

Decision 10/CMP.7

Modalities and procedures for carbon dioxide capture and storage in geological formations as clean development mechanism project activities

The Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol,

Recalling the provisions of Articles 3 and 12 of the Kyoto Protocol,

Also recalling decisions 3/CMP.1, 2/CMP.5 and 7/CMP.6,

1. *Adopts* the modalities and procedures for carbon dioxide capture and storage in geological formations as clean development mechanism project activities contained in the annex to this decision;
2. *Decides* to periodically review the modalities and procedures for carbon dioxide capture and storage in geological formations as clean development mechanism project activities and that the first review shall be carried out no later than five years after the adoption of this decision, on the basis of recommendations made by the Executive Board of the clean development mechanism and by the Subsidiary Body for Implementation, and drawing on technical advice provided by the Subsidiary Body for Scientific and Technological Advice, as needed;
3. *Also decides* that any revision of the modalities and procedures contained in the annex to this decision shall not affect clean development mechanism project activities already registered in accordance with these modalities and procedures or any project activities registered in accordance with the modalities and procedures contained in the annex to decision 3/CMP.1 or the annex to decision 5/CMP.1;
4. *Agrees* to consider, at its eighth session:
 - (a) The eligibility of carbon dioxide capture and storage project activities which involve the transport of carbon dioxide from one country to another or which involve geological storage sites that are located in more than one country;
 - (b) The establishment of a global reserve of certified emission reduction units for carbon dioxide capture and storage project activities, in addition to the reserve referred to in paragraph 21(b) of the annex to this decision;
5. *Requests* the Subsidiary Body for Scientific and Technological Advice to consider, at its thirty-sixth session, provisions for the type of project activities referred to in paragraph 4(a) above, including a possible dispute resolution mechanism, and for the global reserve of certified emission reduction units referred to in paragraph 4(b) above, with a view to forwarding a draft decision on these matters for consideration by the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol at its eighth session;
6. *Invites* Parties and admitted observer organizations to submit to the secretariat, by 5 March 2012, their views on the issues referred to in paragraph 4(a) and (b) above and requests the secretariat to compile the submissions into a miscellaneous document.

Annex

Modalities and procedures for carbon dioxide capture and storage in geological formations under the clean development mechanism

A. Definitions

1. For the purpose of this annex, the definitions contained in the annex to decision 3/CMP.1 shall apply mutatis mutandis to carbon dioxide capture and storage project activities under the clean development mechanism (CDM). In addition, the following definitions shall apply:

(a) “Carbon dioxide capture and storage” (CCS) means the capture and transport of carbon dioxide from anthropogenic sources of emissions, and the injection of the captured carbon dioxide into an underground geological storage site for long-term isolation from the atmosphere;

(b) A “geological storage site” means a paired geological formation, or a series of such formations, consisting of an injection formation of relatively high porosity and permeability into which carbon dioxide can be injected, coupled with an overlying cap rock formation of low porosity and permeability and sufficient thickness which can prevent the upward movement of carbon dioxide from the storage formation;

(c) The “operational phase” means the period that begins when carbon dioxide injection commences and ends when carbon dioxide injection permanently ceases;

(d) The “closure phase” means the phase that follows the operational phase and is the period that begins when carbon dioxide injection permanently ceases and ends when the geological storage site has been closed;

(e) The “closure” of a geological storage site means the completion of the sealing of the geological storage site, including the appropriate plugging of wells relating to the geological storage site;

(f) The “post-closure phase” means the phase that follows the closure phase and is the period that begins when the geological storage site has been closed;

(g) “Seepage” is defined as a transfer of carbon dioxide from beneath the ground surface or seabed ultimately to the atmosphere or ocean;

(h) The “site development and management plan” is the documented description of how a geological storage site will be operated and managed;

(i) “History matching” means the process of comparing observed results from the monitoring and measurement of a geological storage site with the results of the predictive numerical modelling of the behaviour of carbon dioxide injected into the geological storage site, and the use of the observed results to calibrate and update numerical models and modelling results. It can involve multiple iterations;

(j) “Liability” means the legal responsibility arising from the CCS project activity or the relevant geological storage site, with the exception of the obligations arising from a net reversal of storage as set out in section K below but including all obligations related to the operation of the storage site (e.g. monitoring, remedial measures, etc.), to compensate for or remedy any significant damages, including damage to the environment, such as ecosystem damage, other material damages or personal injury;

(k) “Remedial measures” means actions and measures intended to stop or control any unintended physical leakage or seepage of carbon dioxide, to restore the integrity of a geological storage site, or to restore long-term environmental quality significantly affected by a CCS project activity;

(l) A “net reversal of storage” of carbon dioxide means that:

(i) For a verification period during the crediting period, the accumulated verified reductions in anthropogenic emissions by sources of greenhouse gases (GHGs) that have occurred as a result of a registered CDM project activity are negative (i.e. the seepage from the geological storage site of the CCS project activity exceeds the remainder of the emission reductions achieved by the CCS project activity);

(ii) For a verification period after the end of the last crediting period, seepage has occurred from the geological storage site of the CCS project activity.

