Past and future of CCS in Norway

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Co-ordinator EERA JP CCS

2017-11-06

COP23- Bonn

EERA
European Energy Research Alliance
CCS - Carbon Capture and Storage

Global leadership

Full chain - upcoming FEED studies

European leadership in R&I

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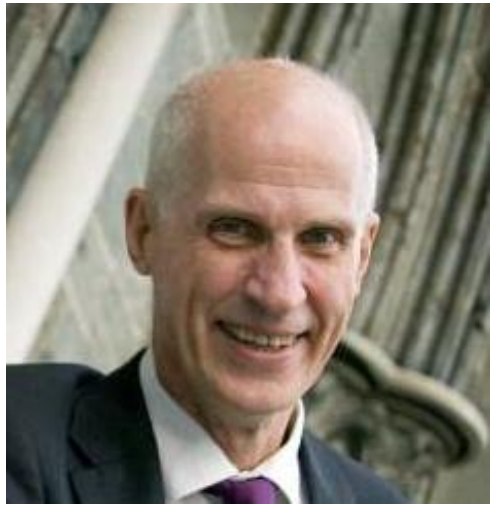
1987



Norwegians Erik Lindeberg and Torleif Holt

Concept of geological storage of CO_2

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1991

Norwegian offshore CO_2 tax introduced

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1996 - Sleipner

Statoil pioneers CCS off-shore - Utsira - 1 Mton/yr

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2000

Prime minister Bondevik resigns on:

Not allowing gas power plant without CCS

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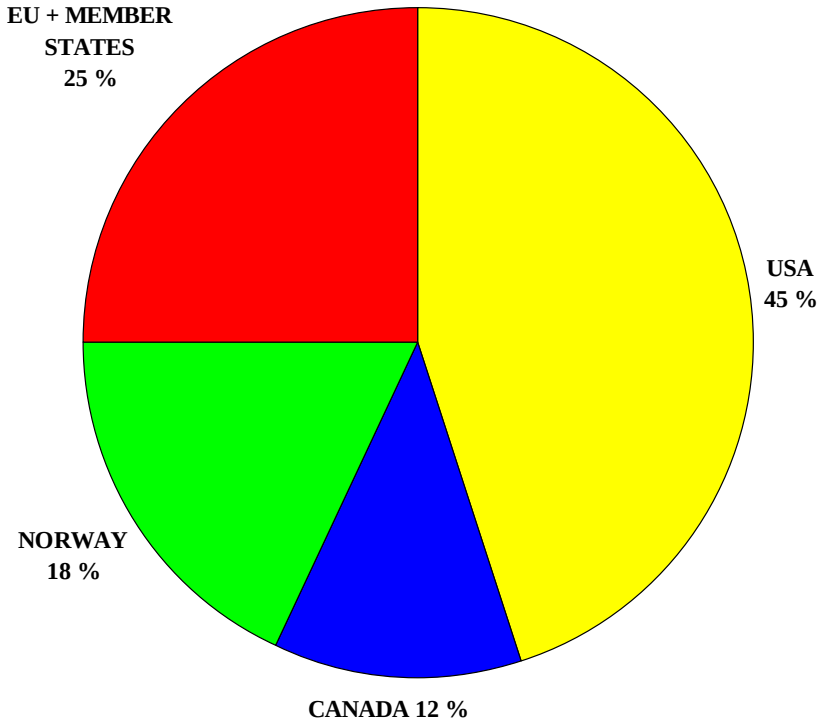
2001-2005



