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Reforming the Clean Development Mechanism to accelerate Technology Transfer

By Joëlle de Sépibus*

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The Clean Development Mechanism (CDM) is the largest technology-transfer mechanism under the United Nations Framework Convention on Climate Change (UNFCCC). The idea of maintaining it or scaling it up in the post-2012 period, to accelerate technology transfer, is hence attractive. The weak environmental integrity of the CDM and its propensity to promote predominantly end-of-pipe technologies, however, caution against its perpetuation under a new global climate accord. This paper proposes that, if the CDM were to be maintained, reforms should be adopted to improve the investment conditions for key climate technologies and modify the incentive structure of the CDM. While such reforms contribute to making key technologies more attractive for investors they do not address the CDM's inability to foster policy reforms. This paper therefore suggests that the CDM is progressively phased out in favour of sectoral carbon crediting mechanisms.

Introduction

Innovation and technology transfer is critical for achieving low carbon and climate resilient development.[1] This is recognised by both the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol (KP) which request Parties to cooperate in the development, diffusion and transfer of environmentally sound technologies.[2] It was however only with the Bali Action Plan (BAP)[3] that the issue moved center stage. Developing countries had made it clear that without "enhanced action on technology development and transfer" no ambitious global climate deal could

[1] A study led by Dechezleprêtre drawing on patent data for thirteen climate technologies shows that innovation in climate change technologies is highly concentrated in Japan, Germany and the USA. International transfers mostly occur between developed countries (75%), whereas exports from developed countries to emerging economies are still limited (18%). According to the authors this suggests a huge potential for the development of North–South transfers. See Dechezleprêtre et al. (2009: 4); see also Tomlinson et al. (2009).

[2] See Articles 4.1, 4.3, 4.5 and 11.1 UNFCCC.

[3] The BAP was adopted by the Conference of the Parties (COP) of the UNFCCC to launch the negotiation process for a new international climate agreement for the period after 2012 to be concluded at the UN conference in Copenhagen in December 2009. See FCCC/CP/2007/6/Add.1; Bazilian et al. (2008: 5).

be struck for the period after 2012. Developed countries hence agreed to support nationally appropriate mitigation actions (NAMAs) of developing countries by "technology, financing and capacity-building" in a "measurable, reportable and verifiable manner".[4] As a result, the transfer of both financial resources and technology has become a central "supporting pillar" for both mitigation and adaptation in the UNFCCC negotiation process for a new global climate accord.[5]

So far, the principal international tools financing technology transfer have been the funds administered by the Global Environmental Facility (GEF)[6] and the Adaptation Fund.[7] A rather effective instrument for supporting the diffusion of mitigation technologies under the Kyoto Protocol has been the Clean Development Mechanism (CDM),[8] which rewards investors from developed countries for investing in projects in developing countries resulting in additional reductions in greenhouse gas emissions. Although it has no explicit technology mandate, the CDM has facilitated technology transfer by financing emission reduction projects that use technologies currently not available in host countries.[9] Moreover, the CDM has financed adaptation technologies through a levy of two percent on the proceeds of the CDM projects.

Given the important financial flows[10] generated by the CDM and its contribution to technology transfer, many stakeholders are pressing to keep or even upgrade the CDM in the post-2012 climate regime.[11] The continued recourse to the CDM in its current form is, however, problematic.[12] The dubious additionality of many projects, the absence of a truly neutral verification process and the deficiencies of its oversight have largely contributed to weaken the credibility of the CDM as an offset mechanism. Further, in leaving the initiative largely to private actors focusing on short-term abatement measures, the CDM has failed to foster policy reform. Worse still, perverse incentives tend to protract rather than strengthen the implementation of mitigation policies.

Recognizing both the potential of the CDM to foster technology transfer and its environmental shortcomings, this study investigates whether the CDM can be reformed to allow it to serve the Bali mandate more forcefully while also securing its environmental integrity. The paper begins by introducing the reader to the current discussions on the future international framework for technology transfer. In section II it summarises the

[4] Bazilian et al. (2008: 19).
[5] Bazilian et al. (2008: 19); European Commission (2009: 9).
[6]The GEF is a global partnership among 178 countries, international institutions, non-governmental organizations (NGOs), and the private sector to address global environmental issues. See http://www.gefweb.org/
[7] The Adaptation Fund was established to finance concrete adaptation projects and programmes in developing country Parties to the Kyoto Protocol that are particularly vulnerable to the adverse effects of climate change. See also UNFCCC, Expert Group on Technology Transfer (EGTT) (2009b:36).
[8] Article 12 of the Kyoto Protocol.
[9] See Seres (2008).
[10] The CDM has grown to a global multi-billion dollar market with about 1.5 to 2 billion Certified Emission Reductions (CERs) being issued up to 2012. See Schneider (2008: 24).
[11] Key elements being explored include a broadening of its scope[11] and the inclusion of "sectoral" or "policy" CDMs. See Sterk (2008).
[12] De Sépibus (2009); Wara (2008), Lohmann (2008), McCully (2008), Schneider (2007, 2008).

main concerns expressed with respect to the environmental integrity of the CDM and reviews the literature regarding its contribution to technology transfer. Section III proposes to enhance the investment conditions of host countries for key technologies and to change the current incentive structure of the CDM. Section IV concludes by discussing the pros and cons of substitution of the CDM with a sectoral carbon crediting mechanism.

