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Road-rail intermodality and the Clean Development Mechanism

Opportunities and obstacles focusing Brazil

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***Abstract* - The approval of methodologies involving the transportation sector confronts methodological concepts that hinder the eligibility of such projects as Clean Development Mechanism, mainly because it is a segment whose emissions come from mobile sources. The verification of additionality and monitoring of emissions, in principle, can be regarded as some of the key barriers to fit transportation sector projects into the CDM framework. This paper discusses these issues and examines, in particular, the road-rail intermodality. Since the partial replacement of cargo transport via trucks by wagon trains presents a great potential for mitigating emissions of greenhouse gases, this paper also analyzes the characteristics that a project involving road-rail intermodality must possess in order to be approved by the Executive Board of the United Nations Framework Convention on Climate Change. It also analyzes the main difficulties that such a project might face.**

Keywords - Climate Change; Brazil; Transportation Sector; Intermodality; CDM

I - INTRODUCTION

The transportation sector is crucial for economic activity and has a growing demand in line with population growth and GDP [1]. It is currently the sector that has the highest growth rates of greenhouse gases - GHG - emissions [2], contributing about 13.1% of global emissions [1]. The trend is that its participation continues to grow in coming decades, reaching nearly 20% of global GHG emissions in 2030 [3]. The transportation sector, together with the service sector, increased energy consumption by 37% between 1990 and 2005 [2]. In 2007, the transportation sector accounted for 61.2% of world oil demand [4] and it is projected that by 2020 its oil demand will reach 77% [3].

There is no simple solution to combat the high and increasing levels of GHG emissions from the transportation sector worldwide. In order to achieve substantial reductions in greenhouse gas emissions in the transportation sector, many institutional and infrastructure challenges must be overcome. Those challenges include: low fuel price elasticity by owners of passenger vehicles; ever-increasing demands for personal travel, air travel and freight; difficulties to make low-carbon fuels become economically viable and also difficulties to the large-scale commercialization of more efficient and lower volume capacity engines [5] In the carriage of passengers, where there is a predominance of the use of private cars, the energy efficiency gains in fuel consumption is neutralized by the number of miles traveled and the increase in the number, size and weight of cars [6]. In the road freight transportation (trucks), although the average energy intensity per tonne-km decreased about 10% between 1990 and 2005 (below 1% per year), it was also neutralized by higher growth rates of travel in the same period [2].

Projects related to CDM in the transportation sector can reduce greenhouse gases emissions, mainly CO_2, and can also bring other benefits in terms of sustainability, such as the improvement of air quality and health of people living in big cities, the reduction of noise, the reduction of dependency on oil [7], and depending on the type of project, it would also bring improvements in the quality of transit [8] [9]. In the specific case of projects involving a shift from the road modal to the rail modal, the less intensive use of the road system could retard the advance of traffic jams as well as alleviate the existing ones [3]. Therefore, the

search for opportunities to implement projects of GHG reductions in the transportation sector is crucial in mitigating global climate change [1].

In face of that, it was expected that a large number of projects to reduce GHG emissions from the transportation sector would be underway within the Clean Development Mechanism - CDM - and the United Nations Framework Convention on Climate Change - UNFCCC - frameworks. However, by December 2012, only two projects involving the transportation sector had passed, totaling only 0.25% of total projects by sectoral scope [10].

CDM projects are a major incentive for action; however, the methodological concepts hinder the eligibility of CDM projects in the transportation sector, mainly because of the difficulty to prove the additionality of these projects. Among the few methodologies and projects approved under the CDM concerning the transportation sector, none involves the change of modals, despite the large potential for energy savings and GHG emissions mitigation that the partial replacement of cargo transport via trucks by wagon trains can provide [11] 12] [13].