Norwegian CCS R&D boosted

18 % of global

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2008 – Snøhvit

0.7 Mt/yr

– 2017

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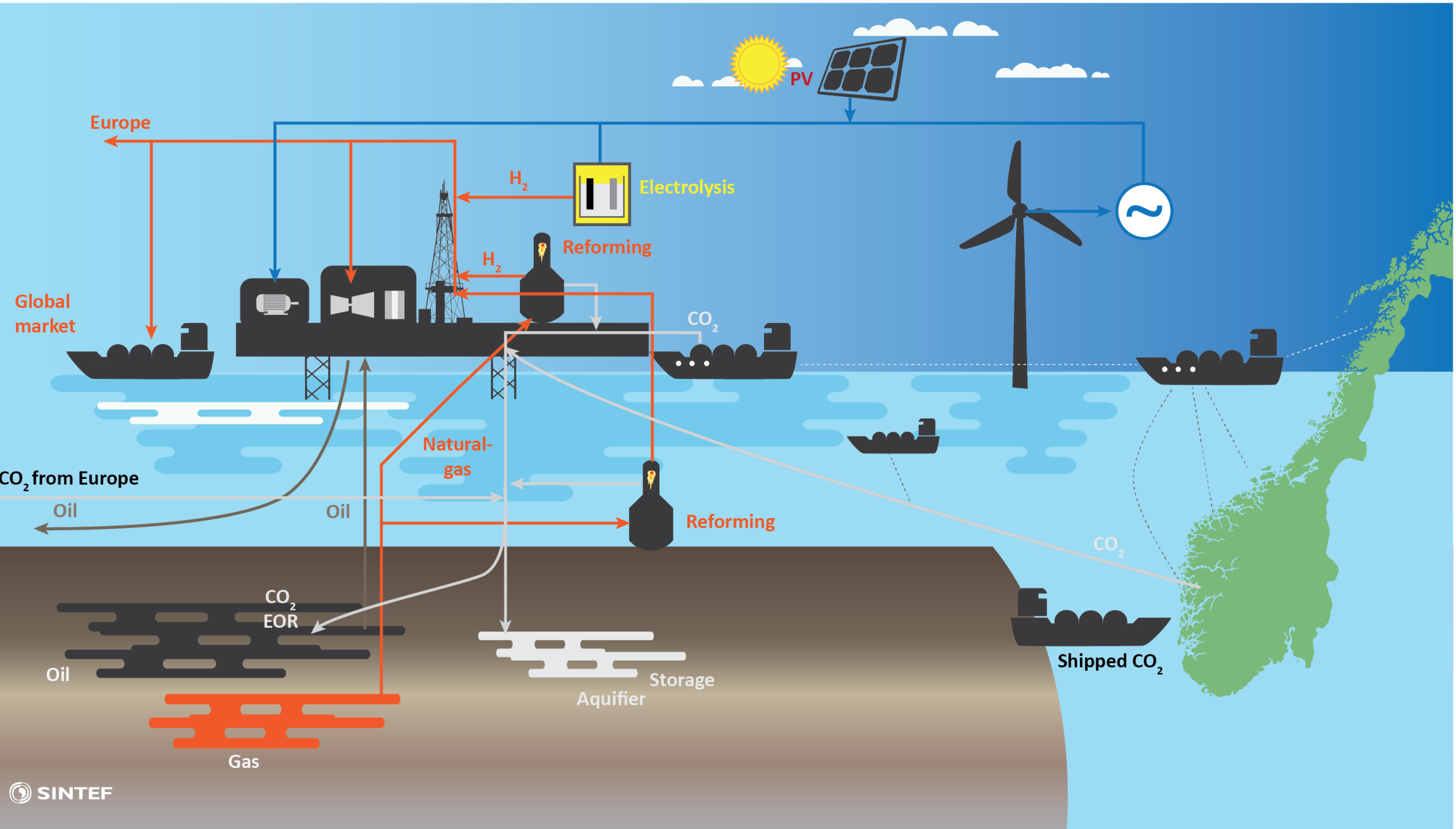

PV
Europe
H_2
Electrolysis
Reforming
H_2
Global market
CO_2
Natural-gas
CO_2 from Europe
Oil
Oil
Reforming
CO_2
CO_2 EOR
Oil
Storage
Aquifer
Shipped CO_2
Gas
SINTEF

