資料２

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Norwegian CCS Activities

Presentation to Japan Central Environment Committee

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Cover image: CO2 Technology Center Mongstad.
Image provided by Gassnova.

Agenda

- Norwegian CCS at a glance
- CCS Policies
- 20 years of Experience
- Full-scale CCS
- CLIMIT
- CO_2 Technology Center Mongstad
- CCS Regulatory Framework
- Governmental bodies and their roles

Norwegian CCS at a glance

- CCS for more than 20 years; Sleipner and Snøhvit
- The first CCS projects, a result of carbon tax and sale of natural gas
- Previous attempts of full-scale demo projects cancelled
  - Kårstø: 2005-2010
  - Mongstad: 2009-2013
- New CCS strategy in 2014
- Dedicated regulatory framework for CCS since 2014
- Ongoing full-scale project commenced in 2015

Norwegian CCS policy

Full-Scale CCS	R&D	Demonstration
• By 2022	• CLIMIT • FME	• TCM

International collaboration

- Collaboration with EU and member states of the EU
- MoU with the US to advance cutting edge technology
- CCS support in emerging and developing countries
- International co-operation fora

Sleipner

Photo: Statoil

- **Operational** since 1996
- **Location:** Central North Sea, Offshore Norway
- **Industry:** Natural gas processing
- **Capture Type:** Industrial separation (1.0 Mtpa, new build)
- **Storage:** Dedicated geological storage in Utsira Formation, above the Sleipner East field

Snøhvit

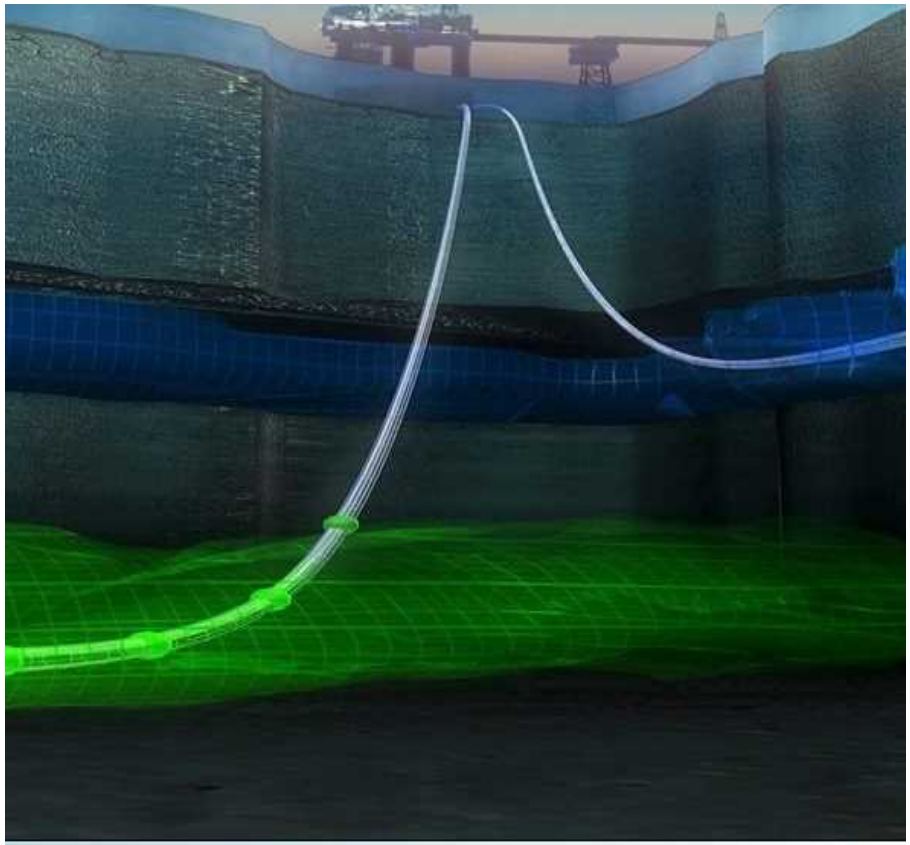

Illustration: Statoil

- **Operational** since 2008
- **Location:** Offshore Hammerfest, Barents Sea, Norway
- **Industry:** Natural gas processing
- **Capture Type:** Industrial separation
- **Storage:** Dedicated geological storage - offshore deep saline formation; Tubåen Formation and Stø Formation

GASSNOVA's three initiatives in advancing CCS

'CCS is an important part of the government's climate policy, and our ambition is to realise at least one full scale demonstration project for CCS ',

