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Progress on including CCS projects in the CDM: Insights on increased awareness, market potential and baseline methodologies

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Abstract

The inclusion of CO_2 capture and storage (CCS) in the Kyoto Protocol's Clean Development Mechanism (CDM) is still subject to controversy and discussion. Although the debate seems to proceed in a direction of more open information exchange between Parties and stakeholders, noticeable progress is slow. This paper discusses substantial results on CCS in the CDM based on three recent results: the outcomes of a capacity building effort in Africa, the development of new and improved methodologies for hypothetical CCS projects, and a new estimate of the market impact of CCS natural gas operations on the CDM.

Keywords: CO2 capture and storage, climate change, Clean Development Mechanism, international climate policy, Africa

1. Introduction

Climate change is currently mentioned as one of the most pressing issues on the international policy agenda. Both industrialized and developing countries have expressed their concern over rapidly rising greenhouse gas emissions. Increasingly, the emerging economies in the developing world are contributors to the climate change problem [1]. Although their historical responsibility for the climate problem and their per capita emissions remain relatively small, their current and future emissions contribute a rapidly increasing share to global carbon emissions. CO_2 capture and storage (CCS) is already recognized by industrialized countries as an important option to reduce CO_2 emissions. Increasingly, however, there is an insight that CCS needs to be deployed in rapidly developing coal-rich economies too if dangerous climate change is to be prevented.

Currently, the only instrument to provide incentives for CCS in developing countries is the Clean Development Mechanism (CDM), a mechanism under the 1997 Kyoto Protocol that allows industrialized countries with an emission reduction target (Annex-B countries) to achieve part of their emission reductions in the developing world (non-Annex-B countries) through trade in project-based emission reductions. Carbon prices under the CDM are currently in a range that would help early opportunities in the CDM become economically viable, although they are probably too low to provide an incentive to CCS in the power sector [2].

The bigger problem, however, is that early submission of CCS projects to the CDM Executive Board, the governing body of the CDM, have led to severe controversies and, up to now, no admittance of CCS projects in the CDM. The barriers to allowing CCS in the CDM are partly technical, such as how to account for the emission reductions, how to estimate risks of future leakage, and how to establish the project boundary [3]. Below the surface

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of the negotiations, however, other considerations play a major role. De Coninck [4], among other issues, names the following: 1) the relative immaturity of CCS and hence its perceived unsuitability for deployment under the CDM; 2) crowding out of other project types from the CDM market; 3) CCS should be developed and tested in developed countries before implementing it under the CDM.

This paper aims to provide some insights into some of these issues. Firstly, we report on two workshops held in Africa in September 2007, the experiences there, and their relevance for CCS in the CDM. Secondly, we report early results of the quantitative impact of CCS in the natural gas processing sector, a mature technology which would likely constitute the early potential of CCS in the CDM. Thirdly, we report on the outcomes of three hypothetical baseline methodologies. To enable for technological diversity and address as many methodological issues as possible, we included on the capture side a new-build coal-fired power plant, a retrofit coal-fired power plant and a gas processing operation. On the storage side, we included a gas field, a saline formation and an Enhanced Coal Bed Methane (ECBM) operation. Lastly, we suggest an institutional framework, making use of the strengths of the CDM procedures and adding to them were CCS asks for extra checks and balances.

2. Awareness of CCS in developing Africa

In September 2007, two regional workshops on CCS and CDM were held in Dakar, Senegal and in Gaborone, Botswana. The workshops were attended by in total 130 stakeholders from around 30 Sub-Saharan African countries. The participants included government representatives, environmental organizations, industry representatives and researchers. The level of knowledge on both CCS and the CDM was low in both workshops, although on both fronts better in the Gaborone workshop. This was partly because of the South African participants in that workshop, where most researchers and government representatives are quite familiar with CCS and industry is even working on processes to capture and store CO_2.