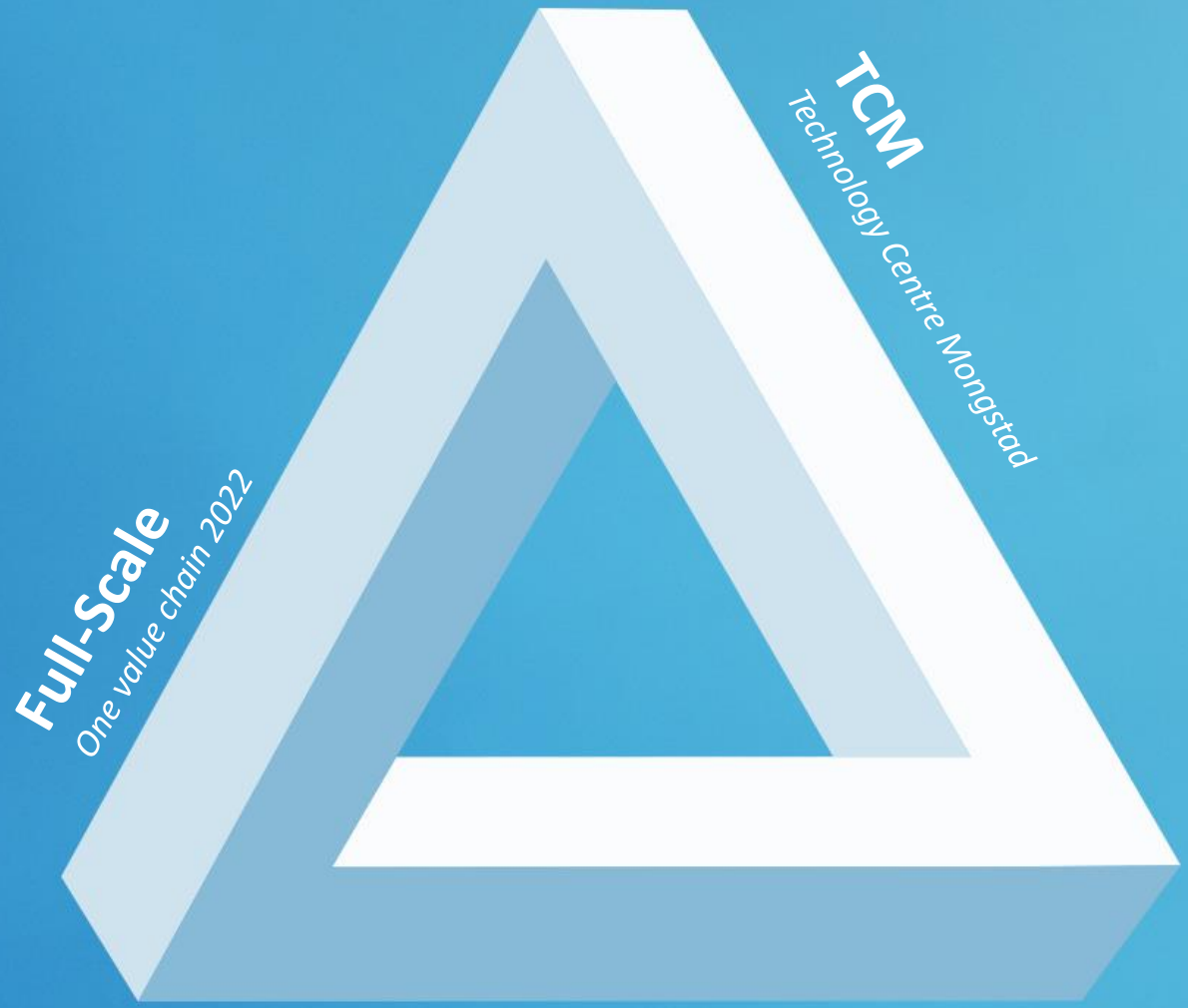
How Norway is building a full-scale CCS value chain

