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Methodological issues under the Kyoto Protocol
Carbon dioxide capture and storage in geological formations as clean development mechanism project activities

Synthesis of views on technological, methodological, legal, policy and financial issues relevant to the consideration of carbon dioxide capture and storage in geological formations as project activities under the clean development mechanism

Note by the secretariat

Summary

This document has been prepared to support the consideration of carbon dioxide capture and geological storage as project activities under the clean development mechanism. In highlighting the technological, methodological, legal, policy, financial and other issues additional to those referred to in the previous synthesis of views on this subject (FCCC/SBSTA/2008/INF.1), the note synthesizes the views of Parties contained in document FCCC/SBSTA/2008/MISC.10 and of non-governmental organizations posted on the UNFCCC website.

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I. Introduction

A. Mandate

1. The Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol (CMP), by its decision 1/CMP.2, invited intergovernmental organizations (IGOs) and non-governmental organizations (NGOs) to provide to the secretariat, by 31 May 2007, information on the following issues relevant to the consideration of carbon dioxide capture and storage (CCS) in geological formations as project activities under the clean development mechanism (CDM):

(a) Long-term physical leakage (seepage) levels of risks and uncertainty;

(b) Project boundary issues (such as reservoirs in international waters or several projects using one reservoir) and projects involving more than one country (projects that cross national boundaries);

(c) Long-term responsibility for monitoring the reservoir and any remediation measures that may be necessary after the end of the crediting period;

(d) Long-term liability for storage sites;

(e) Accounting options for any long-term leakage (seepage) from reservoirs;

(f) Criteria and steps for the selection of suitable storage sites with respect to the potential for release of greenhouse gases (GHGs);

(g) Potential leakage paths and site characteristics and monitoring methodologies for physical leakage (seepage) from the storage site and related infrastructure, for example, transportation;

(h) Operation of reservoirs (for example, well-sealing and abandonment procedures), dynamics of carbon dioxide (CO_2) distribution within the reservoir and remediation issues;

(i) Any other relevant matters, including environmental impacts.

2. By the same decision, the CMP also invited Parties to make submissions to the secretariat, by 21 September 2007, on the same issues, taking into account the submissions referred to above.

3. The Subsidiary Body for Scientific and Technological Advice (SBSTA), at its twenty-seventh session, took note of and considered the submissions and requested the secretariat to prepare a synthesis report based on these, highlighting technical, methodological, legal and policy issues contained therein.[1] The synthesis report prepared in response to this request, hereinafter referred to as the "first synthesis report",[2] was considered by the SBSTA at its twenty-eighth session.

4. Furthermore, the SBSTA, at its twenty-seventh session, invited Parties, IGOs and accredited NGOs to submit to the secretariat, by 16 June 2008, their views on, and including but not limited to, technological, methodological, legal, policy and financial issues additional to those referred to in paragraph 1 above, and in particular reflecting the informal discussions that took place at SBSTA 27, highlighting the particular concerns of Parties.[3] It also requested the secretariat to prepare a synthesis

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[1] FCCC/SBSTA/2007/16, paragraph 96.
[2] FCCC/SBSTA/2008/INF.1.
[3] FCCC/SBSTA/2007/16, paragraph 97.

report based on these submissions for consideration together with the first synthesis report by the SBSTA at its twenty-ninth session.[4]

B. Scope of the note

5. This note presents a synthesis of information and views relating to the consideration of CCS in geological formations as CDM project activities, as contained in five submissions from Parties and six submissions from NGOs.[5] In some chapters the reader is requested to refer to the first synthesis report, reflecting instances where submissions referenced this material.

6. The six main chapters of this document cover the six areas to be considered by the SBSTA, namely technological, methodological, legal, policy, financial and other issues. Following an approach similar to that adopted for the first synthesis report, each chapter is further divided into sections covering the issues raised in decision 1/CMP.2 (see para. 1 above) as well as other issues raised. A section at the beginning of each chapter covers general points raised in the submissions, where considered appropriate.

7. The secretariat received submissions from five Parties: Brazil, New Zealand, Norway, Saudi Arabia and Slovenia on behalf of the European Community and its member States (as supported by Albania, Bosnia and Herzegovina, Croatia, Serbia, the former Yugoslav Republic of Macedonia, Turkey and Ukraine). Six NGOs submitted information: The Carbon Capture & Storage Association, Greenpeace International, the International Chamber of Commerce, The International Emissions Trading Association, SustainUS, and the World Coal Institute. For ease of reading, the above organizations are referred to collectively in the document as organizations.

II. Technological issues

A. Links with other chapters

8. This section should be considered in conjunction with chapter III of the first synthesis report, where technical issues based on submissions from Parties and organizations are reviewed.

9. There are inherent links between the technological issues outlined in the present chapter and in subsequent chapters of this report, in particular chapter III, because methodological approaches could relate to specific technological aspects of CCS; chapter IV, because legal approaches may be required to enforce certain technological approaches; chapter V, because levels of risk and uncertainty can be determined by specific technological aspects of CCS; and chapter VII (other issues), because capacity-building efforts could also include technical assistance.

B. General points

10. Several Parties and organizations suggested that CCS is a proven technology with several decades of experience in capture, transport, storage and monitoring of CO_2 already accumulated in the oil and gas industry in Canada, Norway and the United States of America. On the other hand, two organizations suggested that CCS has not been proven or tested at a demonstration scale (for coal-fired power plants with capture, transport and storage) or deployed at widespread, large-scale commercial levels.

11. One Party mentioned that CCS encompasses a great number of unspecified technologies which, it suggested, makes it difficult to consider it as an emission reduction technology. Two other Parties agreed that there is a range of technological options for capture, transportation and storage, and suggested that this range should be reflected when considering CDM methodologies and CDM project design documents (PDDs) for CCS.

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[4] FCCC/SBSTA/2007/16, paragraph 98.

[5] The submissions from Parties are compiled in document FCCC/SBSTA/2008/MISC.10, and the submissions from organizations are available at <http://unfccc.int/parties_and_observers/ngo/items/3689.php>.

C. Site characteristics

12. One Party and an organization provided details of the site characteristics of the Sleipner CCS operation. They reported that since 1996, the Sleipner Vest field has stored about 10 million tonnes of CO_2 in the Utsira Formation, a saline aquifer located 1,000 m below the seabed of the North Sea. In terms of geology, the Utsira Formation consists of unconsolidated sandstone and thin horizontal shale layers that spread the CO_2 laterally, capped by a seal consisting of an extensive 800 m thick shale layer. They outlined that a range of collaborative research projects have been undertaken on this project, including the Saline Aquifer CO_2 Storage (SACS)[6] and CO_2 from Capture to Storage (CASTOR)[7] projects. One Party also outlined site characteristics of the Tubåen Formation, a saline aquifer located 2,600 m below the seabed of the Barents Sea, with greater heterogeneity and generally poorer fluid transport characteristics than the Utsira Formation. This formation is currently storing about 700,000 tonnes of reservoir CO_2 separated from natural gas from the first European liquefied natural gas production plant (Snøhvit).[8] The Party indicated that the different site characteristics of Sleipner and Snøhvit enable useful contrasts and comparisons to be made in terms of reservoir performance, and a programme has been set up to monitor the behaviour of the injected CO_2.[9]

13. Another submission from an organization suggested that no experience currently exists with large-scale storage sites or the behaviour of large amounts of CO_2 injected underground.

