The Research Council of Norway

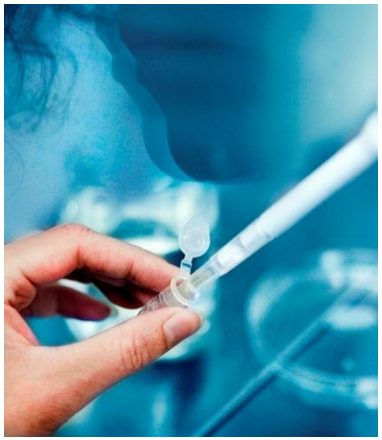
Norwegian instruments for promoting CCS development

Mongstad June 13th, 2012

Åse Slagtern

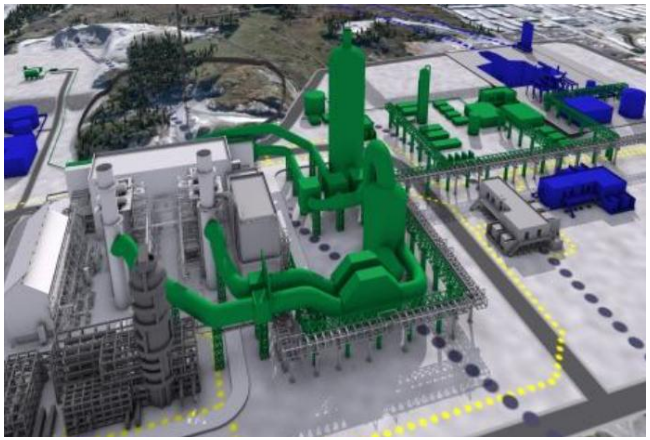
Norwegian Public funded CCS projects

- R&D



- TCM

- Full scale CCS at Mongstad

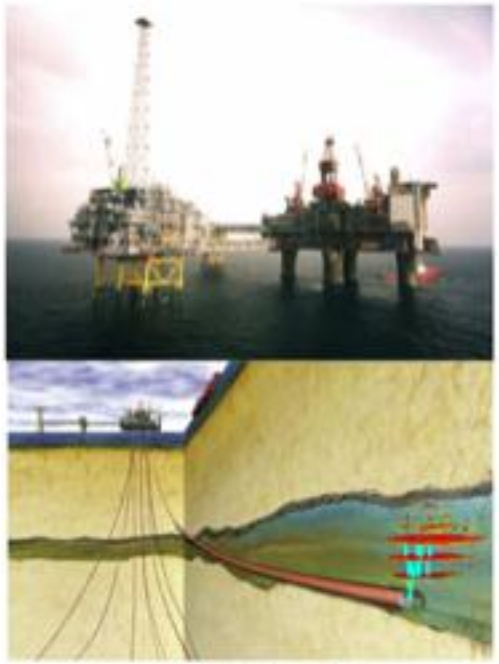


- Public funding for CCS 2012
  - Mongstad: 2 900 M NOK (£ 330 Million)
  - CLIMIT, research centres, infrastructure, NORDICCS: 200 M NOK (£ 23 Million)

