21 February 2011
Ref: LW

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Carbon Capture and Storage Association Submission; *Carbon dioxide capture and storage in geological formations as clean development project activities*

Summary

The Carbon Capture and Storage Association (CCSA) welcomes the opportunity to submit its views on how the issues identified in Decision -/CMP.6, paragraph 3 can be addressed. The CCSA believes that Carbon Capture and Storage (CCS) fulfils the purpose and criteria of the Clean Development Mechanism (CDM) and should be included as an eligible technology. The inclusion of CCS in the CDM would represent an important contribution to achieving the ultimate objective of the Convention.

CCS is an essential technology to deliver deep emission reductions to fossil fuel based power generation and CO_2 -intensive industries such as iron and steel, cement, refining and chemicals. Combining CCS with renewable biomass can create 'negative emissions' which actually removes CO_2 that has already been released into the atmosphere.

To date much of the focus on CCS deployment has been in developed countries. Most of the world's operating CCS projects are in developed countries as are the majority of the recently announced programmes for constructing additional CCS projects. The inclusion of CCS in the CDM would represent an important step forward to accelerating the deployment of CCS in developing countries enabling them to also benefit from the deployment of CCS.

The CCSA has considered the list of issues outlined in paragraph 3 (a) – (o) and has provided views on how these can be satisfactorily resolved in the modalities and procedures that will be developed by the Secretariat. The CCSA recommends that the CMP adopt the Tier 3 methodology outlined in the IPCC 2006 Guidelines as the guiding principles for the developments of modalities and procedures for CCS projects activities under the CDM.

The CCSA would like to make the following recommendations;

1. Site selection: Robust site characterisation and selection procedures are the most important stage of a CCS project development activity and central to ensuring that the injected CO_2 is permanently contained within the geological formation. The CCSA recommends that CMP adopt performance based and technology-neutral site selection

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criteria and considers the criteria in the European CCS Directive to be an appropriate approach.

2. Monitoring plans: Monitoring of the injected CO_2 provides assurance that the CO_2 is permanently contained. Monitoring plans are highly site specific and the monitoring criteria should be performance based. Monitoring of the storage site should continue for the period of the CO_2 injection and after the injection of CO_2 has ceased and the store closed. The monitoring should continue until the results show that the stored CO_2 is permanently contained.

3. Role of modelling: Computer modelling is an important tool used by CCS Project Developers to support the site characterisation and selection process. Modelling would not be used as the sole monitoring tool and that the information derived from modelling complements the data collected separately from other CO_2 measurement and monitoring techniques as recommended by the 2006 IPCC Inventory Guidelines.

4. Project boundaries: The project boundary for CCS projects should encompass the whole chain; capture, transportation and storage. This is consistent with standard CDM practice. The CO_2 storage site project boundary will be determined during the site characterisation and selection. Any release of CO_2 from the project boundaries will be identified by the monitoring plan and accounted for as project emissions.

5. Transboundary projects: A number of countries may have no option but to develop transboundary CCS projects if they wish to store CO_2. The 2006 IPCC Guidelines outlines how Parties should report emissions from transboundary projects and should inform the development of any transboundary projects.

6. Accounting for project emissions: The 2006 IPCC Guidelines provides a comprehensive approach to accounting for project emissions from CCS activities. CCS project emissions will include the emissions from each part of the CCS chain – CO_2 capture, transportation and storage included within the project boundary.

7. Risk and safety assessment: The site selection criteria adopted by the CMP should include criteria to guide the risk and safety assessment of the potential CO_2 storage sites. CCS projects developed under the CDM and should include an assessment of the risks and safety of the development and operation of the full CCS chain. The CCSA does not believe that the Impact Assessments for CCS project needs to be undertaken by independent entity(ies) as this is not standard CDM project development practice.

8. Liability: The liability of a CCS project takes two distinct forms, the climate liability in the event that the stored CO_2 seeps and is released into the atmosphere and the liability for any local impacts from the CCS project. The CCSA that the Host Country should be required to demonstrate that liability provisions have been established for the climate liability. The local liability issues are a national issue and should be addressed on the basis of arrangements established by the Host Country.

Introduction

The Carbon Capture and Storage Association (CCSA) welcomes the opportunity to submit its views on how the issues identified in Decision -/CMP.6, Carbon Dioxide Capture and Storage in Geological Formations as Clean Development Project Activities, paragraph 3 can be addressed in modalities and procedures guiding CCS project activities in the CDM.

The CCSA brings together a wide range of specialist companies across the spectrum of CCS technology, as well as a variety of support services to the energy sector. The Association exists to represent the interests of its members in promoting the business of Carbon Capture and Storage (CCS) and to assist policy developments towards a long term regulatory framework for CCS, as a means of abating carbon dioxide emissions.

The CCSA believes that Carbon Capture and Storage (CCS) fulfils the purpose and criteria of the Clean Development Mechanism (CDM) and should be included as an eligible technology that is credited on the basis of the real, measurable and long-term benefits to climate change mitigation it can deliver. The inclusion of CCS in the CDM would represent an important contribution to achieving the ultimate objective of the Convention.

CCS is vital to enable the world's rising energy needs, and the subsequent increase in fossil fuel use, to be compatible with the deep greenhouse gas emission reductions that are needed. CCS is an essential technology to deliver deep emission reductions to fossil fuel based power generation. CCS in CDM can ensure that developing countries do so in a secure and environmentally sustainable manner. Furthermore, CCS is the only CO_2 mitigation technology that can deliver deep emission reductions at scale in a number of CO_2 -intensive industries such as iron and steel, cement, refining and chemicals. There is also increasing interest in combining CCS with renewable biomass in order to create 'negative emissions' which would actually remove CO_2 that has already been released into the atmosphere and permanently storing it in deep geological formations.

The importance of CCS technologies to addressing climate change is highlighted by the IEA's Energy Technology Perspectives 2010 which shows the technology deployment needed to cut CO_2 emissions by 50% by 2050. This work indicates that CCS is expected to contribute to 19% of the total emissions reduction in 2050 which is the second largest contribution to CO_2 emissions reductions amongst all of the mitigation technologies. This would result in annual emissions reductions from CCS of over 8 GtCO2 in 2050 and is equivalent to over 3000 CCS projects operating worldwide in both developed and developing countries. The inclusion of CCS in a portfolio of emissions reductions also results in the lowest cost of achieving the deep emission reductions. The IEA found that attempting to reduce emissions without CCS would drive up the costs by over 70%[1].