B. Role of the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol

2. The provisions of section B of the modalities and procedures for a clean development mechanism, contained in the annex to decision 3/CMP.1 (hereinafter referred to as the CDM modalities and procedures), shall apply mutatis mutandis to CCS project activities under the CDM.

C. Executive Board

3. The provisions of section C of the CDM modalities and procedures shall apply mutatis mutandis to CCS project activities under the CDM, with the exception of the provisions of paragraph 5(e) on recommendations to the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol (CMP) relating to simplified modalities, procedures and definitions for small-scale project activities.

4. In addition, the Executive Board of the clean development mechanism (hereinafter referred to as the Executive Board) shall adopt relevant documents as defined in the hierarchy of documents of the Executive Board, drawing on technical and legal expertise and striving to ensure a high degree of conservativeness, including, inter alia, with regard to:

(a) A project design document for CCS project activities, taking into account appendix B to the annex to decision 3/CMP.1;

(b) The selection and characterization of geological storage sites, as specified in appendix B to this annex;

(c) The risk and safety assessment, as referred to in paragraph 10(c) below and specified in appendix B to this annex;

(d) The environmental and socio-economic impact assessments, as referred to in paragraph 10(d) below;

(e) Monitoring requirements, as specified in appendix B to this annex;

(f) Requirements for financial provision, as referred to in paragraph 10(g) below and specified in appendix B to this annex;

(g) The site development and management plan, as specified in appendix B to this annex;

(h) Specific criteria tailored for the accreditation of designated operational entities (DOEs) that guarantee a high level of their expertise, competencies and independence.

D. Accreditation and designation of operational entities

5. The provisions of section D of the CDM modalities and procedures shall apply *mutatis mutandis* to CCS project activities under the CDM. In addition, DOEs responsible for validation and verification of CCS project activities must have all appropriate experience relevant to CCS, as required by the Executive Board.

E. Designated operational entities

6. The provisions of section E of the CDM modalities and procedures shall apply *mutatis mutandis* to CCS project activities under the CDM.

F. Participation requirements

7. The provisions of section F of the CDM modalities and procedures shall apply *mutatis mutandis* to CCS project activities under the CDM. In addition, the provisions of paragraph 8 below shall apply to CCS project activities.

8. A Party not included in Annex I to the Convention may only host a CCS project activity under the CDM if it has submitted an expression of its agreement to the UNFCCC secretariat to allow the implementation of CCS project activities in its territory and provided that it has established laws or regulations which:

(a) Set procedures that include provisions for the appropriate selection, characterization and development of geological storage sites, recognizing the project requirements for CCS project activities under the CDM set out in appendix B to this annex;

(b) Define means by which rights to store carbon dioxide in, and gain access to, subsurface pore space can be conferred to project participants;

(c) Provide for timely and effective redress for affected entities, individuals and communities for any significant damages, such as environmental damage, including damage to ecosystems, other material damages or personal injury, caused by the project activity, including in the post-closure phase;

(d) Provide for timely and effective remedial measures to stop or control any unintended seepage of carbon dioxide, to restore the integrity of a geological storage site, and to restore long-term environmental quality significantly affected by a CCS project activity;

(e) Establish means for addressing liability arrangements for carbon dioxide geological storage sites, taking into account the provisions set out in paragraphs 22 to 25 of appendix B to this annex;

(f) For a host Party that accepts the obligation to address a net reversal of storage in the situation referred to in paragraph 26 below, establish measures to fulfil such an obligation.

G. Validation and registration

9. The provisions of section G of the CDM modalities and procedures shall apply *mutatis mutandis* to CCS project activities under the CDM, with the exception of paragraph 37(c). In addition, the provisions of paragraphs 10 to 13 below shall apply to CCS project activities.

10. In addition to the requirements contained in paragraph 37 of the CDM modalities and procedures, the DOE shall also confirm that the following requirements are met:

- (a) The participation requirements set out in paragraph 8 above are satisfied;
- (b) The geological storage site has been characterized and selected in accordance with paragraphs 1 to 5 of appendix B to this annex and the conditions set out in paragraph 1 to 3 of appendix B to this annex are fulfilled;
- (c) A risk and safety assessment has been carried out, in accordance with the laws and regulations of the host Party and the provisions set out in paragraphs 6 to 9 of appendix B to this annex;
- (d) Environmental and socio-economic impact assessments have been carried out in accordance with the laws and regulations of the host Party and in accordance with the provisions set out in paragraphs 26 to 29 of appendix B to this annex, including with regard to potential transboundary impacts, drawing upon the risk and safety assessment referred to in paragraph 10(c) above. Such assessments shall also include a detailed description of the planned monitoring and remedial measures to address any environmental and socio-economic impacts identified, and be compiled in accordance with procedures as required by the host Party;
- (e) The results of the assessments referred to in paragraphs 10(c) and (d) above confirm the technical and environmental viability of the proposed CCS project activity;
- (f) Provisions for liability have been agreed in accordance with the laws and regulations of the host Party and the provisions set out in paragraphs 22 to 25 of appendix B to this annex;
- (g) Financial provisions have been put in place by the project participants in accordance with the requirements set out in paragraphs 18 to 21 of appendix B to this annex;
- (h) The provisions in the project design document for monitoring, including the monitoring plan, are in accordance with this annex and appendix B to this annex;
- (i) The project participants have provided a description and analysis of the environmental conditions in the area of the geological storage site prior to any storage of carbon dioxide, including a description of the following:
 - (i) The hydrology, aquifer and groundwater properties, such as acidity and dissolved gases;
 - (ii) Where appropriate, the soils and soil gas properties, such as a carbon dioxide isotope analysis and carbon dioxide flux rate;
 - (iii) The ecosystems and the possible presence of rare or endangered or sensitive species and their habitats;
 - (iv) Climatic data;

