



# **Norway's Policies to Reduce Emissions of Greenhouse Gases through Carbon Capture and Storage (CCS)**

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**Tone Skogen**

**Deputy Director General  
Norwegian Ministry of Petroleum and Energy**



## Outline

- Why carbon capture and storage?
- Norwegian CCS policy
- The Norwegian CCS projects
- Challenges related to CCS
- International cooperation on CCS
- Concluding remarks

# The energy and climate challenge

- Securing energy supply while mitigating climate change
  - Economic growth requires energy: the importance of securing energy supply
  - Mitigating climate change: limit global mean temperature increase to 2°C to avoid dangerous climate change



# The advantage of CCS: securing energy supply and simultaneously mitigating climate change

- It is necessary to develop clean-energy technologies, and implement sustainable energy systems
  - CCS is part of the solution
  - in addition to other measures such as energy efficiency and increased use of renewable energy sources



# Norwegian CCS policy

*Developing CCS is necessary to mitigate climate change, in combination with renewables and energy efficiency*

- **The Norwegian Government:**

- has ambitious goals for wide-spread use of CCS
- cooperates closely with industrial actors
- provides public funding

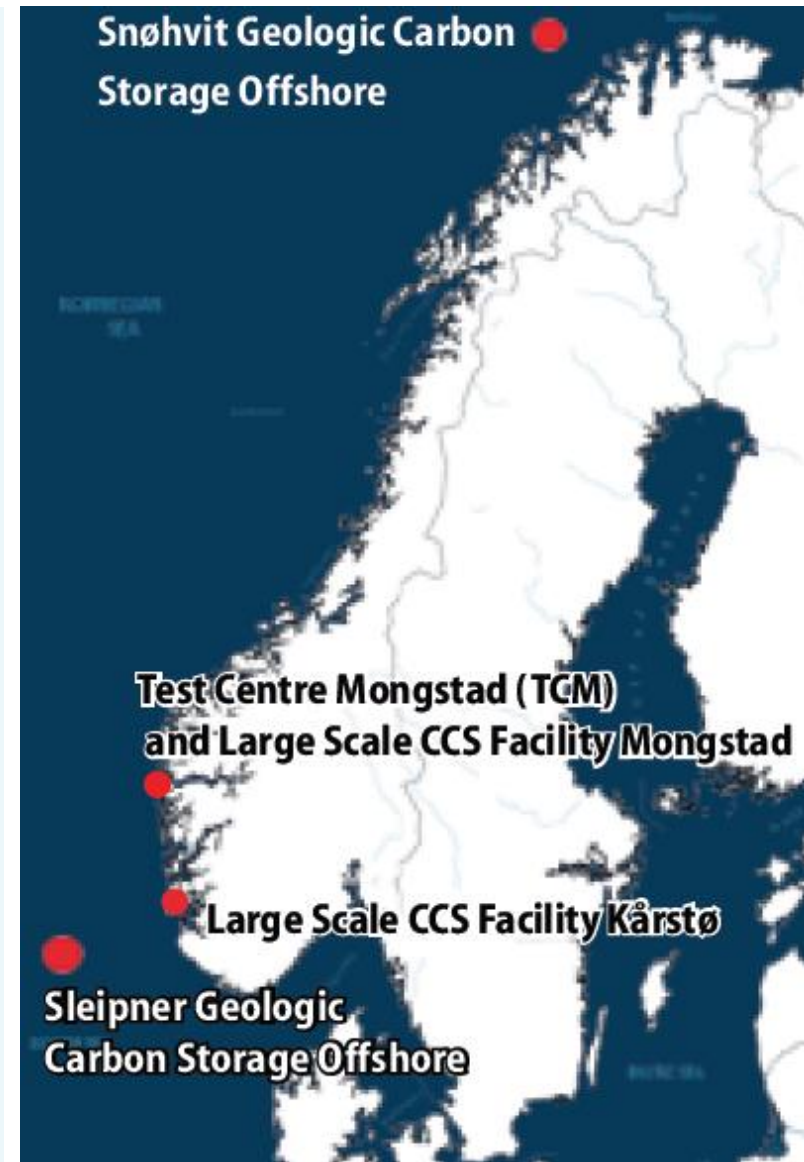
- **Several national CCS-projects in progress**

