Energy substitution, transport infrastructure and energy efficiency under the clean development mechanism - Will the baseline make a difference?

Cécile Blanco, International Research Centre in Agricultural Sciences for Development (CIRAD)
Anna Engleryd and Sandrine Mathy, International Centre for Research on Environment and Development (CIRED)

1. SYNOPSIS

This paper compares different baseline methods influence on the profitability and feasibility of three potential CDM projects concerning: energy substitution, urban transport and end-use energy efficiency.

2. ABSTRACT

The double objective of the Clean Development Mechanism, CDM, is (1) to ease a sustainable development of developing countries, and at the same time, (2) to open a margin of flexibility for industrialised countries seeking to fulfil their emission reduction commitments. A number of project types in line with these two objectives can be imagined.

A fundamental condition for eligibility is that the projects result in an environmental additionality compared to a situation without the project, i.e. additional emission reductions compared to a pre-determined baseline. This baseline thus serves to determine the emission reduction credits resulting from a specific project and, depending on the level of remuneration of these credits, influences the economic profitability of the project. The setting of this baseline is therefore crucial for the concerned actors' interest to engage in different CDM projects. Upon this depends the potential for the CDM to function as a catalyst making implementation of otherwise unprofitable emission reduction projects possible.

This paper discusses the importance of how the baseline is set for the economic feasibility of three possible CDM projects concerning; (1) energy substitution, (2) urban transport, and (3) end-use energy efficiency. A comparative case study serves to illustrate the attributable emission reductions and the economic feasibility of different projects under different baseline assumptions, and the importance of the baseline setting for the mix of project types under the CDM.

3. INTRODUCTION

Under the Kyoto Protocol, industrialised countries will commit themselves to a quantitative greenhouse gas (GHG) emission reduction target of 5.2% compared to their emissions in 1990. It is the governments of these countries who will be responsible for the emission reductions before the United Nations Framework Convention on Climate Change, but to realise their committed quota, however, they will need the co-operation of private entities in their own country. This concretely means that these targets will be transferred on to national actors accountable for GHG emissions through national policies and measures.

To provide industrialised countries with a margin of flexibility in fulfilling their emission reduction commitments, as well as to reduce the overall cost of meeting the abatement target, the Kyoto Protocol provides for three so called flexibility mechanisms through which a part of the assigned amounts could be realised supplementary to domestic policies: Emissions Trading, Joint Implementation and the *Clean Development Mechanism*. This paper focuses on the latter which is the only instrument including developing countries' participation.

The *Clean Development Mechanism* (CDM) allows industrialised countries to meet part of their obligations by carrying out projects that reduce GHG emissions in developing countries given that these projects also help to promote a sustainable development and go in line with national development priorities. The projects will generate *Certified Emission Reductions* (CERs) that can be used by the industrialised country to fulfil a part of its commitment. The number of CERs attributed to a specific project depends on the performance of the project and on the *baseline* i.e. an estimation of what would have happened in the absence of the project.

This paper investigates the impact of how the baseline is set for the interest of the concerned actors to engage in different CDM projects. From the point of view of the host country, the CDM could constitute a good means to attract foreign investment capital to strengthen national development resources that are often scarce compared to the needs.

Many studies have shown the attractiveness of power production and energy substitution projects in the CDM. In such cases the definition of the baseline is fairly easy since the emissions mainly result from one unique source. This study compares one energy substitution project to two projects in other categories for which the reference situation is more controversial: urban transport and end-use energy efficiency. For these project categories many methodological problems have to be solved since emissions are diffuse and depend on consumption patterns and lifestyles. These sectors are nonetheless very important in terms of emissions as well as development, and should therefore be eligible under the CDM.

The first section of this paper discusses the methodology of baseline determination and its influence on project implementation decisions. In a second part, different baselines are calculated for three potential CDM projects. They are then applied to the three projects and the results are compared in a third section before some conclusions are drawn.

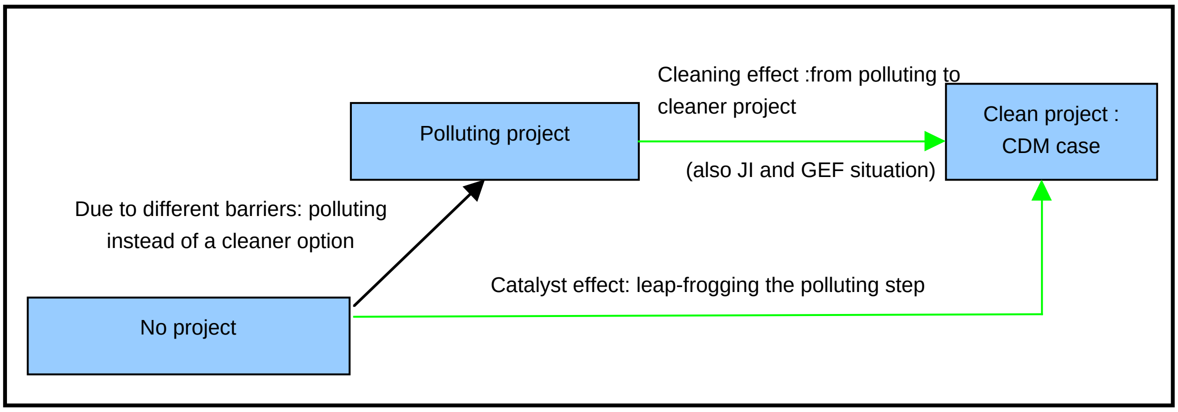
4. BACKGROUND, CDM BASELINES

The Principle of the CDM

By offering an additional value to a project linked to its level of GHG emissions, the CDM can have an impact on project implementation in two different ways as illustrated by figure 1:

1. Allow a switch from a polluting option to a clean option (comparable to Joint Implementation and GEF funds) for an already ongoing or planned project
2. Have a catalyst effect on clean development where no project is planned: it might help *"to realise clean projects where not even polluting projects are undertaken"* (Gouvello, 2000).

