

Unofficial translation: Gassnova's report on potential full-scale CCS projects in Norway - pre-feasibility study

Background

The Norwegian government presented its Carbon Capture and Storage (CCS) strategy in the Ministry of Petroleum and Energy's budget proposition to Stortinget in October 2014 (Prop. 1 S (2015-2015)). One of the initiatives of the strategy is a mapping of potential full-scale projects in Norway. The initiatives contribute to fulfilling the government's ambition to realize at least one full-scale CCS demonstration facility by 2020. The Ministry has tasked Gassnova, in cooperation with Gassco and the Norwegian Petroleum Directorate (NPD), with an analysis on potential full-scale CCS projects in Norway. This work has been conducted in the form of a pre-feasibility study. The Norwegian Environment Agency has also provided input to the report. On 4 May, the Ministry received the pre-feasibility report. This abstract sums up the most important findings of the report and Gassnova's recommendations. The report contains sensitive business information and hence has to be exempt from public.

The objective of the pre-feasibility study has been to clarify whether there is a basis for initiating a project process for a full-scale demonstration facility for the capture, transport and storage of CO₂. The main requirements of the initiatives is that they should have an incentive effect, contribute to learning and global knowledge sharing and reduce barriers to technology deployment. In addition, the initiatives ought to provide a net benefit relative to cost and the state's risk exposure. The initiatives also have to be realistic and feasible.

Mandate

The mandate for the study Gassnova, Gassco and the NPD have completed was issued 25 November 2014. The target segment for potential CO₂-capture sites was mainly existing land-based emissions sources with emissions above 400 000 tons of CO₂ per year. The possibilities for transport and storage of CO₂ from potential capture facilities in Norway have also been studied. Gassnova has been responsible for coordinating the work, and has also been in charge of the studies on capture and storage. Gassco has been responsible for the study on CO₂-transport. The NPD's role has been to contribute with expertise on the Norwegian continental shelf, helping to define the projects and sharing relevant data..

The pre-feasibility study consists mainly of an account of business drivers and the need for incentives and framework conditions, technical aspects of the different parts of a CCS project, unclassified cost estimates and a preliminary schedule for realising a full-scale project. Issues concerning the planning of transport and storage of CO₂ have been separated from capture-related issues. The study of capture and transport solutions has been done in collaboration with owners/operators of industrial facilities, while Gassnova has studied storage solutions in dialogue with potential storage actors in this first phase. Gassco has prepared a separate pre-feasibility study on transport. In the pre-feasibility study, it has been a prerequisite that those planning capture projects do not have to plan or finance transport and storage of the CO₂.

Capture

Gassnova has built on a mapping study performed in 2012. The Norwegian Environment Agency's list of emissions of CO₂ from land-based industry has been the basis for the mapping work. The emissions may vary from year to year.

Mongstad

In connection with the issuance of the CO₂ emissions permit for the Combined Heat and Power (CHP) plant at Mongstad, the Norwegian state and Statoil in 2006 signed an agreement about CCS at Mongstad (the “Implementation Agreement”). Based on this agreement, the Technology Centre Mongstad was built, and full-scale CCS from the CHP and refinery was studied. In 2013, the state chose to discontinue the work on planning full-scale CCS at Mongstad, inter alia because the risk related to the Mongstad facility was too high. The circumstances that were taken into consideration in autumn 2013 have not since changed considerably. Therefore, the Mongstad refinery is not relevant for further studies

Kårstø

Based on previous studies, Gassco’s assessment is that CO₂-capture from the emission points at the gas processing facility at Kårstø as a stand-alone initiative is not realistic.

Hammerfest LNG

In the mapping report from 2012, Hammerfest LNG did not consider itself relevant for further CO₂-capture studies. Other measures with comparable CO₂reduction and lower risk have been identified. The Norwegian Environment Agency has confirmed that no new information has been forwarded changing the assessment of the potential for CO₂-capture from the Statoil facility at Melkøya.

Norcem Brevik

In the mapping from 2012, Norcem considered itself relevant for further CO₂ capture studies. Norcem has also provided input to the pre-feasibility study. The CO₂ concentration in the flue gas emissions from cement production is high (16-19 percent), and there is residual heat for CO₂ capture. According to Gassnova, the cement industry needs more information on the potential for CCS. At the pilot facility in Brevik, Norcem has tested several different capture technologies with public support from the research and development programme Climit.

