Submission from Norway on

Carbon Capture and Storage in Geological Formations as project activities in the Clean Development Mechanism

At the sixth session of the Conference of the Parties serving as the Meeting of the Parties to the Kyoto Protocol, the Decision -/CMP.6 invited Parties to submit their views related to carbon dioxide capture and storage in geological formations as a mitigation technology.

Norway welcomes the confirmation of the eligibility of carbon dioxide storage in geological formations as project activity in the Clean Development Mechanism. We further welcome the opportunity to present our views on appropriate modalities and procedures for this type of project activity. This submission should be considered in conjunction with our previous submissions on this issue.

1. Definitions

- Carbon dioxide capture and storage - a process consisting of the separation of CO_2 from industrial and energy-related sources, transport to a storage location and long-term isolation from the atmosphere.
- Leakage - the net change of anthropogenic emissions by sources of greenhouse gases which occurs outside the project boundary, and which is measurable and attributable to the CDM project activity.
- Physical leakage/seepage – CO_2 released from the storage site to the atmosphere.

2. General comments

If we are to reach our global long-term goal as stated in article 2 of the Framework Convention on Climate Change, we need to use a broad and comprehensive portfolio of mitigation options. Such a portfolio should include a variety of mitigation options. According to the IPCC, CCS has, after energy efficiency, the second largest potential for global emission reductions. In light of its vast potential of reducing emissions,
Norway sees carbon capture and storage in geological formations as an imperative part of such a broad and comprehensive mitigation portfolio.

The Intergovernmental Panel on Climate Change (IPCC) defines carbon capture and storage (CCS) as "a process consisting of the separation of CO_2 from industrial and energy-related sources, transport to a storage location and long-term isolation from the atmosphere". CCS in general should not be viewed as a distinct technology, but rather as a vital mitigation option, consisting of various technological options, many of which are already individually commercially viable and proven.

Due to the importance of the energy sector as source of GHG emissions, most attention has so far been paid to capturing CO_2 from power generation. However, the most attractive conditions for capturing could be found in industrial sectors where plants generate gas streams with high concentrations of CO_2. Such streams are found in the chemical processes used to produce ammonia of hydrogen, in coal-to-liquids and gas-to-liquids processes, in blast furnaces and cement kilns and in the processing of natural gas. For dominating industrial sectors, such as cement, iron and steel production, ammonia production and refineries, CO_2 storage could therefore contribute to significant emission reductions.

The Executive Board (EB) of the Clean Development Mechanism (CDM) has approved methods that are relevant for parts of a CCS CDM project. Norway recommends using existing CDM rules and modalities where appropriate. Exception is to be made for the CCS specific issues not covered by the CDM rules and modalities. The text in this submission is therefore a general description in areas where existing rules and modalities may be applicable and more specific in areas where new may be needed.

3. Storage site selection criteria

According to the IPCC Special Report on CCS, a retention time of CO_2 for several thousand years can be obtained for well-selected, designed and managed geological storage sites. It is also most likely that the CO_2 may gradually be immobilised by various trapping mechanisms, so that it will be stored for up to millions of years. Thus, the selection of appropriate storage sites for CCS projects is of fundamental importance to ensure long-term permanence and the environmental integrity of the projects; and consequently, the selection of a storage site should be based on stringent and robust criteria.

The examination of possible storage reservoirs in geological formations should be based on e.g. best available scientific knowledge, knowledge obtained by intergovernmental and national governmental institutions, industry and research institutions.

The suitability of a geological formation for use as a storage site shall be determined through a characterisation and assessment of the potential storage complex and surrounding area pursuant to the criteria specified below. A geological formation shall only be selected as a storage site, if there is under the proposed conditions of use no significant risk of leakage, and if no significant environmental or health risks exist.

The following criteria should form the basis for storage site selection. The EB should ensure that storage sites proposed for CCS projects in the CDM have been thoroughly characterised and analysed, and that the documentation is a part of the Project Design Document (PDD).

1: No projects in international waters

Norway would not recommend projects using geological formations in international waters or projects that cross into international waters due to the legal complexities associated with such projects.

2: No significant risk of physical leakage

The long-term risk for physical leakage or seepage has to be minimised and only projects designed with a high expectation of no seepage should be approved.

The IPCC Special Report on Carbon Dioxide Capture and Storage states that "the proportion of CO_2 retained in appropriately selected and managed sites is […] likely to exceed 99% over 1,000 years". Over time, it is also possible that the CO_2 will be immobilised by various trapping mechanisms.

