Status on Norwegian CCS activites

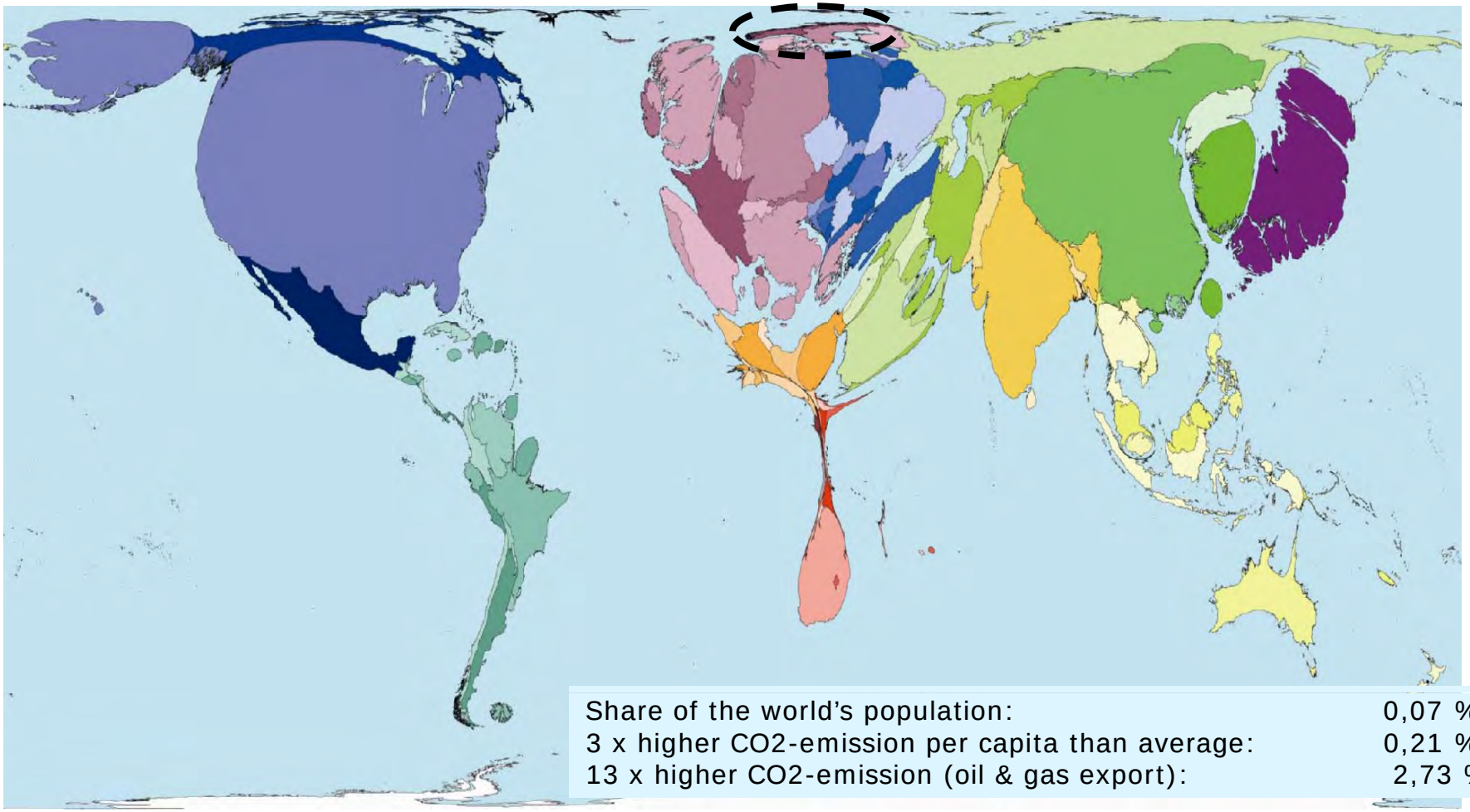
Dr. Per Christer Lund, Counsellor Science and Technology, Innovation Norway

We give local ideas global opportunities

Norway's CO_2 footprint.

World's 2nd largest exporter of natural gas
World's 5th largest exporter of oil
The petroleum industry is important for Norway:
- **One half of total exports**
- **One fourth of GDP**
- **One third of total Government income**

World's 2nd largest Sovereign Wealth Fund USD 400 million



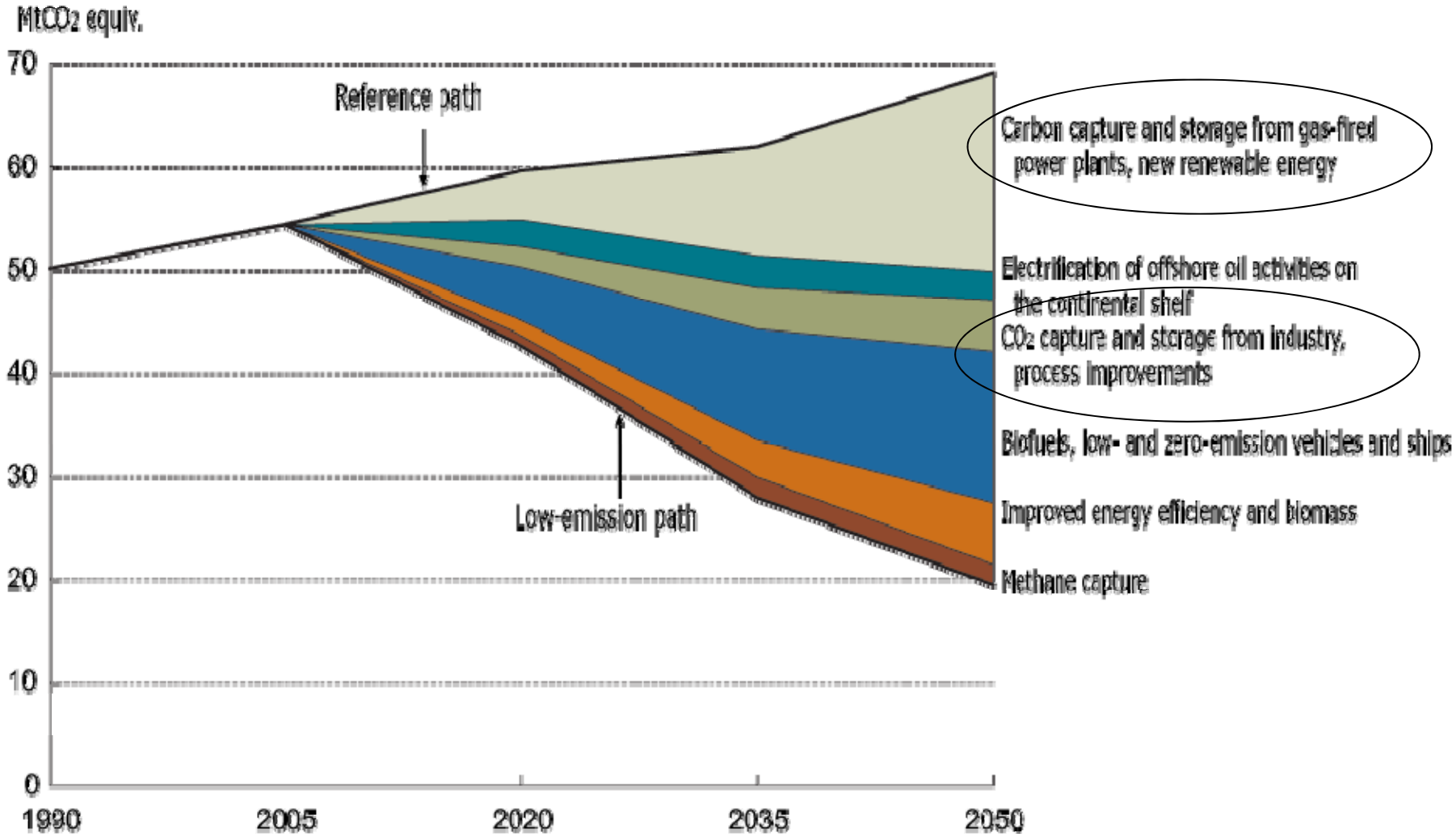
Share of the world's population:	0,07 %
3 x higher CO2-emission per capita than average:	0,21 %
13 x higher CO2-emission (oil & gas export):	2,73 %

Courtesy: www.worldmapper.org

The Norwegian Climate Policy

- **Agreement among ruling and opposition parties in the parliament :**
  - **Global target: limit average temperature hike to 2° C above pre-industrial level**
  - **Strengthen Norway's "Kyoto commitment" from 1% above 1990-level to 9% below 1990 level**
  - **Reduce Norway's carbon emission footprint with 40% within 2020**
    - **Reduction of >20 MtonCO2 including forestation**
  - **Norway shall be "carbon neutral" within 2030**
    - **Carbon emission reductions may be domestic/offshore reductions or through purchase of international emission credits**
    - **However – the target is that 50%-65% of the reduction shall be domestically**
- **Prime Minister Jens Stoltenberg's New Year Address 2007:**
  - **"Norway will take a pioneer role for development of technologies for CO2 capture and storage within 7 years – demonstrated at the European CCS Test Center Mongstad"**
  - **"This is a large, national project and can be compared to the US Moon Landing project in the 1960's"**

How to get there?