The early start of CCS in Norway

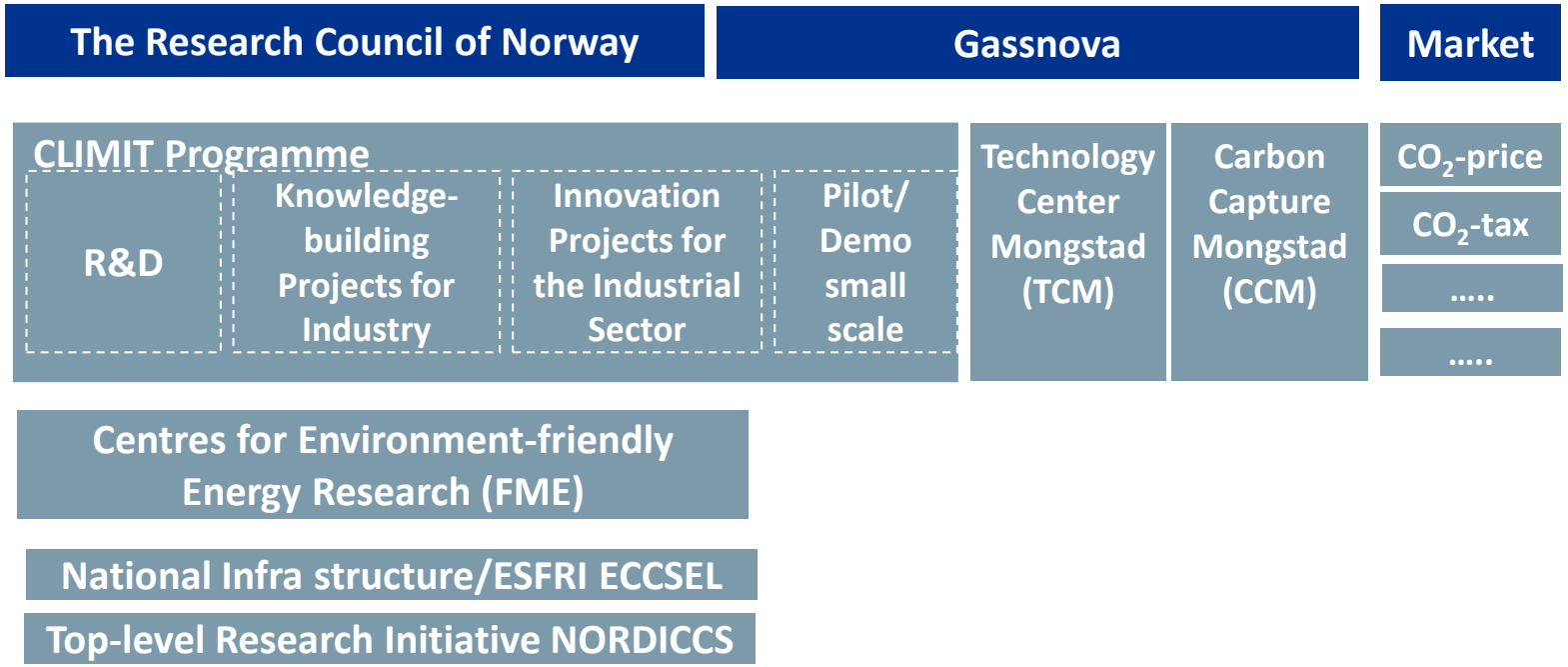
Erik Lindeberg

- Erik Lindberg and Torleif Holt of SINTEF introduces gas power with CO_2-capture and EOR
- Parliament White paper 46 (1988/89)
- CO_2-tax is introduced (1991)
- Statoil decides CO_2-storage at Sleipner (1996)
- Early R&D followed by several large projects (KMB CO_2 (2002)



Illustrasjoner: Statoil

Norwegian CCS instruments



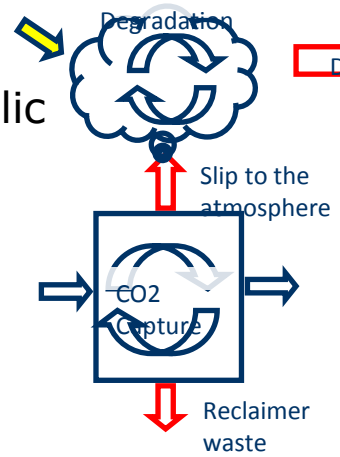
Financing bodies:

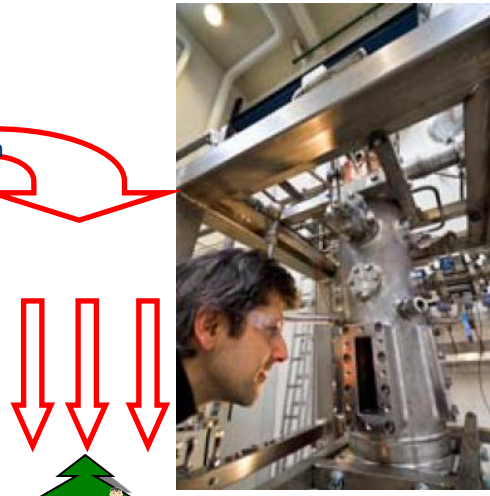
- **Ministry of Petroleum and Energy**
- **Ministry of Education and Research**

