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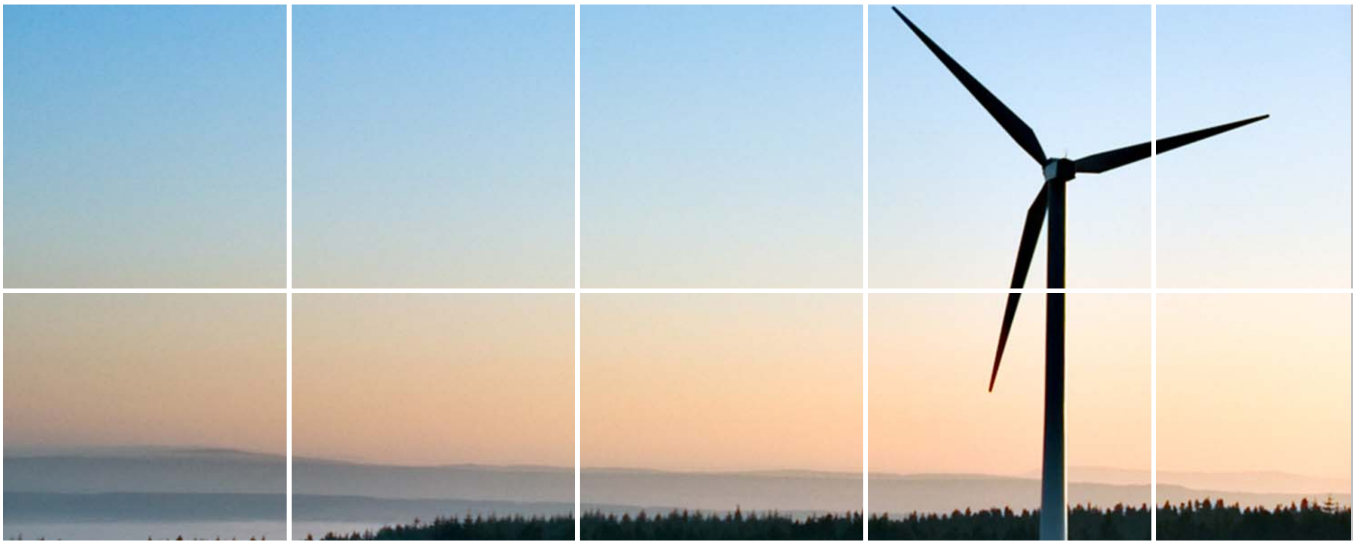

Briefing paper "Technology Transfer through the Clean Development Mechanism (CDM)"

Author: Bipasha Chatterjee, AEA Technology

Study on the Integrity of the Clean Development Mechanism

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Briefing paper "Technology Transfer through the CDM"
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Summary

This briefing paper has been produced as part of a Study on the Integrity of the CDM for the European Commission. Its focus is to assess the effectiveness of the Clean Development Mechanism (CDM) in transferring low carbon technologies to developing countries.

Based on a literature review, the following limitations of the CDM as a means for encouraging technology transfer have been highlighted:

- Technology transfer through the CDM prevails in a few countries and sectors, and bypasses others.
- The CDM, while contributing to individual project level technology transfer, has been incapable of encouraging more widespread policy support for technology transfer, for example in energy systems.
- Technology transfer through the CDM often means import of foreign equipment which does not improve technological understanding and capacity to innovate in developing countries (Schneider et al, 2008)
- Technology transfer in the CDM is not consistently monitored because there is no common definition of what is considered technology transfer. Data is collected on the basis of Project Design Document (PDD) claims and cannot always be compared across projects.

While it is understood that the host countries and external factors (e.g. patent issues, international oil price, and trade barriers) play important roles in scaling-up low carbon technology transfer, this paper focuses only on the role of Kyoto Protocol and the CDM in technology transfer. The main purpose of this paper is to assess how to reform structures and policies at the supply side (UN level) and demand side (EU level) in order to scale-up technology transfer, which will ultimately help in meeting global emissions reduction targets. Alternative policy options, such as the Sectoral Crediting Mechanisms (SCM), are also considered regarding their potential for technology transfer.

Tables 4 and 5 summarise the criticisms made by various authors about the CDM’s role in technology transfer. The Tables also provide an assessment of the strengths and weaknesses of the quantitative and qualitative evidence used by critics.

The paper concludes that sectoral crediting and trading systems have advantages over the CDM in delivering low carbon technology transfer to developing countries. These are summarised below.

- Greater potential for sector-wide transfer of technologies for emissions reduction through a SCM.
- A SCM is more likely than the CDM to support large-scale technology transfer, potentially creating an incentive to import and adapt new technologies.
- By operating at a sector level rather than project level, a SCM could encourage more fundamental structural change to energy systems, to encourage widespread uptake of low carbon technology.

1 Introduction

Background of the briefing paper

This briefing paper was produced as part of a study commissioned by the European Commission (EC). The purpose of the study was threefold:

i) to develop an understanding of the merits and limitations of the Clean Development Mechanism (CDM) as it stands;
ii) to assess the CDM's environmental integrity, such as its impact on sustainable development and its contribution towards financing "additional" emissions reduction projects;
iii) to assess alternative mechanisms that could achieve emissions reductions at a greater scale to that of the CDM.

The specific tasks under the study were to produce a number of briefing sheets and a final report that would:

- Assess merits and shortcomings of the CDM relative to a set of (EU policy) criteria;
- Inform CDM related actions at UN (supply-side) and EU (demand-side) level to improve the effectiveness, efficiency, regional distribution and contribution to sustainable development of the CDM. Further, to explore the options for a transition away from project-based crediting towards sectoral mechanisms and other global policies.
- Assess and suggest reforms to the CDM governance structures to improve transparency, predictability, and simplicity e.g. through use of more objective and standardised approaches for setting baselines and determining additionality.

The purpose of this particular briefing sheet was to assess the CDM's contribution to the transfer of sustainable technologies to developing countries for emissions reduction. It aims to include:

- Qualitative analysis on scale of transfer and current barriers to sustainable technology transfer (including the impact of CDM on transformation of energy systems and policies in developing countries);
- Review of empirical evidence in literature with a focus on renewable energies and energy intensive sectors;
- Options for improvement and reform to achieve technology transfer in a way that meets the CDM's sustainable development goal.

Information was obtained through a literature review, analysis and interviews with selected experts. No generation of primary data was expected by the Commission.

The context

The Clean Development Mechanism (CDM) is a mitigation mechanism under the Kyoto Protocol that aims to finance emissions reduction in developing countries. Although the CDM has no explicit technology mandate, it is expected to facilitate technology transfer (TT). Technology Transfer has the potential to help developing countries reduce emissions effectively through introducing low carbon technologies, development of local know-how on modern technologies and stimulating sustainable development. Within the current CDM design and process, the TT agenda is driven mainly by the Designated National Authority (DNA) of a CDM host country rather than the CDM Executive Board (EB) of the United Nations Framework Convention on Climate Change (UNFCCC). A CDM Project Design Documents (PDD) needs to be approved first by the DNA of a host country before it is submitted to the UNFCCC for the registration of the project and grant of Certified Emission Reductions (CERs). Some DNAs, such as that of China and

India, have stronger requirements than others for meeting their approval criteria for technology transfer through CDM projects. Overall, 30% of all projects in the pipeline, accounting for 48% of estimated emission reductions, involve technology transfer while 24% of the projects in the pipeline do not indicate TT. If the sample of analysis consisted only of projects that explicitly refer to TT, 40% of projects in the pipeline would contribute to TT, accounting for 59% of emission reductions (UNFCCC 2010).

