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Wzrost niskowęglowy: zrównoważoność i rozwój technologiczny z perspektywy Indii

Low Carbon Growth: An Indian Perspective on Sustainability and Technology Transfer

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Streszczenie

Artykuł przedstawia doświadczenia związane z transferem technologii w kontekście przeciwdziałania zmianom klimatycznym na przykładzie Indii. Transfer technologii może przynieść oczekiwane rezultaty, gdy kraje rozwijające się sprostają standardom zawartym w międzynarodowych porozumieniach. W kontekście zmian klimatycznych i transferu technologicznego została przeanalizowana skuteczność instrumentu CDM (Clean Development Mechanism, mechanizm czystego rozwoju). Uwzględniono aspekty społeczno-polityczne i ekonomiczne. Przykład wrażliwości indyjskiego eksportu w obliczu alternatywnych systemów regulacyjnych, takich, jak nałożenie podatku węglowego, ukaże znaczenie mechanizmów transferu technologii pomiędzy rozwiniętymi a rozwijającymi się krajami.

Osiągnięcie rozwoju zrównoważonego przy pomocy wybiegających w przyszłość mechanizmów transferu technologicznego pozwoli powiększyć wkład Indii do globalnego rozwiązania problemu klimatycznego.

Słowa kluczowe: zmiany klimatyczne, rozwój zrównoważony, transfer technologii, mechanizm czystego środowiska, umowy handlowe

Abstract

This paper provides an Indian perspective on the issue of technology transfer, in the specific context of tackling climate change. The paper examines how technology transfer issues have panned out when developing countries have had to meet standards laid down in international agreements. In addressing climate change, the efficacy of the CDM as an instrument to facilitate technology transfer is analysed. The socio-political and economic analysis of implementing the clean development mechanism provides useful insights. An indicative exercise on India's export vulnerability in the face of alternative regulatory regimes such as imposition of carbon tariffs demonstrates the importance of technology transfer mechanisms between the developed and developing countries.

The attainment of sustainable development through forward looking mechanisms of technology transfer will improve India's contribution to a global solution for climate change.

Key words: climate change, sustainable development, technology transfer, clean development mechanism, trade agreements

1. Introduction[1]

The Indian economy has experienced high rates of growth in terms of its GDP during the last couple of decades. The recent success story of the Indian economy is rooted to a large extent in the globalised nature of its economic and social activities. Many of these economic activities have been driven by the adoption of policy that has focused on India's external relations and exports sector. In spite of this high growth, reducing the absolute numbers of the poor and ensuring a minimum threshold level of clean energy consumption remain a challenge for the economy in achieving sustainable development. There are several developmental milestones which remain to be achieved and for which continued and rapid growth of the economy is an imperative.

Climate change has added a whole new dimension for a growth strategy which seeks to improve the economic and social well being of the people in India. Sustainable development requires the integration of climate change effects in order to ensure that the long term consequences of development activities are not detrimental to human well being (Dasgupta, 2009). Given that climate change is a problem of the global commons, reducing vulnerability to climate change depends on the adoption of appropriate adaptation and mitigation strategies which yield globally fruitful results. Across the world, attention increasingly been focused on the green house gas emissions (GHGs) that are likely as a result of India's development in the years to come. Engagement with this issue at a global level has been mostly through the forums provided by the *United Nations Framework Convention on Climate Change* (UNFCCC).

This paper proposes to study in depth the issue of technology transfer, which is a major area of focus for adoption of a low carbon growth path. Effective technology transfer, in a globalised economy, can help India in its pursuit of sustainable development, while the country contributes to the international community through lower GHGs.

2. Identifying Key Concerns

The recent *Copenhagen Accord* has been described as a political, and not legally binding document (Letter to…, 2008). Developed and developing countries have been engaged in tackling the challenges posed by climate change under the framework laid down in the UNFCCC, the *Kyoto Protocol* and the *Bali Action Plan* (BAP). The *Copenhagen Accord*, from the stated Indian perspective, is meant to facilitate ongoing negotiations (in the two tracks) in accordance with the principles and provisions of the UNFCCC, the *Kyoto Protocol* and the BAP. Specifically these two tracks are the *ad hoc* working Group on long-term co-operative action and the *ad hoc* working group on *Kyoto Protocol.*

On the basis of the UNFCCC principles of equity and common, but differentiated responsibility and respective capabilities in protecting the climate system, the *Kyoto Protocol* set binding targets for only Annex-I countries (industrialized countries). Under this approach, the binding targets required industrialized countries to reduce GHG emissions to 5.2% of 1990 levels over the five-year period 2008-12. The UNFCCC and *the Kyoto Protocol* exempted developing countries from GHG emissions targets. As per *the Kyoto Protocol* Annex-I countries were required to meet their targets through domestic/national measures with the help of three mechanisms - emissions trading (the carbon market), clean development mechanism (CDM) and joint implementation. Of these the CDM is most widespread in involving the developing countries, particularly India and China. The CDM promotes sustainable development in the developing countries while helping Annex-I countries to achieve their emission reduction targets by earning certified emission reduction (CERs).