CLIMIT

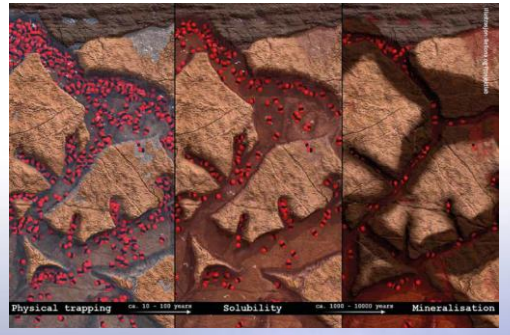
Climit:
A financial instrument for realisation of CCS

- The Norwegian RD&D CCS programme since 2005
  - About 900 M NOK (125 M euro) in public funding for about 200 projects since 2005
- Climit-R&D - administrated by the Research Council of Norway
  - Budget 2012: 90 MNOK (12 M euro)
- Climit-Demo - administrated by Gassnova
  - 82 M NOK (11 M euro) is transferred to the program from public funds each year





Impact on nature



CLIMIT

Post combustion Norway – R&D to application

- R&D projects conducted by the ACC (Aker Clean Carbon) and SINTEF
- Comprehensive program for the PhD program is established
- Pilot constructed at Tiller
- Significant cost reduction for capture using amines has been achieved

CO_2 capture test facility at Norcem's cement plant in Brevik, Norway

- Pre-project on the design of test facilities for post-combustion CO_2 capture from cement production
- Norcem A/S, HeidelbergCement og ECRA (European Cement & Research Academy)
- 2010 – 2011, 13 500 kNOK/ 50 % support from CLIMIT
- Technologies:
  - Aker Clean Carbon, amine
  - Alstom Carbonate looping and Chilled Ammonia
  - Small scale testing of membrane technology
- Focus on utilization of waste heat from the cement production
- Phase II (2012- 2016) – currently application to Climit on construction and testing

CLIMIT

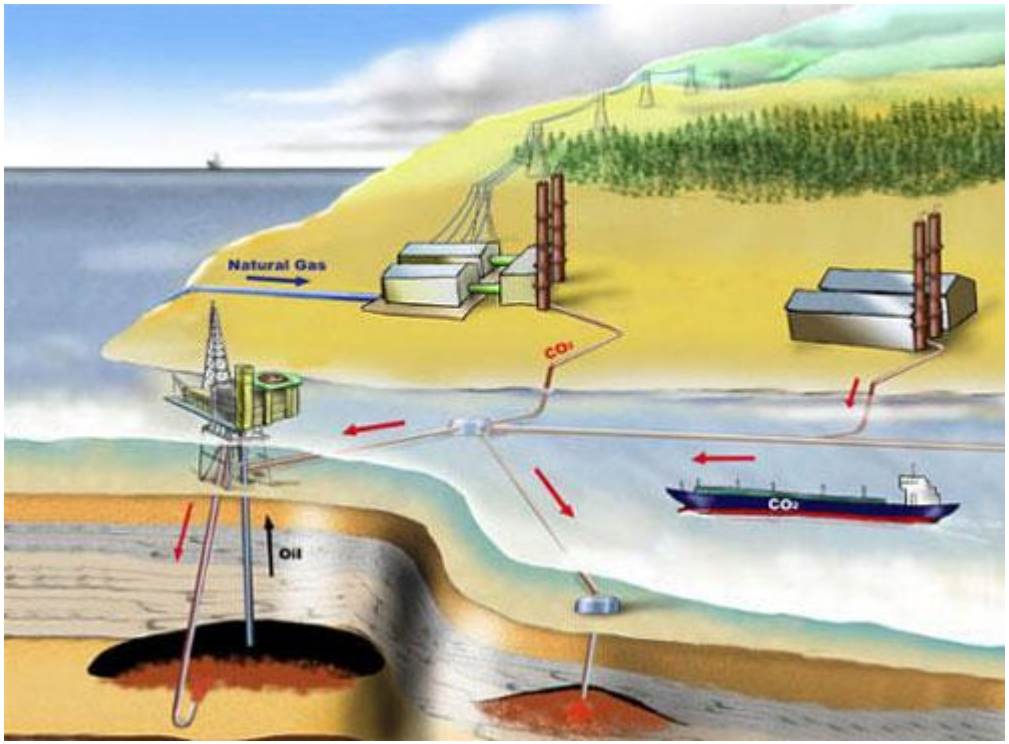
Innovative capture technologies – BIGCO2