To date much of the focus on CCS deployment has been in developed countries. Most of the world's operating CCS projects are in developed countries as are the majority of the recently announced programmes for developing additional CCS projects. The inclusion of CCS in the CDM would represent an important step forward to accelerating the deployment of CCS in developing countries by ensuring a much needed income stream for CCS projects and enables developing countries to also benefit from the deployment of CCS. There are a significant number of low-cost CCS opportunities, such as natural gas processing plants, in developing countries which could be incentivised by the inclusion of CCS in the CDM. These early, relatively low-cost opportunities could store CO_2 that is today being vented into the atmosphere. Furthermore, the inclusion of CCS in the CDM will send an important signal that

[1] Energy Technology Perspective 2010, International Energy Agency

CCS is a valid CO_2 mitigation technology helping to spur additional sources of funding and support for CCS which will enable increased deployment and emissions reductions to be delivered.

The CCSA has considered the list of issues outlined in paragraph 3 (a) – (o) and has provided views on how these can be satisfactorily resolved in the modalities and procedures that will be developed by the Secretariat. Having considered the list of issues contained in paragraph 3 the CCSA has grouped these under the following headings;

1. Site selection (Para. 3.a & d)
2. Monitoring plans (Para. 3.b & d)
3. Role of modelling (Para. 3.c)
4. Project boundaries (Para. 3.e - g)
5. Transboundary projects (Para. 3.h)
6. Accounting for project emissions (Para. 3.i)
7. Risk and safety assessment (Para. 3.j - l)
8. Liability (Para. 3.m - o)

In the submission below the CCSA has provided an overview of the approach to reporting emissions from CCS projects and addressed each of the eight issues identified in paragraph 3. a – o. For each of the eight issues the CCSA provides a short summary of the issue under discussion, considers existing approaches that have been taken to address these issues and outlined how the issues could be addressed within the CDM framework.

<u>Accounting for emissions from CCS projects and integration with CDM framework</u>

Geological formations of the type that are suitable for the storage of CO_2 are natural systems that demonstrate a significant degree of variability between sites. This variability means that the effectiveness of individual sites to permanently store CO_2 will differ and site specific selection, development and operation plans must be developed and implemented to ensure permanent containment of CO_2. For this reason the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (hereafter 2006 IPCC Guidelines) has concluded that a Tier 1 or 2 approach to reporting emissions, i.e. emission factors, are inappropriate and instead has developed a Tier 3 site specific approach to estimating and reporting emissions from CCS projects.

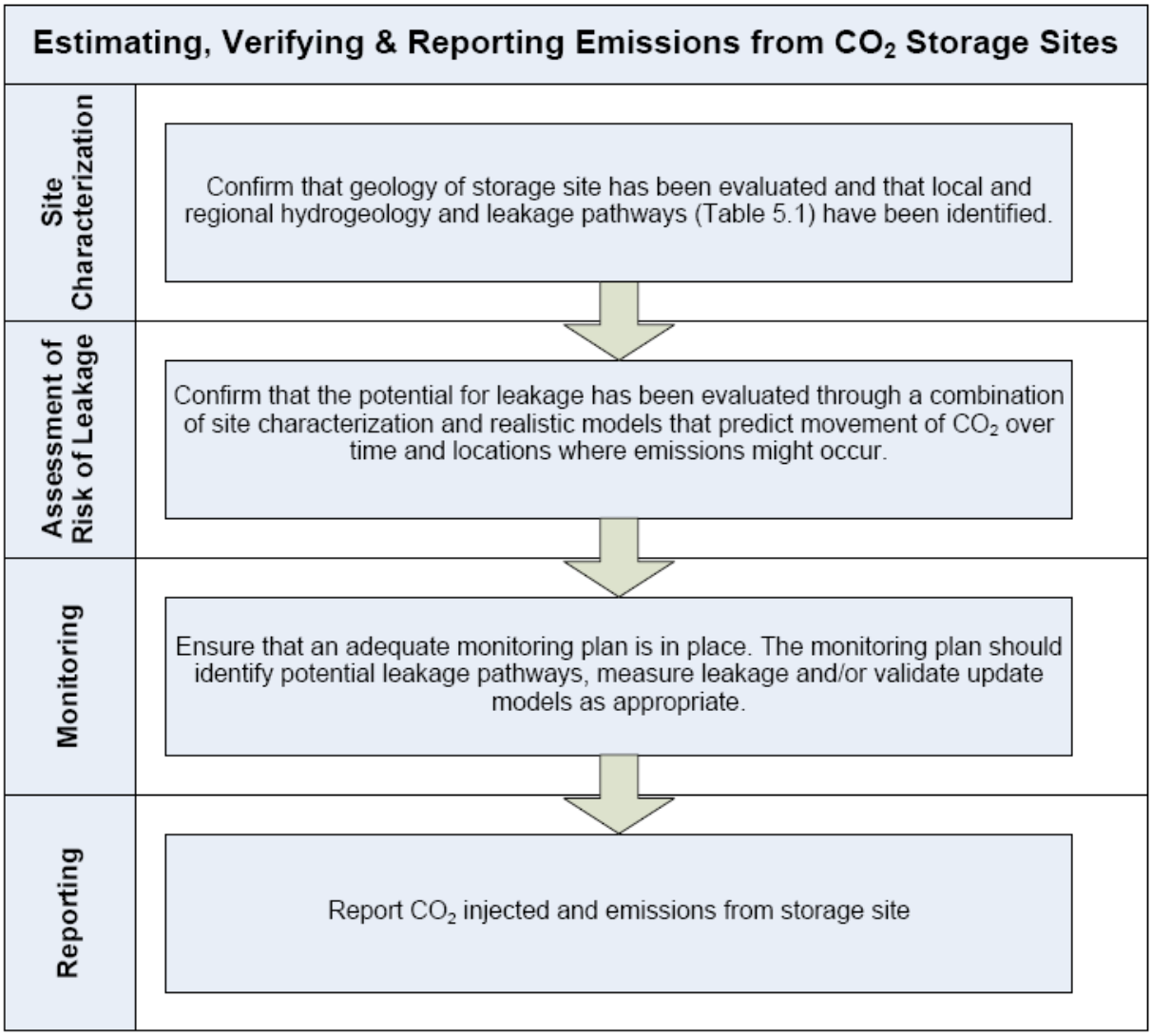
The Tier 3 approach to emissions estimation requires the collection of a greater range of data than either the Tier 1 or 2 approaches and is a more accurate method of reporting emissions. The Tier 3 approach to reporting emissions from CCS projects involves a sequential process of (Figure 1);

1. Thorough site characterisation to understand the geology, chemistry and hydrology of the geological formation,
2. Assessment of leakage risk of the site based on the characterisation of the site,
3. Selection of the site to be used for storage based on the findings of the site characterisation and leakage risk assessment,
4. Development and implementation of a site specific monitoring plan,
5. Reporting of the CO_2 that is injected into the formation and any emissions from the project.