Figure 1. Two possible impacts of the CDM on project implementation



The additionality criteria

The Kyoto Protocol states that for a project to be eligible under the CDM, "reductions in emissions [should be] *additional* to any that would occur in the absence of the certified project activity" (Kyoto Protocol 1997). This means that for a project to be eligible to the attribution of CERs, it must be proven that it would not have been realised if the CDM did not exist. The *"additionality"* criterion is manifold and can be interpreted in many ways. *Technical additionality* concerns if the technology used in the project is likely to have penetrated the market, or be used, in the host country even without the project in place. *Financial additionality*, means that the funds for CDM projects must not be taken from for example aid programs already in place, but must come on top of such. *Economic additionality* concerns the viability of the project that should not be a no-regret project for the investor. The project should thus, in economic terms, have an internal rate of return below the discount rate, i.e. not be profitable on its own. *Environmental additionality* (sometimes called emissions additionality) means that the project should result in true emission reductions. A qualitative reference situation is identified and the baseline emissions associated with it quantified. The difference between the project's emission performance and the baseline emissions constitutes the additional emission reductions attributable to the project in the form of CERs.

There are two determinants of the absolute emission level: the emission factor per level of activity (EF) (expressed as emissions per passenger/km, per refrigerator/year, and per ton pig-iron produced in our examples), and the activity level (AL) (expressed as passenger km, no of appliances, and ton of pig-iron produced in our examples). The absolute emission level is the emission factor multiplied by the level of activity (EF*AL). The evolution of both EF and AL in a project vary according to the type of CDM impact as below:

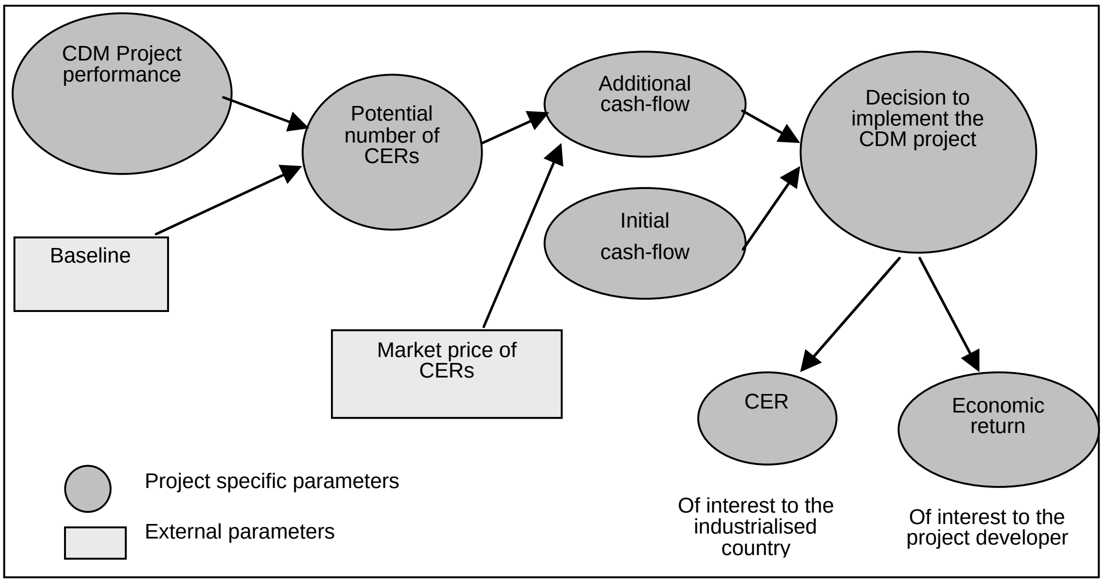
CDM impact	Reference situation	EF	AL	Absolute level emissions
"Cleaning"	More polluting project	Decreased	Constant	Decreased
"Catalysing"	No project	Decreased	Increased, particularly in a situation of unsatisfied demand	Can decrease or increase

We see that where the CDM acts as a catalyst for project development, i.e. in a situation where no project would normally be put in place due to technical, societal, financial or other barriers, its role is quite paradoxical since a undoubtedly "clean" project (in the sense of EF compared to current technological options in a given sector) might actually increase the absolute level of emissions. The increase in AL, the development component of the CDM project, "neutralises" the decrease in EF. This might be problematic when it comes to quantifying the emission reduction (see next paragraph).

The CDM's impact on project implementation: the catalyst function

The number of CERs related to the level of baseline emissions is crucial for the CDM to function as catalyst to make more environmentally friendly projects, that are of interest to the host country, economically feasible. This is related to the economic additionality earlier mentioned. We suppose that a project needs an internal rate of return (IRR) that is higher than the discount rate to be economically viable. As these rates are specific to each investor and in many cases confidential, we can just note that many emission reducing projects do not meet this criterion, and are further faced with other barriers, as they would otherwise have been implemented without regret. Seen from the investors' perspective the implementation of a project highly depends on its economic profitability, which in the case of CDM projects will be modified by the flow of Certified Emission Reductions. The CDM's influence on the implicated actors' investment decisions can schematically be presented as in figure 2.

Figure 2. The CDM's catalyst function on project implementation



The pre-estimated carbon reduction performance of the project will be compared to the baseline and result in a potential number of CERs. This number of CERs multiplied by the market price for CERs will result in an additional CER cash flow to be added to the initial cash flow which would be the result if no CDM was in place. Based upon the modified cash flow the investor calculates a number of key indicators upon which he or she bases the investment decision. If the result of the modified cash flow means that the IRR is now higher than the discount rate, the CDM can be said to have had a catalysing effect.

