The Norwegian Research Programme CLIMIT: CCS from strategy to reality

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What will it take to cut global CO$_2$-emissions by 50% in 2050 relative to current levels (IEA WEO 2010)?

Why CCS? Three unavoidable reasons:

- CCS provides one option: Not either renewables or CCS but both-and
- CCS may provide a transition technology from a fossil to a sustainable energy era
- CCS needed for industry emissions - is as important as for power production
Coal and gas power with CCS

The Challenges – What do we have to do?

1. Develop and demonstrate competitive technologies for mass production,

2. Deploy 2-3000 CCS power plants by 2050 and

3. Safely take care of 15-20bn tons of CO2 annually, say within 2050
Background
Norwegian CCS policy

- CCS has been and still is a “hot” political issue in Norway
- Norwegian CCS policy based on Parliamentary Climate Agreement
- Objective: To achieve full scale CCS on Gas power plants and large industrial CO2 point emission sources, and
- Norway should be (and has been) an “Early mover”:
  - The Offshore CO2 Tax → Sleipner, Snøhvit CCS projects
  - Plans for several early CCS projects for EOR, Gas power
Background

Norwegian Government CCS Initiatives

- State enterprise Gassnova SF established (2005)
- The CCS RD&D Program CLIMIT established (2005)
- Technology Center Mongstad (TCM) – now being completed
- The Mongstad full scale energy plant
- Transport and subsea storage solutions and mapping of relevant sites in progress
The Norwegian CCS RD&D program CLIMIT

- Vision: Accelerate commercialisation of CCS technologies by financial stimulation of RD&D
- A national collaboration between Gassnova SF and RCN
- Promotes and funds R&D and Demo CCS projects on fossil Power and large industrial point emission sources
- Active international collaboration in CCS RD&D
- Annual budget of ~21 M€
CLIMIT Objectives – Research Challenges

- Develop, demonstrate and verify cost and energy efficient capture processes with low environmental side effects
- Establish a significant R&D project portfolio of new, cutting edge capture technologies (with demos from 2015)
- Contribute to safe and cost efficient transport, storage and monitoring of CO2
- Establish good understanding of environmental side effects in the CO2 value chain for licensing procedures
- Contribute to identify and close technology gaps in the CCS value chain
- Support commercialization of technologies, methods and services
The CLIMIT Program: A Cooperation between Gassnova and RCN covering the entire value chain

- **Research**
  - CLIMIT-R&D: 12 M€
  - Industry: 40-50 M€

- **Development**
  - CLIMIT-Demo: 9 M€ +

- **Demo**

- **Commercial**

Gassnova SF and The Research Council of Norway
CLIMIT Funding Distribution (MNOK)

Type of Project Areas

CLIMIT Demo: Area
Running projects, June 2011 (MNOK)

- 113,2 (34 %)
- 211,6 (63 %)
- 7,0 (2 %)
- 3,4 (1 %)

CLimit R&D: Type
Accounts 2010 (MNOK)

- Research (60,3 73 %)
- KMB (6,5 8 %)
- BIP (16,2 19 %)
- Other
Two off-gas sources and
Two capture technologies:

- From CHP
  - CCGT
    - 3.5% CO₂
  - RCC
    - 13% CO₂

- From Refinery
  - Amine Plant
  - Carbonate Plant

TCM Capacity: 100,000 t/yr CO₂
Examples of CLIMIT Projects

3C - Compact CO₂ Capture

- Project Type: Industrial development (2008-2012)
- Responsible: Statoil
- Budget: 64,6 MNOK (32,2 MNOK from CLIMIT)
- Project Targets
  - Reduce CAPEX by 40-50% (Compared to BAT)
  - Reduce OPEX by 30-40%
  - Low environmental footprint capture facility
Example of CLIMIT Projects

Geological Storage of CO₂: Mathematical Modelling and Risk Assessment (Matmora)

- R&D Project (KMB: 2007-2011)
  - Responsible: University of Bergen
  - Budget: 20.5 MNOK - CLIMIT Support: 16 MNOK

- Results
  - Improved understanding of storage mechanisms
    - New modelling tools show that dissolution of CO₂ in water may be a more important trapping mechanism than earlier assumed
  - Faster simulations
    - 2D-models based on vertical equilibrium show accurate results. This enables 10 to 100 times faster simulation time compared with traditional 3D models
Examples of CLIMIT Projects

**CO₂ Field lab for monitoring and safety assessment**

- **Responsible:** SINTEF
- **Partners:** NGI, BRGM, Schlumberger, Beurau Veritas, British Geological Survey, Geosciences Montpellier, ImGeau, UiO, Ruden AS, Shell
- **Site:** Svelvik (south of Oslo)
- **Budget:** 95 MNOK (49 MNOK from CLIMIT)
- **Targets**
  - Injection of CO₂ into a 300m thick glacial morain
  - Study CO₂ flow and simulation of shallow leakages
  - Validation of monitoring methods
- **Focus:** Monitoring, public acceptance
Example of CLIMIT Projects

HSE related Amine emissions from Capture plants

- Several projects on Amine Emissions to Air During Carbon Capture
- Total Budget: 7M€ (since 2008)
  - Example: Atmospheric Degradation of Amines (ADA: 2008-2011)
  - Responsible: NILU and University of Oslo

- Project results
  - MEA (MonoEthanolAmine) itself is not problematic
  - MEA degradation in the atmosphere does not give nitrosamines
  - MEA degradation in atmosphere gives nitramine
    - Expected lower toxicity than nitrosamines
  - Small amounts of alkyl amines found in solvent
  - Nitrosamines has short lifetime in the atmosphere
Road map for implementation:

Government role in CCS – An optimistic view

- 2010
- 2020
- 2050

Share of cost in CCS chain:

- Governance & policy
- Commercial Market
- Technology Development and Demo

Government: Operational role “early mover”
Challenges in commercialization:

EU SET Plan CCS Energy Industry Initiative

Objective: **10-12 CCS demo and full scale plants by 2020**

Demo by 2015, Full scale by 2020, Emerging market by 2030??

Additional Cost for CCS, per ton CO2

Average Avoidance costs (reduction through demo and R&D/new technologies)
Conclusions

- CLIMIT has a large project portfolio that covers the entire CCS development and value chains: *RD&D in Capture, Transport and Storage*
- CLIMIT Contributes to identify and close technology gaps in the CCS value chain
- CLIMIT Supports commercialization of technologies, methods and services and has “close to market” activities
- CLIMIT offers access to a professional and experienced network and secretariat
- CLIMIT provides substantial financial support to *good* projects

Thank you for your attention!
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