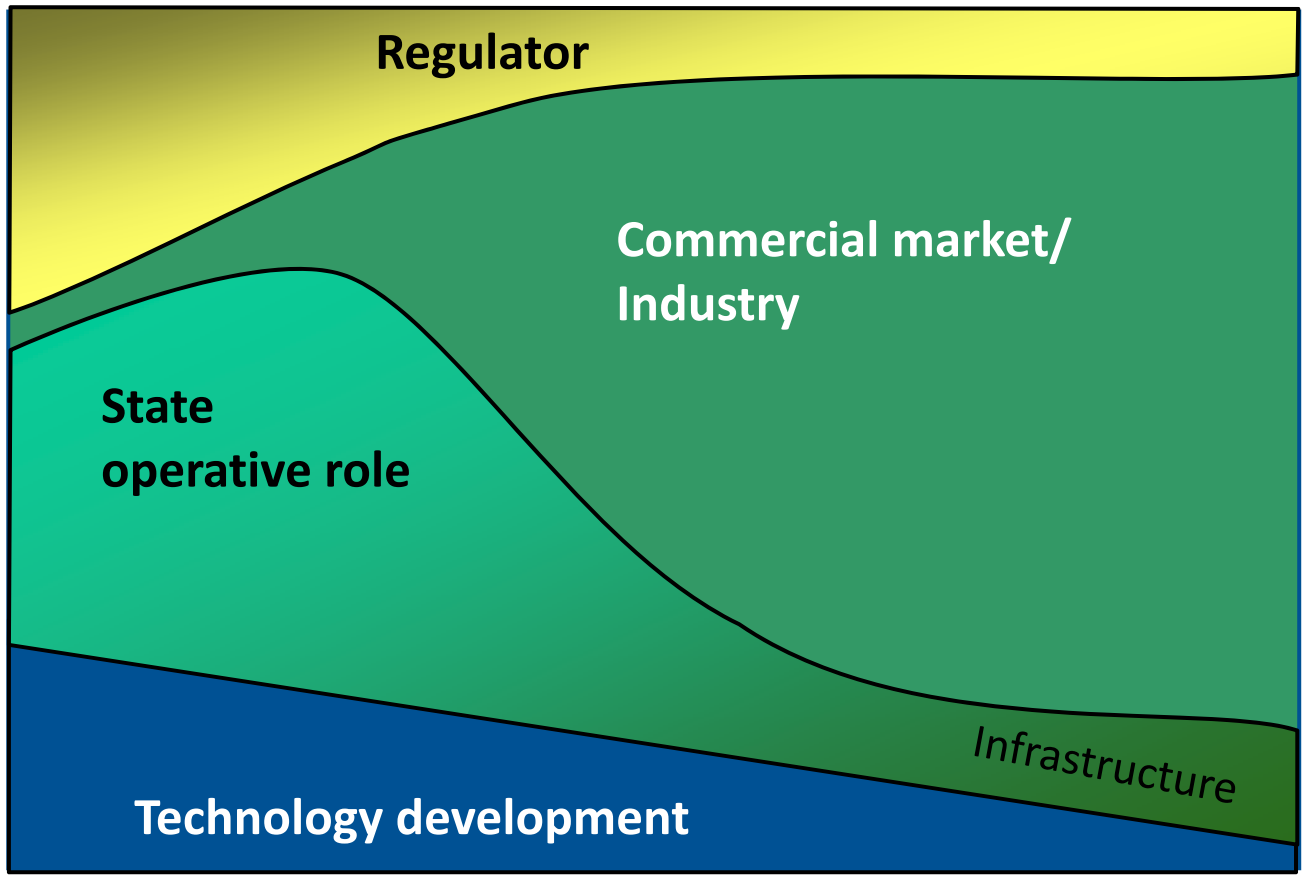
Gassnova SF

The Norwegian state enterprise for carbon capture and storage

- **Established 2005 as part of Ministry of Petroleum and Energy**
- **Transformed Jan-08 to state enterprise (SF)**
- **Managing the Norwegian state's interests in CCS**
  - **Support to technology development**
  - **Project development and execution**
  - **Acting as an advisor for the authorities**
- **CLIMIT**
  - **Research and development programme**
  - **State and industry funding**
- **Projects**
  - **Demo and full scale**
  - **State financing**
  - **Supplier involvment/development**
  - **Ownership models/consortium**
  - **Value chain: Capture, transport and storage**
- **Studies**

Source: Gassnova

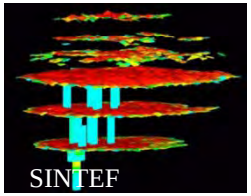
CCS – government vs industry roles



Source:
Gassnova

Challenges in the CCS value chain

Complex value chain: Market design and regulations

Source	Capture	Transport	EOR	Storage	Control
	 Aker Kværner		 Statoil	 Statoil	 SINTEF

Cost

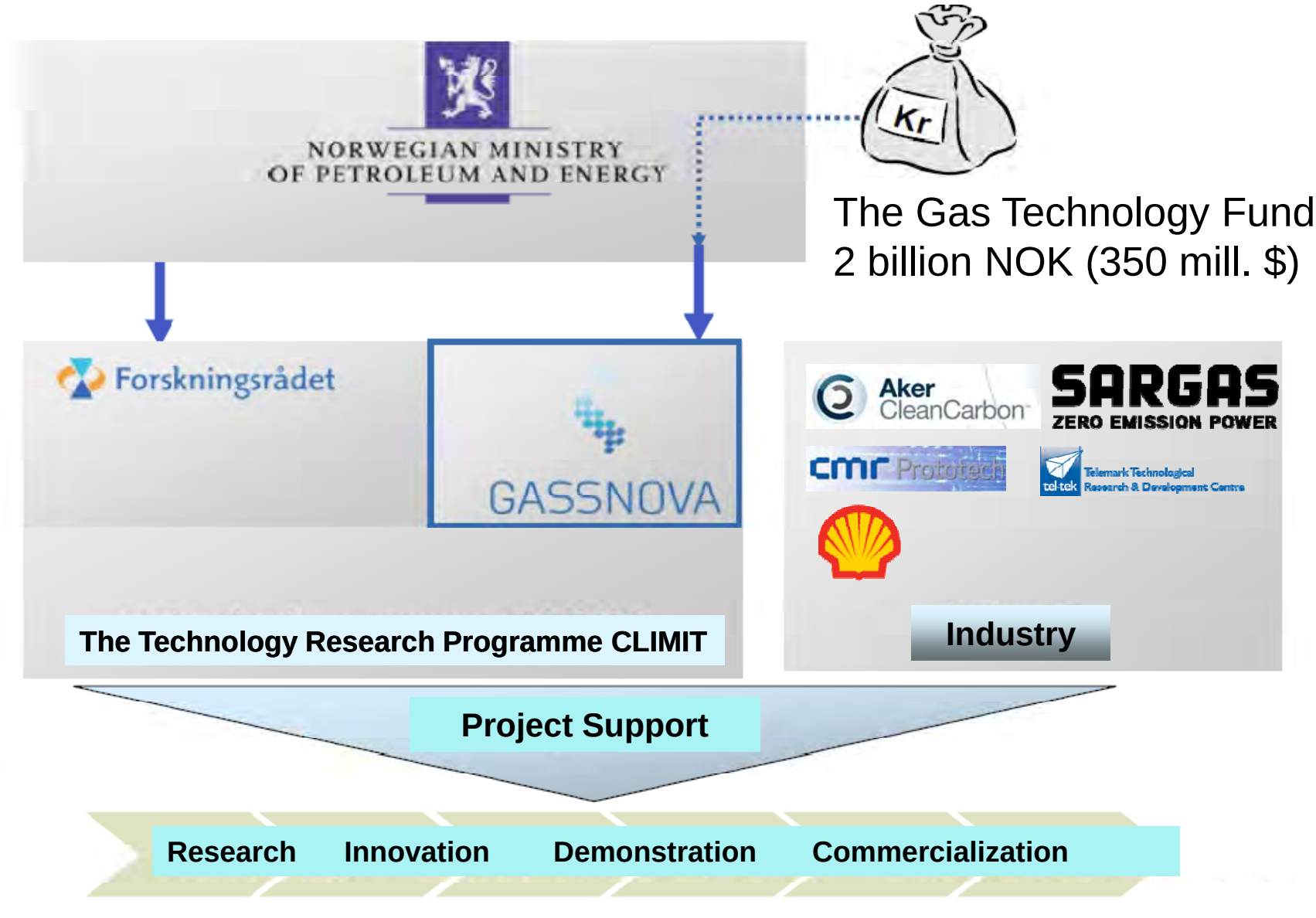
- ✓ Technology development
- ✓ Scale up & verify
- ✓ "First of its kind"