D. Potential leakage paths

14. Two organizations suggested that leakage (seepage) remains a difficult problem, presents risks, and has not been properly addressed in developed countries to date. One outlined the lack of knowledge about the extent and rate at which leakage could occur over long periods of time, and in support, cited the Intergovernmental Panel on Climate Change (IPCC) *Special Report on Carbon Dioxide Capture and Storage* (SRCCS) on this matter, where it is stated that “although storage projects are now in operation and being carefully monitored, time is too short and overall monitoring too limited, to enable direct empirical conclusions about the long term performance of geological storage”.[10]

15. A Party supported this view, highlighting the leakage (seepage) risk presented by abandoned and unmonitored wells that may be present in CO_2 storage sites. It further outlined that CO_2, when combined with water, will become corrosive to the cement used to close wells, posing a risk of failure of the concrete plugs in these wells. The risk of a sudden, massive release of CO_2 was also highlighted, and a scenario was outlined where this could occur at a time when the CO_2 concentration in the atmosphere might be much higher than present. This, it concluded, could lead to the risk of a “runaway” greenhouse effect.

E. Operation of reservoirs and remediation

16. In the context of monitoring the dynamics of CO_2 distribution, a Party reported that for the Sleipner storage project, a time-lapse 3D seismic survey was carried out in 1994 (prior to the start of injection), and again in 1999, 2001, 2002, 2004 and 2006, and a new repeat seismic survey will be carried

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[6] More information on the SACS project can be found at <www.co2captureandstorage.info/project_specific.php?project_id=88>.
[7] See <https://www.co2castor.com>.
[8] The *2006 IPCC Guidelines for National Greenhouse Gas Inventories* refer to this as formation CO_2 (CO_2 present in the oil and gas when it leaves the reservoir) volume 2, chapter 4, p. 4.35.
[9] See <www.co2store.org>.
[10] Metz B, Davidson O, de Coninck HC, Loos M and Meyer LA (eds.). 2005. *IPCC Special Report on Carbon Dioxide Capture and Storage. Prepared by Working Group III of the Intergovernmental Panel on Climate Change.* Cambridge and New York: Cambridge University Press, p. 246. Available at <http://www.ipcc.ch/pdf/special-reports/srccs/srccs_wholereport.pdf>.

out in 2008. It reported that the data showed that no unexpected movement of CO_2 in the storage reservoir and no seepage of the stored CO_2 have occurred. The Party further commented that the Utsira Formation is "by no means an unusual geological formation in terms of storage potential, and the Sleipner storage operation represents just one of many potential subsurface storage sites". Another Party suggested that no long-term experience exists in sealing CO_2 injected into depleted oil and gas reservoirs, implying that the experience of monitoring projects such as Sleipner is too short-term to be relied upon.

17. The issue of operational risk posed by CO_2 storage sites was also considered in some submissions. Issues associated with storage site area and changes in area over time as a consequence of CO_2 migrations were raised in two submissions.[11] A Party suggested that this could lead to migration of CO_2 to areas beyond that originally envisioned during the site characterization and selection phase, and thus could pose the risk of CO_2 encountering previously undetected fractures and faults; that is, potential leakage paths. The Party also added that this could lead to accounting issues, for example, by leading to emissions in international waters or in countries other than where the project was originally sited (see chapter III D below in relation to project boundaries and chapter IV C below in relation to projects in international waters and/or crossing national boundaries).

F. Environmental impacts

18. In considering the environmental effects of CO_2 storage, an organization suggested that CCS would result in further environmental impacts of mining activities because of a 30 per cent increase in energy demand by coal-fired power plants employing CCS.[12]

19. The environmental benefits that CCS could deliver in terms of reducing local atmospheric pollution, and hence reducing harm to human health and ecosystems, were also noted by an organization. A Party suggested that CCS has many similarities to nuclear energy in terms of its long-term burden on the environment.

III. Methodological issues

A. Links with other chapters

20. This chapter should be considered in conjunction with chapter IV of the first synthesis report. It is also important to note that monitoring methodologies for geological CO_2 storage sites are intimately linked to the operation of reservoirs (chapter II E) and potential leakage paths (chapter II D) as discussed in this report and in the same chapters in the first synthesis report. This is because the monitoring methodology applied to a geological storage site should be based on the specific characteristics of the particular site, its boundaries and the potential leakage paths identified therein, as well as on good operational practice in managing the storage site.

21. It is also important to consider issues raised in other parts of this report in relation to methodological issues, including chapter IV D, where issues relating to options for long-term accounting are considered, and chapter VII, which contains reviews of other issues in relation to capacity-building, institutional needs and technology transfer, possible implications for increased fossil fuel production (leakage), and the handling of temporal issues around the difference in time periods between the crediting period and closure of a storage site. This is because the options for long-term accounting can have repercussions for methodological approaches (e.g. through a policy decision to have different crediting

[11] An example was provided as follows: a 1,000 MW coal-fired power plant would produce 8.6 million t CO_2 per year which, if injected underground, would lead to an underground CO_2 plume of covering an area of 18 km^2 in the first year of operation, and could eventually produce a plume covering an area of 200–360 km^2 after closure (depending on the amount injected and the thickness of the storage formation).

[12] The implication being that more coal is required by a power plant employing CCS to achieve the same power output.

periods for CCS projects), where institutional issues may mean that an alternative approval process could be required for CDM methodologies for CCS, and temporal issues could result in the need for legal rules or alternative methodological approaches for CCS projects.

B. General points

22. Some general comments in relation to GHG inventory accounting were raised in submissions, covering the approach to calculating emission reductions from CCS projects, and the need to avoid potential perverse incentives for technologies with higher emissions, and to ensure that emissions from additional fuel used in CCS projects are taken into account.

23. An organization expressed the view that CCS projects can result in the measurable, long-term reduction of anthropogenic GHG emissions. One Party highlighted that CCS projects are energy-intensive, and emissions from the energy usage of CCS projects must be accounted for in the methodological approach. It also pointed out that an accounting methodology must take into account potential perverse incentives to low-efficiency technologies (for example, replacing combined cycle gas turbines (CCGTs) with the less-efficient gas-fired boilers and steam turbines which produce more concentrated CO_2 streams) and the deployment of more carbon-intensive projects (for example, the development of CO_2-rich gas fields to gain more credits from CCS relative to less-CO_2-intensive fields). To account for these factors in CCS projects, one Party proposed that the emission reductions could be calculated as follows:

$$ER = BL - (PE + LE)$$

Where:

ER = emission reductions delivered by the project in t CO_2

BL = baseline for the project, which may be equal to the amount of emissions of CO_2 produced by the plant in t CO_2

PE = project emissions from the CCS operations, including emissions associated with CO_2 capture (emissions from fuel combustion to generate energy required for the CO_2 capture processes, and emissions of uncaptured CO_2), emissions from transportation and injection of the CO_2 (combustion emissions and fugitive leaks), and any emissions of CO_2 as a result of seepage from the storage site, in t CO_2. This could include any indirect emissions associated with power bought in for any part of the CCS chain of activities

LE = leakage emissions relating to any indirect emissions arising as a consequence of the project, outside the project boundary

C. Criteria and steps for storage site selection

24. One Party proposed that properly managing the risk of leakage of CO_2 by setting strict criteria for, inter alia, site selection and management must be a precondition for including CCS as a CDM project activity. This view was also reflected in a number of other submissions from Parties and organizations, in reiterating points made in the first synthesis report (paras. 31 and 37) that selection of proper storage sites is of vital importance to prevent seepage and ensure the environmental integrity of the projects, and that flexibility is required to allow for improvements in knowledge of and experience in CCS, and to accommodate different geological conditions and the distinct storage characteristics thereof, the latter potentially presenting different capacities of different geological formations to isolate CO_2 from the atmosphere.