The following conclusions could be drawn with respect to CCS [5]:

- The priority for Africa is economic development. In the field of climate change, Africa's priority is adaptation, not mitigation. However, for both economic development and adaptation to climate change, increase in energy consumption is necessary. As far as CCS can help this the technology could be useful, but climate change mitigation is not a priority for the continent.
- If insufficient incentives are given, CCS may increase the cost of electricity to consumers. This is a cause of concern among participants. There is a need to get more certainty of the cost of the different CCS options, also those outside of the electricity sector.
- In case CCS would be eligible under CDM, there should be proper accounting for seepage, e.g. by discounting the Certified Emission Reductions (CERs).
- Several issues regarding liability for monitoring and accounting of GHG reductions over long time scales are discussed. In Norway (host of the Sleipner and Snøhvit CCS projects) the Petroleum Act gives guidance for these issues, but after productivity of the gas fields has ceased the government takes over responsibility. The question is whether such a model could be replicated in African countries.
- The CDM is the only mechanism currently that has the potential to incentivise CCS in Africa. In that light inclusion of CCS should be considered by UNFCCC parties.
- Early demonstration projects in the African region could help build more confidence in the technology; funds could be set up to support this if the CDM incentive is insufficient.
- More capacity building on CCS is necessary. Also developing a detailed atlas of suitable storage sites in Africa would be useful.

The workshops was for many participants, including negotiators in the UNFCCC, the first time they heard about CCS. This highlights that, before an informed consensus decision can be taken on CCS in the CDM, capacity building with many more government representatives should probably take place. The unawareness of some stakeholders in relevant countries could provide a significant barrier to approval of CCS in the CDM. During the first COP/MOP meeting after the September 2007 workshops, by the way, many African representatives dropped their resistance to CCS in the CDM, although it could not be confirmed that the workshops were the main driver for this.

3. CDM market impacts of natural gas processing CCS

Various estimates have been made on the market impacts of CCS in the CDM. The main questions addressed in such analyses are: how much CCS would be implemented under the CDM, would it crowd out other options to a significant degree, and would the inclusion of CCS lead to a drop in the CER price? Contrasting cost estimates of CCS in the power sector with current and future estimated CER prices leads to the quick conclusion that it is unlikely that CCS in the power sector will be deployed to a significant degree before 2020. The CDM being a market mechanism looking for the lowest-cost mitigation options, it is likely to opt for CCS in the natural gas processing sector, which also dominate the currently implemented CCS projects with the Sleipner and Snøhvit projects (both off the coast of Norway) as well as the In-Salah project (onshore in Algeria) being of that kind. Until recently, data on this were hard to get by and estimates were based on top-down assumptions, such as in IPCC [6] which arrives at some 50 $MtCO_2$ per year in 2002, based on very rough approximations. IEA [7] did a similar analysis and arrived at 334 $MtCO_2$ per year in 2020 that sector. Recently, Zakkour et al. [8] used bottom-up data to arrive at a technical potential 313 $MtCO_2$ in 2020. At CER prices lower than 30 US$/$tCO_2$, the economic potential would be around 250 $MtCO_2$ in 2020. This does not take into account potentially slow legislation and licensing processes.

We present here also a bottom-up analysis based on a database that was kindly made available by IHS, an oil and gas consultancy which owns a database of gas fields around the world, and their CO_2 contents. With the help of this database, we analyze the potential for GHG mitigation by CCS in the natural gas processing in non-Annex I countries. The technical potential is estimated to be 146 – 222 $MtCO_2$ per year in 2020. Figure 1 shows the break-down by country for the central estimate of 174 $MtCO_2$-eq/yr.