GASSNOVA

GASSNOVA SF

The Norwegian State Enterprise for CCS

GASSNOVA's three initiatives in advancing CCS



CLIMIT

Research, Development and Demonstration program

CLIMIT: RD&D Program

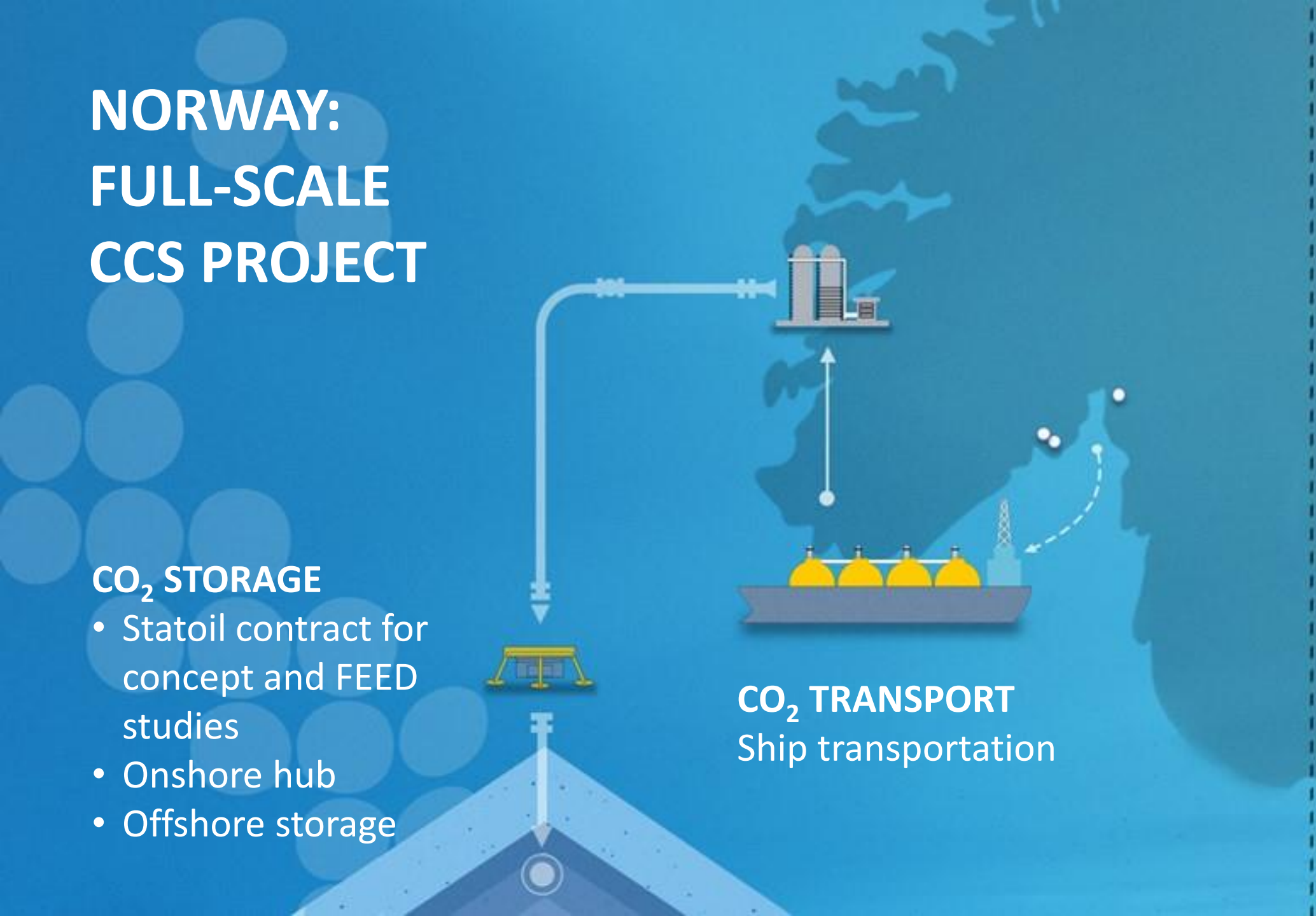
More than 500 projects - Annual budget approx. 23 M€

- Three focus areas:
  - Early full-scale CCS value chain in Europe
  - Large-scale storage of CO_2 on the Norwegian shelf in the North Sea
  - Future cost effective solutions for CCS
- International cooperation

TECHNOLOGY CENTRE MONGSTAD (TCM)

