The Clean Development Mechanism and Sustainability in the Transportation Sector

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ABTRACT

The Clean Development Mechanism (CDM) is a program under the Kyoto Protocol designed to help developing countries reduce their greenhouse gas (GHG) emissions. The program was originally adopted to reduce the cost of compliance for Annex I countries and, as a result, has failed to foster renewable, transportation-related, or small projects that have uncertain gains for Annex I countries. The fundamental question is whether or not the CDM can incentivize sustainable development, especially in terms of GHG reductions, in the ever-growing transportation sector of the developing world. Among the various transportation projects, fuel switch and mode switch projects are the most common options in the CDM, mainly because travel activity, vehicle efficiency and occupancy, and infrastructure investments are too broad for a project-based approach. A sectoral approach or Nationally Appropriate Mitigation Actions (NAMAs) could provide a better fit for transportation policies; however, probably due to its more complex structure, no sectoral transportation option has been approved in the CDM. This paper reviews and critiques the CDM, and considers modifications to improve the program in these contexts.

Keywords: The Clean Development Mechanism, Sustainability, Developing countries, Greenhouse gases.

INTRODUCTION

The transportation sector's share of world-wide greenhouse gas (GHG) emissions is estimated at about one-fourth of the total and is expected to be the most rapidly growing sector in the next decades (1). The growth is not distributed evenly, and its main source is developing countries. Between 1970 and 2001, motorized mobility (in terms of passenger-kilometers) has risen by 888% in India, about 7.8% average annual growth rate, with only 88% population growth in the same period (2). Average annual transport energy growth rates are estimated at 4.2% for China, 3.6% for India, and 3.2% for Africa while the figure is 0.9% for Organization for Economic Co-operation and Development (OECD) Europe and 1.2% for OECD North America for the 2000-2030 time period (3). By 2020, road infrastructures are estimated to rise by 80 percent in low- and middle-income countries (4), and by 2030, more than half of all vehicles in the world will be in non-OECD countries (5).

On the other hand, the shares of transportation modes with higher GHG emissions, especially private cars, are growing in developing countries. In India, the road share in passenger mobility increased from 35% in 1950-1951 to 87% in 2000-2001 (2). In addition, the developing world's large cities are already jammed with vehicles. Seventeen percent of all registered cars in China are located in Beijing, Shanghai, Chongqing, and Tianjin (6). Finally, highly polluting used cars have higher shares in some developing countries. For example in Peru, 70% of the vehicle ownership annual growth has been from used vehicles discarded from countries like the U.S. (7).

According to the Kyoto Protocol, the Clean Development Mechanism (CDM) can reduce the costs of complying with the Annex I countries' targets through investing in projects aiming to reduce GHG emissions in developing countries. While the Kyoto Protocol specifies that the CDM projects must help host countries achieve sustainable development and must produce "real, measurable, and long-term" climate change mitigation (8), a large proportion of the Clean

Development Mechanism (CDM) projects has few direct environmental, economic, or social effects other than GHG emission mitigation (9-10).

In fact, the program has failed to foster certain types of projects: renewable, transportation related, energy demand management, and small projects. Part of the reason for this failure is the high transaction costs, the slow approval process, the uncertainties about the future of the market, and the lack of necessary institutions in host countries (11-12). However, the main reason lies in the basis of the program. The CDM promotes a market that aims to provide developed countries with the least costly options to comply with their Kyoto targets. Therefore, the program fails to support the projects with co-benefits other than GHG emissions reduction, especially in the transportation sector (13-14). The failure of the program to actively involve developing countries is another concern. The Energy Information Administration (15) reports that developing countries emitted approximately 60% of global CO_2 in 2010, but the estimated annual emission reductions through the CDM account for just 1.50% of total annual CO_2 emissions in 2010 (16). But modified or used efficiently, the program is capable of providing funds for the transportation sector projects while reducing GHG emissions.

The answer to the question of whether the CDM can incentivize GHG reductions in the developing world is not clear. Is it possible to effectively use or modify the program to reach the sustainability goal, especially in the transportation sector? How can the CDM address sustainable transportation in the developing world? What are the main problems resulting in low approval of transportation projects? What will the future of the program be? How can the CDM be modified? This paper attempts to answer these questions in detail.

The remainder of the paper provides a background of the GHG emissions from transportation in developing countries and the policies to address the emissions. The next section presents the CDM in detail, reviewing its development and procedures. Afterwards, the transportation projects in the program pipeline, the transportation fit into the program, and the possible modifications to the CDM or probable new structures are discussed. Finally, conclusions summarize the main points.

POLICIES AND STRATEGIES TO REDUCE GHGS

One of the main problems of climate change policies for transportation is that GHG emissions from the sector are very difficult to control/measure. This is due to: highly dispersed emission sources i.e. individual vehicles, long chain of decisions and processes, institutional complexities, and less carbon-intensive energy substitutes (17-18). Six fundamental strategies have been proposed to reduce GHG emissions from the sector. Each strategy can be pursued through three general categories of policies and instruments (18). Table 1 summarizes these strategies and the policies and instruments in detail. A wide range of policies is available but an integrated approach is the key to success.

TABLE 1. Strategies, policies, and instruments to reduce GHG emissions from transportation.