Definition of Technology Transfer

The Intergovernmental Panel on Climate Change (IPCC 2000) defines technology transfer:

> *"as a broad set of processes covering the flows of know-how, experience and equipment for mitigating and adapting to climate change amongst different stakeholders such as governments, private sector entities, financial institutions, non-governmental organisations (NGOs) and research/education institutions".*

This study follows the above definition to assess the merits and shortcomings of the CDM in terms of contributing to technology transfer. However, neither the IPCC nor the UNFCCC define a standard or technology to determine what qualifies as an effective technology transfer for climate change mitigation. This is because the CDM is a market mechanism that gives the market freedom to mitigate emissions in the most cost effective manner.

Assumptions

For the purpose of this study, the assumption is that the CDM should target low carbon technologies which contribute to emission reductions in a sustainable way. Moreover, the use of the technologies should be additional, i.e, the projects should be implementing technologies that are not financially viable under a business as usual scenario. The reason for such an assumption is that this briefing sheet supports a larger assessment study of the integrity of the CDM which focuses primarily on the CDM's impact on sustainable development and additionality.

While end-of-pipe TT can contribute to emission reductions, in this study they are considered as a less sustainable form of low carbon TT. The end-of-pipe technologies remove already formed contaminants from a stream of air, water, waste, product or similar and are normally implemented at the last stage of a process before the stream is disposed of or delivered. Thus, end-of-pipe technologies do not prevent production of GHG emissions[1]. This is particularly prominent in the case of technologies employed for reducing HFC 23. There has been strong criticism that the projects developers have purposely increased the production of HFC23 to gain CDM revenues by implementing end-of-pipe technologies. In this case, the CDM might have created a "perverse incentive" to increase emissions - clearly this would be defined as an unsustainable form of technology transfer.

This study also assumes that while host country policies and external factors play a dominant role in low carbon technology transfer, CDM supply side and demand side factors are also capable of influencing low carbon TT. The Kyoto mandated reductions from projected Annex B "business-as-usual" emission levels, is referred to here as the "demand" for carbon offsets. In the context of the CDM, the "supply" refers to CDM credits which Annex 1 countries (the buyers) could purchase to offset their emissions (Figueres, Year Unknown)[2].

This briefing sheet aims to answer the following questions:

- What are the current successes and concerns about technology transfer through the CDM?

[1] This assumption in based on the discussions with Thomas Bernheim from the EC and arguments presented by Joelle De Sepibus in his paper published by NCCR Trade Regulation (De Sepibus 2009).

[2] This definition of CDM demand side and supply side comes from Christiana Figueres in her article available at: http://figueresonline.com/csdafinal/English/publications/cdm/wp.figueres.html; She is the Executive Secretary of the United Nations Framework Convention on Climate Change (UNFCCC) since May 2010.

- What types of technology are transferred through the CDM to developing countries and in what scale?
- What are the impacts of the CDM on transformation of energy systems in developing countries?
- What are the supply and demand side options for reforming the CDM and for alternative mechanisms that could contribute to increased technology transfer?

The methodology adopted for the research in this paper includes:

- A literature review;
- A high level review of relevant secondary data; [3]
- Interviews with experts;
- Analysis of the gathered information.

[3] In this article we have based our analysis on the findings of Seres and Haites. We cannot verify the figures that they have generated through their word search in the PDDs. However, since their published papers are peer reviewed, we have used their findings as secondary data and information.

2 Overview of the debate on the concerns

There are three main categories of literature which cover the issues related to technology transfer and the CDM:

Table 1: Core categories of literature on the CDM related to technology transfer

Type of literature	Main authors / organisations
Quantitative analysis of technology transfer	**Dechezlepretre, A.; Glachant, M; Meniere Y.; Haites, E.; Seres, S.**
Policy review and reform of CDM design, and processes for enhancing technology transfer	**De Sepibus, J.; Schatz, A.B., Wara, M., Teng, F & Chen, W & He, J (Tsinghua university, China), ENTTRANS.**
Country based case studies of technology transfer	**Hansen, U.E (Malaysia), Wang, B (China), Lewis, J.I (China), Hultman et al (forthcoming – Brazil and India)**

The main concerns with technology transfer through the CDM expressed in the literature are listed below.

- The rate of technology transfer through the CDM has fallen.
- Technology transfer through the CDM prevails in a few countries and sectors, and bypasses others.
- The CDM, while contributing to individual project level technology transfer, has been incapable of encouraging more widespread policy support for technology transfer, resulting in the transformation of energy systems.
- Technology transfer through the CDM often means import of foreign equipment which does not improve technological understanding and capacity to innovate in developing countries (Schneider et al, 2008)
- Technology transfer in the CDM is not consistently monitored because there is no common definition of what is considered technology transfer. Data is collected on the basis of Project Design Document (PDD) claims and cannot always be compared across projects.

Before discussing the major concerns it is important to understand the problems with the metrics that are used for assessing technology transfer through the CDM. For example, the existing literature and databases use a proxy variable to measure technology transfer through the CDM rather than documenting post project data from surveys of the technologies employed and transferred. The following section therefore explains these main metrics for measuring technology transfer through the CDM. Section 5 then elaborates on the main concerns of technology transfer through the CDM identified above.

3 Main metrics for measuring technology transfer

The EB requires the CDM project developer to submit a Project Design Document (PDD) to the UNFCCC for registration and approval of the projects under the Kyoto Protocol crediting mechanism. Since TT is not an explicit objective of the CDM, the PDDs do not necessarily give information on technology transfer. However, there is often a brief section in the PDDs which describes the technology which will be used and transferred. Quantitative studies of TT estimate the scale of TT in the CDM by counting references to transfer of equipment, knowledge or both in PDDs. An example is shown in Table 2.

The United Nations Environment Programme Risoe Capacity Development for the CDM (CD4CDM) pipeline database[4] (hereafter UNEP Risoe CDM Pipeline Database) collects global data on all the CDM projects that have been registered and are in the pipeline for approval. While the database includes detailed information on several factors that influence TT, it does not include any specific information or data on TT. The UNFCCC has commissioned independent consultants and experts, such as Stephen Seres and Erik Haites, to develop a technology transfer database by analysing the full set of PDDs for all the CDM projects in the pipeline[5]. The UNFCCC is due to make some sections of the database, which were used for a comprehensive UNFCCC study in 2010, available to the public.[6]

Limitations with using the PDD information and data for technology transfer assessment:

Table 2: Technology transfer claim in the CDM PDDs

All projects in the pipeline (30 June 2010)	Number of projects
Project design documents (PDDs) stating no technology transfer	2262
PDDs mentioning some form of technology transfer	1516
PDDs with no direct indication of technology transfer (might or might not have technology transfer)	1206

Source: UNFCCC (2010)

As shown in Table 2, there are 1,206 projects which were excluded from the quantitative analysis by Seres and Haites (UNFCCC 2010) because of no mention of TT. Moreover, Antoine Dechezleprêtre added in an interview by AEA that “PDD editors have an incentive to overstate the existence of technology transfer.”[7] In follow-up interviews by Seres and Haites, some project developers indicate that many of these projects will involve technology transfer, though the nature of the technology transfer often differs from that anticipated when the PDD is prepared. Thus, the current analysis based on the ex-ante information cannot be considered completely reliable. To improve the understanding of the CDM’s real contribution to technology transfer, it is important that interested parties commission follow-up surveys of all the registered projects for collecting primary and post-PDD data directly from the project developers and technology suppliers.

Some trends can still be drawn from this evidence base however, and these form the basis of the criticisms discussed in the following sections.