In order to be approved under CDM framework, a project must fulfill a series of requirements. The reason for these criteria is to assure that the project demonstrates the accomplishment of the objectives of the CDM, which are: the reduction of GHG emissions and / or the carbon sequestration through activities that stimulate the sustainable development of the host country of the project. In total, there are four eligibility criteria: voluntary participation; real, measurable and long-term benefits; additionality; and sustainable development.

In the specific case of the transportation sector, the proof of additionality, the quantification of additionality and the monitoring of emissions have been the hardest concepts to demonstrate within the CDM process. This difficulty is related to the establishment of limits of coverage, the influence of public policies for the sector and especially the definition of the level at which the additionality will be established to define the baselines, since the transport sector involves mobile sources for which monitoring is difficult [6]. Another major hurdle for the transportation sector is that the CDM Executive Board (EB) does not approve projects carried out under governmental programs. Hence Programmatic CDM (or Programme of Activities - PoA) was created to reduce the barriers for the implementation of small projects under the "umbrella" of a larger governmental program[1].

Programmatic CDM or Programme of Activities (PoA) was launched by the UN in 2007 as an option within the CDM that facilitated the registration of a group of small projects with the same methodology, but at different times or places. The rules for approval of these projects are similar to traditional CDM, but with the difference that the program as a whole (aggregating the various projects) is submitted to receive the registry of the United Nations. The major advantage is that, over time, new projects can be reviewed as part of the PoA previously approved.

The main difference between a CDM project and a PoA project is that in the first an activity should be clearly outlined in the Project Design Document (PDD). Each PDD refers to a single activity, which is "closed" after validation at the UN and no other activity can be included in this project [14] [15]. The PoA will act as if the PDD is open to the introduction of new project activities that meet the definitions of the project initially registered and which can be included during the accreditation period. The major advantage is that each new project will face simpler procedures in order to become part of the Programmatic CDM [2].

Therefore, Programmatic CDM appears as a new option to increase the number of CDM projects, mainly in the areas of energy efficiency and transportation. Brazil has a potential for the employment of CDM programs to generate project activities, such as PROCONVE (Program for Control of Air Pollution by Motor Vehicles), CONPET (National Program for the Rationalization of the Use of Oil and Natural Gas Derivates), the PNPB (National Biodiesel Production and Use Program) and even a resurgence of Pro-Alcohol (National Alcohol Program)[3].

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[1] Programmatic CDM or Programme of Activities (PoA) was launched by the UN in 2007 as an option within the Clean Development Mechanism (CDM) that facilitated the registration of a group of small projects with the same methodology, but at different times or places. There were many expectations that at COP 15 (Copenhagen - 2009 -) ways of encouraging and expanding the PoA would be discussed, but discussions were dimmed due to the impasse between developed and developing nations to impose targets on greenhouse gas emissions and due to the discussions on REDD (Programme on Reducing Emissions from Deforestation and Forest Degradation).

[2] In the Programmatic CDM there are three documents to register the program of activities, which are the PoADD form (which contains all information regarding the methodology and funding), the CPA model form (CDM Programme Activity which contains all generic information about the project) and a CPA complete form (which contains the details of the CPA to be validated). Each project activity should have a CPA which, in future, may be submitted to the UN without validation and registration. The verification and additionality does not need to be made in all CPAs, except on that submitted as a model [14] [15].

[3] PROCONVE main goal is the reduction of air pollution by setting emission limits, inducing technological development of the manufacturers and determining that vehicles and engines meet the emission maximum limits on standardized tests and fuels. CONPET offers free technical support to the transportation industry - freight and passengers - in order to rationalize the consumption of diesel and promote better air quality, reducing the emission of black smoke from buses and trucks. Pro-Alcohol is the Brazilian program of large-scale substitution of oil derivatives. The effort was both in the production of anhydrous ethanol for blending with gasoline,

In the specific case of a project involving a modal shift from road to rail (called Intermodal Project in this study), the partial displacement of freight transportation from roads to railroads would not happen simultaneously but over the years. In order to have this project approved by the EB as a Clean Development Mechanism, it would be imperative that it fit into the Programmatic CDM, since each company/carrier willing to use railroads instead of highways could add into a single PDD, previously approved, a new CPA concerning the new "route". This would reduce bureaucracy and costs of adoption of this new "route" under the CDM framework, making it economically viable and thus generating carbon credits.