I. The international framework of technology transfer

The centrality of the technology question comes from the realisation that a reduction of emissions consistent with the objective of the European Union, which is to keep global warming under 2 °C higher than pre-industrial levels, would entail developed countries having to reduce their emissions in the range of 25–40% by 2020 and 80–95% by 2050, whereas developing countries would need to limit the rise in their greenhouse gas emissions (GHG) by 15–30% below those of 1990 by 2020.[13] To reach such an ambitious goal a significant scale-up of public and private research and development (R&D) programs as well as enhanced deployment[14] and diffusion[15] programs, together with private-sector investment flows for mitigation technologies are necessary in both developed and developing countries.[16]

As developing countries often lack the capacity to develop and finance critical climate technologies, developed countries[17] will have to increase the pace and extent of the current technology transfer.[18] This does not merely mean increasing the supply and shipment of hardware but also requires fostering the "processes covering the flows of know-how, experience and equipment" and the capacity of developing countries to "understand, utilize and replicate the technology" to "adapt it to local conditions and integrate it with indigenous technologies".[19] The latter is critical as only the acquisition of domestic capacities to master the received knowledge and to innovate from it will allow developing countries to sustain a low-carbon path.[20]

[13] European Commission (2009: 5).
[14] Deployment means initiatives that seek to accelerate investment in and use of near-commercial technologies, resulting in cost reductions and improvements in technology maturity and market acceptance. See UNFCCC, EGGT (2009a: 17).
[15] Diffusion refers to efforts to increase the adoption of and investment in existing technologies, with existing technologies defined as those technologies that are commercial and cost-effective for application in markets around the world. See UNFCCC, EGTT (2009a: 22).
[16] See UNFCCC, EGTT (2009a: 37).
[17] Dechezleprêtre et al. note in their study on patent data that China, Russia and South Korea have become major innovators in climate technologies. Technology exchanges between emerging economies, however, are almost non-existent. According to this study there is hence also a huge potential for South–South exchanges—particularly given that these countries may have developed technologies that are better tailored to the needs of developing countries. See Dechezleprêtre et al. (2009: 30).
[18] According to the Chair of the EGTT around US$ 260.670 billion per year of additional investment above current levels in mitigation technologies will be required by 2030 to stabilize the climate. See UNFCCC, EGTT (2009a: 10).
[19] For a review of the literature on technology transfer see Bazilian (2009: 10ff).
[20] See International Centre for Trade and Sustainable Development (2008).

In response to increasing awareness of the pressing need to boost technology transfer, in 2001 the COP[21] set up a comprehensive technology transfer framework,[22] which led to the establishment of a web-based portal for technology-related information,[23] the conduct of capacity building programs and the elaboration of so-called technology needs assessments (TNAs[24]). The COP moreover supported efforts to improve policy and market conditions with the aim of accelerating the uptake of technologies by developing countries. Finally, it created an Expert Group on Technology Transfer (EGTT)[25] whose function is to identify ways to facilitate the development and transfer of technology activities.[26]

Notwithstanding these efforts, a study led by Dechezleprêtre drawing on patent data shows that the measures have not led to any "visible effect" on technology transfer.[27] Aware of the need to scale up the efforts, the COP decided in Bali to strengthen the international framework for technology transfer.[28] Parties were requested to explore new mechanisms to accelerate the deployment, diffusion and transfer of technologies, to reinforce cooperation on research and development and to foster technology cooperation in specific sectors as well as to develop tools that would enable the measurement, reporting and the verification of the support provided by developed countries for mitigation actions in developing countries.

The first concrete steps towards realizing these plans were taken by the COP in December 2008, when it adopted the "Poznan strategic programme on technology transfer" which foresees scaling up the funding for technology transfer by US$ 50 million.[29] The COP also requested the GEF to expedite technology transfer projects, to assist developing countries and to prepare or update their TNAs.[30] Stepping up its support, the GEF has since then pushed developing countries to go beyond identifying technology needs and to develop so-called Technology Action Plans (TAPs) for prioritized mitigation and adaptation technologies.

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[21] The Conference of the Parties of the UNFCCC.

[22] The technology transfer framework identified five key themes: technology needs and needs assessments, technology information, enabling environments, capacity-building, and mechanisms for technology transfer.

[23] See the homepage of TT-clear on the internet at http://unfccc.int/ttclear/jsp/index.jsp

[24] In the TNAs, developing countries define their needs with respect to the deployment and the diffusion of environmentally sound technologies.

[25] From 2001 to 2007 the EGTT reported to the Subsidiary Body for Scientific and Technological Advice (SBSTA). Since Bali, the expert group has also been reporting to the Subsidiary Body for Implementation (SBI). See http://unfccc.int/ttclear/jsp/EGTT.jsp

[26] In April 2009, the EGTT published three reports, a strategy paper evaluating the principal options that would allow enhancement of technology development and transfer in the long run, a paper addressing financing options and a study on performance indicators related to the effectiveness of the technology transfer framework. See UNFCCC, EGTT (2009a, b, c).

[27] Dechezleprêtre et al. (2009: 3).

[28] Bazilian et al. (2008: 18).

[29] UNFCCC, EGTT (2009a: 21).

[30] Global Environmental Facility (2009).

In the current negotiations, consensus seems to be emerging on certain key priorities, but has yet to be reached on the specific form and function of a new international technology transfer framework.[31] Parties seem to concur on the need to build enabling environments for technology diffusion through the creation of appropriate policy frameworks; to increase international collaboration on key technologies; to create centers of excellence that incentivize innovation; and mechanisms for accelerating the diffusion of existing technologies.[32] With respect to the generation of new financial resources, the main variants proposed by Parties are contributions of public finance, funds generated from market mechanisms and levies on international transactions.[33]

The role that the CDM will be attributed within this new framework is not yet clear.[34] Given its potential for mobilizing private entities to combat climate change,[35] it might be useful to investigate whether it could be reformed so as to channel more financial flows towards most needed climate technologies.

II. The Clean Development Mechanism

The CDM, established by the Kyoto Protocol to allow industrialized countries to achieve a portion of their required emission reductions in countries without emission targets, was designed with the dual aim of helping developing countries to achieve sustainable development and of assisting industrialized countries to comply with their GHG reduction obligations. Article 12 of the Kyoto Protocol set out the basic provisions of the CDM, but left out many details of its operation. These were completed by the so-called "Marrakesh Accords" which laid down the principal modalities and procedures of the CDM[36] and numerous decisions[37] of the Executive Board (EB), in charge of the supervision of the CDM.[38]

Each CDM project cycle starts with the establishment of a project design document (PDD),[39] by a project developer. The project developer must demonstrate that his or her

