Clean Development Mechanism

for Low-income Household

Appliances

Criteria for Site Selection,

Implementation and

Participants' Choice

Abbreviations

ANEEL Agência Nacional de Energia Eléctrica

CDM-POA-DD Programme of Activities Design Document

CDM-CPA-DD CDM programme activity Design Document

CEEE Companhia Estadual de Energia Elétrica

CPA CDM programme activity

COPEL

DNA Designated National Authority

DOE Designated Operating Entity

PDD Project Design Document

PoA Programme of Activities

PROCEL Programa Nacional de Conservacao de Energia Eléctrica

SM salário mínimo value in 2006 R$ 350 per month

UN-FCCC United Nationals Framework Convention for Climate Change

1. Introduction

Clean Development Mechanism projects (CDM) are the most important instrument of the Kyoto Protocol. The crucial aspect of this instrument is its “bottom – up” approach. Any organisation can propose such a project and decide on its own preferences how this CDM operates, within the limits of the CDM parameters defined in the Marrakesch Agreement of 2001. Consequently, these CDM appear in the order of rising specific costs to the CDM owning organisations. Among the 2,000 – odd CDM projects defined until mid-2007, only few concern the household level as the first waves of CDM were HFC-23, Methane in landfills and then in coalmines, N2O and so on.

Energy efficiency CDM in household appliances are in their early stages. Only a handful of such CDM implemented on a small scale are validated at present. Kuyasa in South Africa was a first case, started in 2004 (Project Ref. 0079), but remained the sole one until 2007, when the Ghana lightbulb one was approved. Therefore, there is a limited amount of advice and guidance about the actual preparation and implementation of such CDM.

In order to reduce the barriers in the form of financial risk in relation to potential gains, the regulatory authority for CDM, the U.N Framework Convention of Climate Change (UN-FCCC), has approved the regulations for the CDM called Programmatic CDM. The possibility to realise such Programmatic CDM is seen as a crucial factor to expand CDM into household appliances.

This document is intended to serve as a guide to preparing programmatic CDM for appliances. In order to avoid abstractions for complex opportunities, this document uses one empirical case, the replacement of old refrigerators in Brazilian Favelas, in order to present the information required.

The crucial aspect of the Programme of Activities is that such a CDM is appropriate for distributed energy savings. A single appliance has less than one CER of emission reduction per year, and only by adding a large number of units, a CDM becomes viable. The opportunity to combine an unlimited number of appliances involves predicting the aggregated outcome of the many distributed energy savings. Such Programmes of Activities, if pursued in many countries and sectors, could provide a major push to engage in Demand-side Management (DSM) in developing countries. In the past, DSM in developing countries was inhibited because of the different time scales of utilities’ economics versus household economics. I.e. the savings relevant to the utilities economics are beyond the time horizon of the household decisions.

2. CDM Outline

Most CDM projects are designed to fit the carbon traders' concerns. The commodity CER has to take certain shape and structure to improve its tradeability. The technology, the site and the participants are mainly chosen to minimise risk and costs. The same applies here. We assume that there is a CDM investor who wishes to create CERs with high social benefits and who has no preferences for locations or participants.

