

# INDUSTRIAL CCS

## FEASIBILITY STUDIES IN NORWAY



GASSNOVA

*2016 CSLF Technology Workshop*

Trude Sundset, CEO



## CCS IS A PART OF THE SOLUTION

- COP21: From urgency to action!
- Obama: “The best chance we have to save the one planet that we've got.”

# **GASSNOVA SF**

## **THE NORWEGIAN STATE ENTERPRISE FOR CCS**

**For 10 years, Gassnova has navigated the intersection between high-level politics, technology and commercial interest to find solution to the climate challenge. We have made major progress.**

### **Purpose:**

- **Manage the State's interests in relation to CCS and implement projects**
- **Advise the Ministry of Petroleum and Energy in CCS issues.**
- **Contribute to technology development and knowledge-sharing through specific CCS projects and implementation of the CLIMIT programme.**
- **Approx. 40 employees**

**Govern a total budget of approx. 40 € millions (in 2016)**



**CLIMIT  
R&D**



**GASSNOVA**

**GASSNOVA IS  
SET UP TO  
SUCCEED  
WITH CCS**

**FULL-  
SCALE**

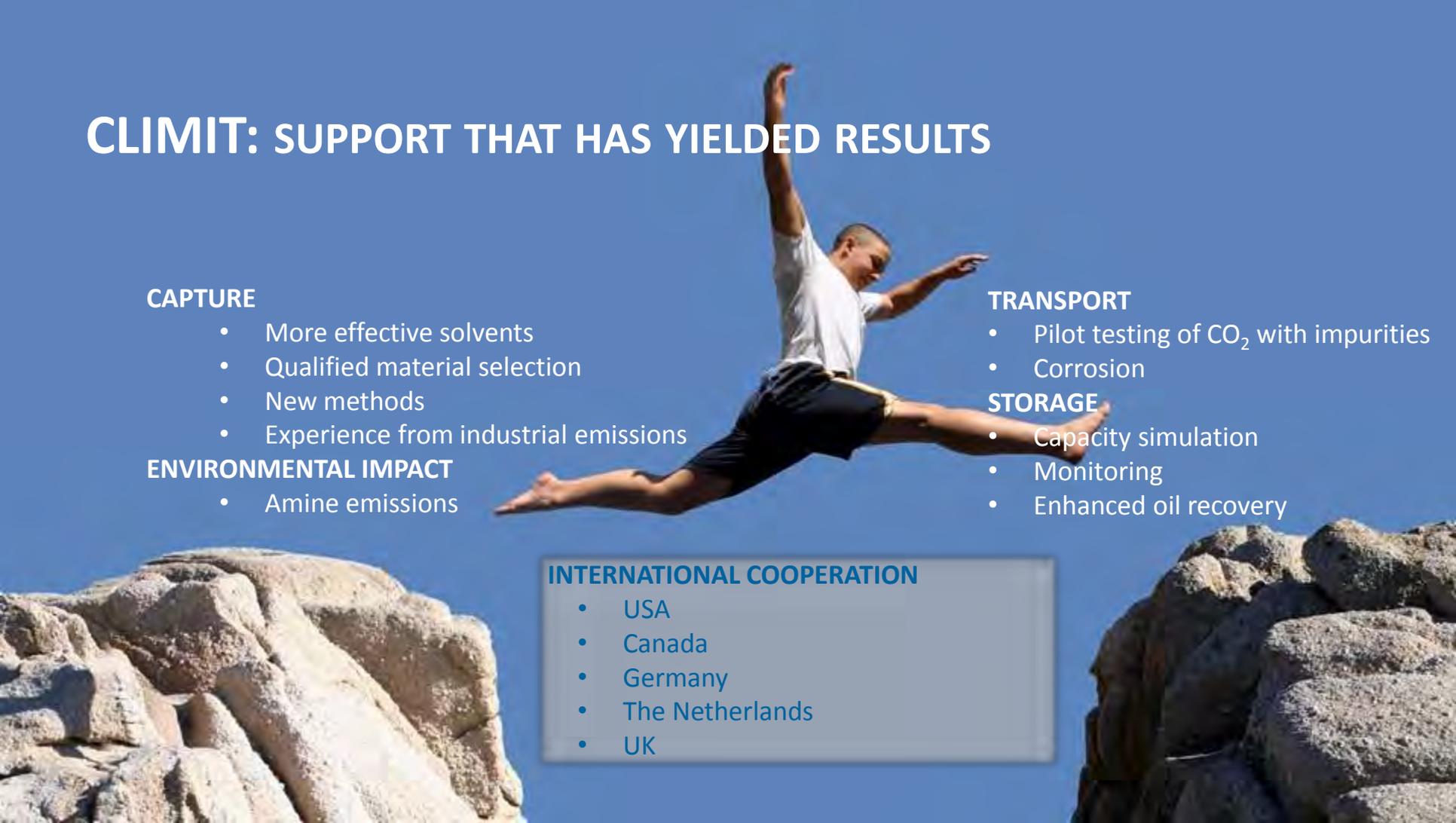
**TCM  
Demo**



## **CLIMIT: FROM R&D – DEMO**

- Annual budget 25 million Euro since 2005
- More than 300 projects have received support