*“All new gas fired power plants shall be based on technology for CO<sub>2</sub> capture”*



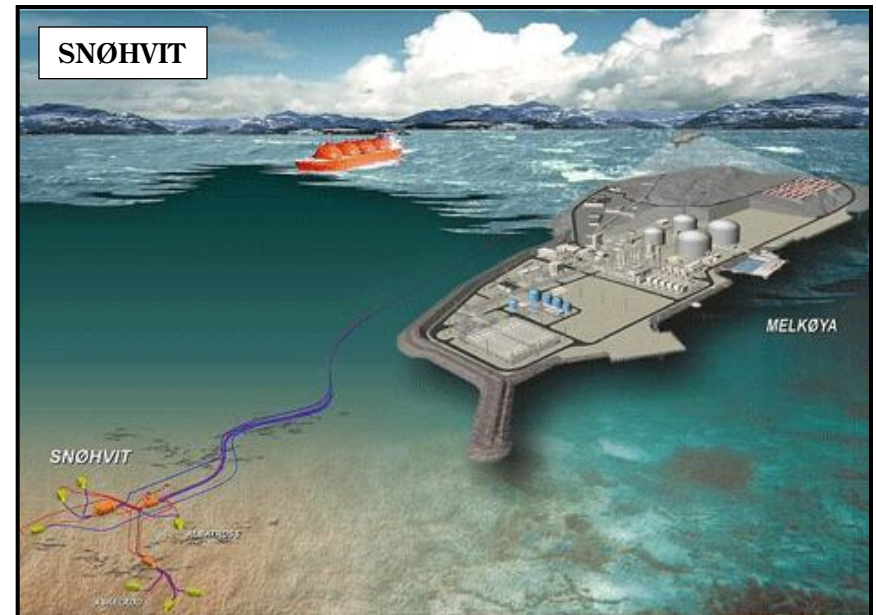
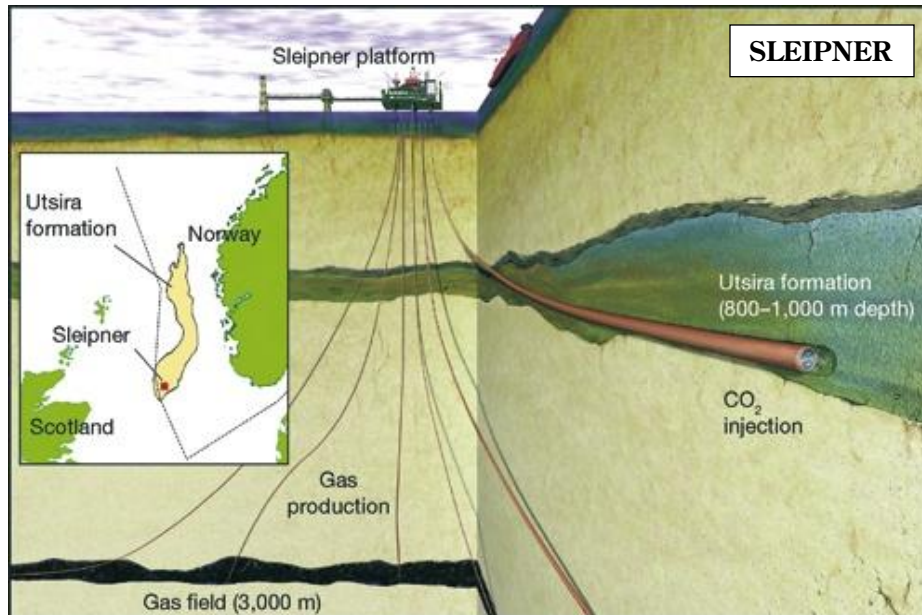
# CCS on the map in Norway