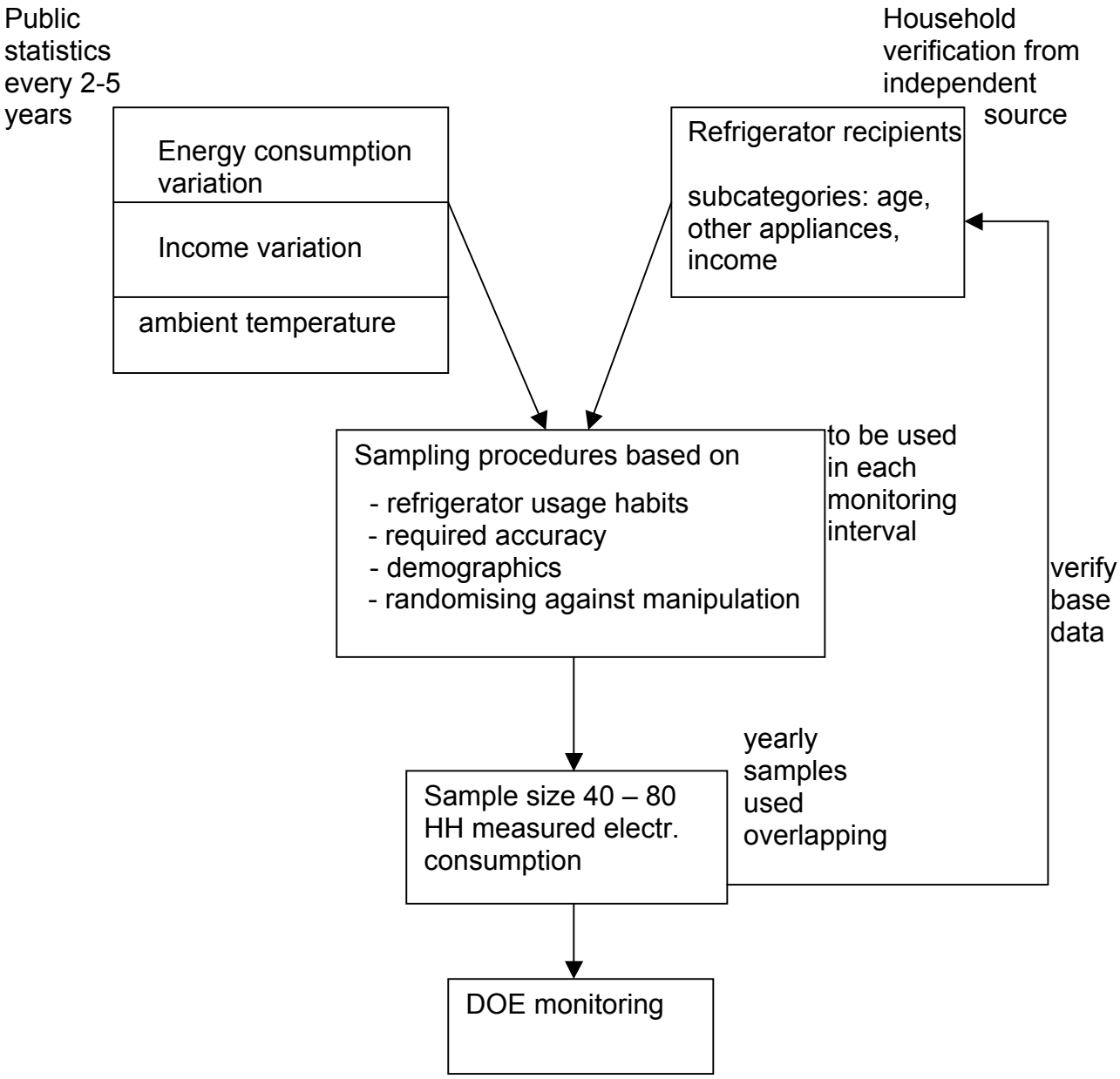
Therefore the investor defines the operational parameters such as choice of households, types of refrigerator distribution and monitoring arrangements purely out of the pursuit of as many CERs as possible and as many households as possible. This does not imply that the design advice would be limited to such an CDM investor, these criteria are just as useful to investors with other interests only that in this case these criteria alone are not enough to define the operational parameters.

We proceed by describing first the site selection and then the participants selection. However there is no sequence, both need to be seen as dependent and related. In many cases it is likely that the participants selection takes precedence, i.e. the suitable organizations for the implementation override the criteria for locations. A strong and well managed NGO will achieve superior CDM results no matter what the social structure of the neighbourhood where the NGO is active. Once the success factors are clarified and many uncertainties of implementation are known, participants selection might become less important than site selection.

Implementation work on the ground and the formalities of CDM are independent. Contract negotiations, measurements and other operational activities can proceed on their own pace. In the Brazilian case, there is one exceptionality, the Brazilian DNA requests that the invitations to the stakeholder participation have to be distributed before the PDD is submitted. The other parts of the CDM registration process are the same as in all countries. Once the DNA issues a Letter of Approval for the PDD, the stakeholder consultation takes place, the DOE submits the PDD for validation at the UN-FCCC, afterwards DOE requests the registration and finally the DOE submits annual monitoring reports are requests the issuance of the CERs.

