Carbon Capture and Storage under the Clean Development Mechanism – An Overview of Regulatory Challenges

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The safe and secure deployment of Carbon Capture and Storage in developing countries could be a way to reconcile their economic development with the objective of climate change mitigation. The Clean Development Mechanism could provide the required additional financial incentive to enable the implementation of CCS projects. However, the inclusion of this technology in the CDM faces non-negligible regulatory challenges that cannot always be answered on the basis of the existing methodologies. The Conference of the Parties serving as the meeting of the Parties has announced the necessity of further guidance. In this context, this article identifies and offers elements of answer to the key issues at stake.

I. Introduction

Most future growth in greenhouse gas emissions is expected to come from developing countries because of their rapid economic development and expansion of energy-intensive industries.[1] The deployment of Carbon Capture and Storage (CCS) in these countries could play an important role in the mitigation of these emissions. Moreover it is estimated that, given the location of major oil and gas fields (constituting potential sites for the storage of CO2) in developing countries[2], the 'bulk of emission reductions from CCS by 2050' could take place there.[3]

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[1] IPCC, Fourth Assessment Report: The Mitigation of Climate Change, Cambridge 2007, p. 253, available at www.ipcc.ch/pdf/assessment-report/ar4/wg3/ar4-wg3-chapter4.pdf. See also Stern, The Economics of Climate Change – The Stern Review, Cambridge 2006, p 169, available at www.hm-treasury.gov.uk/stern_review_climate_change.htm.

[2] Hendriks/Graus/van Bergen, Global Carbon Dioxide Storage Potential and Costs, Utrecht 2004, quoted in Watanabe/Duckat/Sterk, "Carbon Capture and Storage under the Clean Development Mechanism – Impact on the Long-term Climate Goal, Energy Supply Planning, and Development Paths", JIKO Policy Paper 2007, p. 9.

[3] Philibert/Ellis/Podkanski, Carbon Capture and Storage in the CDM, Paris 2007, p. 7. On the technical potential of CCS see also IEA, Energy Technology Perspectives, Paris 2006; Hendriks et al, "Costs of Carbon Dioxide Removal by Underground Storage", in Williams et al (eds.), GHGT-5: Proceedings of the Fifth International Conference on Greenhouse Gas Control Technologies, Cairns 2000.

The deployment of CCS is nevertheless hindered by its high costs[4], as well as by the lack of maturity of this technology and the limited regulatory experience accumulated in this field. With the exception of some Enhanced Hydrocarbon Recovery projects (EHR), CCS is unlikely to take place in developing countries without additional financial incentives.[5]

This contribution analyzes whether the Clean Development Mechanism of the Kyoto Protocol (CDM) could provide this additional financial incentive to CCS projects. Since the CCS technology contrasts in several respects with 'traditional' CDM project activities, we examine whether the current regulatory framework governing the CDM is or can be adapted to the specificities of CCS projects.

Promoting CCS in developing countries by including this technology under the CDM is a heavily discussed topic within the framework of the international negotiations on climate change. This contribution therefore starts by presenting the discussion on the integration of CCS into the CDM and by highlighting the actors involved in this discussion.

Secondly, it examines how the 'additionality' of CCS project activities could be determined. The potential competition between CCS and the promotion of renewable energy and energy efficiency will be central in this section. Indeed, by storing CO2 into the subsurface, CCS makes fossil fueled industrial processes 'climate-friendly' and could create a perverse incentive for energy-inefficient and higher emitting technologies.[6] It could constitute a potential competitor to renewable energy and energy-efficiency projects[7], overwhelm the CDM market and 'crowd out other projects'.[8] The core question will be how the potential 'threat' that CCS represents for 'more sustainable' projects could be avoided within the CDM?[9]

Thirdly, this contribution examines how the emission reductions of CCS projects could be determined. CCS generates an energy penalty in comparison to traditional techniques since it requires additional energy use to operate the capture, transport and injection

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[4] Philibert/Ellis/Podkanski, supra, note 3, p. 11. See also IPCC, Special Report on Carbon Dioxide Capture and Storage, Cambridge 2005, p. 10, available at www.ipcc.ch/ipccreports/srccs.htm; Watanabe/Duckat/Sterk, supra, note 2, p. 12 and 22; De Coninck et al., Acceptability of CO2 Capture and Storage – A Review of Legal, Regulatory, Economic and Social Aspects of CO2 Capture and Storage, Petten 2006, p. 18-21, available at www.ecn.nl.

[5] See de Coninck, "Trojan Horse or Horn of Plenty? Reflections on Allowing CCS in the CDM" Energy Policy 2008, p. 929. See also Philibert/Ellis/Podkanski, supra, note 3, p. 11, considering that '[u]nless there is a value to store CO2 there is virtually no driver for the deployment of these technologies – except perhaps in the case of a few [Enhanced Oil Recovery] projects.'

[6] IEA Greenhouse Gas R&D Programme, ERM – Carbon Dioxide Capture and Storage in the Clean Development Mechanism, Cheltenham 2007, p. 20, available at www.co2captureandstorage.info/networks/CCS-CDM.htm.

[7] See Watanabe/Duckat/Sterk, supra, note 2, p. 22.

[8] De Coninck, supra, note 5, p. 934.

[9] Ibid, p. 935, considering that '[o]ne of the most prominent arguments against allowing CCS in the CDM is the conviction of many individuals that, rather than applying a remedy like CCS, the CDM should support the better solution to the CO2 intensity in the energy sector: renewable energy. Underlying this is the conviction that renewable energy is to be preferred over CCS.'

installations. Moreover CCS projects can have an impact on the primary energy markets. Does accounting for these effects represent a new challenge for the CDM?

Fourthly, we analyze the crucial issue of the permanence of emission reductions generated by CCS projects. CCS aims to avoid the emission of CO2 into the atmosphere, not its formation.[10] The CO2 stored could unexpectedly escape from the storage site, resulting in only a 'temporary' reduction of emissions. Traditional CDM project activities generate 'permanent' emission reductions. Are the current CDM rules adapted to this risk of potential 'impermanence' and, if not, how can it be integrated into these mechanisms?[11]

Furthermore, this contribution examines the challenge of developing adequate methodologies to monitor the emissions of CCS project activities. What methodologies and procedures are adequate to monitor the potential release of CO2 from storage sites?

Finally, we examine the fulfillment of the criteria of sustainability. Can CCS projects be considered as sustainable and who should be competent to assess this?

II. Integrating CCS in the CDM: Current state of the discussion

In accordance with Article 2, para 1, a, iv) of the Kyoto Protocol, each Annex I Party shall, in achieving its quantified emission reduction commitments elaborate policies and measures such as '[r]esearch on, and promotion, development and increased use of (…) carbon dioxide sequestration technologies'. The Kyoto Protocol does not deal with the issue of CCS into more detail.[12]

The 2006 IPCC Guidelines for National Greenhouse Gas Inventories provide guidance on how to account for and monitor the emissions of CCS projects implemented in Annex I countries.[13] Such guidance has not yet been adopted for CCS projects implemented under the CDM in non-Annex I countries.