		Type of policy or instrument		
		Regulation	Market-based Instruments	Direct Investment
Strategy	Vehicle Efficiency	Performance standards such as the U.S. CAFE40 standards	Febate system, Fuel tax	R&D investment in vehicle efficiency
Strategy	Roadway Infrastructure	road quality standards, signal coordination	Private roads	Capacity enhancement of roadways
Strategy	Fuel Choice	Mandates requiring some fleets running on special fuels	Subsidies or taxes for some fuels	Investment in R&D and marketing of alternative fuels
Strategy	Mode Choice	Bans on private vehicles entrance to city centers	Parking fees, roadway tolls, subsidies for transit riders	Investment to improve the quality of transit service
Strategy	Travel Activity	Mixed use zoning, no drive days	Market incentive for high density development	Investments in optimizing goods logistics
Strategy	Vehicle Occupancy	Laws prescribing number of passenger per vehicles	Incentives for carpooling	Investment in intermodal freight centers

In addition to implementing these policies, measures to calculate the effects of policies are required. Schipper et al. (19)'s "ASIF", implemented in the CDM calculations, provides an important framework to understand the determinants attributing to the transportation emissions. Energy use in transportation and respectively its GHG emissions is a function of total activity (A), mode share (S), fuel intensity (I), and fuel type (F). Each of the mentioned policies and strategies tries to influence one or more of these components. Ultimately, a comprehensive plan for transportation requires intervention in all the components.

Nearly all of the strategies to reduce GHGs induce co-benefits. Many of them meet the local transportation needs through local pollution reductions and higher quality services. Some of them, especially fuel switch and fuel efficiency, are in line with energy security policies. While these policies often offer significant co-benefits, their financing and political acceptance has been a problem especially for developing countries. Finding a source of funding, e.g. form the CDM, can be a great driver for these policies and investments.

CDM UNDER THE KYOTO PROTOCOL

Emission Reduction Mechanisms

Concerns have grown about climate change in recent years. The developed world has been constantly blamed for its high GHG emissions but the developing world's share is growing at much higher rate. An international movement involving all countries and supported by effective mechanisms seems essential. These mechanisms should be able to control GHG emissions in an efficient flexible way, simultaneously promoting equity. Two main available broad options are: carbon tax, and carbon market. Regardless of which option to chose, decisions about the point of regulation (consumers or suppliers) and the sectors to be covered should be made.

Although the point of regulation and the sector coverage can affect the option(s) to choose, other forces are more influential. The Carbon market option is usually preferred in an international base, such as the European Union Emissions Trading Scheme (EU ETS). The political concerns were the main rationale in the European Union (EU) decision to choose a carbon market over a carbon tax: The tax requires unanimity. The carbon tax could completely fail if a single country did not accept the tax (20). In addition to unanimity, the carbon tax may need good measures of elasticity to function. In contrast, a cap and trade carbon market cannot be stopped by a single country and is free of elasticity calculations. However, a carbon market needs cautious framework construction. A new commodity, emission allowance, should be carefully defined and allocated to the market.

The main strength of carbon markets is their flexibility. One of the flexible options provided is emission offsets from outside of the market. The offsets can provide a lower cost emission reduction opportunity from verified projects (21). Theoretically, the offsets can contribute to sustainable development goals by supporting environmentally friendly projects.

The CDM

Carbon transactions are purchase contracts by which one entity agrees to pay for the GHG emissions reduction of another entity as a way to meet its own GHG emissions reduction commitments. Under the CDM, buyers purchase credits from a project that can verifiably demonstrate GHG emissions reduction compared to do-nothing trends (22). These verified reductions are called Certified Emission Reductions (CERs), which can be produced potentially from any sector. Only CERs are approved that are additional to any emissions reduction that would occur in the absence of the project (8). In addition, the CER calculations have to include leakage- changes in emissions outside the project boundary.

The CDM market is regulated by the United Nations Framework Convention on Climate Change (UNFCCC). Figure 1 shows the common CDM project cycle from submission to CER issuance. After receiving Project Identification Note (PIN), the project should be designed in a specific format defined in the Project Design Document (PDD). Projects can either use an approved CDM methodology or develop a new methodology, when the project does not fit any existing methodology. A Designated Operational Entity (DOE) validates the PDD. Meanwhile the project should be nationally approved by the host country's Designated National Authority

(DNA). Then the Executive Board (EB) of the CDM project validates and registers the project. The project owner should monitor emissions reduction, which is later verified by a DOE. Finally, the EB issues the CERs. The CERs can only be sold at the end of this cycle. The process can take as low as 1 year and as much as 2 years if a new methodology is proposed while the total cost of the cycle ranges from $50,000 to $1.3 million depending on the size of the project. Recently, the average length of the process has been increased as a result of tighter regulatory process (23-24).