In addition to these binding commitments on emission reductions, the *Kyoto Protocol* and the UNFCCC include detailed requirements for Annex-I countries on reporting the extent of emissions and the mitigation measures that they undertake. This requirement to report is an essential means of monitoring compliance. There are also a number of provisions requiring developed countries to assist developing countries in meeting their obligations. In fact, the participation of developing country parties in greenhouse gas emission reductions is explicitly linked to financial support and technology transfer from developed country parties. The BAP is in agreement with the cap and trade approach but recognizes that specific mechanisms need further refinement. The BAP calls for enhanced action on the *Kyoto Protocol* and calls for measurable, reportable, and verifiable (MRV) emission reduction commitments on the part of developed countries.

It also considers the involvement of developing countries in mitigation efforts through nationally appropriate mitigation actions which should be enabled by developed countries through technology, financing and capacity building that is measurable, reportable and verifiable.

While the BAP explicitly lays down the onus on developed countries to help developing countries in their mitigation efforts, which would be measurable, reportable and verifiable, there is now an emerging view amongst developed countries on extending MRV provisions to actions undertaken in developing countries as well on the grounds that this could enable more comprehensive information on global GHG mitigation actions, more informa-

[1] The authors are grateful to Anwarul Hoda and R. K. Sethi for providing valuable insights and to Disha Bhattacharjee for her research assistance.

tion to assess the effectiveness of such actions, and greater recognition of GHG mitigation actions undertaken in developing countries (Ellis *et. al,.* 2009). Developing countries on the other hand are resisting the application of MRV to them on the grounds that this is against the spirit of the BAP. Further, even the proposition that mitigation actions taken by *Non-Annex I Parties* will be subject to their domestic measurement, reporting and verification the result of which will be reported through their national communications *every two years* (Report, 2010, #5, p. 6) will have financial implications. Putting in place appropriate skills, institutional and regulatory mechanisms for coping with MRV systems will imply additional costs for these countries. The development of guidelines by COP, which ensure national sovereignty in international consultations, and analysis of voluntary mitigation actions has been emphasized by India (Ramesh, 2010).

The issue of environment has also featured prominently in the WTO. *The Marrakesh Accord* (1994) lay down the foundation for mainstreaming environment into the WTO. The preamble to the *Marrakesh Agreement* recognized sustainable development as an integral part of the multilateral trading system, and the importance of environmental protection. The Preamble also observed that WTO Members would recognize that the optimal use of the world resources would be *in accordance with the objective of sustainable development, seeking both to protect and preserve the environment and to enhance the means for doing so in a manner consistent with their respective needs and concerns at different levels of economic development.* Environmental provisions were included within some of the new agreements under the WTO. The two most important agreements are the *Agreement on Technical Barriers to Trade* (TBT) and the *Agreement on the Application of Sanitary and Phytosanitary Measures* (SPS), which contain provisions for the use of standards to protect health and the environment.

Another concern is based on apprehensions about a future, where annual total emissions from some of the developing countries exceed those of the developed world, thereby providing a rationale for adopting alternative regulatory regimes. This takes the form of an overall emissions reduction target for developing countries such as India, backed by legal measures to penalize non-compliance. Alternatively, it could also lead to trade measures aimed at offsetting possible asymmetries in competitiveness and preventing carbon leakage that occurs through the relocation of industries to countries with lower or no carbon taxes. The American *Clean Energy Act* (2009) also known as *Waxman-Markey Climate Change Bill*, for example, has an explicit reference to India and China: *The Administrator of the US EPA shall present a report to the Congress regarding whether China and India have adopted greenhouse emissions standards at least as strict as the standards required under this Act.*

Against this backdrop, the Indian government has advocated that India should be a part of the solution to the challenges posed by climate change. This is not withstanding the consensus on historical responsibilities for the source of GHG emissions, but is rather a recognition of the adverse economic consequences that are projected for India based on currently available scientific evidence on climate change. This provides a convenient way of rethinking on how strategies to tackle climate change can impact larger economy wide decision-making processes. In particular, this discussion paper seeks to raise some concerns with regard to trade and climate change for the Indian economy, drawing on current developments in regulatory regimes both within and outside the economy[2].