The crucial element of these steps is the methodology and its flexibility and costs under each sites' conditions. The application of a methodology comprises four general parts, illustrated in the following diagram. First variables independent from the CDM and the site are established, second site variables from other sources are collected, thirdly the sampling procedures are controlled, and fourthly a sample of refrigerators are measured. Based on these results, the emission reduction compared to the baseline case are calculated and this constitutes the monitoring report.

FIGURE 1: Refrigerator CDM Monitoring



3. Site selection

A programmatic CDM allows to cover a large geographic area, even in different countries, and, most importantly, to expand the CDM over time. Each CDM Activity must allow to apply the same set of parameters for its operation and annual verification of emission reductions. Besides these parameters, a CDM Activity also reflects local specifics of the households in an area.

In Brazil, Favelas have a long history of municipal planning and administration. During the military period, Favelas were the object of political struggles between groups of society. During the democratic period, increasingly creative experiments occurred that showed that Favelas can be the geographic units of social policies, offering the Favela population access to education, health services, employment creation and so on. The Ministry of Cities was created only in 2003 in order to coordinate the mostly municipality driven efforts and to popularize an "enabling approach" that consists of strengthening the Favela population's means to transform their Favela.

To design a household CDM Activity, the social characteristics of Favelas are the most important ingredient. It is necessary to define the average household parameters as well as the range of households which are allowed to participate and derive the conditions for their participation. A distinct feature of Brasilian low income settlements is their small size. All large cities in Brazil have several hundred of Favelas, Sao Paulo with 1,500, Rio de Janiero around 660, Fortaleza or Bahia around 600. Therefore the administrative unit of the Favela is also a suitable size for a CDM Activity, as the number of households is within a range that one implementing organization can cover, between several hundred to up to 5,000 households. On the other hand, since information and public perception is important, covering the whole Favela follows the local political processes.

Site selection for household appliance CDM comprises selecting the Favela and deriving economic parameters that allow to define the CDM implementation. Comparing Favelas for their suitability for a refrigerator CDM can be based on the following factors:

Size of the Favela

Paid electricity bills

Part of the refrigerator of the electricity costs

Part of the electricity costs of the total household budget

Number of households without refrigerator

Average income of the Favela

Disposable monthly incomes

Part of the low-income population in the Favela

Participation of households in Favela development efforts

3.2 Municipalities' Data

These nine factors are positively correlated to CDM potential. They overlap in significance because they correlate, however they might also differ depending on the composition of the Favela population.

For the Brazilian case, these factors can be found in several source of data. As it should be for Favelas, the data is partly contradictory because the population is frequently shifting, and the data itself the result of political processes that are likewise unstable.

TABLE 1: Favela size data from Ministry of Cities and from the World Bank

	Favela Households 2000 by Ministério de Cidades	Percentage of Favela HHs of all municipal HHs	Informal households 1998 by World Bank	Informal households increase 1991-1998 World Bank
Sao Paulo	416.143	8.76	438.900	69 %
Rio de Janeiro	349.183	18.78	447.470	58 %
Recife	57.723	9.56	252.700	53 %
Belo Horizonte	107.212	11.99	135.180	45 %
Salvador	65.443	9.69	92.200	73 %
Fortaleza	84.609	16.64	138.300	58 %
Brasilia	8.246	1.38	42.100	
Belem	130.951	30.73	62.700	- 16 %
Porto Alegre	53.447	10.56	172.700	217 %
Manaus	39.505	11.98		
Curitiba	42.854	9.33	76.900	144 %

The data from the Ministry is based on census produced by the national statistics office IBGE and is prone to underestimating the size of Favelas due to biases in the data generation. On the other hand, the World Bank data comes from municipal research bodies who are close to Favela development organizations whose genuine interest is to increase the size of their interventions (Torres 2001).
Utility data is also prone to overestimates. Coelba estimates that there are 357 Favelas in Salvador where 25 % of the population lives, contrasting with the estimate of 9.69 % by the Fundacao Pinheiro.