- **Present CCS sites**
  - Snøhvit
  - Sleipner
- **CCS on gas fired power plants:**
  - Technology Centre Mongstad (TCM)
  - Large Scale Facility Mongstad
  - Large Scale Facility Kårstø
- **CO<sub>2</sub> transport and storage solutions**

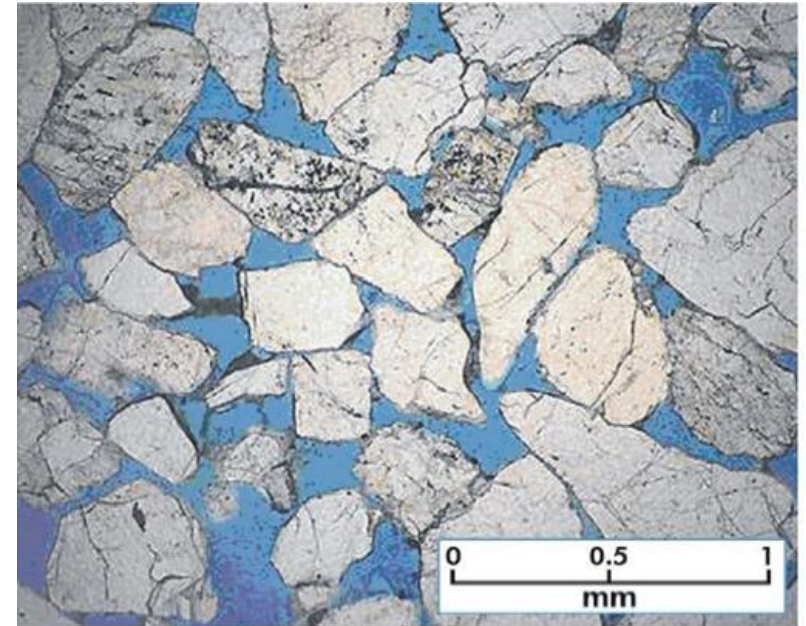


# Norway's unique CO2 storage experience

- Since 1996 a total amount of 10 million tonnes of CO2 has been stored in a geological formation above the Sleipner field in the North Sea. Monitoring shows no leakage of CO2.
- The Snøhvit Field in the Barents Sea provides gas to the world's first LNG plant with CCS. In April 2008, the first amount of CO2 from this field was injected and stored in a geological formation.



# Sleipner Geologic Carbon Storage Offshore



*CO<sub>2</sub> will be trapped as a supercritical fluid in tiny pore spaces within the storage rock, as is shown by the blue spaces in this photograph of a microscopic section of storage sandstone. The white grains are mostly quartz.*

- Sleipner A platform: 13 yrs of CO<sub>2</sub> storage in a geological formation 1,000 metres below the seabed
- This is the only facility in the world where large quantities of CO<sub>2</sub> have been stored in a geological formation under the seabed for several years

# Project plans: Mongstad

- Refinery and oil terminal
- Gas-fired combined heat and power plant under construction

- **Develop CCS in two stages:**

**Stage 1** – carbon capture technology centre (TCM)

- Industrial cooperation. (100 000 tonnes CO<sub>2</sub>)

**Stage 2** – full scale carbon capture facility

- Will capture 1.2 million tons CO<sub>2</sub> annually
- investment and operation costs financed by the government
- StatoilHydro cover costs equal to their alternative costs of CO<sub>2</sub>
- The government will finance transport and storage