It is in this context that a policy focused on the expansion of rail and intermodal terminals would be suitable[4]. This policy could be held by the Brazilian federal or state governments, or even by private investments, with or without government assistance (through a Public Private Partnership - PPP, for example), so that it would involve the modernization of the rail fleet and railways, and / or the construction of new lines and / or the purchase new trains. After all, in the Brazilian transportation sector, most of the freight is transported on road (58% of ton per useful kilometer - TKU), and thus the rail modal, accounting with 25% of TKU, presents the greatest potential for expansion in Brazil [16].

Such actions would result in the decrease in cargo transportation by trucks in Brazil, and thus causing the decrease in the use of diesel oil and CO_2 emissions. The carbon credits (CER's) would benefit the government responsible for infrastructure works, or the private sector (operators of the railway lines, companies that have their cargo carried, or even the company responsible for logistics and freight). Thus companies that migrated from modal over time, i.e. opted for the use of railroads to the detriment of highways, could add a new CPA in the PDD concerning the new "route". Some private companies are already acting as coordinators of PoA projects, thus claiming the possible CER's [17].

In this article, the main goal is to analyze the characteristics that a project involving the road-rail intermodality (Intermodal Project) must have in order to win approval by the Executive Board (EB) of UNFCCC. In parallel, we report and discuss the major difficulties that a project of this nature might face in order to comply with the CDM framework.

II - INTERMODAL PROJECT

The Intermodal Project consists in increasing the participation of the railway modal in the cargo transportation array, in order to make it more efficient, safer and cheaper than the previously adopted model (centered on the road modal). The project would be a result from a public-private partnership (PPP) in which the public sector would be responsible for investments in infrastructure (rails, stations, terminals, etc.), and the private sector responsible for investments in fleet and system operation. The coverage area of this hypothetical project could be a state, one of the five regions of Brazil or even Brazil as a whole.

Briefly, the main aspects that make up the Project Intermodal consist of: (1) Expansion and modernization of the railway infrastructure, especially by building modern and efficient intermodal terminals (CLIs, integrating the rail and the road modals, allowing rapid operations of loading and unloading cargo; (2) Purchase of new trains with larger load capacity, hence yielding greater fuel efficiency per TKU [18] [19], generating greater efficiency of freight transportation and thereby reducing the level of emissions per RTK transported when compared with the situation of the absence of the project, and; (3) Integrated fare among rail operators. In this context, the Intermodal Project becomes attractive to customers because of the lower cost, greater safety and greater reliability, motivating its use instead of road transport (trucks).

III - REQUIREMENTS OF THE EXECUTIVE BOARD FOR THE APPROVAL OF CDM PROJECTS

According to the Executive Board, a project must necessarily satisfy several requirements to be approved under CDM framework. One of these requirements is that the project has to contribute to the sustainable development of the host country. In this respect, the Intermodal Project proposed here would contribute to the sustainable development through the reduction of CO_2 emissions, particulate matter and NO_x by increasing the efficiency of freight transportation, improving the quality of life, and reducing traffic jams, noise and accidents. Besides these aspects, we should mention the decrease in the incidence of respiratory diseases, the creation of temporary jobs to perform the works of infrastructure, and permanent jobs, especially in intermodal ports (CLIs, all bringing macroeconomic benefits to the state holding the project and Brazil.

and in the production of hydrated alcohol for use in the Otto cycle vehicles powered exclusively by this fuel. PNPB is a program of the Federal Government which aims to implement the technically and economically sustainable production and use of biodiesel originated from raw materials such as vegetable oil, animal fat and plant disposal, replacing fossil diesel, and focusing on social inclusion and regional development, through the creation of jobs and the generation of income.