(j) The proposed project activity conforms to all other requirements for CCS project activities set out in the present decision and other relevant decisions adopted by the CMP or the Executive Board.

11. In addition to the requirements contained in paragraph 40 of the CDM modalities and procedures, the DOE shall, prior to the submission of the validation report to the Executive Board, have received from the project participants written confirmation by the designated national authority of the host Party of the following:

(a) That the right to store carbon dioxide in, and gain access to, the proposed geological storage site has been conferred to the relevant project participants;

(b) That the host Party agrees to the financial provision, in accordance with paragraphs 18 to 21 of appendix B to this annex, described in the project design document;

(c) That the host Party accepts the allocation of liability as proposed in the project design document and the transfer of liability referred to in paragraph 25 of appendix B to this annex;

(d) Whether or not the host Party accepts the obligation to address a net reversal of storage in the situation referred to in paragraph 26 below.

12. The project boundary of a CCS project activity shall include all above-ground components, including, where applicable, the following:

(a) The installation where the carbon dioxide is captured;

(b) Any treatment facilities;

(c) Transportation equipment, including pipelines and booster stations along a pipeline, or offloading facilities in the case of transportation by ship, rail or road tanker;

(d) Any reception facilities or holding tanks at the injection site;

(e) The injection facility;

(f) Subsurface components, including the geological storage site and all potential sources of seepage, as determined during the characterization and selection of the geological storage site, carried out in accordance with appendix B to this annex.

13. The project boundary shall also encompass the vertical and lateral limits of the carbon dioxide geological storage site that are expected when the carbon dioxide plume stabilizes over the long term during the closure phase and the post-closure phase.

H. Monitoring

14. The provisions of section H of the CDM modalities and procedures shall apply *mutatis mutandis* to CCS project activities under the CDM. In addition, the provisions for monitoring set out in appendix B to this annex shall apply to CCS project activities.

I. Verification and certification

15. The provisions of section I of the CDM modalities and procedures shall apply *mutatis mutandis* to CCS project activities under the CDM. In addition, the provisions of paragraph 16 below shall apply to CCS project activities.

16. In addition to the provisions contained in paragraph 62 of the CDM modalities and procedures, the DOE contracted by the project participants to perform the verification shall:

- (a) Determine whether monitoring was conducted in accordance with the monitoring plan and the provisions for monitoring set out in paragraphs 10 to 17 of appendix B to this annex;
- (b) Determine whether the site development and management plan is being adhered to;
- (c) Determine whether significant deviations were observed during history matching and whether, in such a case, a recharacterization of the geological storage site, an update of the risk and safety assessment, an update of the environmental and socio-economic impact assessments, a revision to the project boundary, and a revision to the monitoring plan have been conducted, as necessary, in accordance with the provisions set out in appendix B to this annex;
- (d) Determine whether seepage occurred from the geological storage site of the CCS project activity during the verification period;
- (e) In the case that such seepage occurred:
 - (i) Determine whether the remedial measures and plans described in the risk and safety assessment were implemented and effective;
 - (ii) Determine whether a net reversal of storage occurred as a result of the seepage;
- (f) In the case that a net reversal of storage occurred, quantify the amount of the net reversal of storage that occurred as a result of the seepage;
- (g) Determine whether there have been any unintentional transboundary effects;
- (h) Where applicable, determine whether the geological storage site has been successfully closed.

17. The initial verification and certification of a CCS project activity may be undertaken at a time selected by the project participants. Subsequent verification and certification reports shall be submitted to the Executive Board not later than five years after the end of the previous verification period. Verification and certification shall continue beyond the end of the last crediting period of the proposed CCS project activity and shall only cease after the monitoring of the geological storage site has been terminated in accordance with the conditions for the termination of monitoring, as set out in paragraph 16 of appendix B to this annex.

J. Issuance of certified emission reductions

18. The provisions of paragraph 65 of the CDM modalities and procedures shall apply *mutatis mutandis* to CCS project activities under the CDM. In addition, the provisions in paragraphs 19 to 23 below shall apply to CCS project activities.

19. A certification report submitted for a verification period during the crediting period shall constitute a request to the Executive Board for issuance of certified emission reductions (CERs) equal to the verified reductions in anthropogenic emissions by sources of GHGs that have occurred as a result of the registered CCS project activity.