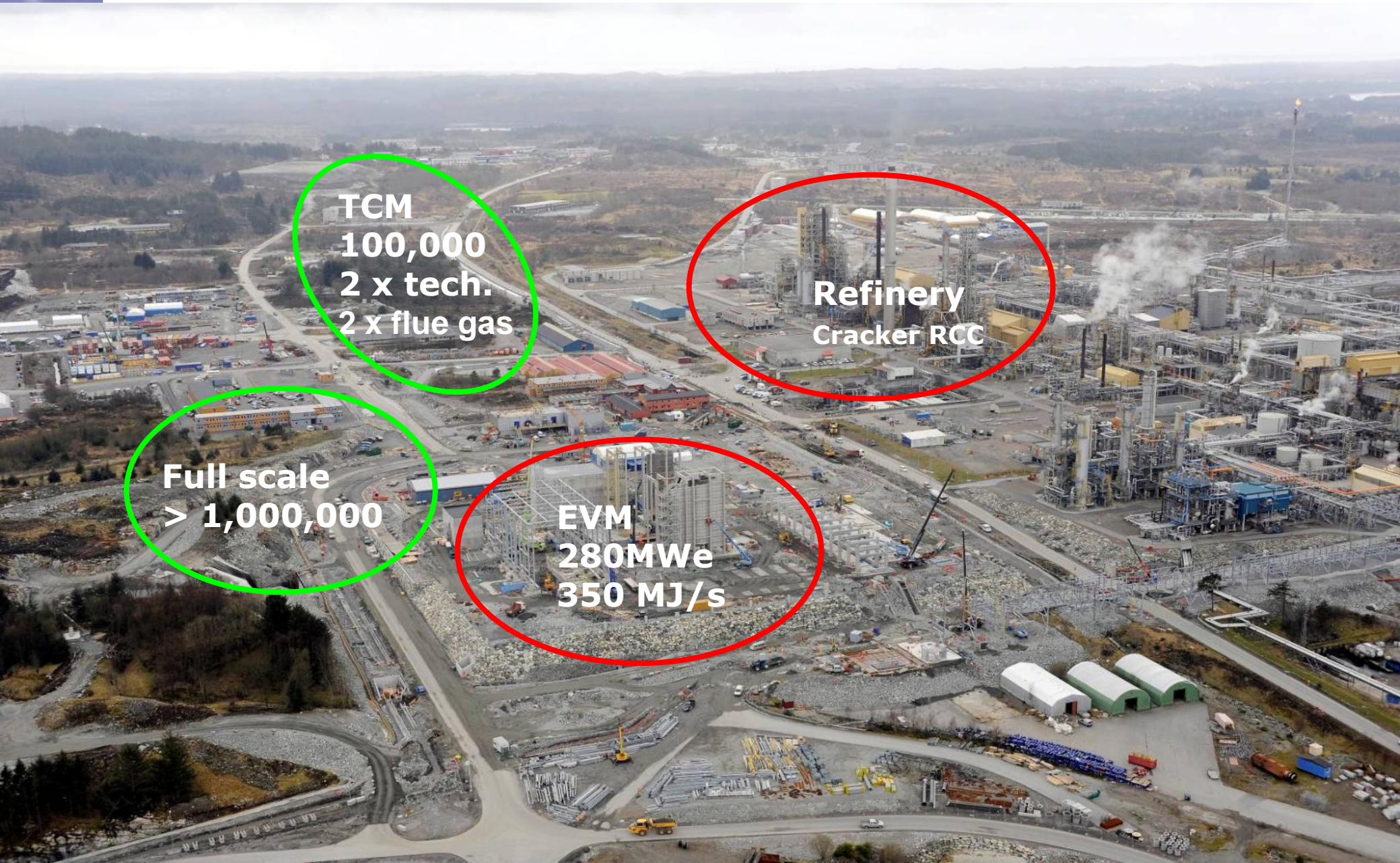
# Mongstad refinery

TCM  
100,000  
2 x tech.  
2 x flue gas

Refinery  
Cracker RCC

Full scale  
> 1,000,000

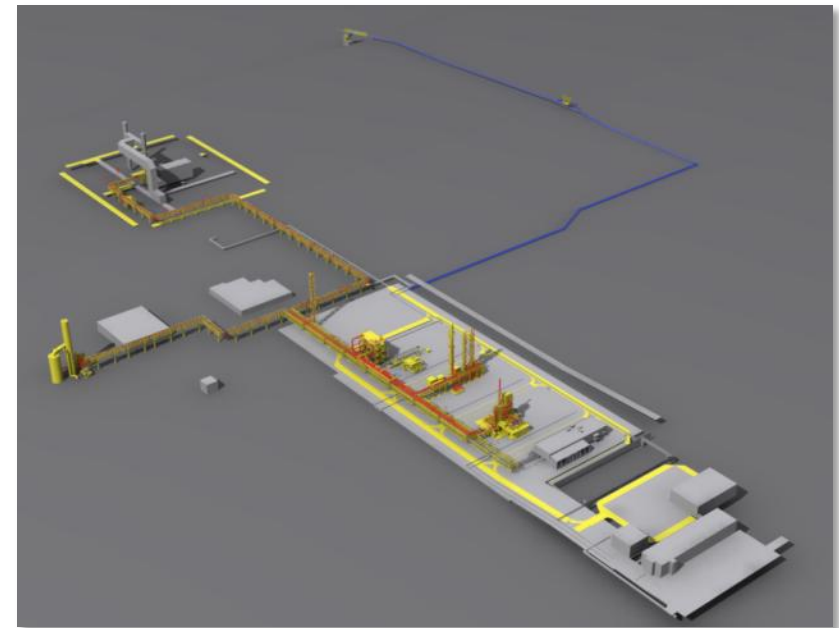
EVM  
280MWe  
350 MJ/s



# Project Plans: European CO<sub>2</sub> Technology Centre Mongstad (TCM)

*Scope: develop, test verify and demonstrate technology in order to reduce cost and risk*

- Construction started in June 2009
- Facility start-up: 2011
- Two technologies tested: Amine and Chilled Ammonia technology
- Two sources of flue gas
- Capture capacity; 100 000 tons
- Partners: Gassnova, Shell, StatoilHydro



