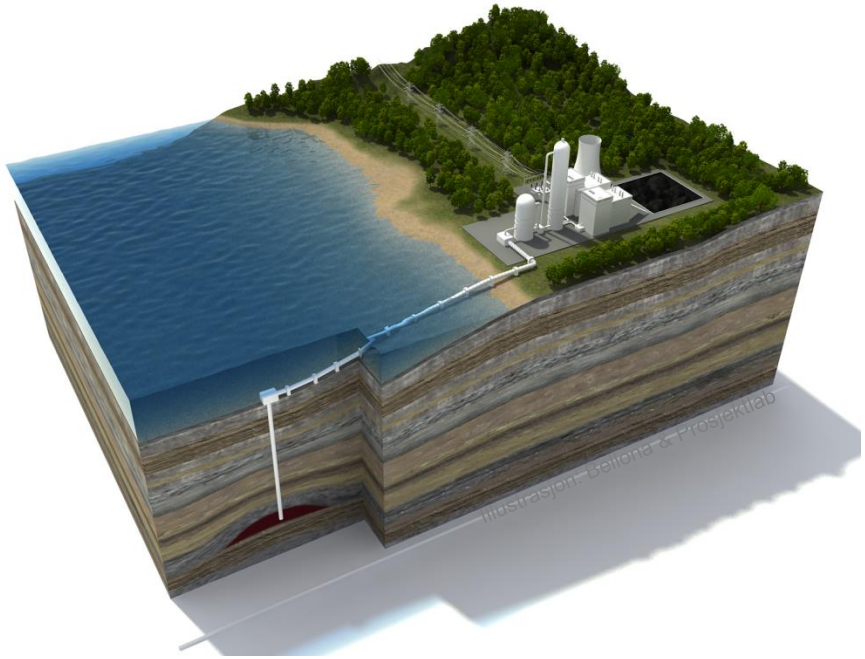
CCS projects in Norway and prospects for CCS in Europe

HiPerCap workshop 13. September 2017



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CCS Instruments for CCS in Norway

Accelerated development of CCS technology

The Research Council of Norway

GASSNOVA

Industry

R&D Infrastructure → R&D-Centers → CLIMIT → CO2 TECHNOLOGY CENTRE MONGSTAD → Demo → Commercial

CLIMIT Programme plan 2017-2022

- Early full-scale CCS value chain in Europe
  - Making technology available
  - Use experience in full scale projects
- Large-scale storage of CO_2 on the Norwegian shelf
  - Accelerate scale-up of technology
- Future solutions for CCS
  - CCS available for a wide range of industries

International R&D collaboration is needed

- The CLIMIT Program Plan has a strong focus on international collaboration
- Several ongoing initiatives
  - ERA-Net Cofund ACT
  - Horizon 2020
  - Infrastructure ECCSEL
  - MoU USA-Norway

CLIMIT Capture projects

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

One step closer to bringing CO2 capture technology to the marketplace

January 11, 2017

May Britt Hägg, a professor in the Department of Chemical Engineering at the Norwegian University of Science and Technology holds the CO2 membrane separator she and her research group have developed. Credit: Per Henning, NTNU

Air Products has signed an exclusive license agreement with the Norwegian University of Science and Technology (NTNU) for membrane technology for CO_2 capture.

Lyncée Tec

NTNU, through its commercialization arm NTNU Technology Transfer, announced on 10 January that it has entered into an exclusive license agreement with Air Product. The agreement allows Air Products the rights to use NTNU's proprietary fixed site carrier (FSC) membrane technology in conjunction with Air Products' proprietary PRISM membrane technology for carbon dioxide (CO_2) capture applications.

ACT – A European R&D cooperation on CCS – ERA-NET Cofund

- Several Member states in a consortium (ministries/funding agencies) establishing one or several **common calls** with top up financing from EC
  - EC finances 50% of the MS total budget.
- Focus on **demonstrating and validating solutions**.