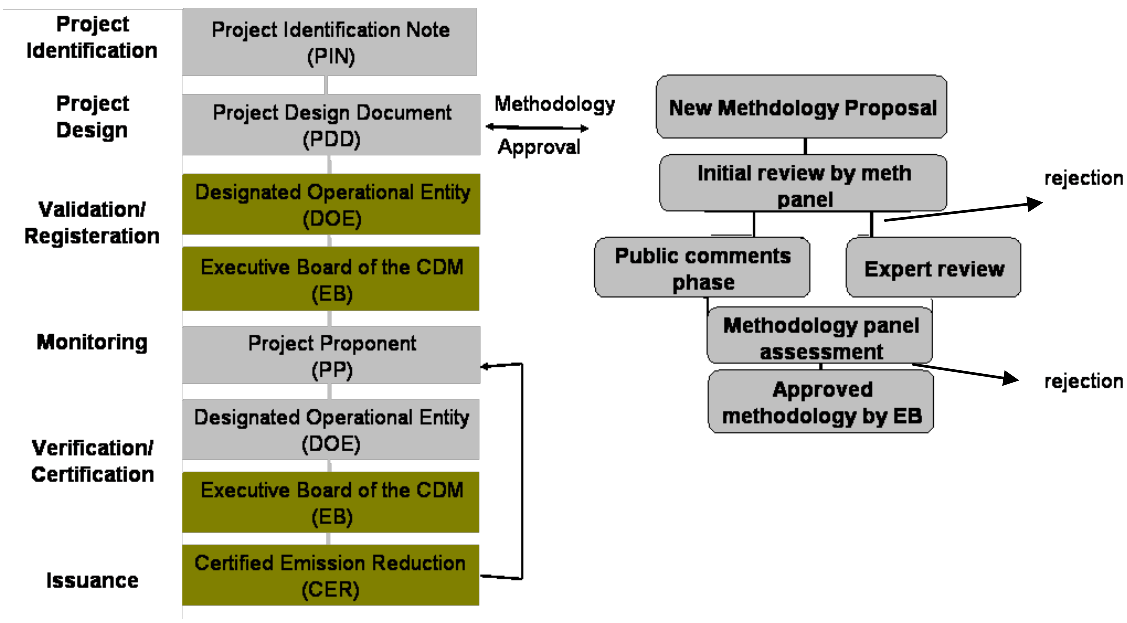

FIGURE 1. CDM project cycle.

Figure 2 shows the distribution of all the 4277 registered CDM projects (as of June 2012) by host party, scope, and CERs (16). China is the leader in terms of the number of projects (48.8% of total) and also dominates the market in terms of CERs and transaction values (63.7% of total). The EU and Japan were the main buyers, largely through their private sector; 78% of the market share was private buyers in 2007 (25). While the energy sector has the highest number of projects, gas-capturing (especially HFC destruction) projects are financially dominant. Over time, the share of transactions from renewable energy, energy efficiency, and fuel-switching projects increased, with the energy efficiency share jump being the highest. As of June 2012, only fifteen transportation projects were approved out of 4277 registered projects (16).

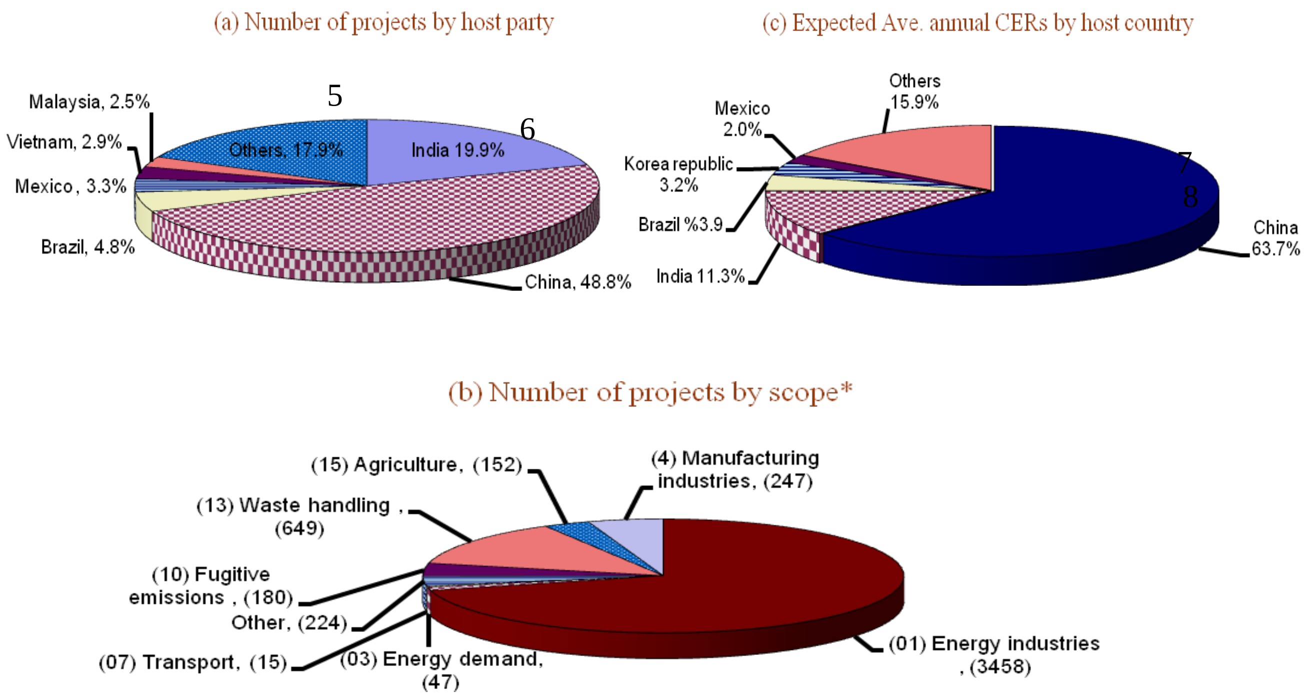

FIGURE 2. Distribution of all registered project activities (data source: UNFCCC(16)).