This approach places a strong emphasis on effective site characterisation, selection and monitoring as the key to ensuring the long-term, environmentally safe storage of CO_2. Where CO_2 is injected into appropriately selected and managed storage sites and the monitoring of the stored CO_2 shows it to be behaving as predicted and not leaking then the 2006 IPCC Guidelines recommends reporting that there are no emissions of CO_2 from the storage site.

The CCSA believes that the emissions estimation guidance for CCS contained within the 2006 IPCC Guidelines represents international best practice, provides assurance that CCS activities are developed in a manner that ensures the greatest protection of the environment and are the common global basis for the reporting of emissions from CO_2 storage sites. The Tier 3 approach detailed in the IPCC 2006 Guidelines is the result of a substantial body of work undertaken by the IPCC, is consistent and fully supported by the IPCC Special Report on Carbon Dioxide Capture and Storage and has been used as the basis for the establishment of other CCS reporting methodologies internationally. For example, the London and OSPAR Conventions and the regional legislation developed in the EU, Japan, Australia and elsewhere have all been based on the 2006 IPCC Guidelines approach to the reporting of emissions.

Figure 1: 2006 IPCC Guidelines approach to reporting emissions from CCS projects.



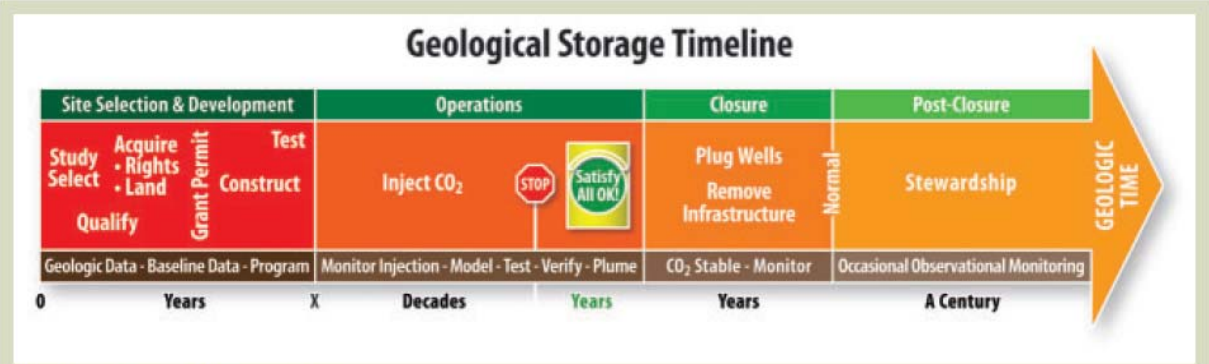
The CCSA recommends that the CMP adopt the Tier 3 methodology outlined in the IPCC 2006 Guidelines as the guiding principles for the developments of modalities and procedures for CCS projects activities under the CDM.

The lifecycle of CCS projects comprises of four distinct phases (Figure 2):

1. Site selection; Storage site characterised, selected and developed.
2. Operations; CO_2 injected into the geological store.
3. Closure; CO_2 injections ceases and the storage site closed.
4. Post-closure; CO2 permanently contained in the storage site.

The CCSA believes that it will be helpful for Parties to remain cognisant of the CCS project lifecycle and the four distinct project phases as they consider the issues raised in Paragraph 3. For example, the approach to monitoring during the "operations" phase of the project is very likely to be different from what is appropriate during the "post-closure" period.

Figure 2: Typical CCS project lifecycle[2]



The four phases of CCS projects.

The CCSA believes that the current CDM institutional arrangements are suitable for CCS and that CCS project activities can be developed in a safe and environmentally effective manner under the current CDM modalities and procedures. The only change that would be required is the establishment of a CCS sectoral scope that would be used to accredit Designated Operational Entities (DOEs) to ensure that they have the required competencies to undertake the project validation, verification and certification stages of the CDM project development process.

<u>Addressing issues identified in Decision-/CMP.6, Paragraph 3</u>

1. <u>Site selection</u>

Decision- / CMP.6, Paragraph 3;
(a) The selection of the storage site for carbon dioxide capture and storage in geological formations shall be based on stringent and robust criteria in order to seek to ensure the long-term permanence of the storage of carbon dioxide and the long-term integrity of the storage site;

(d) The criteria for site selection and monitoring plans shall be decided upon by the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol and may draw upon relevant guidelines by international bodies, such as the 2006 IPCC Guidelines for National Greenhouse Gas Inventories;

[2] The CO_2 Capture Project is a joint industry project of major energy companies. The CO_2 Capture Project published *A Technical Basis for Carbon Dioxide Storage* in 2009. The book is available from the following website: http://www.co2captureproject.org/co2_storage_technical_book.html

Issue overview

Robust site characterisation and selection procedures are widely recognised to be the most important stage of a CCS project development activity and central to ensuring that the injected CO_2 is permanently contained within the geological formation. Determining the suitability of a geological formation for use as a potential storage site requires an assessment of the site's characteristics. The data collected during the site characterisation should provide the project developer with information on the potential storage and injection capacity of the geological formation, the characteristics of the surrounding geological formations that will act as the CO_2 trapping mechanisms and any potential seepage pathways for the stored CO_2.

The characterisation and selection of CO_2 storage sites utilises the technologies and practices of other industries that operate in the subsurface including petroleum, underground gas storage and water management. The precise approach and the technologies used is based on the characteristics of the site under consideration as the suitability and applicability of specific characterisation technologies will differ substantially between sites. The CCSA therefore recommends that the site selection criteria should be performance based and technology-neutral and considers the criteria outlined in the European CCS Directive to be an appropriate model to follow. This approach is more appropriate than prescriptive criteria which simply set requirements for each physical parameter of the store. The performance based approach requires each project developer to demonstrate that the permitting requirements have been met for that individual site. The development of performance based regulations is common in industries where there are significant differences between projects and enables technical solutions to be developed for the specific challenges of each project.

The CCSA would also like to note that an integral part of the site characterisation and selection process involves undertaking a site specific risk assessment. A broader discussion on risk assessment is covered in section 7 below.