[31] The paper identifies institutional structures and their governance, delivery of financial support, and technology cooperation and cooperative research and development as key issues reflected in Party submissions. See UNFCCC, AWG-LCA (2009)
[32] Staley et al. (2009: 7).
[33] UNFCCC, Ad-hoc Working group (2009: 8).
[34] In the current negotiations the EU has been asking for a phasing-out of the CDM for advanced developing countries.
[35] See http://uneprisoe.org/
[36] The "Modalities and procedures for a clean development mechanism as defined in Article 12 of the Kyoto Protocol" were adopted by the 7th session of the United Nations Framework Convention on Climate Change Conference of the Parties (UNFCCC COP) held in Marrakesh, Morocco, in December 2001 and confirmed by the First session of the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol (hereafter "COP/MOP") in Montreal in December 2005; FCCC/KP/CMP/2005/8/Add.1 Decision 3/CMP.1. Hereafter, the "CDM rules".
[37] The decisions of the EB have been numbered sequentially and are available on the Internet at: http://cdm.unfccc.int/EB/index.html
[38] CDM rules, par. 5.
[39] The PDD contains details about the proposed CDM project, including a description of the project activity that will reduce GHG. See CDM rules, Appendix B.

project leads to emission reductions that are 'additional' to those that would have occurred under a 'business as usual' scenario and has to make sure that the project meets the conditions set out by the host country. The PDD, together with a "letter of approval" from the host country is then submitted by the project developer to an independent entity, the Designated Operation Entity (DOE), for validation. The DOE reviews it[40] and submits it to the EB for registration. The request for registration by the DOE is considered granted unless three or more of the EB members request a review.[41]

If everything goes to plan, the EB issues the credits in the amount of one Certified Emission Reduction (CER) for each tonne of carbon dioxide equivalent[42] of emissions reduced.[43] The CERs resulting from a CDM project can be purchased by private and public entities, but are used by an Annex I Party at the end of the Kyoto Protocol's commitment period to demonstrate its compliance with its commitment.

A. The shortcomings of the environmental integrity of the CDM

At the heart of the environmental integrity of the CDM lies the concept of 'additionality', which ensures that credits are not issued for emission reductions that would have occurred anyhow.[44] So far, the establishment of transparent and objective criteria for assessing the additionality of a project has remained problematic.[45] The principal concern is that they rely on criteria and assumptions that would be hard to verify and are easy to manipulate.[46] This problem is further exacerbated by the fact that the emission reductions claimed by project proponents are verified by private entities which are chosen and paid by them.[47] The resulting conflict of interests creates a significant risk that the verification process is not carried out objectively.[48]

Another delicate issue relates to the decision of the EB that project proponents may ignore policies aiming at the reduction of GHGs passed by host countries after 2001 when calculating the amount of credits generated by their project. This decision was taken to avoid the deterrent effect the CDM has on the adoption of such legislation. Many developing countries had indeed become reluctant to implement climate-friendly policies for fear that this would result in fewer projects being hosted by them.[49] The decision of the EB, though welcomed to prevent a stalemate regarding the adoption of climate legislation, has a serious drawback. By allowing project proponents to proceed this way,

[40] CDM rules, par. 26 ff.
[41] CDM rules, par. 41.
[42] This measure is used by cl imate experts to compare the global warming potential (GWP) of GHGs other than carbon dioxide (CO_2) with the GWP of the latter.
[43] CDM rules, par. 64 ff.
[44] See Schneider (2008: 20).
[45] Schneider (2008: 23).
[46] De Sépibus (2009: 13).
[47] Schneider (2008: 14).
[48] Schneider (2008: 14).
[49] See Willis et al. (2006: 18).

the danger that the CDM is generating meaningless credits has been significantly enhanced. Calculated on a biased baseline, the number of credits generated by these projects is artificially inflated. Moreover, the passage of time will exacerbate the problem. As developing countries start to adopt policies for tackling climate change, the baseline used to calculate the number of credits will become less and less plausible.

Comment [s1]: Query on footnote 49 (highlighted). Page number?

B. The contribution of the CDM to accelerating technology transfer

When the CDM was launched it was expected to lead to large transfers of technologies and expertise "flowing from the technologically developed North to the South".[50] On the basis of many studies which had demonstrated that foreign direct investment generally promoted knowledge transfer, the hope was that the CDM would become a new and effective channel for investments in innovative green technologies.

The surveys conducted so far, which have examined the propensity of CDM projects to lead to technology transfer, indicate that this expectation has only partly been met.[51] According to an analysis undertaken by Seres for the UNFCCC, about 36% of the CDM projects examined, accounting for 59% of the annual emission reductions, refer to some form of technology transfer.[52] The study demonstrates that agriculture, hydrofluorocarbons (HFC), landfill gas, nitrogen dioxide (NO_2) and wind projects tended to have more frequent recourse to foreign technology, whereas biomass, cement, hydro and transport projects did so less often.[53] These results confirm the findings of an earlier investigation, led by Dechezleprêtre, which identified two main areas of technology transfer: end-of-pipe destruction of non-CO_2 GHGs with high global warming potentials, such as HFCs, methane (CH_4) and nitrous oxide (N_2O), and wind power.[54]

Most of the projects examined by Seres involve the transfer of both equipment and knowledge.[55] The study also provides evidence that technology transfer is more common in projects with foreign participants and in large-scale projects than in unilateral and/or small-scale projects.[56] In general, the reasons given in this study for the import of foreign

[50] Doranova et al. (2009: 5).
[51] See Dechezleprêtre et al. (2009); Doranova et al. (2009); Haites et al. (2008); Seres et al. (2008); Youngman et al. (2008).
[52] The sources used by this author are principally the Project Design Documents (PDD). As no definition of "technology transfer" is provided to project participants, each project is free to use its own interpretation. Most project participants seem to interpret "technology transfer" as meaning the use of equipment or knowledge not previously available in the host country for the CDM project. See Seres (2008: 7).
[53] Seres (2008: 10).
[54] Dechezleprêtre et al. (2007: 27).
[55] About 32% of the projects that claim technology transfer involve only imports of equipment. Transfers of knowledge alone occur in 15% of the projects. See Seres (2008: 18).
[56] No direct link, however, can be established between the share of technology transfer and the size of a country or its per capita GDP. Generally, technology transfer is less apparent in projects hosted by Brazil, China, and India. See Seres (2008: 8).

technologies are that they are not available domestically or that they are more efficient and/or more reliable than similar domestic ones.[57]

Other studies show that the probability that the CDM leads to technology transfer is higher for countries with an open economy, strong GDP growth[58] or which have a good investment climate.[59] They also suggest that the likelihood that projects will include foreign technology is greater in host countries with a subsidiary of an Annex-I country firm.[60] Finally, it is noted that there is no clear-cut pattern as regards the transfer of technology to countries at more advanced stages of development.[61].