25. The following factors to be taken into account for site selection were included in submissions:

(a) An assessment of the capacity of a geological formation to trap CO_2, which will come from analysis of the efficacy of the cap rock (physical trapping) and other trapping mechanisms (e.g. chemical CO_2 trapping);

(b) Evidence of geological stability (e.g. in terms of susceptibility to seismic activity);

(c) An assessment of all potential leakage (seepage) pathways (see chapter II D);

(d) A thorough risk assessment of the storage site and operations therein;

(e) An assessment of environmental impacts (the potential impacts of the operation, of any potential CO_2 seepage, and of increased mining, highlighted in chapter II F);

(f) A credible demonstration that CO_2 within the reservoir will reach a stable distribution in the long term, with zero seepage to the atmosphere.

26. In terms of methodological steps, there was broad agreement across several Parties and organizations that any methodology applicable to CCS as a CDM project activity would need to incorporate the following aspects:

(a) Good site selection and management;

(b) Project design and management;

(c) Effective regulation;

(d) A thorough risk assessment of the storage site and operation, including an assessment of all potential seepage paths and environmental impacts, using detailed site characterization and simulation techniques;

(e) Monitoring requirements;

(f) Treatment of transfer of liability;

(g) Treatment of transboundary issues;

(h) Remediation plans;

(i) Development of appropriate host country institutional arrangements.

27. Several Parties and organizations noted that methodological steps should draw on various sources including the *2006 IPCC Guidelines for National Greenhouse Gas Inventories* (hereinafter referred to as the 2006 IPCC Guidelines), the SRCCS, items in paragraphs 31, 37 and 38 of the first synthesis report, the work on CCS in the CDM by the International Energy Agency (IEA) Greenhouse Gas R&D Programme[13] and available industry best practice.

28. Several submissions, however, noted that site selection issues are difficult to address, and have not been properly addressed in developed countries to date. One submission also suggested that these issues have been examined by reputable institutions without a satisfactory solution, implying that caution should be exercised in evaluating published material.

[13] IEA Greenhouse Gas R&D Programme. 2007. *ERM – Carbon Dioxide Capture and Storage in the Clean Development Mechanism*. Available at <http://www.co2captureandstorage.info/networks/CCS-CDM.htm>.

D. Project boundaries

29. One Party and two organizations reiterated views expressed in the first synthesis report (para. 43), namely that the project boundary of the CCS project activity should comprise the full chain of CCS operations covering three separate processes: capture, transport and injection/storage of CO_2 (including subsurface components, wells and other potential direct seepage pathways; the storage reservoir; locations around the reservoir; and emissions from enhanced hydrocarbon recovery).

30. Conversely, a different Party suggested that whereas clear definitions for baselines, project boundaries and project emissions are required in the CDM modalities and procedures,[14] this is not possible for CCS projects. This Party argued that a "pillar of the CDM mechanism" – namely the project boundary – cannot be applied to CCS activities, because of their unique characteristics. The same Party also suggested that the project boundary could be dynamic, which could necessitate monitoring outside the limit of any boundary.

E. Monitoring methodologies for leakage

31. As argued in the case for project boundaries, one Party highlighted that the concept of monitoring as normally applied in the CDM cannot be applied to potential CCS project activities because of various complexities involved in defining the monitoring plan for a CCS project. Complexities noted in its submission include:

(a) That many different injection points from different project activities in different time frames can use the same storage site;

(b) That dynamic monitoring with different monitoring plans over time may be necessary;

(c) That one of the main elements of the PDD is a detailed monitoring plan with clear responsibilities and description of monitoring procedures, which would not be possible for the time horizon of a thousand years as might be applicable to a CCS project;

(d) That lateral flows could expand the monitoring area and increase the risk of CO_2 reaching areas with undetected fractures and faults;

(e) That the CDM modalities and procedures require both project emissions and emissions from leakage to be measured, and that stored CO_2 is not well characterized, but rather can only be modelled.

32. Because of these reasons, the Party suggested that it is not possible for CCS to be a CDM project activity.

33. On the other hand, a Party and an organization highlighted that monitoring technologies and methodologies for safe storage of CO_2 are available and in use by the petroleum industry, including seismic reflection survey[15] and gravimetric survey techniques.[16]

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[14] Decision 3/CMP.1.

[15] A seismic reflection survey measures the travel times of seismic waves refracted from interfaces between subsurface layers. The 2006 IPCC Guidelines note a variety of seismic techniques that are capable of imaging subsurface geological structures (rocks and contained fluids), and the distribution of CO_2 in the subsurface. The technique is widely used in the oil and gas industry (see volume 2, chapter 5, annex A5.1, table 5.1).

[16] The 2006 IPCC Guidelines note that gravimetric surveys can determine mass and approximate distribution of injected CO_2 from minute changes in gravity caused by injected CO_2 displacing the original pore fluid from the reservoir. They can also detect vertical CO_2 migration from repeat surveys, especially where phase change from supercritical fluid to gas is involved because of a change in density. The guidelines report that this technique is widely used in the oil and gas industry (see volume 2, chapter 5, annex A5.1, table 5.1).

34. Several Parties and organizations suggested that monitoring plans could be developed consistent with the methodological advice in the 2006 IPCC Guidelines and relevant parts of the SRCCS and from other available industry best practice. Further, one Party also suggested that for validation and verification of CCS projects, a qualified designated operational entity (DOE) with appropriate expertise across technical, regulatory and liability aspects, such as those highlighted throughout this report (e.g. relevant baseline and monitoring methodologies, deep knowledge of IPCC and available industry practice), would be required as part of including CCS as a CDM project activity.

IV. Legal issues

A. Links with other chapters

35. This chapter should be considered in conjunction with chapter V of the first synthesis report, where legal issues are reviewed, based on submissions from Parties and organizations.

36. In addition, legal issues relating to long-term responsibility for monitoring and liability are intimately linked to accounting options for long-term seepage from reservoirs as reviewed in chapter V C. This is because policy decisions regarding options for accounting will determine how liability is coupled to or unbundled from any certified emission reductions (CERs) created by a CCS project activity (see first synthesis report, para. 76).

B. General points

37. There is broad agreement among the majority of Parties and organizations that CCS needs effective regulation in order to ensure safe deployment, and that this should be a precondition for deployment of a CCS project in any circumstance. In this context, submissions refer to several examples of comparable legislation where technical issues similar to those associated with CCS or similar activities have been addressed and may be drawn upon by Parties not included in Annex I to the Convention (non-Annex I Parties), including:

(a) The Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1972 (London Convention) and the 1996 Protocol thereto, and the 1992 Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention);

(b) The proposed European Union draft legal framework on the geological storage of CO_2;[17]

(c) The 2006 IPCC Guidelines;

(d) The Norwegian Petroleum and Pollution Control Acts[18] (as applied to the Sleipner project);

(e) Oil, gas and mineral laws, for example relating to sour gas injection (which often includes CO_2), that are already well established in many developing countries.

[17] Available at <http://ec.europa.eu/environment/climat/ccs/eccp1_en.htm>.

[18] Act 29, November 1996, No. 72 relating to petroleum activities <http://www.npd.no/regelverk/r2002/Petroleumsloven_e.htm> and the Act of 13 March 1981 No. 6 concerning protection against pollution and concerning waste <http://www.regjeringen.no/en/doc/Laws/Acts/Pollution-Control-Act.html?id=171893>.

