The Research Council of Norway

CCS in Norway

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Bucharest – workshop
UEFISCDI, 20 June 2018

Population: 5 258 317

GDP: $ 391 billion, GDP per capita: $ 73 450

A resource-based economy

hydroelectricity
fishing & seafood
mining
minerals
petroleum
shipping

Total R&D expenditure in Norway
63 345 million NOK
(~ 6 400 million EUR)

R&D by performing sector

Business:	54%
Higher education:	31%
Public sector:	15%

76 500 researchers
PhD degrees 2017: 1493
39 % from other countries

The Research Council's sphere of action encompasses

All subjects and disciplines
All thematic areas
All aspects of society, from basic research to research-based innovation and commercialization

Norway's CCS-history

Prime minister Kjell Magne Bondevik, resigns March 2000

- **Since 1996**: **Sleipner** with CO_2 capture from natural gas and offshore storage
- **2000:** First time on history that a prime minister resigns because of to climate issues. He resigned due to lack of support for CCS on Gas-power plant.

- **2008: Snøhvit** (gas field)
- **2012**: **TCM -** Test centre Mongstad (CO_2 capture pilot)
- **2013:** Full scale CCS at Mongstad gas power plant terminated
- **2015**: Ongoing feasibility studies with ambition of full scale demonstration by 2020,
- **2018**: Two candidates into FEED

- More than 20 year practice
- More than 10 years of development.
- RD&D projects (CLIMIT programme) and TCM can pave way for full scale CCS in near future…

- **Norway a leading CCS nation**

Prime minister Erna Solberg, since September 2013

Policy Instruments for CCS in Norway

Accelerated development of CCS technology

The Research Council of Norway

GASSNOVA
TECHNOLOGY CENTRE MONGSTAD

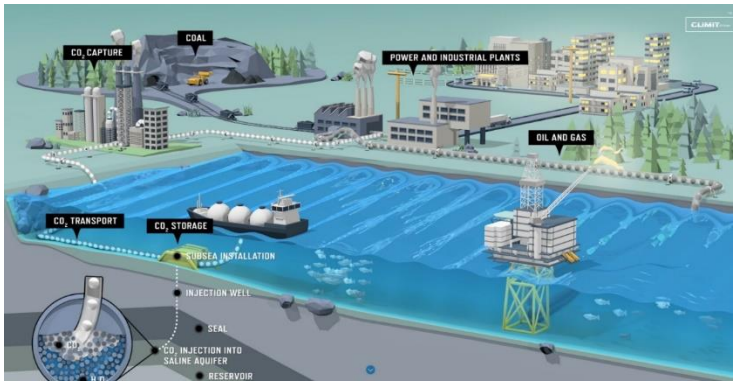
Industry

Infra-structure → R&D-Centers → **CLIMIT** → → **Demo** → **Invest.**

CLIMIT is the national programme for research, development, piloting and demonstration of CO_2 capture and storage (CCS) technologies for power generation and other industrial sources.