Comment [s2]: pattern?

In conclusion, the surveys demonstrate that the CDM has contributed to accelerate the transfer and the diffusion of certain mitigation technologies and countries, but for others it has remained ineffective.[62] Moreover, if the CDM has proven relatively successful at attracting both finance and technical assistance on a project level, it has been incapable of encouraging policy changes, let alone the setting up of the institutional and technical capacities necessary to foster innovation.[63] Finally, being a market instrument that concentrates on single projects, the CDM has probably not promoted "much cumulative technological learning", a prerequisite for any long-term uptake of new technologies.[64]

The emphasis placed on cheap abatement strategies to maximize short-term profits means moreover that in most cases, it is not the technology with the greatest potential to reduce the long-term carbon footprint of a country that is chosen, but the one which generates the cheapest carbon credits. As a result, highly profitable industrial gas[65] or landfill projects with low ancillary environmental and social benefits, using existing end-of-pipe technologies, dominate the CDM pipeline and generate the lion's share of technology-transfer-based emissions reductions. [66]

Comment [s3]: Query on footnote 66 (highlighted). What does SF6 stand for?

Though developing countries may guide the choice of technologies by formulating sustainability criteria for the projects they host, their capacity for gearing the CDM towards certain types of technologies which would address their needs and priorities is

57 Seres (2008: 18).
58 Glachant et al. (2008:17).
59 Pueyo Velasco (2007: 5).
60 Glachant et al. (2008:17).
61 In theory, this factor has an ambiguous effect, as high capabilities are necessary to adopt a new technology, but also imply that many technologies are already available locally. The survey led by Dechezleprêtre shows that for this type of countries the propensity to take recourse to technology transfer is high for the energy and chemicals industries, but low for agricultural projects. See Dechezleprêtre et al. (2007: 27).
62 Doranova et al. (2009).
63 See Bazilian et al. (2008: 37).
64 United Nations Department of Economic and Social Affairs (2008).
65 The reduction of so-called "super-pollutants" (CH_4, N_2O, HFC-23, polyfluorocarbon (PFCs), sulfur hexafluoride (SF6) is highly beneficial as reductions in emissions of these chemicals lead to far greater reductions in global warming than one molecule of CO_2. Compared to CO_2's GWP of 1, the GWPs of the other super-pollutants are dramatically higher. GWPs: CH_4, 21; N_2O, 310; HFC-23, 11,700; PFCs, 6,500–9,200; and SF6, 23,900. Because CERs are awarded on the basis of the GWP of a gas, investors can receive thousands more CERs for a one-ton reduction of a super-pollutant than CO_2. See Schatz (2008: 719).
66 See UNEP RISOE at http://www.cdmpipeline.org/cdm-projects-type.htm#1

limited. Indeed, as the formulation of technological requirements limits the number of projects they may host, developing countries have few incentives to require and/or to enforce them. Moreover, as positive ancillary benefits of technologies (i.e. improved knowledge and skills, employment opportunities, and improved environmental quality) are not financially rewarded, they fail to have a significant influence on investment flows.[67] The share of projects with high sustainability benefits such as energy efficiency programmes has accordingly remained tiny despite the considerable efforts to make their registration easier.[68] Also, the CDM has so far hardly contributed to finance any large-scale infrastructure in the low-carbon energy or public transport sector.[69]

A positive evolution can be noted with respect to the promotion of certain renewable energy sources.[70] As a result of the adoption of less bureaucratic rules for small-scale projects[71] their number has substantially increased in recent years. This apparent success must however be put into perspective as the "additionality" of many of these projects is dubious, the CDM revenue generally enhancing their profitability only marginally.[72] Moreover, mainly hydro and wind projects have been registered but there have been hardly any technology with a high mitigation potential, but important upfront costs, such as solar, geothermal or tidal energies.[73] Finally, as McCully notes in his critique of Asian hydro projects, the additionality of these projects is all the more questionable as many of the registered projects had already started before the request for registration was formulated.[74]

Comment [s4]: is relativized a real word?

Finally, a study on the contribution of the CDM to sustainable energy technology transfers highlights the fact that project developers often favour technologies "anchoring in existing systems and know-how".[75] As a result, in the field of electricity production, the CDM has largely contributed to financing large fossil-fuel power stations which lock the host country into a high-carbon path.[76] The propensity to fund such projects is moreover enhanced by the fact that historically these industries have had close ties with governments and are able to pay upfront the large transaction and consultancy costs incurred by CDM projects.

III. Reforming the CDM to foster the transfer and diffusion of critical climate technologies

[67] Schneider (2008: 29).
[68] See UNEP RISOE at http://www.cdmpipeline.org/cdm-projects-type.htm#1
[69] United Nations Department of Economic and Social Affairs (2008: 39).
[70] See UNEP RISOE at http://www.cdmpipeline.org/cdm-projects-type.htm#1
[71] See Leguet et al. (2008: 75).
[72] A project is additional if the project would not have been implemented in the absence of the CDM. Schneider demonstrates that if the CDM contributes only marginally to the profitability of a project the argument that the project would not have been implemented without the CDM is implausible. This is however the case for most projects using renewables. See Schneider (2007: 40).
[73] See UNEP RISOE at http://www.cdmpipeline.org/cdm-projects-type.htm#1
[74] See McCully (2008: 5).
[75] ENTTRANS (2007: 9)
[76] See de Sépibus (2009).

Despite the shortcomings of the CDM stakeholders stress its direct and indirect benefits[77] and push for its maintenance under a future climate agreement. The CDM may thus well continue to play a role in the future, if only transitorily and/or for certain countries. While recognizing the potential of the CDM to leverage private finance for investments in low-carbon technologies, we believe that if the CDM is to be maintained, reforms should be undertaken to bring it more in line with the BAP and the international framework for technology transfer.

