TCM – Highlights

TCM HIGHLIGHTS

- 2006
  - State and Statoil agreed to build test centre
  - Agreement to start planning and engineering

- 2007
  - Planning completed and preparatory work starting

- 2008
  - TCM Partnership established

- 2009
  - Opening of Administration complex
  - Sasol joined partnership

- 2010
  - Preparation for operations

- 2011
  - Plant start-up early 2012

- 2012
  - End of five-year test period

- 2016

-- catching our future
International Co-operation

GASSNOVA: 75.12%
Statoil: 20%
Shell: 2.44%
Sasol: 2.44%

Other potential partners to be invited
Ambitions

- Test, verify and demonstrate CO2 capture technology owned and marketed by vendors
- Reduce cost, technical, environmental and financial risks
- Encourage the development of market for CO2 capture technology
- Aim at international deployment
How does CO₂ capture work?

1. Flue gas with CO₂ from a gas power plant / refinery is cooled.
2. The cooled flue gas enters the absorption tower.
3. Water wash is applied to remove impurities.
4. CO₂ is absorbed by the solvent in the absorption tower.
5. The solvent with CO₂ is heated in a heat exchanger to strip off the CO₂.
6. The hot solvent without CO₂ heats up the cool solvent with CO₂ in a heat exchanger.
7. CO₂ is captured and recycled to the absorption tower.
Test Strategy – Overall Concept

- Combined Heat & Power plant (CHP)*
  - CO₂ 3.5%

- Cracker (RFCC)
  - CO₂ 12.9%

- Amine
  - Treated exhaust

- Mobile Test Unit
  - Treated exh.

- Chilled Ammonia
  - Treated exhaust

Total capacity 100 ktonnes CO₂ per year

* CHP design capacity of 280MW electricity and 360MW heat.
Two flue gas sources

Combined Heat & Power plant (CHP)*
Max 5% of total flow
From one stack
Pre-treatment
28 – 56 000 Sm³/hr
3.5 – 9 mole% CO₂
14.4 % O₂
5 ppmv NOₓ
≈ 0 ppmv SOₓ
Capture processes
(amine or chilled ammonia)
Recycle
22 – 25 000 tonnes CO₂/yr
3,1 - 7,4 tonnes CO₂/h

Cracker (RFCC)
Max 11% of total flow
Pre-treatment
22 – 50 000 Sm³/hr
12.9 mole% CO₂
4.2 % O₂
183 ppmv NOₓ
≈ 30 ppmv SOₓ
Capture processes
(amine or chilled ammonia)
74 – 82 000 tonnes CO₂/yr
9,7 tonnes CO₂/h

Relevant for a number of industrial processes including gas and coal fired power plants.

* CHP design capacity of 280MW electricity and 360MW heat.
TCM project

Start-up:

• First Technology Q4 2011
• Second Technology 2012

• End of May 2011:
  • 77 % completed
  • 3 495 000 manhours worked
  • 3,9 BNOK spent (465 M€ / 690 M$)
  • 900 people directly involved
## Key figures for TCM

<table>
<thead>
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<th>Total TCM</th>
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<tr>
<td>Structural steel</td>
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## Construction philosophy

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<th>Area</th>
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<td>Amine plant</td>
<td>Prefabricate modules</td>
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<td>Site-build of foundations</td>
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<td>Slip-form concrete structure</td>
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<td>Chilled Ammonia plant</td>
<td>Stick-build at site</td>
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<td>Site-build of foundations</td>
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<td>Slip-form concrete structure</td>
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<td>Utilities and infrastructure</td>
<td>Prefabricate modules</td>
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<td>Prefabricate concrete elements</td>
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Prefabrication

PAU assembly at Aker Stord
Fabrication of equipment
Piperacks installed
Seawater intake

- catching our future
Mechanical installations
TCM organisation build up

- Company Meeting (4+4)
  - Technology Committee (4+4 Partners reps.)
    - Managing Director (73)
      - Financial Manager (2)
      - Communication Manager (1)
      - Technology Manager (8)
      - QR/HMS Manager (3)
      - Admin. Co-ordinator (1)
      - Operations Manager (57)
# Schedule

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- **catching our future**
Knowledge sharing

• Co-operate with research organisations and other CCS projects
• Participate in CCS conferences and give papers
• Keep outside world updated on status through website
• Good communication with media and NGO’s
• Subject to vendor confidentiality agreements
Combat climate change through technology

An Introduction to TCM

Steel installations are arriving

www.tcmda.com

NEWS

South-African ambassador impressed by CCS center
Visit by Members of the Norwegian Parliament
2 million work hours without any serious incidents

ABOUT TCM

Technology Centre Mongstad is the world’s largest facility for testing and improving CO2 capture. Knowledge gained will prepare the ground for CO2 capture initiatives to combat climate change. TCM is a joint venture between the Norwegian state, Statoil, Shell and Sasol.

– catching our future
Our Objectives

- Improve and verify CO2 capture technology for large scale
- Become a globally recognized centre of competence on CO2 capture