BIGCO2 is an international collaborative research project lead by SINTEF in the period 2007-2011

Achievements have been obtained:

- Membranes
- CLC - Chemical looping combustion
- Pressurized combustion
- Improved post combustion
- Power cycles

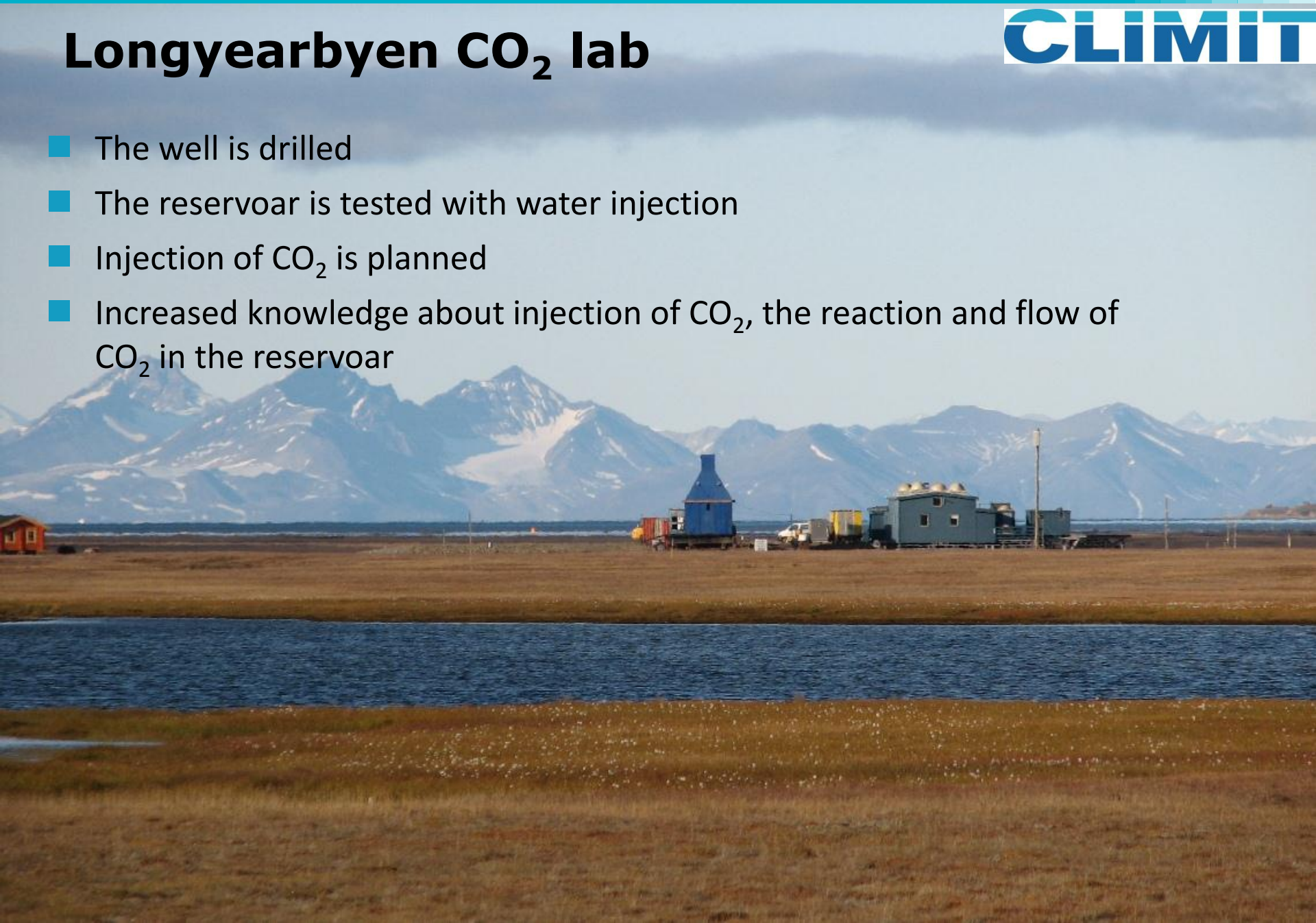
BIGCO2 has contributed to SINTEF's international standing within CCS R&D and laid the basis for several new important projects