Terje Søviknes, Minister of Petroleum and Energy

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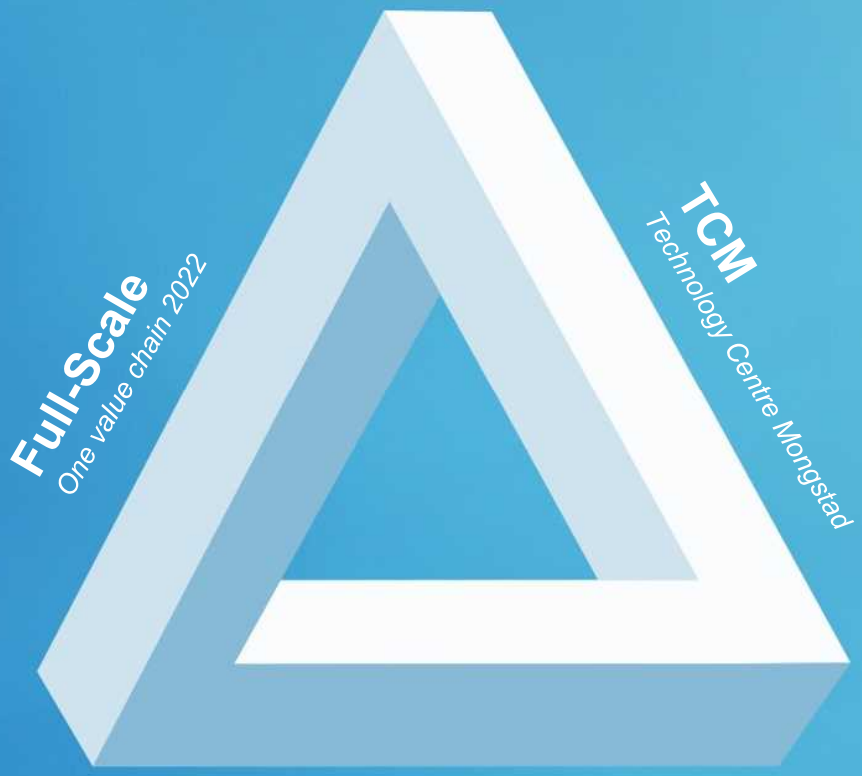

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The Norwegian full-scale project