# CLIMIT: SUPPORT THAT HAS YIELDED RESULTS



## CAPTURE

- More effective solvents
- Qualified material selection
- New methods
- Experience from industrial emissions

## ENVIRONMENTAL IMPACT

- Amine emissions

## TRANSPORT

- Pilot testing of CO<sub>2</sub> with impurities
- Corrosion

## STORAGE

- Capacity simulation
- Monitoring
- Enhanced oil recovery

## INTERNATIONAL COOPERATION

- USA
- Canada
- Germany
- The Netherlands
- UK

# CO<sub>2</sub> TECHNOLOGY CENTRE MONGSTAD (TCM)

2012 → 2017 → 2020

## Test campaigns with international customer base:

- Aker Solutions
- Alstom (now GE)
- Shell Cansolv
- Carbon Clean Solutions

## Planned test campaigns:

- ION Engineering (USA)
  - Test Agreement signed 9 August 2016

## Reference campaigns on MEA:

- MEA (30 wt%) is well suited
- Data open to third party

**Owners:** Gassnova (on behalf of the Norwegian state), Statoil, Shell and Sasol

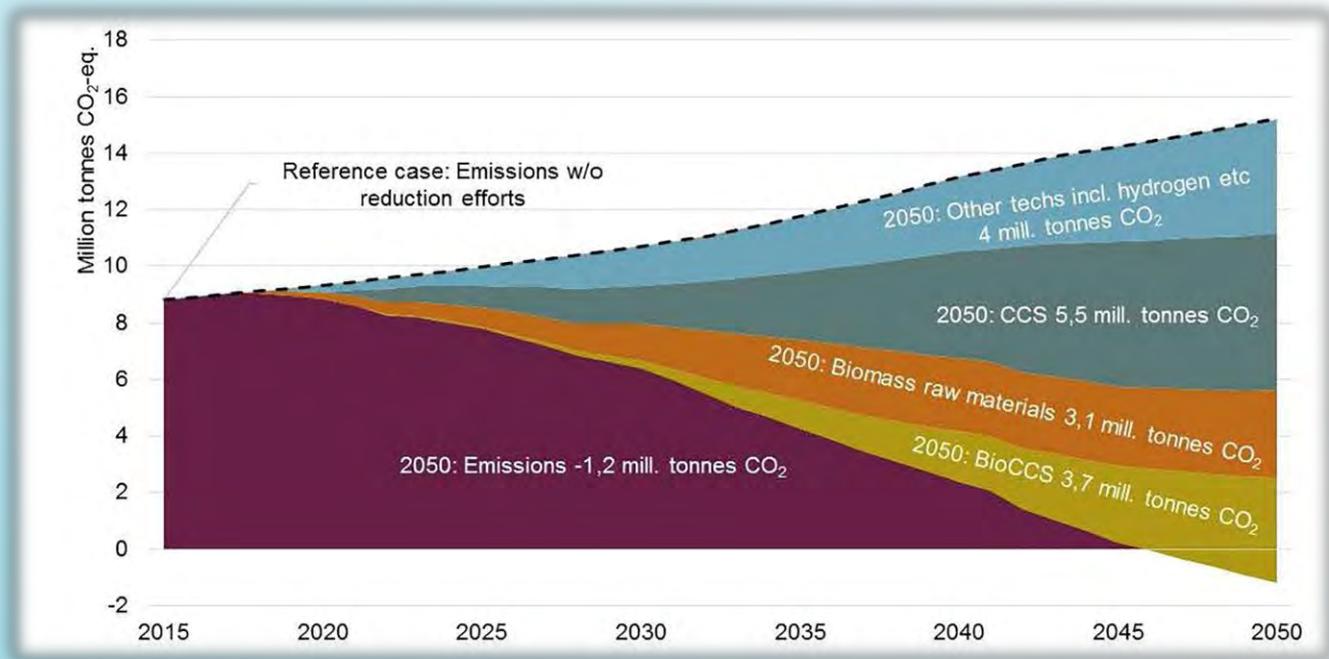
A close-up photograph of two hands shaking in a firm grip. The hands are positioned in the center-left of the frame, with the fingers interlocked. The background is a soft, out-of-focus green, suggesting an outdoor setting with foliage. The lighting is bright and natural, highlighting the texture of the skin.