***Note: A project can be registered in more than one sector.**

Table 2 shows the volumes, values, and average prices of transactions from 2005 through 2011. The carbon market grew very fast during 2005-2008 era but the growth has slowed down latter while the CDM market grew with a lower pace and even shrank from 2007 to 2011 (volume and value). In 2005 and 2011, the total value of the transactions was about US$2.4 billions and US$3 billions respectively for the CDM market. The market value had a pick in 2007 and then started to shrink. On the other hand, the average price of a ton of CO_2-equivalent emission fluctuated in the EU ETS and significantly decreased recently, but the price increased over time for primary CDM projects and recently decreased as a response to the EU market price decline. Nevertheless, short run CDM market prices are relatively stable despite the high volatility in the EU ETS. The main reason is the market power of China and its minimum price floor (22). In 2011, the average price of a ton of carbon on the primary market slightly decreased, reached the US$11/ton of CO_2 (26).

TABLE 2. Carbon markets in 2005-2011 (data sources: 22, 26, and 27).

Market	Year	Volume (M t CO2e)	Value (M US$)	Ave price (US$/t CO2)
EU ETS	2005	321	7,908	25
	2006	1,101	24,357	22
	2007	2,060	49,065	24
	2008	3,093	91,910	30
	2010	6,789	133,598	20
	2011	7,853	147,848	19
Primary CDM	2005	341	2,417	7
	2006	450	4,813	11
	2007	552	7,433	13
	2008	389	6,519	17
	2010	224	2,675	12
	2011	263	2,980	11
JI	2005	11	68	6
	2006	16	141	9
	2007	41	499	12
	2008	20	294	15
	2010	41	530	13
	2011	28	339	12

TRANSPORTATION AND THE CDM

Transportation Projects in the CDM

Although the CDM has been a relatively popular tool (as of June 2012, 2.15 billion CERs are registered for 4277 projects), only fifteen transportation projects have been approved. Table 3 shows some of the proposed and all of the approved transportation-related projects. No project is proposed in the roadway infrastructure and vehicle occupancy fields. Few mode switch and fuel switch projects, two vehicle efficiency projects, and one travel activity project are proposed, and among them, only twelve mode switch, two vehicle efficiency, and one fuel switch projects were approved until June 2012 (16). Another important note about the table is that the expected CERs from transportation projects are considerably lower than the average CERs for all projects. The dominant project type is the Bus Rapid Transit (BRT) projects along with two metro projects, one cable car project, one alternative fuel production, one mode shift from car to train, and one efficiency improvement in metro system project.

TABLE 3. Proposed and approved CDM transportation projects (data sources: 16, 23, 28-29).

Project title	Host	Scope	Status	Expected CERs
Urban Mass Transportation System, Bogota	Colombia	Mode switch	Rejected	-
Khon kaen fuel ethanol project from sugarecane	Thailand	Fule switch	Rejected	401,960
Auto LPG fuel	India	Fuel switch	Rejected	2,542,723
Bus Rapid Transit (BRT), Bogota	**Colombia**	**Mode switch**	**Approved-2006 AM0031**	**246 563**
Biodiesel in transport sector	India	Fuel switch	Rejected	120,696
Modal shift of product transport road to sea	Brazil	Mode switch	Rejected	47,172
Biofuel production-biodiesel from sunflower	Thailand	Fuel switch	Rejected	442,170
BRT project, Lines 1-5 EDOMEX	**Mexico**	**Mode switch**	**Approved-2011 ACM0016**	**145,863**
Biolux Benji Biodiesel project, Beijing	China	Fuel switch	NA	123 211
Cosipar- modal shift of product transport	Brazil	Mode switch	Withdrawn	47 172
Behavior-oriented demand management-Ecodrive	Thailand	Travel activity	Rejected	-
Emission reductions by low-greenhouse gas emitting vehicles	**India**	**Vehicle efficiency**	**Approved-2007 AMS-III.C. ver.**	**41,160**
Cable CARS Metro Medellin	**Colombia**	**Mode switch**	**Approved-2010 AMS-III.U.**	**17,290**
BRT Chongqing Lines 1-4	**China**	**Mode switch**	**Approved-2010 AM0031 Ver. 3**	**218,067**
Plant-oil production for usages in vehicles	**Paraguay**	**Fuel switch**	**Approved-2010 AMS-III T.**	**17,188**
Modal Shift from road to train for transportation of cars	**India**	**Mode switch**	**Approved-2011 AMS-III.C. ver.**	**23,001**
BRT Zhengzhou	**China**	**Mode switch**	**Approved-2011 AM0031 Ver. 3**	**204,715**
Metro Delhi	**India**	**Mode switch**	**Approved-2011 ACM0016**	**529,043**
BRT Metrobus Insurgentes	**Mexico**	**Mode switch**	**Approved-2011 ACM0016 Ver. 2**	**46,544**
Mumbai Metro One, India	**India**	**Mode switch**	**Approved-2011 ACM0016 Ver. 2**	**195,547**
BRT Transmetro Barranquilla	**Colombia**	**Mode switch**	**Approved-2011 AM0031 Ver. 3**	**55,828**
BRT Macrobus Guadalajara	**Mexico**	**Mode switch**	**Approved-2012 AM0031 Ver. 3**	**54,365**
MIO Cali (BRT)	**Colombia**	**Mode switch**	**Approved-2012 AM0031 Ver. 3**	**242,187**
BRT Metroplus Medellin	**Colombia**	**Mode switch**	**Approved-2012 AM0031 Ver. 3**	**123,479**

NA: Not Available
* There is one biofuel production project based on cooking oil wastes which is categorized in the chemical sector.