The consideration of CCS as CDM project activity has gained particular interest following the submission of three new methodologies for approval by the CDM Executive Board: NM0167 "The White Tiger Oil Field Carbon Capture and Storage Project in Vietnam", NM0168 "The Capture of the CO2 from the Liquefied Natural Gas

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[10] Bode/Jung, "Carbon Dioxide Capture and Storage (CCS) – Liability for Non-Permanence under the UNFCCC", HWWA Discussion Paper 2005, p. 13, available at http://ssrn.com/abstract=776285.

[11] A related question is whether, given the limited experience regarding the application of CCS technologies, it should already be exported to developing countries and countries in transition or, first, be developed and tested in industrialized countries. See de Coninck, supra, note 5, p. 933.

[12] For the legal status of CCS under the United Nation Framework Convention on Climate Change and the Kyoto Protocol see Matthes et al, CO2-Abscheidung und –Ablagerung bei Kraftwerken Rechtliche Bewertung, Regulierung, Berlin 2007, p. 107-119, available at www.oeko.de/oekodoc/759/2007-222-de.pdf; See also Bode/Jung "On the integration of Carbon Capture and Storage into the international climate regime", HWWA discussion paper, 2004, available at http://ssrn.com/abstract=629026.

[13] See 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Chapter 5: Carbon Dioxide Transport, Injection and Geological Storage, 5.5.

Complex and its Geological Storage in the Aquifer Located in Malaysia" and SSC-038 "Anthropogenic Ocean Sequestration by Changing the Alkalinity of Ocean Surface Water".[14] On the basis of the recommendations of the CDM Methodologies Panel[15], the CDM Executive Board refused to approve the proposed methodologies, considering that the approaches and procedures suggested did not address the methodological and accounting issues in an appropriate way.[16] According to the CDM Executive Board, 'it is questionable whether some issues can be resolved without further guidance from the [Conference of the Parties serving as the meeting of the Parties] and/or a technical body on CCS.'[17]

The Conference of the Parties serving as the meeting of the Parties confirmed in its decision 1/CMP.2 that the approval of new methodologies regarding CCS can only occur once it has adopted guidance on this. The integration of CCS in CDM has been considered during CMP.3 in Bali, where the Parties agreed to further work on this issue in order to reach an agreement during CMP.4, in December 2008 in Poznan. It requested the CDM Executive Board to continue to consider proposals for new methodologies and invited intergovernmental, non-governmental organizations[18] and Parties[19] to communicate their views.[20] These submissions were synthesized[21] and considered by the Subsidiary Body for Scientific and Technological Advice (SBSTA).[22] The synthesis of the SBSTA shows the divergence of views of the Parties on several key issues.

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[14] See http://cdm.unfccc.int/methodologies. See also Kirkman, Presentation on CCS under the CDM – Update of Progress and Issues given at the Carbon Forum America, 26-27 February 2008.

[15] CDM-Meth Panel, Draft Recommendation on CO2 Capture and Storage as CDM Project Activities Based on the Review of Cases NM0167, NM0168 and SSC_038, Twenty-second meeting Report, Annex 12, 13 September 2006.

[16] CDM Executive Board, Recommendation on CO2 Capture and Storage as CDM Project Activities Based on the Review of Cases NM0167, NM0168 and SSC_038, EB 26 Meeting Report, Annex 13, September 2006.

[17] Ibid.

[18] Greenpeace International, the International Emissions Trading Association, the International Petroleum Industry Environmental Conservation Association, the International Risk Governance Council, the World Coal Institute, WWF, the International Chamber of Commerce and Sustain US have submitted their views.

[19] Japan, Saudi Arabia, Canada, Norway, Portugal on behalf of the European Community and its Member States, Korea, Brazil, New Zealand, Slovenia on behalf of the European Community and its Member States have submitted their views on the topic, available at http://cdm.unfccc.int/about/ccs/index.html.

[20] These issues concerned: long term physical seepage, project boundary issues (such as reservoirs in international waters, several projects using one reservoir) and projects involving more than one country (projects that cross national boundaries), long-term responsibility for monitoring reservoirs, long-term liability for storage sites, accounting options for long term seepage, criteria and steps for the selection of suitable storage sites with respect to the potential for release for greenhouse gases, potential seepage pathways, operation of reservoirs. See below for the definition of these notions.

[21] See SBSTA, Synthesis of Views on Issues Relevant to the Consideration of Carbon Dioxide Capture and Storage in Geological Formations as Clean Development Mechanism Project Activities, 9 April 2008, FCCC/SBSTA/2008/INF.1. See also SBSTA, 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 Project Activities, 25 September 2008, FCCC/SBSTA/2008/INF.3.

[22] 28th Session of the SBSTA, 13 July 2008. See Report of the SBSTA on its Twenty-Eight Session, FCCC/SBSTA/2008/6, 24 July 2008, item 125-127. The SBSTA did not agree to adopt the conclusions proposed by the Chair.

The importance laid on the approval at the highest level of guidance for the inclusion of CCS in the CDM can be explained by the unique challenges constituted by the CCS technology. Issues such as the permanence of the emission reductions generated by CCS and the impact of this technology on primary energy markets determine to a large extent its potential contribution to the international climate change mitigation efforts. They require adequate and robust regulation that cannot always be found in existing methodologies.

III. Additionality

In order to qualify for support under the CDM, participants to CCS project activities will have to demonstrate that their investments generate fewer emissions than would have been the case according to normal practice (or 'business as usual') and that their project activity is being implemented because of the financial support provided by the project mechanism[23]. This additionality of a project activity can be determined in relation to a baseline scenario representing all reasonable potential alternatives to the proposed project activity.[24] The absence of guidance to select the most plausible baseline scenario was one of the reasons advanced by the CDM Executive Board to refuse the NM0167 (White Tiger Oil Field) and NM0168 (Capture of CO2 from LNG in Malaysia) methodology submissions.[25]

It is often submitted that the main alternative to CCS project activities is the implementation of the source industrial process with the emission of CO2 into the atmosphere.[26] Indeed, this is still common practice or business as usual. The IEA Greenhouse Gas R&D Programme considers for instance that:

> 'the CDM baseline scenario must be considered to be the deployment of the underlying project without CCS. Therefore, contingent on appropriate demonstration of additionality for specific projects, the baseline scenario which reasonably represents the most likely course of action in absence of the CDM project activity will be venting of generated CO2 directly to the atmosphere'.[27]

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[23] See paragraph 43 of the Modalities and Procedures for a Clean Development Mechanism, Decision 3/CMP.1 (FCCC/KP/CMP/2005/8/Add.1, 30 March 2006). See also Decision 1/CMP.2 (FCCC/KP/CMP/2006/10/Add.1) and Decision -/CMP.3, Further Guidance Relating to the Clean Development Mechanism.

[24] See CDM Executive Board, Methodological Tool for the Demonstration and Assessment of Additionality (Version 04). See also CDM-Executive Board Revision to the Methodological Tool 'Combined Tool to Identify the Baseline Scenario and Demonstrate Additionality' (Version 02.1).

[25] CDM Executive Board, Recommendation on CO2 Capture and Storage, supra, note 16, p. 8-9.