3: Thorough analysis and assessment of geology and geophysics

The PDD should include thorough data analysis and assessment of the storage site's geology and geophysics.

4: Thorough analysis and assessment of hydrogeology

The PDD should include thorough data analysis and assessment of the hydrology and particularly any existence of drinkable ground water.

5: Thorough analysis and assessment of the geochemistry

The PDD should include thorough data analysis and assessment of the geochemistry, e.g. calculation and modelling of the CO_2 dissolution rates and mineralisation rates.

6: Thorough analysis and assessment of the geomechanics

The PDD should include thorough data analysis and assessment of the geomechanics, e.g. permeability, and fracture pressure.

7: Thorough analysis and assessment of the seismicity

The PDD should include thorough data analysis and assessment of the seismicity of the area surrounding the project.

8: Thorough analysis and assessment of potential pathways for physical leakage or seepage

The PDD should include thorough data analysis and assessment of the potential pathways for physical leakage or seepage. This includes all subsurface components such as wells and all other potential direct pathways that may lead to seepage of physical leakage, e.g., injection, observation of abandoned wells, mineshafts and boreholes.

9: Thorough analysis and assessment of the storage capacity

The PDD should include a thorough analysis and assessment of the storage capacity of the formation.

4. Risk & safety assessment

The modalities and procedures for CDM project activities require that the project participants shall develop a risk and safety assessment. A thorough risk assessment is therefore an integral part of any CCS CDM project activity and the assessment should include all relevant above-ground and subsurface installations and the storage site. The risk and safety assessment and the analysis will form the basis for determining the project boundary and for developing the monitoring plan.

Assessment of the risks and safety of a project should be based on international criteria and standards, like ISO31000 standard[1], and best industry practices and standards. Under the OSPAR Convention, it is developed Guidelines for Risk Assessment and Management of Storage of CO_2 Streams in Geological Formations offshore. These guidelines provide a generic guidance for CO_2 storage project activities in general, not directly related to CDM project activities. However, they cover many of the topics listed in Decision 2/CMP.5 and Decision -/CMP.6.

[1] ISO31000: Risk management – Principles and guidelines

The risk and safety assessment of the storage site should include, inter alia:

i. Containment risks:
ii. Capacity and injectivity risks:
iii. Measurement, verification, accounting and reporting risks

The project participants should document the risk and safety assessment results in full and submit this with the PDD.

During the closure phase, a final risk and safety assessment should be carried out to establish that the risk levels are acceptable before storage site is relinquished to the host country.

5. Socio-environmental impacts assessment

An assessment of the possible impacts, both positive and negative, that the project may have on the environment shall be undertaken following the existing rules and modalities of the Clean Development Mechanism.

The Social-Environment Impact Assessment should cover, inter alia, how domains surrounding the project boundary may be affected by the project, possible effects of potential physical leakage or seepage of the stored CO_2, effects potentially induced seismicity or geological or any other potential consequences for the environment (both local ecosystems and the global climate), property, public health or global effects to the climate directly attributable to the clean development project activity during and beyond the crediting period.

6. Monitoring plan

Stringent monitoring plans shall be in place and be applied during and beyond the crediting period in order to reduce the risk to the environmental integrity of carbon dioxide capture and storage in geological formations.

The modalities and procedures for CDM project activities require that the monitoring plan for a project activity provides for e.g. the collection and archiving of all relevant data necessary for estimating greenhouse gas emissions and determination of project baselines. Identification of all potential sources of increased emissions outside the project boundary that are significant and attributable to the project activity during the crediting period should also be included. A monitoring plan is to be developed by the project participants and included in the PDD. The monitoring plan should be consistent with the existing modalities and procedures for CDM as well as the requirements of IPCC 2006 GHG Inventory Guidelines, relevant parts of the IPCC Special Report as well as available best industry practices. It is important that monitoring plan encompass and incorporate all site specific issues identified during site selection and the risk and safety assessment.

Proper monitoring of the storage site is required to ensure that any seepage/physical leakage from the site will be detected, accounted for and brought under control. It is important that the monitoring plan covers the CO_2 storage and addresses any possible seepage/physical leakage pathways. These pathways would have been identified during the analysis of the storage site (see 3. Storage site selection criteria) and the risk and safety assessment (see 4. Risk & safety assessment).