Confidence

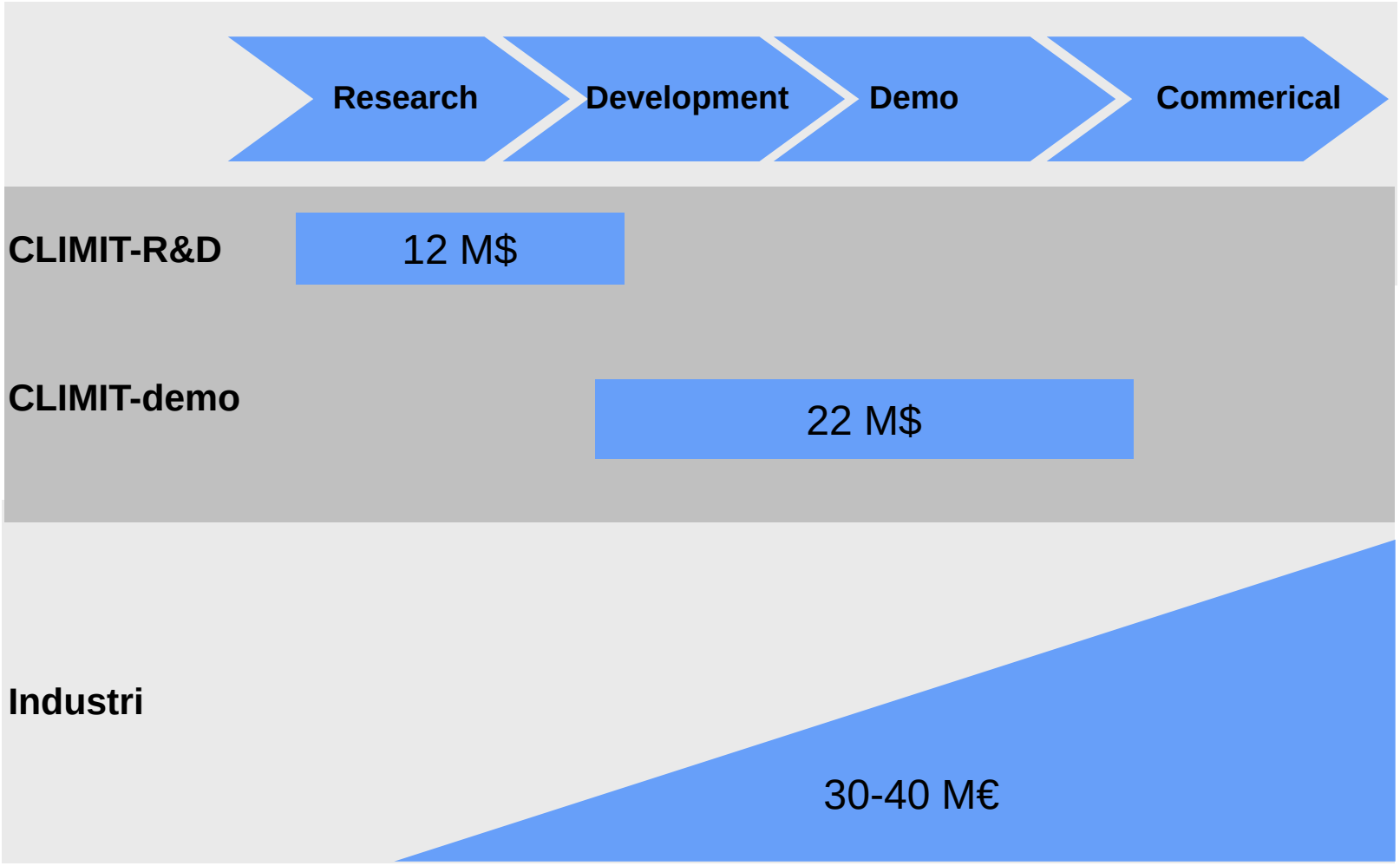
- ✓ Methods
- ✓ Demonstration
- ✓ legislation

Source: Gassnova

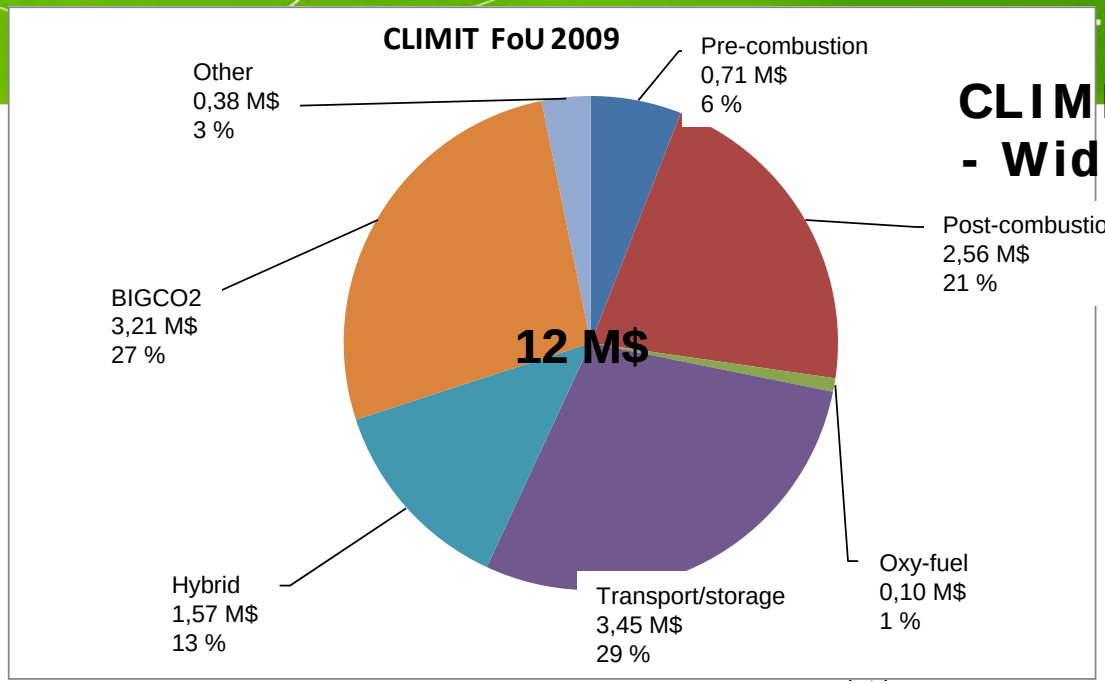
The Norwegian CO2 Capture Research Structure