Technology transfer lies at the core of mitigation to tackle climate change challenges. An important concern is the way in which the issue of technology transfer is likely to pan out in this debate on climate change. While the developing world is increasingly convinced about the enabling role that the developed world has to play, the challenges in designing it are immense. There seem to be no clear mechanisms to enable technology transfer as yet, although market based instruments have conventionally provided economists with some tools which may be used for GHG abatement technological innovation and up-gradation. Examining some of the existing trade agreements that have dealt specifically with issues related to the environment is useful in this context.

Some of the key questions that this paper proposes to address through analytical and empirical evidence are as follows:[3]

- *How have developing countries coped with the environmental challenge of meeting standards? Have developed countries provided technical assistance to developing countries in meeting these challenges? How have developing countries coped with the requirements of reporting trade reform measures to the WTO?*
- *To what extent has the CDM mechanism facilitated technology transfer? What has been the contribution from CDMs across sectors, by scale of activities and ownership of projects?*

[2] Current projections of GHG emissions as per the recent set of climate modeling studies released by the MoEF (September 2009) suggest that emissions are likely to range between 2.77 to 5.0 tons CO_2e per capita.

[3] Some of these issues has been raised earlier by scholars (see for instance Dasgupta and Taneja, 2010).

- *What is the extent of vulnerability of Indian exports to trade measures being currently debated?*

3. International Technology Transfer and Accountability: Lessons from WTO Agreements

The Agreement on Technical Barriers to Trade (TBT) of the World Trade Organization (WTO) allows Members to adopt measures necessary to protect human, animal and plant life or health, or the environment. The Agreement encourages Members to use international standards where these are available. This Agreement is subject to the same principles as the GATT, that is, Articles I and III are its cornerstone, and exceptions, in Article XX, also apply to it. Article I requires Members not to discriminate between "like" products from different trading partners by according them equally "most favoured nation" status. Article III requires Members to follow the principle of national treatment, which requires Members to not discriminate between their own and "like" foreign products. Article XX lays down a number of specific instances in which WTO Members may be exempted from GATT rules.

Paragraphs (b) and (g) of Article XX are two exceptions that are of particular relevance to the protection of the environment. According to these two paragraphs, WTO members may adopt policy measures that are inconsistent with GATT disciplines, but necessary to protect human, animal or plant life or health - paragraph (b), or relating to the conservation of exhaustible natural resources - paragraph (g). GATT Article XX on General Exceptions consists of two cumulative requirements. For a GATT-inconsistent environmental measure to be justified under Article XX, a member must perform a two-tier analysis proving: first, that its measure falls under at least one of the exceptions - e.g. paragraphs (b) and/or (g), two of the ten exceptions under Article XX; and, second, that the measure satisfies the requirements of the introductory paragraph (the chapeau" of Article XX), i.e. that it is not applied in a manner which would constitute *a means of arbitrary or unjustifiable discrimination between countries where the same conditions prevail", and is not "a disguised restriction on international trade* (WTO-UNEP, 2009).

When international standards are found to be an ineffective or inappropriate means for the fulfilment of the legitimate objectives, countries may deviate from them; for instance, because of fundamental climatic or geographical factors or fundamental technological problems. The TBT Agreement recognizes that environmental protection constitutes such a legitimate objective.

Environmental standards requirements as laid down in the TBT agreement have become necessary drivers for technical change. In an overall sense, the command and control approach has been the dominant one, with meeting standards for trade primarily governing the relationship between trade and environment. Although trade agreements, such as the TBT Agreement, have provisions for technical assistance to developing countries, they are not mandatory and have largely been ineffective. Thus, in the absence of economic instruments, the burden of adopting relevant technology to meet standards requirements have been left primarily to the individual entrepreneur, with the entrepreneur being expected to make a switch over to more efficient technology driven by his net benefits. In other cases, positivists have hoped that "corporate social responsibility" (CSR) will play its role, buttressed by demand side influences such as through green ratings of products. Growing evidence is claimed of firms adopting a third generation CSR approach where environmental and social concerns are the starting point for the business activity, as opposed to being factored in at the end (Saqib, Sehgal and Pamlin, 2009)[4].