**WE NEED TO  
REALIZE FULL  
SCALE PROJECTS  
TO DEVELOP  
CCS FURTHER**

# NORWAY:

## INDUSTRY AIM TO HAVE ZERO EMISSIONS BY 2050

CCS IS AN IMPORTANT TOOL TO REACH THIS GOAL



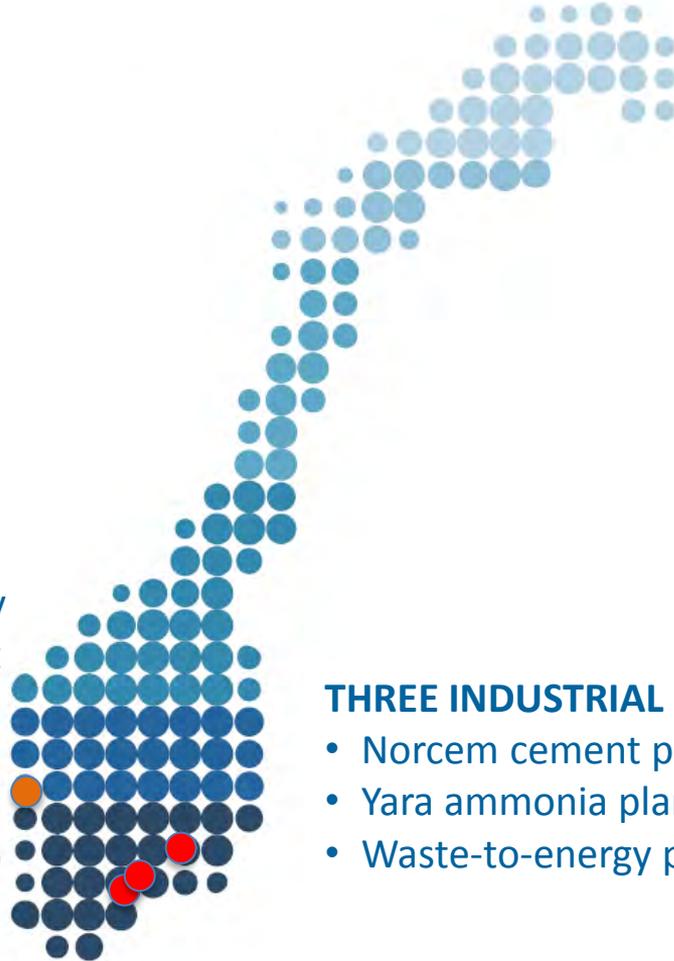
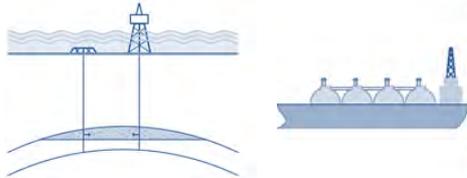
The Norwegian process industries' roadmap  
Combining growth and zero emissions by 2050