Illustration: Gassnova

Schedule for Norwegian full-scale

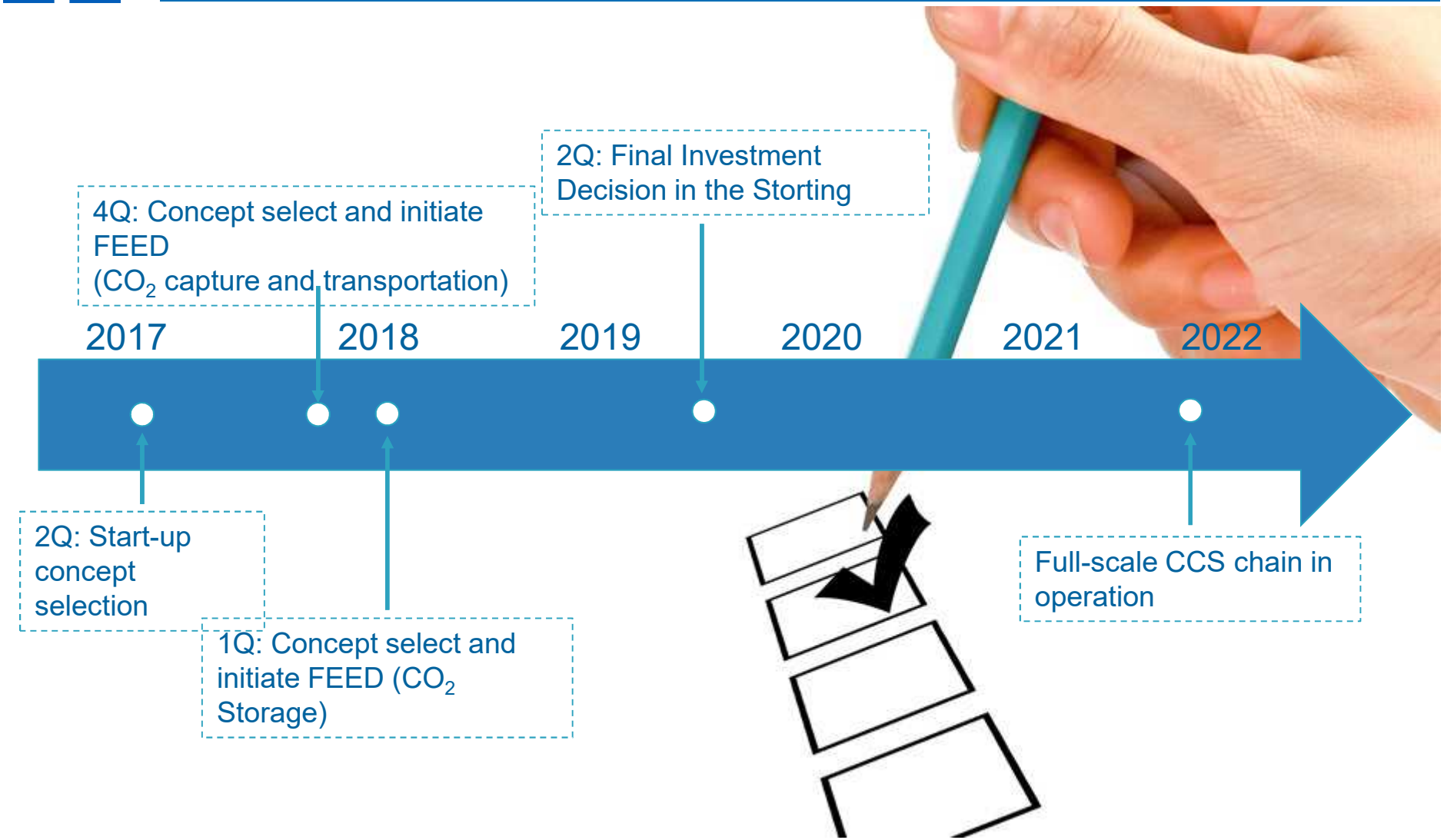
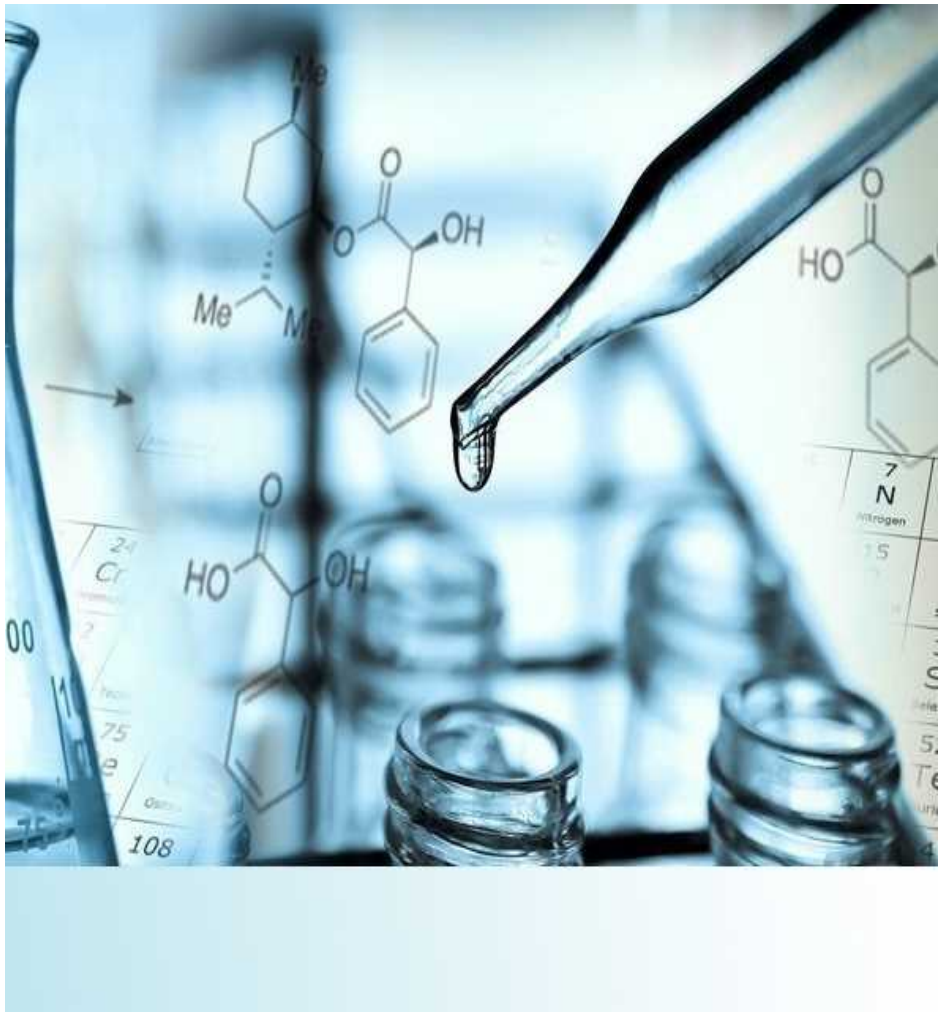