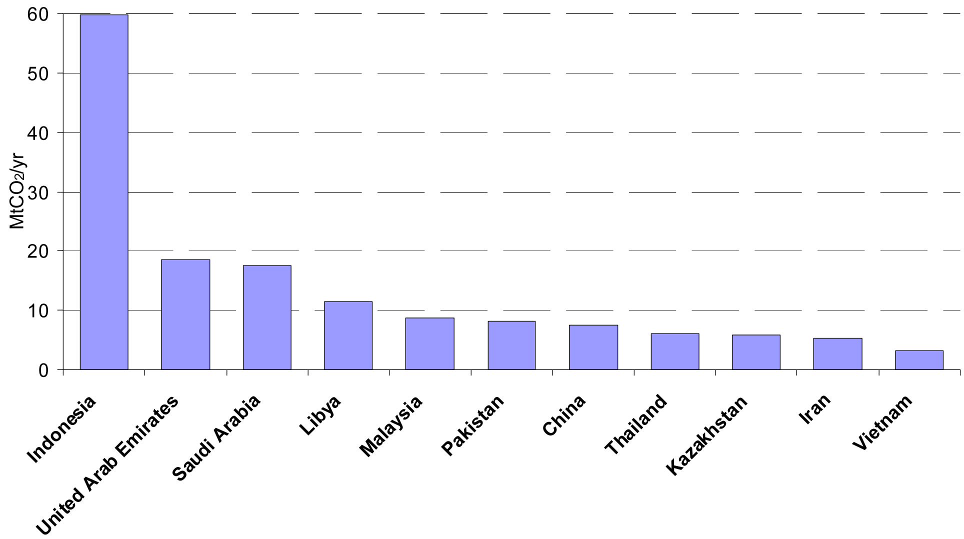

Figure 1 Mitigation potential for CCS in natural gas processing for 2020.

In order to compare this with other technologies we show a marginal abatement cost (MAC) for the non-Annex I region, based on earlier ECN work [9]. The abatement cost has been calculated using the approach in [8]. The overall MAC curve (solid line in Figure 2) includes the major sectors, greenhouse gases and technologies that are currently eligible under the CDM, as well as CCS outside the natural gas processing sector. The dotted line in figure 2 shows the same MAC curve but with inclusion of CCS for natural gas processing.

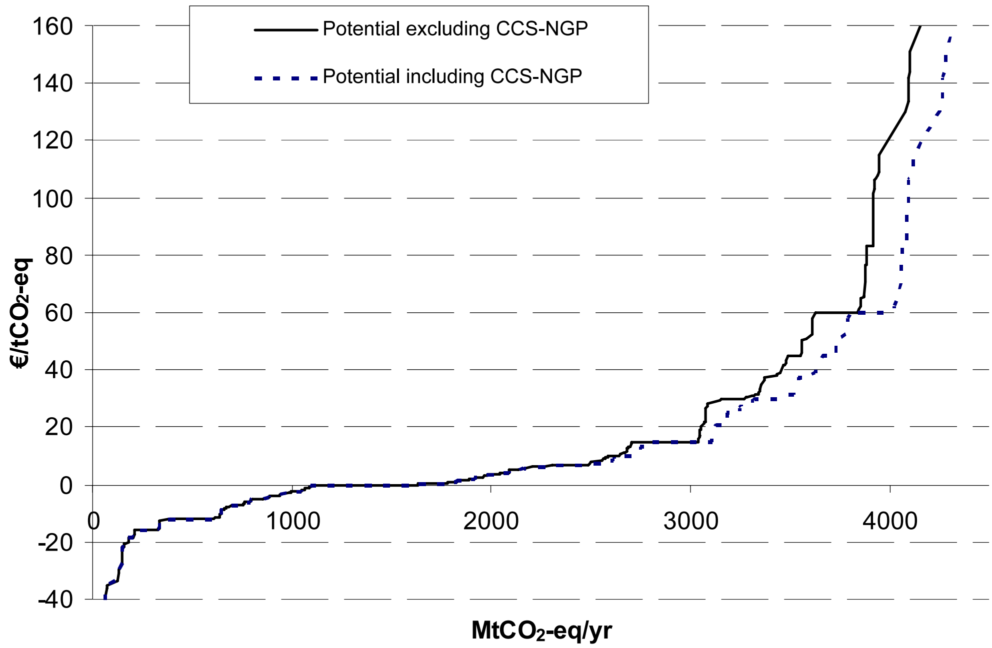

Figure 2. Marginal GHG abatement cost curve for non-Annex I countries in 2020 (with input from [9]).

The total annual economic potential up to 30 €/tCO_2 is more than 3 GtCO_2-eq/yr. It can be concluded that there is a small economic potential for CCS natural gas processing operations at costs below 20 €/tCO_2, but that the larger potential is at costs between 20 and 30 €/tCO_2. Overall, CCS in natural in natural gas processing could add about 5-7% to the CDM project portfolio. This is a small but not insignificant figure. However, CCS in the natural gas processing or otherwise would not have a large CDM market impact.