The basic characteristics of all major cities in Brazil is that 99 % of the Favela households use electricity, that a considerable part of the households maintain illegal connections to the grid and utilities attempt to formalize these as customers, that the Favelas grow between 4 – 7 % per year in size and that their infrastructure conditions deteriorate. The total number of Favela households in Brazil lies between

1.6 mio (World Bank), 4.5 mio (UN Habitat) and over 5 mio (Fundacao Pinheiro). The total number of refrigerators with CFCs as refrigerant is estimated by the Brazilian Ministry of the Environment to be around 30 mio. units.

3.2.1 Income distribution

The income distribution is an important factor for three different reasons. It allows to define the economic conditions of the refrigerator exchange offer, to estimate the number of refrigerators and it is important to demonstrate the additionality of the CDM.

The general trend since 1990 has been a rapid increase in the size of Favelas, a deterioration of environmental conditions, for example in Rio de Janeiro Favelas spread to steeper and less accessible areas, the Favelas densities increase. All Favelas have a majority of wage earners and all offer most formal and informal commercial services. Those Favelas with higher shares of low-income households, i.e. < SM5, tend to become even poorer and the Favelas with higher incomes, > SM10, tend to attract more growth. In other words, the inequality among the Favelas is increasing strongly.

Generally, there is no data available on income distribution of a specific Favela, while there is sufficient data on the municipality level.

TABLE 2: Income distribution in Favela households

	< SM3	3<SM<5	5<SM<10	> SM10
Sao Paulo	51	20	18	10
Rio de Janeiro	61	16	16	7
Recife	82	8	6	4
Belo Horizonte	69	17	10	4
Salvador	75	10	7	8
Fortaleza	77	7	8	8
Brasilia	49	18	20	14
Belem	64	17	12	7
Porto Alegre	52	18	19	11
Manaus	61	14	14	10
Curitiba	52	22	18	7

Source: Fundacao Pinheiro, Deficit Habitacional no Brasil

The difference between the poorest and the “richest” Favelas is that in Recife, Salvador or Fortaleza 3/4 of the households have less than SM3 income whereas in Brasilia, Sao Paulo, Porto Alegre or Curitiba half of the households are in that category.
There is little difference across Brazil with respect to house ownership in Favelas. About two thirds of the households <SM3 own the house and the land, although the title to the land might often not be legally valid. House ownership does not vary with the level of poverty because most of these houses are built through community efforts (“multirão”) using second-rate materials.
Statistical poverty profiles for Brazil always find that education has the highest correlation with poverty. Age, gender, ethnicity and even the occupational status of the household head do not correlate to poverty. Of course on average black or indigenous households are substantially more likely to be poor than white-headed households, however the poverty profiles find that it is education or regional location that correlates better with income. In other words, white households are richer and have higher education. This is only the observation of the situation not the causality. At the end of the next chapter the income distribution will be compared to the electricity expenditures and the average refrigerator age.

3.2.2 Appliance Ownership

Preparing a CDM project, it is necessary to estimate the appliance population and its usage parameters so that the terms under which households join can be defined. Once the CDM project is implemented, the reverse procedure is needed to calculate the emission reduction. In generic terms this estimation involves the following steps.

Step 1: establish the appliance ownership specifically for as many household variables as possible

Step 2: estimate the service needs according to ambient conditions

Step 3: establish the average electricity bills for the household groups

Step 4: define the most important parameters for appliances, for the case of refrigerators, the age of the refrigerator since it combines the emission reduction and the household income

Step 5: Comparing billing records and appliance population to verify data consistency

Step 6: define the target appliance population from the household parameters and check the accuracy compared to micro data

99 % of the Favela households use electricity. The important variable regarding household income is the connection to wastewater discharge. On average 50 % of Favela households do not discharge to the collection system, which represents the largest public health problem in Favelas. The Favela upgrading efforts are generally insufficient and recent and thus extending the sewage collection system is currently the main focus of Favela upgrading in almost all large cities in Brazil.