….12 YEARS

- Annual budget approx. 22 million EUR
- 500+ projects have received support



….last 5 YEARS international cooperation with

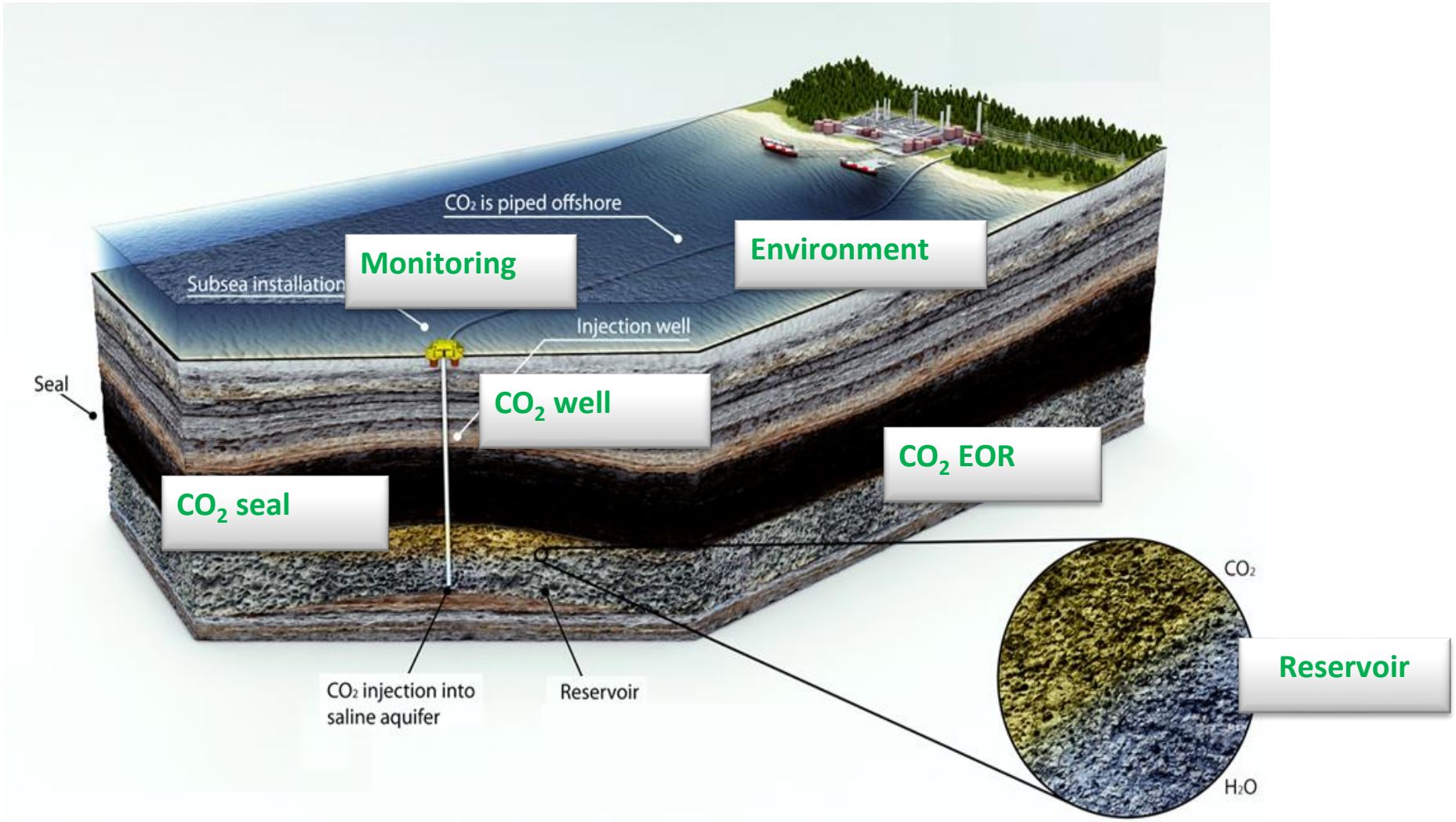
- US –DOE
- Canada
- Netherland
- Australia
- Germany
- UK

Cooperation between Gassnova and The Research Council of Norway
Joint Secretariat and Program board

CLIMIT Program plan 2017-2022

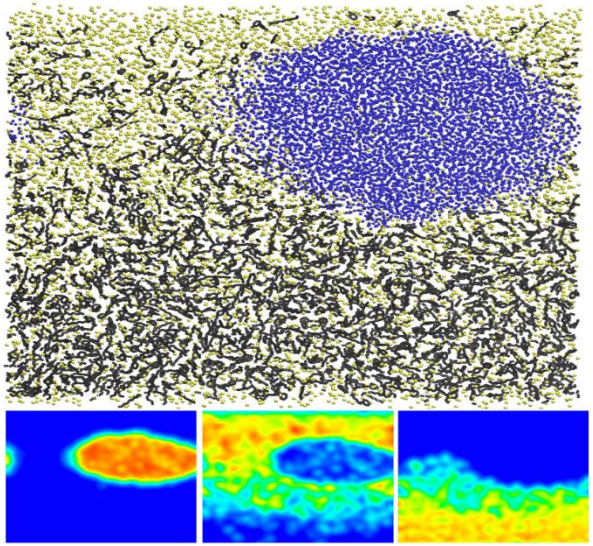
- Support early fullscale CO_2-valuechain in Europe
- Large scale CO_2 storage offshore in Norway
- Future CCS solutions