[4] Available at: http://cd4cdm.org/
[5] Information on the full database was available on the basis of an interview with Stephen Seres and Erik Haites.
[6] Available at: http://cdm.unfccc.int/about/CDM_TT/index.html
[7] This is an interview quote from Antoine Dechezleprêtre. AEA interviewed him on 25th March, 2011.

4 Issue focused review and assessment of the merits of the CDM

The merits of the CDM as a means for transferring low carbon technology are noted in the literature as follows:

- The CDM is the largest market-based mechanism that incentivises the private sector to finance low-carbon technology transfer to developing countries (Schneider et al., 2008).

CDM is the largest technology-transfer mechanism under the United Nations Framework Convention on Climate Change (UNFCCC). Until 2008, the CDM drove an investment flow of around 9 billion Euros into projects containing technology transfer and the level of investment has grown further (Schneider et al., 2008). This exceeds the investment generated by the Global Environment Facility (GEF), a fund specifically set up to promote technology transfer (Egenhofer et al., 2007).

- The CDM has contributed to transferring not only equipment but also knowledge.

Table 3 shows that 52% of the projects in the pipeline which claim to have received TT involved both equipment and knowledge transfer. .

Table 3: The CDM's contribution to equipment and knowledge transfer (2010)

All projects in the CDM pipeline (30 June 2010)	Number of projects claiming TT	% of projects claiming TT	% of annual emissions reduction
TT of equipment only	515	34	34
TT of knowledge only	209	14	11
TT of equipment and knowledge	792	52	54

Source: UNFCCC (2010)

- The CDM has indirectly contributed to developing domestic technology capacity in developing countries.

Results regarding technological capabilities are very interesting and call for deeper research as this is an area where the CDM has the potential to deliver useful benefits. In a regression analysis by Dechezleprêtre, A., Glachant, M., Ménière, Y. (2008), it was found that there is a significant relationship between the technological capabilities of a country and the types of technology transfer it attracts. Countries with higher technology capability attract TT in the energy sector and in the chemicals industry, but have low rates of TT in the agricultural sector. The countries with high technology capability are able to develop less sophisticated agricultural technologies domestically, while in the energy sector they require more R&D knowledge and equipment transfer from other countries (Dechezleprêtre, Glachant and Ménière, 2008). Although, this scenario was true early on, a recent analysis by Seres, S and Haites, E (UNFCCC 2010) shows that countries with higher technology capability and numbers of CDM projects in specific project categories have a tendency to develop their own capacity for domestic technology in that specific sector in the long run irrespective of the level of sophistication. This is evident in the declining trend in technology transfer through the CDM in China, India and Brazil.

- The CDM has contributed to technology diffusion, reducing the payback period and improving the internal rate of return (IRR) of clean technology projects.

Research by Hansen (2008) in Malaysia and (Ang 2009) in China show that by improving the IRR of low carbon projects, the CDM has contributed to increasing diffusion rates of technologies. Even if "diffusion" is not equal to transfer, higher diffusion rates contribute to reductions of technology costs through learning rates and economies of scale.

5 Issue focused review and assessment of the limitations of the CDM

There are a number of limitations identified in the literature on TT through the CDM. However, these criticisms are not always supported by robust evidence. The following table has listed the limitations noted by different authors. Table 4, Column 2, shows whether the evidence to support the arguments of the authors is strong, needs further investigation or is in the form of incomplete hypothesis. The table also presents the explanations by AEA that explain the weakness or strengths of the critics' arguments.

Table 4: Criticism by authors on transferring low-carbon technologies through the CDM to developing countries and the robustness of the supporting evidence

Limitations identified in general literature by various authors and explanations by AEA	Strength of quantitative evidence used in the existing literature is assessed by AEA
1. **Limitation noted by Critics:** The rate of TT through the CDM has declined over time.	**Incomplete hypothesis**: It neither brings out an accurate picture nor indicates a failure in the CDM process to transfer technology.
Explanations for Limitation 1 by AEA: **1a)** The rate of decline in CDM projects with TT for China, Brazil and India are steep but the rate of fall is modest for all other countries.	**Supporting evidence:** As more projects of a given type are implemented in a country, over time the rate of technology transfer declined in that country, such as, in China, Brazil and India. • The evidence does not indicate a failure in the CDM process for transferring technology. This could actually be seen as a sign of success.
2. **Limitation noted by critic:** Technology transfer through the CDM is concentrated within industrial gas projects and bypasses the other categories such as cement, hydro, biomass and others.	**Supporting evidence:** Ratio analysis and Probability analysis /Regression analysis; • Robustness of PDD based data on sectors are variable ; • Good evidence in the Cement sector. • Needs further investigation especially in the Hydro and the transport sector.
Explanation for limitation 2 by AEA: **2a)** End-of-pipe technology transfer through the CDM is common within the Industrial gas and Chemical projects. These are not necessarily sustainable form of technology transfer (see Assumptions in Section 1). In reality, low carbon sustainable technology transfer bypasses the industrial gas projects as well as bypasses other high energy intense sectors (e.g. Cement), electricity production sectors (e.g., Hydropower), and other sectors (e.g. Transport sector).	
3. **Limitation noted by critic:** The CDM, while contributing to project level technology transfer, has been incapable of encouraging overall policy changes in the area of transforming the energy systems in developing countries.	**Supporting evidence:** Strong theoretical analysis.
Explanation for limitation 3 by AEA:	• Needs further investigation with additional quantitative data.

3a) The CDM rewards short-term abatements. The purpose of the CDM has never been to incentivise innovation and structural changes that allow the large-scale deployment of renewable energies.	

Table 5: Regression analysis by Seres and Haites (UNFCCC 2010) of low-carbon technology transfer through future CDM projects

Regression analysis results	Statistical Evidence
1. Larger projects are more likely to involve TT;	Robust data/ regression co-efficient positive and significant
2. Small-scale projects are less likely to involve TT.	Regression co-efficient negative but not significant
3. Unilateral projects are less likely to involve TT.	Regression co-efficient negative but not significant
4. Hydro, Biomass Energy, Cement, Fugitive Gas, PFCs and SF6 and Reforestation and Afforestation projects are less likely than average to involve technology transfer.	Needs further sectoral investigation
5. Energy Efficiency (Industry), HFCs, N2O, Transportation and Wind projects are more likely than average to involve technology transfer.	Needs further sectoral investigation
6. TT for CDM projects is more likely in a host country with a smaller population, with lower Official Development Assistance (ODA) per capita, where it is harder to operate a business, lower import tariffs, with a lower ranking on the democracy index, and with lower technical capacity as measured by the knowledge stock (UNFCCC 2010)[9]	These results are preliminary. Additional and more current, more complete time series data are needed to test the robustness of results (UNFCCC 2010).

It is important to note the difference between limitations listed in Table 4 and Table 5. Table 4 assesses the current impact of CDM projects on technology transfer. Table 5 results are based on a logistic regression analysis by Seres and Haites (UNFCCC 2010) that shows the probability that a project with different characteristics (technology type, scale, unilateral/bilateral, host country) involves technology transfer.

The following sections elaborate on the findings listed in Table 4 and Table 5.

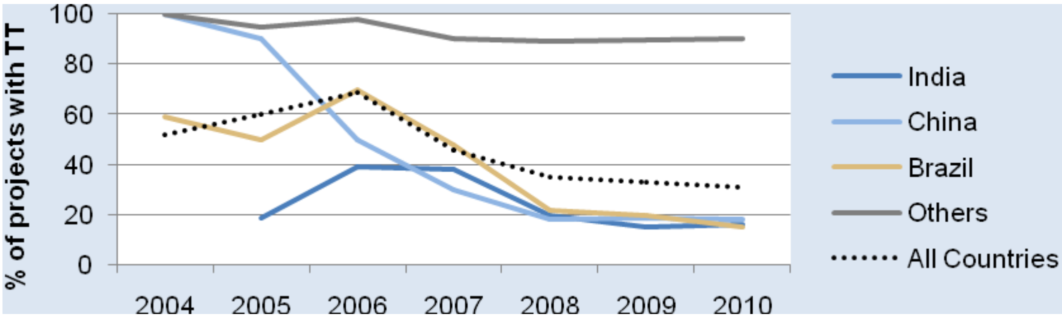
5.1 The scale and rate of TT through the CDM has declined over time.

