TECHNOLOGY CENTRE MONGSTAD

A world class industrial scale test centre for carbon capture

Introduction

Industrial collaboration preparing technology for a carbon constrained future

Carbon Capture and Storage (CCS) from large CO_2 point sources has been identified as a cornerstone technology in the quest to combat climate change. The IEA, The European Union as well as the IPCC, all indicate that CCS may contribute about 20 % of the CO_2 emission reductions needed to achieve the widely accepted goal of curbing global warming within 2 ºC by 2050. Gassnova, the majority owner of TCM, believes that world wide deployment of CCS would be required by around 2030 and onwards.

To achieve this, large scale investments in research and development of technology as well as construction of a number of large scale demonstration plants would be required over the next 15 years. Investments in CCS will have to be complemented with other major initiatives in the power sector such as large scale development of renewable energy sources, energy conservation and fuel switching from coal to gas if this ambitious goal is to be achieved.

For CCS, the major obstacles to world wide deployment seem to be: High CO_2 capture costs and unproven technology at scale, public concern over the safety of geological storage of large amounts of CO_2 and lack of an internationally harmonized regulatory framework to incentivize and regulate CCS deployment.

The Government of Norway has undertaken to support the maturing of CCS mainly through three initiatives:

1. Funding of CCS research and development programs in industry and in the research community (www.climit.no)
2. Construction of a world class CO_2 Technology Centre Mongstad (TCM), in Norway
3. A subsequent full scale CCS demonstration project, also to be constructed at Mongstad, based on i.e experience from TCM

A key element of this development strategy is to work in close collaboration with industrial players for technology development as well as for project development and execution. The government is implementing these initiatives through its fully owned subsidiary, Gassnova.

World’s largest test centre for CCS

TCM is already well known in the CCS industry. The Financial Times, after a recent visit, labelled TCM “the holy grail for advocates of carbon capture and storage”. TCM enters the operational phase early 2012, with the objective to become a point of reference for the CCS industry. The facility has a capacity of 100,000 tonnes of CO_2 per year, thus allowing for industrial-scale testing of various technologies.

Ambitions

The main ambitions of TCM are to:

- Test, verify and demonstrate CO_2 capture technology owned and marketed by vendors
- Reduce cost, technical-, environmental- and financial risks of the CCS technologies
- Encourage the development of the market for carbon capture technology

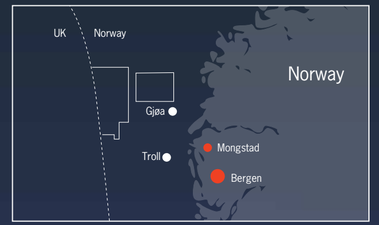
TCM is well-suited for long-term qualification of distinct capture technologies. In the initial phase, the technology vendors, in cooperation with TCM, will test their respective technologies. TCM will be responsible for developing the further test programmes after the initial phase of approximately one year. In order to bring this vital technology to the world, it is essential that the lessons learnt and improvements made can be shared. TCM will coordinate information sharing among TCM owners and other key stakeholders.

Knowledge in focus

TCM has systems and infrastructure for accumulation of operational experience over the long term, as well as facilities and capacity for researchers, students and other visitors. The main purpose of TCM is to demonstrate post-combustion carbon capture at large scale and share the experience between owners, vendors and the general public. TCM’s test activities will make the company’s owners capable of evaluating and undertaking future full scale CCS investments, as well as improving technology vendors’ ability to provide the world with cost efficient and commercially viable CO_2 capture plants.