Portfolio CO_2 storage

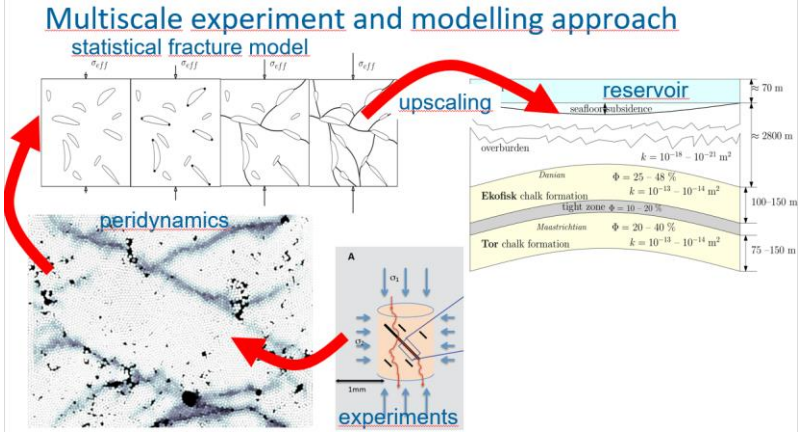


CO_2 storage and CO_2 EOR

- Emulsions
- Hydrate (EGR)
- Foam
- Mobility control
- EOR and CO_2 storage in North sea chalk oil field
- CO_2 dissolution in oil and wettability
- Fundamentals for CO_2 -HC interactions
- Subsea technology for EOR



Emulsions



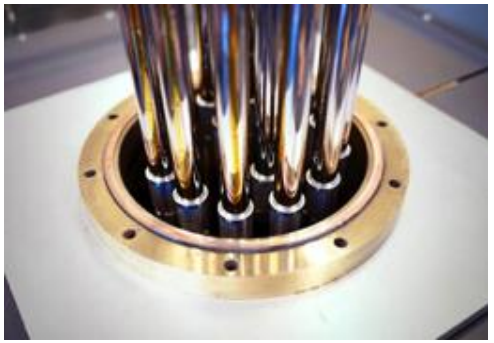
Portfolio CO_2 capture

- Post-, pre- and oxy combustion
- Technologies:
  - Polymer membranes
  - Ceramic membranes
  - Pd-membranes
  - Solvents
  - Sorbents
  - Combustion
- Process and system development and analysis
- Environmental aspects