Quantifying environmental additionality : constructing a baseline emission scenario

Once the environmental additionality has been assessed on a qualitative basis, one has to quantify the level of emissions associated with it. Two baseline determination approaches are distinct in theory. For the determination of both the emission factor and the activity level for the reference situation these factors can be estimated: (1) specifically for a given project taking into account its particular conditions, *"project-specific baseline",* or (2) by using varying levels of spatial aggregation to establish *benchmarks* or *multi-project baselines*.

The reference situation might evolve over time, and a revision of the baseline might be appropriate to guarantee the environmental integrity of the attribution of the CERs, particularly for projects with long lifetimes. For simplicity this has been ignored in this exercise.

Pros and cons of different baseline determination methods

Establishing credible baselines is likely to be a complex, highly technical and time-consuming process, giving rise to additional costs whatever method used. High transaction costs related to the baseline setting diminishes the relative economic profitability, and thus have to be minimised in order to minimise investments barriers. Transaction costs have a proportionally larger negative impact on smaller projects than on larger projects and might affect the investor more in the case of project specific baselines than when benchmarks are used. This is due to the fact that the cost of developing a baseline is likely to be significant in both cases, but through standardisation economies of scale can be achieved which would reduce the relative cost for a project developer since other actors, i.e. host country institutions or the Executive Board of the CDM, would likely carry part of the cost for the development of benchmarks.

Baselines will never be completely equitable and fair, but applying consistency in the treatment of similar projects should be a basic condition. Transparency in how the baseline is calculated can help to facilitate approval and acceptance of the project by the different parties and entities involved and can therefore contribute to a shorter delay between proposing and initiating a project. The use of benchmarks could greatly enhance transparency and ease the review.

Artificial inflation of an individual baseline, and consequently the amount of emission credits associated with a given CDM project, is referred to as gaming. Project specific baselines have a relatively higher potential for gaming than the more standardised benchmarks, given that the standardisation process is not systematically biased to a higher level.

Benchmarks do on the other hand have a higher propensity to allow some projects that would have gone ahead anyway to generate credits. The number of so-called free-rider projects could be limited by using project specific baselines.

If a given CDM project leads to increases in emissions outside the project boundaries that are not taken into account in the baseline, this is referred to as leakage. The possibility to capture leakage might be higher when using project specific baselines. However, seeking to cover all direct and indirect emissions that could be associated to a given project is burdensome and would higher transaction costs no matter if benchmarks or project specific baselines are used.

5. POSSIBLE CDM PROJECTS IN BRAZIL

In section "The CDM's impact on project implementation: the catalyst function" (chapter 4), we saw that two major interconnected factors that influence the investors' or project developers' choice to implement or not a CDM project are closely connected to the baseline setting, namely the distribution of CERs and the economic profitability of the project. We will in the following investigate the baseline's impact on these two factors for three possible CDM projects dealing with: energy substitution, urban transport and end-use energy efficiency.

Hypotheses

The following hypotheses have been used when quantifying the economic impact of the CDM under different baseline choices:

Timeline and accreditation

The CDM project timeline is set to 13 years (2000-2012): only emission reductions realised in this period will be remunerated with CERs. Two accreditation dates are fixed: 2008 for emission reductions for the period 2000 - 2007 and 2013 for 2008 - 2012. The baselines will remain the same for the whole timeline.

Choice of baselines

We compare the results in terms of additional emission reductions for each project-example when using (1) a static continental (South-American) benchmark, (2) a static national benchmark (Brazil), (3) a regional benchmark (south-east Region in Brazil) with reference to recent developments, (4) a regional benchmark with reference to a possible future evolution, and (5) a project-specific baseline.

Indicators

The following *indicators* have been calculated for the different projects:

Total Project Cost / Number of CERs,

The total cost of the project over its whole lifetime (not taking into account any of its monetary or non-monetary benefits), and using a 10% (fairly low) discount rate is divided by the potential number of CERs attributed to each project according to each baseline type. This indicator is commonly used in Joint Implementation and CDM project proposals: it shows the investment needed to reduce emissions by 1 ton of carbon, or the marginal cost to produce the emission reductions.

Net Present Value of CERs / Total Project Cost

The discounted value of the "CER flow" (see Figure 2), divided by the total project cost. This indicator expresses the added value attributed to a project's cashflow by the valuation of the CERs if, as probable, an international CER market develops. To calculate this indicator we have used a CER value of US$ 20/tC and considered that the benefit linked to their valuation intervene at the two accreditation dates specified above. This indicator, though very dependant on the value of the CERs for which uncertainties are important, is interesting in a CDM context as it measures the mechanism's catalyst effect on the project implementation decision. Indeed, as seen in figure 2, from an investor's perspective, both the environmental (CER) benefit and the classic commercial benefits (usually difficult to estimate due to confidentiality) will be taken into account in his decision to undertake or not a development project.

We consider that all data needed, parameters taken in account, sources and sinks of emissions etc, are determined once for the whole duration of the crediting period 2000-2012. The validation of the baseline over a certain time assures to some extent the investor who can take an expected number of CERs into consideration for his investment decision.

Brazil as an illustrative example

We use projects carried out in Brazil as illustrative examples. Brazil is an important country in the international climate change debate. The country is releasing some 80 million metric tons of carbon into the atmosphere each year, which makes it the largest emitter in Central and South America. This is relatively low emissions for a country of it's size which is mainly due to the fact that more than 95% of the electricity is today hydro based. This situation is however predicted to change in a near future. The Brazilian economy, which is already today one of the largest in the world, is expected to grow by 50 – 100 % by 2010 (WRI, 1998) which will mean a large increase in these emissions.