The reporting and evaluation of national trade policies is a fundamentally important activity in the WTO, which is undertaken by the Trade Policy Review Body (TPRB). All policies including those related to the TBT Agreement are reported by Members. At the centre of this work is the Trade Policy Review Mechanism (TPRM). All WTO Members are reviewed, the frequency of each country's review varying according to its share of world trade. It is mandatory for each Member to report regularly to the TPRB. Member countries - developed and developing have adhered to the requirements of the Trade Policy Review Body. The review mechanism thus enables the regular collective appreciation and evaluation of the full range of individual Members' trade policies and practices and their impact on the functioning of the multilateral trading system.

Several inferences can be drawn from the TBT Agreement: (i) adhering to environmental standards has been undertaken without the support of any market based financial instruments (ii) technological assistance from the developed countries has not been forthcoming (iii) developing and least developing countries have been subjected to a review process.

[4] The way businesses have engaged with the environment has changed over the years. The first generation CSR was motivated by altruistic notions of socially responsible behaviour while the second generation CSR has taken positive steps to control environmental damages largely in response to state regulations. The emergence of market based instruments have helped businesses to move to a third generation CSR where business opportunities have enabled environmentally responsible behaviour.

Since there now exists reasonable consensus on the scientific evidence on climate change, Article XX may be relevant in this context. Although the way in which the measures are implemented and negotiated have to be just and equitable across Members. There are lessons to be drawn from the existing trade agreements that are relevant to the challenge posed by climate change. The above discussion indicates that while trade measures have been implemented through meeting standards, technological assistance, in spite of the provisions made in the agreements has not taken place due to its non-mandatory nature. This has forced compliance costs on developing countries, which are not offset in the short to medium term. Against this experience, it is not surprising that India's earlier submissions to the UNFCCC state that review and verification of mitigation actions by developing countries should apply only to specific mitigation actions where transfers of finance or technology between a developed and developing country partner is involved. In such cases MRV procedures would vary across contractual agreements depending on the requirements of the parties involved.

Moving to a low carbon growth path poses immense technological challenges for India. Financial constraints are a key aspect in facilitating the technological up-gradation. It is in this backdrop, that we examine the Clean Development Mechanism, its potential in the Indian economy, and the challenges in making it a more effective tool for technology transfer. The Clean Development Mechanism is a financial mechanism that can provide us with learnings on more effective design of economic instruments that help the economy to cope with trade related regulatory regimes.

4. Instruments of Technology Transfer: The Clean Development Mechanism in India

In India, 1464 CDM projects have obtained host country approval - the second highest in the world, only after China. In terms of registered projects at the UNFCCC, 467 projects are from India constituting 24.7% of worldwide registered projects. CER's issued for Indian projects stand at 72,108,309 accounting for 20.9% of CERs issued worldwide.

Paradoxically, the CDM, although designed as an international economic instrument with the objective of transferring technology from developed to developing countries, seems to have been instead instrumental in making such transfers domestically. This is unlike other countries where technological transfer between countries has been quite prominent.

Noting that technology transfer is central to the *Kyoto Protocol*, Seres (2008) analyses the technology transfer claims made by CDM project participants [5]. For this analysis he considers only technology transfer claims between countries and not within countries. He finds that technology transfer claims for India occurred in only 16% of the projects accounting for 41% of the annual emission reduction. For China, on the other hand, technology transfer claims were found in 28%, of the projects accounting for 59% of the annual emission reduction. Mexico reported technology transfer in 91% of the projects, accounting for 83% of annual emission reduction (Table 1).

Table 1. Technology Transfer for Projects in Selected Host Countries

Host Country	Number of Projects	Estimated Emission Reductions ($ktCO_2e$/yr)	Average Project Size ($ktCO_2e$/yr)	Technology Transfer Claims as Percent of	
				Number of Projects	Annual Emission Reductions
Brazil	274	26,986	98	28%	57%
China	1168	267,260	229	28%	59%
India	902	64,661	72	16%	41%
Malaysia	113	11,643	103	79%	88%
Mexico	180	11,157	62	91%	83%
South Korea	43	16,179	376	49%	82%
Other host countries	616	75,643	123	59%	61%
Total	3296	473,530	144	36%	59%

Source: Seres, 2008

A host country can influence the extent of technology transfer involved in its CDM projects. It can do this explicitly in the criteria it establishes for approval of CDM projects. For instance China requires that *CDM project activities should promote the transfer of environmentally sound technology to China*. This is a general provision - not a mandatory requirement for each project. India, on the other hand, has adopted a broad concept of technology transfer, similar to that of the IPCC special report, which includes technology transfer *within* the country. Other factors, such as tariffs or other barriers to imports of relevant technologies, perceived and effective protection of intellectual property rights, and restrictions on foreign investment also can affect the extent of technology transfer involved in CDM projects.