Illustration: Gassnova

CLIMIT: RD&D funding



- More than 300 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

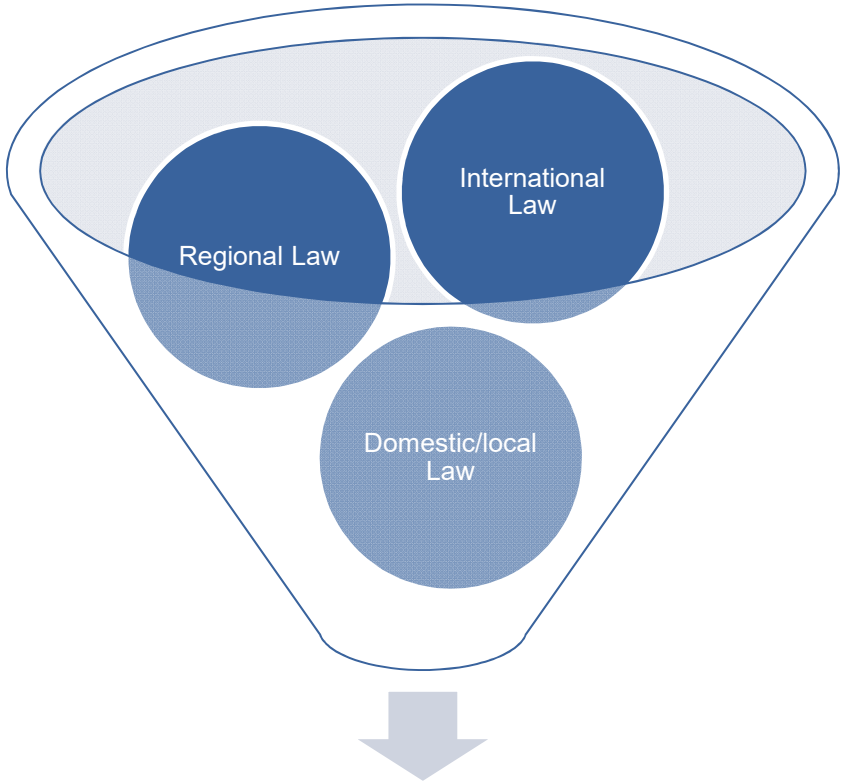
Source: Gassnova

CO_2 Technology Center Mongstad

- Operational since 2012
- World's largest test facility for capture
- Share expertise, knowledge and experience
- Owners: Gassnova, Statoil, Shell and Total

Photo: Gassnova

CCS regulatory framework



Norwegian regulatory framework for ccs

International law*
United Nations Convention on Climate Change (UNFCCC)
KYOTO Protocol
PARIS Agreement
BASEL Convention
United Nations Convention on the Law of the Sea (UNCLOS)
LONDON Convention, 1972
1996 Protocol to the London Convention
OSPAR Convention

EU law*
CCS Directive –Directive 2009/31/EC
ETS Directive –Directive 2004/35/EC
Monitoring and Reporting Regulations – Commission Regulations (EU) No 601/2012
Industry Emissions Directive - Directive 2010/75/EU
Environmental Liability Directive - Directive 2004/35/EC

Norwegian Laws*
The Continental Shelf Act
The Petroleum Act
Greenhouse Gas Emission Trading Act
Act relating to CO_2 tax in the petroleum activity on the continental shelf
The Pollution Control Act
The Public Administration Act
The Planning and Building Application Act

Norwegian regulations*
The Pollution Control Regulations
Regulations for Transport and Storage
The petroleum regulations
The Greenhouse Gas Emission Trading Regulations
The Environmental Impact Assessment Regulations
The Planning and Building Application Regulations
The Framework Regulations
The Management Regulations
The Technical and Operational Regulations
The Activities Regulations
The Facilities Regulations

*A selection of relevant regulatory framework

CCS Regulatory framework

- Norwegian Petroleum Act
  - Petroleum Regulations
- Norwegian Continental Shelf Act
  - Regulations for Transport and Storage of CO_2
- Norwegian Pollution Control Act
  - Pollution Control Regulations