Natural gas -> Hydrogen production and CO_2 capture

PALLADIUM MEMBRANES for hydrogen production and CO_2 capture

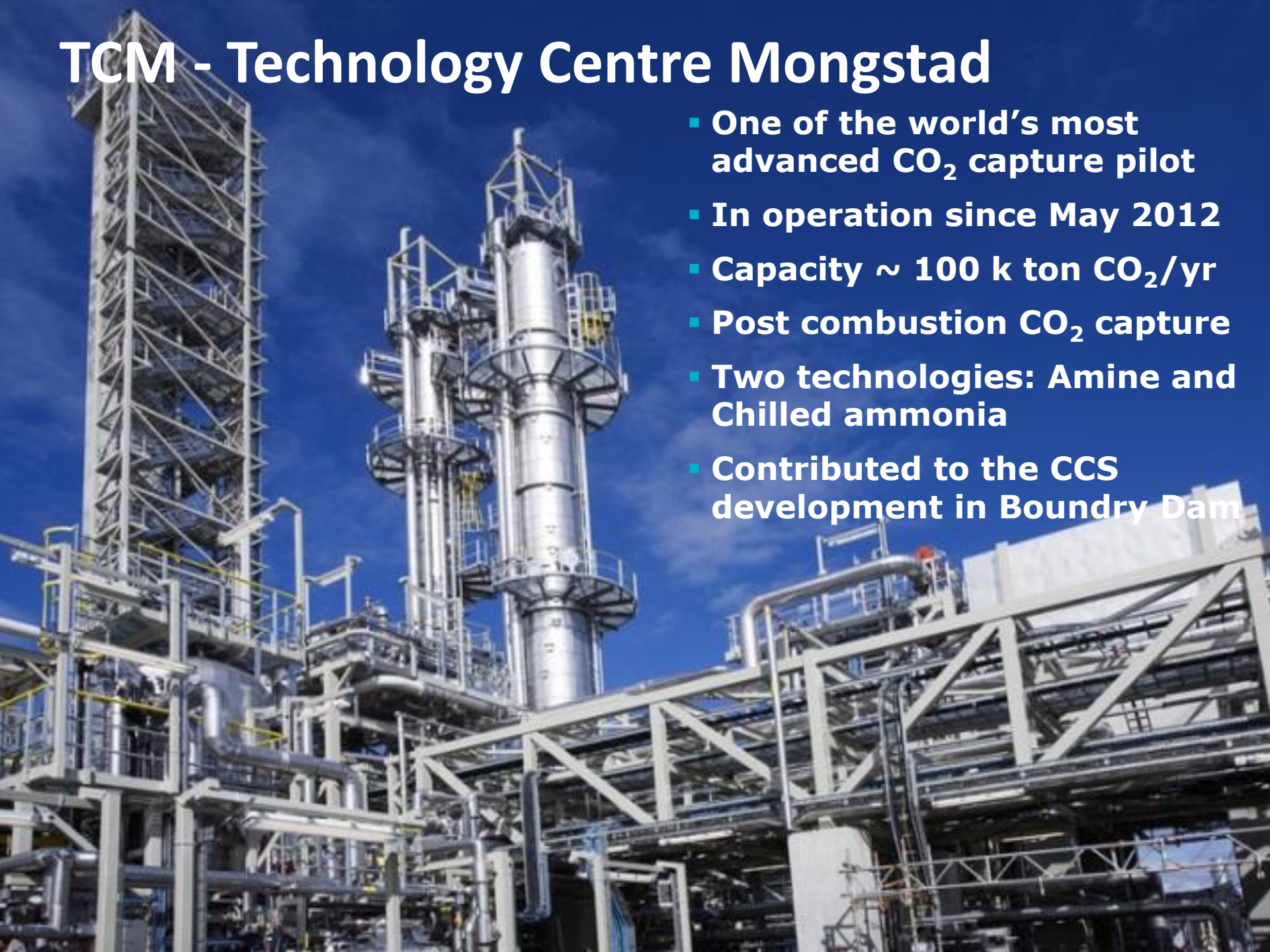
- Technology developed by SINTEF from fundamental research at early 1990's
- Research and development supported by CLIMIT R&D
- Development, improvement and upscaling by Reinertsen AS, now HYDROGEN Mem-Tech AS, in partnership with SINTEF and supported by CLIMIT Demo
- Total budget ~90 MNOK, 58.5 MNOK CLIMIT support