As an alternative to the CDM, the Global Environmental Facility (GEF) can also finance transportation projects. Similarly, transportation is one of the least addressed sectors by the GEF (30).

Switching Modes or Switching Fuels?

Switching mode and switching fuel projects are the most common options in the CDM pipeline. Table 4 shows some of the potentials of switching modes (31). The difference in emissions between these modes is huge. The GHG emissions of cars are close to 10 times those of a BRT system while the best present fuel switch, like from gasoline to natural gas-derived hydrogen, leads to no more than a 200% decrease. The vehicle occupancy change also cannot offer a reduction as high as offered by mode switch. However, the mode switch option may require combination of policies from direct investment in modes with lower GHG emissions to demand management (curbing private car use and making behavioral changes).

TABLE 4. CO_2 per passenger-km for different modes (data source: Wright and Fulton(31)).

Mode	Load factor	Fuel consumption (liter/100km)	CO_2 (gr) per passenger Km
Car	1.5	10.8	174
Minibus	20	30.3	43
Motorcycle	1	2.2	53
Taxi	2	10.8	130
BRT	100	64.1	18

* It is assumed that Cars, Motorcycles, and Taxis use Gasoline and that Minibuses and BRTs use Diesel.
** It is assumed that gasoline contains 2.42 CO_2 (kg)/liter and that Diesel contains 2.87. Note that this is low because life cycle emissions have not considered in these figures.

To analyze the policy options, the costs of a project should be considered along with the reduction benefits. Table 5 summarizes the costs per ton of reducing CO_2 emissions (leverage factor) for some scenarios in the city of Bogota, Colombia (31). It should be noted that co-benefits are not considered in the calculation. The costs of fuel switch scenarios are much higher than those of mode switch ones. The bicycle switch scenario has the lowest cost but the package scenario leads to lower shares for cars and minibuses and the resulting benefits of lower gas consumption and pollution. Thus, the package might be preferred. In fact, part of mode-shift projects' costs can be (partially) offset through the CDM especially with the present prices-US$11/ton. However, fuel switch scenarios are probably inevitable in the long term due to energy security considerations and limited fossil fuel even though they suffer from commercialization uncertainties.

In conjunction with mode switch and fuel switch projects, land use planning and other approaches has the potential to be adopted into the program (32). In another study, Zegras (17) reviewed three case studies for the city of Santiago, Chile: a feeder bus technology switch, a bicycle switch, and land use planning. Respectively, the estimated leverage factors are –US$80, US$30-118, and US$2 (considering the possible co-benefits while the projects in Table 5 do not include co-benefits). The study shows the emissions reduction potential of land use planning projects in the CDM and the attractiveness of the feeder bus option irrespective of the CDM support. Nevertheless, mainly mode switch projects with small CERs have been approved so far while land use planning, travel activity/demand management, and infrastructure investment related projects are certainly capable of providing long term emissions reductions along with sustainable improvements.

TABLE 5. Cost of fuel and mode shifts per emission reductions (Bogota, Colombia) (data source: Wright and Fulton (31)).

Targeted mode	Scenario	Costs (U.S. 1000$)	Estimated costs per CO_2 reduction (U.S.$/ tone CO_2)
Bus	Fuel switch to natural gas	Incremental vehicle cost: 20-30/ km Refueling infrastructure costs:10-20/ vehicle	442-infinite**
Bus	Fuel switch to hybrid electric	Incremental vehicle cost: 65-100/ km Refueling infrastructure costs: 0	148-1942
Bus	Fuel switch to fuel cell	Incremental vehicle cost: 250-1000/ km Refueling infrastructure costs:20-50/ vehicle	463-3570
BRT	5-10% switch to BRT	Infrastructure costs: 125,000-250,000	55-66
Walking	Share increase from 20 to 25%	Infrastructure costs: 60,000	17
Bicycle	Share increase from 1 to 5-10%	Infrastructure costs: 30,000-60,000	14-15
BRT, Walking, Bicycle	Shares: BRT 10%, walking 25%, bicycle 10%	Infrastructure costs: 370,000	30

* Base case shares: car: 20%, motorcycle: 4%, taxi: 5%, minibus: 50%, BRT: 0%, walking: 20%, bicycle: 1%
** No CO_2 reductions.
*** The table only accounts for the costs while large benefits are resulted from less fuel consumption and less pollutions.

Matching the CDM and Transportation Projects

Any CDM project proposal must use an approved methodology or provide a new one. At least seven large-scale transportation and nine biofuel production methodologies have been proposed and only three transportation-related and one biofuel methodology (in the chemical sector) have been approved until June 2012 (16). The success rate for transportation-related methodologies has been lower than the average rate due to the methodological complexity of the sector's projects. Monitoring requirements are one of the main problems due to the difficulty of gathering information from highly dispersed sources (23 and 33). Zegras (17) points to some other transportation-specific methodological problems:

- Baseline problem: difficulties in the estimation at present and, consequently, the future.
- Leakage: boundary or rebound effect problems; project-induced activities outside the projects' boundaries, e.g. additional personal car use due to the reduced congestion yielded by a new mass transit project.
- Institutional complexities: overlapping institutions, unclear authority, plans, and programs.