Much of the stress placed on the Brazilian environment is due to the rapidly increasing urbanisation and ranges from GHG emissions to air and water pollution in the rapidly growing cities. A recent census shows that 81.2 percent of Brazil's population now live in cities, versus 75.6 percent in 1991. That is high and can be compared to the relatively overcrowded Europe where 75 percent of the population live in cities. Given these facts there seems to be a large potential for CDM projects in urban areas in Brazil that would couple GHG abatement with attenuation of local environmental problems and thus be of mutual interest for the host country and the investor. We will here take a closer look at the most developed, and by consequence most urbanised region in the country, the South-east, including the States of São Paulo, Rio de Janeiro and Minas Gerais. A number of potential CDM projects in this region can be identified as below.

6. END-USE ENERGY EFFICIENCY: MARKET TRANSFORMATION FOR EFFICIENT REFRIGERATOR/FREEZERS [1]

Current context and trend

Today about 20 million Brazilians lack access to electricity services, and the total demand grows with about 6-7% per year. At the same time inefficient supply and usage cause much waste, giving rise to frequent blackouts and brownouts especially in the big cities. In order to meet demand, about 27 000 MW of installed capacity should be added to the system over the next 8-10 years representing investments of close to USD 38 billion (World Bank 1999). Considering that much of the attractive hydropower resources are nearly exhausted, a major demand side effort is necessary to limit the otherwise huge increase in primary fossil energy supply required to sustain the growth of the economy, as well as to mitigate the serious environmental consequences of expanded energy consumption. CO_2 emissions from electricity have been forecasted to grow from about 27 million tons in 1999 to an accumulated value of 2 174 million tons by 2018 if unchecked.

Increased end-use energy efficiency would therefore both help to fulfil the Kyoto objectives by reducing the need for polluting electricity production and go well in line with the development goals of Brazil as the national development plan recognises the need to take actions to improve the utilisation of energy. Barriers to the implementation of energy efficiency projects include lack of public awareness about the potential benefits of energy efficient technologies, lack of credible information, and risks (technological, financial and economic) perceived by energy suppliers, users and potential investors in such projects.

Potential CDM project: market transformation for energy efficient refrigerators / freezers

The project studied builds upon PROCEL[2]experience and would form part of a market transformation strategy for domestic refrigerators. It consists of demonstration activities, information and marketing, in combination with a modest rebate program aiming to promote the market supply and diffusion of highly energy efficient refrigerator/freezers. The idea is that such activities shall inspire local manufacturers to produce and offer more efficient units by making these units the choice of the consumers.

Domestic refrigeration accounts for about 32% of total domestic electricity use in Brazil (Leonelli, 1998) and sales of refrigerators has been growing rapidly in recent years due in part to economic stabilisation and increasing disposable income among medium and lower income households. As a result, a number of multinational firms have entered the market. The timing is thus good for Brazil to adopt efficient technology and this might be a precondition for local manufacturers to keep up with the increased competition. Further, the savings potential is important as the mean refrigerator/freezer today in use in Brazil is estimated to consume about 1050 kWh/year to compare with Europe's today most efficient unit consuming only 220 kWh/year.

The result of a market transformation project can only be evaluated in the long term. The CDM project, as part of the total market transformation strategy, is designed to cover 12000 two-door refrigerators/freezers as efficient as the today best available technology on the European market. Compared to the average units in use in Brazil, this unit consumes about 830 kWh/year less (or almost 80% less). The total estimated cost of the project amounts to $US 980 000 including marketing, administration and evaluation.

Additionality of project

Technological additionality

The technology involved is the best available on the European market today. This highly efficient unit was put on the market in March 2001 as the result of a pan-European procurement project called Energy+[3]. Even if the technology used is fairly well known, such units are not likely to be produced and bought in Brazil without incitative measures.

Economic additionality

As the total cost is estimated to US$ 980 000, using a 10% discount rate and assuming a 15-year lifetime of the appliances, the cost of saved energy (CSE) from a national perspective can be calculated to 9,5 US$/MWh, meaning a total CSE of close to 1000 000 $US. One must however remember that the actor paying for the project is not the same one that profits from the energy savings. Since this kind of market transformation projects do not generate any direct income for the investor they do not enter into a private company logic, but are rather carried out by institutional actors. The only return upon investment is the carbon rent why this project is clearly economically additional.

Construction of possible baseline scenarios

Baselines for end-use energy efficiency projects could be calculated as follows. First the electricity consumption per appliance is estimated and multiplied by the GHG emissions per unit of electricity produced to get the EF. The activity level, AL, is then defined and multiplied with the EF to get the baseline. The Emissions per unit of electricity produced is not influenced by the project performance and therefore treated as exogenous. It might however change during the project lifetime if, for example, the source or technology for electricity production changes why a re-evaluation of the baseline might be important.

In this example the electricity consumption per unit, and project savings are based upon PROCEL information on current technology performance and no of free riders, and European best available technology. The AL of 12000 units is used uniformly in all baseline options since the project is designed to cover this fixed number of appliances. The emissions per unit of electricity produced is the varying factor giving rise to different baseline values. The low baseline emission in the Brazilian benchmark case is related to the high percentage of electricity being hydro generated.