[26] IEA Greenhouse Gas R&D Programme, supra, note 6, p. 43. See also Telnes, "CCS Project Validation and Verification under the CDM – Will the Existing Framework Suffice?", presentation given in Paris, 26 September 2006, available at www.iea.org/Textbase/work/2006/ghget/Telnes.pdf.

[27] IEA Greenhouse Gas R&D Programme, supra, note 6, p. 43.

On this basis, the alternative scenario to the CCS retrofit of existing installations would be the continuation of operation of this activity.[28] For new build installations, the alternative scenario would be conventional techniques that would have been implemented without CDM support.

Applied to the electricity production sector, however, this approach fails to take sufficiently into account the development of electricity production from renewable energy sources as potential alternative to CCS projects. Indeed, electricity production of one existing fossil-fuelled power plant could be replaced by renewable energy projects.[29] Renewable energy projects could also constitute alternatives to new CCS projects. Not considering the possibility of electricity production on the basis of renewable energy sources in the baseline scenario of CCS projects could constitute a perverse incentive for the deployment of renewable technologies. Moreover, as highlighted by the CDM Executive Board in its assessment of the NM0167 methodology submission, it is important to examine in the baseline scenario analysis whether the CCS project would prevent actions aiming at improving the energy efficiency of the concerned installations.

The investment, barrier and common practice analyses of CCS projects can be expected to be 'reasonably straightforward'.[30] Indeed, it is generally considered that, currently, CCS projects are rarely financially attractive.[31] The IEA Greenhouse Gas R&D Programme identifies five main (potential) drivers for the deployment of CCS projects: Enhanced Hydrocarbon Recovery, gas disposal, tax avoidance, license to operate and research and demonstration.[32] It concludes on this basis that:

> '[i]n practice, therefore, with the exception of these conditions –which must be considered in demonstrating project additionality – the only reason for CCS project deployment in non-Annex 1 countries will be the generation of CERs via the CDM coupled with the good will of the project developer to act responsibly toward the environment (since the current value of CERs may not cover the whole cost of the CCS project).'[33]

Project participants will have to demonstrate that their project does not benefit from the abovementioned drivers and that it is not supported by policies enabling its financial viability without being registered as a CDM project activity. They could also highlight

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[28] For the electricity production sector for instance, this would be continuing to use all power generation equipment that was already used prior to the implementation of the project activity and undertaking business as usual maintenance. See for instance CDM Executive Board, Approved baseline and monitoring methodology 'Methodology for rehabilitation and/or energy efficiency improvement in existing power plants', AM0061/version 01.

[29] See for instance CDM Executive Board, Revision to the approved baseline methodology 'Renewable energy projects replacing part of the electricity production of one single fossil fuel fired power plant that stands alone or supplies to a grid, excluding biomass projects' AM0019/Version 02, 19 May 2006.

[30] IEA Greenhouse Gas R&D Programme, supra, note 6, p 42.

[31] See among others Philibert/Ellis/Podkanski, supra, note 3, p. 11.

[32] IEA Greenhouse Gas R&D Programme, supra, note 6, p 23.

[33] The IEA Greenhouse Gas R&D Programme considers that '[i]n any CCS project other than an EHR or acid-gas co-disposal projects, demonstration of financial additionality will not be required, as inherently there is no economic benefit involved with capture and storing the CO2.' Ibid, p. 44.

the current technological barriers of CCS as well as barriers due to prevailing practice in this field that prevent them from implementing the project without CDM support. Furthermore, it can be expected that the absence of CCS projects implemented in the same region without financial support will not be difficult to prove.

As regards Enhanced Hydrocarbon Recovery, the CDM Executive Board considered in its assessment of the NM0167 methodology submission that the barrier analysis may be more relevant in early stages of CCS development. It based its reasoning on the consideration that risks are higher when technology is not yet established and experience is lacking. In accordance with the CDM Executive Board, investment analysis may become more relevant in case CCS for EHR becomes a more mature technology.

IV. Emission reductions

1. Baseline emissions

Given the fact that the amount of emission reductions (and thus emission credits) generated by a project activity is calculated in relation to baseline emissions, the deployment of CCS under the CDM will depend on the accurate elaboration of this baseline.[34] What baseline approach could be adequate for CCS project activities?

In accordance with the CDM Executive Board, baseline emissions for CCS projects should be determined on the basis of the amount of CO2 avoided, not CO2 captured.[35] For retrofits to existing installations, the baseline emissions could be calculated on the basis of the operating characteristics of the pre-retrofit installations (i.e. their historical emission factor).[36] However, since CCS generates additional power consumption (the so-called 'energy' or 'capture penalty') the baseline approach will have to be adjusted accordingly.[37]

For new build (post- or pre-combustion) CCS installations, the baseline emissions will have to be calculated on the basis of the emission factor of economically attractive

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[34] See Decision 3/CMP.1 (FCCC/KP/CMP/2005/8/Add.1). See Kartha/Lazarus/Bosi, "Baseline Recommendations for Greenhouse Gas Mitigation Projects in the Electric Power Sector" Energy Policy 2004, p. 546. See also Fischer, "Project-based Mechanisms for Emissions Reductions: Balancing Trade-offs with Baselines" Energy Policy 2005, p. 1809.

[35] CDM Executive Board, Recommendation on CO2 Capture and Storage, supra, note 16, p. 8.

[36] See IEA Greenhouse Gas R&D Programme, supra, note 6, p 23. For the electricity production sector, however, the quantity of electricity generated in the project activity would not have to exceed the average historical electricity production in the pre-retrofit installation. In case the quantity of electricity generated in the project activity is higher than the average historical electricity production in the pre-retrofit installation the baseline will have to take into the emission factor of the electricity grid to which the project activity is connected. See for instance CDM Executive Board, Approved baseline and monitoring methodology 'Methodology for rehabilitation and/or energy efficiency improvement in existing power plants', AM0061/version 01, p. 7 and 8. See also CDM Executive Board, Approved baseline and monitoring methodology 'Energy efficiency improvements of a power plant through retrofitting turbines', AM0062/version 01.

[37] See below under 'project boundary'.

technologies that would be used in the absence of the project.[38] For new electricity project activities, this baseline approach (including the emissions associated with the energy penalty[39]) can be calculated on the basis of the operating margins of the electricity grid to which the project activity is connected. Applied to CCS projects, it can however be feared that such approach will penalize the deployment of renewable electricity projects in favor of CCS. Indeed, it is based on the assumption that new project activities avoid a proportional fraction of all generation installations of an electricity system[40] and is thus biased towards existing fossil-fuel (and often inefficient) power plants. An alternative would be to calculate the baseline on the basis of an estimation of the type of power plant that would have been built in the absence of the project.[41] Such an approach would allow taking into account the promotion of renewable energy projects by host countries. It would also allow adapting the baseline to the emissions of the most recent and efficient fossil-fuel power plants added to the electricity grid to which the project activity is connected. This appears to be indispensable to limit the potential perverse incentive of CCS projects for higher emitting technologies.[42]

It can be argued that the determination of a baseline approach for CCS project activities can be done on the basis of existing approved baseline methodologies. Given the potential threat that CCS represents for renewable energy and energy efficiency projects, the baselines should make sure that the precedence of these projects is duly integrated.