CLIMIT

Longyearbyen CO_2 lab

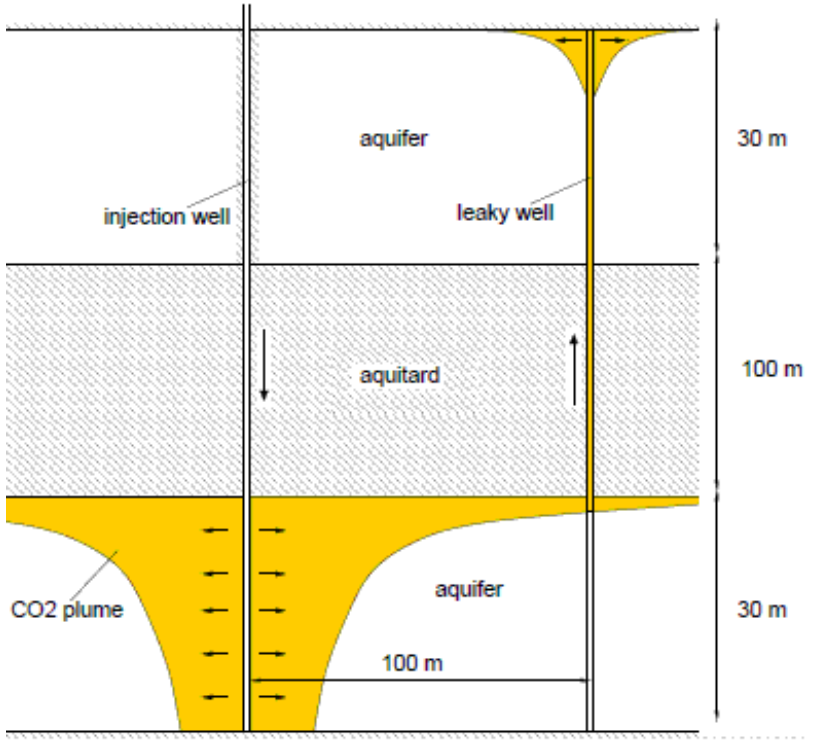
- The well is drilled
- The reservoar is tested with water injection
- Injection of CO_2 is planned
- Increased knowledge about injection of CO_2, the reaction and flow of CO_2 in the reservoar



Risk assessment of CO_2-storage

CLIMIT

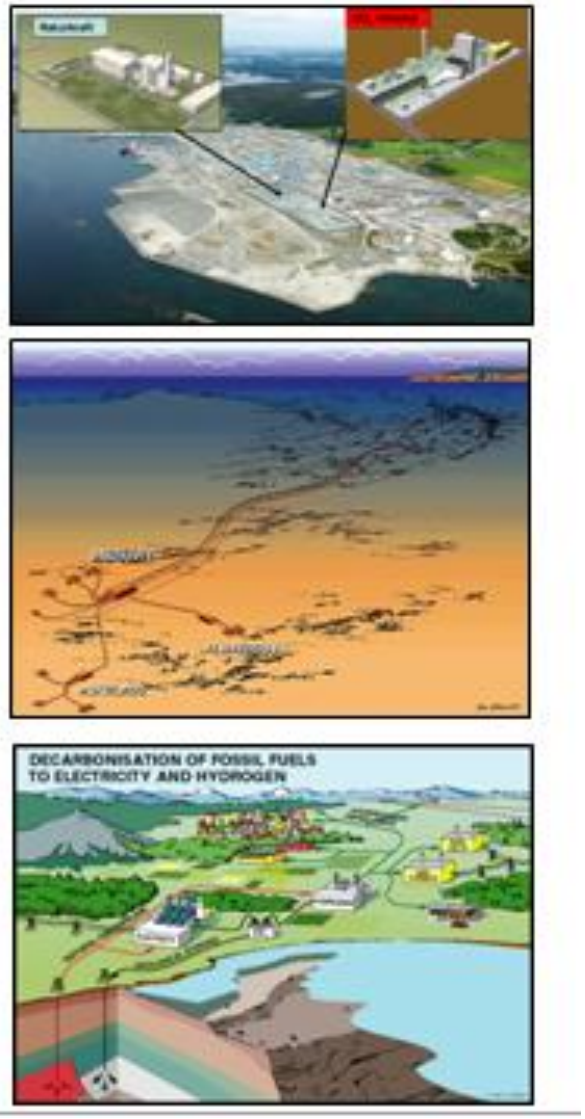
- MatMoRA: Geological Storage of CO_2: Mathematical Modelling and Risk Assessment
  - Project manager: UiB
  - Partners: SINTEF, Univ. Stuttgart, Princeton Univ., Hydro, Statoil, Shell
  - Budsjett: 20,5 mill NOK (2007-11)
- Results: Developed analytical and numerical tools to be used fir risk assessment related to CO_2-storage