20. A certification report submitted for a verification period after the end of the last crediting period shall not constitute a request for issuance but shall provide, where applicable, information on the amount of any net reversal of storage that occurred during the verification period as a result of seepage from the geological storage site of a CCS

project activity, in accordance with these modalities and procedures and any decisions of the Executive Board.

21. Upon submission of a certification report for a verification period during the crediting period and upon finalization of the consideration of the certification report by the Executive Board, the CDM Registry Administrator, working under the authority of the Executive Board, shall, promptly, issue the specified quantity of CERs into the pending account of the Executive Board in the CDM registry, in accordance with appendix D to the annex to decision 3/CMP.1. Upon such issuance, the CDM Registry Administrator shall promptly:

(a) Forward the quantity of CERs corresponding to the share of proceeds to cover administrative expenses and to assist in meeting the costs of adaptation, respectively, in accordance with Article 12, paragraph 8, of the Kyoto Protocol, to the appropriate accounts in the CDM registry for the management of the share of proceeds;

(b) Forward 5 per cent of the CERs issued to a reserve account of the CDM registry, established for the CCS project activity for the purpose of accounting for any net reversal of storage, as referred to in paragraph 3(a) of appendix A to this annex;

(c) Forward the remaining CERs to the registry accounts of the Parties and project participants involved, in accordance with their request.

22. The last certification report, submitted after the monitoring of the geological storage site has been terminated in accordance with the conditions for the termination of monitoring, as set out in paragraph 16 of appendix B to this annex, may constitute a request to forward any remaining CERs in the reserve account established for the purpose of accounting for any net reversal of storage to the registry accounts of the Parties and project participants involved.

23. Upon submission of the last certification report, referred to in paragraph 22 above, and upon finalization of the consideration of the certification report by the Executive Board, the CDM Registry Administrator shall, promptly, forward any CERs remaining in the reserve account established for the purpose of accounting for any net reversal of storage to the registry accounts of the Parties and project participants involved, in accordance with their request.

K. Addressing non-permanence

24. Where a verification report determines that a net reversal of storage occurred during the verification period as a result of seepage from the geological storage site of a CCS project activity, the Executive Board shall:

(a) Notify the CDM Registry Administrator to cancel, up to the amount of the net reversal of storage, the CERs issued for the CCS project activity held in the CDM registry:

(i) Firstly, from the reserve account established for the purpose of accounting for any net reversal of storage, as referred to in paragraph 3(a) of appendix A to this annex;

(ii) Secondly, from the pending account;

(iii) Finally, from the holding accounts of the project participants, proportional to the amount of CERs for the CCS project activity held in each holding account;

(b) Determine any outstanding amount of the net reversal of storage for which no units were cancelled under paragraph 24(a) above and, where such an amount is

outstanding, request the project participants to transfer, within 30 days after the notification, an amount of assigned amount units (AAUs), CERs, emission reductions units (ERUs) or removal units (RMUs) equivalent to the outstanding amount to a cancellation account of the CDM registry established for this purpose, as referred to in paragraph 3(b) of appendix A to this annex, or a cancellation account of the national registry of any Party.

25. Where a verification report is not submitted within the time frame specified in paragraph 17 above, the Executive Board shall forthwith notify the project participants to provide the outstanding verification report. If the verification report is not received within six months of the receipt of the notification by the project participants, the Executive Board shall:

(a) Notify the CDM Registry Administrator to cancel all CERs that were issued for the CCS project activity and are being held in the CDM registry;

(b) Subsequently request the project participants to cancel, within one year after the notification, an amount of AAUs, CERs, ERUs or RMUs equivalent to the amount of CERs issued from the start of the CCS project activity:

(i) Minus any AAUs, CERs, ERUs or RMUs that were transferred to a cancellation account for the purpose of compensating for a net reversal of storage, prior to the notification of the CDM Registry Administrator referred to in paragraph 25(a) above;

(ii) Minus any CERs issued for the CCS project activity that were cancelled in accordance with paragraph 25(a) above.

26. If the project participants do not comply, fully or partially, with the requirements set out in paragraphs 24 or 25(b) above, the outstanding amount of units shall be transferred to a cancellation account of the national registry of a Party included in Annex I to the Convention (Annex I Party) or the CDM registry, within one year of the notification by the Executive Board, by:

(a) The host Party, if the host Party has accepted the obligation to address a net reversal of storage in such a situation in its letter of approval;

(b) The Annex I Parties which hold CERs issued for the CCS project activity in accounts of their national registries, if the host Party has not accepted the obligation to address a net reversal of storage in such a situation in its letter of approval.

27. If the host Party has accepted the obligation to address a net reversal of storage in such a situation in its letter of approval, the Executive Board shall determine the outstanding amount of units that must be cancelled and notify the host Party concerned of the requirement for cancellation. To meet this requirement, the host Party shall transfer an amount of AAUs, CERs, ERUs or RMUs equivalent to the outstanding amount to the cancellation account established for this purpose in the CDM registry or a cancellation account of the national registry of any Party.