2. Project emissions

The project boundary for CCS project activities will have to be structured on the basis of the four subsystems of CCS: capture and compression, transport, injection and storage.[43] Within this structure, what emissions are under the control of the project participants and are reasonably attributable to the CCS project activity?[44] A distinction must be made between the emissions from above- and underground installations.

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[38] See IEA Greenhouse Gas R&D Programme, supra, note 6, p 23.

[39] See Haefeli/Bosi/Philibert, Carbon Dioxide Capture and Storage Issues – Accounting and Baselines under the United Nations Framework Convention on Climate Change (UNFCCC), Paris 2004, p. 26, available at http://iea.org/textbase/papers/2004/css.pdf.

[40] This is particularly the case when the baseline is calculated taking into account the generation-weighted average emissions rate of all plants. See Kartha/Lazarus/Bosi, supra, note 34 , p. 553.

[41] This corresponds to the so-called build margin method. Ibid, p. 555-558. Kartha, Lazarus and Bosi consider that it will be very difficult to accurately guess the timing and type of new plant additions. They therefore argue in favor of a combined margin approach (i.e. operating together with build margin methods). See also IEA Greenhouse Gas R&D Programme, supra, note 6, p 27. The IEA Greenhouse Gas R&D Programme further recommends to take into account the position the project activity might have in the merit order in the electricity system in which it will operate.

[42] In order to avoid perversely supporting retrofits of existing installations ahead of new build CCS projects, the IEA Greenhouse Gas R&D Programme recommends to adapt the baseline after the first crediting period. In the later crediting periods, the baseline should be calculated on the basis of the approach for new build project activities. This would enable to reflect more efficient technologies in the absence of the CCS project.

[43] See 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Chapter 5: Carbon Dioxide Transport, Injection and Geological Storage, 5.5.

[44] See paragraph 52 of the Modalities and Procedures for a Clean Development Mechanism.

The above-ground installations used for the capture and compression, transport and injection of CO2 include the source installation generating the CO2, the capture plant, the compression or liquefaction facilities, the transportation equipment (pipeline or ship), booster stations along a pipeline, intermediate storage facilities, other reception facilities and the injection facility.[45] The emissions of these installations could be calculated and monitored on the basis of approved monitoring methodologies applied in existing CDM project activities.[46] It can therefore be considered that the inclusion of these above-ground installations in the project boundary does not constitute a new challenge.

Determining the emissions of the underground activities of CCS appears to be much more challenging. Firstly, CO2 can be released into the atmosphere during the injection process.[47] The injection wells and other pathways should thus be included within the project boundary and their potential emissions should be closely monitored. Secondly, the CCS project boundary shall comprise the geological site where the CO2 is stored.[48] The definition of the project boundary for this component will be based on a preliminary study of the characteristics of the storage site (e.g. permeability and CO2 migration rate of the site).[49] Thirdly, the CCS project boundary will have to include the locations around the storage site where CO2 could migrate.[50] Finally, the emissions associated with EHR should also be encompassed in the CCS project boundary.

The project emissions consist of all emissions generated within the project boundary. It is generally admitted that these emission include[51]:

(a) Fugitive emissions, i.e. the emissions resulting from imperfect capture and/or physical leakage of CO2 during the transport or injection process;
(b) Indirect emissions or 'leakage', i.e. emissions resulting from the use of additional auxiliary power required for CCS;
(c) Physical leakage or 'seepage', i.e. gradual, long term release of CO2 from the storage site or other sub-surface locations;
(d) Storage site breach, i.e. emissions resulting from the (sudden) failure of the storage site.

The issues raised by 'leakage' emissions are analysed hereunder, before examining, in a subsequent chapter, the 'seepage' emissions and (non)-permanence of CCS project activities.

3. Leakage emissions

[45] See IEA Greenhouse Gas R&D Programme, supra, note 6, p 10-11. See also Submission by Canada Consideration of Carbon Dioxide Capture and Storage as Clean Development Mechanism Project Activities (23 October 2007). p. 4 and 5.
[46] IEA Greenhouse Gas R&D Programme, supra, note 6, p 11.
[47] Well bore failure is considered as one of the weakest point in the overall containment system. Ibid, p. 11.
[48] Ibid, at 11-12. See also Submission by Canada, supra, note 45, p. 4.
[49] Ibid, at 12. See below under 'monitoring methodologies'.
[50] Ibid, p. 13. See also Submission by Canada, supra, note 45, p. 5.
[51] See SBSTA, Synthesis of Views, supra, note 21, p. 7.

Paragraph 51 of the Modalities and Procedures for a Clean Development Mechanism defines 'leakage' 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'. In accordance with paragraph 50 of these Modalities, the emission reductions of project activities shall be adjusted for this leakage. The notion of leakage must thus be distinguished from 'seepage', referring to 'the escape of injected CO2 from a storage reservoir'[52].

Emissions attributable to CCS project activities, but occurring outside of their project boundary, can, firstly, relate to the impact of CCS projects on the primary energy market.[53] Since CCS installations burn fossil-fuels (with the exception of biomass co-firing), it can be expected that the deployment of this technology will increase the consumption of such fuels. The construction of new CCS installations can thus be expected to increase the emissions related to the extraction, processing and transportation of such fuels. These increases will have to be considered as leakage emissions of these CCS projects.[54] Since existing installations already burn fossil fuels, retrofitting these installations with CCS will have a more limited impact on the emissions of the primary energy sector. Nevertheless, the emissions in this sector generated by the additional auxiliary power required for the capture and transportation process (the 'energy penalty') will have to be accounted for.[55]

Secondly, in CCS projects involving biomass co-firing, leakage could be generated by the preparation and transportation of biomass, and by the removal of biomass from other potential users. Existing methodologies already tackle the leakage related to the use of biomass.[56]

Thirdly, leakage emissions can result from the combustion of additional hydrocarbon fuels obtained with the use of EHR.[57] Some analysts have argued that, since EHR would lead to additional hydrocarbon fuels on the market, the emissions generated by their combustion would offset the emission reductions of the CCS project activity. The CDM Executive Board considered in its evaluation of the NM0167 methodology submission that this technology failed to take into account 'the impacts of increased oil production due to EHR on oil markets and any increase in overall oil use emissions'.[58]

Determining the 'leakage' emissions of CCS project activities could primarily be done on the basis of existing methodologies. One major question remains open and is subject to debate: do emissions related to the consumption of additional fuels obtained with EHR be

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[52] See Secretariat to the United Nations Framework Convention on Climate Change, Report on the Workshop on Carbon Dioxide Capture and Storage as Clean Development Mechanism Project Activities, 15 August 2006, FCCC/KP/CMP/2006/3, p.5.

[53] IEA Greenhouse Gas R&D Programme, supra, note 6, p. 47.

[54] Ibid, p. 48.

[55] Haefeli/Bosi/Philibert, supra, note 39, p. 26-27.

[56] See for instance methodology ACM0006.