Yara Porsgrunn

In connection with the mapping from 2012, Yara considered the ammonia plant in Porsgrunn as relevant for further CO₂ capture studies. Yara has provided input to the pre-feasibility study. Yara has total emissions of approximately 1,1 million tons of CO₂ a year at full production, some of this is sold to the food industry.

Hydro Aluminium Sunndal

In connection with the mapping from 2012, Hydro did not consider the Sunndal facility relevant for further CO₂ capture studies, mainly because the CO₂ emission points at the plant site are interspersed and the flue gas has a low CO₂ concentration (0,9-2,5 percent). Hydro is planning to expand the production at Hydro Aluminium Karmøy. The relevance assessment for further studies has not changed since 2012.

Noretyl (Ineos) Rafnes

In connection with the mapping from 2012, Noretyl did not consider the petrochemical facility in Bamble relevant for further CO₂ capture studies, mainly because the emission points at the facility are placed far from each other. In addition, due to a long maintenance cycle an attachment would not be possible until 2022. Gassnova has contacted Noretyl again and received confirmation that the potential for CO₂ capture remains unchanged.

Alcoa Mosjøen

In connection with the mapping from 2012, Alcoa Norway declared that the facility in Mosjøen would not be relevant for further CO₂ studies because of technical difficulties. The CO₂ concentration is low (down to 0,9 percent), there are several, but interspersed sources, little space and lack of residual heat for a CO₂ capture facility. Alcoa is studying potential CO₂ emission reductions by improvements in process and operations.

Gassnova has contacted Alcoa again and received confirmation that the potential for CO₂ capture remains unchanged.

Klemetsrud

Gassnova has also been in touch with the Waste-to-Energy Agency of Oslo, which is considering CO₂ capture from the waste incineration facility at Klemetsrud. Gassnova indicates that it may be realistic to capture approximately 400 000 tons of CO₂ per year. Klemetsrud may be a relevant facility for CO₂ capture, which could potentially be combined with other capture projects. Further studies are required before concluding on the viability of the Klemetsrud plant for CCS and Gassnova will continue its dialogue with Oslo municipality on the issue.

Transport

Transportation of CO₂ by ship and pipeline is being conducted in several sites today and is a more technologically mature process than that of capturing and storing it. Transport of CO₂ by ship is a commercial service offered by several possible suppliers. Gassco has documented that a ship-based solution will be the most cost-effective solution when transporting limited amounts of CO₂ over relatively long distances. The study shows that different concepts may be used, but which is the more suitable will vary depending on conditions at the capture and storage sites, such as pressure and temperature. Certain elements also require technology development, primarily related to offloading and injection at sea.

Gassco has previously performed feasibility studies on CO₂-transport via pipeline in relation to the planning of a full scale CO₂ -capture facility at Mongstad. If feasibility studies for CO₂-capture and -storage shows that other combinations of CO₂ volume and distance are more relevant than what is envisaged in the pre-feasibility study, a pipeline alternative may still be matured without impinging on an investment decision. The transport concepts assessed in the pre-feasibility study are considered deployable by the time capture and storage operations could commence.

Storage

Gassnova has identified sites which may be technically suitable for CO₂ storage and companies with a potential interest in taking part in potential feasibility studies in the future. In their communication with Gassnova, it has been stated that their participation is conditional on framework conditions and support measures, According to Gassnova, none of the potential storage alternatives have been fully studied to the level required for a pre-feasibility study. Hence, more in-depth analysis is required before a preferred alternative can be selected. Existing storage sites, oil and gas fields in late-stage production and prospective storage sites abroad have been considered.

Existing storage sites

Since 1996, approximately 15 million tonnes of CO₂ has been injected and stored in the Utsira formation via the Sleipner platforms. The Norwegian Petroleum Directorate, Statoil, the research institute SINTEF and Gassnova have evaluated the Utsira formation as a CO₂ storage site and concluded that it is well suited for storing large volumes.