Baseline	Emission factor, EF (tC/unit/year)	EF* AL (12000 units) tC/12000 units/year
Benchmark South America	0,286125 [1)]	3433,5
Benchmark Brazil	0,0126[2)]	151,2
Benchmark region past	0,252[3)]	3024
Benchmark region future	0,189[4)]	2268
Project specific	NA[5)]	NA[5)]

1. 272,5 tC/GWh produced = Weighted average emissions all sources.
2. 12 tC/GWh produced = Weighted average emissions all sources
3. 240 tC/GWh produced = Weighted average fossil fuels
4. 180 tC/GWh produced = Weighted average fossil fuels 25% less CO2 intensive than average.
5. Not applicable without transactions costs that would crowd out this kind of project.

Emission rates based on IEA estimations (AIE 1999, AIE 2000). Consumption per unit based upon PROCEL estimations (www.electorbras.procel.br; Leonelli 1998)

Project environmental performance

Assuming 30% free-riders (those who would have bought a highly efficient refrigerator anyway), the net savings would be approximately 7001,4 MWh/year during 15 years (but only 13 of those fall inside the CDM project timeline). Electricity savings are 105 GWh and the environmental benefits are thus related to the avoidance of emissions of green house gases and local pollutants like SOx and NOx, which would result from the production of this amount of electricity. This would lead to positive externalities on the urban environment where power stations are located nearby large cities, which is often the case in order to eliminate distribution losses.

Impact on development

Other important project benefits include that more people would be able to benefit from electricity services when every service consumes less energy. Since one important aim of market transformation projects is to introduce a trend of decreasing prices for good products more households would get access to high quality products which would further raise their living standard. By inciting local manufacturers to start producing more efficient units the competitive power of local industry may increase and job formation might be positively influenced. The national development plan recognises the need to take additional actions to improve the utilisation of energy to meet the needs while seeking environmental benefits.

7. URBAN TRANSPORT: RAIL TRANSPORT IN RIO DE JANEIRO

Current context and trend[4]

The Rio de Janeiro Metropolitan Region, RJMR, with 10 million inhabitants spread irregularly over 18 individual municipalities and is dominated by the Rio de Janeiro Municipality (RJM) with 5.7 millions inhabitants. RJM generates 4.500.000 jobs. Each day 13 million person trips take place in the RJMR, of which 40% are home-to-work trips. Of the total trips, 67% are effectuated by public transport, 11% by car, 20% by foot and the remaining 2% by other modes. Of the public transport trips, 77% are effectuated by bus (private operators), 14.5% by taxis, 4% by suburban train, 3% by subway, 1% by ferry. Of the 8.7 million trips effectuated by public modes, about half use more than one mode, requiring modal transfer. This level of urban transport activity dominated by the road-based motorised modes has a significant impact on the local environment. Despite an existing 264 km rail network, the lack of integration between the Metro (only 23 km) and the bus company discourages rail trips, in favour of buses and cars, creating heavy congestion during peak hours and significantly increases home to work travelling time. Rio's geography and topography with its hills and tunnels limits space for fully segregated busways.

The metropolitan rail system could replace a large portion of the current road-based urban trips thereby decreasing bus congestion and reducing travelling time. However, the infrastructure and equipment need to be rehabilitated, and the management system modernised. A private sector orientation seems preferable.

Potential CDM project: Rail transport in Rio de Janeiro

The studied project would cost US$324 million and consist of two components and one subcomponent:

- **An infrastructure and equipment component** (96% of the total project cost) including
  - Rehabilitating/ refurbishing rail fleet and infrastructure
  - Rehabilitating or building transfer stations between the trains and other modes (metro, buses, and ferries)
- **An institutional and policy development component** (4% of the total project cost)
- An environment and traffic subcomponent including
  - A study to review ongoing vehicle inspection/maintenance program
  - A comprehensive review of traffic violation fines

Additionality of project

Technological additionality

Rehabilitating and refurbishing will be realised by foreign contractors with some of the best available technology, locomotives and wagons.

Economic additionality

The total cost of the project is US$324 million. Without municipal subsidies the project would not be economically viable, and the decision to invest in such big programs does not meet private investor criteria, but is driven by social concerns. It should be noted that subsidies to the transport sector represent a heavy economic burden which is not sustainable for the municipality.

Construction of possible baseline scenarios

It is impossible to determine the emissions of all sources in the transport sector. Millions of cars and motorcycles, and thousands of buses all emit different rates of many different pollutants. To calculate the baseline, the demand affected by the project has to be determined. There is a choice to do here: all modes of transport may be taken into account (all modes including by foot, only motorised, only public transport, only cars, only rail transport...), then the boundaries of the project: Some actual reductions of emissions are very difficult to specify as for instance, with decongestion on urban roads, speed of vehicles gets higher and time of travel gets lower so global consumption is affected. This will not be taken into account in a benchmark approach. The lasts steps are to choose the parameters for each mode of transport (tC/pass.km; tC/t.km, MJ/km...) and the level of aggregation (country, region, town). Baseline emissions result from the sum of emissions of each mode of transport within the boundaries of the project.

Baseline	Emission factor (gC/pass.km)				EF x AL (thousand tC)			
	Car[6]	Train	Metro	Bus[6]	Car	Train	Metro	Bus
[1)]Benchmark South America	81.7	9.5	12.3	10.9	399	108	65	282
[2)]Benchmark Brazil	65.4	8.2	3.3	9.1	319	92	17	235
[3)]Benchmark region past	78.1	8.2	6.8	8.5	381	92	36	219
[4)]Benchmark region future	59.9	6.5	5.4	7.3	305	74	29	175
[5)]Project specific	NA	NA	NA	NA	NA	NA	NA	NA

1) buses and cars: obsolete and uncontrolled technology, energy used for train is mainly diesel, electricity used for metro is weighted average emissions all sources

2) buses and cars: obsolete and uncontrolled technology, energy used for train is mainly diesel with Brazilian efficiency, electricity used for metro is weighted average emissions all sources

3) buses and cars: obsolete and uncontrolled technology, energy used for train is mainly diesel with Brazilian efficiency, electricity used for metro is weighted average emissions fossil fuels

4) average gain in efficiency around 20%

5) Not applicable without transactions costs that would crowd out this kind of project.