As of 30 June 2010, 30% of projects in the pipeline and 48% of the estimated emission reductions claim to involve TT. This is compared to the 2007 and 2008 studies (Seres and Haites, 2008) which showed the frequency of overall technology transfer to be 39% and 36% of projects respectively, and 64% and 59% of the annual emission reductions reported (UNFCCC 2010). The following section elaborates on the explanatory statements from Table 4, adding a more detailed understanding to the declining trend:

5.1.1 The rate of decline in the CDM projects with technology transfer for China, Brazil and India are steep, but the rate of fall is modest for all other countries.

Figure 2 developed by Haites and Seres for UNFCCC (UNFCCC, 2010) shows that decline in projects with TT is only significant for the larger emerging economies, but remains more stable for other countries.

Fig. 2 Trends in technology transfer by number of CDM projects (2004-2010)



Source: UNFCCC (2010)

The trend showing decline of TT via the CDM in China, India and Brazil are based on information from a large number of PDDs that are well designed with relatively better information on TT[8] because of the DNA requirements (see section 1: The Context). In the early years large economies required TT. However, more recently the requirement for specific project-type TT through the CDM or any other routes reduced as countries with high technology capabilities learnt and replicated quickly (Dechezlepreˆtre et al., 2008). The end result being higher project numbers with cheaper home-grown technologies.

Supporting evidence to the above arguments is provided in the latest UNFCCC report (UNFCCC 2010). In this report, a regression analysis covering 3778 CDM projects shows that as more CDM projects of a given type are implemented in one country, the rate of technology transfer through the CDM declines. This suggests that the falling trend in technology transfer through the CDM does not necessarily jeopardises emissions reductions in developing countries (as low carbon domestic technologies are used in the CDM projects) nor is it directly a fault of the CDM[9]. The falling trend is an inherent characteristic of all technology transfers from developed countries to emerging economies over time with or without the CDM.

However, from the perspective of scaling up mitigation efforts to meet emissions reduction targets for maintaining a 2 degree centigrade global average temperature, it is important that environmentally sustainable low carbon technologies are transferred to developing countries. Once transferred, they must also be sustainably implemented, and to be most effective this would be in high energy intense sectors, the power generation sector and transport sectors. While the CDM is not the prime reason for falling trend in technology transfer in certain kinds of sectors in China, India and Brazil, it has failed to encourage the most effective form of low carbon technologies to be transferred to energy intensive sectors, power sectors and transport sectors of developing countries. Section 5.2 looks at the TT contribution of the CDM to different types of sectors.

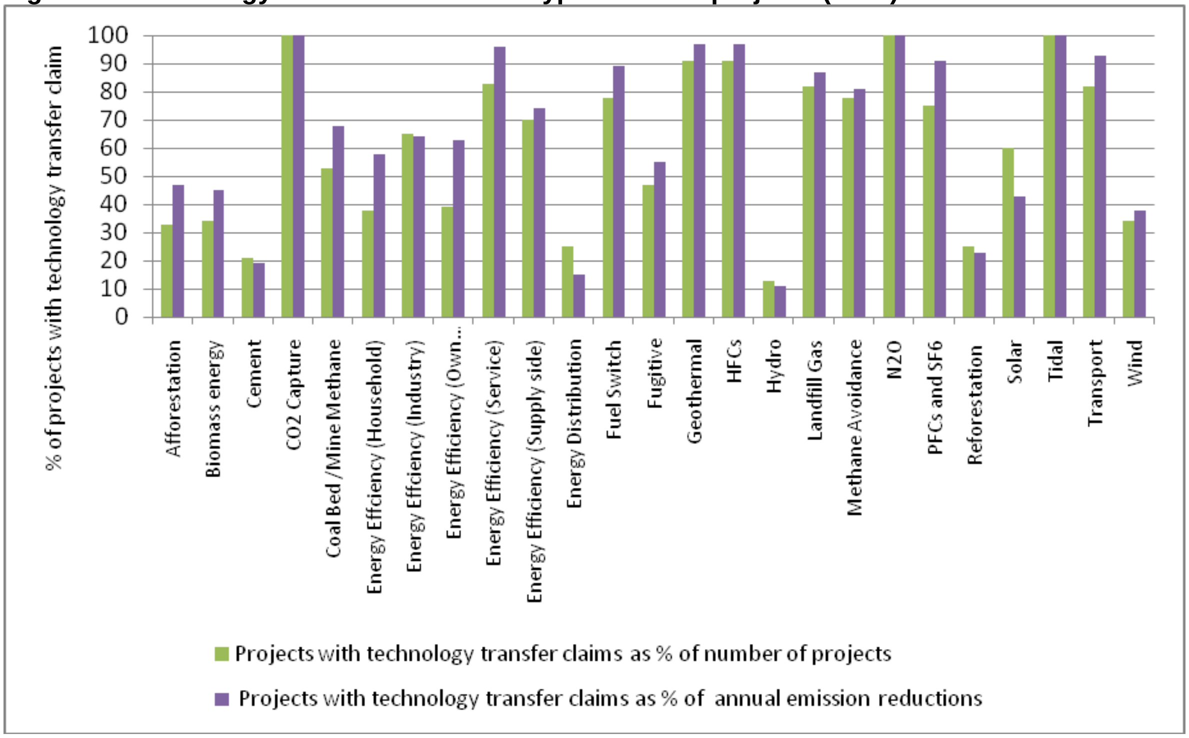
5.2 Technology transfer through the CDM is concentrated within the industrial gas sector

Figure 3 shows that almost all industrial gas projects have demonstrated technology transfer (e.g. HFC and N2O projects). Amongst renewable energy projects, Tidal and Geothermal projects have 100% contribution to technology transfer. In the Energy Efficiency (EE) sector, the EE service type projects also

[8] Stephen Seres in his interview with AEA in 10th March, 2011 clarified that the PDD data on TT for India, Brazil and India were more robust than other country PDDs because the DNAs of these countries prefer technology transfer. Antoine Dechezleprêtre however thinks that some PDD editors in these countries overstate the TT claims because of the TT requirements by the DNAs.
[9] Erik Haites in his interview with AEA in 10th March, 2011 clarified that both the regression analysis conducted in 2007 and 2009 by him, consistently shows that Host country factors such as their technological capability play a significant role in technology transfer to developing countries with or without the CDM.

show high technology transfer. CO_2 capture, Landfill gas and Transport projects are other types of CDM projects where technology transfer claims in the PDDs are very high (80%-90% of total projects).

Figure 3: Technology transfer to different types of CDM projects (2008)



Source: UNFCCC 2010

However, Figure 3 does not specify the kind of technology that has been transferred through these projects for emissions reduction. Section 5.2.1 develops a more detailed picture of the technologies transferred through different types of CDM project.