38. Several submissions referred to the legality of CCS activities under the Kyoto Protocol and the CDM modalities and procedures. Points raised in this context include:

(a) That CCS is incompatible with Article 12 of the Kyoto Protocol as CCS does not stimulate sustainable development and emission reductions (see also chapters VI D and VII B);

(b) That because of the modelled nature of monitoring subsurface CO_2 storage, CCS is inconsistent with the CDM modalities and procedures;

(c) That because CO_2 in the reservoir changes the sealing capacity of the reservoir ecosystem, it should be considered as a land use and land-use change type of activity, for which only afforestation and reforestation are allowed in the first commitment period of the Kyoto Protocol (see chapter VI C below);

(d) That CCS is not compatible with the CDM modalities and procedures or decision 5/CMP.1, which require technologies included in the CDM to be environmentally safe and sound, and project activities to demonstrate achievement of sustainable development as well as emission reductions, and also require equitable geographic distribution of CDM project activities;

(e) That CDM institutional structures would need to be considerably modified to accommodate CCS, for example by changing the roles of DOEs, and requiring the involvement of insurance companies (see chapter VII C below).

39. In contrast, various submissions from Parties and organizations expressed the following views on this issue:

(a) CCS is recognized under the Kyoto Protocol, in Article 2, paragraph 1(a) (iv), as an important GHG mitigation technology that promotes sustainable development;

(b) CCS projects can result in real, measurable, long-term reductions of anthropogenic GHG emissions;

(c) The present modalities and procedures for the CDM cover most issues related to CCS project activities (see chapter VII C below).

40. There was broad agreement across several submissions that there may be capacity needs in non-Annex I Parties to ensure effective regulation of CCS projects (see chapter VII C below).

C. Projects in international waters and/or crossing national boundaries

41. One Party highlighted the transboundary legal implications and problems that could arise in international waters or among Parties included in Annex I to the Convention (Annex I Parties) and non-Annex I Parties in the event of cross-border migration of CO_2 and subsequent seepage. It also highlighted the complexity that may be presented by the occurrence of seepage emissions in international waters, likening the issue to the challenges presented by bunker fuels. On this note, another Party suggested that these complexities could be best avoided by prohibiting projects with storage reservoirs in international waters.

42. Support for a statement in the first synthesis report (para. 64) – and the reference therein to the 2006 IPCC Guidelines in terms of handling cross-border accounting issues and their applicability to the CDM – was expressed in a submission by an organization.

D. Long-term responsibility and liability for storage site monitoring and remediation

43. Several Parties noted that the PDD would need to set out arrangements for, inter alia, site closure and abandonment, responsibility for monitoring, liability and remediation, and credible demonstration of the expectation that CO_2 within the reservoir would reach a stable distribution in the long term, with no seepage to the atmosphere. They suggested that the CDM Executive Board (CDM-EB) should assess these elements for their appropriateness prior to registration of a project.

44. Other submissions focused on the need for, and means of, allocating responsibility for monitoring and liability for remediation in the event of leakage. In this context, the following points were raised in submissions:

(a) In the event of accidental seepage of CO_2, liabilities should be appropriately attributed, covering:

 (i) Liability for offsetting the actual amount of CO_2 accidentally released (i.e. climate change damage). This should be covered under future CO_2 emissions regulation;

 (ii) Liability for any damage caused by a release (for example, damage to the local environment);

(b) Liability for safety issues should be dealt with through appropriate national regulations;

(c) The economic arrangements to compensate for damage (i.e. those outlined in para. 44 (a) above) should be addressed via the arrangements by which the storage project has been funded, which could be designed into the requirements for including CCS as a CDM project activity;

(d) There is a need for clearly defined liability extending beyond the project crediting period. Thus liabilities need to be defined in the short, medium and long term;

(e) Ultimate long-term liability should lie with the host country, the project proponent or the country using the CERs. In the case of the latter two, this should help to ensure close monitoring of the project and offer incentives to use only the safest projects;

(f) The long-term nature of CCS means that post-project closure monitoring and remediation liability can be practically assumed only by the host country because the storage reservoir lies within its jurisdiction (see first synthesis report, para. 70). The host country is most able to manage the operating conditions and post-closure controls in the event of any seepage over the long term;

(g) The host country must have an appropriate liability regime in place before it can host a CCS project under the CDM;

(h) The CDM provides the best opportunity for a liability regime to be developed on a project learning-by-doing basis, as has typified the evolution of the CDM to date;

(i) Liability should be flexible and could be suitably defined specific to each project and national circumstance in the same way as sustainable development criteria are employed in host countries within the CDM process;

(j) The risk of seepage reduces over time, and thus the level of any liability transferred following closure of a CO_2 storage site will be low;

(k) A balance must be struck between liability and commercial practicality.

45. However, other submissions from a Party and an organization suggested different views on these matters, as follows:

(a) These issues have not been properly addressed in developed countries to date, despite having been examined by reputable institutions;

(b) Owner liability is only possible for 20–60 years within the current CDM framework, but CCS activities have a time frame of millennia, over which time companies and even States can cease to exist;

(c) Transferring liability for a storage site from the operator to the host country would require the State to finance monitoring and undertake remediation, the costs of which would be unknown. It is also not possible to estimate the potential costs of impacts to the environment and public health, or calculate them in present value terms so as to then include these costs in the CDM project activity (see para. 59 (d) below).

46. One submission referred to the discussion presented in the first synthesis report (para. 70), in relation to its views on long-term responsibility and preference for host country liability.

47. A Party likened the long-term responsibility issues posed by CCS to those posed by nuclear waste, and highlighted the complex insurance and government surveillance requirements involved in its management. Several submissions highlighted the need to continue monitoring beyond the end of the project, and over the longer term, after injection.

V. Policy issues

A. Links with other chapters

48. This chapter should be considered in conjunction with chapter VI of the first synthesis report. Furthermore, there are links between the present chapter and chapter IV D above (in so much as long-term responsibility and liability for storage site monitoring and remediation are inherently linked to policy choices for long-term accounting options – see also para. 76 of the first synthesis report), chapter VI, where financial issues are covered (as policy issues inherently relate to financing aspects of climate change mitigation), and elements covered in chapter VII, where issues such as the contribution of CCS to sustainable development and institutional and capacity-building needs are reviewed.

B. General points

49. All Parties and most organizations were in agreement that CCS is an option in a portfolio of mitigation options, regardless of whether it is included in the CDM. Several Parties and organizations reiterated that CCS will be needed together with energy efficiency and renewable energy in mitigating climate change to limit the global average temperature increase to 2 ºC, possibly with emissions peaking in the next 10–15 years and then reducing to 50 per cent of 1990 levels by 2050. On this note, one submission referred to scenarios from the IEA which indicate that the potential for reducing emissions through the increased use of renewable energy and energy efficiency is limited. It went on to suggest that, on this basis, while energy efficiency, renewables and other low-carbon energy generation technologies such as nuclear power will play a vital role in tackling climate change, they will not be able to address the huge expected growth in CO_2 emissions associated with the electricity supply industry, and other industrial processes, particularly in emerging economies. Drawing similar conclusions, several Parties suggested that to achieve emission reduction objectives, substantial cuts in emissions from coal-fired power plants will need to be made in both industrialized and developing countries. In particular, they suggested that there is a need to focus on countries where economic development is resulting in large increases in fossil fuel consumption.

50. In contrast, a Party and two organizations suggested that CCS is best suited to Annex I Party emissions, where a fossil fuel infrastructure is in place, where there is a short-term need to reduce emissions (i.e. a transition technology to a low-carbon future), and where there is support from host governments to develop CCS technologies. They suggested that use of CCS in developing countries would depend on the technical maturity, costs, diffusion and transfer of the technology and assessment of environmental issues. It would also depend on whether CCS would create perverse incentives for these countries to invest scarce resources in fossil fuel instead of other low-carbon technologies, which, these submissions argue, would increase the technology gap between developed and developing countries.