Modelling is a vital part of the different stages in the development of CCS projects. The models used build on extensive experience from the petroleum industry and other industries. Monitoring technologies and methods for environmentally sound storage of CO_2 are available and in use by industry. Valuable information on adaptation of these methods and techniques to CCS CDM project activities could be drawn from existing CCS projects and ongoing research projects. This includes well-known seismic as well as gravimetric techniques.

At appropriate intervals during the project, the fate of the CO_2 plume should be monitored, verified, accounted for and reported and the risk and safety assessment updated. This will require robust baseline data and the quantification of associated uncertainty ranges for the appropriate monitoring technologies to be established prior to CO_2 injection and a risk and safety assessment performed to provide assurance that the maximum risk during operation is acceptable. During the closure phase, a final risk and safety assessment should be carried out to establish that the risk levels are acceptable before storage site is relinquished to the host country.

The monitoring should go far beyond the crediting period (10 years or 7 years, with the possibility to be renewed twice). The responsibility for monitoring in the post crediting, post closure period, must be clearly defined and agreed between the project participants and the host country and this must be clearly addressed in the PDD (see 8. Liability).

7. Project boundary

According to the modalities and procedures for the CDM, "the project boundary shall encompass all anthropogenic emissions by sources of greenhouse gases under the control of the project participants that are significant and reasonably attributable to the CDM project activity".

The project boundary of the CCS CDM project activity should comprise of any potential greenhouse gas emissions resulting from the three separate processes; capture, transportation, and injection/storage of CO_2. This includes, inter alia, fugitive emissions, indirect emissions resulting from the use of electrical and other energy sources required for the project and potential seepage.

As physical and geochemical properties of geological formations may vary, the definition of project boundary should be project specific to make sure all potential project-related emissions are accounted for. Items that should be properly addressed in the project boundary include:

i. The above ground components, e.g., the installation where the CO_2 is generated, the capture facility, any additional CO_2 treatment facilities, the compression facility, the transportation equipment and booster stations along a pipeline or offloading facilities in the case of transportation by ship, any reception facilities or holding tanks at the injection site, and the injection facility. These components present similar technical elements to any CDM project. Emissions from these components can therefore be calculated using techniques and approaches applied in other CDM project activities.

ii. Subsurface components and all other potential direct pathways that may lead to seepage of physical leakage, e.g., injection wells, observation of abandoned wells, mineshafts and boreholes. These potential seepage pathways will need to be monitored as part of the overall project monitoring plan.

iii. The formation where the CO_2 is stored. Site characterisation and storage performance assessment studies carried out in advance of CO_2 injection operations will define the boundary for the storage site.
iv. The geology surrounding the storage site such as the cap-rock or spill points at the lateral edges of a geological structural trap.

Cross-border projects

Cross-border projects are allowed under the CDM and do not pose any additional challenges from a project boundary perspective, with respect to CO_2 transported from one country to be stored in another or where two(or more) countries share storage sites. It does, however, pose the question of determining liabilities in the post-closure post crediting period of the project, and would entail resolving legal responsibility and liabilities for the involved countries.

8. Liability

The emission reductions resulting from each project activity under the CDM shall, according to Kyoto Protocol, contribute to real, measurable and long-term benefits to the mitigation of climate change. As stated earlier, it is vital for Norway that CERs from CCS projects are considered as solid as CERs from other CDM emission reduction projects.

On this basis we see a need for clearly defined liability for the short, medium and long-term liability of stored CO_2.

In the PDD, the participants should demonstrate procedures for the proper and safe sealing and abandonment of the storage. It should also demonstrate all available evidence indicates that the stored CO_2 will be completely and permanently contained within the formation.

Furthermore the PDD should show how binding regulatory provisions will be in place to permit, regulate and control the CCS project, including in the post closure post crediting period. Thus the PDD must clearly define: short-term, medium-term, and long-term liabilities; accounts for any seepage and the remediation required in the different periods.

The short to medium-term liability should as a rule rest with the project participants. Post-closure/ medium-term and long-term liability should be agreed upon between the host country and the project participants.

The EB should ensure that the issue of liability is appropriately addressed in the PDD.

Cross-border projects and liability

If cross-border projects are to be registered in the CDM, the PDD shall include clearly defined and agreed liability between the involved host countries. The PDD shall also be approved by all the involved host countries' DNAs.

9. Reporting, accounting and verification

Norway recommends using existing CDM rules and modalities where appropriate. .

Capture, transportation and injection processes will require additional energy. Any emissions due to this should be accounted for and be subtracted from the amount of CO_2 stored.