[4] It is noteworthy that Brazil still presents a large deficit in the provision of transport services by road, rail, sea, inland waterway and in the port system. The lack of investment in the expansion, maintenance and upgrading of such services causes a high impact on the economic activity, representing a competitive disadvantage for Brazilian companies in relation to its competitors in the international market.

Another requirement of the EB refers to the effective reduction of GHG emissions (additionality). In the case of the Intermodal Project, it brings more balance to the freight transportation industry, equalizing road and rail modals. It would lead to a decrease in CO_2 emissions, and this would occur for two reasons. First, the rail modal emits less CO_2 per tonne-kilometer [12]. Second, mainly because the lower consumption of diesel. Indirectly, the project would also cause a reduction of vehicle emissions in general since it contributes to the improvement of traffic conditions in the areas of influence (this indirect contribution in reducing emissions should not be included in the project because it is difficult to quantify).

According to another requirement of the EB, the CDM project proponent needs to present a document that expresses the environmental impact caused by the project-related activities, including an environmental impact report and the term of reference for the environmental impact assessment. In Brazil this requirement would be more easily fulfilled since IBAMA (Brazilian Institute of Environment and Renewable Natural Resources) already demands an Environmental Impact Assessment (EIA) and an Environmental Impact Report (RIMA) for all infrastructure projects.

A clear and efficient monitoring plan[5] is also one of the requirements of the Executive Board. The monitoring of the Intermodal Project would consist in collecting freight transportation data from rail operators and from the many trucking companies or companies that own or use trucks to ship their products (i.e. the same method which is used to build the array of cargo transportation published by governmental agencies such as the Ministry of Transport). The monitoring plan always has to follow the baseline methodology previously established in the PDD of the project.

In relation to the crediting period, there are two possibilities for CDM projects: (1) Duration of seven years, with the possibility of two renewals for the same period, or; (2) Duration of ten years with no renewal option. In both cases, the CERs crediting period has to be specified. In the specific case of Programmatic CDM, the project duration can extend up to 28 years or four periods of seven years.

In order to evaluate the emissions from the activities of the CDM project in focus (i.e. the Intermodal Project), the methodology of calculation must necessarily contain:

a) The description of formulas used to calculate and estimate anthropogenic emissions of greenhouse gases of the CDM project activity, by sources, within the project boundary; and the description of the formulas used for the calculation and projection of leakage. The result of these calculations represents the emissions from the project activity under the CDM;

b) The description of formulas used for the calculation and projection of the baseline anthropogenic emissions of greenhouse gases, by sources, and the description of the formulas used for the projection of leakage. The result of these calculations represents the emissions baseline.

The difference between the results obtained from the calculations (b) and (a) represents the emission reductions from the CDM project activities (additionality).

IV - POSSIBLE BARRIERS THAT THE INTERMODAL PROJECT WOULD HAVE TO OVERCOME IN ORDER TO WIN EB APPROVAL

The obstacles for the implementation of PoA projects in the transportation sector include the lack of methodologies concerning leakage, free-riders, baseline, double counting and monitoring [17]. The following is an analysis of these issues, as well as their importance in relation to the Intermodal Project.

Project boundary

For some Programmatic CDM projects, the exact location of individual activities is known since its inception. In other programs, the geographic coverage of the program is known at the beginning, but not the specific location of each program participants. In PoA, the exact location of the actual emission reductions can be determined later and it consists of the project boundary. The boundary definition would not be a barrier to the Intermodal Project, since the boundary would be either a State, or a Region or even the whole of Brazil.