The Federation of Norwegian Industries

# NORWAY: FEASIBILITY FULL-SCALE CCS PROJECT

## CO<sub>2</sub> TRANSPORT AND STORAGE

- Ship transportation
- Intermediate onshore storage
- Offshore storage in an aquifer
- The Ministry of Petroleum and Energy is ultimately responsible for transport and storage



## THREE INDUSTRIAL EMISSION LOCATIONS

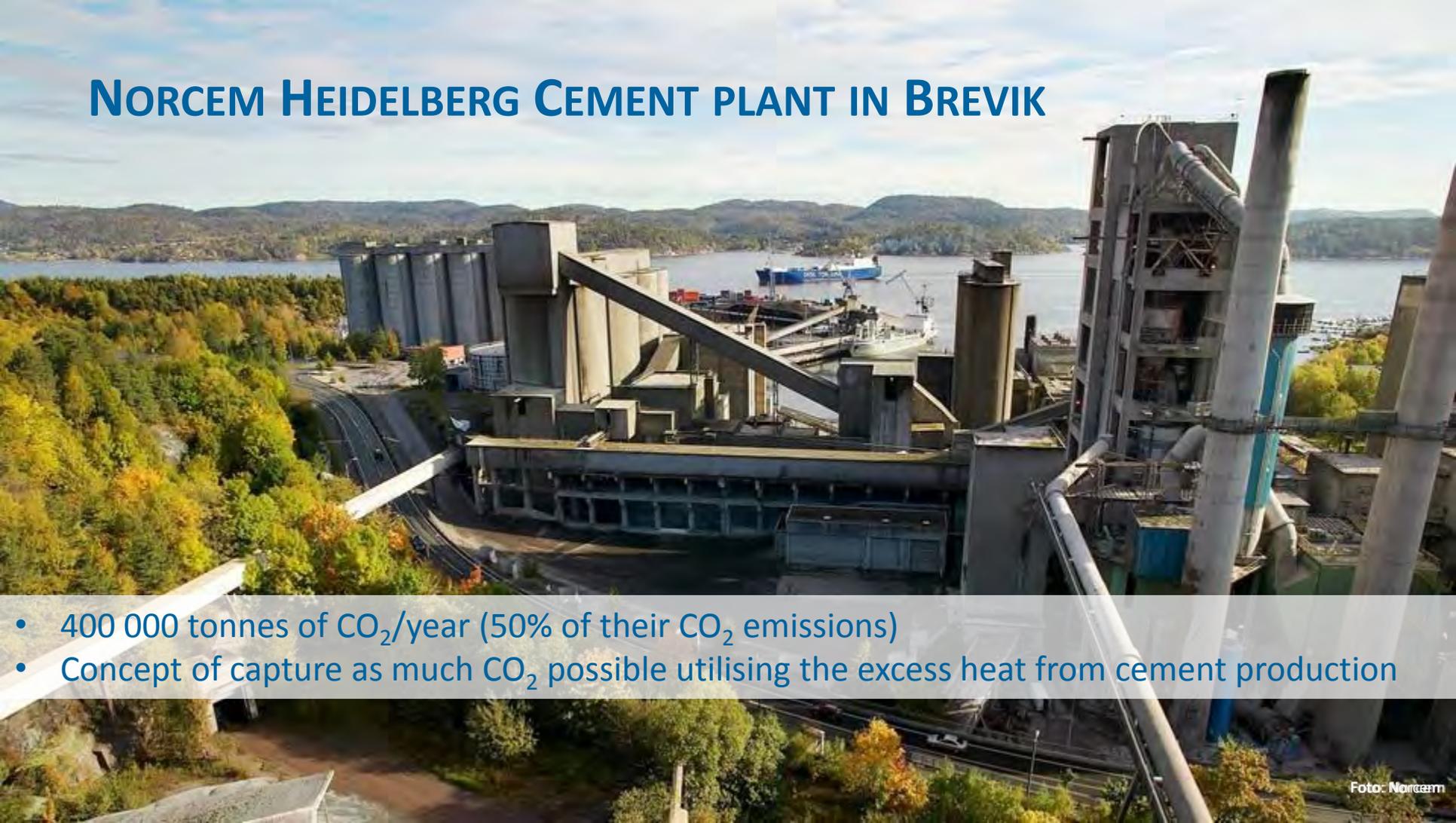
- Norcem cement plant
- Yara ammonia plant
- Waste-to-energy plant