R&D → **DEMO**

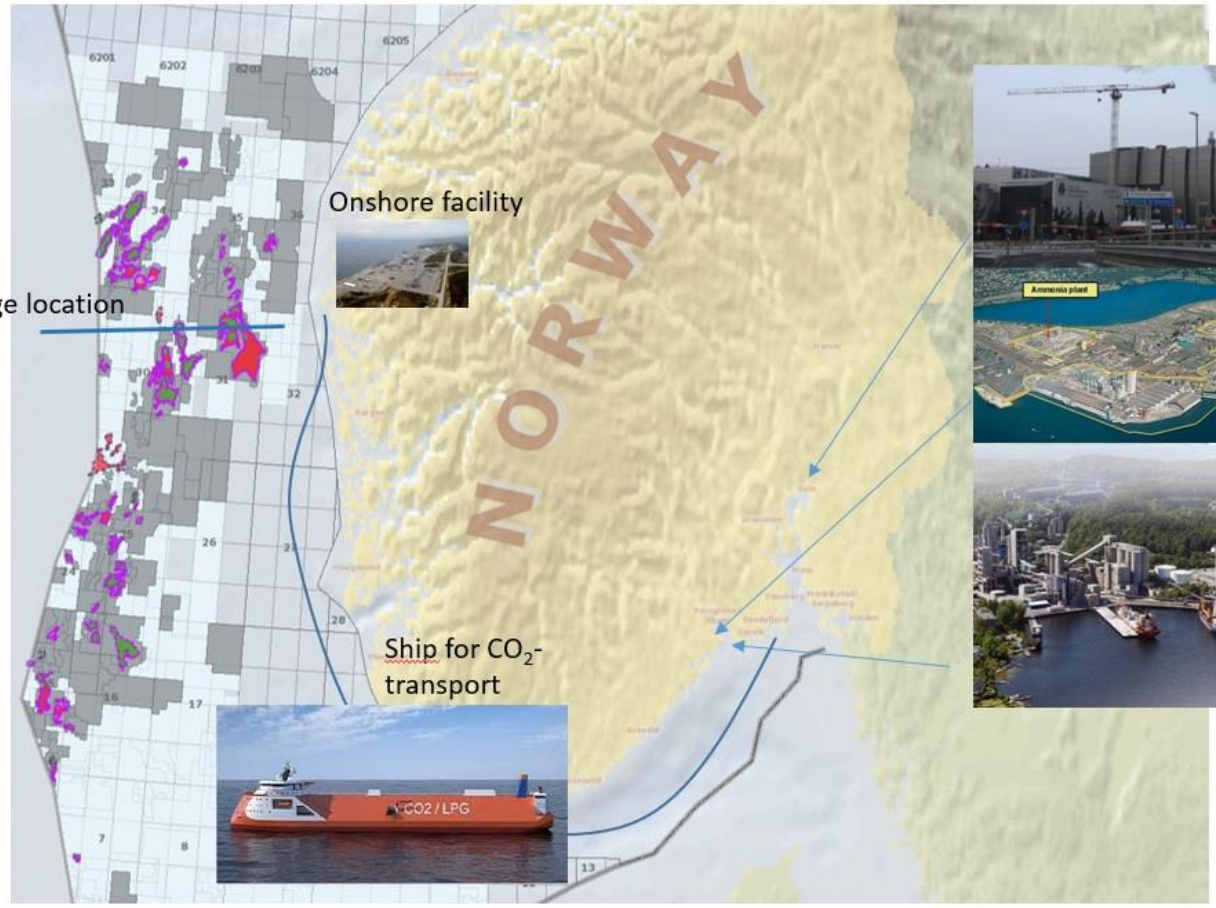
Membran pilot at Statoil - Methanol plant Tjeldbergodden

TCM - Technology Centre Mongstad



- One of the world's most advanced CO_2 capture pilot
- In operation since May 2012
- Capacity ~ 100 k ton CO_2/yr
- Post combustion CO_2 capture
- Two technologies: Amine and Chilled ammonia
- Contributed to the CCS development in Boundry Dam

Norwegian full scale projects



Klemetsrud, waste incinerator, Oslo

Yara, ammonia plant, Porsgrunn

Norcem, cement facotry, Brevik

effective solution for CCS in Norway, provided this results in technology development internationally.

Centres on Environment-friendly Energy Research FME)

Centre for intelligent electricity distribution – CINELDI

Centre for an Energy Efficient and Competitive Industry for the Future HighEFF

Mobility Zero Emission Energy Systems MoZEES

Norwegian CCS Research Centre NCCS

Research Centre for Sustainable Solar Cell Technology SuSolTech

Norwegian Research Centre for Hydropower Technology HydroCen

Norwegian Centre for Sustainable Bio-based Fuels and Energy Bio4Fuels

The Research Centre on Zero Emissions Neighbourhoods in Smart Cities – ZEN Centre

Norwegian CCS Research Centre, NCCS

The ambition of the NCCS Centre is to overcome key barriers to implementation of a full-scale CCS chain, reduce the financial risk involved and make solutions more affordable.