Baseline

Before the approval of the Intermodal Project, the EB has to approve a Programmatic methodology concerning the intermodal exchange (trucks for trains). As of the date of completion of the present study (March, 21th, 2013) no methodology involving intermodality had been approved; and judging by the

[5] The monitoring plan includes the form of collection and archiving all relevant data necessary for calculating, according to the baseline methodology established in the PDD, the reduction of emissions of greenhouse gases that have occurred within and outside the boundary of a CDM project activity, provided they are attributable to the project activity and during the crediting period.

negative experience of Aracruz Celulose[6] in the adoption of a methodology involving intermodality, one can consider that the definition of a baseline is currently the major impediment to the Intermodal Project. The methodology is applicable is analyses of alternative baselines demonstrate that the continuity of the current system leads to a higher level of GHG emissions in the absence of the project.

Additionality

The proof of environmental additionality (i.e. GHG reductions from the Intermodal Project in relation to baseline) depends mainly on the methodology to be approved in advance by the EB. The determination of the baseline would face difficulties because the data on the cargo transportation are widespread among operators of the rail system, among the many trucking companies and among the companies that use trucks to ship their products. Since the fuel adopted in the two modals is the same (diesel oil[7]), the formulas for calculating emissions would be somewhat simpler than the formulas used in the methodology of TransMilenio[8], for example. One problem would be the standardization of an average emission rate taking into account the entire fleet of trucks that travel within the project boundary, after all there are trucks of various brands, sizes, "ages" (new, old, very old) and levels of maintenance (proper, inadequate, or without maintenance). This will certainly hamper the definition of the baseline. The gradual replacement of the fleet of older vehicles with new fuel-efficient vehicles should also be taken into account in establishing the methodology. The baseline of the methodology used at TransMilenio simplified the calculation, since it employed a constant average rate of annual improvement in each category of vehicle. In the case of the Intermodal Project there would be only the truck category.

The most problematic issue is the show the evidence of financial additionality, i.e.to show that the Intermodal Project is not a business as usual case, since the modal shift from road to rail modal transportation of cargo is often economically beneficial by itself in principle [20] [21] [18], not depending on the revenues from CERs to make the Intermodal Project economically viable. We must mention that the revenue generated through the sales of CERs can be an important incentive for the shift of paradigm in the Brazilian transportation sector, particularly in the freight industry. Notably because there are great barriers to promote the modal shift from road to rail, and the investments in infrastructure are high [22]. There is also the alternative in which the government agency responsible for building the infrastructure becomes the claimant of the carbon credits and, as infrastructure expenditure is greater than the possible values generated from the sales of CERs, this would denote the project is not business as usual.

Free riders

The CPA must specify the approach used to estimate emission reductions attributed to free riders (projects that are not additional *per se*) as part of the original proposal and the methodological follow-up. From this, all other reductions of emissions will be considered additional. It is also one of the great difficulties of the Intermodal Project, as it would be difficult to distinguish which participants would have changed their transportation modal even without the benefits of CERs. The fact that participants are not known in advance also makes it difficult to choose the methodology that will be used [17]. Another problem concerning the free riders is that the project does not

[6] In 2005, Aracruz Celulose tried to develop a methodology for modal shift in freight transportation. There would be a shift form road transportation (trucks) to the waterway modal (barges). Each barge would be able to carry a quantity of wood equivalent to 100 truckloads of logs. According to the final EB report, the main reasons for not approving the methodology proposed by Aracruz were the errors in creating the baseline and methodology, which should have been worded more generally, but was worded to be very specific to the project in question. The methodology also assumes no leakage. According to the EB report, this case is problematic, as it would allow projects that generate credits in the factories by means of the reduction of production instead of increasing efficiency provided by the modal shift in the transportation of raw materials. There were also errors in the calculation of CH_4 and N_2O emissions generated from the fuel combustion in the baseline and in the project [23].

[7] There is a general decline in the use of electricity by railroads in Brazil. In the State of São Paulo, for example, which concentrates most of the railways in the country, the electricity consumption by this modal fell by 7.7 times between 1991 and 2004. In contrast, the use of diesel oil grew 1.4 times in the same period [24].