[57] On this issue see Philibert/Ellis/Podkanski, supra, note 3, p. 23-25. See also Watanabe/Duckat/Sterk, supra, note 2, p. 14.

[58] CDM Executive Board, Recommendation on CO2 Capture and Storage, supra, note 16, p. 9.

accounted as leakage emissions? The answer to this question is important since their qualification as leakage emissions would radically reduce the support of CCS under the CDM.[59]

V. Permanence

In contrast to traditional CDM project activities, CCS does not avoid the formation of greenhouse gases. It aims at avoiding their emission into the atmosphere.[60] Therefore CCS projects will only reduce greenhouse gases as long as they remain trapped in the storage site. How to manage the risk of a future escape of CO2 into the atmosphere (or 'seepage') under the regulatory framework of the CDM?

If seepage occurs during the crediting period of the project activity, the released emissions can be accounted for as project emissions.[61] The question raises however how these emissions will be accounted for if the seepage occurs after the crediting period? The essence of this regulatory challenge is 'whether rewards are provided today for emissions that might occur in the future, and whether there is a mechanism to suitably account for these future emissions'.[62]

1. Seepage and site selection

Scientists generally agree that the probability of CO2 escape from the reservoir in the long term is very limited 'assuming that sites are well selected, designed, operated and appropriately monitored'.[63] The careful assessment and selection of geological storage sites appears thus to be a crucial element to achieve permanent emission reductions with CCS project activities.[64] In contrast to Annex I countries, non-Annex I countries are not hold by quantified emission reduction targets. The seepage of emissions captured and stored by project activities in non-Annex I countries could therefore not jeopardize their emission reduction commitments. Given the absence of such incentive, the question

[59] On this discussion see de Coninck, supra, note 5, p. 935. According to de Coninck, '[t]he oil that is recovered additionally will be combusted, generating about two times as many CO2 emissions as the CO2 injected. If these emissions are accounted for, the CO2 emissions of the CDM project would be even higher than the emissions without the CDM project.'
[60] Bode/Jung, supra, note 10, p. 13.
[61] The amount of CERs will be accordingly reduced or CERs will be replaced by the project participants with other valid units. See CDM Executive Board, Recommendation on CO2 Capture and Storage, supra, note, p. 7. See also IEA Greenhouse Gas R&D Programme, supra, note 6, p. 55.
[62] Ibid, p. 54. Watanabe, Duckat and Sterk highlight that '[n]on-permanence was recognized as one of the most severe methodological issues as it is still difficult to predict long-term seepage rates for a full-scale project'. Watanabe/Duckat/Sterk, supra, note 2, p. 14. See also Olawuyi, "Enlisting Carbon Dioxide Capture and Storage as a Clean Development Mechanism Project: Legal and Regulatory Issues Considered", available at http://ssrn.com/abstract=999508.
[63] IPCC, supra, note 4, p. 246.
[64] See SBSTA, Synthesis of Views, supra, note 21, p. 11, considering that '[p]arties and organizations all broadly agree that site characterization and selection is the most critical element in ensuring long-term or permanent CO2 storage from CCS.' See also Submission by Portugal on behalf of the European Community and its Member States, supra, note, p. 21-22; IPCC, supra, note 4, p. 33; Philibert/Ellis/Podkanski, supra, note 3, p. 13.

raises how procedures guaranteeing the selection of appropriate storage sites could be integrated in the CDM?

The approval and registration of CDM projects is subject to a process involving the project participants, host and home country authorities and the CDM Executive Board. The CDM Executive Board could adopt criteria and procedural requirements for the selection of appropriate storage sites that must be fulfilled by CCS project activities before being registered as CDM.[65] Such assessments could be included in the Project Design Documents and their accurate fulfillment would thus have to be validated by the Designated Operation Entities.[66] However developing countries are often characterized by weak administrative capacity. Given the high technical complexity of CCS projects and the specific knowledge requirement to assess the adequacy of storage sites, it could be considered to create groups of international experts to assists these national entities.[67] The CDM Executive Board could be tasked to confirm the fulfillment of this procedure before proceeding to the registration of the CCS project as CDM.

2. Liability and Responsibility

Potential seepages occurring after the crediting period will have to be compensated.[68] Such compensation is not only indispensable to guarantee the environmental (or climate) integrity of CCS project mechanisms. It could also provide a decisive incentive for the concerned parties to select and/or approve appropriated storage sites and to ensure their safe closure.[69] How and to what entity should responsibility and liability for seepage be assigned?[70]

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[65] See SBSTA, Synthesis of Views, supra, note 21 , p. 13. See also See Submission by Portugal on behalf of the European Community and its Member States, 17 October 2007, p. 23. The European Commission, for instance, proposed criteria for the characterisation and assessment of storage sites for CCS projects implemented within the European Union. The selection of storage sites shall occur on the basis of these criteria. See European Commission, Proposal COM(2008) 18 final for a Directive on the geological storage of carbon dioxide and amending Council Directives 85/337/EEC, 96/61/EC, Directives 2000/60/EC, 2001/80/EC, 2004/35/EC, 2006/12/EC and Regulation (EC) No 1013/2006, OJ C 2008 118/4.
[66] See IEA Greenhouse Gas R&D Programme, supra, note 6, p. 57 and 76-77.
[67] Ibid, p. 76.
[68] As already mentioned above, seepage emissions occurring during the crediting period could be considered as project emissions. On liability and CCS (especially in the United States) see de Figueiredo, The Liability of Carbon Dioxide Storage, Massachusetts 2007, available at http://esd.mit.edu/people/dissertations/defigueiredo_mark.pdf; Wilson et al., “Liability and Financial Responsibility Frameworks for Carbon Capture and Sequestration”, WRI Issue Brief 2007, available online at www.wri.org; See also Kerr, ”Legal and Regulatory Developments: The Path Forward to Advance Carbon Dioxide Capture and Storage as a Climate Change Solution”, International Energy Law and Taxation Review 2007, p. 235-236.
[69] Wilson et al. argue that the ‘delineation of who is responsible for potential liabilities associated with CCS (and for how long) will influence the construction, operation and management of CCS projects.’ E Wilson et al, supra, note 68, p. 5.
[70] The CDM Executive Board considered in its assessment of the NM0167 and NM0168 methodology submissions that they failed to address how it would be ensured that any necessary remediation measures after the end of the crediting period would be undertaken. CDM Executive Board, Recommendation on CO2 Capture and Storage, supra, note 16, p. 7.

The issue of (non-)permanence of emission reductions and the validity of emission credits (CERs) has already been the basis of concern about the feasibility of 'carbon sinks' as CDM project activities.[71] The notion of 'carbon sinks', or 'Land Use, Land-Use Change, and Forestry' (LULUCF) activities, refers to the capture and storage of CO2 by vegetation and soils.[72] As with CCS, carbon sinks achieve emission reductions only as long as the CO2 remains captured or 'sequestrated'. To address the impermanence of carbon sinks[73], temporary CERs (tCERs) and long-term CERs (lCERs) were created. These specific credits are only valid for a limited period in time and must thus be replaced. Every five years since the start of carbon sinks projects, the net CO2 removals achieved by these projects must be verified and certified by independent review. Should such 'temporary' crediting mechanism be applied to the emission reductions achieved by CCS project activities or should CCS projects benefit from traditional CERs? If traditional CERs are issued for CDM CCS project activities, how then should the issue of impermanence be addressed?