The low-income tariff created by the Brazilian government in 2002 (Law n. 10.438) provides energy tariff discounts to low-income families. These are eligible when the average monthly consumption is below 80 kWh based on the previous 12 months, without exceeding 220 kWh more than once during this period. They are also eligible of their consumption is between 80 – 220 kWh when they participate in social programmes of the government such as the Bolsa-Familia programme. There is a large part of the population that, despite having low incomes, do not benefit from these tariffs because they exceed the consumption limits. This contributes to high rates of unpaid bills.

PROCEL provides summary data of electricity tariffs for the regions. These tariff averages should not be used for cost analysis but they are indicative of the level of subsidies provided. These official records do not represent the considerable numbers of non-paying electricity users which, in some regions amount to up to 50 % of all households. Cost analysis should use only micro measurement data. The macro records do allow some degree of extrapolation of the potential for household appliance CDM.

TABLE 3: Electricity tariffs and low-income consumption

	Average residential tariff R$/MWh	Average low-income tariff R$/MWh	Total low-income consumption MWh	Total number of low-income customers
North	302.88	145.89	69.62	1,100,323
Northeast	255.20	118.86	437.68	7,846,611
Centre	295.83	147.19	72.04	987,336
Southeast	306.10	151.70	439.42	6,130,981
South	292.23	144.84	132.54	1,840,052

The use of refrigerators is influenced by the ambient temperature and household appliances can be compared directly when used in the same bioclimatic zone. Such zones have been established for Brazil by Roriz et al. in 1999 based on the thermal conditions in typical buildings. The following table contains the data for the winter period. These results do not reflect the housing conditions and refrigerator types in Favelas. Therefore they can be used only comparatively between cities.

TABLE 4: Household appliance usage in different bioclimatic zones, winter

	Refrig use kWh/d	Refrig electr %	Freez use kWh/d	Freez electr %	Light use kWh/d	Light elect %	Showe use kWh/d	Sho elec %	A/C use kWh/d	A/C Elec kWh	TV use kWh/d	TV elec %
Belem, Manaus, Fortaleza, Recife, Salvador	2.00 - 2.61	31 - 41	0.28 - 0.83	6 - 10	0.91 - 0.93	11 - 19	0.24 - 2.16	5 - 26	0.14 - 0.29	2 - 6	0.45 - 0.50	5 - 10
Brazilia	2.59	36	0.59	8	1.03	15	1.25	15	0.3	5	0.49	7
Rio de Janeiro	2.65	31	0.79	9	0.96	11	2.23	26	0.14	2	0.46	5
Sao Paulo, Belo Horizonte	2.69	30	0.74	8	1.02	11	2.35	26	0.1	1	0.49	6
Porto Alegre, Curitiba	2.7	32	0.71	8	1.03	12	2.19	26	0.02	0	0.51	6

Source: E.Ghisi et al. 2007

The results show that for the population as a whole, the climatic differences between North and South of Brazil do not affect the composition of the electricity bill. In other words, conditions of lifestyle, economic well-being are stronger that climatic differences. If in one Favela people have less expenditure for the electricity bill the impact on the behaviour is the same irrespective of the location. This applies equally for the summer period.

TABLE 5: Electricity expenditure

	Percentage HHs with refrigerators of all municipal HHs	Expenditure for electricity, average for the state, R$ per month			
		< SM3	3<SM<5	5<SM<10	> SM10
Manaus	94	20.96	41.62	46.42	159.0
Belem	89	15.44	27.66	33.04	107.3
Sao Luis	89	9.63	22.52	28.80	66.55
Recife	91	9.64	19.66	33.64	66.67
Fortaleza	87	14.97	20.66	33.06	72.19
Salvador	92	11.46	19.45	29.49	60.91
Brasilia	96	32.67	39.41	39.56	59.94
Vitoria	97	25.66	35.66	50.73	87.55
Cuiaba	97	26.48	47.07	62.40	117.95
Belo Horizonte	97	17,53	32.56	45.63	75.11
Sao Paulo	98	23.10	36.49	47.96	75.66
Rio de Janeiro	99	34.77	55.52	65.91	121.5
Curitiba	97	25.15	41.12	48.98	71.66
Porto Alegre	97	29.15	38.03	51.39	77.65

Source: Pesquisa de orcamentos familiares 2002-2003, IBGE

The expenditure data corresponds to averages across the state for income groups. These comprise urban poor and rural poor. These results come from large scale statistical surveys which has the advantage of reflecting typical household conditions and the results are less influenced by such factors as how many households avoid paying bills.