[8] TransMilenio is an integrated bus rapid transit system in Bogota (Colombia), which employs articulated buses on segregated lanes with stops at modern stations equipped with electronic turnstiles. Feeder buses depart from neighborhoods to feed the main system. Its main environmental aspect consists in a greater efficiency of passenger transportation, reducing the emissions per passenger when compared with the situation of the absence of the project. The main aspects that make up the project are: a new road infrastructure consisting of exclusive lines for high-capacity buses for passenger transportation; centralized control of the fleet, allowing monitoring, reporting and real-time responses for contingencies, and; rationing the existing bus fleet, reducing by more than one-third the current 9000 vehicles in operation in Bogota, avoiding the risk of falling efficiency (occupancy) in the system remaining [9].

include the companies that already used the rail modal before the project implementation.

"Rebound effect" and repressed demand

The rebound effect refers to increased demand for energy services when the cost of the services decline as a result of technical improvements in energy efficiency. The argument is that, due to lower cost, consumers alter their behavior increasing consumption [25] [26].

The rebound effect does not apply to the Intermodal Project because it is not feasible for most companies to use the freight service (which is paid) just because it has become less expensive. The use of freight services is directly related to the demand for goods, which may even increase if the company transfers that gain to its products; however this does not fit the "rebound effect".

Leakage

Leakage is defined as the net change of greenhouse gases emissions which occurs outside the project boundary, and which is measurable and attributable to the CDM project activity. Regarding the leakages of the Intermodal Project, due to the emissions coming from the construction of the infrastructure, from new trains and from the transportation of fuel to the railway stations, the measurement becomes more complicated but not impossible.

Double accounting

Since there are many players involved in a program, the risk of double accounting may be amplified. Only the coordinating entity in charge of the project should claim CERs. An adequate monitoring would help in preventing this problem. In the case of several execution entities which are potentially interested in the ownership of CERs, the project participants may sign an agreement not to claim the CERs. The potential claimants may transfer their credits to the project proponent in exchange for a share of the CERs issued, or the equivalent value. This agreement may be either a separate agreement or settled in advance at registration [17]. Therefore the double accounting is an obstacle that can be overcome at the Intermodal Project without difficulty.

Monitoring and verification

Monitoring and verification are essential to ensure that the CERs correspond to real reductions in emissions [25]. Each Programmatic CDM project must use an approved monitoring methodology that fits the project. An accurate monitoring of the data that must be collected for subsequent calculation of baseline emissions, actual emissions and fugitive emissions is essential. The monitoring specifies how the data must be collected and archived, and also approaches the uncertainty, the quality assurance and the procedures control that will be used [17]. When the Programmatic CDM project involves many small actions, such as the proposed Intermodal Project, the methodology has to provide adequate monitoring. Generally, the monitoring is not applied in all places if a program involves many participants. Instead, a sampling plan is used to select the participants which are monitored and the results are then extrapolated to the full program with an acceptable level of statistical accuracy [17]. It is noteworthy that sampling is already part of the approved methodologies for some small scale projects. Depending on the implemented measures, emission reductions can be monitored by combinations of measurements and calculations, by billing analysis, and/or by employing mathematical and statistical models [17].

V - CONCLUSIONS

The adoption of a methodology emerges as a major challenge for projects involving modal shift. In this context, we point out that until the final elaboration of the present study (March, 21th, 2013) no methodology involving intermodality had been approved. A major obstacle is the demonstration that projects involving a shift from road transportation to rail transportation (even partially) are not business-as-usual. The demonstration of additionality, the free riders, the double accounting, the quantification of leakage, and the monitoring and verification are also obstacles to approving such projects. The simplification of the eligibility criteria, carefully avoiding free riders, can be an effective alternative to leverage CDM projects involving the transportation sector.

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