storage.



## NORTHERN LIGHTS SCOPE

### Transport

Liquid CO<sub>2</sub>  
transported by ship.



### Receiving terminal

Intermediate onshore storage.  
Pipeline transport to offshore storage location.



### Permanent storage

CO<sub>2</sub> is injected into a saline aquifer.

100 km

2 600 m



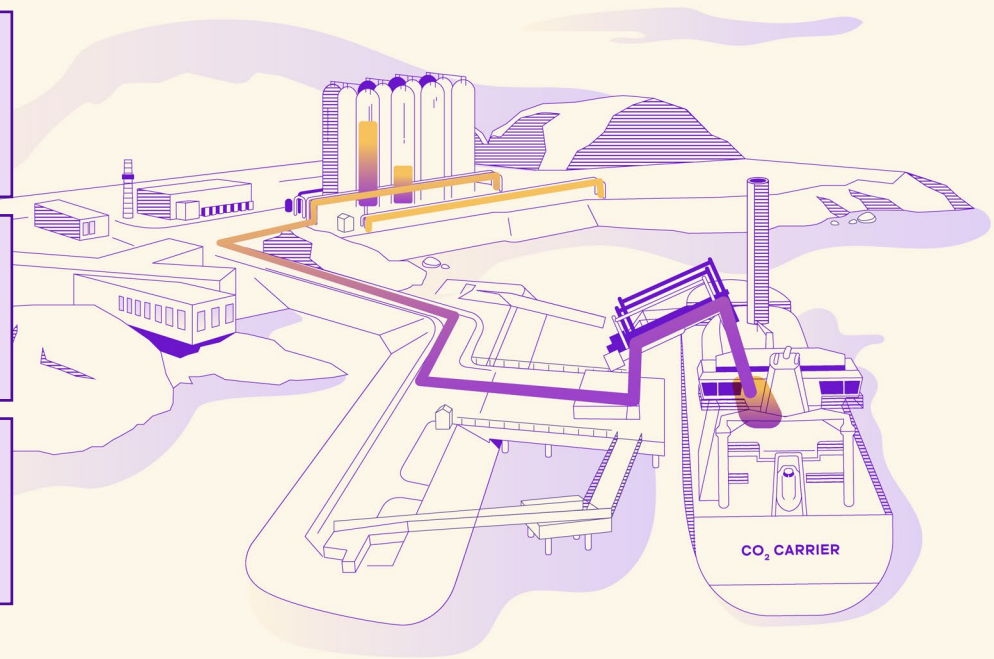