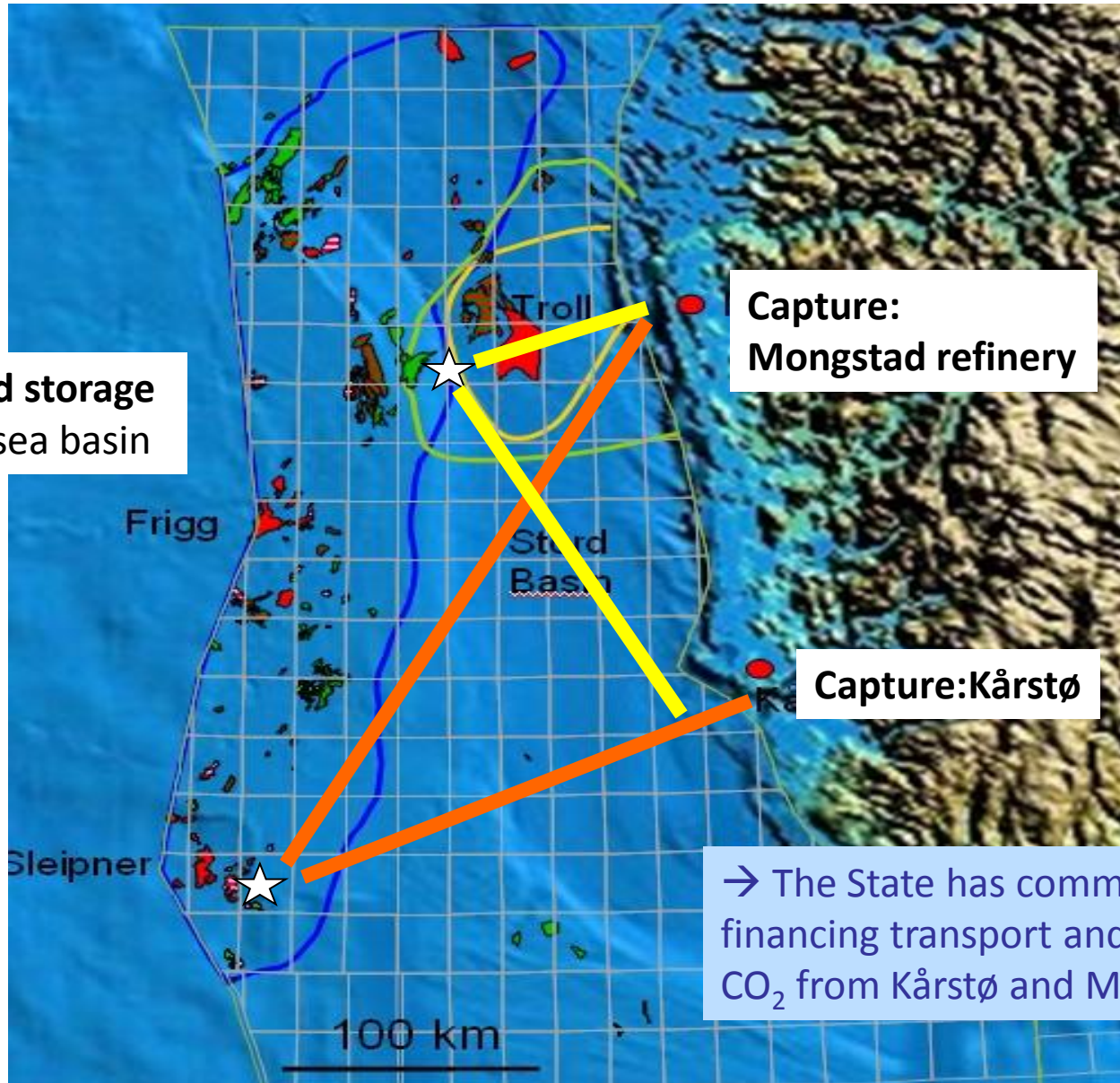
**StatoilHydro**



  
GASSNOVA

# CO2 transportation and storage options

Transport and storage  
