IEAGHG Information Paper: 2016-IP19; Study Report on CCS Options in Norway Released

On Monday 4th July the Ministry of Petroleum and Energy presented the feasibility study report on full-scale carbon capture, transport and storage (CCS) in Norway.

The aim of the feasibility studies was to identify at least one technically feasible CCS chain with corresponding cost estimates. Such a chain includes capture, transport and storage of CO_2. The results show that it is technically feasible to realise several alternatives in Norway.

Three industrial options have been assessed and have completed feasibility studies of CO_2 capture;

- Norcem AS has assessed the possibility for capturing CO_2 from the flue gas at its cement factory in Brevik,
- Yara Norge AS has assessed CO_2 capture from three different emissions points at its ammonia plant at Herøya in Porsgrunn
- and the Waste-to-Energy Agency in Oslo municipality has assessed CO_2 capture from the waste recovery plant at Klemetsrud (Klemetsrudanlegget AS).

Gassco has carried out a study of ship transport of CO_2 between locations for capture and storage for different conditions (pressure) at vapour/liquid equilibrium. Gassco considers all solutions for the studied transport conditions are technically feasible.

Statoil ASA has completed feasibility studies of CO_2 storage at three different sites on the Norwegian continental shelf. Both Statoil and Gassnova consider a solution for developing a CO_2 storage site with onshore facilities and a pipeline to the Smeaheia area as the best solution given the project's objective. The Smeaheia area is located east of the "Troll" field, approximately 50 km from the coast. This solution has the lowest implementation risk, large storage capacity and it is relatively easy to develop the capacity of the infrastructure.

The cost for planning and investment for such a chain is estimated at between 7.2 and 12.6 billion kroner (excluding VAT). The planning and investment cost will depend on how much CO2 will be captured, where it will be captured from and how many transport ships are needed. The cost estimates are based on the reports from the industrial players and have an uncertainty of +/- 40 percent or lower.

The Ministry of Petroleum and Energy has had overall responsibility for the feasibility studies. Gassnova SF has been project coordinator and responsible for capture and storage, while Gassco AS has been responsible for transport.

The Government will present further plans for CCS in the state budget for 2017.

The plan going forward is to follow a step wise approach, following industry best practice for maturing projects on CCS. The feasibility studies are an important part of this work with the aim of realising a full-scale CCS chain in Norway within 2022, which is lower in costs than projects considered in Norway earlier.

For further details go to: https://www.regjeringen.no/en/aktuelt/good-potential-for-succeeding-with-ccs-in-norway/id2506989/.

The full report, in Norwegian can be found at the link above.

The Report Summary in English, taken from the web site is attached.

John Gale
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Summary – Feasibility studies - CCS project in Norway

1.1 Introduction

In its political platform "Sundvolden-erklæringen", the Government states that it will "invest on a broad front to develop cost-effective technology for carbon capture and storage (CCS) and seek to construct at least one full-scale carbon capture demonstration plant by 2020". The Government's CCS strategy was presented in the budget proposition for 2015. The strategy covers a wide range of activities, including the assessment of potential full-scale CCS projects in Norway.

Gassnova' s pre-feasibility study report on potential full-scale CCS projects in Norway from May 2015identified several emission sources and storage sites, which may be technically feasible for a CCS project. It also identified industrial players, which could be interested in participating in further studies. In the autumn of 2015, the Government decided to continue the project and initiated a feasibility study.

The Ministry of Petroleum and Energy has had overall responsibility for the feasibility studies. Gassnova SF has been project coordinator and responsible for capture and storage, while Gassco AS has been responsible for transport.

Three industrial players have completed feasibility studies of CO_2 capture; Norcem AS has assessed the possibility for capturing CO2 from the flue gas at its cement factory in Brevik, Yara Norge AS has assessed CO_2 capture from three different emissions points at its ammonia plant at Herøya in Porsgrunn, and the Waste-to-Energy Agency in Oslo municipality has assessed CO2 capture from the waste recovery plant at Klemetsrud (Klemetsrudanlegget AS). Gassco has carried out a ship transport study with assistance from Larvik Shipping AS and Knutsen OAS Shipping AS. Statoil ASA has completed feasibility studies of CO_2 storage at three different sites on the Norwegian Continental Shelf.

The aim of the feasibility studies is to identify at least one technically feasible CCS chain (capture, transport and storage) with corresponding cost estimates. The results from the feasibility studies show that it is technically feasible to realise a CCS chain in Norway.

The feasibility studies demonstrate a flexible CCS chain. Instead of transporting CO_2 by pipeline to a storage site, the plan is to transport CO_2 by ship to a connection point tied to the storage site. A flexible transport solution and ample storage capacity can contribute to realising capture from further sources. That way, the initial investment in CO_2 infrastructure can be utilised by several projects.

1.2 Technical feasibility and costs

CO_2 capture is technically feasible at all three emission locations. Given the project's objective both Statoil and Gassnova consider a solution with an onshore facility and a pipeline to "Smeaheia" as the best solution for CO_2 storage. The "Smeaheia" area is located east of the "Troll" field, approximately 50 km from the coast. This solution has the lowest implementation risk, large storage capacity and it is relatively easy to increase the capacity of the infrastructure. Developing a CO2 storage site is possible in many different ways, but other solutions than with an onshore facility will entail a higher technical risk.

Ship transport of CO_2 between locations for capture and storage have been assessed for three different conditions (pressure) at vapour/liquid equilibrium. Gassco considers the solutions for all three studied transport conditions (low-pressure, medium-pressure and high-pressure) as technically feasible.