The total amount of CO_2, including emissions from the additional energy consumption necessary to operate the capture, transportation and injection processes, can be estimated by using the methods and guidance in the IPCC 2006 GHG Inventory Guidelines. The capture processes are well defined in space and time, and their emissions (from additional energy use, fugitives etc.) are covered by the Guidelines. For estimation purposes, the reduced CO_2 emissions should be determined by measuring the amount of CO_2 stored and deducting it from the total amount of CO_2 produced.

The location of guidelines for compiling inventories of emissions from the CO_2 capture and compression system depends on the nature of the CO_2 source:

- Stationary combustion systems (mainly electric power and heat production plants): Volume 2, Chapter 2, Section 2.3.4.
- Natural gas processing plants: Volume 2, Section 4.2.1.
- Hydrogen production plants: Volume 2, Section 4.2.1.
- Capture from other industrial processes: Volume 3 (IPPU) Chapter 1, Section 1.2.2, and specifically for
  (i) Cement manufacture: IPPU Volume, Section 2.2
  (ii) Methanol manufacture: IPPU Volume, Section 3.9
  (iii) Ammonia production: IPPU Volume, Section 3.2
  (iv) Iron and steel manufacture: IPPU Volume section 4.2

Volume 2, Chapter 5 covers carbon dioxide transport, injection and geological storage.

10. The potential for perverse outcomes

There have been concerns raised about the possibility that emissions reductions from CCS activities would overflow the global CDM market. To our knowledge this argument is not based on factual figures as far as the near and mid-term is concerned.

It is unlikely that potential CCS-projects will have a large crowding-out effect on other CDM project activities, due to the long lead times for implementation and relative high technology costs. The potential market effect of any specific technology or project activity in subsequent commitment periods under the Kyoto Protocol will depend on the ambition level and content of these commitments, and should not have any impact on rules and modalities for CDM projects.

11. International regulations, guidelines etc.

Other conventions have addressed issues and adopted guidelines relevant to the international regulation of the application of carbon dioxide capture and storage, including risk assessment, environmental impact assessment and legal aspects: e.g. the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter and the OSPAR Convention.

Under the OSPAR Convention Guidelines for Risk Assessment and Management of Storage of CO_2 Streams in Geological Formations have been developed. These guidelines provide a generic guidance for offshore CO_2 storage activities in general, not directly related to CDM project activities. However, they cover many of the topics listed in Decision 2/CMP.5 and Decision -/CMP.6.

The OSPAR Convention is the current legal instrument guiding international cooperation on the protection of the marine environment of the North-East Atlantic. Work under the Convention is managed by the OSPAR Commission, made up of representatives of the Governments of 15 Contracting Parties and the European Commission, representing the European Community. The mission of the OSPAR Convention*" is to conserve marine ecosystems and safeguard human health in the North-East Atlantic by preventing and* *eliminating pollution; by protecting the marine environment from the adverse effects of human activities; and by contributing to the sustainable use of the seas."*

In 2006, amendments to the 1996 Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1972 (London Protocol) were adopted. The amendments regulate the sequestration of CO_2 streams from CO_2 capture processes in sub-seabed geological formations, for permanent isolation, thereby creating a basis in international environmental law to regulate this practice. Guidelines on how to store CO_2 in sub-seabed geological formations were adopted by the Parties to the London Protocol in 2007. These guidelines address how to store CO_2 in a manner that meets all the requirements of the London Protocol and is safe for the marine environment, over both the short- and long-term. The Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1972, the "London Convention" for short, is one of the first global conventions to protect the marine environment from human activities and has been in force since 1975. Its objective is to promote the effective control of all sources of marine pollution and to take all practicable steps to prevent pollution of the sea by dumping of wastes and other matter. In 1996, the London Protocol was agreed to further modernise the Convention and, eventually, replace it. Under the Protocol all dumping is prohibited, except for possibly acceptable wastes on the so-called "reverse list". The Protocol entered into force on 24 March 2006.

Similarly to the Guidelines under the OSPAR Convention, the regulations and guidelines under the London Protocol do not directly apply to CDM project activities, but provide an environmentally safe framework for storage of CO_2. Offshore CCS CDM projects in countries which are Party to the London Protocol will need to follow these regulations and guidelines when they enter into force. The Parties to the Kyoto Protocol may chose to build on or use elements in the existing regulatory work developed and adopted by other Conventions.

12. Fully fungible Certified Emission Reductions

For Norway it is important that Certified Emission Reductions (CER) resulting from environmentally sound CCS project activities under the CDM be considered as solid and viable as CERs from other CDM project activities.