5.2.1 More effective and sustainable low carbon technology transfer bypasses industrial gas, chemical and other key sectors

Table 6: Technology Transfer through the CDM (2007)

Mechanism	Number of projects	% of technology transfer
End of pipe	205	69
New Unit	268	36
Input Switch	39	33
Change in the production process	111	20

Source: Dechezleprêtre, Glachant, Ménière (2007)

Critics argue that CDM is a mechanism which drives projects to avail the cheapest opportunities for emissions reductions, regardless of whether they lead to a long-term move away from fossil fuels. The quantitative analysis by Dechezleprêtre, Glachant, Ménière (2007) shows the prominence of end-of-pipe TT rather than CDM's contribution to new units in ground-breaking low-carbon technologies (Table 6). The end-of-pipe technologies remove already formed contaminants from the environment. It is normally implemented as a last stage of a process before the GHG is emitted. Thus, end–of-pipe technologies do not prevent production of GHG and pollutants, and are considered in this study as technologies with a lower impact on sustainable development. The following sectoral reviews show how the quality of TT (type of TT) varies in the CDM sectors.

Table 7: Technology transfer in selected CDM project types (2010)

Type of projects	No. of projects	% of total projects with TT	Average project size (CO_2e/yr)
Renewable Energy			
Biomass	643	34	67,974
Geothermal	15	91	222,085
Hydro	1372	13	109,965
Solar	47	60	22,402
Tidal	1	100	315,440
Wind	923	34	91,732
Energy Intensive			
Cement	32	21	152,152
Industrial Gases			
HFC	22	91	369,6440
N20	70	100	711,373
PFC & SF6	17	75	291,838
Others			
Transport	24	82	100,435

Source: UNFCCC 2010

Industrial Gas Projects

Table 7 highlights TT in selected sectors. Industrial Gas projects show the largest concentration of projects with TT. Many authors are highly critical of Industrial Gas projects which they believe yield disproportionally high profits for project developers and create “perverse incentives” to increase GHG emissions to then mitigate. Such end-of-pipe technologies in the Industrial Gas sector are not effective sustainable form of technology transfer (see Assumptions in Section 1).

Cement Projects

The Cement production sector is highly energy intensive. The energy cost for running a cement plant is almost 40% of the total manufacturing cost (for example in projects analysed by Fukui and Krishna (2011) in India). Therefore, there is a large potential for reducing emissions through reducing the energy consumption in cement plants. 89 CDM Cement projects had been registered worldwide by the end of 2010. These use four abatement methods to reduce emissions: use of alternative fuels, production of blended cement, implementation of energy efficiency measures, and implementation of waste gas/heat utilisation. In India, the main technology used for CDM projects is the blended cement production technology. In China, waste gas/heat utilisation technology is more popular. In other countries the use of alternative fuels is the most common option (Fukui and Krishna 2011).

Table 8: The types of technology used for emissions reduction in the CDM Cement projects

Type of technology used	CDM Cement projects in India	CDM Cement projects in China	CDM Cement projects in other countries
Alternative fuels	4	0	8
Increase production of blended cement	13	5	2
Energy efficiency measures in the factory	5	0	1
Waste gas/heat utilization	4	42	5
Total	**26**	**47**	**16**

Source: Fukui and Krishna 2011

Since the blended cement technology uses locally available materials, there has been no TT in this sector in India. Because these technologies are easily available in India, the EB has changed the baseline for blended cement projects. Therefore, most blended Cement projects are now considered non-additional projects. India could still earn CDM revenues in the Cement sector by adopting waste gas/heat utilisation technology which is very popular with Chinese CDM Cement projects. Despite opportunity for earning CDM revenues, such TT through the CDM Cement project was 0% until 2008 in India (Dechezlepetre 2008). There were only 4 CDM Cement projects in India at the end of 2010 using the waste gas/heat utilisation technology that has been transferred from developed countries. In contrast, in China TT for implementing waste gas/heat utilisation method through the CDM is much higher because Chinese Cement projects are bilateral/multilateral projects carried out in partnership with international companies from Annex 1 countries. Indian Cement projects are usually unilateral (the local project developers are also the owners of the obtained CERs, with no foreign project participants) and therefore the Indian project developers may find it too expensive to transfer technology from Annex 1 countries (Fukui & Krishna 2011) (For further explanation of unilateral projects see footnote 14). Thus, except for China, the CDM Cement sector shows very low technology transfer (21%) from developed countries mainly because of the unilateral nature of projects.

Transport Projects

The transport sector contributes to 23% of energy-related CO_2 emissions internationally. It is also the fastest growing sector in terms of GHG emissions in developing countries (Replogle and Bakker 2011). Global transport energy-related CO_2 emissions are projected to increase by 1.7% a year from 2004 to 2030 (GTZ 2010). Therefore, emissions reduction in the transport sector is essential. There are currently 36 CDM transport projects in the pipeline. Out of the 6 registered projects, 4 are small scale and 2 of these claim TT. The transferred technology is mainly Japanese technology related to regenerative braking. However, in the CDM pipeline, 82% of the transport PDDs claim technology transfer (UNFCCC 2010). The technologies to be transferred are mainly from Sweden, Japan, France, Italy, China and Malaysia (UNFCCC 2010). None of these projects are registered yet. This lack of approval of projects in the CDM transport sector is due to difficulties meeting carbon leakage and emissions monitoring requirements.

Table 9: Technology Transfer potential in the CDM Transport Sector

Methodologies in the pipeline for emissions reduction through the CDM transport projects	% of projects within the pipeline utilising each type of methodology	Technology transfer
Bus rapid transit	42	Usually no claim of technology transfer but some knowledge transfer acknowledged
Biodiesel for transport	22	Equipment transfer
Rail: Regenerative braking	8	Equipment transfer
Modal Shift: Road to Rail	14	Usually low level of technology transfer
Motorbikes	11	Usually low level of technology transfer
Metro	3	Equipment transfer
Total number	36	82% of projects in the pipeline claim technology transfer

Source: CDM pipeline database (2011)

Table 9 indicates that the transport sector pipeline shows potential for TT, but due to complexities in baseline calculation, the projects that get registered are mainly those with small scale energy efficiency TT. The EB has currently mandated the Methodology Panel to improve methodologies for mass transit and bus rapid transit projects so that more CDM transport projects can be approved and enter the pipeline. The experts have indicated that the methodologies are too data intensive, additionality assessment is too complex, and leakage and monitoring requirements too costly (Raplogle and Bakker 2011). Because of these issues, despite technology transfer opportunities, transport sector projects are low in number in the CDM pipeline. Thus, the scale of technology transfer through the transport project remains very low under the CDM.

Hydro Projects
In Table 6, the renewable energy sector shows variable characteristics. The Hydro projects, despite having very high occurrence in total, show very low levels of technology transfer. Only 178 of the 1372 claim technology transfer. The small scale Hydro projects use local technologies, but large scale Hydro projects do demonstrate technology transfer, especially to China.

A UNFCCC (2010) study carried out a regression analysis to explain such an imbalance in project–type related technology transfer. Certain supply side characteristics drive the technology transfer at project level. Seres and Haites, authors of the UNFCCC study (UNFCCC 2010), conducted a logistic regression analysis based on PDD data. The results with a significant coefficient are listed below.

- Large scale projects are more likely to involve TT
- Small scale projects are less likely to involve TT
- Unilateral projects[10] are less likely to involve TT
- Projects that are growing more in number in a country are less likely to involve TT
- Energy Efficiency (Industry), Transportation and Wind projects are more likely than average to involve TT
- Cement and biomass projects are less likely than average to include TT

5.3 The CDM has been incapable of encouraging overall policy changes in the area of transforming the energy systems in developing countries.