The option of issuing 'temporary' CERs for CCS projects is generally not supported by analysts, since this would negatively affect the fungibility and thus the market value of those credits.[74] It would thus reduce the financial support for such projects under the CDM. Moreover, some authors consider that such crediting mechanism does not constitute a sufficient incentive for appropriate long-term monitoring and liability. It would thus not avoid seepage in the long term.[75]

If 'permanent' CERs are issued to CCS projects, liability for long-term seepage could be assigned to the buyer of the CERs, to the project participants or to the host country.[76]

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[71] Scholz/Noble, "Generation of Sequestration Credits under the CDM", in Freestone/Streck, Legal Aspects of Implementing the Kyoto Protocol Mechanisms – Making Kyoto Work, Oxford 2005, p. 269.

[72] See Bosquet, "Specific Features of Land Use, Land-Use Change, and Forestry Transactions", in Freestone/Streck, supra, note 71, p. 281.

[73] See paragraph K of the Modalities and procedures for afforestation and reforestation project activities under the clean development mechanism in the first commitment period of the Kyoto Protocol (FCCC/KP/CMP/2005/8/Add.1, Decision 5/CMP.1).

[74] See Philibert/Ellis/Podkanski, supra, note 3, p. 19-20. See also IEA Greenhouse Gas R&D Programme, supra, note 6, p. 56; Submission by Portugal on behalf of the European Community and its Member States, supra, note 65, p. 26; Submission from Norway on the Inclusion of Carbon Capture and Storage in the Clean Development Mechanism, 16 September 2008, FCCC/SBSTA/2008/MISC.10. In contrast, Bode and Jung argue that 'expiring CERs similar to those issued for CDM forestry projects could be one option for guaranteeing liability for the stored CO2 in the framework of the international climate regime.' Bode/Jung, supra, note 10, p. 10.

[75] See Philibert/Ellis/Podkanski, supra, note 3, p. 19-20. See also SBSTA, Synthesis of Views, supra, note 21, p. 18.

[76] An other option (not further discussed hereunder) would be to apply a 'discount rate' when issuing CERs to CCS projects. With such crediting mechanism, a proportion of CERs corresponding to an estimated amount of long term seepage emissions would be reduced from the number of CERs issued to CCS projects. This amount could also be set aside in a credit reserve and by issued to compensate seepage emissions. Such a mechanism could however not account for unexpected events and would not constitute an appropriate incentive to minimize the occurrence of such seepage. See SBSTA, Synthesis of Views, supra, note 21, p. 18; Philibert/Ellis/Podkanski, supra, note 3, p. 20; and IEA Greenhouse Gas R&D Programme, supra, note 6, p. 56; See also Bode/Jung, supra, note 10, p. 8-9.

The option of making the buyer liable for long term seepage is, to a certain extent, comparable with a temporary crediting mechanism. Indeed, under this scenario, the buyer of CERs issued from CCS projects would have to compensate long term seepage emissions by replacing the CERs with other credits in proportion to the seepage. Since the CERs will ultimately be used by Annex I countries to comply with their emission reduction targets, these countries would ultimately be liable. This option could be criticized on the basis of the same arguments developed against temporary crediting for CCS projects: such buyer liability will affect the market value of the CERs from CCS projects and would not provide an appropriate incentive for long term monitoring. Moreover, responsibility would not be laid on the parties that implement (or approve) the projects.

On the contrary, making the project participants liable would incentivize the parties that operate and control the project to minimize the probability of long term seepage.[77] Indeed, it can be expected that requiring project participants to compensate long term seepage emissions with other emission credits will dissuade them to select inadequate storage sites. However, given the difficulty to attach present day value to future (long term) CO2 emissions[78], market players could be reluctant to invest if such a long term and uncertain burden is imposed on them.

Making the host country liable for long term seepage would remove this burden from project developers, while keeping the liability on parties that control the implementation of CCS projects.[79] Indeed, if hold liable for long term seepage emissions, host countries will be incentivized to only approve CCS projects using appropriate storage sites. Given the long term nature of potential seepage emissions of CCS projects, it appears also practical to lay the liability on public authorities.[80] However, under the CDM, host countries are not bound by emission reduction targets. They thus will have to compensate long term seepage emissions by buying other emission credits on the international market. It can be questioned whether this does not represent too heavy a burden for developing countries.

An alternative would be to divide the liability over two periods of time. The project participants would be liable for the seepage emissions occurring after a relatively short period following the end of injection. The risks of emissions during this period could be covered by insurance companies. After this period, liability could be laid on the host

[77] See IEA Greenhouse Gas R&D Programme, supra, note 6, p. 56. See also Philibert/Ellis/Podkanski, supra, note 3, p. 20. According to Wilson et al 'financial responsibility requirements serve as an inducement to firms to properly operate and manage their facilities'. Wilson et al., supra, note 68, p. 5.

[78] See IEA Greenhouse Gas R&D Programme, supra, note 6, p. 54, considering that '[i]t is unclear whether it is truly feasible to try and attach present day values to emissions that may occur 1000's years into the future, if ever.'

[79] See Submission by Portugal on behalf of the European Community and its Member States, supra, note 65, p. 26, considering that '[w]ith host country liability, the Party that most adequately can ensure the operating conditions of the project is liable'.

[80] See SBSTA, Synthesis of Views, supra, note 21 , p. 19.

country.[81] Such transfer of liability could for instance be subjected to an assessment of the storage site by national authorities, reducing the probability of future seepage to a minimum.[82] During this assessment, national authorities could be assisted by a group of international experts.

Another possibility would be to cap the long term liability of project participants. The IEA Greenhouse Gas R&D Programme considers in this respect that:

> 'in the absence of certainty over future CER prices, there is a critical need to cap the contingent liability on the requirement to purchase any CERs in the event of seepage emissions. Without a cap on liability, investment decision-making would be impossible as the project would involve the taking-on of unquantifiable contingent liabilities, which be commercially unworkable.'[83]

It can be concluded that there are different options available to assign responsibility and liability for the long term release of CO2 from storage sites. The Conference of the Parties serving as the meeting of the Parties will have to make a choice. In this context, the challenge will be to provide the right incentive to project developers to ensure the permanence of the stored emissions and at the same time enable the commercial viability of CCS projects. In this respect, it is submitted that the division of liability between project participants and host countries over two time periods offers the best outcome.

3. Multi-jurisdictional and multi-project aspects

Geological storage sites may extend over the territory of different countries.[84] Moreover, CO2 injected in one country could migrate and be physically released (seepage) in another country. The same storage site may be used for different projects, involving different project participants, possibly operating in different countries. The countries concerned could be non-Annex I and/or Annex I countries. The capture could for instance

[81] The European Commission, for instance, advocates a comparable approach in its Proposal for a Directive on the geological storage of carbon dioxide. In accordance with this Proposal, the responsibility for the closed site, including all ensuing legal obligations, shall be transferred to the competent authority where a storage site has been closed pursuant to a certain procedure and when all available evidence indicates that the stored CO2 will be completely contained for the indefinite future. See European Commission, Proposal for a Directive on the geological storage of carbon dioxide, supra, note 65, p. 25.