51. A number of submissions focused on the role the CDM can play in promoting demonstration, deployment and diffusion of CCS technologies. Several Parties and organizations suggested that the CDM is an appropriate means of promoting genuine technology cooperation, dissemination, transfer and deployment by providing limited seed financing to catalyse early projects (see para. 66 (e) below). Several submissions, however, suggested that the CDM should focus on renewable energy and energy efficiency projects, and should not support fossil-fuel-based projects (also see para. 67 below). On this issue, a submission from another organization highlighted the conclusions of the thirty-fourth meeting of the CDM-EB when, in approving CDM methodology ACM0013,[19] the CDM-EB noted that a number of developing countries are dependent on fossil fuels and will remain so in the future, and that this methodology will help efficient technology development in such countries.[20]

52. One Party proposed a pilot phase for including CCS as a CDM project activity. It envisions the pilot phase as a way to build capacity and close the present knowledge gaps covering CCS technologies, provide a means of addressing the concerns raised by some Parties in respect of CCS activities (e.g. the lack of practical experience, the need for capacity-building and knowledge sharing), and clarify various methodological issues posed by inclusion of CCS as a CDM project activity, all in a learning-by-doing context, while at the same time contributing to the worldwide demonstration and diffusion of CCS. It proposed the following principal features of such a pilot phase:

(a) Limited duration;

(b) A maximum number of projects;

(c) A maximum creditable tonnage or a specified number of tonnes per annum per project, for example thereby setting a maximum volume of CERs allowed into the market as a result of the pilot project;

(d) Crediting which starts after registration, according to CDM-EB procedures;

(e) A window of opportunity to register projects in the first commitment period of the Kyoto Protocol (i.e. before 2013);

(f) Evaluation of the pilot phase at the earliest opportunity.

53. The submission also proposed that a decision by the CMP at its fourth session should set out provisions for how the technical, methodological, policy and legal issues (including liability) are to be tackled in such a pilot phase, taking into consideration past submissions by Parties and the synthesis reports prepared by the secretariat. It suggested that the CDM-EB be mandated to register a limited number of projects for a pilot phase of a limited duration, to be credited under the CDM, and to report in its annual report on progress under the pilot phase. On this basis, the Party invited project proponents to submit methodologies and PDDs from the full range of technological options for capture, transportation and storage to facilitate the demonstration of a diversity of situations in a range of geographical locations.

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[19] "Consolidated methodology for new grid connected fossil fuel fired power plants using a less GHG intensive technology".

[20] See the report of the thirty-fourth meeting of the CDM-EB, paragraph 16 <http://cdm.unfccc.int>.

Such submissions should be designed, developed and submitted to the CDM-EB in the usual manner, considered by the CDM-EB for approval, and assessed according to the normal additionality criteria. Approved and registered projects would then be admitted and verified in the normal way before the issuance of CERs. One organization supported this view, suggesting that following approval by the CMP, technical issues would be resolved according to standard CDM procedures.

54. Responding to this proposal, which was tabled during SBSTA 27, an organization suggested that there is no need to pilot CCS in developing countries in order to improve knowledge of technical issues, because CCS can be tested wherever a coal-fired power plant and a geological formation suitable for storage exist. The organization argued that countries in Europe, as well as other industrialized countries, have sufficient coal-fired power plants, emitting hundreds of millions of tonnes of CO_2 per year, for application of CCS. It suggested that using developing countries as “testing grounds” for CCS would result in developed countries reaping benefits (e.g. by acquiring offset credits as opposed to taking domestic action) and developing countries being left to shoulder the long-term burden presented by CCS. A Party supported this view, proposing that developed countries should be the first to use CCS in order to acquire knowledge on the risks relating to leakage, monitoring and liability, and avoid passing on premature experiences to developing countries.

55. A different organization noted that, while the potential to mitigate emissions using CCS exists in both developed and developing countries, a large number of CCS “early opportunities”[21] exist in non-Annex I Parties,[22] and it suggested that these offer the opportunity to gain the experience and cost reductions needed along the pathway to wider deployment of CCS in the longer term. It argued that application of CCS to early opportunities, using CDM finance, can provide valuable experience in capturing concentrated streams of CO_2 at reasonable cost. It went on to suggest that together with demonstration projects in developed countries focused on lowering capture costs, the CDM can make an important contribution to building the necessary conditions for scaling up deployment and diffusion of CCS at a global level.

56. One organization suggested that each year of delay of CCS to deployment means an increase of millions of tonnes of CO_2 emissions in the atmosphere.

C. Accounting options for any long-term seepage

57. This section should be considered in conjunction with issues relating to long-term responsibility and liability for storage site monitoring and remediation (chapter IV D) and issues relating to the difference in time between the crediting period and the closure of a storage site (chapter VII E).

58. Several submissions sought to propose options for considering accounting options for long-term seepage. Consolidated views in this context include:

(a) That accounting rules should be consistent with current rules under the CDM;

(b) That accounting rules should relate to the net quantity of CO_2 stored, and should deliver CERs that are as permanent and fungible as CERs from other project activities;

(c) That temporary or long-term CERs are not appropriate for CCS projects;

(d) That a thorough analysis of the storage site is required before renewal of a CDM crediting period is granted. If the analysis shows that direct or indirect seepage has taken place, it could be decided to deny renewal of the project as a CDM project;

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[21] It highlighted that “early opportunities” are described in the SRCCS (in footnote 12, page 44) as projects that are likely to “involve CO_2 captured from a high-purity, low-cost source, the transport of CO_2 over distances of less than 50 km, coupled with CO_2 storage in a value-added application such as EOR [enhanced oil recovery].”

[22] In this context the organization cited the SRCCS, chapter 2, figure 2.9, page 97.

(e) That the best way to avoid complex accounting rules is to ensure a high level of permanent storage, following appropriate site selection and management criteria (see chapters II and V C);

(f) That host country permitting requirements could be used as a means to set up a requirement for an operator/project proponent to set aside provisions to replace issued CERs in the possible event that seepage occurs at a CO_2 storage site – within a defined time period;

(g) That residual liabilities for host countries in relation to the replacement of CERs in the possible event that seepage occurs at a CO_2 storage site beyond the period of operator/project proponent liability, could be covered through provisions such as insurance, or by other financial assurance mechanisms such as the holding of funds in escrow;

(h) As an alternative, that the provisions described in paragraph 58 (g) above could also be determined by the CDM-EB and administered by the UNFCCC secretariat.

59. Conversely, other submissions from a Party and organizations suggested the following factors need to be taken into account when considering this issue:

(a) That because the time frame of a CDM project is much shorter than the potential lifetime of a CCS storage project, the CDM is currently unable to adequately address the potential leakage of stored CO_2;

(b) That "permanence", an issue which has been examined by reputable institutions without a satisfactory solution, does not apply to CCS;

(c) That a mechanism for cancelling units after seepage is verified would not be possible if the seepage occurs in 200 or 500 years' time;

(d) That the risk of possible future seepage from CO_2 storage sites would need to be estimated, translated into economic terms and internalized to the project activity costs for the operator/project proponent, which is not possible over such long time frames using existing economic theory;

(e) That a statistical approach to anticipate seepage would be highly uncertain because, while it may be able to account for low-level, long-term (chronic) seepage emissions, it would not be able to account for extreme seepage events such as a sudden (acute) release, for which it would be difficult to assign a probability;

(f) That the inclusion of a new type of activity under the CDM would need to be accompanied by a decision of the CMP (see para. 38 above).

60. A Party outlined that its proposed pilot phase (para. 52 above) could act as a means for developing appropriate arrangements, and highlighted that project participants could be required to set out in a PDD, inter alia, how they plan to address accounting for any seepage.