# FOCUS: Delivering on commitments

**1** Deliver Phase 1 - operational in 2024

**2** Develop **commercial expansion (Phase 2)**

**3** Deliver on **growth ambitions** to meet market demand

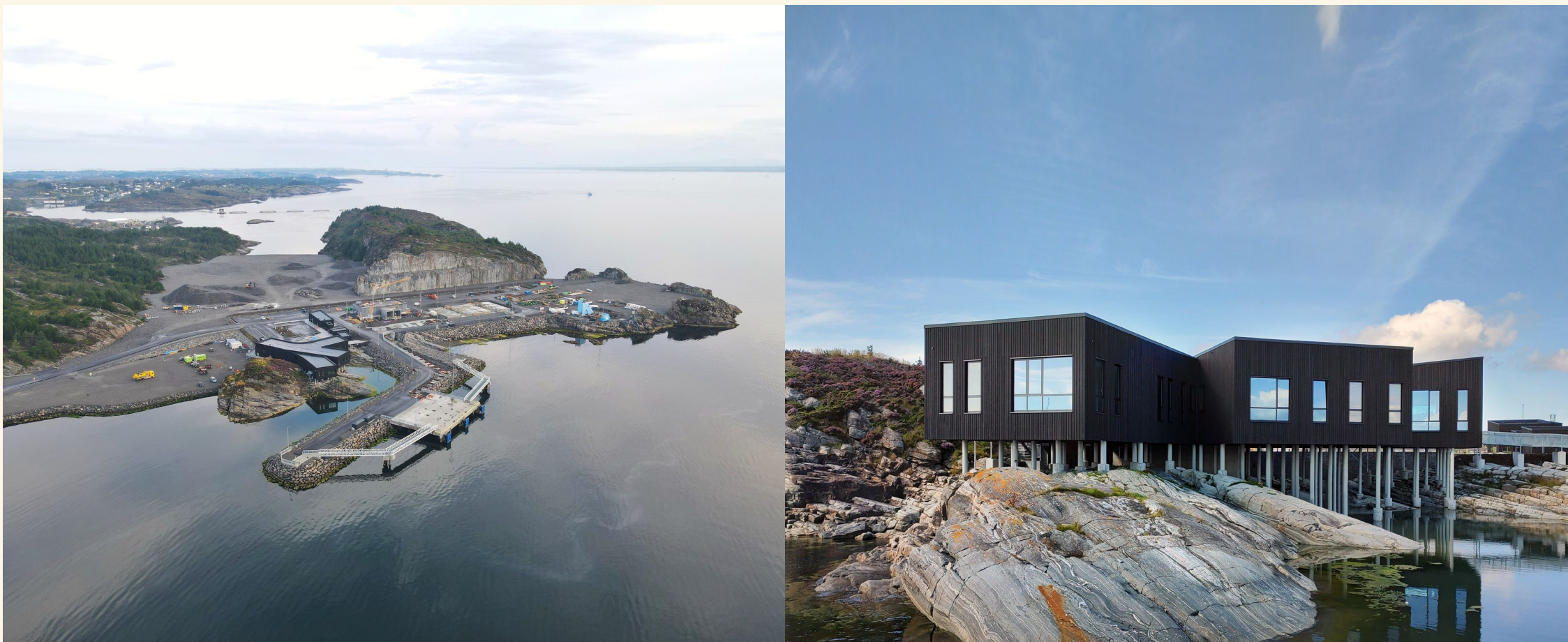


# Started construction of worlds largest CO2 ships at Dalian yard, China





# Northern Lights facilities

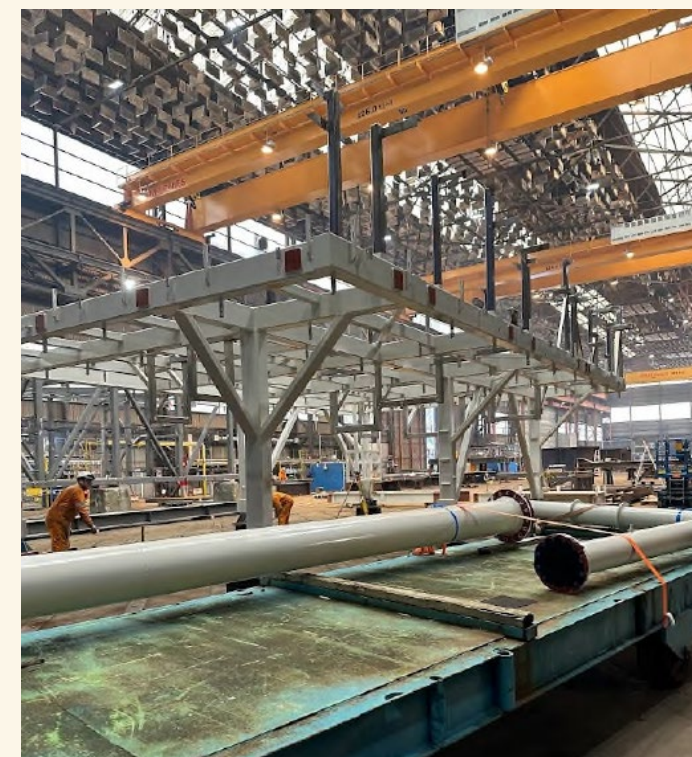
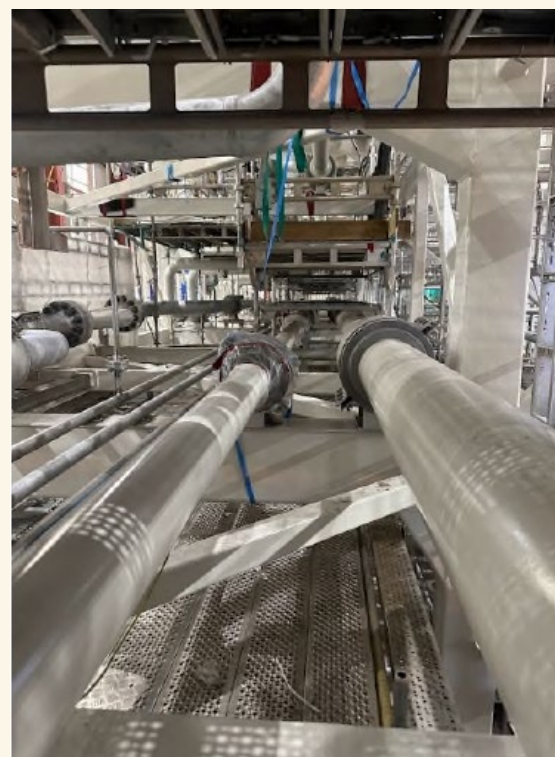