Baseline estimation is needed to calculate present GHG emissions, and post-project emissions are subtracted from the baseline (34). The high uncertainty of the forecasts, institutional incapability, trustworthiness of data, and the expense of data collection are problematic. Baseline standardization can partially solve this problem through reducing the cost of creating the baseline and lowering fraud and mistake possibilities (35). As a pioneer in this area, Salon (36) tried to identify opportunities for the standardization in the transport sector. Baseline estimation, as the core of the CDM project design, is still a big challenge to transportation projects seeking approval. Eichhorst et al. (37) also explored the concept of standardized baselines for CDM in the transport sector using BRT as a case study examining the suitability of different ASIF elements for standardization and the similarity and differences of existing methodologies. The authors suggested some further development for standardized baselines. Nevertheless, only three transportation methodologies have been approved.

Leakage refers to the net GHG emissions change outside the projects' boundaries. Transportation is linked to almost all economic activities. This makes estimating the leakage a huge challenge. The examples of leakage in transportation are (23):

- Construction-related emissions.
- Emissions due to additional travel resulting from providing better service.

Institutional complexity is another concern. In most countries, the transportation sector is formed by different inter-related institutions with overlapping obligations. Even determining the project owner who receives the CERs is a challenge. In the TransMilenio case, the municipality that makes the final decision about implementing the system is specified as the owner. But central governments, financial institutions (as the main source of funding), operators, and even customers can also be considered as the owner (23). Another problem results from the planning conflicts between these institutions. However, a methodology that includes a clear framework for considering common problems has a higher chance of approval.

Using an approved methodology, projects in areas other than mode switch, fuel switch, and vehicle efficiency can be adopted for the CDM. Land-use planning, congestion pricing, travel behavior management, car sharing, and system efficiency are other possible areas. As an example, Pokharel (38) suggests using a trolley bus system and replacing diesel vans with electric vehicles for Nepal. Even setting standards or providing subsidies can be qualified for the program. In spite of Gruter's prediction (23) of approval of new transportation project types, the main approved projects are BRT projects, while only one biofuel project in small scale and two metro projects have been approved. In total, only three methodologies have been approved in the transport sector.

Theoretically, setting standards or providing subsidies could qualify for the program. The key to a successful methodology is showing that the project is additional (would not occur without the CDM's help), that special care is given to the leakage problem and baseline calculation, that the sustainability goal is considered, and that the project can be monitored using some parameters (24).

From a broader perspective, a CDM project might include sectoral approaches. In transportation, the sectoral approach can tackle the methodology requirements while including broader activities with deeper impacts (39). The UNFCCC decided that "Project activities under a program of activities" can be registered as a single project (40). Later, the CDM EB included programmatic projects which implement a policy, standard, or a stated goal (41). As a result, a transportation master plan can also qualify for the program. The sectoral approach is one of the suggested mechanisms for developing countries to adopt in a post-2012 climate change regime.

Similar to the sectoral approach, Nationally Appropriate Mitigation Actions (NAMAs) have been proposed to substantially reduce transportation emissions in developing countries. NAMAs are also capable of overcoming the baseline and uncertainties in estimating emissions (42-43). Dalkmann et al. (28) suggested two main advantages of sectoral approaches. First, if approved, these approaches might mitigate the methodological problems to some extent. For example, leakage problem is easier to calculate for a sector than a small project. Second, they can employ activities that cannot be implemented in a restricted local context, enabling the CDM to deeply impact long-term structural trends.

Ellermann et al. (44) proposed a sectoral approach for Beijing, China's transport based on sector no-lose targets. Although the sectoral approach seems promising, the related methodologies will become more complex and less likely to be approved (28). Millard-Ball (45) showed that large uncertainties in the regulator's predictions of the baseline can make sectoral targets an extremely unattractive mechanism in practice. Millard-Ball (45) suggested setting a generous crediting baseline but, hinted that other less efficient climate policy instruments such as grant programs can be more robust in practice. Cai et al. (46) pointed out the main problems of using a sectoral crediting mechanism: difficulties in determining a baseline, the over-supply problem in the carbon market, the likelihood that mitigation costs will be higher than carbon credits, the immature market and its misleading price signals, and inadequate capacity building.

In spite of all of the problems in registering CDM projects, local governments pursue political gains in addition to financial support through the CDM projects. A registered CDM project represents a showcase which provides political dividends and reduces political barriers (32). This circumstance might support the progress of some CDM projects in transportation while it can decrease implementation of the sustainable CDM projects with high co-benefits but low chance of approval.

CDM, SUSTAINABILITY, AND TRANSPORTATION

In general, sustainable development entails three dimensions: economic, environmental, and social sustainability or equity. With no exception, a sustainable system should provide economic efficiency, ecological stability, and social equity. A sustainable transportation system focuses on providing people access to different destinations while minimizing the negative effects of transport, maximizing economic prosperity, and promoting equity. Successful or not, the CDM goal is integrating sustainability and climate change mitigation concepts.

Although the growth in motorized vehicle ownership and use usually follows income trends, several other factors can affect this growth: regulations, vehicle fees, land use patterns, and the quality of alternative modes. As an example, Hong Kong's low level of car dependency results from strict controls on parking, the high cost of vehicles, and convenient and cheap public transportation (47). Wright and Fulton (31) note that "Developing nations can potentially leap-frog past transport-intensive stages of economic growth and proceed directly into a new, less vehicle-dependent transport paradigm" (page 695).