The cost for planning and investment for such a chain is estimated at between 7.2 and 12.6 billion kroner (excluding VAT). The planning and investment cost will depend on how many sources the CO_2 will be captured from, how much CO2 will be captured from each source, and how many transport ships are needed. Operational costs vary between approximately 350 and 890 million kroner per annum for the different alternatives. The cost estimates are based on the reports from the industrial players and have an uncertainty of +/- 40% or better.

1.3 Assessments of the benefit of the project

In order for a full-scale project to gain socio-economic returns it has to contribute to the reduction of barriers and costs for the next CCS projects. In parallel with the feasibility studies the Ministry of Petroleum and Energy has carried out a Concept Evaluation, which seeks to answer whether full scale CCS is socio-economically profitable. The Concept Evaluation sets requirements for a project in order to achieve these effects. The following aspects from the Concept Evaluation form the basis for evaluating the benefit from a CCS project:

- Achieve knowledge that can be transferred across countries and sectors.
- Provide a storage solution with sufficient capacity for economies of scale.
- Demonstrate that CCS is a safe and effective climate measure.
- Contribute to improvements of the market situation for CCS.

The assessment of benefits from a CCS chain shows that all CCS chain alternatives will contribute to reducing barriers and costs for coming CCS projects. This is in particular valid for alternatives, which establish and qualify storage sites and other infrastructure with capacity to store excess amounts of CO_2.

Through realisation of one of the alternatives important learning will be achieved; construction and operation of CO_2 capture facilities integrated with existing industry facilities, regulation of CCS chains (for example handling of CCS in the ETS and application of the regulations for CO2 transport and storage), the establishment of a business model for capture, transport and storage, updated cost estimates and the further development of technology.

For CO_2 storage an onshore facility will be well suited to provide economies of scale in the sense that it has capacity to receive volumes from other CO_2 capture projects. Investing in more than one capture project will document to a greater extent that CCS is a safe and effective climate measure. This is because of lower risk of lack of CO_2 for the chain, and because cost per unit CO2 reduced will be reduced with increasing CO_2 volumes in the chain.

All alternatives can contribute to a bigger market for CCS, and this will be strengthened if capture from several CO_2 sources is developed. Stimulation of the market for CCS is important to achieve further technology development and cost reductions for other future projects.

1.4 Framework conditions and incentive structure

The starting point of the State is a split of cost and risk between the State and the industry players that participate in the project. During the feasibility study phase, the State has informally explored possible incentives and principles for sharing cost and risk in the development and investment phase.

State support for a first CCS project will be a combination of several elements. State aid rules prohibit covering more than the cost related to CCS. A combination of aid for investment and operations could be a solution. Important parameters such as required rate of return, discount period, and length of state aid period will also have to be determined before an investment decision can be made. The State's effort on establishing framework conditions and incentives for a first CCS project is directed at the State and the industry players having as concurring incentives as possible to build and operate a cost effective CCS chain.

1.5 Next phase – the concept and FEED phase

The next phase will be used to optimise concepts to find the best suited solution for a CCS chain, clarify technical requirements in the chain, and develop a technical and commercial basis for an investment decision. Preparing for the construction phase is also part of the task. This work is necessary to provide a sufficient basis for an investment decision for both the State and the industry players.

According to the feasibility study report the next step in the project should be a combined concept and Front End Engineering and Design (FEED) phase, which would be announced as a competitive process in the autumn of 2016. Contracts for the concept and FEED phase could be signed first quarter 2017 and the work could be finished early in the autumn of 2018. This work will form the basis for the quality assurance and decision processes for an investment decision (Decision Gate 3) which is planned for the spring of 2019. A full-scale CCS project could then be realised in 2022. The industry actors will have to make their own investment decisions, therefore they should be allowed to carry out the concept and FEED phase according to their own project execution models and procedures.

Based on the result from the feasibility studies, Gassnova recommends that several of the industry actors be given the opportunity to continue preparing for CO_2 capture in the next phase. Several participants will provide competition, which will contribute to assurance for cost effective solutions in the project. Further assessment of several emission sources also reduces the risk of the project not being completed should one of the CO_2 emission sources not be able to provide CO_2.

Gassnova will be responsible for leading and implementing the project in the concept and FEED phase. Gassco will be responsible for work related to transport. The Ministry of Petroleum and Energy will have overall responsibility for the development of framework conditions and incentives.

Before the concept and FEED phase is announced, it has to be decided how many actors will receive aid for the concept and FEED phase and, if relevant, at what point a choice between them should be made. Criteria for the selection will have to be established and communicated to the industry players. Before commencing the concept and FEED phase, the overall design basis for the CCS chain, pressure and temperature conditions for ship transport and development solution for the CO_2 storage site will have to be clarified. These issues will have to be thoroughly discussed with the industry players, and decisions should be based on what is optimal and will give the best balance of cost and benefit for the total chain.

The CCS-project is subject to external quality assurance under the Norwegian state's quality assurance process for large public investments (KS-ordningen). The report from the external quality assurance team will be finalised 31 August 2016.

- 2016 (DG1): Completion of feasibility studies and a decision for allocations from the state budget
- 2016: Announcement of project plan in autumn 2016 with the start of conceptual and preliminary engineering studies
- 2019 (DG3): Pre-negotiated agreements based on preliminary engineering studies, and any investment decision no later than the summer of 2019 (DG3)
- 2022 (DG4): Start of operation
- 2030: Operation Support Period as agreed with industry players, renegotiation or continued operation without state aid.
- 2046 (DG5): End of operation after 25 years of technical lifetime
- 2047 (DG6): Post closure monitoring and verification of stored CO_2.