## Aker Stord yard:

Fabrication of piping, pipe racks, stair towers and other structures

Shipment to site in Øygarden from November 2022 – March 2023





# First shipment of tanks – November 2022



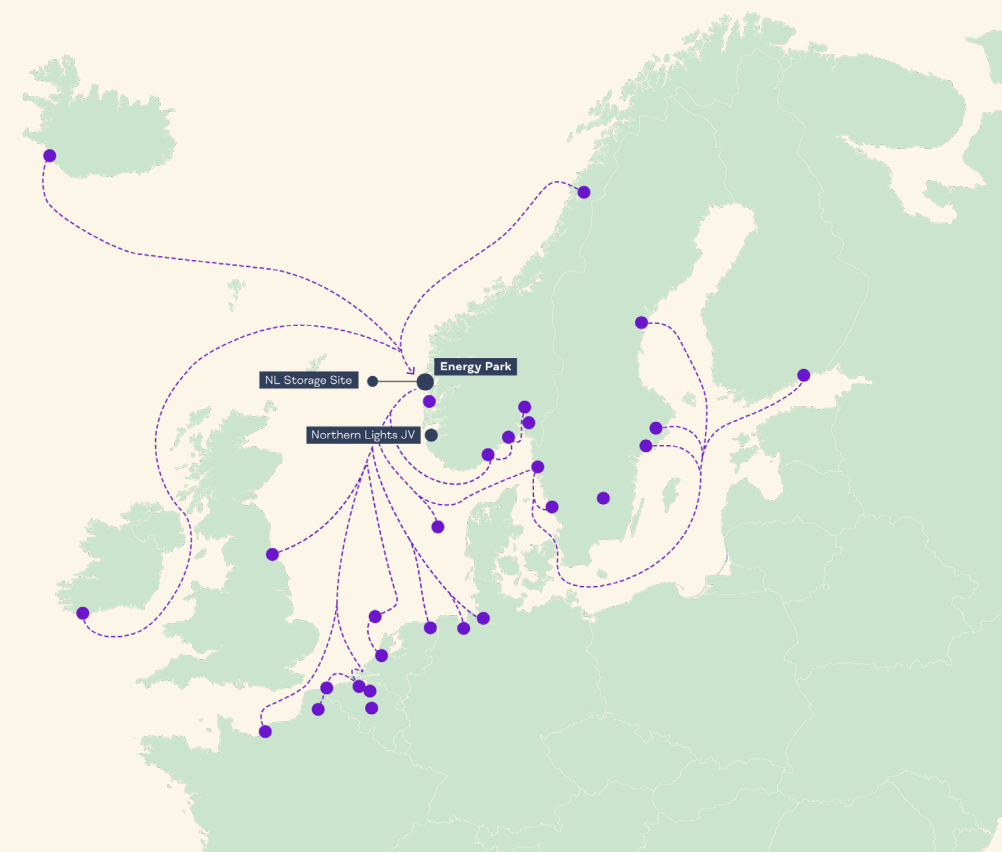
# Building a market for CO<sub>2</sub> storage