The CDM has been subjected to much criticism due to its utilization for plucking *low hanging fruits*. There have also been concerns about defining region and technology specific baselines for measuring emission reductions through CDM activities. Suggestions have also been put forth on how the design of the mechanism can be improved (Narain and Veld, 2008). The low hanging fruits issue is

[5] Seres (2008) analyzes the technology transfer claims in the project design documents of 3296 projects in the CDM pipeline as of June 2008.

concerned with the adoption of least costly and easily available abatement options while postponing adoption of more expensive ones. Outcomes on extent of technology transfer also depend on the way the baseline is defined, whether relative to output or as an absolute level, thereby interactively determining the amount of financial compensation from plucking the low hanging fruit (Germain *et al*, 2007).

Two commonly heard laments in the discussions on CDMs in India are the limited number of large-scale projects and the low level of public sector engagement in the sector. To further examine these issues, data on CDM projects accorded by the National CDM Authority is analyzed. The data indicates that less than a quarter indeed can be classified as activities in the large scale with the rest being small-scale CDM project activities (SSC) (Table 2)[6]. However, in terms of CERs, 63% is accounted for by large-scale projects as compared to 37% by the smaller scale activities. Seres (2008) finds that projects that claim technology transfer are, on average, substantially larger than those that make no technology transfer claim. In the Indian context therefore it is not surprising that technology transfer has been limited.

Table 2. Clean Development Mechanism Projects (Host country approvals as on November 1, 2009)

Activity Scale	No. of Projects	Proportion of Projects	CERs up to 2012	Proportion of CERs
Large	357	24 %	391237336	63 %
SSC	1107	76 %	224385902	37 %
Total	1464	100 %	615623238	100 %

Source: Ministry of Environment and Forests, Government of India

An examination of data on PSU and non-PSU categories shows that the distribution of CDM projects between the two categories differs substantially.

Table 3 shows that public sector CDM projects accounted for only 7.6% of the total number of projects. These units accounted for 11% of the total CERs. A more detailed analysis at the sectoral level reveals interesting differences between the public and private projects.

Table 3. CDM projects accorded by National CDM authority

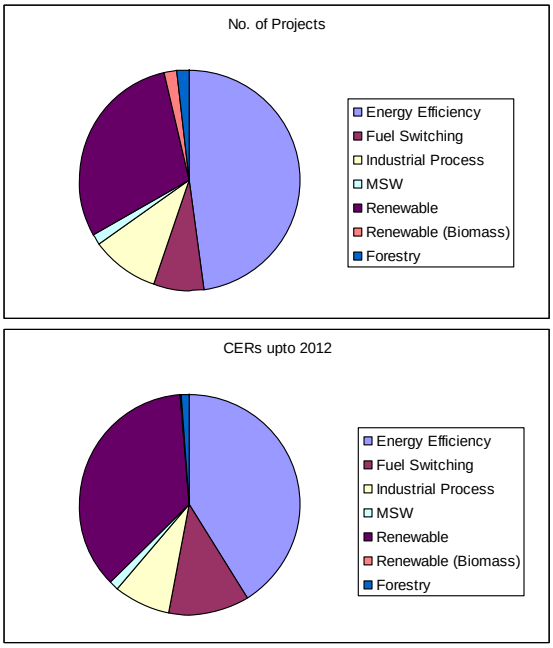
Sectors	No. of PSU Projects	PSU CERs up to 2012	No. of Non-PSU Projects	Non-PSU CERs up to 2012
Energy Efficiency	53 (48%)	28095142 (41%)	392 (29%)	191118729 (35%)
Fuel Switching	8 (7%)	8035130 (12%)	69 (5%)	52456169 (10%)
Industrial Process	11 (10%)	5618915 (8%)	54 (4%)	99337528 (18%)
MSW	2 (2%)	1030246 (2%)	31 (2%)	10228609 (2%)
Renewable	33 (29%)	24706009 (36%)	459 (34%)	97482712 (18%)
Renewable (Biomass)	2 (2%)	111658 (0%)**	341 (25%)	89362678 (16%)
Forestry	2 (2%)	808870 (1%)	7 (1%)	7230843 (1%)
Total	111 (100%)	68405970 (100%)	1353 (100%)	547217268 (100%)

Source: Ministry of Environment and Forests, Government of India

Note: All figures have been rounded off. Figures in parentheses are percentage of total