28. If the host Party has not accepted the obligation to address a net reversal of storage in such a situation in its letter of approval, the Executive Board shall:

(a) Determine the outstanding amount of units that must be cancelled;

(b) Request the international transaction log administrator to identify the quantity of CERs issued for the CCS project activity held in each national registry, distinguishing between units in holding accounts and other accounts, for the current and previous commitment periods;

(c) Immediately notify the international transaction log that, in accordance with these modalities and procedures, the CERs identified as being in holding accounts are

ineligible for transfers other than for the purpose of the requirement set out in paragraph 26 above. When the requirement for cancellation, as set out in paragraph 26 above, has been satisfied, the CERs issued for the CCS project activity in holding accounts shall be again eligible for transfer;

(d) Determine the outstanding amount of units that must be cancelled by each Annex I Party proportionally, by dividing the amount identified in paragraph 28(b) above by the total outstanding amount;

(e) Notify each Annex I Party which holds CERs issued for the CCS project activity in accounts of its national registry of the requirement for cancellation, as determined in paragraph 28(d) above. To meet this requirement, the relevant Annex I Parties shall transfer an amount of AAUs, CERs, ERUs or RMUs equivalent to the outstanding amount to the cancellation account established for this purpose in the CDM registry or a cancellation account of their national registries.

Appendix A

Additional requirements for the clean development mechanism registry to address carbon dioxide capture and storage project activities under the clean development mechanism

1. The provisions of appendix D to the modalities and procedures for a clean development mechanism, contained in the annex to decision 3/CMP.1 (hereinafter referred to as the CDM modalities and procedures), shall apply mutatis mutandis to carbon dioxide capture and storage (CCS) project activities under the clean development mechanism (CDM). In addition, the provisions of this appendix shall apply to CCS project activities.

2. The CDM registry, established and maintained by the Executive Board of the CDM, shall be used to ensure the accurate accounting of the issuance, holding, transfer, acquisition and cancellation of certified emission reductions (CERs) from CCS project activities under the CDM.

3. In addition to the registry accounts specified in paragraph 3 of appendix D to the CDM modalities and procedures, the CDM registry shall have:

(a) A reserve account for each CCS project activity, where the CDM Registry Administrator holds CERs for the purpose of accounting for any net reversal of storage;

(b) A cancellation account to which CERs from CCS project activities are transferred to account for any net reversal of storage, in accordance with the provisions set out in the annex above.

4. Upon the request of the project participants, the CDM Registry Administrator shall, after the end of a commitment period, carry over any CERs held in a reserve account for a CCS project activity to the subsequent commitment period.

Appendix B

Additional requirements for carbon dioxide capture and storage project activities under the clean development mechanism

1. Selection and characterization of the geological storage site

1. Geological storage sites shall only be used to store carbon dioxide as project activities under the clean development mechanism (CDM) if, under the proposed conditions of use, there is no significant risk of seepage, no significant environmental or health risks exist, and the geological storage site will comply with all laws and regulations of the host Party.

2. The geological storage site is not located in international waters.

3. The following shall be evaluated when determining whether geological storage sites shall be used to store carbon dioxide as project activities under the CDM consistent with paragraph 1 of this appendix:

(a) All available evidence, such as data, analysis and history matching, indicates that the injected carbon dioxide will be completely and permanently stored such that, under the proposed or actual conditions of use, no significant risk of seepage or risk to human health or the environment exists;

(b) Whether the geological storage site is suitable for potable water supply.

4. For the purpose of determining whether the requirements set out in paragraph 1 to 3 above are met, the project participants shall take the following steps to characterize the proposed geological storage site:

(a) Step 1: data and information collection, compilation and evaluation. This step shall involve the collection of sufficient data and information to characterize the geological storage site and determine potential seepage pathways. The collected data and information shall be evaluated in order to make a preliminary assessment of the site's storage capacity and to assess the viability of monitoring. The data and information shall be evaluated for its quality and, where required, new data shall be collected;

(b) Step 2: characterization of the geological storage site architecture and surrounding domains. This step shall involve the assessment of known and inferred structures within the injection formation(s) and cap rock formation(s) that would act as barriers to, or facilitators of, the migration of injected carbon dioxide. This step shall involve the compilation of (a) numerical three-dimensional static earth model(s) of the geological storage site. The uncertainty associated with key parameters used to build the model shall be assessed. The model shall be used to characterise, inter alia:

(i) The structure of the geological containment;

(ii) All relevant geological properties of the injection formation(s);

(iii) The cap rock formation(s) and overburden;

(iv) The fracture system;

(v) The areal and vertical extent of the geological storage site (e.g. the injection formation, the cap rock formation, overburden, secondary containment zones and surrounding domains);

(vi) The storage capacity in the injection formation(s);

(vii) The fluid distribution and physical properties;

(viii) Other relevant characteristics;