4. Methodological dilemmas of CCS in the CDM

A third issue related to CCS is whether the current CDM modalities and procedures can accommodate the specifics of CCS technologies. In order to check that, we have developed illustrative baseline methodologies for three hypothetical CCS project activities under the CDM. To address as many methodological issues as possible, the following technologically diverse methodologies were elaborated:

- Capture of CO_2 from an existing coal-fired power plant and its use in a newly developed ECBM recovery operation.
- Capture of CO_2 from a new-build pulverized coal plant, excluding plants co-firing bio-mass, and its subsequent storage in depleted oil or gas fields or saline formations.
- Capture of CO_2 from a natural gas processing plant and storage in depleted oil or gas fields or saline formations.

In the process of following CDM regulations on the baseline methodology format document (available on http://cdm.unfccc.int), a number of methodological dilemmas were identified and addressed. The most crucial ones are summarized in the table below.

Table 1: Overview of results of hypothetical baseline methodologies [10]

		Retrofit + ECBM	New build + gas/oil/saline formation	Natural gas processing + gas/oil/saline formation
Data	CO_2 source	Existing pulverized coal-fired power plant	New pulverized coal-fired power plant	Natural gas processing plant
	Capture process	Retrofit post-combustion	Post-combustion	Not specified
	Transport	Pipeline	Pipeline	Pipeline (short)
	Storage	ECBM operation	Depleted gas or oil reservoir, or saline formation	
Dilemmas	Project boundary	CO_2 source and capture, transport and injection infrastructure, and full storage complex	CO_2 source and capture, transport and injection infrastructure, and full storage complex	CO_2 compression, transport and injection infrastructure and storage complex
	Energy penalty accounting	Assuming electricity from the grid	Assuming most conservative of a) baseline; b) grid build margin; c) grid operating margin	Emission from fossil fuel combustion supplying power for compression, transport and injection
	Additionality demonstration	Combined tool for demonstration of additionality and baseline methodology	Tool for demonstration of additionality	Combined tool for demonstration of additionality and baseline methodology
	Accounting of hydrocarbon recovery	Conservatively neglected as gas recovered in ECBM likely cleaner than the baseline	Not applicable	Not applicable
	Monitored gases	Capture: CO_2 Storage: CO_2, CH_4	Capture: CO_2 Storage: CO_2, CH_4	Capture: CO_2 Storage: CO_2, CH_4
	Leakage	Emissions resulting from extra coal mining	Emissions resulting from extra coal mining	No leakage
	Long-term liability	Provision in baseline methodology applicability conditions that host country should overtake liability after the storage site is proven safe		

The work done on the methodologies suggests that most issues can be solved within the framework of a normal CDM baseline methodology format. An extra feature may include more space for detailed monitoring and geological data. However, we did conclude that it would be helpful if some targeted institutional settings could be added to the current CDM institutional infrastructure. These are elaborated in the next section.

5. Recommended institutional actions

Based on the issues encountered while developing the CCS baseline methodologies, we recommend a number of institutional arrangements. These will be needed to check compliance with requirements on site characterization and selection, monitoring and liability, and could be described in a decision of the CDM Executive Board or the COP/MOP, or in more detailed applicability conditions for CCS baseline methodologies. Building on the existing institutions and checks and balances in the CDM, we suggest the following institutional structure for guaranteeing that CCS is implemented safely and permanently under the CDM:

- The applicability conditions in the CDM baseline methodology require that the host country has legislation in place to permit CCS operations in a responsible manner and deal with site selection, monitoring, site development and long-term liability.
- The competent authority for CCS permitting in the host country drafts a decision on a storage permit for the

CCS operation, in which site integrity and storage permanence are duly dealt with.

- The Designated National Authority (DNA) in the host country includes the draft decision of the competent authority in its Letter of Approval on the CCS project as a CDM activity.
- A dedicated CCS accreditation would be required for Designated Operational Entities (DOEs) for performing Third Party validation and verification of CCS operations. The DOE should have demonstrable experience with CCS. It would validate and verify according to the normal procedures for CDM projects.
- A CCS panel under the CDM Executive Board (in functioning analogous to the existing AR or the SSC panels) consisting of geological, technical and legal experts considers:
    - whether the host country indeed has an effective legislative framework in place, and thus whether the requirements are met. This would need to happen only once before the project registration.
    - the validation report of the DOE on technical details. Guided by that advice, the CDM Executive Board approves or rejects the request for registration of the CCS-CDM project.
    - the verification report by another accredited DOE on the request for issuance of the CERs. The CCS Panel opinion on this will guide the CDM Executive Board in this decision, apart from the usual considerations on the credits generated by the CDM project.