Partners of ACT– Commitments to 1st Joint Call January 2017

NO	RCN (coordinator)	3 M€
NO	Gassnova	3 M€
DE	FZJ/PtJ	6 M€
NL	RVO	4 M€
CH	DETEC	4 M€
UK	DECC/BEIS (4M£)	5.5 M€
RO	UEFISCDI	1 M€
TR	TUBITAK	2 M€
ES	MINECO	0.35 M€
GR	CERTH	0
EC	Contribution:	12,8 M€

Total budget for projects, 1st call: 41.2 M€

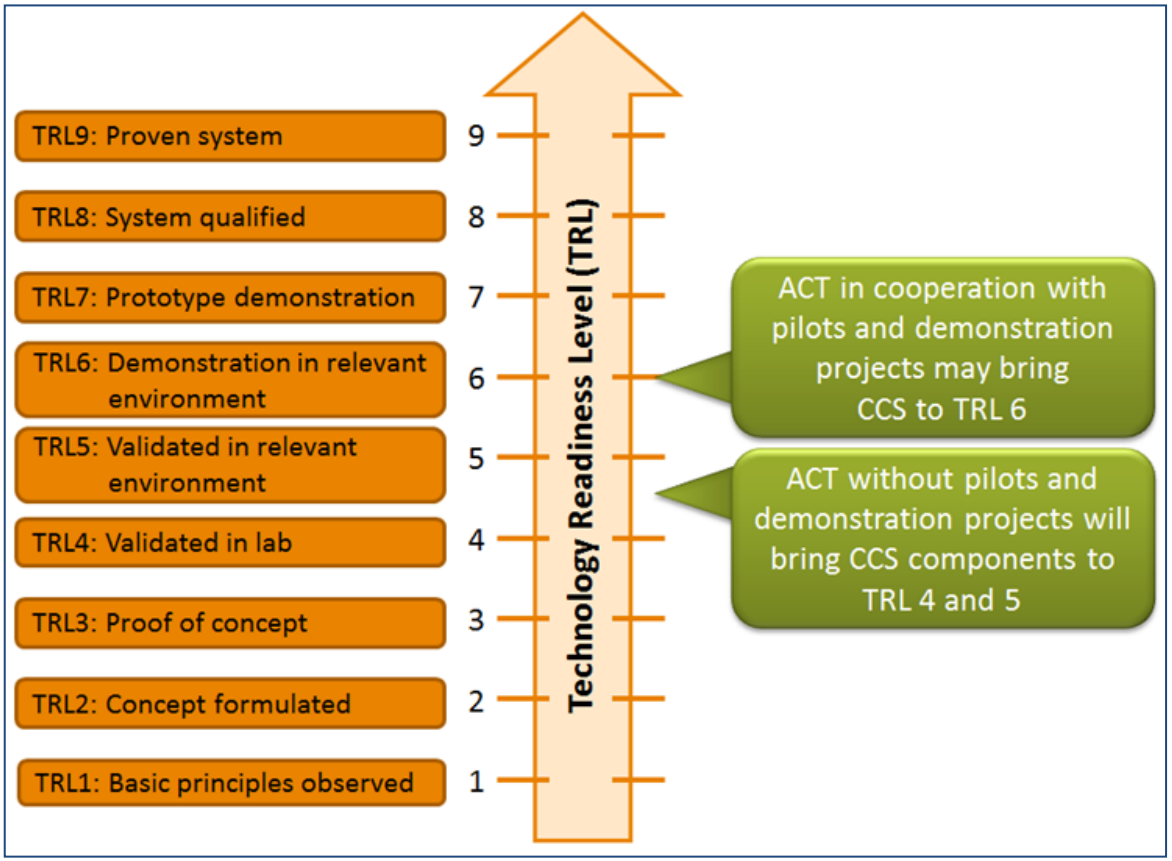
Canada, US, Italy and France have showed interest in ACT, yet none of these have joined as partners

ACT asked for projects in cooperation with pilots


Norcem, Breivik


Rotterdam CO2 Hub


SaskPower, Canada



Big project – higher TRL
Smaller projects – lower TRL

Relevant to industry

Co-funded by the European Commission within the Horizon 2020

New ACT projects

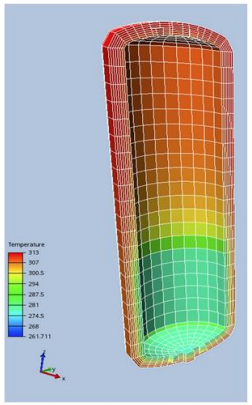
- 8 projects have been offered funding from ACT
- Contract negotiations ongoing
- The new projects will be kicked off Sep 2017
- In total: 36 M € from ACT