In the North sea basin



Capture:  
Mongstad refinery

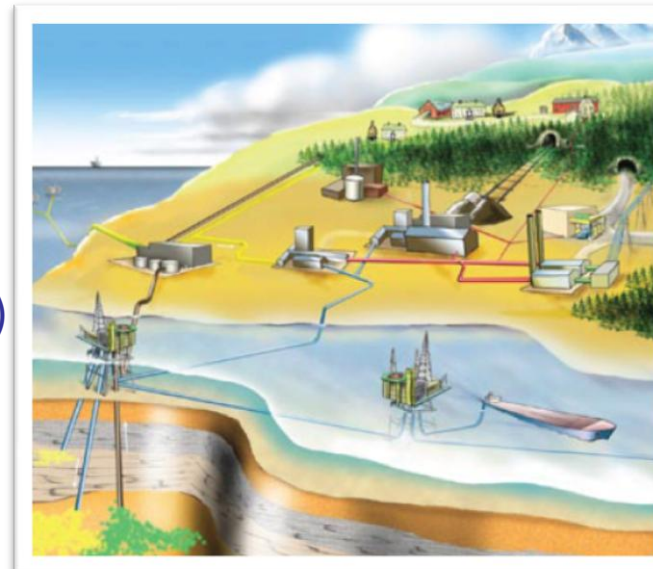
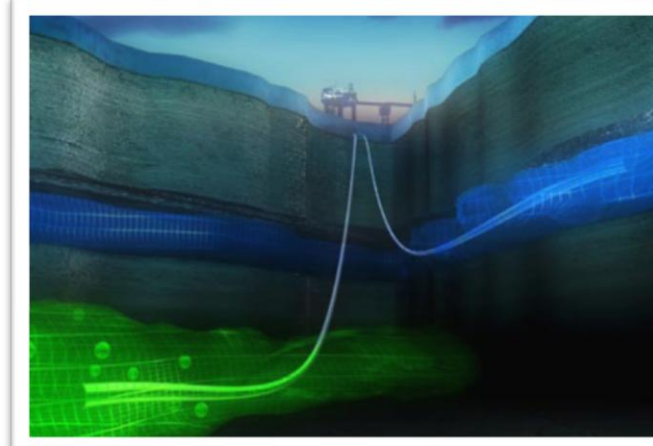
Capture:Kårstø