With such considerations in mind, this paper builds on the current discussions on the potential of the CDM to accelerate technology transfer. It recommends in particular giving the CDM a clear mandate for the transfer and diffusion of low carbon technologies. To avoid this goal being merely paid lip service, this paper explores also how investment conditions for projects promoting key climate technologies can be improved. Finally, it offers a list of structural reforms that would allow channeling private investment flows towards those technologies that are the most needed to ensure a long-term reduction of GHGs.

A. A technology mandate for the CDM

The Kyoto Protocol has assigned the CDM a double goal: the reduction of GHGs and the promotion of sustainable development in developing countries. It remains silent, however, on the technology issue. Although this situation has been partly remedied by the COP which recognized that CDM must lead to technology transfer[78] a new climate agreement should explicitly state that the CDM must contribute to the transfer and the diffusion of key climate technologies. Only if the CDM has a clear technology mandate will it be justifiable for the reforms to place a stronger emphasis on this role.

Moreover, to gain a good understanding as to how the CDM fosters technology transfer and diffusion, a consistent database should be established. So far, the PDDs constitute the main source of information for the studies exploring this topic.[79] The information provided by project developers remains however often approximate and sketchy.[80] For instance, none of the documents examined by Seres indicated the commercial arrangements for the technology transfer and, in certain cases, the PDDs did not even reveal the origin of the technology.

This lack of information is unfortunate. A reform of the CDM should thus also include a requirement that project developers provide more information on the transfer and the

[77] Among the benefits most often cited are awareness-raising, capacity building and its potential to help in discovering cheap mitigation options.
[78] Recognizing the importance of technology in tackling climate change and the necessity for its transfer to developing countries, the Conference of the Parties (COP) decided in 2000 that the CDM must also lead to the transfer of "environmentally sound technologies". See FCCC/CP/2000/5/Add.3.
[79] When submitting their projects, developers are requested to state which technology will be employed and to provide a description of how the technology and related know-how will be transferred to the host country, in their project documents. See Section A.4.3 of the PDD.
[80] Seres et al. (2008: 6)

diffusion of technologies.[81] For instance, it would be useful to know precisely why foreign, local technology or a combination of both was used what kind of equipment or knowledge was transferred, whether it has improved the technological capacity of local staff or whether it involved the transfer of intellectual property rights. Indeed, only if more in-depth information can be gathered through the CDM on the use of low carbon technologies can the lessons be drawn and shortcomings in the international framework be addressed.[82] In practical terms, this means that the information provided by the PDDs should be more comprehensive and that monitoring reports should clearly explain which technology was used, how it was transferred and whether it has contributed to capacity-building in the host country. This information should then be regularly compiled and updated by the EB and made available to the wider public through a user-friendly database accessible on the Internet.

B. The enhancement of investment conditions for CDM projects fostering critical climate technologies

To increase technology transfer and diffusion, host countries should improve investment conditions for crucial CDM projects and provide them with tailor-made support. To determine which CDM projects should be given preferential treatment developing countries will have to carry out thorough TNAs,[83] which purpose is to identify the key technologies needed to reduce the adverse effects of climate change, to find out about the market and identify trade barriers that hinder their transfer and to assess the policy, institutional and finance options for overcoming these barriers.[84] The national focus of these assessments is of particular importance as the type and the size of the technologies and their barriers vary considerably from country to country.[85]

Comment [s5]: Unclear who is promoting what.

When assessing the technology needs of a country, particular attention should be paid to avoid anchoring them inadvertently in existing technologies and infrastructures.[86] A large empirical study on the promotion of sustainable energy services has revealed that ingrained habits and insufficient information often prevent the available low carbon

[81] See also Schneider et al. who suggest that a requirement should be introduced that obliges project developers to provide information on the technological specification and the name of the technology supplier as well as on key problems occurring during operation, in the monitoring reports. See Schneider et al. (2008: 2937).
[82] Schneider et al. add that the creation of a database relating to the transfer and the diffusion of technology would be very valuable for use by policy-makers to continuously assess the CDM's technology-transfer performance and thereby identify capacity-building needs. See Schneider et al. (2008: 2937).
[83] See UNFCCC (2007).
[84] Barriers may take the form of high costs of new technology, lack of technical information, import and export restrictions, inadequate government policies, outdated procurement requirements, inappropriate technology standards, and lack of experience in accelerating technology uptake. See EGTT (2009a: 25 ff.); Staley et al. (2009: 12 ff.)
[85] See Global Environmental Facility (2008).
[86] ENTTRANS (2007: 11).

technologies from being fully considered.[87] It thus recommends that before agreeing on a portfolio of low carbon technologies, developing countries should have improved the technology-related knowledge of all stakeholders involved[88] and should undertake a "market mapping exercise"[89] to identify the appropriate business enabling environment, the market chain and the market supporting services of a particular technology. The results of the latter may then assist developing countries in designing TAPs which determine more concretely how critical technologies should be deployed in the short- and medium term.[90]

Once a portfolio of prioritised technologies has been agreed upon, special support should be granted to CDM developer considering their deployment. Many studies show indeed that certain technologies will only be realized if measures are taken to minimize the risks associated with their implementation.

Following the example of certain Designated National Authorities (DNAs) that carry out promotional activities, host countries could set up agencies whose mission would be to provide tailor-made support to developers who invest in key technologies.[91] These agencies, could, for instance, create a database containing crucial project information, sponsor demonstration programmes for new technologies, establish an Internet portal, create newsletters, organize seminars and training courses for project developers, assist in the creation of market networks, and provide translation services and assistance for the design of PDDs.[92] To be successful these agencies would require sufficient staff and should not operate in isolation from DNAs and other decision makers.[93] Indeed, only if close cooperation is established among all actors involved in the implementation of climate policies can the process for foreign investors be streamlined and the effectiveness of the support measures be enhanced.

Comment [s6]: database?