The world's largest and most flexible test facility for CO_2 capture

NORWAY: FULL-SCALE CCS PROJECT



CO_2 STORAGE

- Statoil contract for concept and FEED studies
- Onshore hub
- Offshore storage

CO_2 TRANSPORT

Ship transportation

CO_2 CAPTURE

Norcem HeidelbergCement
Cement plant

Yara Porsgrunn
Ammonia plant

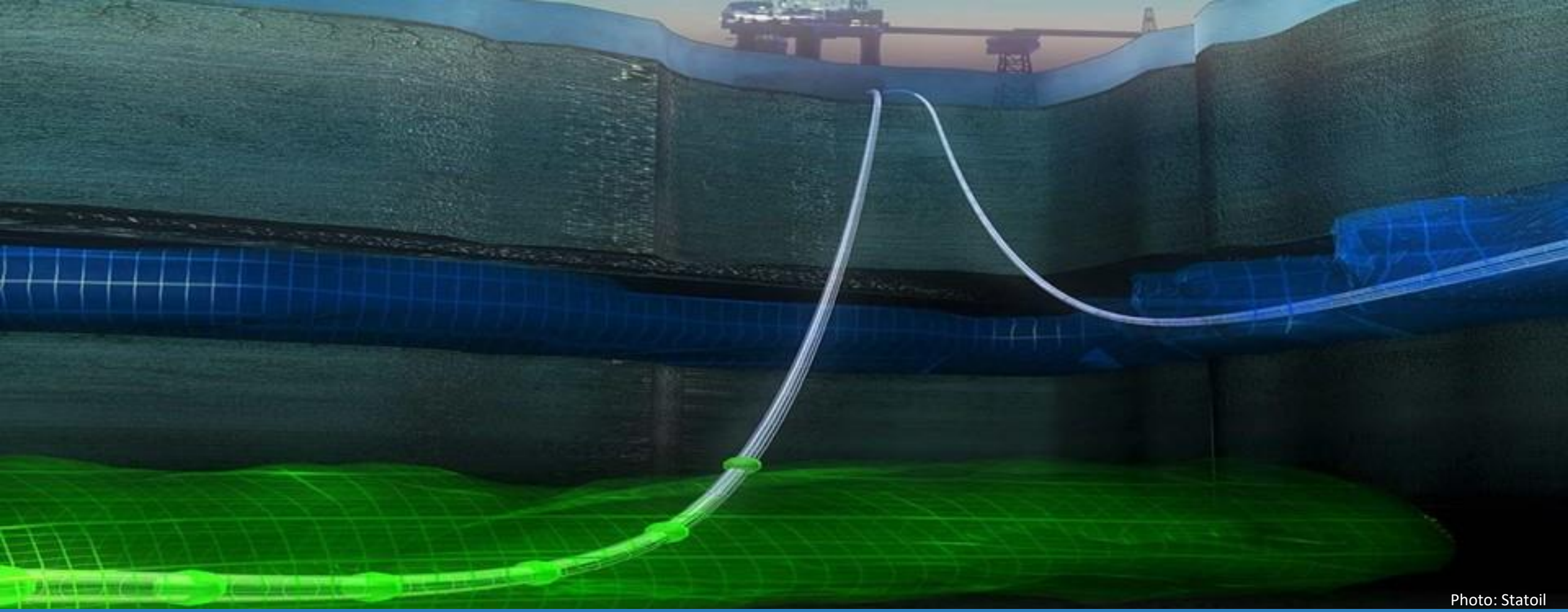
Fortum Oslo Varme AS
Waste-to-energy plant

CO_2 CAPTURE IS TECHNICALLY FEASIBLE AT ALL THREE EMISSION LOCATIONS

- 1,5 Mt CO_2 /Year
- No technical showstoppers
- Different learning potential of the three players