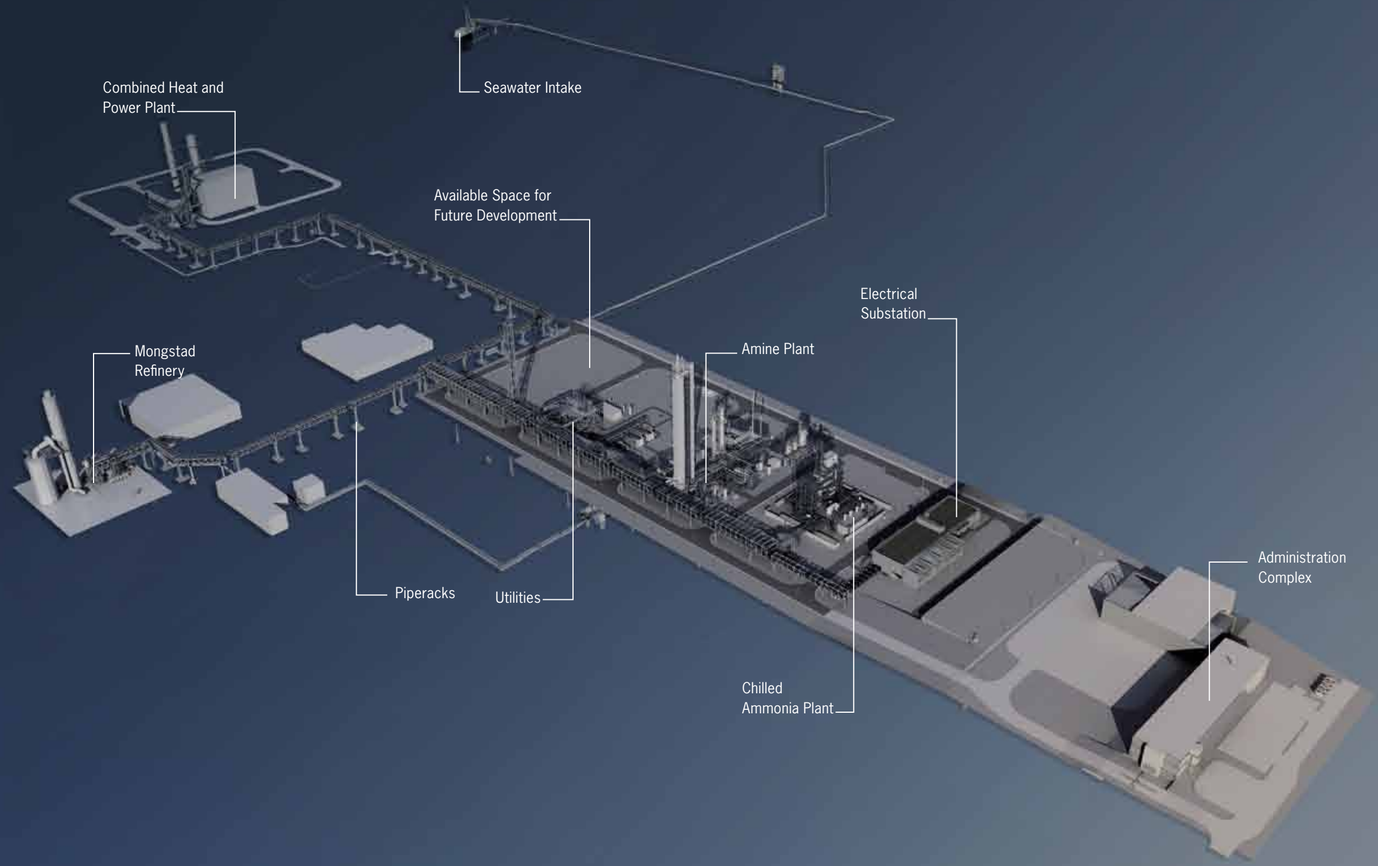
Key facts about TCM:

Total area:	63 000 m²
Capture Type:	Post-Combustion
Technologies:	Amine and chilled ammonia technologies
Capacity:	100 000 tonnes CO_2 / year
Budget:	5.8 Billion Norwegian Kroner
Owners:	Gassnova, Statoil, Sasol, Shell
Technology Vendors:	Aker Clean Carbon, Alstom



A distinctive opportunity at Mongstad

Located next to the Statoil Mongstad oil refinery northwest of Bergen, Norway, the CO_2 Technology Centre will have access to flue gas from the gas-fired combined heat and power plant and the flue gas from the refinery catalytic cracker. The CO_2 contents are about 3.5 % and 13 %, respectively, which provides TCM with a unique opportunity to be able to investigate capture technologies relevant for coal and gas fuel power plants, as well as other industrial applications. TCM has chosen to focus on demonstrating and improving two technologies for post-combustion capture. The technologies are particulary relevant for retrofit of existing plants.



TCM DA – the Company

History

October 2006: Norwegian government and Statoil sign agreement to build the centre
May 2009: Norwegian parliament approves project
June 2009: TCM DA is established by Gassnova, Statoil and Shell.
May 2010: Sasol joins as owner
October 2010: Administrative offices opens
Early 2012: Testing period starts

Owners

TCM is a joint venture between Gassnova (on behalf of the Norwegian state), Statoil, Shell and Sasol. TCM is owned by potential end users of the CO_2 capture technology. TCM's partners have made a clear commitment to technology improvement and are investing approximately 750 Million Euro in the construction and development of the technology centre.