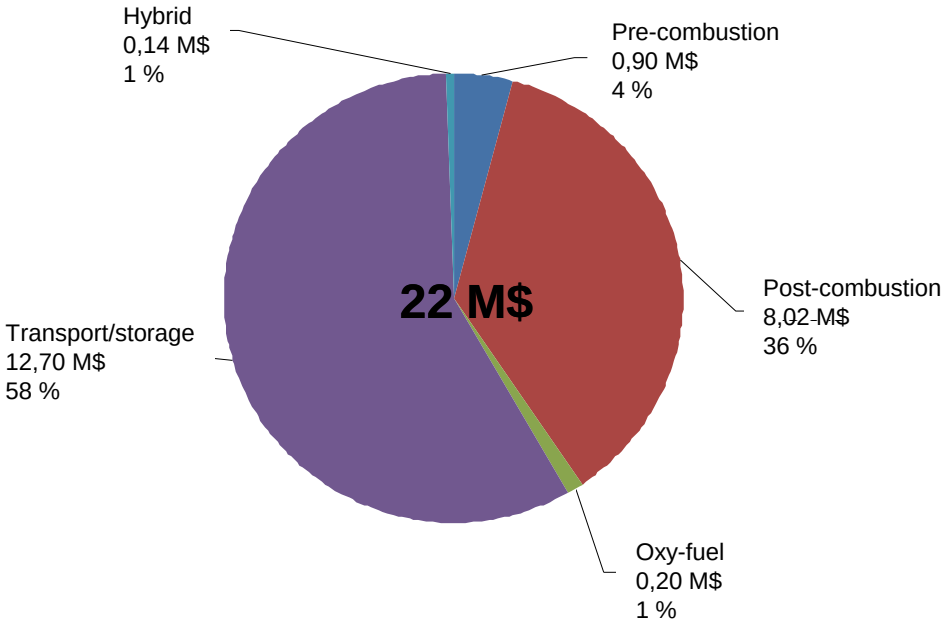
CLIMIT: A financial instrument for accelerating CCS development



CLIMIT-R&D
- Wide technology focus

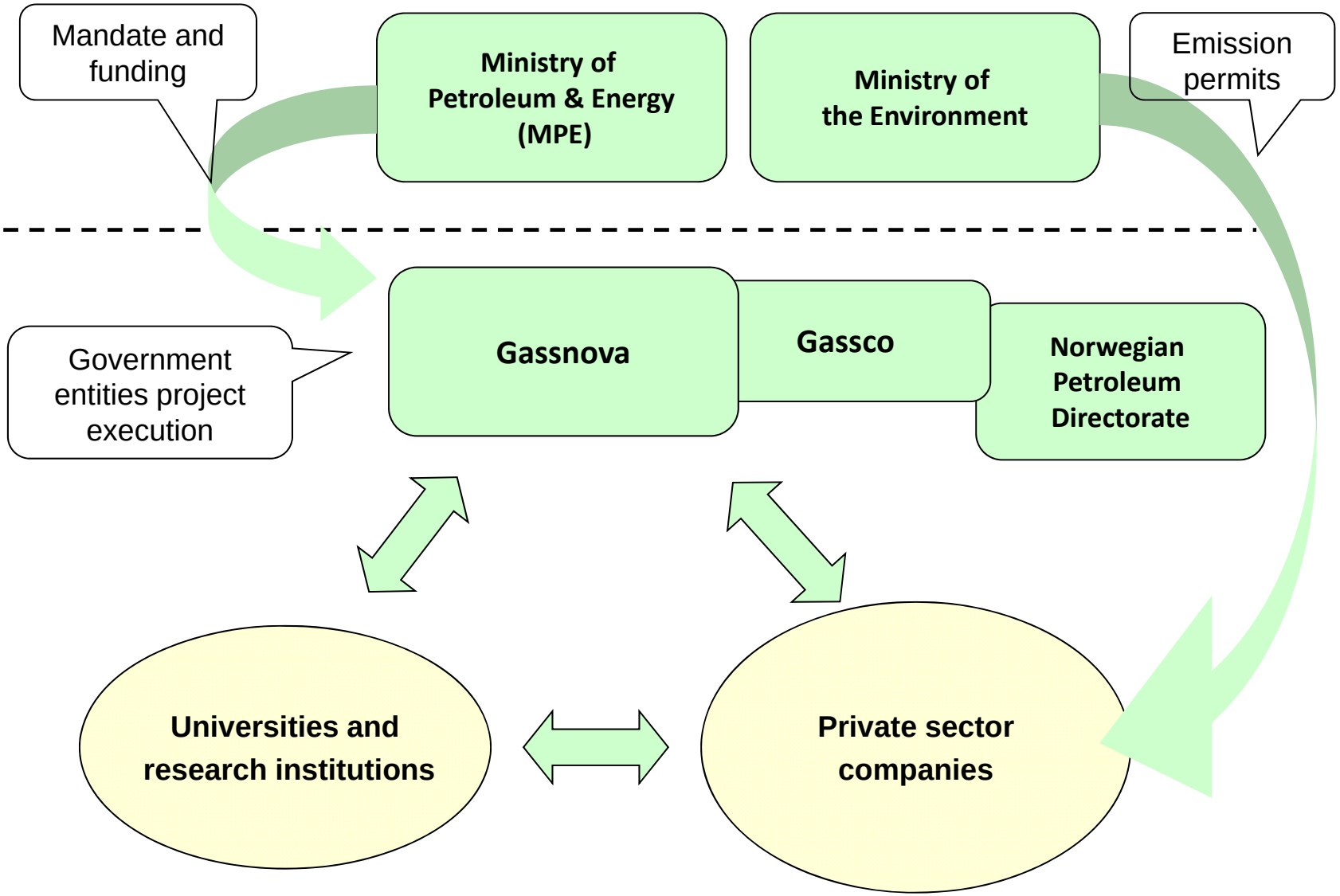


CLIMIT-demo
-narrower technology focus



Source: Gassnova

CCS project execution model - Norway



Source: Gassnova

Research on CCS in SINTEF and NTNU

- **Programmes**
  - **BIG….**
    - **CO2**
    - **CLC**
    - **H2**
    - **CCS – FME**

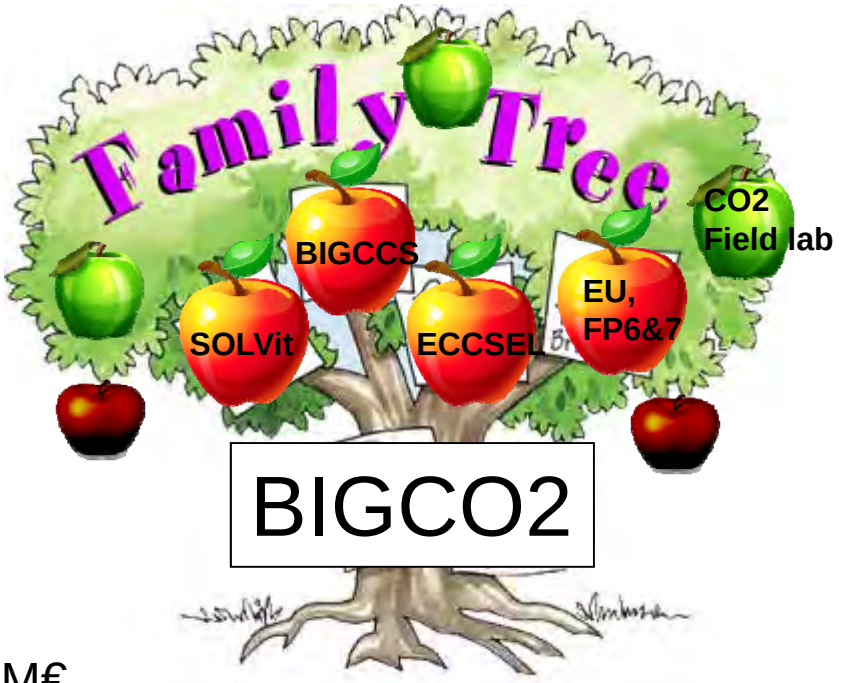
    90M€
  - **ECCSEL**
    - **European CCS Labs**