To assist these agencies in achieving their tasks, international assistance will be crucial both to finance their programmes and to build up capacity. Such as the UNFCCC Secretariat which provides information seminars for DNAs, regular trainings should be organized for the staff of these agencies. Moreover, a database containing key information should be established and made available to the wider public. Finally, an

[87] Studies carried out by the UNFCCC also revealed shortcomings in the current TNAs, which should be addressed by the financial means foreseen by the Poznan technology program. See Global Environmental Facility (2009).

[88] Awareness-raising can take the form of information dissemination coupled to programmes of visits to existing demonstrations of technologies, demonstration programmes or support for exhibitions of new technologies. See ENTTRANS (2007: 45).

[89] See for more details on market mapping ENTTRANS (2007: 98).

[90] International assistance and cooperation will be crucial in the establishment of these plans as many developing countries lack the required expertise and capacity to design new climate policies. Recognizing these needs the GEF has recently increased the financial aid foreseen for the establishment of TAPs. See Global Environmental Facility (2009).

[91] These tasks should not be carried by the DNAs themselves to avoid conflicts of interests. See ENTTRANS (2007: 36).

[92] ENTTRANS (2007: 15, 36).

[93] ENTTRANS (2007: 15).

international body could be designated to act as a facilitator and be responsible for setting up an Internet portal allowing interaction between the various stakeholders.

C. Structural reforms of the CDM

The CDM's focus on cheap short-term abatements has principally favoured end-of-pipe technologies at the expense of renewable technologies and energy efficiency strategies. Although this bias may to a certain extent be corrected by the enhancement of general investment conditions and support measures for this type of projects, investment flows may not be channeled towards these technologies in the absence of a more fundamental reform of the CDM. In the following section we therefore formulate some proposals ranging from the establishment of technology lists to to the introduction of a fast-track CDM and a discounting factor for undesirable abatement strategies.

A straightforward possibility for bringing the CDM into line with the technology needs and priorities of developing countries would be to set up an international list of eligible and banned technologies, which would have to be revised from time to time to reflect changing circumstances.[94] While such an option would allow the promotion of the technologies deemed the most useful for tackling climate change while excluding those that are less desirable, a consensus on which technologies to accept or to ban would probably be difficult to obtain. There have been many attempts in the past to compile lists of supported or forbidden technologies, but these have in general been dismissed or were so overloaded as to become essentially meaningless, while any effort to ban certain technologies has proven challenging.[95]

Comment [s7]: what is meant by over-stuffed in this context?

To avoid such a deadlock, each host country could also set up its own list of eligible or banned technologies based on the TNAs conducted in their countries. A priori such a differentiated approach would best fit the needs and priorities of each country. There is, however, a strong probability that most countries will never consider seriously limiting the number of eligible technologies for fear of losing projects to other countries which offer cheaper abatement possibilities. This option, therefore, has little potential to reverse the actual investment trends.

Investment flows can also be directed to key technologies if certain developed countries, or all of them, decide to accept only projects that meet certain technological requirements or if they establish quotas. Developed countries could, for example, require that a certain percentage of the portfolio of CERs come from projects using a specific type of technology. The probability of these options being adopted is again quite low as stakeholders exert strong pressure on their governments to allow recourse to cheap offsets.[96]

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[94] So far nuclear energy and carbon capture are excluded from the CDM. Some Parties have however expressed the wish to include them after 2012. See UNFCCC, Ad-hoc working group (2009).
[95] Staley et al. (2008: 18).
[96] See Schneider (2008: 30).

Another option to speed up the adoption of key technologies would be to establish a list of technologies that would be deemed additional and would benefit from expedited registration.[97] Hence projects employing these technologies would not have to demonstrate explicitly that they are additional. By simply cancelling the additionality test for certain projects, the risk that the CDM would generate more meaningless credits is however significant.

As an alternative to lists of eligible or banned technologies, one could also introduce a framework allowing the introduction of a discounting factor for credits generated by less needed technologies. This would allow more credits to be allocated to projects promoting key technologies while granting fewer to others, the amount of emission reductions being equal. Such an option could be implemented either on the supply side or the demand side of the CDM.[98] It would help to address one of the principal concerns concerning the CDM: the creation of huge incentives to invest in projects for the abatement of non-CO_2 "super-pollutants" with a high global warming potential (GWP) at the expense of investments in desperately needed low-carbon energies. The abundance of these cheap non-CO_2 credits does indeed create a perverse incentive not to invest in CO_2 reducing projects, allowing countries to meet their obligations under the Kyoto Protocol by investing in a few lucrative projects, "quenching their thirst for further investments".[99]

Discounting would, by contrast, force investors to inject more funds into renewable energy projects, leading in turn to a much wider array of transferred technologies. Moreover, by limiting the number of emissions credits issued while maintaining the same level of emission reductions, discounting also addresses the concerns regarding the insufficient environmental integrity of the CDM.[100] Finally, unlike an outright-ban of certain technologies reducing the so-called "super-pollutants", discounting would still allow their elimination while ensuring that promoters and host countries would not collect huge windfall profits.[101]

When setting the discounting factor, Schatz in his analysis of the shortcomings of the CDM proposed to fix the discount rate of a CDM project based principally on the marginal abatement costs (MAC) for each pollutant and the various abatement processes.[102] Moreover, numerous other factors should be taken into account, such as the

[97] See UNFCCC, Ad-hoc working group (2009: 12).
[98] On the supply side, only a certain percentage of the calculated emission reductions are issued as CERs. On the demand side, only a certain percentage of the CERs can be used for compliance. See Schneider (2008: 37)
[99] Schatz (2008: 722).
[100] Schatz points out that a discounted CDM would also prevent some of the current abuses. For instance, industrialists in host countries would be less inclined to produce super-pollutants, because they would no longer receive so many credits. See Schatz (2008: 729).
[101] Wara suggests that the costs of eliminating the so-called super-pollutants could be drastically reduced by setting up a special fund rather than using the CDM. See Schatz (2008: 735).
[102] The reason for basing the discount rate on the MAC is that the CDM fails to equalize the market price of an emissions reduction with its actual cost and thus assists in creating a scenario where industrialized nations often pay between 10 and 100 times more than the actual cost of these reductions. See Schatz (2008: 704).

project type and size, the country which hosts the project, and the transaction costs.[103] A possibly less contentious option would be to establish a uniform discount rate for each type of technology. Whereas this option would probably be less efficient, its relative simplicity would ensure a greater comprehensibility for investors. On the other hand it would still allow the economic attractiveness of certain technologies to be reduced and conversely the promotion of others. As recommended by Schatz, a panel of reputable economists could be mandated to fix the discount rates so as to allow investments to be primarily channelled towards the most needed technologies.[104]

Comment [s8]: comprehensibility?