6) rate of occupation for car: 1.2; for buses: 45

Calculations are based on several studies such as « Sustainable transport, Priorities for Policy reform », World Bank, 1996 ; EM Generic Database Documentation for Transport Processes prepared by M. Schmied, Oko Institut, 1999.

Project environmental performance

There would be a positive environmental impact through the reduction of fossil fuel consumption, reduction of motor-vehicle related emissions, and a reduction in road congestion, with a consequent improvement in air quality and noise pollution.

Impact on development

The project would mainly benefit the low income population since they depend on bus, metro and suburban rail services. The integration of these different modes of public transport would result in lower travel times and other benefits bringing down the overall generalised (tariff, time, and safety) transport cost for the user and thus alleviate the burden that urban transportation imposes on low-income households. Concessionaires of the bus, rail metro and ferries will negotiate joint tariffs which are less than the sum of individual tariffs. The credits of emission reductions would either come as an additional subsidy to lower joint tariffs or to lower individual tariffs (metro and rail tariff are US$0.45 per passenger; with the CER tariffs could fall down to US$ 0.40 per passenger). This would represent a good incentive for potential users.

Development of an integrated public transport system under a regional co-ordination body in charge of combining state and municipal pricing and subsidy policy, prioritising major investments and proposing common demand management measures, are important non-quantifiable benefits. Finally, giving the operation and maintenance concession of the proposed project to a private operator would be a first step towards decreasing the investment and subsidy burden (in 1998 subsidies amounted to US$ 27 million) on the state and thus free money to be spent on other development necessities.

8. ENERGY SUBSTITUTION IN BRAZILIAN PIG-IRON PRODUCTION

Current context and trend

The production of pig-iron - a basic component for the production of foundry pieces and steel - requires an important consumption of fossil coal, and, as such, contributes significantly to climate change. An exception exists however in Brazil, mainly in the state of Minas Gerais, south-east Brazil, where the production of higher quality, sulphur-free pig-iron is carried out in small blast-furnaces using sustainably grown charcoal (the emissions are compensated by absorption during regrowth)[5]. For the purpose of supplying energy to this industry, fast-growing plantations, mainly eucalyptus, have been developed in the beginning of the 80's: this is on of the rare examples of industrial plantation of eucalyptus for energy purposes.

Today Brazil, still a major exporter of pig-iron, is faced with growing international competition from countries such as the former Soviet Union and China, with important coal resources. This traditional method of pig-iron production is likely to disappear very soon. The existing plantations in Brazil are currently ageing, and there is an urgent need to replant which implies high investment costs. A lack of fiscal incentives to pursue plantation programs, added to the decrease in the price of coal on the international market, lowers the competitiveness of charcoal-produced pig-iron and induce their replacement by coal blast-furnaces.

Potential CDM project: small units of charcoal pig-iron production

The project studied emerges from a recent CDM project proposal made by PLANTAR, a Brazilian company specialised in the industrial production of charcoal. It consists of the following components: the plantation of 23.100 hectares of Eucalyptus on fallow land over 7 years, and their maintenance over three rotations for the production of charcoal and the implantation of small-scale charcoal blast-furnaces with a life-time of 21 years, for an annual production of 180 000 ton pig-iron.

Additionality of project

Technological additionality

As mentioned, pig-iron production using charcoal has been used in the region of Minas Gerais for a long time. However, the trend is now towards a progressive disappearance of this technology, with a switch to coal: maintaining traditional methods is technologically additional since it goes against the technological trend. If today, other means to produce steel are being investigated, using less emitting technologies, they are at a development stage, and pig-iron accounts for the majority of the steel production.

Economic additionality

The total project cost is estimated to US$ 60 514 000, using a 10% discount rate and assuming a 28 year lifetime. This gives a marginal cost of US$ 16 / ton pig-iron, which should be compared to the production of pig-iron in large blast furnaces using coal of around US$ 8.8 / ton in this region: this means an additional cost of switching from coal to charcoal to US$ 7.2 / ton pig-iron.

Construction of possible baseline scenarios

The emissions resulting from the pig-iron production depend on both the fuel used (coal, coke, petroleum coke or charcoal) and the energy efficiency of the blast furnace at a given aggregation level. The emission factors have been expressed per unit of pig-iron produced (not per unit of reducing agent due to lack of data)[6]. The annual pig-iron production corresponding to AL is 180 000 tons. The specific emission factors might evolve a lot over time, due to possible major changes in production technologies, why a re-evaluation of the baseline might be important.

Baseline	Emission factor TC/ t pig-iron	EF* AL TC/year
1)Benchmark South America	0,380	68 400
2)Benchmark Brazil	0,431	77 580
3)Benchmark region past	0,380	68 400
4)Benchmark region future	0,462	83 160
5)Project specific	0,513	92 340

1. Weighted average EF for pig-iron production in Brazil (75% of South American production) and Argentina (approx. 25%).
2. Weighted average EF for pig-iron production for Minas Gerais (74,5% of Brazilian production), and Carajas and Espirito Santo (25,5%). The EFs for those latter are difficult to obtain.
3. Weighted average EF for pig-iron production from sustainable charcoal (27% of regional production, EF=0), coal (70%, EF=0.513) and unsustainable charcoal (3%, EF=0.705) (coming from native forest that will not be replanted).
4. Weighted average pig-iron EF for sustainable charcoal (10%) and coal (90%)
5. EF for coal (100%).