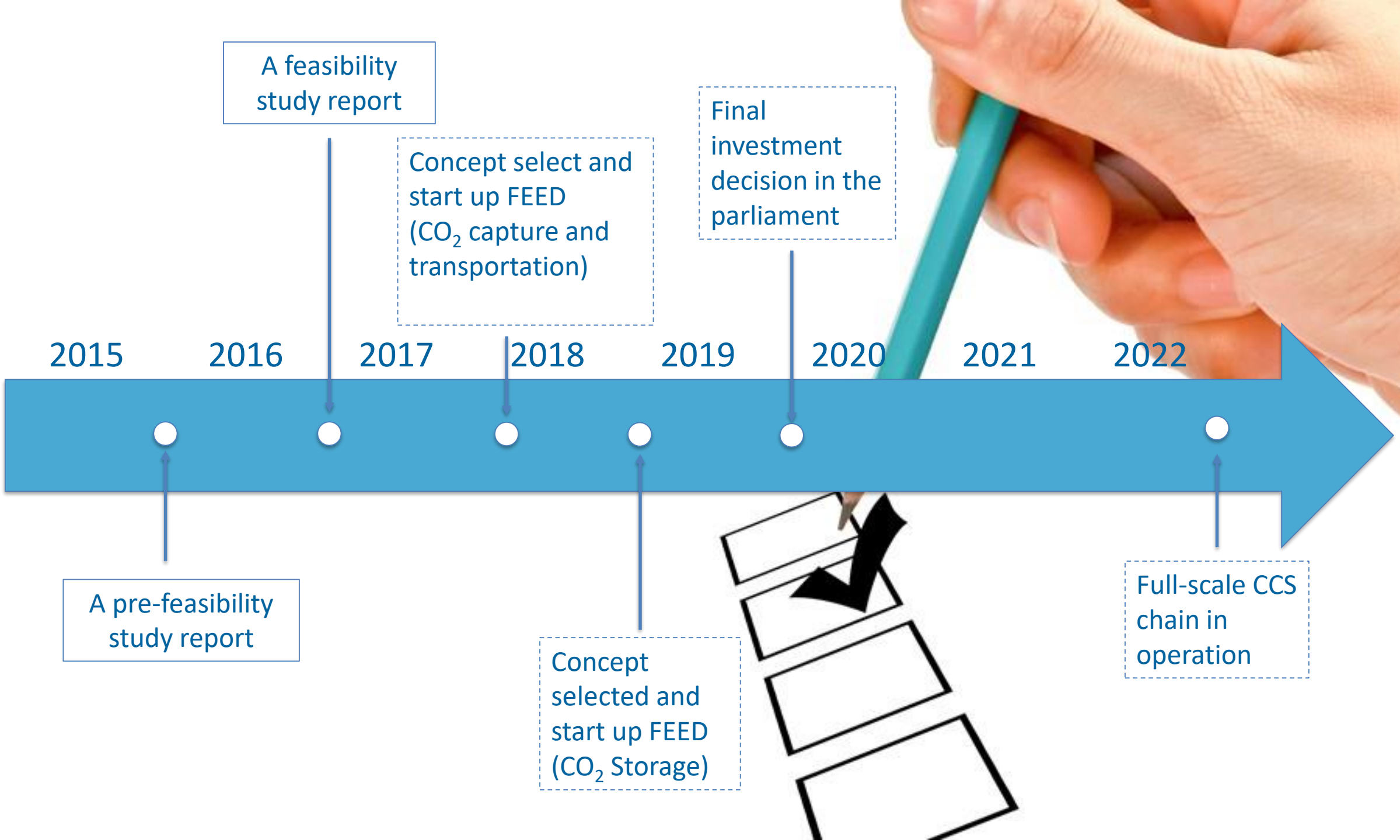
CO_2 TRANSPORTATION

- Plans envisage CO_2 being shipped by sea from capture facilities in eastern Norway to intermediate storage on the west coast
- The CO_2 would then be piped to a subterranean store



CO_2 STORAGE

- An offshore storage site in a saline aquifer
- The "Smeaheia" storage located 50 km from the coast
- Large storage capacity (project will utilize < 1%)


A feasibility study report
Concept select and start up FEED (CO_2 capture and transportation)
Final investment decision in the parliament
2015
2016
2017
2018
2019
2020
2021
2022
A pre-feasibility study report
Concept selected and start up FEED (CO_2 Storage)
Full-scale CCS chain in operation

CCS HIGHWAY

CO_2 from other emitters in Europe?