*“Net zero near impossible without CCS” (IEA)*

- **Northern Lights is the first** to commercialise CO<sub>2</sub> transport and storage as a service
- **Significant interest and demand** for our services
- **First commercial agreement** with Yara in August

## Challenges

- Establishing **first of its kind contracts** for transport and storage
- Streamlining and adapting **regulatory framework**
- Establishing **bilateral agreements** for cross-border CO<sub>2</sub> transport
- Changing geopolitical situation: **security of energy vs. climate targets**

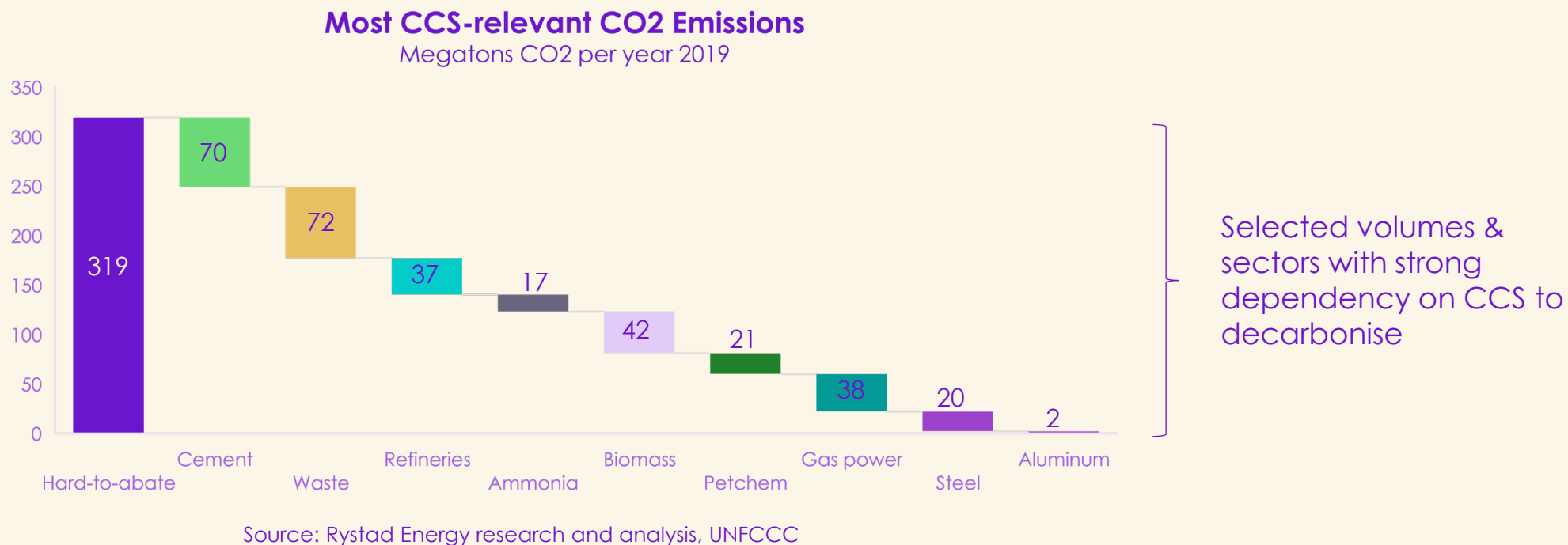




# Market potential

→ **Hard-to-abate industries** most relevant for CCS projects

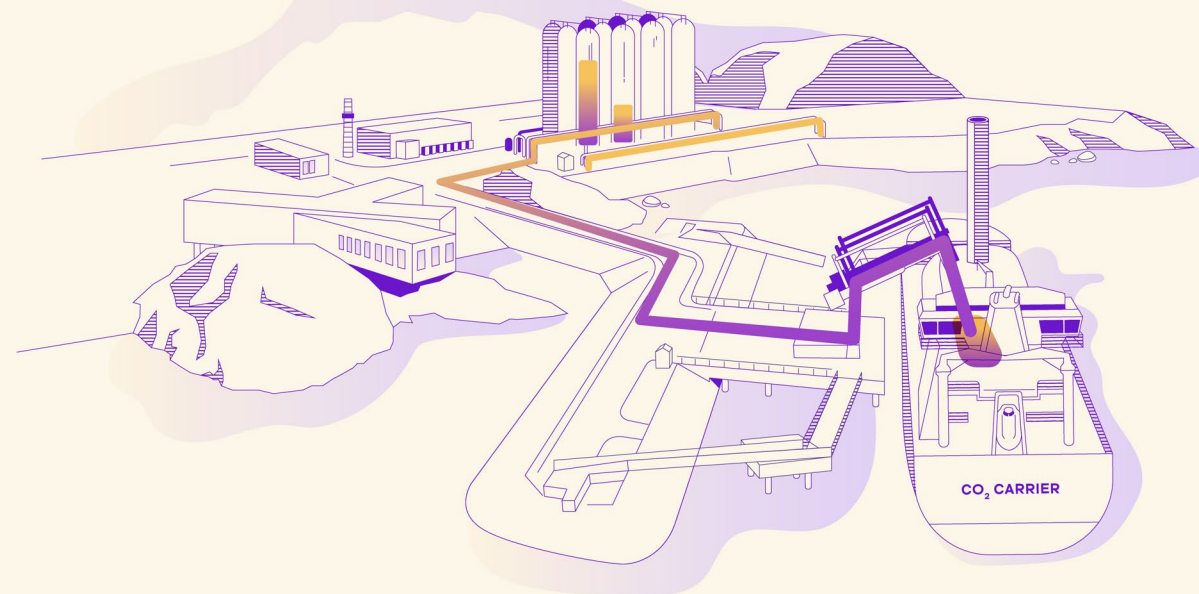
→ **Total CO2 emissions** from these sectors in Europe: **319 MTPA**



# Northern Lights is more than Longship

**Significant** and long term **growth ambitions** on NCS

- First step: Expanding Northern Lights total capacity **from 1.5 to 5 million tonnes CO<sub>2</sub>** per annum, with potential for more
- Investment decision planned first half 2023
- At the same time: Grow business and **mature storage capacity and capability** to meet the market demand





# A vision turns into reality

We are...

- ...on budget and plan
- ...facilities ready in 2024
- ...contributes to a CCS momentum in Europa

But,

Challenging being a first mover,  
still steps to go.





# Northern Lights

[norlights.com](http://norlights.com)



# Filip Neele

CCS SCIENTIST

## CCS developments in The Netherlands

Filip Neele is the lead scientist on CO<sub>2</sub> transport and storage on TNO's subsurface team in Utrecht. With a background in geophysics, he has been active in the field of CCS since 2006 and has set up and led projects that cover a wide range of topics in CO<sub>2</sub> transport and storage, such as regional screening studies for CO<sub>2</sub> storage capacity and detailed storage feasibility assessments.

Content

**CLIMIT**  
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#CLIMITSUMMIT2023  
7–9 February



 The Research  
Council of Norway

GASSNOVA 



**TNO** innovation  
for life

A large, dark, atmospheric photograph of an offshore oil rig at sea. The rig is silhouetted against a cloudy, grey sky. The water is dark and calm. The overall tone is industrial and serious.

# CCS DEVELOPMENTS IN THE NETHERLANDS

FILIP NEELE, TNO  
FEBRUARY 2023