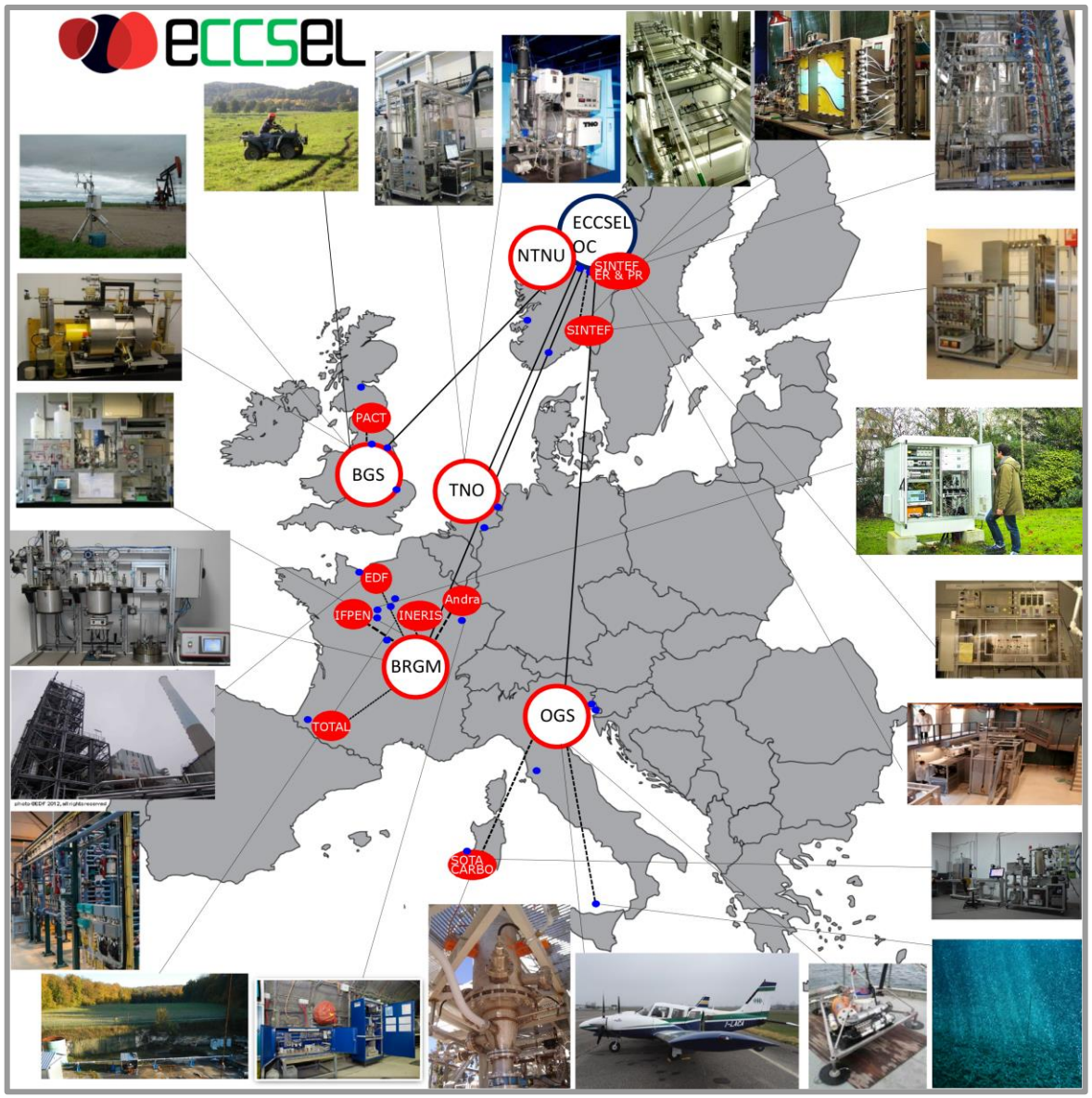
The centre organises its activities into two main areas:

- CCS for Norwegian industry
- Storage of European CO_2 emissions in the North Sea basin

The NCCS centre will:

- develop new generations of CO_2 capture technologies
- develop solutions for more cost-effective and safe transport of CO_2
- refine methods for safe CO_2 storage and new monitoring techniques
- review the many possibilities available for storing large quantities of CO_2 in the North Sea

Host: SINTEF Energy Research
Website: www.sintef.no/projectweb/nccs/



European Carbon Dioxide Capture and StoragE Laboratory Infrastructure

ECCSEL ERIC

- *5 countries*
- *15 owners*
- *54 research facilities*

www.eccsel.org

E-mail:
info@eccsel.org

Vision and Objectives

ECCSEL vision: Enabling low to zero CO_2 emissions from industry and power generation

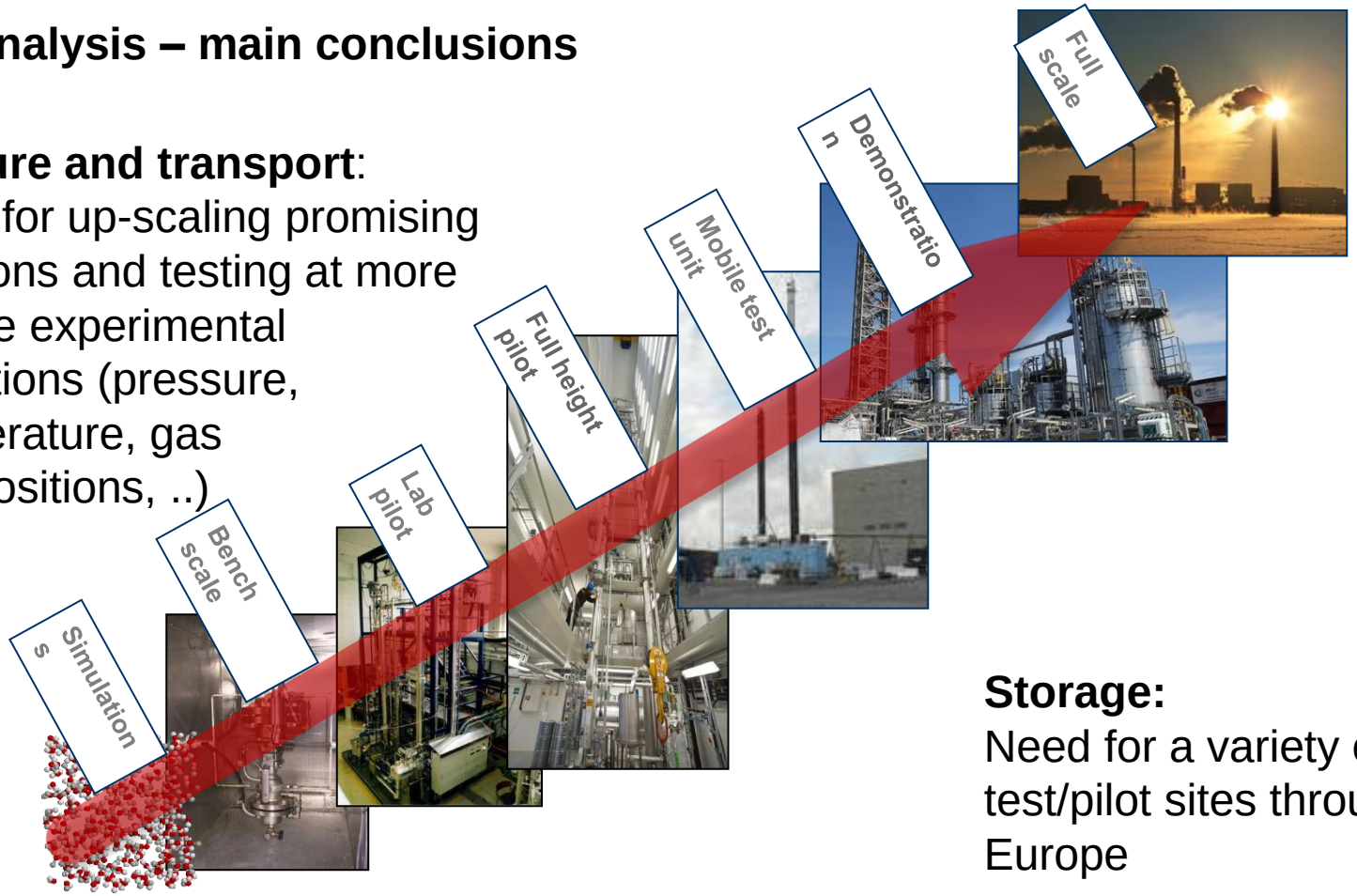
Main objectives

- Establish and operate a world class distributed CCS research infrastructure in Europe
- Integrate and upgrade existing research facilities and supplement with new ones
- Enhance European science, technology development, innovation and education in the field of CCS
- Enable spin-off activities and generation of new business

Investments

Gap analysis – main conclusions

Capture and transport:
Need for up-scaling promising solutions and testing at more severe experimental conditions (pressure, temperature, gas compositions, ..)

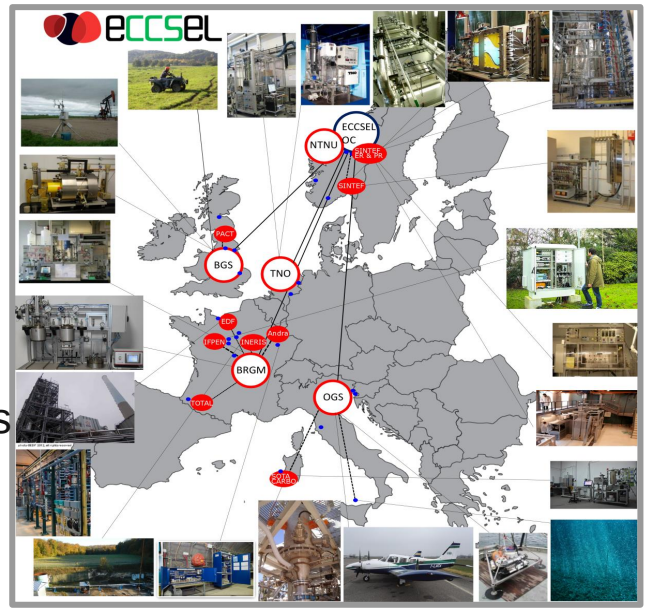


Storage:
Need for a variety of test/pilot sites throughout Europe