    82M€
  - **SOLVit**
    - **ACC**

    40M€
  - **Other projects**
    - **Various industrial partners**

    50M€
  - **EU FP6&FP7**
    - **Largest R&D provider within CCS in FP6 and FP7**

    24M€



Source: NTNU and SINTEF

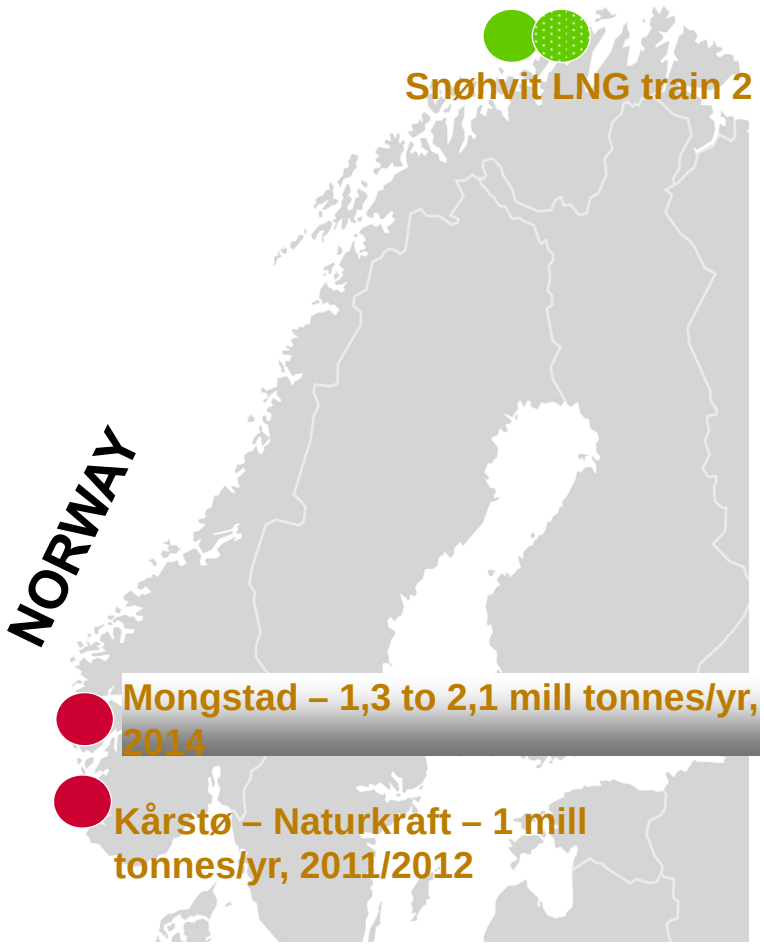
Norwegian CCS projects

Cleaning up our operations

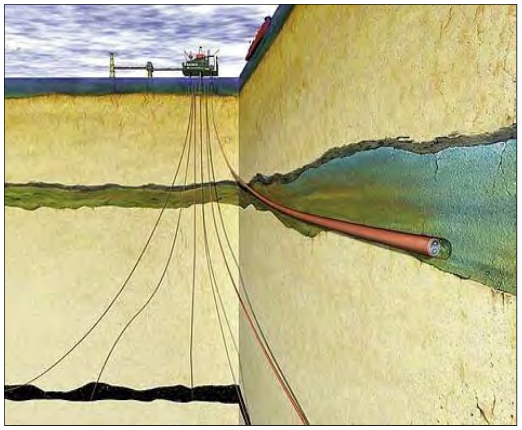
CO_2 from natural gas

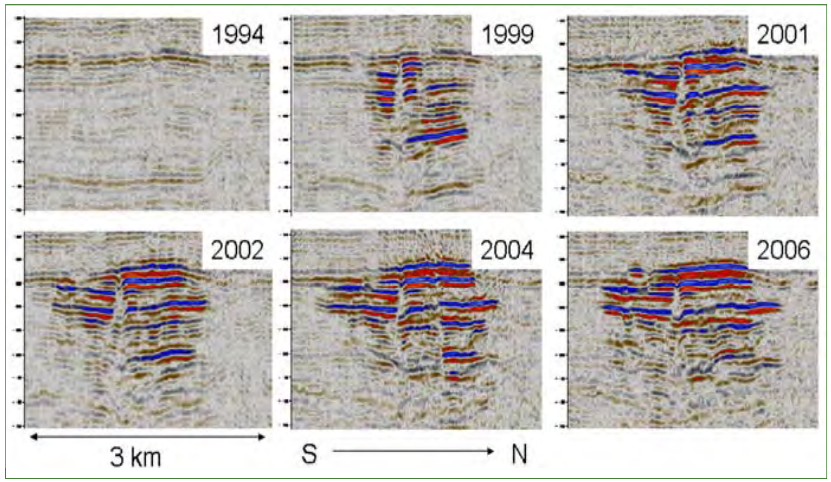
Cleaning up our products

CO_2 from electricity generation



The Sleipner experience – the starting point

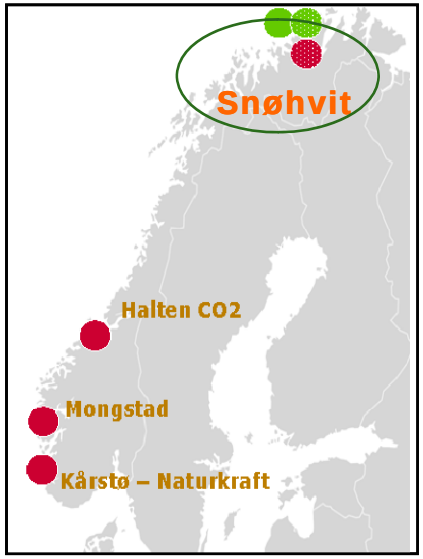


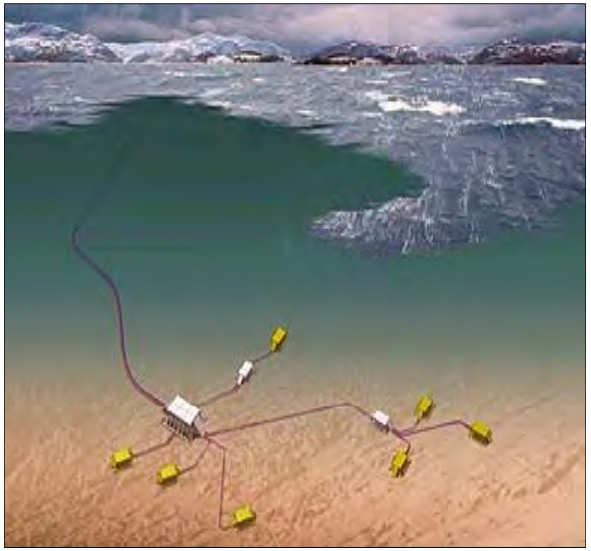


- **Started in 1996 – 10 year of CO2-injection in October 2006**
- **Separating and injecting nearly 1 mill. tons CO2 annually**
- **Storing in saline aquifer above natural gas reservoir**
- **Driver: the ~45US$/ton CO2-tax imposed in 1992**
- **Learning and confidence building through a series of large EU-wide R&D programs**