[82] Ibid. See also Philibert/Ellis/Podkanski, supra, note 3, p. 21, considering that '[t]he probability of 'spontaneous' leaks from the reservoir would then be so low that the most important remaining risk may be that of an accidental man-made damage to the integrity of the subsurface storage. The host country, being able to decide who can use the subsurface and for what, would be best placed to prevent this from occurring.'

[83] IEA Greenhouse Gas R&D Programme, supra, note 6, p 57. See also SBSTA, Synthesis of Views, supra, note 21, p. 19.

[84] It could also take place in international waters. See Philibert/Ellis/Podkanski, supra, note 3, p. 16-17. See also Purdy, "The Legal Implications of Carbon Capture and Storage under the Sea", Sustainable Development and Policy 2006, p. 22; IEA, Legal Aspects of Storing CO2, Paris 2005, p. 21-28.

take place in an Annex I country and the storage in a non-Annex I country, and vice versa.[85] To whom should these seepage emissions be attributed?

The 2006 IPCC Guidelines for National Greenhouse Gas Inventories provide some elements of answer to these questions.[86] In accordance with these Guidelines, if CO2 is captured in one country and exported for storage in a different country, the exporting country should report the amount of CO2 captured and exported. The importing country should report the amount of CO2 imported and any emissions from injection and geological storage sites. Moreover the Guidelines consider the case where CO2 injected in one country migrates and is released in another country, as well as the case where one storage site is used by different countries.

The direct relevance of the 2006 IPCC Guidelines for CDM projects appears however to be limited. Non-Annex I countries are not hold by emission reduction commitments and thus do not have to report their greenhouse gas emissions. The general idea underlying these Guidelines could nevertheless be useful to determine rules for CDM projects.[87] A similar regulation of the use of common storage sites could, for instance, be integrated into the CDM rules. Moreover, similar obligations could be established in case of import and export of CO2 between non-Annex I countries. These reporting obligations should be imposed on the concerned project participants and should be closely linked to the rules on the allocation of liability to the concerned parties.

The implementation of CCS projects in both Annex I and non-Annex I countries raises further difficulties. If CO2 is captured in a non-Annex I country and stored in an Annex I country, the later should, in accordance with the 2006 IPCC Guidelines, report the potential emissions. This scenario is however highly unlikely to take place. On the contrary, Annex I countries could be tempted to capture CO2 from their domestic industries and store it (possibly after liquefaction and transport by tanker) in non-Annex I countries. Following the reasoning of the 2006 IPCC Guidelines, the importing country would have to report the emissions. Given the absence of reporting obligations for non-Annex I countries, it appears desirable to require the exporting (Annex I country) to report the seepage emissions in its national inventory.[88]

VI. Monitoring methodologies

In order to determine the additionality and permanence of CCS project activities, the project emissions, leakage emissions and seepage emissions must be adequately

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[85] For possible combinations of multi-jurisdictional projects and allocation of liability see Bode/Jung, supra, note 10, p. 7 and 10. Bode and Jung identify CCS projects (a) where both capture and storage occur in Annex I countries, (b) where capture takes place in a non-Annex I country and storage in an Annex I country, (c) where both capture and storage occur in non-Annex I countries and (d) where capture takes place in an Annex I country and storage in an non-Annex I country. Moreover, multi-jurisdictional projects could potentially involve countries having not ratified the Kyoto-Protocol.

[86] See 2006 IPCC Guidelines, supra, note 13 point 5.20-5.21.

[87]. See Submission by Portugal on behalf of the European Community and its Member States, supra, note 65.

[88] See Haefeli/Bosi/Philibert, supra, note 39, p. 21-22.

monitored.[89] The environmental integrity of CCS project activities will depend on the full accounting of these emissions.

The monitoring of the emissions of the above-ground CCS installations and of leakage emissions can be carried out by using existing methodologies developed for 'traditional' project activities.[90]

The monitoring of seepage emissions appears, however, to be much more challenging. It will require the development of new methodological approaches, adapted to the specificity of the geological storage of CO2. The 2006 IPCC Guidelines propose such CCS specific monitoring methodologies.[91] In order to estimate the potential seepage of CO2 into the atmosphere and measure its actual occurrence, these guidelines adopt a four-step monitoring procedure. First, host countries should determine whether an adequate geological storage site characterization report has been produced. This report should identity and characterize potential migration and seepage pathways and contain information about the subsurface. Adequate information about the storage site will facilitate proper site selection and thus limit the probability of long term seepage, what will reduce the level of monitoring needed.[92] Second, host countries should determine whether the operator of the CCS project activity has assessed the potential for seepage at the storage site.[93] Simulations should be made to predict the fate of CO2 injected into the storage sites over the short and long term and to estimate the risk of potential seepage.[94].Third, host countries should determine whether each storage site has a suitable monitoring plan[95]. The monitoring plan should ensure the measurement of CO2 emissions at each well and other appropriate places identified during the simulation phase. Fourth, the emissions of each site must be collected and reported.[96]

Although developed to assist Annex I countries in the estimation, measurement and reporting of CO2 emissions from CCS projects, the application of this monitoring methodology in the context of the CDM has been generally endorsed by analysts and the concerned parties.[97] The regulation of CCS under the CDM would have to guarantee that no CCS project activity is approved without submitting such monitoring plan. Moreover, it will have to guarantee that the abovementioned steps are accurately followed by the project participants. Here also it can be questioned whether host states will have the administrative capacity and technical knowledge to assess the accurateness of the monitoring plans and their implementation. As with the selection and closure of storage

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[89] See Kerr, supra, note 68 , p. 236.
[90] IEA Greenhouse Gas R&D Programme, supra, note 6, p. 60.
[91] See 2006 IPCC Guidelines, supra, note, point 5.13-5.20.
[92] Ibid, point 5.14.
[93] Ibid, point 5.15.
[94] In accordance with the IPCC Guidelines, the fate of CO2 should be predicted 'over centuries to millennia.' Ibid, point 5.15
[95] Ibid, point 5.15.
[96] Ibid.
[97] See Submission by Portugal on behalf of the European Community and its Member States, supra, note 65, p.22. See also IEA Greenhouse Gas R&D Programme, supra, note 6, p. 62.

sites, it can be argued in favour of the creation of an international body assisting host countries in these tasks.

VII. Sustainable development

The contribution of CCS to the 'sustainable development' of developing countries[98] is the subject of an intense debate. Proponents of the inclusion of CCS under the CDM argue that CCS would enable to reconcile the economic development of these countries with their contribution to climate change mitigation.[99] This argument is often reinforced by referring to the inevitable increase in the use of coal to ensure the energy security of developing countries.[100] Moreover proponents consider that CCS would generate benefits in terms of local atmospheric pollution.[101] Opponents or skeptics argue that CCS will not contribute to sustainable development because it would not deliver long-term benefits, would not lead to the transfer of cost-effective, environmentally safe and sound technologies and would double electricity prices.[102] CCS would, according to them, only contribute to the continued exploitation of fossil fuels.