Emerging economies and many smaller developing countries are locked in fossil-fuel based economies where coal is abundant and cheap and oil is subsidised. Fossil-fuel subsidy policies have made renewable energy technologies less cost-effective even with the support of CDM revenues. De Sepibus (2009) has examined the argument that the CDM, while contributing to project level technology transfer, has failed to influence changes in policies for transforming the energy systems in developing countries. The author argues that this is due to the CDM rewarding short-term abatements and failing to incentivise innovation and structural changes. For example, in the case of the renewable energy sector, the technologies are not yet mature and require significant research and innovation to bring project costs down. Supporting infrastructure also needs to be develop to reduce the costs of integrated technologies with supply networks. For example modernised electricity grids for mainstreaming the renewable energy supply and distribution networks for off shore wind and desert solar would make renewable energy projects more attractive.

When designed and launched, it was not the purpose of the CDM to either invest in renewable energy R & D or influence the national policies in countries to support the sector. Thus, other policy instruments are required for advanced solar and offshore wind technologies that have currently failed to be transferred through the CDM to developing countries.

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[10] "Unilateral CDM" projects refer to those CDM project activities that do not have an Annex I Party letter of approval at the time of registration of the project (CDM Rule Book: http://www.cdmrulebook.org/616)

6 Proposed reforms in the CDM supply and demand side and alternative policy options to address technology transfer concerns

Table 10 lists a number of proposals by different authors and organisations for reforming the CDM as well as for adopting alternative routes to enhance low carbon technology transfer to developing countries. This is not a list of recommendations proposed by AEA. As explained in Section 1, the purpose of this briefing sheet is to review and assess the reform options proposed in existing literature. The final report submitted to the Commission develops overall reform options that could resolve a number of issues related to the integrity of the CDM, including some issues related to sustainable technology transfer.

While it is understood that host countries and external factors (e.g. patent issues, international oil price, and trade barriers) play important roles in scaling-up low carbon technology transfer, this paper focuses only on the role of the Kyoto Protocol's CDM in technology transfer. Therefore, we have assessed the listed proposals in terms of supply and demand side reforms only.

Table 10 Limitations identified in general literature	Proposed reforms in the CDM supply side by various authors	Proposed reforms in the CDM demand side by various authors	Proposed measures outside the CDM by various authors
1. The rates of decline in CDM project with TT for China, Brazil and India are steep but modest for all other countries.	A. Streamlining the role of DNAs for appropriate project identification and technology selection and technology need assessment (TNA) by host countries will be useful (ENTTRANS 2008). B. EB could set more objective criteria, including technology standards, technology penetrations rates and sectoral benchmarks. C. Sector-specific additionality approaches could be developed by the EB to ensure underrepresented sectors have greater opportunity for TT under the CDM.		K. The creation of strong international networks of national experts and decision-makers, where knowledge is shared and best practices are compiled and diffused, might prove an effective means to technology transfer to diverse sectors and countries. For example, the New Technology Mechanism under the UNFCCC.
2.TT is concentrated in large scale and bilateral projects whereas small scale and unilateral show less than average probability for TT.	D. Programmatic CDM is very suitable for TT to small scale projects, especially in energy efficiency projects (ENTTRANS 2008). E. EB should set standardised baselines for under-represented sectors such as the transport sector (GTZ et al 2011) F. On the supply side, introduction of a discounting factor for credits generated by less desirable technologies will diversify the type of low carbon TT in host countries (Schatz, 2009).	H. Developed countries could, for example, require that a certain percentage of the portfolio of CERs come from projects using a specific type of TT (De Sepibus, 2009). I. For compliance, Annex 1 countries could require a certain percentage of the portfolio of CERs to come from bilateral/multilateral projects (Aasrud et al 2009).This could reduce the demand for CERs from a large number of unilateral CDM projects that demonstrate low TT (Aasrud et al 2009).	L. A sectoral crediting mechanism based on technology objectives will deliver greater technology transfer and diffusion. 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 (Baron et al., 2009).
3. The CDM, while contributing to project level technology transfer, has been incapable of encouraging overall policy changes in the area of transforming the energy systems in developing countries.	G. Introduction of Technology CDMs (tCDMs) could drive the TT mandate. EB could establish a positive list of technologies under the tCDM that would be deemed additional and would benefit from expedited registration (Teng et al. 2008).	J. Introduction of a discounting or multiplier factor on the EU demand side for credits generated by less desirable technologies (Schatz, 2009). This could encourage more transformational low carbon technologies to be transferred rather than end-of-pipe technologies.	M. New Technology Mechanism under the UNFCCC agreed in the Cancun. K. Sectoral crediting mechanism encourages policy reform and more deeply involves developing countries. They lower transaction costs as the additionality no longer has to be demonstrated for every single project and therefore SCM can have greater coverage and influence over technology transfer (De Sepibus, 2008)

6.1 Improvement in CDM supply side factors

The proposals by various authors included in the literature review numbered A to E in Table 10 are specifically for reforming the CDM. The heart of these proposed reforms is to make the CDM have a more explicit mandate for TT. This would give the EB more authority to select or reject projects if the project developers did not deliver the mandate. Such a TT driven mandate, according to many authors, requires the following changes in the supply side:

- As a supply side reform, EB could set standardised baselines and new additionality approaches for underrepresented sectors.

Experts propose that standardised baselines would help to attract transport projects to the CDM sector. For example, standardised baselines based on emissions intensities of subsectors and specific vehicle fleets could allow better monitoring of GHG emissions in the transport sector. Emissions per unit of travel (e.g. per passenger-Kilometer, or per tonne-Kilometer) will be useful indicators for setting the standardised baselines for Railway networks, Urban transit networks (light rail, bus, metro), Inter-urban bus fleets, commercial fleets etc. (GTZ et al 2011). These sectors need low carbon technology transfer and their improved participation in the CDM would enhance TT. Also, such standardised baselines would pave the way for a gradual transition from the CDM to a sectoral mechanism.

Barbara Haya (2009, 2010) has conducted research on the large Hydro power CDM projects in India with ground data from the project developers. The research shows that project-by-project additionality testing is not feasible because all large hydro projects are developed based on existing government policies and pre arranged investors. Moreover, faulty additionality tests and baseline development in the Hydro sector lead to over crediting by the EB while many underrepresented sectors, which are more genuinely additional, are not receiving credits under the CDM.

The way additionality tests have been applied to the transport sector has been stated as the greatest barrier to the application of CDM to this sector. The UNFCCC has been holding workshops in exploring the expert views on developing sector-specific additionality approaches. Transport sector specific additionality approaches are essential to improve the CDM coverage of this important sector (Replogle and Bakker 2011). There is currently very little transfer of low carbon technologies to developing countries in this sector, particularly relative to its emissions (GTZ et al 2011).

Standardised baselines and improved additionality approaches have the potential to increase the number of small scale projects or underrepresented sectors where TT is required. However, they will not necessarily increase the probability for TT unless there is a clear mandate by the DNAs in the host countries.

- As a supply side reform, only a certain percentage of calculated emissions reduction could be issued as CERs for certain types of technology.

Through the introduction of a discounting factor, more credits can be given to projects which demonstrate TT and fewer credits can be allocated to projects with no TT, or with transfer of unsustainable technologies. Some authors have discussed in detail how discount rates can be calculated based on the marginal abatement cost of each type of technology used or transferred. However, developing differential discount rates is too complex, requires a wealth of data and would also lead to controversies over the selection of technologies for high and low discount rates.

- The EB could design and implement technology CDMs (tCDMs) with technology standard and benchmarks. Under the tCDMs a list of technologies could be developed that would be deemed additional by the EB and would benefit from expedited registration (Teng et al. 2008). This could enable more technology transfer for energy intensive sectors such as Cement.