- 3 large projects (5-14 M€ in funding from ACT)
  - Full chain CCUS by combining pilots all over Europe
  - CCS combined with Hydrogen
  - Handling pressure build-up during CO_2-injection
- 5 smaller projects (1-2 M€ from ACT)
  - Design full scale CCUS for Northern Europe
  - CO_2 storage - Risk assessment and mitigation measures
  - Novel reactor technology for CO_2 capture
  - CO_2 EOR concept for South-East Europe
  - 3D printed CO_2 capture materials
- New common call in 2018

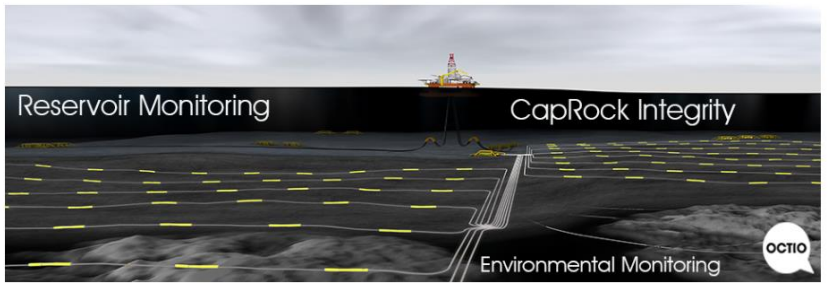
Co-funded by the European Commission within the Horizon 2020

Norwegian full scale projects harvest the result of R&D development supported through CLIMIT and FME

- Capture
  - Supporting development to commercially available capture technologies
  - Pilots
  - Research HSE / emissions
- Transport
  - Basis for CO_2 transport standards
  - Corrosion and impurites in CO_2 stream
  - Focus on ship transport
- Storage
  - Methods for maturing storage reservoars
  - CO_2 seal projects
  - Monitoring technologies



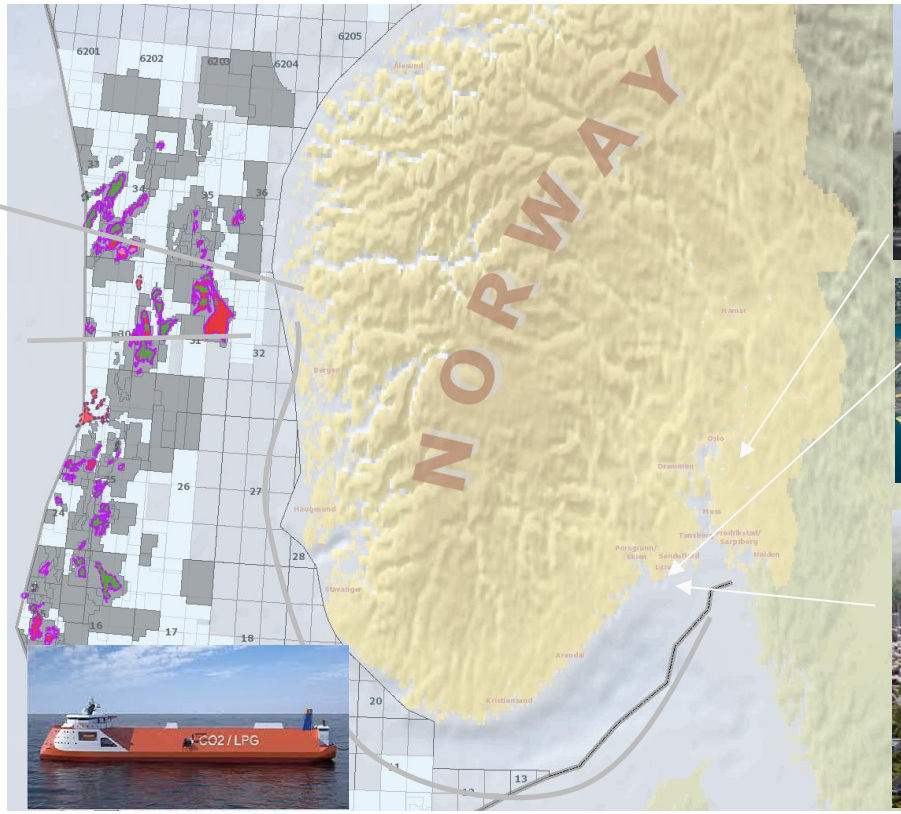
3D model of a steel vessel showing temperature during a depressurisation simulation.