This latter factor renders the utilities' publications fairly useless for CDM, as has been shown in detail for the Caju Favela (ESMAP 2006). While Caju is representative only for Rio's Favelas, the data from Caju should be taken to represent Favela economic conditions across Brazil. Caju is a typical Rio Favela, household income is 15% >SM5, <SM5 28% >SM3, <SM3 36% >SM1 and 22% <SM1 and great differences in appliance ownership so that >SM5 households consume 2.5 times more electricity than <SM1 households. Nonetheless, it was found that the actual utility bills are similar – average >SM5 bill is 26.2R$ and the average <SM1 bill from the utility is 24.8R$. The Caju study interpreted this as indicating that the richer households reduce their bills with theft, paying so-called *gatos*, while the poorest households pay their bills.

Contrary to the little variation of the bills with income levels for Caju, those in Table 5 vary by a factor of 8 for Belo Horizonte but only by a factor of 2 for Brasilia. With the same reasoning than in the Caju study, one could conclude that bills in Belo Horizonte are accurate, reflecting the real variation of appliance ownership, while those in Brasilia are not reliable.

About 30 % of the refrigerators are 10 or more years old, according to a survey by Eletrobras of a sample of 9,850 consumers across Brazil in 2005. Besides the Eletrobras data, the only information on refrigerator units in Favelas available is the above-mentioned Caju study. The Caju study did not record the refrigerator age, so for this crucial variable, Eletrobras data is the only source.

TABLE 6: Average refrigerator age by income class and region

	Income groups in SM multiples											
	1	2	3	4	5	6	7	8	9	10	11	12
North	8.58	5.99	7.69	7.63	7.11	6.07	5.34	6.17	5.6	3.8		
Northeast	7.03	7.04	7.38	7.10	6.54	6.20	6.11	5.18	4.62	2.33	3.00	2.50
Centre	8.11	7.42	6.96	6.57	5.63	5.23	4.59	6.03	6.11	5.67	2.67	3.50
Southeast	8.21	8.23	8.20	7.91	8.40	8.69	8.27	7.54	8.12	8.08	7.94	4.80
South	11.6	11.09	9.06	8.27	7.72	7.51	8.04	7.13	6.00	6.43	7.00	1.50

Source: Eletrobrás survey 2005

These results for regional averages show some counterintuitive differences. In the South, refrigerators are considerably older even so the income inequality to lower than in the North.

The age variation among the refrigerators in a Favela correlates with household income. This observation might appear trivial, but it is an important consideration for the design of CDM projects. A Favela with only very old refrigerators has higher CDM potential, and when the refrigerator age varies a lot, it might be necessary to offer different CDM participation conditions to the households.

The types of refrigerators recorded in the Caju study indicate that the similar income influence in other appliances also has linear character. The richer households have more duplex (two-door) refrigerators, more freezers and much more air-conditioners. For all appliances the correlation with income is monotonous. Between single door and two-door refrigerators it is the corresponding reverse, the households have either one but not both.

TABLE 7: Appliances used in the Favela Caju

	Income groups			
	> SM5	<SM5 <SM3	<SM3 < SM1	<SM1
% of total HHs	14.6	27.8	36.0	21.7
	Appliance ownership Percentage of all Caju households			
Refrigerator	68.7	81.1	88.3	90.0
Duplex refrigerator	31.9	18.1	9.0	14.3
Freezer	26.8	11.7	6.7	2.8
Water filter	73.2	64.6	51.5	41.5
Microwave oven	33.7	18.9	8.4	2.5
Cell phone	59.7	45.5	33.5	20.4
Air-conditioner	45.2	27.0	15.0	4.5
Washing machine	68.8	48.8	34.2	20.4
Electric shower	68.1	53.6	39.9	26.4
	Estimated real power consumption based on appliances present in R$			
Average monthly bill	84.99	59.62	43.62	23.25

Source: ESMAP 2006: 24.