NCCS
NORWEGIAN CCS RESEARCH CENTRE
Industry-driven innovation for fast-track CCS deployment
NCCS

A world-leading partnership

users

GASSCO · Shell · Statoil · TOTAL

vendor, in-kind

CoorsTek · AkerSolutions · ANSALDO ENERGIA · QUAD GEOMETRICS · KROHNE · NORCEM HEIDELBERGCEMENT Group · LarvikShipping · OSLO KOMMUNE

university

NTNU · RUHR UNIVERSITÄT BOCHUM · RUB · UNIS · MIT · UiO : University of Oslo · University of Zurich[UZH] · TUM

research inst.

TNO innovation for life · BGS 1835 British Geological Survey NATURAL ENVIRONMENT RESEARCH COUNCIL · NIST National Institute of Standards and Technology · NGI · SINTEF · Lawrence Livermore National Laboratory

associated

ECCSEL · Norges Rederiforbund Norwegian Shipowners' Association · Norsk olje&gass · U.S. DEPARTMENT OF ENERGY · UKCCS RESEARCH CENTRE · GASSNOVA · SCCS

NCCS

Complements and support the plans for a Norwegian full-scale CCS project within 2022

Single-sink CCS chain, few industry CO_2 sources, 1-5 Mt/a.

Additional CO_2 sources in Norway and Europe can link up to the Norwegian full-scale project –focus on the next phase

Deployment Case 1

CCS for Norwegian industry

Smeaheia aquifer has a storage capacity large enough to store more of Norway's (and eventually Europe's) captured CO_2 than currently planned.

Build on the Sleipner, Snøhvit, and Boundary Dam projects, align with ROAD, and will seek synergies with TCM.

Norwegian industrial CO_2 sources, in the current full-scale chain and beyond 2022

CO_2 volumes in the order of 100 Mt/a will be considered for transport via safe and flexible pipe-line infrastructure

Capturing CO_2 from power and industry sources from all over Europe

Potential to improve the CCS business case by enabling H_2 production with CO_2 capture from natural gas

Deployment Case 2

Storing Europe's CO_2 in the North Sea basin

Enabling development of commercial-scale CO_2-EOR

Cross-border CCS infrastructure, terms and need for change under international and EU/EEA-law

An innovation platform

Deployment Case 1:
CCS for Norwegian industry

Deployment Case 2:
Storing Europe's CO_2 in the North Sea Basin

MISSION INNOVATION
Accelerating the Clean Energy Revolution

European Commission
HORIZON 2020

The European Strategic Energy Technology Plan
SET-Plan
Towards a low-carbon future

U.S. DEPARTMENT OF ENERGY
Norwegian Ministry of Petroleum and Energy
US - NORWAY
COLLABORATION ON CCS/CCUS

Global leadership

Upcoming FEED studies for full chain

European leadership in R&I

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Acknowledgement

GASSNOVA

EERA JP CCS

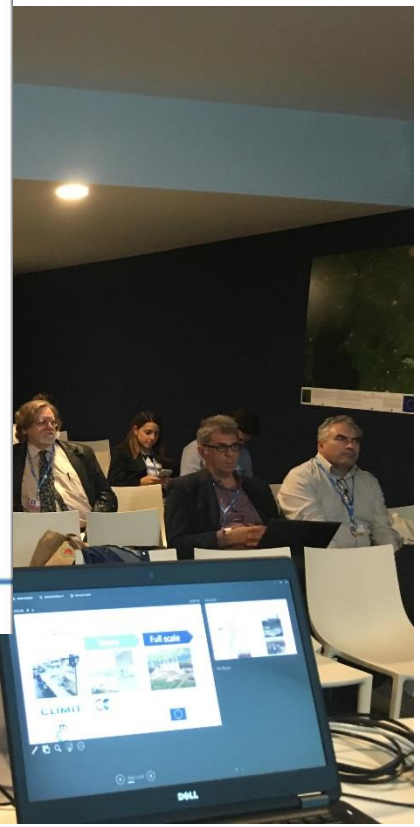
FME NCCS

CLIMIT

EXTRA SLIDES

International collaboration

COP22 Side Event in European Pavillion Nov -16 in Marrakech



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Endurance, Pace and Leadership