Policy makers' decision to follow, in extreme cases, either the path of Hong Kong transportation model or the U.S. auto centered model will be crucial. However, if developing countries follow developed countries' model of motorization, especially the US's, there will be little hope for decreasing or even stabilizing the subsequent emissions from the transportation sector worldwide.

In general, the CDM encounters many criticisms (48). Pearson (13) argues that the CDM fails to promote sustainable development. Based on his analysis, the problem is fundamental and stems from the fact that the program is basically a flexible mechanism for Annex I countries to reduce their commitment costs. This sidelines the long-term renewable or transportation projects with uncertain gains (12). Although the 2007 project approval figures show that the renewable sector's share has risen (25), it is hard to believe that co-benefits will be considered while the least cost is the goal. NGOs' Gold Standard, to support sustainable/environmental friendly projects, has the potential to become effective in this regard (49). The Gold Standard applies two additional screens to filter CDM projects for achieving sustainable development. The Gold Standard if applied can support more sustainable transportation projects. Drupp (49) showed the significant benefits of using the standard. However, the Gold Standard is a voluntary label.

CDM costs are considerable. On average, 14% of the projects' costs are dedicated to taxes and 14% to transaction costs (11). In addition, the real benefits of projects are not clear without knowing the future prices of carbon, and cost/benefit analysis based on inaccurate price signals results in implementing inefficient projects (50). Moreover, developing countries should actively set up their own climate change mitigation policies. The efforts to reduce GHGs may fail without their participation (48).

Figure 3 shows the differences in the emissions reduction shares between the CDM projects (644 registered up to 2007 (51)) and an Annex I country comprehensive plan-Italy n 2006 (52). It should be noted that the direct comparison should be done with cautious. A comparison between a master plan and a project based mechanism is theoretically wrong. However, the comparison is made to show if developing countries were to set a master plan, the plan would involve projects different from the projects that are already in the CDM.

In Italy's master plan, the transportation sector share is %15 whereas for the CDM, this figure is near 0%. It is remarkable that the transportation sector has a high share in Italy's plan given the aforementioned problems with GHG reductions in this sector. This high share is mainly due to the long-run view of a country with binding obligations. In the renewable energy and energy efficiency sectors, the share differences between Italy's plan and the CDM are not as great, but the shares of these two sectors are still lower in the CDM. Gas capturing projects with low long-term return dominate the CDM market.

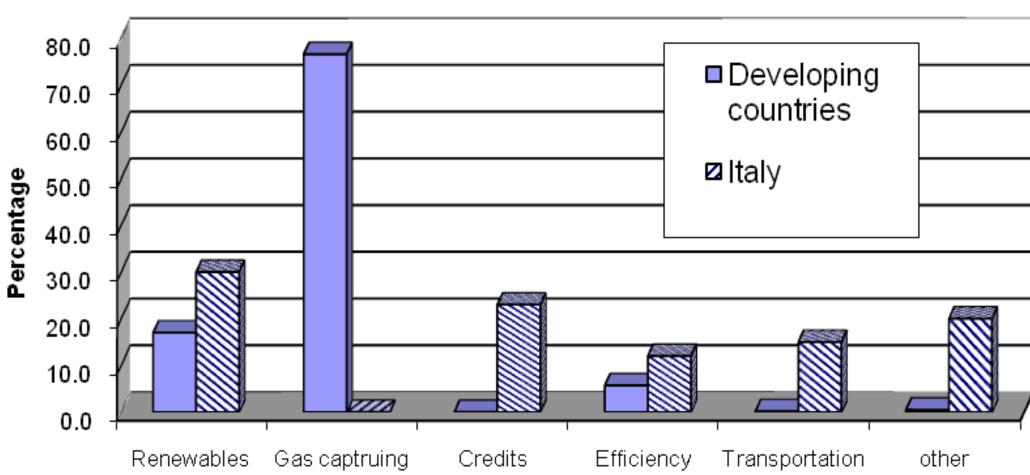

FIGURE 3. The emissions reduction shares for various sectors: Italy vs CDM-developing countries.

Moreover, Mongelli et al. (52) show some evidence of the Pollution Haven Hypothesis (PHH) in the carbon market. According to this hypothesis, regions with looser environmental regulations become more competitive in producing pollution intensive goods. The fact that developed countries have binding obligations (53) to reduce GHGs and developing countries do not illustrates the differences in the environmental regulations between these two sets of countries. This lack of binding commitments dramatically impedes GHG emissions reduction trends in developing countries.

The CDM fails to provide funds for numerous transportation sector projects; near 0% of the CERs are dedicated to transportation. The CDM can use standard baselines, a sectoral approach, and clear designs as ways to raise funds in the transportation sector. But it cannot incentivize the political wills of developing countries to pursue long-term projects (12), which is crucial for the transportation sector. The GEF or the Clean Technology Fund-CTF (54) can better serve the sustainable transportation goal.