(c) Step 3: characterization of dynamic behaviour, sensitivity characterization and risk assessment. This step shall involve an assessment of how the injected carbon dioxide can be expected to behave within the geological storage site architecture and surrounding domains, with a particular focus on the risk of seepage. This step shall utilize numerical dynamic modelling of the injected carbon dioxide using the static model developed in step 2 above to assess coupled processes (i.e. the interaction between each single process in the model), and, where possible, reactive processes (e.g. the interaction of injected carbon dioxide with in situ minerals in the numerical model), and short- and long-term simulations. Such numerical modelling shall be used to provide insight into the pressure and extent of carbon dioxide in the geological storage site over time, the risk of fracturing the cap rock formation(s) and the risk of seepage. Multiple simulations shall be conducted to identify the sensitivity of the assessments to assumptions made. The simulations carried out in this step shall form the basis for risk and safety assessments, detailed in paragraphs 6 to 9 below;

(d) Step 4: establishment of a site development and management plan. Drawing on steps 1–3 above, a site development and management plan shall be established. The plan shall address the proposed conditions of use for the geological storage site and include, inter alia, descriptions of:

- (i) The preparation of the site;
- (ii) Well construction, such as materials and techniques used, and the location, trajectory and depth of the well;
- (iii) Injection rates and the maximum allowable near-wellbore pressure;
- (iv) Operating and maintenance programmes and protocols;
- (v) The timing and management of the closure phase of the proposed carbon dioxide capture and storage (CCS) project, including site closure and related activities.

5. A wide range of data and information shall be used in performing the characterization and selection of the geological storage site, including, inter alia:

(a) Geological information, such as descriptions of the overburden and cap rock formation(s) and injection formation(s), locations of mapped faults, subsurface well and wellbore information, permeability and porosity, which are important in determining the injectivity of the injection formation, and the cap rock formation containment capacity, and information about regional tectonics, including the stress field and historical seismic activity;

(b) Geophysical information, such as the thickness and lateral extent of the storage and cap rock formation(s), pressure, temperature, the existence of faults, and reservoir heterogeneity. Sources of data may include, inter alia, well logs, sonic logs and seismic surveys;

(c) Geomechanical information, such as the stress state and the rock fracture pressure within the injection formation(s) and the cap rock formation(s). Sources of data include borehole data, such as breakouts inferred from caliper and televiwer logs, minifrac results, information about anisotropy within the reservoir, and mud loss events;

(d) Geochemical information, such as information on rock and fluid properties and mineralogy. Fluid properties, such as the brine salinity, should also be used to determine dissolution trapping rates;

(e) Hydrogeological information, such as aquifer characteristics and aquifer flow direction and rates within the geological storage site, the overburden and surrounding domains.

2. Risk and safety assessment

6. A comprehensive and thorough risk and safety assessment shall be carried out in order to assess the integrity of the geological storage site and potential impacts on human health and ecosystems in proximity to the proposed CCS project activity. The risk and safety assessment shall also be used to inform environmental and socio-economic impact assessments.

7. The risk and safety assessment shall consider the following:

(a) Specific risks associated with containment failure resulting in emissions of greenhouse gases from above-ground installations and seepage from subsurface installations, and the potential effects on, inter alia:

- (i) The contamination of underground sources of drinking water;
- (ii) The chemical properties of seawater;
- (iii) Human health and ecosystems (e.g. as a result of carbon dioxide accumulations at dangerous levels in non-turbulent air);

(b) The risk of continuous slow seepage from a geological storage site. This type of event can arise due to, inter alia:

- (i) Seepage along (an) injection well(s) or abandoned well(s);
- (ii) Seepage along a fault or fracture;
- (iii) Seepage through the cap rock formation;

(c) The risk of sudden mass release of carbon dioxide from surface CCS installations, for example due to pipeline rupture.

8. The risk and safety assessment shall:

(a) Cover the full chain of carbon CCS, including surrounding environments;

(b) Provide assurance of safe operational integrity regarding the containment of carbon dioxide, based on site-specific information about the geological storage site, potential seepage pathways, and secondary effects of storing carbon dioxide in the geological storage site, such as brine migration;

(c) Be used to determine operational data for the application of the site development and management plan, such as to set the appropriate maximums of injection pressure that will not compromise the confining cap rock formation(s) and the overburden of the geological storage site;

(d) Take account of the effects of potential induced seismicity or other geological impacts, as well as any other potential consequences for the environment, including on local ecosystems, property and public health, and global environmental effects on the climate directly attributable to the CCS project activity, including effects due to seepage;

(e) Be used to help prioritize locations and approaches for enhanced monitoring activities;

(f) Provide a basis for remedial measures, including plans for responses that can stop or control any unintended emissions from surface CCS installations and seepage of

carbon dioxide, restore the integrity of a geological storage site, and restore long-term environmental quality significantly affected by a CCS project activity. Such measures and plans shall accompany monitoring plans;

(g) Include a communication plan.