A woman wearing a white hard hat and an orange safety vest is shown in profile, looking towards the right. She is holding a blue and white pen and appears to be working on a clipboard. The background shows a construction site with a tall crane and a large building under construction. The sky is clear and blue.

## CO<sub>2</sub> CAPTURE IS TECHNICALLY FEASIBLE

- Sources
  - Cement plant
  - Ammonia plant
  - Waste-to-Energy plant
- No technical showstoppers
- Various regional challenges (e.g.: logistics, proximity to neighbors ...)
- Significant learning potential in all three capture projects

# NORCEM HEIDELBERG CEMENT PLANT IN BREVIK

An aerial photograph of the Norcem Heidelberg Cement Plant in Brevik, Norway. The image shows a complex of industrial structures, including tall silos, conveyor belts, and large storage tanks. The plant is situated on a hillside overlooking a large body of water, with mountains in the background. The sky is blue with some clouds. The foreground shows a road and some greenery.

- 400 000 tonnes of CO<sub>2</sub>/year (50% of their CO<sub>2</sub> emissions)
- Concept of capture as much CO<sub>2</sub> possible utilising the excess heat from cement production

# YARA PORSGRUNN FERTILIZER PLANT



- 805 000 tonnes of CO<sub>2</sub>/year (will capture 90% of the factory's emissions)
- Three main sources of CO<sub>2</sub> emissions from the ammonia plant
- Yara sell 200 000 tonnes of CO<sub>2</sub>/year by liquefaction and ship transport to the market