D. Levels of risk and uncertainty

61. A Party suggested that CCS poses many risks, including the risk of sudden, massive release of CO_2, which is comparable with nuclear risks. As a consequence, strong political, economic and institutional structures are required which are not present in many countries (see chapter VII C). It also suggested that there is a 99 per cent probability that after 100 years some CO_2 could be released into the atmosphere, and furthermore, that this could coincide with a period when atmospheric CO_2 concentrations are higher, possibly resulting in a "runaway" greenhouse effect (see para. 15 above).

62. The majority of submissions focused on possible procedures for managing risk, highlighting the following points:

(a) The risk of seepage is dependent on site selection, site operations, risk management practices, and monitoring and remediation commitments, and these should form a set of preconditions for registration of CCS projects. Appropriate site characterization and selection is critical (see chapter III C);

(b) Risk reduces with time, but the area grows and so risk analysis has to take into account the area that could be affected and the time horizon of a possible leak;

(c) The high degree of uncertainty posed by CO_2 storage can only be reduced with a careful long-term monitoring process that is both capital- and technology-intensive.

63. In making reference to the conclusions of the SRCCS, an organization commented that with appropriate site selection, monitoring systems, regulation and remediation methods, the risks of CCS projects are comparable to those of existing activities such as natural gas storage, enhanced oil recovery and deep underground disposal of acid gas.

64. One organization expressed the view that the risks to human development and the natural environment associated with climate change greatly outweigh those associated with CCS projects, which will be needed together with other mitigation options to achieve the levels of emission reductions needed to stabilize atmospheric CO_2 concentrations this century.

VI. Financial issues

A. Scope

65. This chapter provides a synthesis of views presented in submissions in relation to financial issues, taking into account topics highlighted by Parties during SBSTA 27. As this chapter does not directly relate to the issues listed in decision 1/CMP.2, links to other sections and a section on general points have been omitted. Instead, in highlighting the specific issues raised by Parties and organizations it has been subdivided into the following four sections: financing CCS projects; carbon market impacts; equitable distribution of CDM projects; and the effects on financing for other technologies.

B. Financing carbon capture and storage projects

66. A number of submissions from Parties and organizations highlighted the following points in support for the need for CDM financing for CCS:

(a) Unlike energy efficiency improvements that have inherent commercial benefits, CCS is a technology designed specifically to reduce atmospheric CO_2 emissions, and as such needs incentives;

(b) Costs of industrial activities in which CCS is used are higher than those of equivalent non-CCS industrial operations;

(c) The high costs of CCS projects may discourage their ever being deployed; consequently, there is a need for incentives for potential developers to finance the deployment of CCS technology;

(d) With ongoing CCS technology improvements and deployment, and with large-scale CCS starting beyond 2020, the cost of avoiding CO_2 emission can be estimated to be in the region of EUR 35–50 per t CO_2. This cost may not be low enough to encourage CCS projects, as this will be dependent on the future carbon price, which in turn is dependent on future commitments;

(e) The CDM could be an appropriate means to provide sufficient incentives – or early seed financing – to catalyse funds for a moderate number of early demonstration projects in developing countries. At present the CDM is the only such incentive available to potential operators in non-Annex I Parties. In turn the deployment of early opportunities – possibly using CDM finance – could:

(i) Provide valuable learning-by-doing effects for wider deployment of CCS in the medium term through demonstration of the technology and its costs;

(ii) Promote genuine technology cooperation, dissemination, transfer and deployment;

(iii) Assist in gaining public acceptance of CCS technology and demonstrate the benefits to civil society;

(f) The conclusions of the SRCCS support the view that developing early opportunity projects is a vital part of the development, deployment and diffusion process for CCS;[23]

(g) Early demonstration projects may be subject to additional costs due to uncertainty about costs;

(h) A pilot phase could serve to fulfil parts of this approach by allowing potential developers to suggest methodologies and build experience from which to draw lessons for the future.

67. Other submissions put forward views to argue against financing CCS projects using the CDM:

(a) Because of the high costs of CCS projects, they are not a cost-effective mitigation option;

(b) CDM revenues should be used to promote clean and renewable technologies; the CDM was not conceived for giving subsidies to oil, gas and coal production with CCS;

(c) The CDM should not be used to provide incentives for extraction of methane from deep coal mines;

(d) Fossil fuel producers do not need CDM as a subsidy, taking into account that the current oil price is higher than USD 130/barrel;[24]

(e) Several companies already have considerable know-how and investments in CCS technology;

(f) The end of a CCS project is not the end of the costs, implying that additional expenditure is required post-closure for monitoring and other after-care activities.

68. One Party suggested that a high carbon price may not necessarily be the trigger for CCS in developing countries, suggesting that CCS could be developed through some other framework using specific financial mechanisms. It suggested that funding and partnerships under the Convention could be an option, but not as an offset mechanism that generates carbon credits for use by Annex I Parties as applied in the CDM mechanism. An organization suggested something similar along the lines of a phased approach, with project-based mechanisms providing a valid potential incentive for CCS – especially “early opportunities” – in developing countries in the short term, whereas future financing of widespread deployment of CCS could come from some other mechanism.

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[23] The SRCCS concludes that “early opportunities … could provide valuable early experience with CCS deployment, and create parts of the infrastructure and knowledge base needed for the future large-scale deployment of CCS systems”.

[24] At the time of the submission, 16 June 2008.

C. Carbon market impacts

69. Several submissions expressed concerns over possible impacts on the carbon market that could arise from including CCS as a CDM project activity. Issues raised in this context included the following:

(a) There is a possibility that huge quantities of CERs from CCS projects would be made available in the total CDM ‘offset pool’ to Annex I Parties, which may undermine the carbon market and reduce CER prices;

(b) This would lower the level of domestic mitigation action needed to be undertaken by Annex I Parties as it would open up a new source of cheap CERs;

(c) This would allow coal-fired power plants to operate in Annex I Parties without CCS, whereas similar plants in non-Annex I Parties would be employing CCS, a scenario which one submission suggested is unacceptable;

(d) The appeal of large amounts of CDM credits should not be used to hide the potential negative implications of CCS.

70. In contrast, other views expressed in submissions suggested that such negative impacts could not happen for several reasons:

(a) Although the potential for emission reductions from CCS is large over a longer time period, the argument of undermining the carbon market and reducing CER prices is not based on facts and figures and is therefore likely not to affect the carbon market in the near to medium term;

(b) Prices for CERs have not reached the level needed to finance CCS projects, and there is therefore no danger of early CCS projects undermining the CER market. Only “early opportunity” projects will come to market in the early years, but these projects can provide a valuable early contribution to technology transfer;

(c) Long project lead times, and the rate of CDM approvals which could be applicable to complex CCS methodologies and projects, will limit the number of projects that can be approved and come into operation before 2012;

(d) Because of these different factors, the possible level of deployment pre-2012 could be in the order of tens of millions of tonnes of CO_2 per year;

(e) In the longer term, greater CO_2 cuts will be needed and CCS projects will compete with other mitigation options where they are cost-effective.

71. Another Party suggested that the potential market effect of any specific technology or project activity in subsequent commitment periods will depend on the ambition level and content of these commitments, and should not have any impact on rules and modalities for CDM projects in the first commitment period.

D. Equitable distribution of clean development mechanism projects

72. Several submissions suggested that including CCS in the CDM would further increase the inequality of distribution of CDM projects, as its application would be limited to large emission reduction projects in a few non-Annex I Parties that have major coal-fired power generation and/or oil and gas export operations.