** 0.2%.

Graph 1. CDM projects from Public Sector Units



The data reveals that in the public sector the maximum number of projects are in energy efficiency, followed by renewables, not unexpectedly. The CERs also follow the same pattern in terms of ranking. Across sectors, the comparison in terms of

[6] There are specific guidelines for classifying projects as small scale or otherwise. The types of SSC include:

Type I: Renewable energy project activities with a maximum output capacity equivalent to up to 15 megawatts (or an appropriate equivalent);

Type II: Energy efficiency improvement project activities which reduce energy consumption, on the supply and/or demand side, limited to those with a maximum output of 60 GWh per year (or an appropriate equivalent);

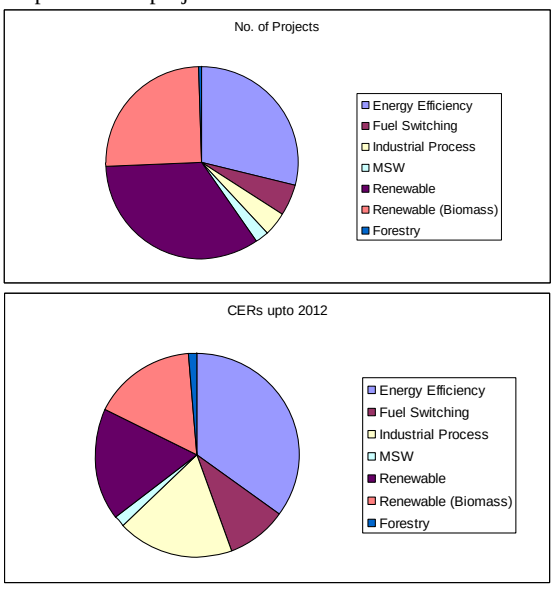
Type III: Other project activities limited to those that result in emission reductions of less than or equal to 60 kt CO_2 equivalent annually.

Source: United Nations Framework Convention on Climate Change, http://cdm.unfccc.int/ Reference/ Guidclarif/ glos_CDM.pdf)

scale of activity as represented by CERs and number of projects is represented graphically (Graph 1). Interfacing these, we compare each sector in terms of the proportion of CERs with the proportion of the number of projects. The proportionate contribution in terms of CERs is higher in fuel switching and renewable, while it is lower in energy efficiency and industrial process. MSW, forestry and biomass are negligible (between 0 and 2%) in comparison to the other sectors.

On comparing the distribution of projects and CERs for non-PSU, CDM projects across sectors; it is found that in the non-PSU projects, renewables and energy efficiency are the two major sectors in terms of number of CDM projects as is the case in the PSU projects. Renewable biomass also constitutes a major sector in terms of number of non-PSU projects. As Graph 2 reveals, more interesting findings are revealed when the CERs across sectors are compared. Our findings suggest that the proportionate contribution in terms of CERs is higher in energy efficiency, fuel switching and industrial processes, while it is lower in the rest, except for forestry.

Graph 2. CDM projects from Private Sector Units



Comparing across PSU and non-PSU projects we find that three core sectors where maximum gains are to be made for climate change mitigation purposes viz., energy efficiency, fuel switching and industrial process, have in fact been using the CDM more effectively than the others. In terms of improving production efficiency for climate change mitigation, these three sectors are obviously critical and the CDM with its financing potential has made an obvious difference, particularly for the non-PSU projects. The proportion of large scale projects is also higher.

One of the oft-repeated criticisms of the CDM mechanism has been its limited impact on north-south technology transfer. Our analysis suggests that the CDM has been used effectively as a financial instrument in transfer of technology domestically, within the economy[7]. While this can be seen as its shortcoming, it also provides learning from an incentive perspective. Essentially the CDM seems to have served as a risk-mitigating instrument, with the revenue generated from CDMs providing a financial cushion for entrepreneurs to upgrade technology. Criticisms of CDM have also revolved around the fluctuations in the price of carbon, and the consequent weakening of the smooth functioning of the incentive mechanism with transaction costs exceeding carbon prices at the margin at times for entrepreneurs.

It may be noted that a project design document that describes the proposed CDM has to be validated by an independent "designated operational entity" (DOE) to ensure that it meets all of the requirements of a CDM project. Since CDM projects in India are mostly small scale, the burden of high transaction costs would expectedly fall on them. To sum, it is generally agreed that although there have been instances of innovation (e.g. in the case of Thermax small gasifiers), what CDM seems to have facilitated most was the mass deployment of technology that was more energy efficient than the existing baselines. Focused effort can now be geared towards greater technology transfer particularly by large firms.