These results correspond to 6,600 households in Caju and this size allows to use the data for statistical calculations. The focus of the study was the assessment of energy poverty mainly through a series of focus groups to generate qualitative information. Caju is probably not illustrative of energy supply in Favelas in general because the distribution of LPG is influenced by criminal groups. Caju is also prominent because it was the first Favela to participate in the *Morar Legal*

programme in which 900 house ownerships in the Favela have been legalised. The high level of *gato* activity in Caju is possibly related to these circumstances. The overall conclusion for Caju was that at full cost, the energy budget per household lies between 6.6 and 14%. So for all income groups the full cost is above the assumed maximum of 5% of the household income.

Crucial results from this study regarding access to credit and payment behaviour will be used later on to define CDM additionality. What is important to stress here is that the big variation in appliance ownership and usage between rich and poorer households found comparing households within one Favela corresponds to the variation in the regional Eletrobras survey. To express it in different words, given the level of economic development in Brazil, appliance ownership in Favelas is a direct result of income and social status.

Energy efficiency of the refrigerators without wear and tear from usage would be efficiency of the new models. The evolution of the consumption of new refrigerators according to the PROCEL labelling system is shown in the following table.

TABLE 8: Average energy consumption of new refrigerators, kWh per year

	1986	1990	1995	2000	2005
One-door	478	440	410	385	340
Compact	390	360	320	290	260

Source: PROCEL 2006

The linear approximation of this reduction for the one-door refrigerator has a standard deviation of R^2 = 0.9918. This linear approximation can thus be used without reducing the accuracy of the data. The approximation allows to calculate what the consumption would be for each income group in TABLE 6.

$$\text{Average consumption [kWh/yr]} = 14{,}903 - 7.2633 * (2005 - \text{age})$$

This approximation gives 420 kWh for SM2 in the South with 11.09 years refrigerator age. Under the average South low-income tariff this is a monthly bill of 5.07 R$ for the refrigerator. This compares to 29.15 R$ average expenditure according to Table 5 for Porto Alegre or 17 % of that.
The same calculation for SM4 in the Centre with 6.57 years gives 388 kWh or 4.75 R$ per month at the average tariff for the Centre. This compares to 39.41 R$ for Brasilia or 12 % of the total.
Or for the Northeast and SM7 this comes to 381 kWh, multiplying the Northeast tariff, it is 3.77 R$ for the refrigerator. Table 5 gives 32 R$ for that income group (5<SM<10), or 11.8 %.
Obviously the calculated refrigerator consumption is lower because the wear and tear of the refrigerator reduces the efficiency from the efficiency of the new models listed in TABLE 8. Furthermore the refrigerator ages from PROCEL are grouped under regions, whereas the expenditures (POF survey from IGBE) give averages for

the states. Nonetheless this calculation allows to conclude that data gathered in 3.2.2 can be internally consistent.

The biggest surprise in the ownership data is the higher average refrigerator age for the south region (bottom row TABLE 6) because with less <SM3 households a lower age would be expected. Being based on a 9,850 strong sample, this should nonetheless be correct. Comparing south and northeast regions for SM1, south has 4.57 years older refrigerators. Using the linear approximation for consumption this translates into 33 kWh (7.2633 * 4.57), a significant part of electricity savings in a CDM, and certainly even higher because of the decrease in efficiency through wear and tear of the refrigerator.

A second observation on TABLE 6 is the strong increase in refrigerator age with decreasing income, in all regions but with the exception of the southeast. For SM10 the average age is half of SM1 but for southeast it is almost the same. This observation should be discarded because the number of >SM10 households in the sample could be too low be useful. Whereas for the <SM5 households the size of the sample makes it more representative.

Next to the refrigerator age, the expenditure for electricity (TABLE 5) is a relevant variable in relation to the income distribution. In the poorer Favelas of Recife, Salvador and Fortaleza, the higher income households consume more than 5 times the electricity than the <SM3 households. In the Favelas of Sao Paulo, Porto Alegre and Curitiba, the difference in electricity consumption is lower. In other words, income appears a more constraining factor in the northeast than the south. In parallel, the <SM3 households in the south pay 3 times the bills of those in <SM3 households in the northeast (30 R$ vs. 10R$). Whereas for 5<SM<10, the south households pay only 50% more than the northeast (48 R$ vs. 32 R$). The low-income tariff in the northeast is only 22% higher than in the south so this cannot explain the difference.