# THE KLEMETSRUD WASTE-TO-ENERGY PLANT IN OSLO

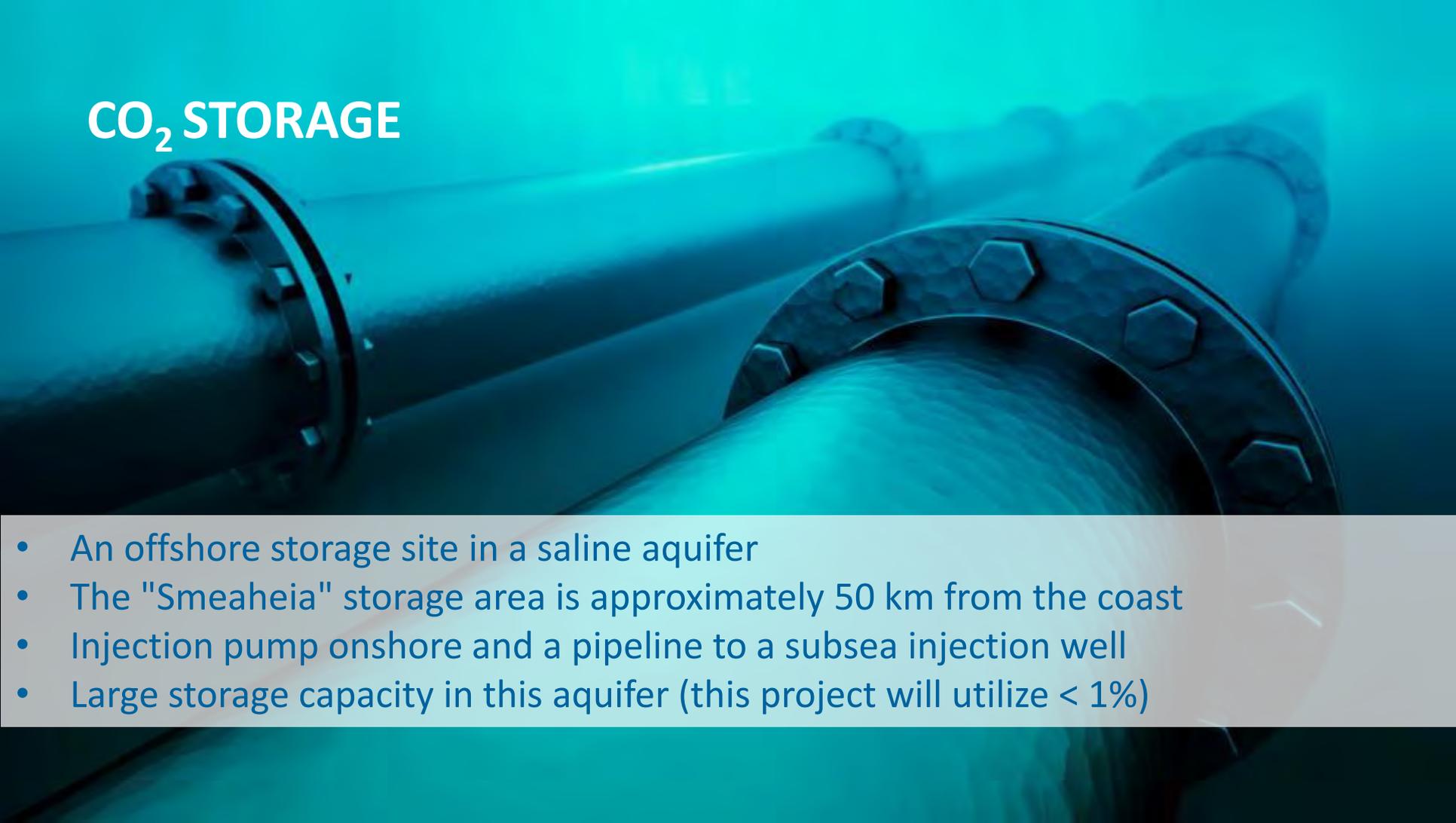
- 315 000 tonnes of CO<sub>2</sub>/year (90% of their CO<sub>2</sub> emissions)
- 60% is bio-fuel making it a CO<sub>2</sub> negative project
- Focus on heat integration to minimize energy loss

# CO<sub>2</sub> TRANSPORTATION



- Ship transportation more flexible – compared to pipelines
- Shipping solutions in the market to transport from quay to quay

# CO<sub>2</sub> STORAGE



- An offshore storage site in a saline aquifer
- The "Smeaheia" storage area is approximately 50 km from the coast
- Injection pump onshore and a pipeline to a subsea injection well
- Large storage capacity in this aquifer (this project will utilize < 1%)

# COSTS

	One source 400 kt CO <sub>2</sub> /y	Three sources 1 300 kt CO <sub>2</sub> /y
Planning and investment costs (€ millions)	791	1384
Operating and maintenance costs (€ millions/y)	39	98

A young boy with short brown hair, wearing a red shirt, is shown in profile, smiling as he reads a book. The background is a library with bookshelves filled with colorful books. A semi-transparent blue box is overlaid on the left side of the image, containing the text.