Financial incentives for CCS

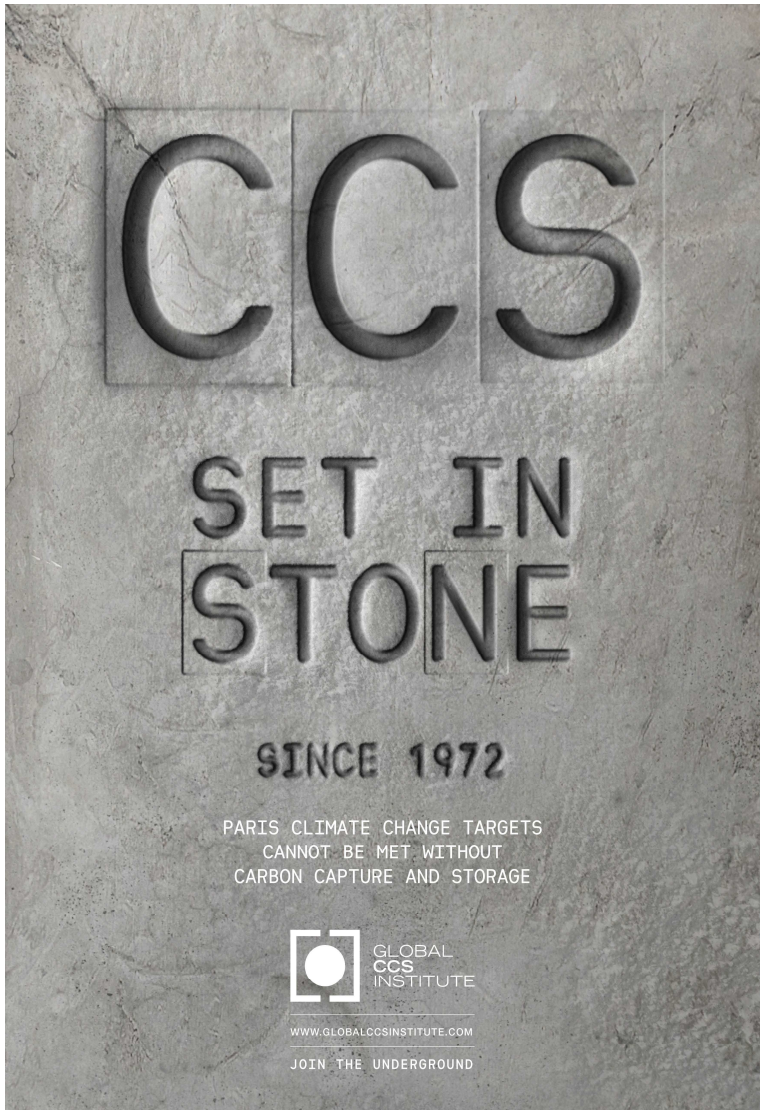
- Act relating to tax on discharge of CO2 in the petroleum activities on the continental shelf (1990)
  - Parliamentary Decision 2017: Tax of 525,25 NOK per ton of CO2 separated from petroleum and discharged
- Greenhouse Gas Emission Trading Act (2005)
  - Joined EU Emissions Trading System (ETS) in 2008
  - Approx. 6 EUR/7 USD per ton (Sept 2017)

Governmental bodies and their roles

- The Norwegian Ministry of Petroleum and Energy
  - Legislative
  - Grants permits for exploration, development, injection and storage
- The Norwegian Ministry of Climate and Environment
  - Legislative
  - International relations and climate agreements
- The Environmental Agency
  - Manage GHG framework and emission permits
  - Impact assessment and supervision of the industry

Lastly…

- Norway has more than 20 years of experience with CCS
- The industrial full-scale demonstration project will be operational by 202, and may pave the way for other projects through:
  - cost and risk reductions;
  - demonstration of technology; and
  - flexible storage solutions
- Research and development, and demonstration important parts of the Norwegian strategy
- International collaboration is essential
- The regulatory framework is developed in accordance with the EU framework



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Back-up slides

Gassnova

- State-owned enterprise responsible for executing Norway's CCS policies
- Three main tasks; R&D, Demonstration and Full-Scale CCS
- Further responsible for providing advice on CCS to the authorities; budget input, strategy, technical, commercial etc.

CLIMIT

- Established in 2005, and expanded in 2008 and 2010.
- Managed by Gassnova in collaboration with the Norwegian Research Council
  - CLIMIT Demo
  - CLIMIT R&D
- Promotes technologies and solutions to reduce costs and broad international dissemination of CCS
- Coordinates with other national activities
  - Research centres for environmentally-friendly energy (FME)
  - Existing and planned infrastructure, like TCM and ECCSEL
  - Financing partner for ACT
  - Secretariat for a bilateral arrangement between the US and Norway

CLIMIT

- Primary objective to support projects that will:
  - Develop knowledge, expertise, technology and solutions that can contribute towards cost reductions and international deployment of CCS.
  - Leverage national advantages and develop new technology and service concepts with commercial and international potential.