OPTIONS TO MITIGATE GHGS IN THE DEVELOPING WORLD

Future of the CDM

Negotiations for a new international climate agreement are ongoing. These negotiations may lead to a replacement – or modification – of the existing Kyoto Protocol, especially the CDM program. In particular, these negotiations include discussions on how and to what extent highly-emitting countries will be involved in GHG emissions reduction in the future. Many specialists suggest radical changes, but it might be beneficial/logical to pursue simple but effective changes to the Kyoto Protocol, which would lead to substantial improvements (55) at least in the short run. During the Durban UNFCCC summit, the topic of some informal discussions was the possible linkage between participating in the CDM and accepting a target under the Kyoto protocol, which was not completely successful (56). Also, parties discussed other issues such as monitoring methodologies, an appeals process, ways to better assess additionality, etc. Based on the Durban summit negotiations, the CDM (Kyoto Protocol) will continue mainly as in the past, with some minor modifications like accepting carbon capture and storage projects for offset credits. The significant outcome of the Durban summit was the creation of a Green Climate Fund (GCF) that sets up a new system to fund NAMAs and sectoral approach (4).

Even though climate change experts have critiqued the Kyoto Protocol's ability to involve the developing world (48), it will most likely continue to be implemented in the same manner as currently for near future (57), at least until 2015. On the other hand, developing countries are more capable of abatement; it is often less expensive to start a new low-carbon technology path than to modify the existing technologies (58). In the transportation context, developing countries' decision makers can choose to follow the transportation infrastructure model of either the U.S. or Hong Kong in terms of private car use. It seems, though, the CDM is not capable of persuading the developing world to adopt the Hong Kong model even though it has supported a few public transportation projects.

Based on the international agreement to continue to use the CDM with a few modifications, the sectoral approach is the only hope to broadly engage the transportation sector of developing countries, which can include transportation master plans or even national transport policies like NAMAs. However, no sectoral transportation methodology has been approved in the

CDM (16), probably due to its more complex structure. Nevertheless, several sectoral proposal and methodologies exist (44) and broader aspect projects have been approved in the GEF, e.g. the Promotion of Environmentally Sustainable Transport in the City of Valencia, Venezuela, and Hanoi Urban Transport Development, Vietnam projects (30). The GEF, with its comparable size of investment, seems more capable of supporting sectoral or national policies.

Other General Options

Post-Kyoto policies require broader participation to ensure environmental integrity and stabilize the GHG concentrations (55). Such stabilization can only be maintained with a worldwide mobilization. Other than a global market, Halsnaes and Shukla (59) have proposed three main international cooperative mechanisms to stabilize the emissions: an international Sustainable Development and Climate Finance Mechanism (SDCFM), technology development and transition programs, and technology standards.

The SDCFM represents international finance mechanisms which support collaboration between two or more parties on emissions trading. The key objective of the SDCFM is creating a market value for GHG emissions. The transportation sector with its current structure is not a good fit for the SDCFM partly because emissions reduction verification is still problematic and the sector is unable to directly pay for its emissions.

Technology development programs have provided significant advancements over the past decades. The National Alcohol Program (PRO-ALCOOL) in Brazil is an important example in the transportation sector. The program produced 550 million barrels of oil-equivalent ethanol, saving $11.5 billion in foreign exchange and avoiding 400 million tons of CO_2 emissions from 1975 to 2000 (59). Similar technology development programs can play an important role in reducing the transportation-related GHG emissions of developing countries.

Local environmental standards can also deliver major climate benefits. Mandatory use of CNG for public vehicles in India and some other countries is an important contribution (60). Although these options seem to be effective to some extent, there may be no other way in the future to ensure stabilizing emissions in the transportation sector than the active and responsive participation of developing countries with binding obligations. The crucial question then is how and to what extent the CDM can play a role in promoting technology development and in enforcing environmental standards. The current CDM seems unable to play an important role.

CONCLUSIONS

The inevitable growth in the transportation energy consumption for developing countries argues for the need for a mechanism to address the resulting GHG emissions. The CDM, along with the GEF, has the potential to be such a mechanism. But only fifteen transportation projects have been approved out of the dozens submitted to the CDM. Methodology problems were the main reasons for these rejections. The baseline, leakage, and institutional complexity problems can be partially solved through a clear framework. BRT or even LRT projects seem to be a good fit for the CDM and especially the GEF. Nevertheless, the transportation sector needs a broader remedy than project-based mechanisms.

Among the various transportation options available to reduce GHGs, fuel switch and mode switch projects are the most common in the CDM. One reason is that these options provide a clearer instrument for GHG emissions reduction. Another, perhaps more influential, reason is that travel activity, vehicle efficiency and occupancy, and infrastructure investments are too broad for a project-based approach. A sectoral approach or NAMAs could provide a better fit for transportation policies, but no sectoral transportation project has been proposed in the CDM. The GEF or even CTF may be better able to support sectoral or national policies. The sectoral approach, as one of the proposed mechanisms in the post-2012 climate change regime, might grow in popularity, but its usage in the CDM is not promising for the transport sector.

On the other hand, there are doubts about the match between the CDM goal and sustainability. A comparison between the projects registered in the CDM and the strategies implemented in the Annex I country Italy shows that the transportation sector, along with the renewable energy and energy efficiency sectors, are under-considered in the CDM. The Pollution Haven Hypothesis also supports the contention that the CDM does not pursue sustainable development. The Gold Standard for sustainable projects may become an effective tool in this regard. However, the Gold Standard is a voluntary label.

Negotiations for an international climate agreement are ongoing. They may result in the replacing or modifying the existing Kyoto Protocol and its CDM. In particular, these negotiations include discussions of the process and the extent to which highly-emitting countries (some of which are developing countries) will be involved in the process. The resulting global markets will eventually necessitate the involvement of the transportation sectors of developing countries.

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