→ The State has committed to financing transport and storage of CO<sub>2</sub> from Kårstø and Mongstad



# CCS – Research & Development

- Norwegian governmental funding for CCS in 2009 is 2917 mill NOK – appr. 440 mill USD
  - Government funding for CCS R&D increased by appr. 40 per cent 2008-2009
- **Public support schemes for CCS R&D in Norway**
  - Research areas cover the entire CCS value chain
  - The CLIMIT programme
  - Centres for Environment-friendly Energy Research (CEER) (Two out of eight dedicated to CCS)



**Goal** → *Develop cost-efficient and future-oriented technology concepts for CO2 management*

# Implementing CCS: Major challenges

Complex value chain: Market design and regulations

Source



Capture



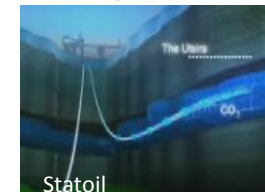
Transport



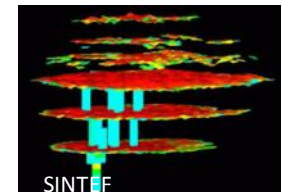
EOR



Storage



Control



**Cost**

- ✓ Technology development
- ✓ Scale up & verify
- ✓ "First of its kind"
- ✓ Establish commercial incentives
- ✓ Stimulate development, deployment and dissemination of CCS technology
- ✓ Public funding in an early CCS-demonstration phase

**Confidence**

- ✓ Methods
- ✓ Demonstration
- ✓ Legal and regulatory frameworks - Issues of safe storage, liability, transport etc.
- ✓ Public acceptance

# International cooperation on CCS is essential

- Cooperating on research and demonstration plants
- Sharing information and experiences
- Creating commercial incentives and regulatory frameworks



In order to...

- Make the technology commercially viable
- Gain public understanding and acceptance of CCS
- Make widespread use of CCS a global reality

# Norwegian engagements for enabling CCS globally

- Action plan to promote CCS internationally
- High-level conference on technology in Bergen May 2009
- Participation in several initiatives and partnerships:
  - GCCSI – the Global CCS Institute
  - Carbon Sequestration Leadership Forum (CSLF)
  - The EU Zero Emissions Platform (ZEP)
  - North Sea Basin Task Force
  - 4-Kingdom Initiative



Fighting Climate Change with  
Carbon Capture and Storage

High-level Conference, Bergen, Norway, 27-28 May 2009

# Concluding remarks

- CCS will be a major tool for mitigating climate change.
- Through widespread use of CCS, we can secure energy supply and simultaneously mitigate climate change. To achieve this it is vital;
  - To show the way - a need for frontrunners
  - To realize projects – show it works
  - Global deployment needed
  - A co-ordinated international effort is required.





**Thank you for your attention**

**[www.government.no/ccs](http://www.government.no/ccs)**

# Additional information related to Norwegian Climate Change Policies

- Norway's ambitious Climate Change Policy
- Why Capture CO<sub>2</sub> from Gas-fired Power Plants?
- A state-owned CCS Company
- Project Plans: Kårstø