9. In order to assess the potential risks of carbon dioxide capture, transportation and storage in a geological storage site, the project participants shall take the following steps:

(a) Step 1: hazard characterization. This shall include an analysis the following:

(i) Potential hazards resulting from the capture, transportation and injection of carbon dioxide;

(ii) Potential seepage pathways from the geological storage site;

(iii) The magnitude of potential seepage for identified potential seepage pathways;

(iv) Critical parameters affecting potential seepage, such as the maximums of injection formation pressure, injection rates and temperature;

(v) The sensitivity to various assumptions made during numerical modelling;

(vi) Any other factors which could pose a hazard to human health and the environment;

(b) Step 2: exposure assessment. This shall be based on the characteristics of surrounding populations and ecosystems, the potential fate and behaviour of any seeped carbon dioxide, and other factors;

(c) Step 3: effects assessment. This shall be based on the sensitivity of species, communities or habitats linked to potential seepage events identified during the hazard characterization and the effects of elevated carbon dioxide concentrations in the atmosphere, biosphere and hydrosphere;

(d) Step 4: risk characterization. This shall comprise an assessment of the safety and integrity of the geological storage site in the short-, medium- and long-term, including an assessment of the risk of seepage under the proposed conditions of use set out in the site development and management plan;

(e) Step 5: contingency plan for large incidents, including seepage. This shall comprise all the necessary plans to be put in place in case of large incidents, including availability of trained personnel, materials and equipment and financial means to mitigate adverse impacts of the incident and teams prepared to act as swiftly as possible.

3. Monitoring

10. Monitoring of CCS project activities under the CDM shall be undertaken to meet the following objectives:

(a) To provide assurance of the environmental integrity and safety of the geological storage site;

(b) To confirm that the injected carbon dioxide is contained within the geological storage site and within the project boundary;

(c) To ensure that injected carbon dioxide is behaving as predicted in order to minimize the risk of any seepage or other adverse impacts;

(d) To ensure that good site management is taking place, taking account of the proposed conditions of use set out in the site development and management plan, established in accordance with paragraph 4(d) above;

(e) To detect and estimate the flux rate and total mass of carbon dioxide from any seepage;

(f) To determine whether timely and appropriate remedial measures have been carried out in the event of seepage;

(g) To determine the reductions in anthropogenic emissions by sources of greenhouse gases that have occurred as a result of the registered CCS project activity.

11. In order to meet the objectives outlined in paragraph 10 above, the monitoring plan for the proposed CCS project activity shall, in addition to the requirements set out in paragraph 53 of the modalities and procedures for a CDM, contained in the annex to decision 3/CMP.1 (hereinafter referred to as the CDM modalities and procedures), during the operational phase, closure phase and post-closure phase:

(a) Reflect the principles and criteria of international good practice for the monitoring of geological storage sites and consider the range of technologies described in the relevant sections of the Intergovernmental Panel on Climate Change (IPCC) *2006 IPCC Guidelines for National Greenhouse Gas Inventories* and other good practice guidance;

(b) Transparently specify which parameters and information will be monitored and collected, and the location and frequency of application of different monitoring techniques during the operational phase, closure phase and post-closure phase;

(c) Provide for specific techniques and methods that can:

(i) Detect and estimate the quantity of the carbon dioxide stored in the geological storage site;

(ii) Detect potential seepage via pathways in the cap rock formation(s) and in the overburden and surrounding domains in the geological storage site;

(iii) Estimate the flux rate and total mass of carbon dioxide from any seepage;

(d) Include provisions for history matching, by using the monitoring results to calibrate and update the numerical models that were used to characterize the geological storage site;

(e) Provide for measurement of the carbon dioxide stream and composition, including impurities, at various points in the carbon dioxide capture, transportation and storage chain, including at the point(s) of injection into the geological storage site, at an appropriate frequency;

(f) Provide for measurement of the temperature and pressure at the top and bottom of the injection well(s) and observation well(s), at an appropriate frequency;

(g) Provide for the monitoring and measurement of various geological, geochemical and geomechanical parameters, such as fluid pressures, displaced fluid characteristics, fluxes and microseismicity, at an appropriate frequency;

(h) Provide for the monitoring and measurement of relevant parameters in the overburden and surrounding domains of the geological storage site, such as the monitoring of groundwater properties, soil gas measurements and measurements of the surface concentrations of carbon dioxide in the air, which shall be calibrated to detect signs of seepage, at an appropriate frequency;

(i) Provide for the detection of corrosion or degradation of the transport and injection facilities;

(j) Provide for an assessment of the effectiveness of any remedial measures taken in the event of seepage.

12. The project participants shall, for each verification period, carry out history matching and, where necessary, update the numerical models used to characterize the geological storage site by conducting new simulations using the monitored data and information. The numerical models shall be adjusted in the event of significant deviations between observed and predicted behaviour.

13. Where significant deviations are observed during history matching or when requesting a renewal of the crediting period, the project participants shall, as appropriate:

(a) Recharacterize the geological storage site, in accordance with paragraphs 1 to 5 above;

(b) Revise the project boundary;

(c) Update the risk and safety assessment, in accordance with paragraphs 6 to 9 above;

(d) Update the environmental and socio-economic impact assessments, referred to in paragraph 10(d) of the annex above;

(e) Revise the monitoring plan, in order to improve the accuracy and/or completeness of data and information, taking into account observed deviations determined during history matching, changes to the project boundary, changes to the risk and safety assessment, changes to the environmental and socio-economic impact assessments, new scientific knowledge and improvements in the best available technology;

(f) Update the site development and management plan, taking account of the results of the activities described in paragraph 13(a–e) above, where appropriate.