The owners and their shares:

Gassnova	75.12 %
Statoil	20.00 %
Shell	2.44 %
Sasol	2.44 %

Company

The company's legal name is CO_2 Technology Centre Mongstad DA.

TCM is a Norwegian unlimited company. Under Norwegian law, the owners are liable for their relative share of the company.

TCM is governed by a board of owners (Company Meeting) with approximately ten meetings a year. Each owner is represented with one member and one deputy member in the Company meetings. Gassnova holds the position of the chairman of the board.

TCM has its own management, which is responsible for operations and the execution and supervision of the testing programmes. Statoil is the operator for the construction of the TCM facility. Both the managing director for TCM and project manager of the construction report to the Company Meeting.

The company has organization number 994 251 295 in the Norwegian Company Registry and was incorporated in 2009.

Location

TCM is located at the Statoil Mongstad oil refinery on Norway's western coast, northwest of the city of Bergen. The facility covers 63,000 m².

Experience

The experienced members of the operational team at TCM come from the refining and petrochemical industries, thus conveying very appropriate skills and knowhow to the operation of the TCM facility.

Technology

Extensive and flexible testing environment

The facilities at TCM are designed to enable the ease of testing third party technologies, in particular process equipment and absorbents. Close to 4 000 online instruments, 100 manual sampling points and a world class laboratory equip TCM with the best available environment for performing tests with high mass and energy balance accuracy levels. TCM provides offices, utilities, control room, laboratories, workshops, warehouse space, meeting rooms, etc. to support the tests. Test activities are further supported by collaboration and co-operation with local and international universities as well as R&D organisations.

Several technologies in parallel

The testing of two technologies is to commence shortly, an amine plant will start up by the early 2012 and a chilled ammonia plant is to start up by the third quarter of 2012. However, the centre has capacity to undertake the testing of more technologies. Several candidates for the third industrial scale slot are under evaluation.

Two different sources of flue gas

Flue gas is provided from two flue gas sources; the Residual Catalyst Cracker (RCC) at the Mongstad refinery, and the Combined Heat and Power plant (CHP).
Flue gas from the CHP represents a gas power plant scenario with 3.5 mole % of CO_2.
Recirculation of CO_2 from the technologies can give a CO_2-concentration of up to 9 mole %.
Flue gas from the RCC represents a coal power plant scenario with 12.9 mole % of CO_2.

The specifically designed infrastructure at TCM enables the verification of a number of industrial processes from both gas and coal fired power sources in a single test program. This can be established with minor modifications of the existing tie-in lines. TCM is the only industrial scale facility worldwide to also have a gas turbine feed.

Suppliers

Suppliers for the two first industrial scale test facilities

After a comprehensive evaluation, TCM selected two CO_2 capture processes, an amine process from Aker Clean Carbon (ACC) and a chilled ammonia process from Alstom.

Amine plant

With Aker Clean Carbon's amine technology, CO_2 is captured by an amine solvent, a liquid comprising of water and amine, which is being used to absorb the CO_2 from the flue gas.

Amine technology has been used for decades in other applications and is therefore considered to have a moderate technical risk. However, TCM will evaluate opportunities for improvements in process design, construction methods and operations with the purpose of cost reduction and to qualify the technology for use in large-scale post-combustion plants. Aker Clean Carbon has included several technology improvements in the plant, such as improved amines, energy savings and emission control.

Chilled Ammonia plant

Alstom's Chilled Ammonia post-combustion technology chosen for testing consists of separating CO_2 from the exhaust gases using chilled ammonia as the solvent to absorb the CO_2.

Chilled ammonia technology, although less widely used than amine technology, holds potential for lower energy consumption per tonne of CO_2 captured. This process will be tested at large scale at TCM with the aim of qualifying and providing the world with a proven technology for CO_2 capture.

Energy companies and process industries with large CO_2 footprints, should prepare for the need to include CCS into their medium term operating technology portfolio. Considerable investments are needed in research, development and demonstration to achieve our goals of world wide deployment of CCS.

TECHNOLOGY CENTRE MONGSTAD

– catching our future

Owners:

GASSNOVA

Statoil

sasol
reaching new frontiers

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