73. Another organization supported this view by highlighting that the adoption of CCS is likely to have a greater impact on emission reductions in some developing countries than others.

74. However, a number of submissions also suggested that this should not be a reason to exclude CCS as a CDM project activity, for the following reasons:

(a) CCS should be a technology that is implemented wherever it is needed;

(b) For some countries, protecting their bio-sequestration capability may be the largest contribution they can make to combating climate change, but for other countries with less extensive bio-production, their potential to store large volumes of CO_2 through CCS may be the most promising option;

(c) Following this perspective, all Parties should take the responsibility to allow an enabling framework to develop which enhances the fullest abatement potential to be realized within countries where large emission reduction potential exists, and not unreasonably discourage this important mitigation option on the basis that it may not be readily available or applicable to their own national circumstances;

(d) Delaying a decision on this matter and the continued exclusion of CCS from the CDM is an impediment to meeting the ultimate objective of the Convention for some Parties;

(e) Impediments to the development and implementation of new technologies should be of great concern to those seeking a solution to climate change;

(f) International regulations and mechanisms should encourage investment in CCS.

75. One submission from an organization noted that that emission reductions from CDM projects must be based on voluntary participation approved by each Party involved. On the other hand, a Party also suggested that although voluntary participation is one of the requirements for participating in the CDM, this does not mean that each country decides for itself if a type of activity is eligible as a CDM project activity. The Party proposed that because CCS presents technical and methodological issues, decisions on its eligibility as a CDM project activity are dependent on a decision by the CMP, rather than being a matter of voluntary participation.

E. Effects on financing for other technologies

76. In addition to the potential sources of finance, the effects that CCS could have on the carbon market and the equitable distribution of CDM projects, some Parties and organizations argue that CCS would postpone, "crowd out" and/or undermine the availability of funding for other, more sustainable mitigation technologies such as energy efficiency and renewable energy; in other words, the large funds flowing to CCS projects would mean that funds were no longer available for technologies such as renewables. Thus, these submissions concluded that the CDM should be focused on investing scarce resources in developing countries in energy efficiency and renewable energy projects, including access to clean, reliable and affordable energy. They also stated that the CDM should not provide perverse incentives for developing countries to develop fossil fuel production, as this would reinforce the technology gap between developed and developing countries.

77. One Party suggested that ensuring that investment in renewable energy and energy efficiency projects is not crowded out should be a precondition for including CCS in the CDM. However, other Parties and organizations suggested that because of the low level of deployment that can be expected in the near future (for the reasons outlined in para. 66 above), this is unlikely to be an issue.

78. On this note, a submission from one organization highlighted that while renewable energy sources can offer large emissions savings and contribute to energy security goals, they often present only an intermittent power supply, and the requirement for baseload power will limit their deployment. It suggested that CCS offers the only realistic option to address emissions from a range of industrial processes, such as cement production or natural gas processing. It suggested that CCS is not a

replacement for other options and indeed can complement renewable technologies; for example, the application of CCS with biomass generation or biofuel refining offers the potential for achieving negative GHG emissions.

79. Another organization suggested that CCS is being funded by Annex I Parties under the guise of renewable energy funding, and funded on a much larger scale than renewable energy and energy efficiency technologies.

VII. Other issues

A. Scope

80. This chapter provides a synthesis of views presented in submissions in relation to other issues, taking into account topics highlighted by Parties during SBSTA 27. As this chapter does not directly relate to the issues listed in decision 1/CMP.2, links to other sections and a section on general points have been omitted. Instead, in highlighting the specific topics considered it has been subdivided into the following four sections: sustainable development and CCS; capacity-building, institutional needs and technology transfer; possible implications for additional fossil fuel production (leakage); and difference in time between the crediting period and closure of a storage site.

B. Sustainable development and carbon capture and storage

81. A range of views were expressed by Parties and organizations in respect of the positive contributions CCS can make to sustainable development, including the following:

(a) Climate change is linked with efforts in development and poverty reduction in so much as the current patterns of energy supply and demand in developing countries threaten to cause severe climate change;

(b) CCS assists economic development by allowing access to competitive supplies of energy, promoting a degree of energy security in a world of increasing energy insecurity;

(c) On this basis, CCS allows economic development and rural electrification in developing countries with coal-based economies to be aligned with the need for the mitigation of GHG emissions;

(d) CCS is the most promising and effective win–win technology for combating GHG emissions (reducing both emissions and economic impacts on developing countries);

(e) Without CCS, the competing pressures of economic, social and rural development may result in a lower level of commitment to reducing GHG emissions in those developing countries with coal-based economies.

82. Several submissions expressed the view that CCS will not contribute to sustainable development. They highlighted the following reasons for this:

(a) The CDM should deliver both short-term credits and long-term benefits; CCS would deliver the credits, but not the long-term benefit;

(b) CCS does not fit with the premise that the CDM should lead to the transfer of cost-effective, environmentally safe and sound technologies;

(c) CCS will only buy time for the current fossil-fuel-based economy;

(d) Implementing CCS would double electricity prices but bring few socio-economic or social and environmental benefits – for example, only minimal employment opportunities;

(e) Continued exploitation of carbon-based energy sources under the CDM, regardless of CCS technologies sequestering the associated GHG emissions, would invalidate the goal of 'sustainable development' in the CDM;

(f) It is of the utmost importance to unequivocally show that CCS technologies are effective and will not adversely impact poor, indigenous or otherwise marginalized communities.

83. The same submissions also suggested that because of the large-scale abatement potential of CCS projects, it would have negative effects on small-scale projects.

C. Capacity-building, institutional needs and technology transfer

84. There was broad agreement among some Parties and organizations that there may be capacity needs for CCS projects in non-Annex I Parties in the area of technical assistance, and in design and implementation of effective regulations. It was suggested that host countries may need to draw on relevant international expertise – including in subsurface fluid management – when making decisions on CCS projects. A view was also expressed in two submissions that early demonstration projects and/or a pilot phase under the CDM could help to deliver capacity-building for, and impetus to, the global demonstration of CCS that is necessary to accurately assess the potential contribution of CCS to climate change mitigation efforts. They suggested that this would lay important groundwork for wider deployment in the future.

85. One Party expressed the view that the present modalities and procedures for the CDM cover most institutional and approval issues relating to CCS project activities. Several submissions suggested that they could be reinforced through the preparation of appropriate guidance by the CDM-EB, and through an independent expert panel. One organization noted that appropriate permitting arrangements could be accommodated within the CDM process, for example through the use of the environmental impact assessment or by introducing a new section to the PDD. The view that long-term monitoring responsibilities should be given to an independent international entity was expressed by one Party.

86. In contrast, one Party proposed that CDM institutional structures would need to be radically modified, for example by changing roles of DOEs and involving insurance companies, in order to accommodate CCS as a CDM project activity. It suggested that this would add unmanageable complexity to the CDM process.

87. One Party indicated its willingness to share its experience and other collaborative and capacity-building efforts with other Parties, drawing on a range of CCS activities it has been involved in over recent years (e.g. the Sleipner and Snøhvit projects (see para. 12 above); the European CO_2 Test Centre in Mongstad; the Mongstad Carbon Capture and Storage Project (full-scale CCS); and the Kårstø project).

D. Possible implications for increased fossil fuel production (leakage)

88. Some concern was expressed that the inclusion of CCS as a CDM project activity may result in an increase in fossil fuel production. This could result in carbon leakage.