While there has been much discussion on the limitations of CDM and on improving the nitty gritties of its design principles, key questions that need to be raised in the context of trade and technology transfer need to be actually placed within a broader framework.

5. Role of Technology Transfer in Reducing India's Export Vulnerability

Some countries, such as France, Germany and the United States have raised concerns about the adverse consequences of imposing a cap and trade system or a straight forward carbon tax on their domestic production in order to cut down on emission levels. Domestic producers would face higher costs and industry would be at a competitive disadvantage as imports from countries that do not have such carbon tariffs would be relatively cheaper. To offset such a disadvantage climate tariffs on imports have been proposed from time to time. The economic rationale for a tariff to protect the competitiveness of domestic industry can take the form of a border tax type adjustment measure[8]. However

[7] As per one estimate the total monetary value from CERs stands at US $ 700 million, notwithstanding the carbon price fluctuations.

[8] These have been much debated upon as they pose huge implementational challenges apart from legal and ethical arguments.

the imposition of such a measure on a developing country could adversely impact its exports. An internationally negotiated treaty on technology transfer from the developed to the developing countries could mitigate climate change without causing such adverse impacts and would greatly reduce adjustment costs for developing countries.

A mapping of the export profile of India's key energy intensive sectors indicates the extent to which these exports are vulnerable to trade measures if they are implemented. The purpose is also to examine the major countries to which such exports are destined. The sectors considered include iron and steel, chemicals, cement, paper and aluminum.[9] Trade data from the Directorate General of Foreign Trade (DGFT) reveals that these products accounted for 17.9% of India's total exports in 2007-08 (Table 4)[10]. The two main products - chemicals and iron and steel accounted for 9.6% and 7.2% respectively. The other energy intensive products accounted for less than 1% of India's exports (Table 4). Further, an examination of major markets for chemical and iron and steel products reveals that the U.S. is the largest market for both these products. The U.S. accounted for 14.7% of India's exports of chemical products while it accounted for 16% of India's exports of iron and steel (Tables 5 and 6).

These export statistics give an idea of the extent of vulnerability that Indian exports are likely to face if the developed countries impose trade measures. While chemicals and iron and steel are the two main products that are likely to get affected, the US is the main market for these two products. It may be reiterated that this exercise is merely indicative and does not consider the mechanism through which our exports are likely to get impacted. However implementing such a mechanism itself may be a cumbersome affair and outcomes could be "messy" (Subramanian *et. al*., 2009).

Table 4. India's Export of Selected Carbon Intensive Products (2007-08)

Product	US $ Million	% Share
Chemicals	15558	9.5
Iron & Steel	11771	7.2
Aluminium	1124	0.7
Paper	487	0.3
Cement	204	0.1
Rest	151217	82.2
India's Total Exports	162988	100.0

Source: DGFT

Table 5. Direction of India's Exports of Chemical Products (2007-08)

Country	US $ Million	% Share
USA	2285	14.7
China	802	5.2
Germany	793	5.1
Pakistan	575	3.7
Indonesia	540	3.5
Top Five Countries	4995	32.1
World	15558	100.0

Source: DGFT.

Table 6. Direction of India's Exports of Iron & Steel (2007-08)

Country	US $ Million	% Share
USA	1888	16.0
UAE	780	6.6
Belgium	658	5.6
Italy	535	4.5
Germany	441	3.7
Top Five Countries	4302	36.6
World	11771	100

Source: DGFT

The exercise above takes into account broad product categories of the Harmonized System of product classification. Real impacts would depend on the specifics of the trade measures whether in the Waxman-Markey Bill or otherwise. Further, if such measures were to become effective, a full costing of the burden would include cascading effects in the economy such as on employment, foreign exchange earnings and forward and backward linkages with other sectors.

6. Technology transfer for tackling Climate Change: Policy recommendations for India

In the discussion above it has been argued that existing agreements under the multilateral trading

[9] Cement: HS Code 2523; Portland cement, aluminous cement, slag cement etc & similar hydraulic cements w/n clrd/in the form of clinkers.
Chemicals: HS Chapters 28 to 38. Inorganic chemicals; organic or inorganic compounds of precious metals, of rare-earth metals, of radioactive elements or of isotopes; o; pharmaceutical products; fertilizer; tanning or dyeing extracts; tannins & derivatives; dyes, pigments & coloring matter; paint & varnish; putty & other mastics; essential oils and resinoids; perfumery, cosmetic or toilet preparations; soap; waxes; polish; candles; modeling pastes; dental preparations with basis of plaster; albuminoidal substances; modified starch; glues; enzymes; explosives; pyrotechnic products; matches; pyrophoric alloys; certain combustible preparations; photographic or cinematographic goods; miscellaneous chemical products.
Paper: HS Codes 48. Paper and paperboard; articles of paper pulp, of paper or of paperboard.
Iron and Steel: HS codes 72 and 73; Iron and steel and products of iron and steel.
Aluminum: HS code76. Aluminium and articles thereof.