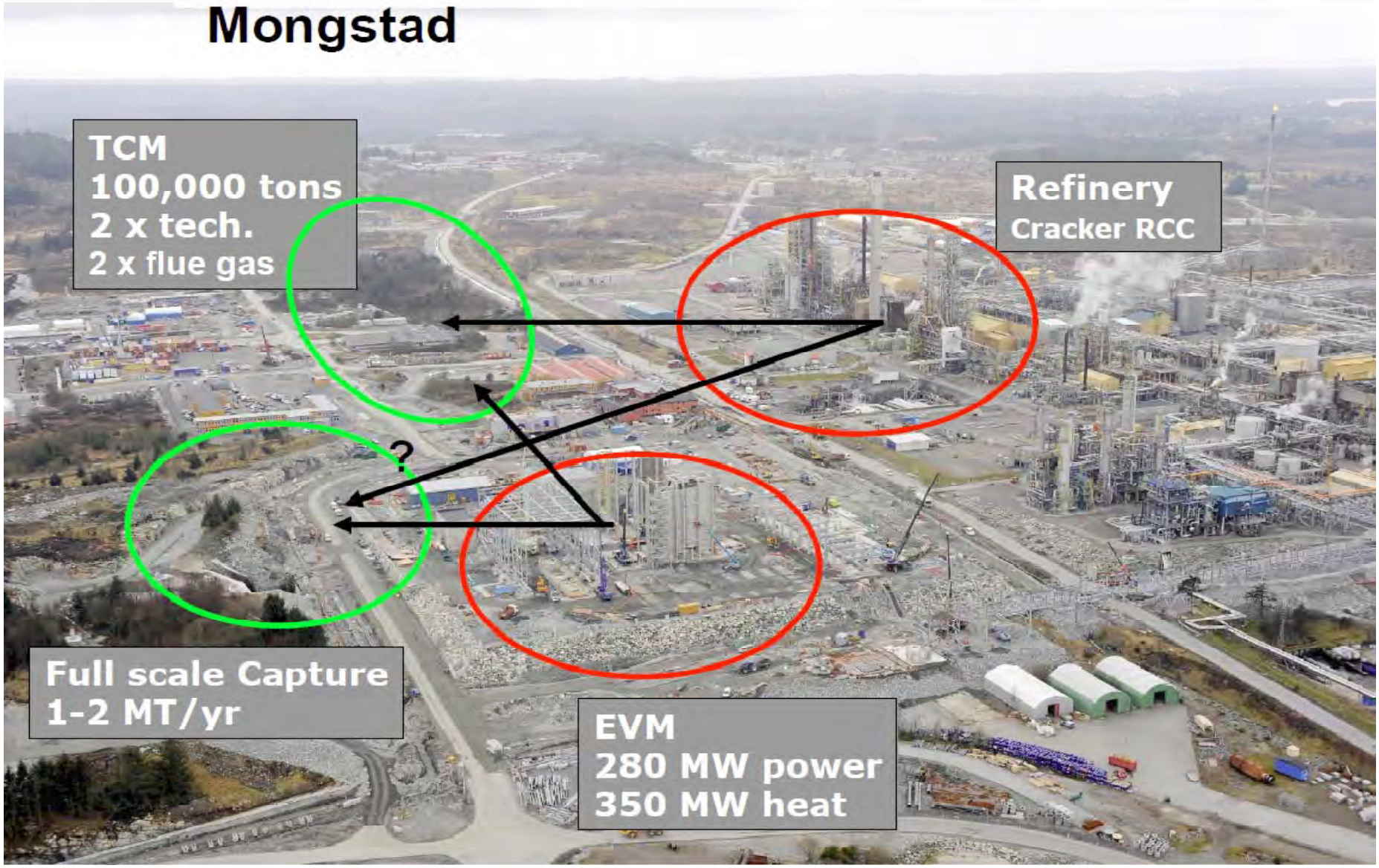
Snøhvit LNG with CCS

- **Piped CO2 separated from natural gas (5-8% CO2) in onshore LNG plant, and re-injecting in sandstone below natural gas reservoir**
- **145 km subsea pipeline transport.**
- **CCS started April 2008 – capacity 700,000 ton/yr**



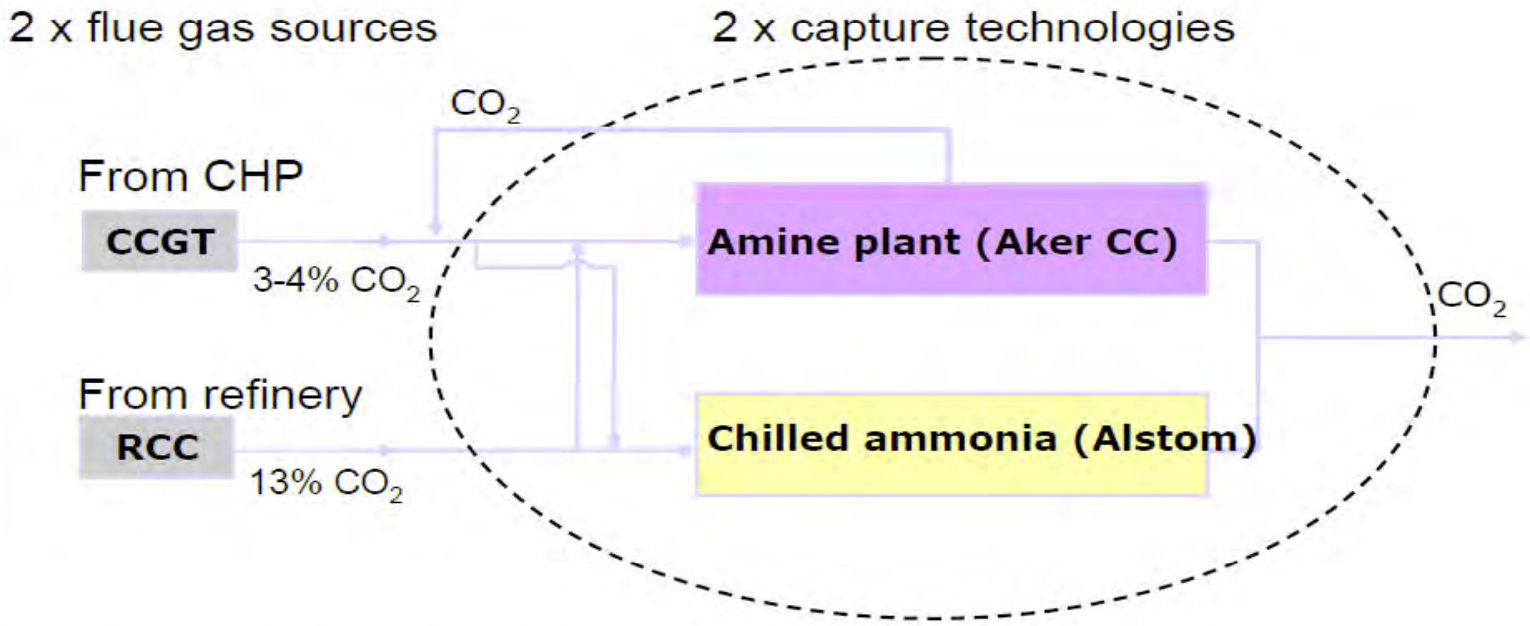


The CO_2 Technology Centre Mongstad (TCM)



Source: Gassnova

TCM process setup



The high CO2 concentration of the flue gas from the refinery allows TCM to simulate flue gas from a coal fired power plant

Source: Gassnova

Mongstad

- 2006: agreement between Norwegian state and Statoil
  - Statoil permit to build CHP provided:
    - Build and finance 20% of Test Centre (step 1)
    - Build full scale capture plant by 2014 for CHP; 100% state financed with Statoil carrying overrun risk. (Step 2)
    - Evaluate capture of refinery sources
  - Transport and Storage handled & financed by the state
  - Statoil to pay alternative costs (e.g. CO2 quota price) aiming at competitive neutrality vs. international industry.