Under the current regulatory framework for CDM, the assessment of the sustainability of potential CDM project activities is a competence of the host countries.[103] Formally the issue of the sustainable character of CCS does therefore not need to be regulated at the international level. In accordance with the current rules, it would have to be assessed on a case-by-case basis by the concerned host country. It appears unlikely that developing countries will accept to renounce to this sovereign prerogative. Given the technical specificities and limited experience with CCS, host countries could be assisted in their evaluation by international experts.

In any case, the international community must regulate other fundamental issues, very closely related to the sustainability of CCS project activities. First of all, as developed before, the rules on CDM will have to ensure good storage site selection in order to minimize as much as possible the occurrence of seepage emissions. Indeed this will determine the contribution of CCS project activities to the objectives of the Kyoto Protocol. Moreover, an international answer will have to be found to the energy penalty

[98] See Article 12, para 2 of the Kyoto Protocol providing that 'the purpose of the clean development mechanism shall be to assist Parties not included in Annex I in achieving sustainable development and in contributing to the ultimate objective of the Convention (…).' See Voigt, "Is the Clean Development Mechanism Sustainable? Some Critical Aspects", Sustainable Development Law & Policy 2008, p. 15-21, available at http://ssrn.com/abstract=1145262.

[99] See among others Submission by the International Chamber of Commerce (ICC) to the Subsidiary Body for Scientific and Technical Advice of the UNFCCC in response to decision FCCC/SBSTA/2007/L.19.

[100] See SBSTA, Synthesis of views, September 2008, supra, note 21, p. 22. On the increasing use of coal in developing countries see International Energy Agency, World Energy Outlook 2007 – China and India Insights, Paris 2007, p. 503. See also Cook and Zakkour, "The New Face of King Coal", Environmental Finance 2005, available at www.environmental-finance.com/2005/0507jul/coal.htm.

[101] Submission of the International Emissions Trading Association to the Subsidiary Body for Scientific and Technical Advice of the UNFCCC in response to decision FCCC/SBSTA/2007/L.19, p. 14 -15.

[102] See among others the submission of Brazil and Greenpeace to the Subsidiary Body for Scientific and Technical Advice of the UNFCCC in response to decision FCCC/SBSTA/2007/L.19.

[103] See paragraph 40 of the Modalities and Procedures for a Clean Development Mechanism.

of CCS projects. In particular, how must the increased consumption and production of fossil fuels generated by CCS and EHR projects be accounted for? A final issue refers to the purity of CO2 streams stored.[104] Is it acceptable to store non greenhouse gases within the framework of CDM project activities?

VIII. Conclusion

There is broad agreement about the fact that CCS constitutes an option in the portfolio of actions to combat climate change. CDM could provide the necessary financial incentive to the implementation of this technology in non-carbon-constrained developing countries.[105] However, the views of the Parties, international organizations and non-governmental organizations submitted to the SBSTA show that the inclusion of CCS in the CDM a controversial issue is. The lack of maturity and related uncertainties with the use of CCS, together with its implications for increased fossil fuel consumption and production raise concerns as regards the desirability to stimulate its deployment in developing countries. If the Conference of the Parties serving as the meeting of the Parties takes the political decision to integrate CCS into the CDM, it will have to answer these concerns by creating a robust regulatory framework guaranteeing the effective contribution of CCS to climate change mitigation.

In this context, the first key regulatory issue refers to the assessment of the additionality of CCS project activities. The challenge is to determine baseline scenarios that will not negatively influence the implementation of new renewable energy and energy efficiency projects. In this respect, it is important not to limit the assessment of alternative scenarios to the continuation of the source industrial process without CCS. Methodologies that fully integrate the potential modernization of the concerned installations and the deployment of renewable energy have to be developed. On the other hand, it can be considered that, given the lack of maturity of CCS, the demonstration of the financial additionality of such projects should be relatively straightforward (with the exception of some EHR projects).

The second challenge is to adopt methodologies that will enable the accurate determination of baseline, project and leakage emissions of CCS projects. This issue is essential given the fact that the amount of emission credits issued will determine the incentive to implement CCS projects. It can be considered that the approved CDM baseline methodologies already provide a potential basis to account for most above-ground project emissions. In addition, specific rules have to be adopted for the project emissions related to the storage activities. The issues at stake are primarily related to the monitoring of such activities and could thus be regulated on the basis of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. As regards leakage emissions, the

[104] This question is also debated within the European Union. See European Commission, Proposal for a Directive on the geological storage of carbon dioxide, supra, note 65, p. 22.

[105] De Coninck, Project-based Kyoto Mechanisms and CO2 Capture and Storage, Petten, 2007, p. 1, available at www.ecn.nl. See also Submission of the International Emissions Trading Association to the Subsidiary Body for Scientific and Technical Advice of the UNFCCC in response to decision FCCC/SBSTA/2007/L.19, p. 3.

methodologies will have to reflect the capture or energy penalty generated by additional electricity consumption. An open question is whether the impact of CCS projects on the primary energy market shall be considered as leakage emissions.

In connection to this last issue, it will have to be determined whether CCS projects qualify as 'sustainable'. It has been argued that this is likely to remain a sovereign competence of the concerned host countries. International agreement will nevertheless have to be reached on specific issues such as the purity of CO2 streams stored. Moreover, host countries could be assisted by a body of international experts.

The main challenge is indisputably the creation of rules to guarantee the permanence of stored emissions. The allocation of liability for seepage plays a central role in this respect. Indeed, it will influence the quality of the project, in particular the suitability of the storage site. On the other hand, however, it may affect the readiness of investors to implement CCS projects if it constitutes too heavy a burden. Different structures of responsibility and liability are available. Together with the IEA Greenhouse Gas R&D Programme, it can be argued that, whatever approach is chosen, the most important consideration is that 'the structure of liability provisions needs to be practical and predictable for both project developers and the wider [greenhouse gas] market.'[106]

The predictability and stability of the modalities and procedures for CCS under the CDM are important considerations when building a business case for such capital-intensive and long-term investments as CCS projects. These investors' concerns clash however with the flexibility needed to integrate the new challenges raised by the inclusion of CCS in the CDM and the general lack of regulatory experience in the field of CCS. Acknowledging this concern, the European Union[107], as well as the International Energy Agency[108], proposed to facilitate the deployment of demonstration CCS projects under a temporary regulatory scheme. On the basis of the experience accumulated within this context, long term rules could be developed.

The discussion on the promotion of CCS by including this technology in the CDM, is still ongoing. The description and arguments presented above are thus provisional. It can nevertheless be concluded that, independently from the concrete choices that will be made by the CMP, the major challenge will be how to reconcile the considerations of predictability and stability with the need for flexibility.

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[106] IEA Greenhouse Gas R&D Programme, supra, note 6, p. 55.
[107] See Submission by Slovenia on Behalf of the European Community and its Member States. This submission proposes a so-called 'pilot phase approach'.
[108] See IEA, Legal Aspects of Storing CO2, supra, note 68, p. 41. See also Kerr, supra, note 68, p. 232.