IV. Sectoral carbon market crediting mechanisms

With the exception of the framework allowing the introduction of a discounting factor, the previously discussed reform proposals do not address the problems related to the environmental integrity of the CDM.[105] They may even exacerbate them if more renewable energy projects of questionable additionality enter the pipeline. Also, they are insufficient to incentivize the large-scale policy reforms necessary for the long-term uptake of key technologies. Finally, the project-related focus, which is inadequate to ensure a constant technological learning process, has not been fundamentally modified by the recently introduced category of “programmatic CDMs”.[106]

Conscious of these shortcomings, the European Union has suggested that the CDM is phased out for advanced developing countries and highly competitive economic sectors in favour of sectoral carbon market crediting mechanisms.[107] This proposal, which is aimed at broadening the current project-by-project focus of the CDM to encompass all of the sources of emissions within entire sectors, may well address certain of the deficiencies of the current CDM. The rationale behind this proposal is that major developing countries should be more deeply involved in fighting climate change and that a sectoral approach allows major emitting sectors to be dealt with cost-effectively. Moreover, if stricter standards are introduced in key polluting sectors, concerns about carbon leakage[108] can be reduced.

In theory, there are many possibilities for designing a sectoral carbon market mechanism. The EU distinguishes between two main categories: a sectoral crediting mechanism,

[103] See for a thorough discussion on the advantages and disadvantages of a uniform discount rate and a flat discount rate Schatz (2008: 730ff).
[104] Schatz (2008: 737).
[105] See for reform proposals to enhance the environmental integrity the CDM de Sépibus (2009).
[106] The concept of “programmatic CDM” relates to project activities which can be registered as a single project under a programme of activities (PoAs). It was first formulated at the end of 2005 by the COP/MOP to allow the promotion of widely dispersed multi-actor energy efficiency activities by the CDM. The EB published the final forms for the submission of PoAs in August 2007. See World Bank, Carbon Finance Unit (2007: 8).
[107] European Commission (2009: 11).
[108] The term carbon leakage refers to a situation where there is an increase in CO_2 emissions in one country as a result of a reduction in emissions by another country with a strict climate policy.

where emissions below a baseline in a particular sector generate ex post emission credits and sectoral trading, where allowances are allocated on an ex ante basis.[109]

Sectoral crediting would be based on an agreed threshold for sectoral emissions or a "no-lose target", set below the business-as-usual (BAU) emission trends. For all the emission reductions achieved beyond the threshold, the developing country would receive emission credits that it could sell. It would however not be obliged to buy credits if emissions are above the threshold.

The sectoral trading approach implies that a sectoral cap is defined that is below BAU emission trends. The developing country would have to take action to keep them below the cap. The difference with sectoral crediting is that tradable units are created ex-ante, and allocated to the developing country to a level equivalent to its target. If the target is not met, the developing country has to buy back units to ensure that the target is reached.

Recently another approach has raised the interest of some countries: a sectoral crediting mechanism based on technology objectives.[110] There is little information on how such a mechanism should be designed and how the technology would be defined.[111] Theoretically the latter can encompass broad categories of technologies and/or energy sources or narrow categories such as specific types of processes (i.e. waste heat recovery, or carbon capture and storage) or types of hardware (i.e. hybrid vehicles or efficient light-bulbs).[112] The formulation of the technological objective may take various forms. It can for example specify that a share of a sector's output has to be produced by a certain process or that a certain percentage of cars must be hybrid. In this case the agreed technological goal forms the baseline.

A technology-based approach offers both potential advantages and disadvantages. On the one hand, a technology diffusion goal is more visible and easier to monitor.[113] A mechanism that supports the introduction of innovative technologies may also be more acceptable for countries like China which have declared technological innovation as a high national priority.[114] On the other hand the setting of technological goals creates uncertainty as to their impact on GHG mitigation. Indeed, unless the latter is measurable, reportable and verifiable it is not clear how such objectives can provide access to the carbon market. [115]

Like the CDM, all sectoral carbon market crediting mechanisms may accelerate technology transfer and diffusion through the carbon signal they provide. Their concrete effects, however, will very much depend on the sector they are applied to and on the details of their implementation.[116] Under these schemes domestic policymakers have a

[109] Baron et al. (2009: 45).
[110] CCAP et al. (2008).
[111] Baron et al. (2009: 36).
[112] Baron et al. (2009: 37).
[113] Baron et al. (2009: 37).
[114] Baron et al. (2009: 38).
[115] Baron et al. (2009: 46).
[116] See CCAP (2009: 9).

wide range of policy options at their disposal to create incentives for investments in advanced technologies, ranging from subsidies for R&D, new financing tools, such as special purpose vehicles reducing barriers to finance, to cap-and-trade programmes.[117]

While cap-and-trade programmes theoretically have a strong potential to accelerate the diffusion of mitigation technologies, their contribution towards fostering innovation is more contentious.[118] Moreover, as the example of the EU emission trading system (EU ETS) highlights, if the caps are weak and allowances are "grandfathered"[119] the system may well have perverse effects encouraging highly polluting entities through the distribution of massive windfall profits.[120] Accordingly, a domestic policy that incentivizes renewable electricity through the grant of feed-in tariffs, if properly set, may well outperform a cap-and-trade programme in terms of technology innovation and deployment.[121]

Another aspect that matters when choosing a sectoral crediting mechanism is the timing of the credits. According to Baron et al. who examined the various forms of sectoral mechanisms, an ex ante allocation that permits the devolvement of allowances to the entities in the sector offers a clear advantage over ex post credits. It broadens the signal of the carbon market to entities that have so far been insulated from it and enables mitigation investments to be directly rewarded through the sale of credits, without having to wait for a sector-wide assessment of emissions performance.[122]

With sectoral crediting, the carbon market incentive to the individual investor is likely to be less clear, as an entity's good performance may be offset by the lack of progress of other entities in the sector and eventually lead to the non-issuance of international carbon credits.[123] On the other hand, the adoption of "no-lose" targets offers the advantage that more ambitious baselines may be set. As they carry no penalty for non-compliance, developing countries may engage in a discussion of more significant reduction goals.[124]

Compared to the CDM, sectoral carbon market crediting mechanisms offer certain clear advantages. Through their focus on sectors they not only encourage projects but incentivize policy reform and more deeply involve developing countries. Second, they lower transaction costs as the additionality no longer has to be demonstrated for every single project. Third, if ambitious baselines are set, the mechanisms will go beyond pure offsetting. Fourth, competitiveness concerns due to strict carbon regulation in developed countries may be reduced if key sectors in major developing countries are subject to similar constraints.