CDM with a technology mandate could increase the number of CDM projects with sustainable TT. Teng et al. (2008) have discussed how tCDMs could be used for bundling projects of similar types of technology transfer. The main difference between a Programme of Activities (PoA) and a tCDM is that PoA focuses on distribution of CERs to bundled projects, while tCDM will focus on the process of technology transfer. The CERs will be issued when the “technology transfer programme” under the tCDM is complete. The additionality test for the tCDMs would require the project partners to prove that the type of technology transfer will be achieved at a much lower scale without the tCDM. The developing countries have now agreed to develop Technology Need Assessments (TNAs) that could help in setting technology benchmarks and a positive/negative technology list under the tCDMs. However, from a TT perspective, positive and negative technology lists are difficult to develop as there will be different interpretation of what are good or bad technologies for transfers. For example, most developing countries believe that transferring nuclear energy technology from developed countries is important and would help in reducing large scale emissions in developing countries. The UN has restricted the use of Nuclear energy technology under the CDM. Until recently, the UN had also considered Carbon Capture and Storage (CCS) as inappropriate technology, but has now included it under the CDM.

- The EB could actively remove the barriers for Programmatic CDM (PoA). This would improve the rate of TT and diffusion of the transferred technology for small scale and Energy Efficiency projects.

The Programmatic CDM, through bundling of projects with similar technologies can benefit from economies of scale and reduce the transaction costs to a great extent. Given that the likelihood of technology transfer seems to be higher in larger CDM projects (as observed in this study), bundling of small scale projects, theoretically speaking, can achieve a similar advantage to large scale projects (Das, 2011).

The longer time frame for which a CDM Project Activity (CPA)[11] is allowed to be registered offers greater scope for setting longer term goals on technology transfer (Das 2011)[12]. Moreover, once a Programme of Activities (PoA) is registered, a CDM Project Activity (CPA) may be included under its ambit at a later date. Furthermore, there is no limit to the number of CPAs that may be included under a PoA at a later date. These provisions are particularly helpful in within-country diffusion of a particular technology, once it is transferred under a CDM PoA.

The Programmatic CDM could be used for large-scale diffusion of a technology which has already been removed from the CDM but is yet to achieve deployment at a required scale. The ‘CFL lighting scheme – “Bachat Lamp Yojana”’ – India’s first registered CDM PoA, has been quoted by Kasturi Das in her research (Das, 2011). Since PoAs are in their embryonic stage, robust empirical evidence is not available to support their hypothesis.

6.1.1 Advantage of Sectoral Crediting Mechanisms in creating greater supply of credits from projects with TT

The main advantage of the SCM is that it gives the developing countries a greater freedom on technology choices. The CDM methodologies are quite prescriptive and restrict many opportunities for emissions reduction through TT such as in the power generation and transport sector.

In the power generation sector, the SCM would allow greater scope for TT to carbon capture and storage (CCS) projects and nuclear energy projects (Baron and Aasrud 2009). So far these two types of projects have been excluded from the CDM. Only recently, after Cancun, has CCS been included in the CDM pipeline (UNFCCC 2009). The developing countries have been very keen to exploit these two TT opportunities for large scale emissions reduction.

[11] A project activity under a Programme of Activities is called a CDM Programme Activity (CPA).

[12] A Programme of Activities should not exceed 28 years, and 60 years for afforestation and reforestation (A/R) Programme of Activities (UNFCCC document EB 47, Annex 29).

The CDM is unable to attract transport sector projects because this sector covers disperse type of technology and knowledge requirements for emissions reduction such as traffic management, transport demand management, fuel switch, design of engines and parts, innovative materials for vehicles, etc. Moreover, the additionality criteria as well as extensive data requirement for monitoring transport projects become too difficult and costly under the CDM system. Sectoral mechanism will allow sectors with such diversity to come under more structured technological change, compared to fragmented projects under the CDM. It is argued by authors that Sectoral Mechanism can scale up TT by bringing in more structured change in intellectual property right and trade barriers for meeting emissions reduction targets (Baron and Aasrud 2009). It also has greater scope for making unilateral projects and small scale projects open to cost-effective technology imports, because the host country governments would then remove trade barriers and allow TT for the whole sector. The economies of scale under the SCM would make technology import more cost effective for all project developers.

A few studies such as that of Helme et al. (2010) examine the Electricity, Cement and Iron and Steel sector in China, Brazil and Mexico, and argue that for these sectors the SCM will work better if the countries are allowed to set technology standards or technology thresholds, for receiving international incentives rather than emissions thresholds. This is because there is a large gap in sectoral emissions data and reliable information. Butzengeiger-Geyer et al (2010) look at 6 sectors in 9 countries and show that to measure emissions of scattered small and big installations under a sector in small countries as well as India and China, will incur very high transaction and monitoring, reporting and verification (MRV) cost. They propose that establishing a technology threshold under the SCM will be cost effective and will deliver better low carbon goals through TT in developing countries.

Finally, most authors have acknowledged that the greatest barrier to technology transfer to relevant projects is the additionality testing approaches for different sectors under the CDM. Haya (2010) believes that non-CDM mechanisms will succeed better in technology transfer because it will not require the additionality tests. SCM has greater potential to cover targeted sectors which require specific technology transfer for emissions reduction because such mechanism can deliver custom made projects.

6.2 Improvement in the CDM demand side factor

Antoine Dechezleprêtre, based on his extensive data analysis of the CDM pipeline as well as patent data of low carbon technologies implemented in developing countries, surmised that the “demand” or “market” for emissions reduction is the most important factor for scaling up technology transfer to developing countries[13].The Kyoto mandated reductions from projected Annex B "business-as-usual" emission levels is referred to by Figueres (unknown Year) as the “demand” for carbon offsets (see footnote 1). Based on her interpretation, in this paper, reform of the CDM demand side means changes to Annex I country preferences for buying certain types of CERs, and changes to EUETS restrictions that could scale up better quality TT. These demand side improvement measures proposed in the literature are as follows (Table 10):

- A discounting or multiplier factor could be introduced on the EU demand side for credits generated by less desirable technologies (Schatz, 2009).

On the demand side, introducing discounting would mean that only a certain percentage of CERs with certain type of technology transfer can be used for compliance (De Sepibus 2009 & Schneider 2008). This could encourage more transformational low carbon technologies to be transferred rather than end-of-pipe technologies.

[13] AEA interviewed Antoine Dechezleprêtre in 25th March, 2011. The question put forward to him in this context was “Since you have been involved in quantitative analysis in the area of technology transfer to developing countries what is the single most quantitatively significant trend that you observe

However, there are concerns that introduction of demand-side multipliers would lead to a fragmentation of the market and the added complexity in the transaction process would prevent smaller compliance entities from supporting the EUETS and the flexible mechanisms (Enel S.p.A 2010). .

- For compliance, Annex 1 countries could require a certain percentage of the portfolio of CERs come from bilateral/multilateral projects (Aasrud et al 2009).This could reduce the demand for CERs from a large number of unilateral[14] CDM projects that demonstrate low TT.

The problem with this proposal is that the multilateral/bilateral projects simply indicate that there are project participants from Annex I countries, which are entitled to all or some of the CERs obtained by the project. However, it does not involve an agreement over any form of TT. Quite often these projects have higher rate of TT only because the projects are larger in size and have a confirmed source of future revenues. As stated by a Yes Bank paper in India (2005), local banks prefer to offer loans to projects which have a prior agreement (Letter of Approval to buy CERs generated by the project) with a foreign partner. In contrast, unilateral CDM projects are considered by local banks/lenders to have a greater financial risk since these projects do not have a prior agreement with the CER purchasers (Yes Bank 2005). This leads the project developers of unilateral projects to spend stringently on cheaper local technologies rather than to invest in technology transfer which requires higher investment. To be noted here that this does not mean that the unilateral CDM projects by definition do not entail technology transfer. If local banks can develop trust and improved project finance/risk sharing schemes for the unilateral CDM projects, these projects can also involve TT. Moreover, restricting purchase of CERs from unilateral projects would mean discouraging developing countries to use locally developed technologies which can be useful for emissions reduction as well. Unilateral projects can often be good for local sustainable development.