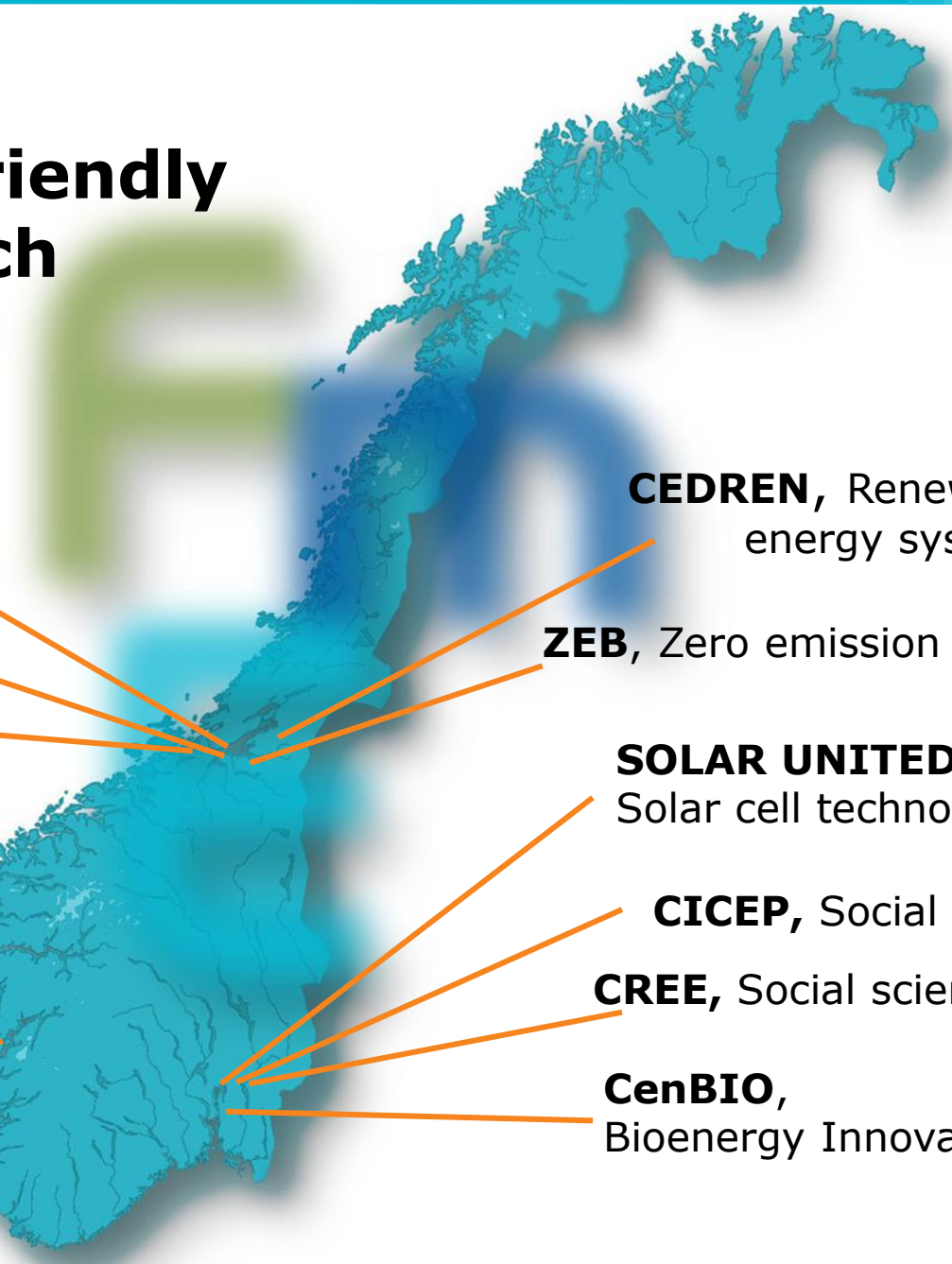
CLIMIT

Guidelines for CCS

- **Project leader: DNV**
- **3 projects on guidelines for CCS:**
  - Qualification of new CO_2 capture technology
  - Transmission of dense, high pressure CO_2 in submarine and onshore pipeline
  - The CO_2 QUALTORE Guideline
    - Qualification of sites and project for geological storage of CO_2
    - *www.dnv.com/co2qualstore/*



Centres for Environment-friendly Energy Research



BIGCCS, CCS

NOWITECH, Offshore wind technology

CENSES, Social science

NORCOWE, Offshore wind energy

SUCCESS; CO_2 storage

CEDREN, Renewable energy systems

ZEB, Zero emission buildings

SOLAR UNITED, Solar cell technology

CICEP, Social science

CREE, Social science

CenBIO, Bioenergy Innovation

ECCSEL - a pan-European distributed research infrastructure

Estimated construction costs: 200-250 mill. Euro

1. Norway (NTNU, SINTEF, RCN)
2. France (IFPEN & BRGM)
3. The Netherlands (TNO)
4. Germany (DLR)
5. United Kingdom (BGS)
6. Switzerland (ETHZ)
7. Spain (CIUDEN)
8. Italy (OGS, ENEA)
9. Greece (CERT/ISFTA)
10. Poland (PGI-NRI)

TFI - NORDICCS

norden
Top-level Research Initiative

- NORDICCS is the Nordic CCS research and innovation platform involving the major CCS stakeholders in the five Nordic countries

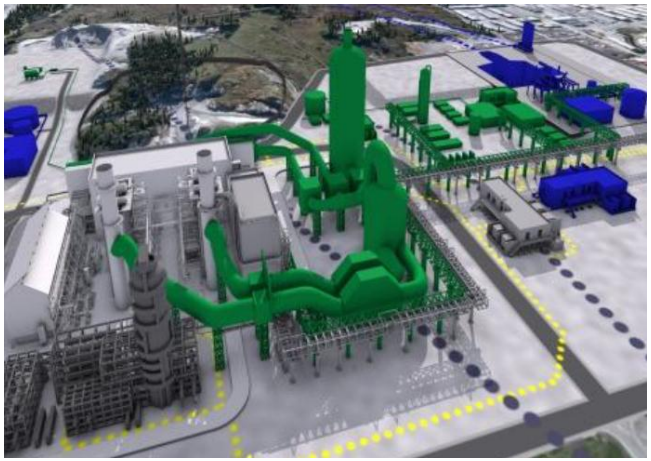
- Duration: 4 yrs
- Budget: 46 million NOK