Following the site selection and risk assessment phases the operator will use the findings to develop a Field Development Plan which will outline the proposed development of the field and the site specific plans for operating and monitoring (See section 2). The Field Development Plan will be agreed with the Host Country.

Existing work of relevance

CO_2 Capture Project: A Technical Basis for Carbon Dioxide Storage

- Chapter 1: Site Selection

CO2QUALSTORE, Guideline for the Selection and Qualification of Sites and Projects for Geological Storage of CO_2[3];

- Sections 2 – 3.6 (p.13 – 27).

European Union Directive on the Geological Storage of Carbon Dioxide 2009[4];

- Annex I, Criteria for the Characterisation and Assessment of the Potential Storage Complex and Surrounding Area Referred to in Article 4(3)

Implications of the Inclusion of Geological CO2 Capture and Storage as CDM Project Activities, A report for the UNFCCC, UNFCCC/EB50 Annex 1 (2009)[5]

[3] Guidelines developed by multiple stakeholders including industry, national authorities and other CCS organisations to provide a systematic approach to selection of CO2 storage sites. http://www.dnv.com/industry/energy/rules_standards/qualstore_guideline_co2/

[4] Regulations governing CCS activities on Europe including criteria for the characterisation and selection of storage sites. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:140:0114:0135:EN:PDF

[5] http://cdm.unfccc.int/EB/050/eb50annagan1.pdf

- Section 3.5 CO_2 storage site characterisation and selection (p.34 – 36)

London Protocol 1996 (LP)[6];

- Risk Assessment and Management Framework for CO_2 Sequestration in Sub-Seabed Geological Structures
  - Chapter 2, Site Selection and Characterisation (p.8 – 10).
  - Appendix 1, Information for the Site Selection and Site Characterisation (p.26 – 28)

SGS New Methodology Submission of 24th August 2009 ref. CDM.VAL1805 NM 'Capture, transport and long-term storage in geological formations of carbon dioxide from natural gas processing operations'[7]

Approach under CDM

Conference of the Parties Serving as the meeting of the Parties to the Kyoto Protocol (CMP);

- Adopt performance based criteria for site selection to be used by CCS project developers.

Project Developer;

- Agrees site selection with the Host Country. Information on the site characterisation and selection activities, along with the site development and operation plans, will be included in the Field Development Plan which will be agreed with the Host Country.
- Details the site characterisation and selection activities in the Project Design Document (PDD). The information provided to be consistent with the CMP site selection criteria

Designated Operational Entity (DOE);

- Independently assesses the information contained in the PDD - including whether the CMP approved site selection criteria were adequately considered - during the project validation stage.

CDM Executive Board;

- Makes registration decision, referring to the CMP criteria.

2. Monitoring plans

Decision- / CMP.6, Paragraph 3;
(b) Stringent monitoring plans shall be in place and be applied during and beyond the crediting period in order to reduce the risk to the environmental integrity of carbon dioxide capture and storage in geological formations;

(d) The criteria for site selection and monitoring plans shall be decided upon by the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol and may draw upon relevant guidelines by international bodies, such as the 2006 IPCC Guidelines for National Greenhouse Gas Inventories;

Issue Overview

Monitoring of the CO_2 that is injected into geological formations provides assurance that the CO_2 is permanently contained and is used to help calculate the level of emission reductions that should be reported from the project. The CCSA would like to emphasise that while the monitoring provides assurance on the emission reductions it is the robust site selection, development and management practices that ensures that the site will permanently store

[6] Currently has 39 Parties and was established to protect and preserve the marine environment. In 2006, Parties adopted amendments (LP.1(1)) to regulate CCS in sub-seabed formations. www.londonprotocol.imo.org

[7] Methodology can be found on the following website: http://www.insalahco2.com/index.php?option=com_content&view=article&id=110&Itemid=169&lang=en

CO_2. As with site selection practices the monitoring programmes developed for CCS utilise the practices and technologies that are extensively deployed in other industrial sectors that operate in the subsurface. The monitoring data collected will also be used by the operator in conjunction with modelling of the CO2 storage site (See section 3).

The monitoring plan is developed based on the findings from the site characterisation and selection phase (see section 1), the site specific risk assessment (section 7) and the site development and operating plans outlined in the Field Development Plan. As a result the monitoring plans are highly site specific and based on the best combination of technologies that can be successfully used at that storage site under the site's operating conditions. Therefore the CCSA recommends that the monitoring criteria are performance based and technology neutral.

Due to the nature of CCS the monitoring must continue to the extent necessary to confirm that the CO_2 has been permanently contained within the storage site. Monitoring of the storage site should continue for the entire period of the CO_2 injection (i.e. the CDM crediting period) and should also continue after the injection of CO_2 has ceased and the store has been closed (i.e. the CDM post-crediting period). The monitoring programme should continue after the site has closed and until the results show that the stored CO_2 plume is evolving towards a stable state which means that there is no reasonable expectation that the CO_2 will leak and the CO_2 is therefore considered to be permanently contained. Once the monitoring results confirm that the CO_2 is permanently contained, then the Project Developer will apply to the Host Country to either stop the monitoring programme or reduce the monitoring to a low-intensity programme.

The CCSA recommends that the monitoring data collected by the Project Developer should be recorded and archived in a manner which enables independent verification of the project if deemed necessary by either the host country or CDM EB.

Finally the CCSA would like to note that while the discussion above has focussed on the monitoring of the CO_2 storage site monitoring will also be required for the capture and transportation parts of the CCS chain in order that an accurate calculation of the total emission reductions can be achieved. The methodologies used to report emissions from CO_2 capture and transport can be found in the 2006 IPCC Guidelines.

Existing work of relevance

CO_2 Capture Project: A Technical Basis for Carbon Dioxide Storage

- Chapter 3: Monitoring Programs for CO2 Storage

European Union Directive on the Geological Storage of Carbon Dioxide 2009;

- Annex I, Annex II, Criteria for Establishing and Updating the Monitoring Plan Referred to in Article 13(2) and for Post-Closure Monitoring

Implications of the Inclusion of Geological CO2 Capture and Storage as CDM Project Activities, A report for the UNFCCC, UNFCCC/EB50 Annex 1 (2009)[8]

- Section 4.1 Monitoring and verification (p.42 – 45)

2006 Intergovernmental Panel on Climate Change Guidelines for National Greenhouse Gas Inventories;

- Volume 2, Chapter 5.7, Methodological Issues (p.5.13 – 5.17).