[10] Subramanian *et. al.* (2009) state that steel, cement, aluminum, paper and chemicals account for 6.4% of India's exports. They however do not mention the product codes that they have considered to arrive at the export figures.

system such as the *Technical Barriers to Trade Agreement* have allowed Members to impose environmental standards on domestic and imported goods for environmental protection. Technical assistance from developed countries has been very limited largely due to the non-mandatory nature of the provisions in the agreement. While the burden of costs to meet standards has been borne by private entrepreneurs, there is now evidence of firms adopting a third generation corporate social responsibility where environmental and social concerns are factored in at the starting point of business. All WTO Members have been able to cope with the requirement of the Trade Policy Review Body to report their trade reform measures that are evaluated[11].

Among the mechanisms that were provided for under the *Kyoto Protocol*, the CDM has played a positive role as a financial instrument that serves to mitigate risk. The CDM has played a role in transferring easily available technology within the economy. Its role in transferring superior technology from developed countries to India has been limited. The CDM projects are mostly small scale projects. Since technology transfer is more likely to take place in large firms than in small firms, limited technology transfer in India through the CDM has been inevitable. The role of public sector in CDM projects has been limited. However, actors in the private sector have been using the CDM mechanism quite effectively for mitigation in three important sectors - energy efficiency, fuel switching and industrial processes.

The energy intensive sectors - chemicals, iron and steel, cement, paper and aluminum account for about 17.9% of India's exports. Two major products-chemicals and iron and steel account for 16.8%. The U.S. is the most important market for these two products accounting for 15.3% of total exports. Thus, if trade measures are indeed being contemplated then Indian exports are vulnerable particularly in the U.S. market.

The above analyses lead to some key recommendations on technology transfer for adopting a low carbon growth path for the Indian economy.

The limited extent of technological assistance from the developed countries justifies the call for a separate technology transfer mechanism. India's submissions on a technology transfer mechanism and the call for a Multilateral Climate Technology Fund to be operated under the supervision of the Conference of Parties deserves strong support. It is envisaged that a *Technology Action Plan* would accelerate research and invention and technology transfer through cooperation, and ensure its financing. The establishment of the Technology Mission under the Copenhagen talks to accelerate technology development and transfer in support of action on adaptation and mitigation that is guided by a country-driven approach (Report, 2010, #11, p. 7) holds promise as a positive development.

If such a mechanism involving transfer from the developed to the developing world does work out, the issue that would have to be tackled is whether developing countries should agree to a standardized MRV process across projects for mitigation activities. Experience with existing arrangements under other treaties suggests that the Indian economy is in a position to cope with these requirements.

Co-operative arrangements for making available, at affordable rates, even technology that is partly government owned is unlikely to be an easy task. The main challenges with regard to transfer of technology are likely to persist, since the majority of these are in the private domain. Past commitments made by developed countries to their domestic constituencies to protect IPRs may make consensus on transfer of technology mechanisms difficult to achieve. While the *Technology Action Plan* refers to the resolving of barriers posed by IPR and licensing of patented technologies, the scope for international action on public domain technologies and co-operation on development of future technology holds out more hope (Government of India…, 2010).

Large scale CDM projects in India need to be encouraged since they are likely to bring in foreign technology. India should therefore seek to give its due to the Indian entrepreneur, and given that compliance costs need to be borne by them, financial mechanisms should also be strengthened. CDM projects need to be encouraged in the public sector through greater awareness and a more active role by government. Private sector participation in sectors such as energy efficiency, fuel switching and industrial processes needs to be encouraged. The focus of policy making should be on improving CDM designs and processes to facilitate technology and financial transfers on a larger scale. This should be pursued simultaneously with efforts to develop more effective technology transfer mechanisms.

[11] India has suggested that the frequency of international consultations and analyses for activities which are supported by international financing/technology under the UNFCCC arrangements, could be graded. This is similar to the trade policy review process under the WTO which is graded depending on the share of world trade. Source: *Remarks of Shri Jairam Ramesh, Minister of State (Independent Charge) Environment and Forests,* Government of India at the 6th MEF meeting, Washington D. C. April 18th, 2010. Communication from MoEF, GOI.

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