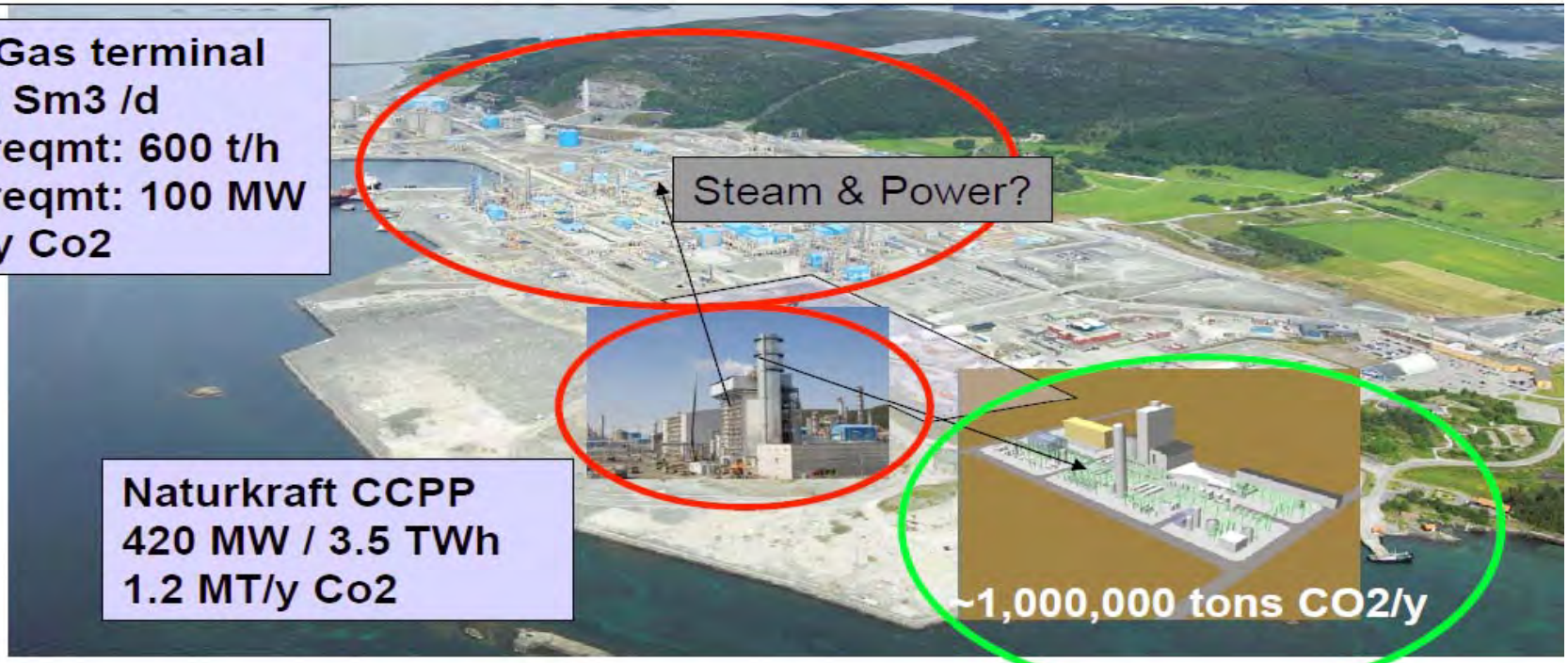
Mongstad Full Scale Capture

Source: StatoilHydro

Kårstø: Full-scale carbon capture plant

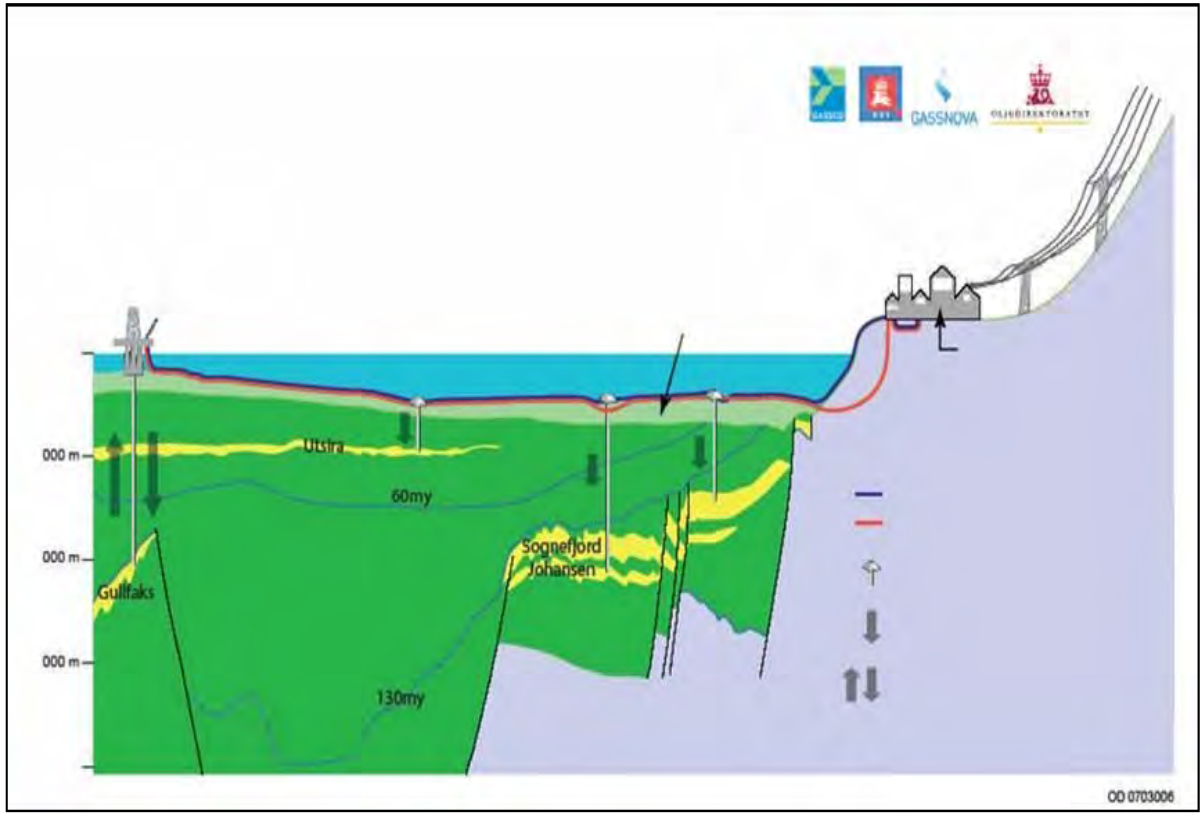
- Original project to capture from Power Plant (1.2 MT/yr) with State funding 100%
- Project scope changed; integration of gas terminal to be evaluated – power plant to be energy supplier (steam & el) to replace 5 current energy suppliers
- Total emission removal 2.4 MT/yr CO2 + significant NOX reductions
- Investment decision 2011/12?

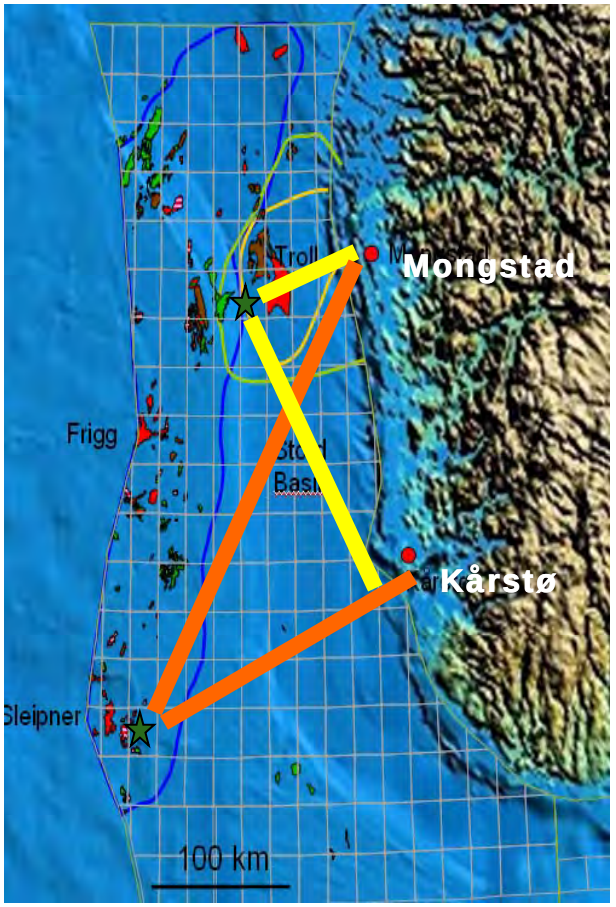
Kårstø Gas terminal
Gas: 88 Sm3 /d
Steam reqmt: 600 t/h
Power reqmt: 100 MW
1.2 MT/y Co2



Storage alternatives for the Norwegian North Sea

- **Pipelines from Mongstad and Kårstø**
- **Deposition sites:**
  - **Utsira (Sleipner)**
  - **Johansen formation (south of Troll)**