[8] http://cdm.unfccc.int/EB/050/eb50annagan1.pdf

- Volume 2, Chapter 5, Annex 5.1; Summary Description of Potential Monitoring Technologies for Geological CO_2 Storage Sites (p.5.22 – 5.30).

Intergovernmental Panel on Climate Change, Special Report Carbon Dioxide Capture and Storage (2005);

- Chapter 5.5 Monitoring and Verification Technologies (p.234 – 242).

London Protocol 1996 (LP);

- Risk Assessment and Management Framework for CO_2 Sequestration in Sub-Seabed Geological Structures
  - Sections 6.20 – 6.24 (p.22 – 28).

SGS New Methodology Submission of 24th August 2009 ref. CDM.VAL1805 NM 'Capture, transport and long-term storage in geological formations of carbon dioxide from natural gas processing operations'

Approach under CDM

Conference of the Parties Serving as the meeting of the Parties to the Kyoto Protocol;

- Adopt performance-based criteria for monitoring plans to be used by CCS project developers.

Project Developer;

- Agrees site-specific monitoring plan with the Host Country. This information will be included in the Field Development Plan which will be agreed with the Host Country.
- Details of the site-specific monitoring plan are included in the PDD. The information provided to be consistent with the CMP monitoring plan criteria.

Designated Operational Entity;

- Assesses the monitoring plan contained in the PDD - including whether the monitoring plan criteria adopted by the CMP were adequately considered - during the project validation stage.
- Confirm that the project developer has implemented the agreed monitoring plan and the emission reductions achieved by the CCS project as demonstrated by the monitoring results during the periodic project verification.

CDM Executive Board;

- Makes registration decision, referring to the CMP monitoring plan criteria.

3. Role of modelling

Decision- / CMP.6, Paragraph 3;
(c) Further consideration is required as regards the suitability of the use of modelling, taking into account the scientific uncertainties surrounding existing models, in meeting the stringency requirements of such monitoring plans, in particular taking into account the 2006 IPCC Guidelines for National Greenhouse Gas Inventories;

Issue Overview

Computer modelling is an important tool used by CCS Project Developers to support the site characterisation and selection process, the risk assessment and the development and implementation of the site monitoring plan. Modelling of the sub-surface has been routinely practiced in the petroleum industry for decades to manage the production of oil and gas from hydrocarbon reservoirs.

A number of models have been developed specifically for the purpose of developing and assessing CO_2 storage projects. Sub-surface models are used to develop an understanding of the CO_2 storage site and surrounding geological formations as well as the presence of any faults or other geological features. Modelling is then used to investigate the behaviour of the CO_2 once injected into the store, the movement of the CO_2 plume within the formation and the interaction with other reservoir fluids. The data generated from the modelling, along with the site characterisation data, are used to inform the development of the monitoring plan. Once injection of the CO_2 commences then the information gathered by monitoring is used to update the models helping to continuously increase understanding of the stored CO_2 and improve the predictive capabilities of the model.

The CCSA emphasises that modelling would not be used as the sole monitoring tool and that the information derived from modelling complements the data collected separately from other CO_2 measurement and monitoring techniques as recommended by the 2006 IPCC Inventory Guidelines. It is on the basis of the synthesis of these various sources of data that decisions on site selection, management practices, etc are made to ensure that the CO_2 is safely and permanently stored.

Existing work of relevance

CO_2 Capture Project: A Technical Basis for Carbon Dioxide Storage

- Chapter 1: Site Selection; particularly section 1.7 "Special site characterization issues for CO2 storage"

2006 Intergovernmental Panel on Climate Change Guidelines for National Greenhouse Gas Inventories;

- Volume 2, Chapter 5.7, Methodological Issues (p.5.13 – 5.16).

Intergovernmental Panel on Climate Change, Special Report Carbon Dioxide Capture and Storage (2005);

- Chapter 5.4, Characterisation and Performance Prediction for Identified Sites (p.225 – 230).

SGS New Methodology Submission of 24th August 2009 ref. CDM.VAL1805 NM 'Capture, transport and long-term storage in geological formations of carbon dioxide from natural gas processing operations'

Approach under CDM

Project Developer;

- Agrees Field Development Plan with the Host Country. The Host Country agreement is based on an assessment that the appropriate techniques - including modelling, measurement and monitoring – are utilised by the Project Developer.
- Details the approaches used for site selection and the development of operation and monitoring plans in the PDD.

Designated Operational Entity;

- Assesses the appropriateness of the techniques used to determine the site selection and establish the operating plans based on the information contained in the PDD during the project validation stage.
- Assesses the operation of the project and the appropriate use of the various techniques during the periodic project verification phase.

CDM Executive Board;

- Makes registration decision.

4. CCS project boundaries

Decision- / CMP.6, Paragraph 3;
(e) The boundaries of carbon dioxide capture and storage in geological formations shall include all above-ground and underground installations and storage sites, as well as all potential sources of carbon dioxide that can be released into the atmosphere, involved in the capture, treatment, transportation, injection and storage of carbon dioxide, and any potential migratory pathways of the carbon dioxide plume, including a pathway resulting from dissolution of the carbon dioxide in underground water;

(f) The boundaries referred to in paragraph 3 (e) above shall be clearly identified;

(g) Any release of carbon dioxide from the boundaries referred to in paragraph 3 (e) above must be measured and accounted for in the monitoring plans and the reservoir pressure shall be continuously measured and these data must be independently verifiable;

Issue overview

Under the CDM the project boundary should "encompass all anthropogenic emissions by sources of greenhouse gases under the control of the project participants that are significant and reasonably attributable to the CDM project activity" (ref). This means that the project boundary for CCS projects should encompass the whole chain; CO_2 capture, transportation and storage. The CO_2 storage site project boundary will be determined during the site characterisation and selection (See section 1) and risk assessment exercise (See section 7). The boundaries of the aboveground facilities can be readily determined using standard project boundary approaches.

A combination of the site characterisation, modelling (See section 3) and monitoring plans will be used to ensure that potential migratory pathways for the stored CO_2 are identified enabling the project boundary to encompass the complete project. Any release of CO_2 emissions from the project boundaries (i.e. the capture, transportation and storage stages) will be identified by the site specific monitoring plans established during the project development stages (See section 2). These monitoring plans enable any emissions from the CCS project activity to be calculated and accounted for as project emissions.

The CCSA believes that all of the relevant data from the monitoring and operation of the CCS project and not just reservoir pressure should be collected and archived by the project operator in order to support the project verification activities.