Calculations are based on data from UNDP Initiative for Sustainable Energy, USGS 1999, Campos Fereira 2000.

Project environmental performance

The replacement of coal by charcoal in the production of pig-iron allows the reduction of GHG emissions, only if biomass is proved to come from a renewable stock: if it comes from the destruction of native forests that will not be replanted, then biomass should not be considered as a renewable energy. The state of Minas Gerais has voted an environmental law imposing that, from 2000, the charcoal come exclusively from sustainable plantations: this should guarantee the sustainability of the biomass used in the project.

The use of charcoal in substitution for mineral coal gives rise to positive externalities on the local environment since it reduces the sulphur emissions which cause acid rain. The certification of the plantations according to the Forest Stewardship Council's (FCS) principles and criteria should guarantee that the plantation forest management is environmentally correct (and particularly that the plantation is not established instead of native forest), socially fair and economically solid.

Impact on development

The PLANTAR project is forecasted to create 3,000 direct jobs in a rural area where employment possibilities are scarce. This would allow the survival of a secular traditional industry, contributing to protect the numerous small independent producers who carry out this production today. The project would doubly contribute to the country's balance of payments: these small metallurgical industries supply the domestic market and also export and as Brazil has few coal reserves, the project would reduce the need to import coal.

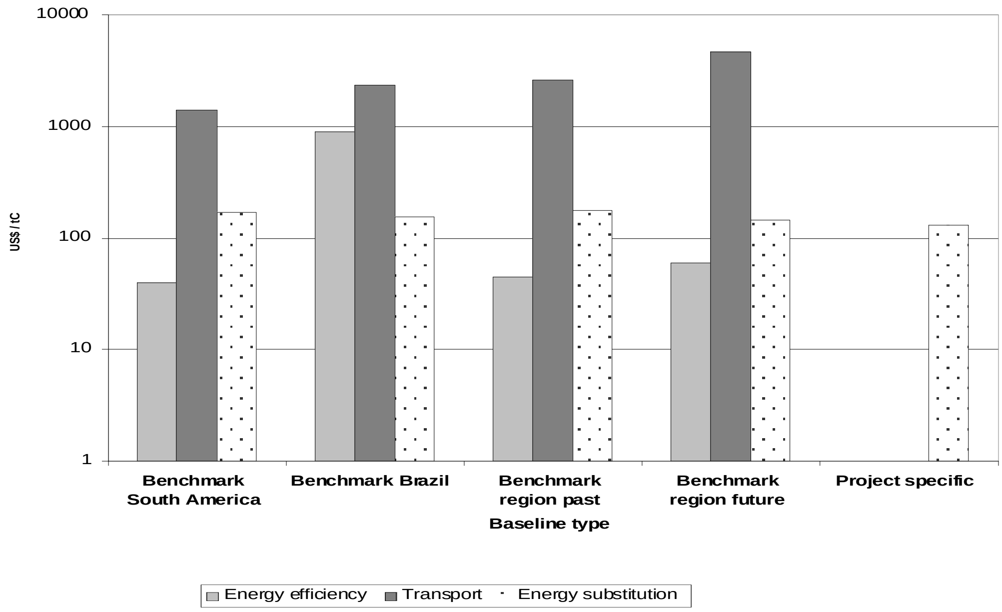
9. RESULTS – THE IMPACT OF THE BASELINE

This section discusses the CDM's influence on the described projects' economic feasibility, and how this impact changes with the deployment of different baselines. The table below summarises the total distribution of CERs (considering 1 tC= 1 CER) to each project that would result from the application of the different baselines types earlier described.

Project type / Baseline Type	Energy efficiency	Transport	Energy substitution
Benchmark South America	24 802	259 031	342 000
Benchmark Brazil	1092	153 918	387 900
Benchmark region past	21 844	139 226	342 000
Benchmark region future	16 383	115 058	415 800
Project specific	NA	NA	461 700

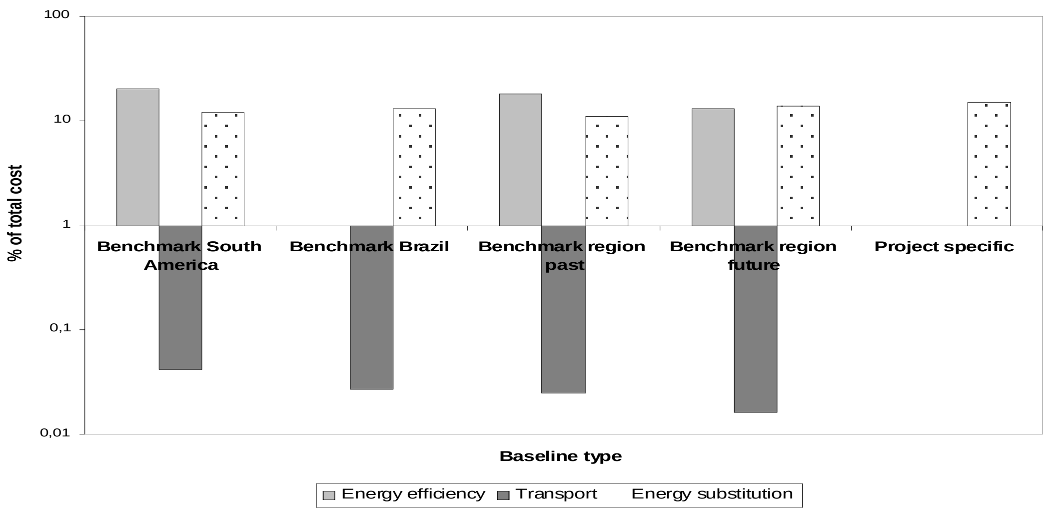
Even if the data used for the calculations are not always precise, and some extrapolations have been necessary where data was missing or incomplete, some general comments can be made. The two following graphs show the effect of the baseline type on the two indicators "Total Project Cost/CER" and "CER Net Present Value/Total Project Cost". A logarithmic scale has been used due to the large dispersion in results between the transport project and the two other projects.