This would rule out any CDM projects in candidate host countries that do not manage to regulate the risks of CCS operations on their territories in a timely fashion. It would avoid the need of an international regulatory regime for CCS. The institutional structure is schematically illustrated in the figure below.

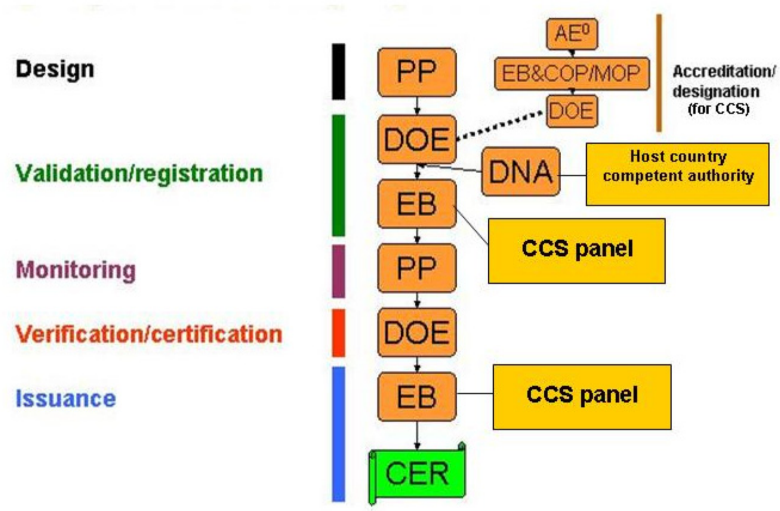

Figure 2: Suggested adjusted CDM project activity cycle for a proposed CCS operation under the CDM. There are three changes in the normal cycle: The DOE needs to be especially accredited, the host country competent authority will have to license the project before the DNA does, and the CCS panel provides advice to the Executive Board on the approval of the project, and on the issuance of the credits. (PP = Project Participants; EB is CDM Executive Board) [10]

The institutional framework for responsible CCS inclusion in the CDM would necessitate the development of regulatory frameworks for CCS in non Annex I countries. In major industrialized regions, notably the European Union, the United States and Australia this has turned out to be time-consuming and to require substantial input from experts in research and industry. While some developing countries may have the resources to develop such a framework themselves, have mining laws that are applicable (such as in Algeria for In-Salah) or are willing to broadly adopt a framework developed in any of the industrialized countries, many countries may prefer to prioritize other policy issues. We therefore recommend that Annex-I countries make available funds to help developing countries develop the legal framework to implement CCS safely.

Any institutional framework on CCS needs to strike a balance between a safe regime and one that is practically feasible. The requirement of national CCS frameworks might slow down the implementation of CCS operations in non-Annex I countries, possibly by years, if such legal frameworks need to be developed. In addition to this, the licensing process itself can take time. In the initial phases, the development of the host country legal framework could combine learning on technology and learning on legislation, if the CDM Executive Board could give a provisional approval. Such a procedure would allow developing countries interested in CCS in the longer term to develop a legislative framework early on.

6. Conclusion

While the inclusion of CCS in the CDM is still highly controversial, progress is made in insights that can help solve information barriers related to CCS in the CDM. Workshops have been held in Africa that have helped negotiators understand CCS better, and have clarified Africa's stake in CCS. It became clear that there is a looming gap in awareness and knowledge in this continent that is potentially rich in storage capacity. An estimate of the potential of natural gas processing CCS in the CDM, based on a previously classified database from the oil and gas industry, suggests that there is considerable potential in the natural gas sector early opportunity, but that CCS is unlikely to impact the CDM market significantly. We have also demonstrated that baseline methodologies can be developed and most dilemmas can be addressed within the CDM structure or with few adjustments. Lastly, we suggest an institutional structure that is compatible with the current CDM modalities, procedures and institutions, and would provide sufficient checks and balances to perform CCS safely and permanently in developing countries.

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