89. One organization raised the issue of CO_2 used for enhanced oil recovery/enhanced hydrocarbon recovery (EOR/EHR). It suggested that the assumption that fossil fuels produced via this route – principally oil from EOR and also potentially gas from enhanced coal bed methane recovery – would replace lower-carbon energy sources such as renewables or nuclear power is unfounded. It noted that in a publication of the IEA and the Organisation for Economic Co-operation and Development, it was concluded that "it is equally likely that this oil or especially this gas comes in substitution of energy fuels with greater carbon content, such as coal or non-conventional oil resources, in which case it further

reduces global emissions instead of increasing them."[25] It also noted the IPCC Fourth Assessment Report[26] conclusion that higher priced conventional oil resources may be replaced by high-carbon alternatives such as oil from oil sands and oil shales, heavy oils, and synthetic fuels from coal and gas, leading to increasing GHG emissions unless production plants are equipped with CCS.

90. In a related context, two organizations also noted the risks associated with "carbon lock-in" of GHG-intensive technologies without any CCS[27] due to the current high levels of investment in coal-fired power plants in developing countries. They suggested that there is a risk that delaying the application of CCS could be a lost opportunity to capture and store these emissions, and that the continuation of this trend will increase the cost of mitigation in the future, and reduce the ability to address climate change.

E. Difference in time periods between the crediting period and closure of a storage site

91. Several submissions raised issues relating to the overall project life of a CCS operation being generally longer than the CDM crediting period. A range of views on this matter were expressed, for example:

(a) If the injection and operation of the CO_2 storage site continues after the termination of the crediting period, this should be addressed by host country regulations and the permitting conditions incumbent upon the project operator;

(b) After the end of the crediting period, there must be an established procedure for monitoring the reservoir and reporting any leakage to the appropriate agencies;

(c) This issue could be handled by a future, yet-to-be defined regime for GHG emission controls that could serve to continue to offer incentives to these operations (see para. 68 above); analogous examples of "grandfathered" support schemes can be seen elsewhere, for example for renewables support contracts in Europe;

(d) Because of the highly additional nature of CCS projects, operations would cease at the end of the crediting period, because there would no longer be a revenue stream to cover the costs of CCS. In practice, therefore, the point of closure of the reservoir should equal the end of the crediting period.

VIII. Summary

92. On technical issues, there is broad agreement among Parties and organizations that understanding potential leakage paths, including consideration of potential leakage pathways beyond the near-term project boundaries, is critical. However, conflicting views on technical issues were apparent among Parties and organizations on:

(a) Whether there is sufficient experience with CCS to decide whether the technology offers a safe, secure, widespread and long-term mitigation option for inclusion in the CDM – or whether the experience so far is not sufficient to provide appropriate insights on this question;

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[25] Philibert C, Ellis J and Podkanski J. 2007. *Carbon Capture and Storage in the CDM*. Available at <https://www.iea.org/textbase/papers/2007/CCS_in_CDM.pdf>, p. 31.

[26] Contribution of Working Group III, <http://www.ipcc.ch/pdf/assessment-report/ar4/wg3/ar4-wg3-chapter4.pdf>, p. 253.

[27] Carbon lock-in risk relates to investment in equipment and technologies with long asset lives and relatively high emissions, which subsequently may not be replaced by lower-emission technologies during their asset life without imposing unnecessarily high costs. In other words, it would represent a lost opportunity to replace them with lower-carbon technologies now.

(b) Whether experience to date with reservoir operation is sufficient to take an informed view of the risk of seepage over the longer term and over a wider area;

(c) Whether there is future risk of a catastrophic seepage event, possibly resulting in "runaway" climate change.

93. On methodological issues, there was broad agreement among Parties and organizations that:

(a) CCS projects can be energy intensive, and the emissions associated with the energy required for capture, transport and storage should be included within the project boundary, as well as any fugitive emissions from the CCS process;

(b) Strict site selection criteria are critical, including assessment of CO_2 trapping mechanisms, geological stability, risk assessment, environmental impact assessment, and demonstration of long-term storage potential;

(c) In the context of site selection, it is important to draw on the 2006 IPCC Guidelines and the SRCCS for information on site selection and site characterization methods.

94. Conflicting views on methodological issues were apparent among Parties and organizations on:

(a) Whether the methodological issues can be resolved sufficiently to guarantee that sites are selected that are able to isolate CO_2 from the atmosphere safely over very long periods of time;

(b) Whether project boundaries can be defined in a way that will work for the CCS;

(c) Whether the current CDM modalities and procedures, and their approaches to project emission reduction accounting, boundaries, monitoring methodologies etc., are applicable to CCS.

95. On legal issues, there was broad agreement among Parties and organizations that:

(a) Robust national and international legal frameworks and legislation are necessary in order to provide assurance on various aspects of project approvals (e.g. site selection, monitoring);

(b) Regulations will be needed that lay down post-closure obligations (e.g. monitoring and allocation of liability) beyond the end of a CCS project;

(c) Capacity-building is needed in non-Annex I Parties on various aspects of CCS project approvals, including development and implementation of appropriate legal frameworks;

(d) There are several key types of liabilities (e.g. for any local damage from CO_2 seepage, or climate damage from release of CO_2 to the atmosphere), although there was no broad agreement on their magnitude or how such liabilities might be allocated over the longer term.

96. Conflicting views on legal issues were apparent among Parties and organizations on:

(a) Whether CCS activities fit within the modalities and procedures of the CDM, or fulfil the purpose of the Convention and Kyoto Protocol;

(b) Whether the CDM institutional structures are sufficient to cope with and address the specific regulatory and assurance requirements potentially posed by CCS projects as CDM project activities;

(c) The size of financial liabilities potentially posed by CCS projects in terms of corrective actions for any damages (e.g. local, global) arising from emissions from storage sites (e.g. seepage or storage site breach), and how they might be allocated over the longer term (e.g. to the host country, to project proponents, to CER buyers or to combinations thereof).

97. On policy issues, there was broad agreement among Parties and organizations that CCS is an important part of the overall portfolio of GHG mitigation options, whether it is in the CDM or not. However, conflicting views on policy issues were apparent among Parties and organizations on:

(a) Whether CCS demonstration should be undertaken in Annex I Parties, non-Annex I Parties, or both;

(b) Whether there should be a pilot phase for inclusion of CCS as a CDM project activity, the extent of this pilot phase if agreed, and the value of early development projects to the overall CCS development process;

(c) How to account for potential long-term seepage and the probability of major seepage events, with a view to evaluating risk and potential liabilities;

(d) Whether it is necessary or possible to manage the risk of seepage over the long term by, for example, internalizing the value of this risk to project proponents in advance, or whether the liability could be allocated via alternative mechanisms, such as regulation or other financial measures.

98. On financial issues, there was broad agreement among Parties and organizations that additional financing is required for projects with CCS as compared with equivalent projects without CCS. However, conflicting views on financial issues were apparent among Parties and organizations on:

(a) Whether inclusion of CCS as a CDM project activity will adversely affect carbon market prices;

(b) The degree to which CCS will develop without carbon market incentives, particularly in non-Annex I Parties, and whether other financial mechanisms should be used rather than the CDM (e.g. financial mechanisms under the Convention);

(c) Whether the CDM is the appropriate vehicle to provide seed finance for emerging technologies such as CCS;

(d) The degree to which CCS inclusion as a CDM project activity could create perverse incentives for more fossil fuel extraction and consumption;

(e) Whether CCS will negatively affect the equitable distribution of CDM projects and, if so, whether that is grounds to exclude it from CDM.

99. There was general agreement that capacity-building is required for CCS projects in non-Annex I Parties in the areas of technical assistance, and design and implementation of effective regulations.

100. No agreement was apparent on the degree to which CCS contributes to sustainable development; whether the current CDM institutional structure is sufficient to handle CCS; or whether CCS could lead coal and gas to displace less-carbon-intensive fuels.

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