ERIC Partner & Collaboration Benefits

Part of an European approved RI legal entity

- International visibility and common marketing
- Cost sharing, saving and prioritization
- Influence on international CC(U)S policies and development
- Partnership with other EU initiatives



Increased funding

- EC; Horizon 2020 ++
- Release national grants (Coordination national funds)
- Joint industry investments
- Joint/coordinated funding applications

Increased facility utilization

- Attract new users and projects
- Standardized and supervised access
- More operational activity
- Increased turnover
- High quality facilities, operation and services

New investments, activities and business

- Research facilities implementation/
- New research projects
- Capacity building, education/training and jobs
- Spin-off businesses and products

ECCSEL Partner Expansion plan

ECCSEL ERIC (Summer 2017)

- **Norway** (Operations Centre)
- **The Netherlands**
- **Italy**
- **France**
- **United Kingdom**

Founding members of ECCSEL ERIC

Expansion plan (2018 –)

- **Switzerland**
- **Poland**
- Czech Rep
- Hungary
- **Romania**
- Slovenia
- Germany
- **Greece**
- **Spain**
- Other EU member states
- Bilateral agreements with oversea states (Japan, Australia a.o.), institutions, industry

EEA grants

Signed Letter of Intent (LoI) to join ECCSEL ERIC

Thank you for your attention

You are welcome to visit us at RCN, Lysaker, Oslo

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