14. Where the information prepared in accordance with paragraph 13 above indicates that the geological storage site no longer meets the requirements set out in paragraphs 1 to 3 above, the issuance of certified emission reduction units (CERs) shall cease.

15. Any seepage that occurs during the crediting period(s) of a CCS project activity shall be accounted for as project or leakage emissions in the calculation of the monitored reductions in anthropogenic emissions by sources of greenhouse gases that have occurred as a result of the registered CDM project activity. Any seepage that occurs after the end of the last crediting period shall be quantified and reported in monitoring reports.

16. The monitoring of the geological storage site shall:

(a) Begin before injection activities commence, to ensure adequate time for the collection of any required baseline data;

(b) Be conducted at an appropriate frequency during and beyond the crediting period(s) of the proposed project activity;

(c) Not be terminated earlier than 20 years after the end of the last crediting period of the CDM project activity or after the issuance of CERs has ceased, whichever occurs first;

(d) Only be terminated if no seepage has been observed at any time in the past 10 years and if all available evidence from observations and modelling indicates that the stored carbon dioxide will be completely isolated from the atmosphere in the long term. This may be demonstrated through the following evidence:

(i) History matching confirms that there is agreement between the numerical modelling of the carbon dioxide plume distribution in the geological storage site and the monitored behaviour of the carbon dioxide plume;

(ii) Numerical modelling and observations confirm that no future seepage can be expected from the geological storage site.

17. The monitoring of the geological storage site shall be conducted by the entity or Party that is liable for the geological storage site, or by an entity that is under contractual arrangement with the liable entity or Party.

4. Requirements for financial provision

18. The project participants shall establish financial provision:

(a) To meet all obligations in accordance with the laws and regulations of the host Party arising from the establishment and operation of the proposed CCS project activity;

(b) To allow for the ongoing safe operation of the geological storage site in accordance with the laws and regulations of the host Party;

(c) To address the risk of project participant insolvency in accordance with the laws and regulations of the host Party;

(d) To offer a means of redress for affected communities and ecosystems in the event of seepage from a geological storage site of a CCS project activity in accordance with the laws and regulations of the host Party;

(e) To enable the host Party to discharge its obligations arising in connection with the transfer of liability in accordance with paragraph 11(c) of the annex above and paragraph 25 below.

19. The financial provision shall cover:

(a) The cost of ongoing monitoring, at an appropriate frequency, of the geological storage site and of verification and certification by a designated operational entity for at least 20 years after the end of the last crediting period of the CDM project activity or after the issuance of CERs has ceased, whichever occurs first;

(b) In the event of seepage, the cost associated with the obligations set out in paragraphs 24 to 28 of the annex above;

(c) The cost of any remedial measures required by laws and regulations of the host Party;

(d) Any other requirements determined by the host Party that are agreed at the time of the host Party approval and described in the project design document.

20. The type and level of the financial provision shall be described in the project design document.

21. The financial provision shall, in accordance with the laws and regulations of the host Party, be transferable to the host Party upon fulfilment of all obligations of the project participants in accordance with these modalities and procedures and the laws and regulations of the host Party or upon insolvency of the project participant.

5. Liability

22. The project participants shall clearly document in the project design document how the liability obligations arising from the proposed CCS project activity or its geological

storage site, as defined in paragraph 1(j) of the annex above, are allocated during the operational phase, closure phase and post-closure phase in accordance with this decision.

23. Relevant provisions of laws and regulations of the host Party, including those referred to in paragraph 8 of the annex above, shall apply to matters related to liability.

24. During the operational phase and any time thereafter until a transfer of liability to the host Party has been effected in accordance with paragraph 25 below, liability, as defined in paragraph 1(j) of the annex above, shall reside with the project participants.

25. A transfer of liability from the project participants to the host Party shall be effected after:

(a) The monitoring of the geological storage site has been terminated in accordance with the conditions for the termination of monitoring, as set out in paragraph 16 above;

(b) The host Party has established that the conditions set out by the designated national authority in its letter of approval, referred to in paragraph 11 of the annex above, and those set out in the relevant laws and regulations applicable to the geological storage site have been complied with.

6. Environmental and socio-economic impact assessments

26. For CCS project activities, as a minimum, the comprehensive environmental and socio-economic impact assessments shall analyse thoroughly and exhaustively air emissions (nitrogen oxides, sulphur oxides, dust, mercury, polycyclic aromatic hydrocarbons, etc.), solid waste generation, and water use associated with current CCS technologies.

27. In all cases, in conducting the environmental and socio-economic impact assessments, best available techniques will be applied in order to facilitate a high level of protection for the environment as a whole and for communities.

28. The environmental and socio-economic impact assessments shall include at least a comprehensive analysis of the environmental and socio-economic impacts.

29. The designated operational entity selected by the project participants to validate a project activity, being under a contractual arrangement with them, shall review the project design document and any supporting documentation to confirm that comments from local stakeholders have been invited, a summary of the comments received has been provided, and a report to the designated operational entity on how due account was taken of any comments has been received.

*10th plenary meeting
9 December 2011*