Potential industry large scale projects CCS in Norway

Statoil:
Onshore facility with pipeline to

Storage location offshore



Klemetsrud:
- Waste incineration
- 315 000 tons CO_2 per year

Yara:
- Ammonia production
- 805 000 tons CO_2 per year

Norcem:
- Cement production
- 400 000 tons CO_2 per year

- Be operational from 2022
- Demonstrate a full chain of capture, transport and storage of CO_2
- Demonstrate CO_2 capture in existing industry.
- Establish a flexible storage solution with possible extra capacity.
- Provide cost and risk reductions for subsequent CCS projects

EU’s new Implementation Plan on CCS and CCU

- Temporary Working Group on CCS/CCU (TWG CCS/CCU)
  - Lead by Ministry of Oil and Energy (Norway) and Dutch governmental authorities
  - Central Norwegian actors: SINTEF, Bellona
- The Implementation Plan will be of great importance to the EU's commitment to CCS in the coming years
- The European Commission is already using the implementation plan actively
- It is important that Norway and the EU work together to succeed in implementing CCS in Norway.
- Great expectations

EU's new Implementation Plan on CCS and CCU

Targets

1. At least one commercial-scale, whole chain CCS project operating in the power sector
2. At least one commercial scale CCS project linked to an industrial CO2 source, having completed a FEED study
3. SET Plan countries having completed feasibility studies on applying CCS to a set of clusters of major industrial and other CO2 sources by 2025-2030
4. At least 1 active Project of Common European Interest for CO2 transport infrastructure, for example related to storage in the North Sea
5. An up-to-date and detailed inventory of the most suitable and cost-effective geological storage capacity
6. At least 3 pilots on promising new capture technologies, and at least one to test the potential of sustainable Bio-CCS at TRL 6-7 study
7. At least 3 new CO2 storage pilots in preparation or operating in different settings
8. At least 3 new pilots on promising new technologies for the production of fuels, value added chemicals and/or other products from captured CO2
9. Setup of 1 Important Project of Common European Interest (IPCEI) for demonstration of different aspects of industrial CCU, possibly in the form of Industrial Symbiosis
10. By 2020, Member States having delivered on their 2030 nationally determined contributions to the COP21 agreement, and having identified the needs to modernise their energy system including, if applicable, the need to apply CCS in order to make their energy systems compatible with the 2050 long-term emission targets

EU's new Implementation Plan on CCS and CCU

R&I activities

1. Delivery of the ROAD project (target 1)
2. Delivery of regional CCS clusters, including feasibility for a European hydrogen infrastructure (targets 2 & 3)
3. Project of Common European Interest for CO_2 transport infrastructure (target 4)
4. Establish a European CO_2 Storage Atlas (target 5)
5. CO_2 storage pilots in operation (target 7)
6. CO_2 capture pilots (target 6)
7. 3 Pilots on promising new technologies for use of CO_2 (target 8 & 9)
8. CCS modelling for policy development (target 10)

EU's new Implementation Plan on CCS and CCU

Proposed flagship activities

- The ROAD Projects (R&I action 1)
- Norwegian industrial CCS cluster (R&I action 2)
- Port of Rotterdam CO_2-Hub (R&I action 2)
- North East UK CCS clusters (R&I action 2)
- Project of Common European Interest for CO2 transport infrastructure (R&I action 3)
- European CO_2 storage pilot (R&I action 5)

Thank you for your attention!

www.climit.no

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