## LEARNING

- Construction and operation of capture plant
- Integration with existing plant in operation
- Establishing business models for CCS
- Liability and regulatory framework
- Risk reduction and CCS technology development

## NEXT PHASE...

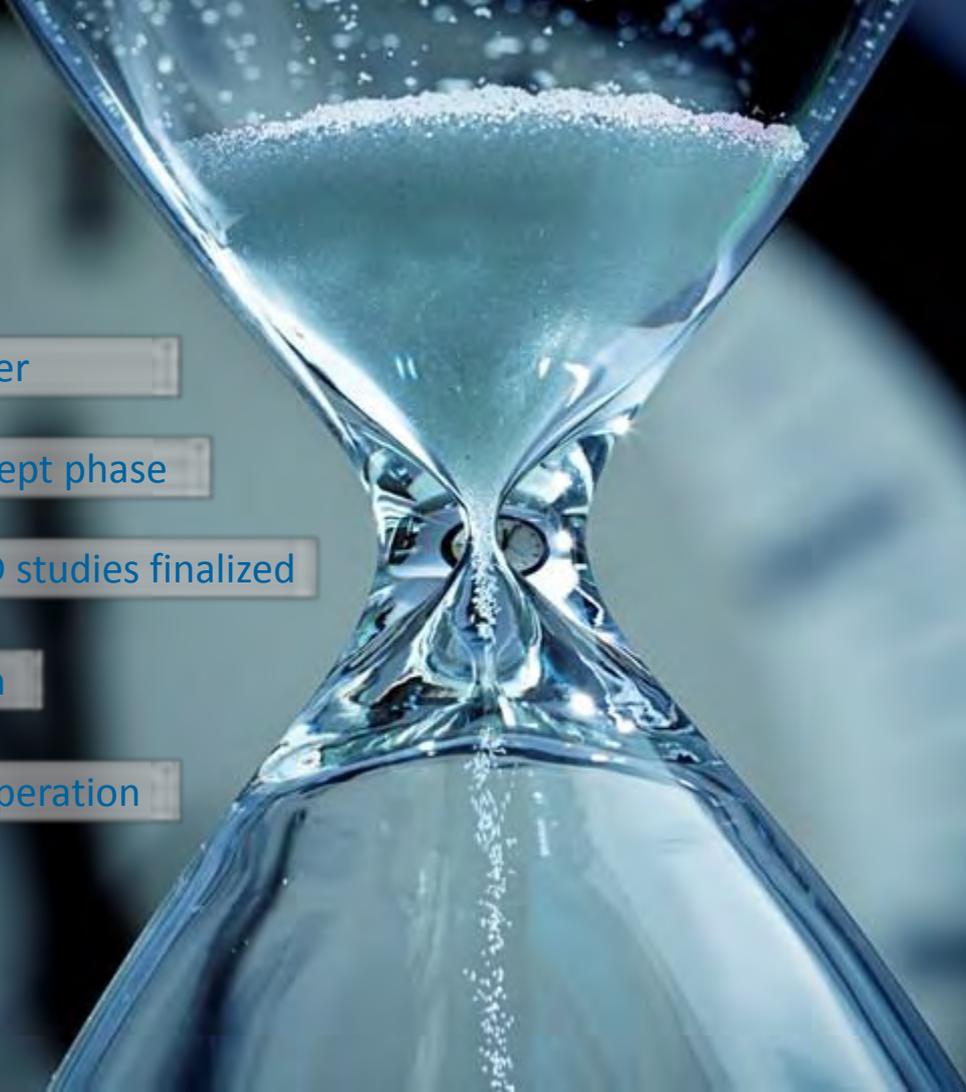
Autumn 2016: Invitation to Tender

First quarter 2017: Start-up concept phase

Autumn 2018: Concept and FEED studies finalized

Spring 2019: Investment decision

In 2022: Full-scale CCS chain in operation



A person wearing blue trousers and colorful sneakers is climbing a stone staircase in a lush, green forest. The person is seen from behind, moving upwards. The background is filled with trees and foliage, creating a natural and vibrant setting.

## NORWAY CCS: THE TIME IS NOW!

- CO<sub>2</sub> emissions from different industries
- Feasibility studies performed in cooperation with dedicated industries
- Solutions with real potential for deployment
- CCS – Necessary to achieve our climate goals
- CCS – Essential for industry to stay competitive in a green economy