Figure 3. Total project Cost /CER



The cost of emission reductions is highest for the urban transport project under all baseline options. The pig-iron energy substitution project shows the least dependence on the baseline option while the effect on the end-use energy efficiency project fluctuates the most.

Figure 4. CER Net Present Value/ Total Project Cost



The catalyst effect of the CDM i.e. its capacity to make otherwise unprofitable projects economically feasible, could be important in the energy efficiency and energy substitution cases, while the transport project would not be significantly affected by the CER attribution.

The source and technology of electricity generation considered highly influence the baseline. If we for instance use a South American aggregated baseline for projects carried out in Brazil, this will not reflect the high actual use of hydroelectricity in Brazil (more than 95% of total production). In such a context, the baseline is inflated and remuneration of credits will be higher than actual reductions. The risk of non-additional projects is high and the environmental integrity of the Protocol is therefore threatened. On the other hand, with a less aggregated baseline i.e. on country level, projects in Brazil will not be favoured by investors due to the currently low level of emission in Brazil (the number of CERs divided by a factor 20).

In the transport sector, the difference in the number of CERs when using the aggregated baseline (South America) and the regional baseline can be divided by a factor 2. This is less than for the energy efficiency project, but nevertheless, for the urban transport project the number of CER's is of secondary order when compared to the total investment cost of the project.

In the pig-iron energy substitution case, the difference between the national and the continental baseline is not significant as Brazil is the major producer in the region. However, the results would be very different with, for example, a "developing countries" or even a "world" baseline including China who is a major pig-iron producer using very polluting production methods (EF=1,05 in 1990).

In a region where power generation is clean, projects inducing emission reductions by saving electricity will not be attractive if the baseline is regional as the level of reduction compared to the baseline will be small. Therefore investors, naturally interested in getting a big amount of credits, will prefer operating in areas where production is the most polluting. If baselines is such cases are national or even more aggregated, the difference in the amount of credits between different projects will only depend on the technology used, no matter where the project takes place. In this context investors will prefer to operate in countries and areas with good investment conditions (politic, economic, and institutional stability), and thus low risk.

The Rio transport project appears the least attractive under all baseline options and the remuneration of credits will never allow overcoming the investment barriers in this sector. Nevertheless, transport projects are explicit priorities of the United Nations Framework Convention on Climate Change because of their structural effect on development. Looking at the probable *project mix* one can first of all note that big investment projects with long pay-back times, like the urban transport project in this case, seem to be crowded out by smaller projects no matter what baseline methodology is used. Market transformation projects in favour of energy efficiency might face problems to attract private CDM investors as they are facing split incentives and are far from entering a private company logic. As the CDM has a double objective of reducing GHG emissions and simultaneously induce additional development, the mechanism should be shaped in a way to favour abatement projects which also have an important developmental dimension. Today this issue is very little discussed. Emission reductions are to be remunerated with CERs, but the development additionality is just a semantic prerequisite. This implies that many strategic development projects need to be developed together with, and with the financial participation of host country institutions to be of any interest under the currently discussed CDM framework.

10. CONCLUSIONS AND RECOMMENDATIONS

The three projects investigated would lead us to think that the CDM may have a catalyst effect on the realisation of clean development projects in the energy sector demanding small and medium investments, such as the energy efficiency and energy substitution projects in this example. In these cases, the mechanism's catalyst effect depends directly on the baseline which, as we have seen, may make the CER outcome significantly different. Depending on the sector and the nature of the project different baselines are to prefer why no unique method can be used.

In order to respect the environmental integrity of the Protocol we would like to recommend a "non-geographic regional approach". Regions presenting similar industrial production or power generation methods could be aggregated to form "technological regions" or technological contexts where uniform baselines could be used. These regions do not necessarily need to coincide with geographical regions. For instance, in the transport sector, four kinds of categories could be defined depending on whether it concerns rural or urban, passenger or freight. For each category, aggregated regional baselines should be established gathering regions showing similar technological characteristics.

For larger development projects (in the more classical meaning of development, such as infrastructure projects), the impact of the CER crediting under the CDM is weak and cannot alone eliminate the implementation barriers under any imaginable remuneration rate why they need to be combined with other policies and measures.

It is a delicate tightrope walk to ensure environmental integrity, keep transaction costs low and at the same time guide investments towards good and prioritised development projects of all sizes and in all investment categories. To conclude, the baseline indeed makes a difference and would probably better serve the aim of the CDM if the development component was incorporated in the evaluation of the projects. This would help ensure developing countries participation and interest in climate change issues, something that has been judged essential if we should manage to stop global warming.

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12. END NOTES

[1] This example is largely based upon a study by Engleryd and Cunha da Costa 2000 (see references).

[2] The Brazilian National Energy Conservation program.

[3] For more information visit the project homepage at www.energy-plus.org

[4] This study is largely based on the World Bank report: « Rio de Janeiro Mass Transit Project », dec. 1997. Report N° 15937-BR.

[5] The sinks have not yet been acknowledged to be eligible under the CDM. However, the Kyoto Protocol specifies that activities consuming sustainable biomass should be considered as non-emitting.

[6] Also taking into account steel production alternatives to furnace pig-iron such as Primary metal direct reduction (DRI) or Electric furnace scrap recycling.