Existing work of relevance

Implications of the Inclusion of Geological CO2 Capture and Storage as CDM Project Activities, A report for the UNFCCC, UNFCCC/EB50 Annex 1 (2009)[9]

- Section 4.3.1 Project boundaries (p.46 – 47)

2006 Intergovernmental Panel on Climate Change Guidelines for National Greenhouse Gas Inventories;

- Volume 2, Chapter 5, Sections 5.2 – 5.6.1 (p5.5 – 5.12).

SGS New Methodology Submission of 24th August 2009 ref. CDM.VAL1805 NM 'Capture, transport and long-term storage in geological formations of carbon dioxide from natural gas processing operations'

[9] http://cdm.unfccc.int/EB/050/eb50annagan1.pdf

Approach under CDM

Project Developer;

- CCS project boundary clearly identified in the PDD.

Designated Operational Entity;

- Assesses whether the project boundary meets the requirements of the CDM M&P during the project validation stage.
- Assesses whether the project boundary operation meets the requirements of the CDM M&P during the periodic project verification phase.

CDM Executive Board;

- Makes registration decision.
- Keep a register of CCS projects which includes a record of the project boundary of the CO_2 store.

5. Transboundary projects (Para. 3.h)

Decision- / CMP.6, Paragraph 3;
(h) The appropriateness of the development of transboundary carbon dioxide capture and storage project activities in geological formations and their implications shall be addressed;

Issue overview

There are a number of circumstances under which transboundary CCS projects could be developed. For example, a country with limited to access to suitable CO_2 stores could export CO_2 to another country which has access to abundant CO_2 storage formations. Alternatively two countries might have access and wish to inject CO_2 into a storage site which crosses a common national border.

The CCSA believes that the overwhelming majority of CCS projects will have project boundaries that are contained well within the national borders of the host country and so in practice there may be relatively few transboundary CCS projects. However, a number of countries may have no option but to develop transboundary CCS projects if they wish to store CO_2. Recognising the need to enable transboundary projects the 2006 IPCC Guidelines provides guidance to Parties on how emissions from transboundary projects should be reported. In addition the Parties to the London Protocol amended Article 6 of the protocol in October 2009 in order to permit the transboundary export of CO_2 for storage in sub-seabed geological formations.

Transboundary projects will have to establish liability regime arrangements that address the particular nature of these projects (See section 8) and these should be guided by the reporting arrangements outlined in the IPCC 2006 guidelines. Where CO_2 is shipped from one country to another for storage then the country which is the source of the CO_2 would report and be responsible for the CO_2 emissions from the capture plant and the transportation of the CO_2 to the storage country. The country that will store the CO_2 will record and be responsible for the CO_2 emissions during transportation once it enters the country and any emissions from the CO_2 storage site. The liability provisions should follow this approach.

Where two countries share a storage site that crosses a common border then both countries will be responsible for reporting the emissions from the CO_2 capture and transportation to the storage site that occurs within their borders. Any emissions from the storage site are to be reported by the countries based on a pre-agreed proportion of the total emissions.

A Party could in theory become an unwitting host to a transboundary project if stored CO2 migrated in the geological formation and crossed a national border. However, in practice this risk would be identified during the site characterisation (See section 1) and risk assessment (See section7) phases and steps taken to address it, i.e. the second country either gives permission for the store to be used or the geological formation is not used as a store. In the very unlikely event that CO_2 is injected in one country and then migrated across a national border and then leaked from the store in another country it would be the country that injected the CO_2 that would be held responsible.

Existing work of relevance

London Protocol 2009 (LP);

- Article 6, Exports of Wastes or Other Matters.

2006 Intergovernmental Panel on Climate Change Guidelines for National Greenhouse Gas Inventories;

- Volume 2, Chapter 5, Reporting of cross-border CCS (p.5.20 – 5.21).

Approach under CDM

Designated National Authority (DNA);

- The DNA of all countries participating in the transboundary CCS project confirm national approval to co-host the project.
- National approvals clearly establish the respective responsibilities of the host countries including liability arrangements. These should be based on the approach for recording emissions from transboundary projects outlined in the IPCC 2006 Guidelines.

CDM Executive Board;

- Makes registration decision only where all the relevant DNAs have indicated approval for the project and clear responsibility for the CO_2 has been apportioned.

6. Accounting for project emissions

Decision- / CMP.6, Paragraph 3;
(i) Any project emissions associated with the deployment of carbon dioxide capture and storage in geological formations shall be accounted for as project or leakage emissions and shall be included in the monitoring plans, including an ex-ante estimation of project emissions;

Issue overview

The 2006 IPCC Guidelines provides a comprehensive approach to accounting for project emissions from CCS activities. CCS project emissions will include the emissions from each part of the CCS chain – CO_2 capture, transportation and storage included within the project boundary (See section 4). The monitoring plan for a CCS project (See section 2) is developed based on the findings of the site characterisation and when coupled with the monitoring of all of the aboveground elements of the project means that all of the project emissions will be accounted for and reported. This approach is consistent with the approach taken to account for emissions from other CDM project activities. Leakage emissions are defined under the CDM "as the net change of anthropogenic emissions by sources of greenhouse gases which occurs outside the project boundary, and which is measurable and

attributable to the CDM project activity". The CCSA believes that where leakage emissions are identified then they can be accounted for and reported.

Existing work of relevance

Implications of the Inclusion of Geological CO2 Capture and Storage as CDM Project Activities, A report for the UNFCCC, UNFCCC/EB50 Annex 1 (2009)[10]

- Section 4.1 Monitoring and verification (p.42 – 45)

2006 Intergovernmental Panel on Climate Change Guidelines for National Greenhouse Gas Inventories;

- Volume 2, Chapters 5 – 5.10 (p.5.5 – 5.21)

SGS New Methodology Submission of 24th August 2009 ref. CDM.VAL1805 NM 'Capture, transport and long-term storage in geological formations of carbon dioxide from natural gas processing operations'

Approach under CDM

Designated Operational Entity;

- Project emissions accounted for and determined during the periodic project verification.
- Leakage emissions accounted for and determined during the periodic project verification.