CO_2 technology Center Mongstad

- Capture Type: Post-combustion
- Technologies: Two existing units designed to test different solvent-based technologies with the space available to add other units / technologies
- Capacity: Two units each approximately 12 MWe in size, combined capturing a total of 100 000 tons CO_2/year
- CO_2 contents are about 3,5 % and 13 %

US-Norway bilateral

- Memorandum of Understanding (MoU) between the United States Department of Energy and the Norwegian Ministry of Petroleum and Energy
- A key part of this cooperation is the development of CCS
- Under the MoU, four technology areas have been selected for cooperation the field of CCUS:

  - Large-Scale Testing of Carbon Capture Technologies
  - CO_2 Storage and MVA (Monitoring, Verification and Accounting)
  - CO2-EOR
  - Crosscutting Research Program

NORCEM HEIDELBERGCEMENT PLANT IN BREVIK

- 400 000 tonnes of CO_2/year (50% of CO_2 emissions)
- Capture CO_2 utilising excess heat from cement production

Slide provided by Gassnova

YARA PORSGRUNN FERTILIZER PLANT

- 805 000 tonnes of CO_2/year
- Three sources of CO_2 from the ammonia plant
- Yara sells 200 000 tonnes of CO_2/year by liquefaction and ship transport to the market

Slide provided by Gassnova

KLEMETSRUD FACILITY WASTE-TO-ENERGY PLANT

(OSLO MUNICIPALITY AND FORTUM)

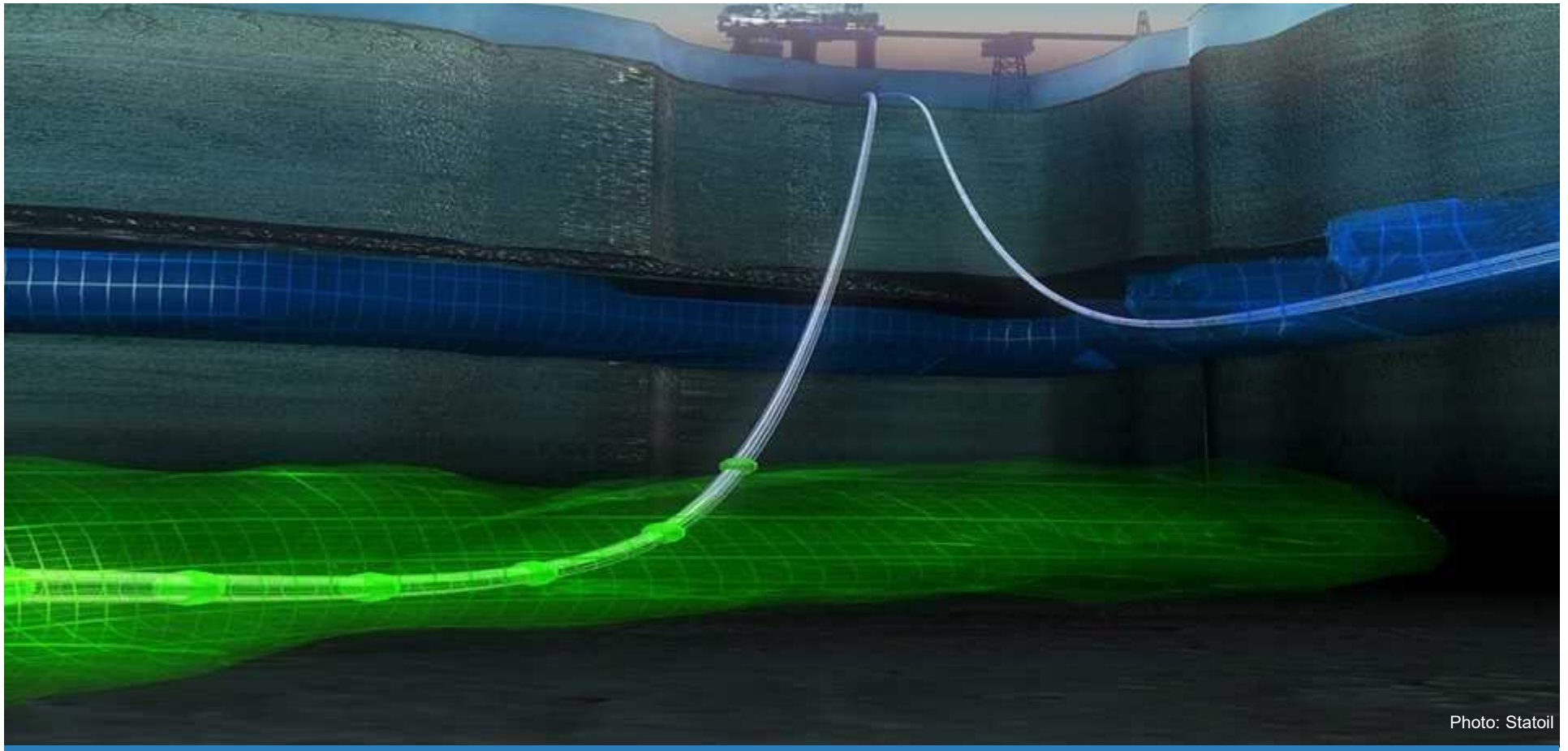
- Ca. 400 000 tonnes of CO_2/year
- 60% is bio-fuel: a CO_2 negative project !
- Focus on heat integration to minimize energy loss