[117] CCAP (2009: 11).
[118] See for a critique of the incentives set by cap-and-trade programmes for renewables Driesen (2006).
[119] The term is used here in the sense that allowances are granted for free based on historical emission trends.
[120] See de Sépibus (2007).
[121] See de Sépibus (2008).
[122] Baron et al. (2009: 32).
[123] Solving this problem entails the country finding ways to compensate over-achievements and to sanction bad performance. See Baron et al. (2009: 7).
[124] Baron et al. (2009: 42).

Though these characteristics seem to favour substitution of the CDM with sectoral carbon crediting mechanisms, the latter may not always live up to expectations. Poor choices of boundaries may limit their potential benefits.[125] In the absence of ambitious baselines, the international carbon market will be flooded with cheap credits that do not correspond to any significant mitigation effort by developing countries. Finally, the elaboration of baselines will require data on current practice as well as expertise on the available mitigation potential and costs, which is not readily available.[126]

Sectoral carbon market crediting mechanisms may also fall short of achieving certain positive side-effects of the CDM. For instance, the CDM market has attracted many different players offering panoply of services in the form of project sourcing, development and methodology writing or offering risk management and carbon-fund management services.[127] Through their active engagement in the international carbon market they have improved access to capital, making private investors aware of new investment opportunities[128] and recipients of available domestic and international technologies.[129] Moreover, different public actors such as development organizations, host countries and the United Nations Environment Programme (UNEP) have helped to raise awareness about carbon revenues among potential technology recipients, intermediaries and technology providers. Last but not least, the CDM has directly contributed to the commercial viability of numerous projects through the carbon revenue.

While the credits generated by sectoral carbon credit mechanisms will continue to attract foreign investors in search of cheap abatement opportunities, the link between technology providers, consultants and technology recipients is likely to be less immediate. For instance, in the case of a sectoral credit mechanism based on no-lose targets, it is the host country that sells the credits and not the technology recipients. While this does not impede technology transfer it may not attract as many international private project developers involved in financing, building and operating an entire project on their own.[130] Accordingly, the potential of technology transfer may be reduced. Also, sectoral carbon crediting mechanisms do not provide incentives to non-covered sectors. If the CDM is abolished and not substituted by other financial mechanisms, attractive opportunities for cheap abatements in non-covered sectors may be overlooked. Finally, if sectoral carbon crediting mechanisms do not include sufficient incentives to industry, sectoral approaches may be less effective than the CDM in leveraging private finance. Given the importance of the private sector as a source of technological innovation and industrial know-how, this could be prejudicial to technology transfer.

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[125] CCAP (2009:9).
[126] See for a discussion of the main design elements of sectoral agreements CCAP (2009: 9).
[127] Schneider et al. (2008: 2933).
[128] See Schneider et al. (2008: 2934).
[129] As such, the CDM has contributed to addressing the four principal barriers to technology transfer, which, according to Schneider et al., are the lack of commercial viability, the lack of information about the investment opportunity, a lack of access to capital and an inadequate institutional framework. See Schneider et al. (2008: 2931).
[130] See for a discussion on the various types of financial involvement of investors and their influence on technology transfer and diffusion Schneider et al. (2008: 2934).

V. Conclusions

Around 9 billion euro will have been put into CDM projects involving technology transfer by 2012.[131] This makes the CDM the largest technology transfer mechanism under the UNFCCC. The idea of maintaining or even scaling up the mechanism under the new global climate agreement to accelerate technology transfer in line with the goal of the Bali Action Plan is hence tempting. The highly concentrated distribution of projects in a few countries such as China, India, Brazil and Mexico as well as the propensity of the CDM to promote technology transfer predominantly in two areas, that is end-of-pipe technologies and wind, however, cautions against a simple perpetuation of the CDM. Also, the dubious additionality of many projects, the perverse incentives prevailing in the verification process and the scant oversight argue for a significant structural overhaul or even for a progressive phasing out of the mechanism.

If, notwithstanding, the CDM were to be maintained, reforms should be undertaken to ensure that it channels investments more effectively towards the technologies most needed for a low carbon future. This goal may be attained through the improvement of investment conditions for key climate technologies by host countries and changes in the incentive structure of CDM projects. While they may contribute to making critical climate technologies more attractive for investors, they only partly address the main shortcomings of the CDM: its incapacity to foster policy reforms and the dubious additionality of many CDM projects.

Such a challenge may well be met more efficiently by a sectoral carbon crediting mechanism that involves more deeply developing countries and allows the adoption of a wide variety of instruments. If a transition to a "sectoral CDM" is envisaged, one lesson should be remembered from the experience with the CDM: it is the environmental ambition of the target and the environmental integrity of the system that will eventually determine the level of technological progress. If baselines are set too close to business-as-usual scenarios and oversight is scant, international carbon prices fail to incentivize the necessary investments in critical climate technologies.[132]

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[131] This figure is calculated based on the percentage of projects involving technology transfer estimated by Seres and an average of 6 euro per CER. See Schneider et al. (2008: 2933).

[132] To increase the level of ambition of the baseline, Schmidt et al. propose to combine a no-lose target with a "technology finance and assistance package" that would provide the initial level of investment and technology transfer required to achieve significant early deployment of key technologies. See Schmidt et al. (2008: 496).

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