7. Risk and safety assessment

Decision- / CMP.6, Paragraph 3;
(j) A thorough risk and safety assessment using a methodology specified in the modalities and procedures, as well as a comprehensive socio-environmental impacts assessment, shall be undertaken by independent entity(ies) prior to the deployment of carbon dioxide capture and storage in geological formations;

(k) The risk and safety assessment referred to in paragraph 3 (j) above shall include, inter alia, the assessment of risk and proposal of mitigation actions related to emissions from injection points, emissions from above-ground and underground installations and reservoirs, seepage, lateral flows, migrating plumes, including carbon dioxide dissolved in aqueous medium migrating outside the project boundary, massive and catastrophic release of stored carbon dioxide, and impacts on human health and ecosystems, as well as an assessment of the consequences of such a release for the climate;

(l) The results of the risk and safety assessment, as well as the socio-environmental impacts assessment, referred to in paragraphs 3 (j) and (k) above shall be considered when assessing the technical and environmental viability of carbon dioxide capture and storage in geological formations;

Issue overview

The robust characterisation and selection of storage sites is the principal step to ensuring that CCS projects permanently store CO_2, are safe and environmentally sound. To achieve permanent storage of CO_2 the site characterisation and selection stages of a CCS project must include a thorough risk assessment to determine the likelihood of CO_2 seepage and the impacts of the seepage in the event that a seepage event occurred. The CCSA recommends that the site selection criteria adopted by the CMP (See Section 1 above) include criteria to guide the risk and safety assessment of the potential CO_2 storage sites.

Geological formations used to store CO_2 differ significantly and they require thorough characterisation in order to better understand the specific features of the site under

[10] http://cdm.unfccc.int/EB/050/eb50annagan1.pdf

consideration and the effectiveness of a site for storing CO_2. The site characterisation must consider not only the storage formation and those geological formations immediately surrounding it but also the nature of the geology and presence of any resources that overlay the proposed storage site as well as the aboveground features. The combination of the site characterisation and modelling simulations (See section 3) enables the Project Developer to identify;

1. Operational parameters, i.e. maximum reservoir pressure and injection rates,
2. Potential seepage pathways of CO_2 from the store,
3. Impacts of any CO_2 seepage, i.e. CO_2 infiltration into other resources or leakage to surface,
4. Any secondary impacts of CO_2 storage, i.e. brine migration.

Those sites that the risk assessment demonstrates to be unsuitable for storage will not be considered further. For the sites that the risk assessment shows can be utilised safely, the Project Developer will establish development, operation and risk management plans to enable the site to be operated in a manner that effectively mitigates the identified risks and impacts. The results of the risk assessment will be used to develop a site specific monitoring plan which monitors any identified features where there is a possibility of CO_2 seepage. In the event that any seepage of CO_2 is identified from the monitoring, remedial action can be undertaken and any emissions accounted for.

CDM Project Developers are required to undertake an Environmental Impact Assessment as an eligibility requirement for projects to be registered under the CDM. The CCSA believes that this eligibility requirement should be extended to CCS projects developed under the CDM and should include an assessment of the risks and safety of the development and operation of the full CCS chain. The CCSA notes in this regard that an EIA for CCS projects are not materially different from the EIAs undertaken on other large industrial projects.

The CCSA does not believe that the EIA assessment for the CCS project needs to be undertaken by independent entity(ies) as this is not standard CDM project development practice. Standard CDM practice requires the project proponent to undertake an Impact Assessment (IA) which may be extended to a full EIA if considered significant by the Host Country which has ultimate control over the EIA. The DOE confirms that an EIA has been undertaken during the project validation phase.

Existing work of relevance

CO2QUALSTORE, Guideline for the Selection and Qualification of Sites and Projects for Geological Storage of CO_2;

- Sections 2.5, 3.5, 4.3, 4.4, Appendix D (p.17; 25 – 27; 37 - 39; 65 – 72).

European Union Directive on the Geological Storage of Carbon Dioxide 2009;

- Annex I, Criteria for the Characterisation and Assessment of the Potential Storage Complex and Surrounding Area Referred to in Article 4(3) – Step 3.3.

Implications of the Inclusion of Geological CO2 Capture and Storage as CDM Project Activities, A report for the UNFCCC, UNFCCC/EB50 Annex 1 (2009)[11]

- Section 6 Environmental issues (p.52 – 55)

London Protocol 1996 (LP);

[11] http://cdm.unfccc.int/EB/050/eb50annagan1.pdf

- Risk Assessment and Management Framework for CO_2 Sequestration in Sub-Seabed Geological Structures

SGS New Methodology Submission of 24th August 2009 ref. CDM.VAL1805 NM 'Capture, transport and long-term storage in geological formations of carbon dioxide from natural gas processing operations'

Approach under CDM

Conference of the Parties Serving as the meeting of the Parties to the Kyoto Protocol;

- Adopt risk assessment criteria and incorporate into the performance based criteria for site selection to be used by CCS project developers.

Project Developer;

- Agrees with the Host Country on whether the storage site should be selected based on results of risk assessment. Information on the site characterisation and selection activities, along with the site development and operation plans, will be included in the Field Development Plan which will be agreed with the Host Country.
- Details the site characterisation and selection activities in the PDD. The information provided to be consistent with the CMP site selection criteria.
- Project developer includes the results of the risk assessment exercise in the PDD.

Designated Operational Entity (DOE);

- Independently assesses the information contained in the PDD - including whether the risk assessment criteria were adequately considered - during the project validation stage.
- DOE confirm that impact assessment undertaken by project developer.

CDM Executive Board;

- Makes registration decision, referring to the CMP criteria.

8. Liability

Decision- / CMP.6, Paragraph 3;
(m) Short-, medium- and long-term liability for potential physical leakage or seepage of stored carbon dioxide, potential induced seismicity or geological instability or any other potential damage to the environment, property or public health attributable to the clean development mechanism project activity during and beyond the crediting period, including the clear identification of liable entities, shall:

(i) Be defined prior to the approval of carbon dioxide capture and storage in geological formations as clean development mechanism project activities;
(ii) Be applied during and beyond the crediting period;
(iii) Be consistent with the Kyoto Protocol;

(n) When determining the liability provisions referred to in paragraph 3 (m) above, the following issues shall be considered:

(i) A means of redress for Parties, communities, private-sector entities and individuals affected by the release of stored carbon dioxide from carbon dioxide capture and storage project activities under the clean development mechanism;
(ii) Provisions to allocate liability among entities that share the same reservoir, including if disagreements arise;
(iii) Possible transfer of liability at the end of the crediting period or at any other time;
(iv) State liability, recognizing the need to afford redress taking into account the longevity of liabilities surrounding potential physical leakage or seepage of stored carbon dioxide, potential induced seismicity or geological instability or any other potential damage to the environment, property or public health attributable to the clean development mechanism project activity during and beyond the crediting period;

(o) Adequate provision for restoration of damaged ecosystems and full compensation for affected communities in the event of a release of carbon dioxide from the deployment of carbon dioxide capture and storage in geological formations must be established prior to any deployment of related activities;

Issue overview

The liability of a CCS project takes two distinct forms. Firstly, there is the climate liability in the event that the stored CO_2 seeps and is released into the atmosphere. Secondly there is the liability for any local impacts from the CCS project, for example damage to the local environment or communities as a result of CO_2 seepage. The inclusion of CCS in the CDM will require the Host Country to implement and demonstrate that provisions have been established to ensure that the climate liability is satisfactorily addressed.