Slide provided by Gassnova

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

Slide provided by Gassnova



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%)

Slide provided by Gassnova

A catalyst for European CCS projects

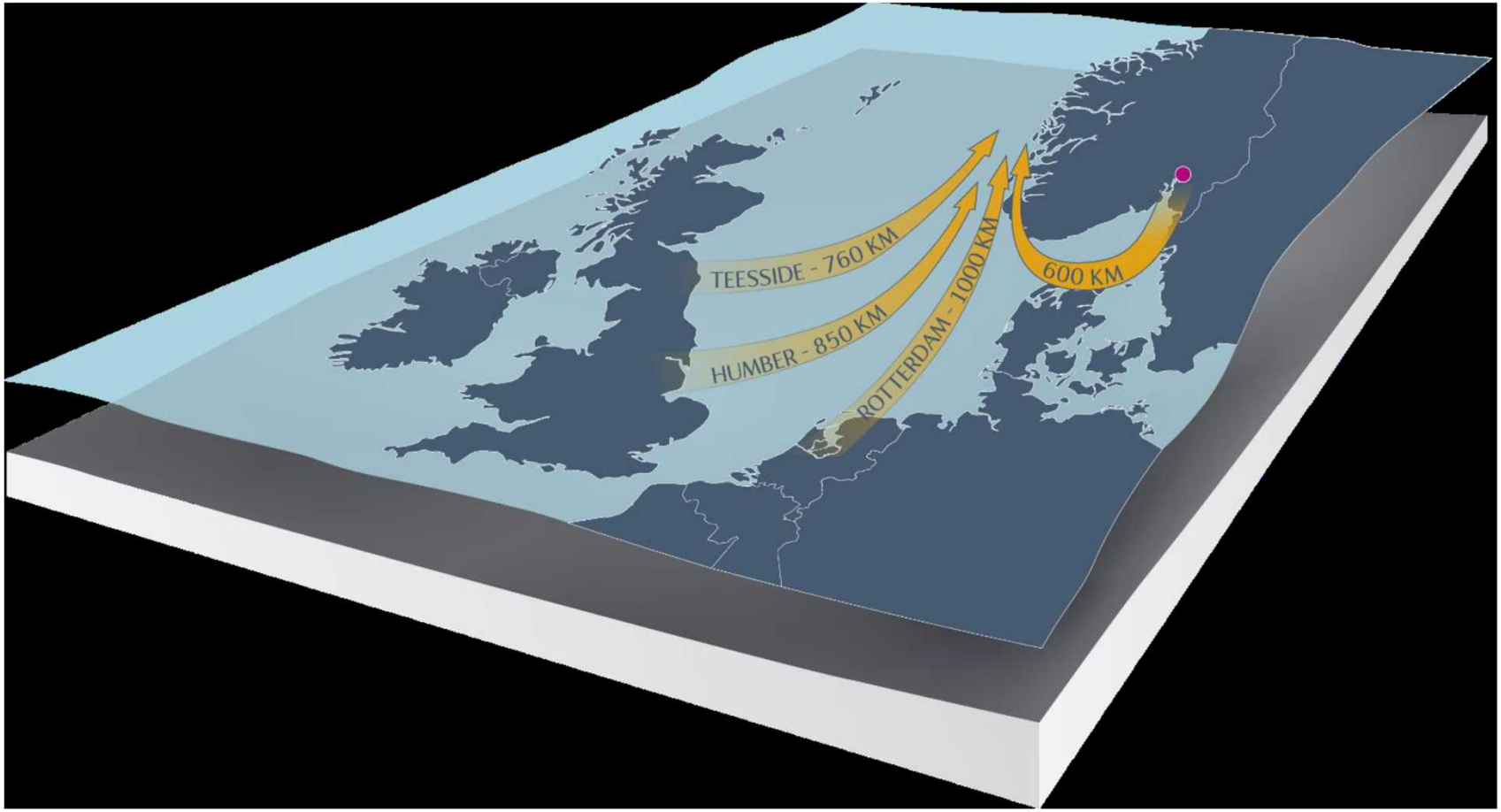
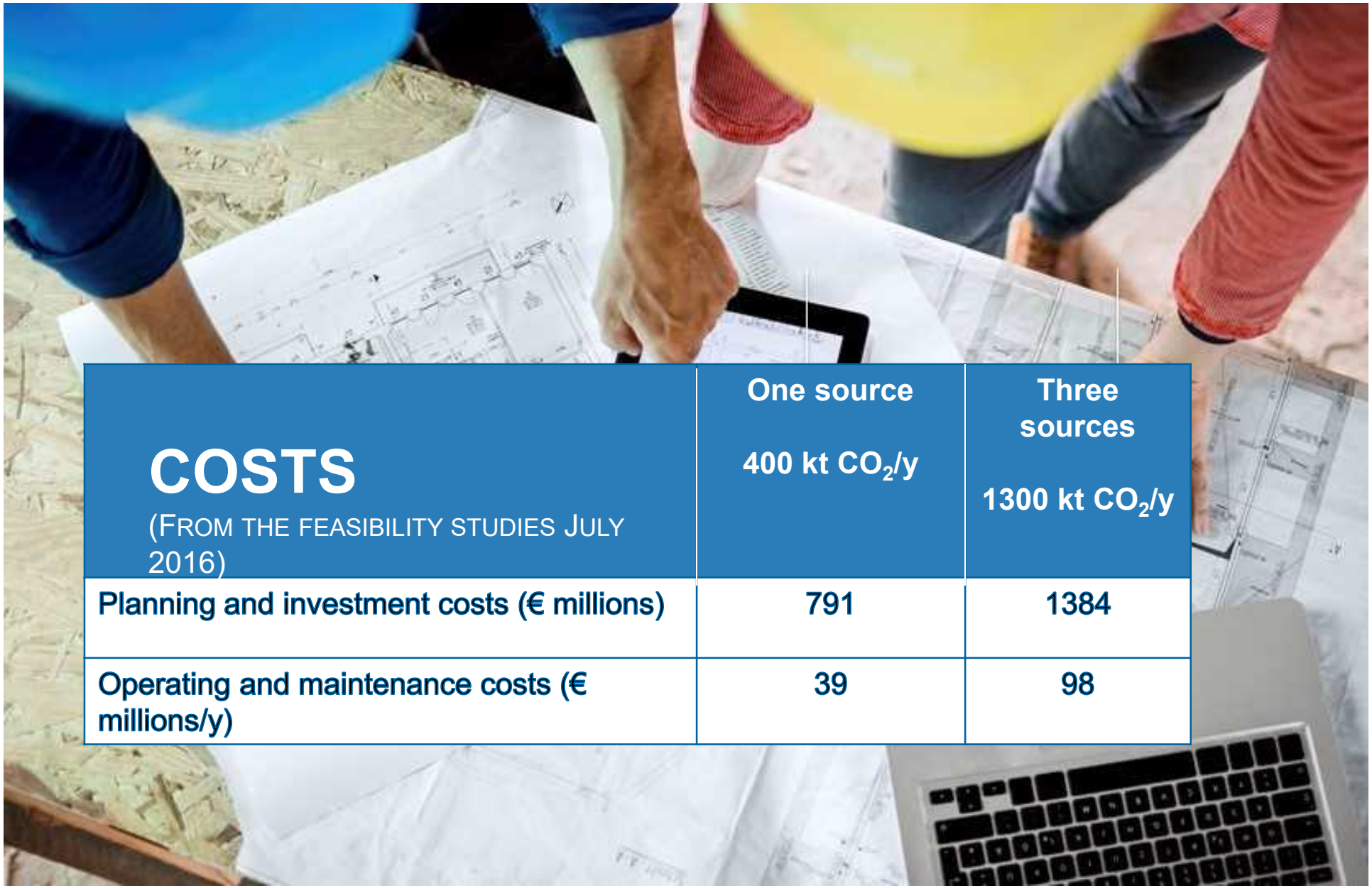


Illustration: Statoil



COSTS

(FROM THE FEASIBILITY STUDIES JULY 2016)

	One source 400 kt CO_2/y	Three sources 1300 kt CO_2/y
Planning and investment costs (€ millions)	791	1384
Operating and maintenance costs (€ millions/y)	39	98

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