SINTEF
VTT
tel·tek
GEUS
Orkuveita Reykjavíkur
NORCEM HEIDELBERGCEMENT Group
SGU Sveriges geologiska undersökning
Statoil
GASSCO
IVL Swedish Environmental Research Institute
NTNU – Trondheim Norwegian University of Science and Technology

Large CCS projects in Norway

- Large capture pilot - TCM
  - TCM (Technology Center Mongstad) with capacity 100 k ton/yr will be in operation spring 2012

- Full scale project
  - Full scale CCS at the Mongstad refinery is planned with decision of investment at latest 2016



- Offshore projects
  - Sleipner: 1 million ton CO_2 stored annually since 1996.
  - Snøhvit: 0,7 million ton CO_2 will be stored annually stored at full operation
  - CO_2 is separated from natural gas in both projects

Summary/Conclusion

- The Technology Center Mongstad – the world's largest CCS test facility
- Although on a smaller scale , there has been done considerable investments in CCS research infrastructure in Norway the recent years (Climit, FME)
- New projects are starting up (NORDICCS, ECCSEL)
- Further interaction between TCM and the research community will follow
- More knowledge is still to be extracted from the ongoing full scale and demo CO_2-storage projects

R&D-efforts are still needed to:

- Mature the existing technology and reduce costs
- Develop new technologies
- Introduce the concept of large underground CO_2-storages