In contrast, local liability issues - such as damage to the environment, property or public health - are a national issue and should be addressed on the basis of arrangements established by the Host Country. The national regulatory approach for managing liabilities in existing industrial sectors should be extended to CCS as appropriate. This is consistent with the approach taken to manage the liabilities from other CDM projects.

A number of countries and regions have developed CCS regulatory frameworks and there is a significant degree of commonality between the approaches taken to address CCS project liability. These approaches should inform the treatment of liability for CCS projects under the CDM. The liability of CCS projects consists of four distinct phases;

1. During the operational phase of the project the Project Developer should remain responsible and liable for the CCS project. Any seepage of CO_2 should be remediated by the Project Developer and any CO_2 emissions from the project will be monitored and accounted for as project emissions.
2. At the end of the operational phase of the project CO_2 injection will cease and the store will be closed. During this post-closure phase the Project Developer will continue to monitor the stored CO_2 (see section 2 above) to ensure it is behaving as expected, evolving towards a stable state and that there is no seepage of CO_2. The Project Developer should continue to hold the liability for the project during this phase of the project lifecycle and will be responsible for any remediation that may be necessary. Any seepage of CO_2 from the store will be monitored and the Project Developer is responsible for surrendering CERs equivalent to the quantity of CO_2 that has seeped.
3. After a period of time continued monitoring will demonstrate that the CO_2 is evolving towards a stable state (“the post-closure period”) and can be considered permanently stored as there is no expectation of further seepage. Once the Project Developer has demonstrated - through meeting pre-agreed performance criteria developed by the project developer and Host Country when issuing the injection permit - that the CO_2 is permanently stored, then responsibility for the store is transferred to the Host Country and the Project Developer has no further liability for the stored CO_2. The liability transfer provisions have been developed as private companies will not remain solvent in the long term and so ultimately the residual liability should be transferred to the state.
4. Some countries may also require the project proponent to make a contribution to the Host Country for monitoring costs post liability transfer. This would be agreed at the site selection stage.

While it is expected that CCS projects will follow the lifecycle outlined above, the detail on the actual implementation of the liability regime and the financial instruments used to meet the liability requirements should be left to the host country to agree with the Project Developer.

The Host Country has a number of approaches available to manage the liability once the Project Developer has demonstrated that the CO_2 is permanently contained in the storage site.

Firstly, the responsibility for the store can revert to the Host Country which is then responsible for surrendering CERs, or equivalent, in the very unlikely event that there is any subsequent seepage of CO_2. It should be emphasised that as the Project Developer has already demonstrated that the CO_2 is permanently contained there is no expectation of any seepage. Alternatively, the Host Country may establish a pool of CERs, or equivalent, accumulated during the CCS operation phase which can be surrendered in the very unlikely event of any subsequent seepage of CO_2.

The CCSA believes that the PDD should clearly allocate responsibility for the stored CO_2 over the full life of the project. Furthermore the DNA should confirm in the project approval document that a liability arrangement has been established that clearly identifies the entity holding the liability at each of the different stages of the project lifecycle.

The allocation of liabilities amongst entities sharing storage reservoirs can be addressed in a number of ways. The Host Country could only permit one Project Developer to operate each storage reservoir so that all of the liabilities reside with one entity. Alternatively, the Host Country may permit more than one operator to operate a storage reservoir contingent on clear allocation of liabilities between entities being established before injection of CO_2 commences. These practices are commonly applied in other industrial sectors and a number of standard commercial arrangements are available to allocate liability between the different entities.

There are a wide number of financial security instruments, or equivalents, which Host Countries and Project Developers can use to address liabilities and contingent liabilities arising from industrial activities. These instruments can be used to ensure that adequate funds are made available to cover the costs of meeting any liabilities such as remediation, compensation, etc in the event that such a situation arises. These mechanisms can be developed and adapted for CCS projects, for example to cover the cost of replacing any seepage emissions that occur after site closure, but before any transfer of liability, with CERs or equivalent. The precise nature of the mechanisms used will be agreed between the Host Country and Project Developer during the site selection phase and will based on an assessment of, *inter alia*, the specific project under consideration, the credit standing of the Project Developer and the favoured mechanisms of the Host Country. In addition, there will be opportunities for Host Countries to adopt the approaches taken by other countries with CCS projects to manage the liabilities and contingent liabilities. As more CCS projects are developed in the coming years it is expected that we will see an evolution in the approaches taken and Host Countries will be able to consider which approach is best suited to their national circumstances.

<u>Existing work of relevance</u>

CO2 Capture Project: A Technical Basis for Carbon Dioxide Storage

- Chapter 4: Development, Operation, and Closure of CO2 Storage

Implications of the Inclusion of Geological CO2 Capture and Storage as CDM Project Activities, A report for the UNFCCC, UNFCCC/EB50 Annex 1 (2009)[12]

- Section 5.1 Risks and liabilities – potential CO_2 seepage (p.48 – 49)

[12] http://cdm.unfccc.int/EB/050/eb50annagan1.pdf

International Energy Agency, Carbon Capture and Storage, Model Regulatory Framework[13];

- Chapter 6, CCS-Specific Issues (Storage) (p.51 – 105).

Approach under CDM

Project Developer;

- Agree liability arrangements with host country that covers the full CCS life-cycle.

Designated National Authority;

- Confirms at the national approval stage the establishment of liability arrangements that covers the full CCS life-cycle and assigns clear responsibility for the liabilities to identified entities. These arrangements should ensure that in the event of any CO_2 seepage that cannot be accounted for as project emissions then an equivalent volume of CERs or equivalent will be surrendered or additional mitigation actions undertaken to compensate for the volume of CO_2 released.

Designated Operational Entity;

- Seepage of CO_2 during the crediting period accounted for as project emissions.

[13] Model framework reviews existing regulatory approaches to regulating CCS and identifies a number of principles for addressing issues associated with CCS. http://www.iea.org/ccs/legal/model_framework.pdf