# Norway's ambitious Climate Change Policy

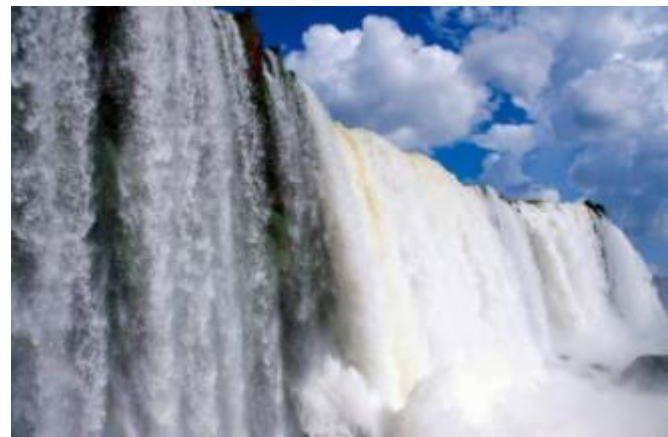
## Broad political consensus on ambitious Climate Change Policy:

- Norway will improve its responsibilities under the Kyoto Protocol by 10 per cent.
- Norway is to be carbon neutral by 2030.
- Targets to be met by substantial reduction of national emissions and by paying for cuts in other countries
- All sectors and industry must contribute
- Considerable funds are allocated to technology development



# Why Capture CO<sub>2</sub> from Gas-fired Power Plants?

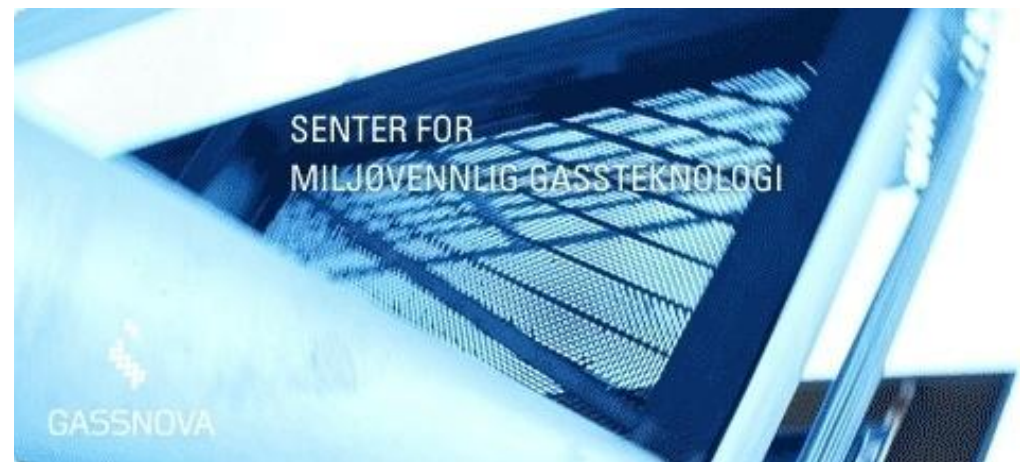
- **Electricity production in Norway is almost entirely based on hydropower**
  - limited potential for further development of hydropower
- **Introduction of gas-fired power plants**
  - security of supply
  - Bridge the gap to a low-carbon future



Picture from Kårstø, Naturkraft

# A state-owned CCS Company

- In order to administer the Government's participation in the CCS-projects, a state-owned company dedicated to CCS, Gassnova SF, has been established.
- The company constitutes an efficient tool in planning and executing CCS projects in co-operation with industrial partners.



# Project Plans: Kårstø

*Scope: scale up existing technology by a factor of 10*

- **Gas-fired power plant start-up 2007**
  - Concessions given without CCS requirement
- **The Government has decided to build a CCS plant at Kårstø**
  - connected to the existing gas-fired power plant
- **Capture of 1 million tons of CO<sub>2</sub>/year**
  - existing technology will be scaled up by a factor of 10
- **2007 – 2009; planning phase preparing**
  - the basis for investment decision in 2009
- **Transport and storage;**
  - Utsira fm or Johansen fm



Kårstø, Naturkraft

The Norwegian Government decided to halt the procurement process for the assignment of contracts to construct the CO<sub>2</sub> capture and storage (CCS) facility at Kårstø in May 2009, until the gas-fired power plant's operational pattern becomes clearer or other solutions that ensure regularity of production and emissions of CO<sub>2</sub> from the power plant become evident.