Source:
Gassnova

Conclusions

- **Norway is a promoter for technologies to combat global warming, with focus on CCS, new/renewable energy, energy efficiency and global carbon market schemes.**
- **Gassnova SF established to run projects, support RD&D and advise the government**
- **Frontrunner on CCS projects and demonstrations:**
  - **The Sleipner CO2 storage project since 1996**
  - **The Snøvit CO2 storage project since 2008**
  - **The European CCS Test Center Mongstad**
  - **The Kårstø CO2 capture project**
- **One of the largest R&C clusters on CCS in the world.**
- **Challenges:**
  - **Public acceptance**
  - **Projects: Retrofit / Brown vs green field / Scaling up**
  - **Health, safety, environment (HSE)**
  - **Commercial: funding / Market development / Industrial partnerships – Consortium.**
  - **Strategy still to be decided: Financing, operation, ownership, competence, international knowledge sharing, i.e. models**
- **Actively seeking collaboration with R&D centers and CCS technology developers world-wide.**

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Carbon Value Chain
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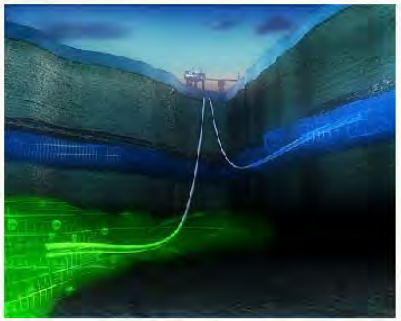
CVC Team Norway

Welcome to Carbon Value Chain Team Norway website.



Carbon Value Chain (CVC)

Carbon Value Chain covers the technical, financial and political value chain of CO2 as a global climate gas. The specific elements include CCS (Carbon Capture and Storage); transport and utilisation of CO2; CO2 pricing (tax, markets, project financing); international carbon markets and trading schemes such as CDM/JI, EU ETS and the geopolitical negotiations of handling climate gases.

Norway is taking a leading role in the global CVC, from development and demonstration of CCS technologies, via establishment of carbon trading markets to an active geopolitical stance. Click here for introduction to Norwegian CVC activities.

Contacts:

INNOVATION NORWAY
Innovation Norway Tokyo office. Contact: Per Christer Lund, Science and Technology Counsellor.

NORWEGIAN EMBASSY
Royal Norwegian Embassy in Tokyo. Contact: Jørn Osmundsen, Second Secretary.

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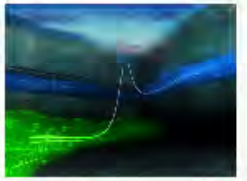
Norwegian CCS Projects

Ongoing and planned Norwegian CCS projects.

Sleipner CCS. At the ***StatoilHydro***-operated Sleipner fields on the Norwegian continental shelf, carbon dioxide from produced gas is captured and stored in a subsea aquifer. Emissions of more than 10 million tonnes of carbon dioxide to the atmosphere have been avoided since production started in 1996.

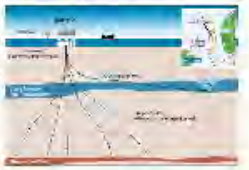


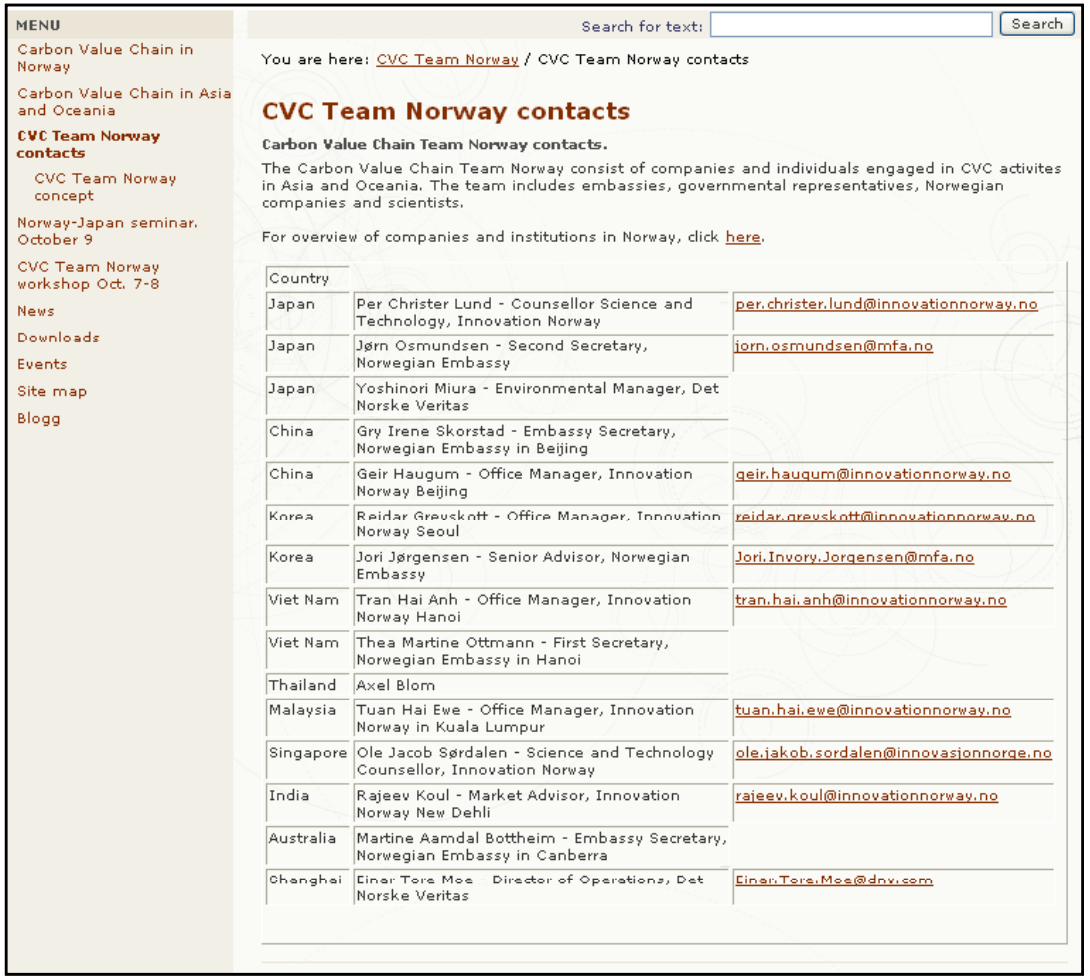
Snøvit CCS. The Snøhvit project is the first petroleum production plant in the Barents Sea. At the onshore LNG plant off Hammerfest in northern Norway, carbon dioxide is captured from the production stream in subsea wells in the Barents Sea, 145 kilometres off the onshore facilities at Melkøya. At full production, the plant has a capture and storage capacity of 700,000 tonnes of CO2 per year.

European CO2 Technology Centre Mongstad. The plant will have the capacity to capture up to 100,000 t of CO2 per year. TCM aims to provide an arena for the development, testing and qualification of CO2 capture technology for the large-scale treatment of flue gases, and to contribute to international deployment based on this experience, thereby helping to reduce the costs and risks of full-scale CO2-capture.

Kårstø gas power plant with CO2 capture. The government has decided that the state will fund CO2 management at Kårstø. CO2 management consists of carbon capture facilities, a CO2 pipeline and facilities for the storage of CO2 in subsea or mountain structures.

Large-scale transport and storage of CO2 from Kårstø and Mongstad. On behalf of the State, Gassnova has the overall responsibility of all assessments and studies on CO2 capture, transport and storage. The CO2 transport and storage project shall ensure that CO2 from the planned carbon capture facilities at the gas-fired power plant at Kårstø and the future energy plant at Mongstad is safely transported and stored.





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CVC Team Norway contacts

Carbon Value Chain Team Norway contacts.

The Carbon Value Chain Team Norway consist of companies and individuals engaged in CVC activites in Asia and Oceania. The team includes embassies, governmental representatives, Norwegian companies and scientists.

For overview of companies and institutions in Norway, click here.

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