The existing injection well at Sleipner has, however, a limited capacity for the volumes expected from a full scale capture facility as outlined in the pre-feasibility study. Gassnova has also pointed out that storing CO₂ from third parties at Utsira via Sleipner raises issues regarding existing legislation concerning responsibility for the stored CO₂, thus posing challenges for the operator of the field.

A study performed by Statoil for Gassnova in 2009 examined another area of Utsira where storage was conducted via pipeline from land. In their communication with Gassnova, Statoil has concluded that utilising existing platforms at Sleipner for the storage of new volumes of CO₂ from a capture project on the Norwegian mainland currently is not an option.

Statoil has pointed out that storing additional volumes in the Utsira formation may be possible by drilling a new well. According to Statoil, new volumes should preferably be injected in a separate part of the formation than the volumes injected from Sleipner.

Storing CO₂ in the same formation as the CO₂ stored from the Snøhvit facility in Hammerfest has not been considered a viable alternative due to long transport distances.

Petroleum fields in late life

Gassnova has evaluated a number of fields in the North Sea that are expected to be phased out in the coming five years. The assessments include the potential for a pilot project utilising CO₂ for enhanced oil recovery (EOR). Fields relevant for preliminary studies have been identified and interest has been expressed in examining the opportunities for an EOR-pilot. Such studies may provide a basis for assessing relevant storage alternatives on the Norwegian continental shelf.

International projects

Gassnova has met with the three CCS projects connected to the North Sea Basin; ROAD, WhiteRose and Peterhead. According to the London protocol, cross-border transport of CO₂ for offshore storage is not allowed. Norway and the UK have ratified an amendment to the protocol changing this, but more countries have to ratify the amendment for it to become effective. None of the projects have made a final investment decision, and storage of CO₂ from a Norwegian project would require investments in i.a. port installations, pipes and necessary equipment. Gassnova considers the Peterhead project most likely for further dialogue on possibilities for joint storage, provided a final investment decision is made, which for Peterhead is planned by the end of the year.

Conclusion and recommendations

Gassnova's pre-feasibility study has identified emission sources and storage sites which may be technically feasible for a CCS project. Gassnova points out that it has not been possible to perform assessments of storage alternatives to the same level of detail as for capture and transport. The interest of the owners/operators of the emission sources is conditional on clarification by the state on framework conditions and have provided input on this in connection with the pre-feasibility study. Based on the work so far, Gassnova recommends continuing the work to facilitate feasibility studies of CO₂ capture at both Norcem and Yara's facilities. Gassnova also recommends continuing the dialogue with the Waste-to-Energy Agency of Oslo about further studies at the Klemetsrud facility.

Gassnova recommends to undertake feasibility studies of CO₂ capture from the facilities whose owners have expressed interest in more detailed assessments.

Through practice and earlier studies it has been documented that transporting CO₂ is viable. Hence, options for transporting CO₂ are more mature than those for capturing and storing it. According to Gassnova, transport of CO₂ by ship can be procured in the open market with several possible suppliers/vendors. However, some challenges specific to offshore storage utilising ships for CO₂-transport will still have to be resolved, regarding, amongst other issues, offloading and injection of CO₂. Different proposals for ship-based transport and offloading have been put forward.

Gassnova has identified industrial companies interested in participating in feasibility studies of storage options. A storage site should be able to handle volumes from multiple sources. Gassnova has underlined that none of the potential storage alternatives have been fully studied to the level required for a pre-feasibility study and as such cannot make recommendations as to which alternative is more suitable.

Gassnova recommends that the government prepares for feasibility studies to be undertaken according to the rules/legislation for pre-commercial procurement. The studies should be divided in two parts: one for capture and one for transport and a storage related analyses. Furthermore, Gassnova recommends that the goals of a project, as well as roles, responsibilities and support mechanisms/measures should be further elucidated before commencing feasibility studies. During this phase, a procurement process should be carried out as to who should be tasked with the construction and operation of a CCS-project. It is also recommended that the government further clarifies how the state will organise the transport and storage phases of a project.

Given a process as outlined in the pre-feasibility report, a basis for an investment decision may be put forward by the autumn of 2018. Deploying a full scale CCS project by 2020 will be very challenging. These are very complex industrial projects, involving a large number of risks and uncertainties. As such, a project plan as outlined in the report must be viewed as tentative.