6.2.1 Advantage of Sectoral Mechanism in creating demand for offset credits from projects with TT

The current targets for emissions reduction by the Annex 1 countries have created restricted demand for offset credits which can be met by the CDM. There are some concerns that there might be over supply of credits through the SCM if it is not matched with increased demand for those offset credits. The Annex 1 countries therefore need to set more stringent emissions reduction targets to create more demand for offset credits from developing countries. Some authors point out that the no-lose-target of the Sectoral Mechanism offers developing countries opportunity to set more ambitious emissions reduction baseline. As there is no penalty for non compliance, developing countries can therefore aim for non-binding targets of greater emission reductions (De Sepibus 2009). Sectoral Trading Mechanism (STM) could also create greater demand for emissions reduction in the developing countries especially if energy intensity targets are set (cap emissions per unit of output or GDP). The stringent cap set for the developing countries would then drive the countries to import more effective low carbon technologies for emissions reduction. Under such scaled up credit demand, there will be greater demand for low carbon TT too. It is also estimated that with increased revenues from the SCM and STM, the countries would have up-front funds for importing technologies. Bloomberg Energy Finance (2011) has estimated that, assuming compliance with 30% carbon intensity reduction target on 2007 levels, China could earn 22 billion Euros through the SCM credit sale by 2020 in comparison to an expected 2 billion Euros through the CDM. Such scaled up revenue earning by developing countries would lead to greater demand for low carbon technology import and transfer.

[14] "Unilateral CDM" projects refer to those CDM project activities that do not have an Annex I Party letter of approval at the time of registration of the project (CDM Rule Book: http://www.cdmrulebook.org/616)

6.3 Role of the New Technology Mechanism

Participants agreed at COP16 in Cancun (2010) upon a preliminary structure for a New Technology Mechanism, with a Technology Executive Committee (TEC) and a Climate Technology Centre and Network (CTCN). The TEC will have an advisory and administrative role, identifying technology needs and priorities of developing countries, coordinating efforts, and providing recommendations for improvement. It will consist of a panel of 20 experts. The CTCN, consisting of a centre and a large network, will serve an operative role in technology transfer on an international to regional scale. It will function mainly to carry out the TEC's directives, as well as to facilitate and improve upon existing initiatives. However, the relationship between the TEC and the CTCN is unclear, and also it is not established as to how the New Technology Mechanism will relate to the existing and new financial mechanisms for technology transfer including the CDM.

7 Conclusion

The CDM supply side is characterised by large scale projects (e.g. the Industrial Gas projects) demonstrating greater concentration of TT. However, these large scale projects show transfer of end-of-pipe technologies rather than transfer of sustainable low carbon technologies which prevent emission of GHGs in the first instance (see assumptions in Section 1). On the contrary, bilateral and multilateral CDM projects, which have greater propensity for attracting TT, are less in number.

Unilateral projects (e.g. Cement projects in India) are less likely to promote sustainable forms of low carbon technology transfer because they are less attractive to local banks. This is because unilateral projects often do not have a pre-arranged CER sale and are therefore viewed as more risky investments. There are other high emission sectors which are bypassed by the CDM. Transport projects are often deemed too complex to undertake due to additionality principles, carbon leakage concerns and monitoring requirements. Similarly, the power generation sector has been locked into a fossil fuel based economy due to the infrastructure and subsidies in developing countries. Grid based offshore wind or desert solar technologies have failed to be transferred through the CDM because they are not competitive with fossil fuels. It follows that the CDM is failing to induce a sustainable form of low carbon TT to developing countries in many of the important sectors, and the potential for emissions reduction in these areas is forgone. This is by design rather than coincidence: as a market mechanism the CDM was not meant to influence policy but to achieve emissions reductions where they are most cost effective. Therefore, the CDM activities are playing a passive role in influencing policy changes for moving towards low carbon economies in developing countries (Teng et al. 2008).

The supply side reforms proposed by various authors in the literature aim to give the CDM a more explicit mandate for TT. This would give the EB more authority to select or reject projects if they did not deliver their mandate. According to the existing body of literature, such a TT driven mandate would require the following changes on the supply side:

- The EB could set standardised baselines and new additionality approaches for underrepresented sectors.
- Only a certain percentage of calculated emissions reduction could be issued as CERs for projects with a certain kind of technology transfers.
- The EB could design and implement technology CDMs (tCDMs) with a technology standard and benchmarks. Under tCDMs a pre-determined list of technologies could be developed that would be deemed additional by the EB which would expedite registration (Teng et al. 2008). This could enable more technology transfer for energy intense sectors such as Cement.
- The EB could actively remove the barriers for programmatic CDM. This would improve the rate of TT and diffusion of small scale and Energy Efficiency projects.

The CDM demand side improvement measures proposed by various authors are given below.

- A discounting or multiplier factor could be introduced on the EU demand for credits generated by less desirable technologies (Schatz, 2009). This would encourage more transformational low carbon technologies to be transferred rather than end-of-pipe technologies.
- For compliance, Annex 1 countries could be required to attain a certain percentage of their portfolio of CERs come bilateral or multilateral projects (Aasrud et al 2009).This would reduce the demand for CERs from a large number of unilateral CDM projects that demonstrate low TT.

AEA concludes that the proposals above do not necessarily ensure changes which would remove barriers for transfer of sustainable technologies through the CDM. The CDM, even with the above mentioned reforms, has no scope for removing host country barriers and other external barriers to technology transfer because it was not designed to do so. The Sectoral Mechanisms, in contrast, have the potential to effect change on a broader basis. This could mean creating a more attractive environment for investors through climate friendly policies, target setting and removed barriers to technology transfer..

It follows that Sectoral Mechanisms (Crediting and Trading) have some advantages over the CDM in delivering low carbon technology transfer to developing countries. There is greater potential for sector-wide transfer of transformational technologies for emission reductions through the SCM. The SCM gives developing countries greater freedom on technology choices than the CDM currently does. They can have greater coverage of sectors for technology transfer including small scale project sectors (energy efficiency projects), energy intensive sectors (e.g. Cement) and other high emission sectors (e.g. power generation and transport sector).

The CDM has failed to deliver high rates of low carbon technology transfer in the above mentioned sectors. The SCM can scale up technology transfer thereby enabling structural change and secure new and low carbon technology within a developing country. Sectoral Trading Mechanism (STM) can strengthen demand for emissions reduction even within the developing countries through a cap on emissions per unit of output (e.g energy intensity caps). Thus Sectoral Mechanisms can motivate developing countries to import advanced low carbon technologies which can lead to greater emissions reductions. Sectoral Mechanisms may also be more lucrative than the CDM for developing countries as they create more demand for technology import which can generate revenue. Thus, Sectoral Mechanisms, if designed carefully, will most likely support large-scale technology transfer while potentially creating an incentive to import and adapt new technologies (Baron and Aasrud 2009).

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List of experts interviewed:

Antoine Dechezleprêtre, Grantham Research Institute on Climate Change and the Environment, London School of Economics, UK.

Barbara Haya, University of California- Berkeley; USA.

Erik Haites, Technology transfer expert, Margaree Consultants Inc. Toronto, Canada.

Stephen Seres, Climate Change Economist, Montreal, Canada.

AEA
6 New Street Square
London EC4A 3BF
Tel: 0870 190 1900
Fax: 0870 190 5545