The composition of the household appliances can not explain these differences in electricity bills because refrigerator ownership is above 90% in all cities. The only appliance difference between northeast and south is that in the south a higher share of the electricity use is in electric showers, whereas in the northeast it is up to 40% for the refrigerator. Both are essential household needs. When refrigerators and showers are of the same importance for well-being, then the lower expenditures in the northeast must indicate that northeastern households are more forced to reduce consumption than the south equivalents within the same income group.

Whatever the reason for the higher electricity expenditures in the south are (TABLE 5), the fact that the electricity bill's share of the income is higher implies that the participation in a CDM should be more attractive in the south. This counterbalances the conclusion that, since the correlation between income level and refrigerator age is so strong, the poorest Favelas hold most CDM potential. It should be stressed that these are not necessarily of the same order. Targeting the oldest refrigerators increases CDM income which is invariant for the participating households, it is more in the interest of the CDM owners. Targeting households with lower bills within the same income group, assuming this corresponds to the highest needs constraints, is more the households' interests and less the CDM owners'. Although it goes together

with targeting the Favelas with more low-income households (because of more older refrigerators) to increase CDM operational ease as households have more incentives.

Ideally, one should consolidate the available information into electricity consumption per appliance for each household group. It is possible to estimate this from the above information, however the gaps between appliance ownership, appliance models and electricity bills can not be filled. For the Brazilian case, we can use this information but it cannot alone predict the CDM results obtainable.

3.3 Household categories for CDM

How can one aggregate the variables to compare available CDM sites ? We continue to investigate this with municipality data because there is no Favela level data available (with the exception of Caju). When the comparison of sites with respect to CDM outcome is defined at the municipal level, the same comparison can then be used on a small set of Favelas and some selected micro level data. In theory one can divide the households into the following categories:

A – pay current bill and pay part of new refrigerator with CDM discount

B – pay bill and do not participate in new refrigerator cost,

C – pay bill and switch off old refrigerator during the day to reduce bill, new refrigerator would therefore increase refrigeration service used, actual bill reduction is less than the efficiency gained because of large rebound, avoided maintenance costs are also relevant

D – pay bill and reduce it always even with the new refrigerator, rebound is smaller than C because bill always remains an important constraint on HH budget

These 4 categories follow from their economic interest towards the CDM. At what level of income these categories lie is difficult to establish based on the household income alone. The number of children, the value of accumulated property and the access to income support play an important role and can not be easily included in one analysis. In the Brazilian context, these categories spread well over the income levels in Favelas:

TABLE 9: Household categories

	Appliance usage	Economic situation	Bill / consumption varies when
A > SM5	usage not affected by electricity bill	Formal employment by head of household, access to credit, bank account and credit card	Efficiency changes, new appliances
B < SM5, > SM3	usage not affected, but more appliances would create this	Formal employment Credit limited	
C < SM3, > SM1	usage sometimes constrained	Informal employment No credit	
D < SM1	usage always constrained	Informal employment no credit	Only when income changes

It can be assumed that households in all 4 groups use *gatos* to reduce their bill but do it for different reasons. According to the energy study in Caju (ESMAP 2006) the highest income households actually use *gatos* more than the poorest households because the actual bills to the households in Caju (from the utility Light in Rio) vary only by a few R$ per month.

The best distinction of these 4 categories is the type of economic concern determining energy behaviour. A household A does not change its consumption behaviour because of the electricity bill and the consumption is expected to increase with the expanding use of air-conditioners. A household B has a smaller number of appliances in use and although it has access to credit, such a household does not satisfy all appliance needs, especially microwave ovens and air-conditioners. A household C reduces the usage of appliances to limit the monthly bill and since the head of household has no formal employment, it can not purchase an appliance with credit. Finally a household D must reduce the bill to the minimum all the time by switching the refrigerator off regularly. The energy study in Caju found that the poorest households do not use *gatos* at all. There is of course some overlap between these categories, for example an exceptional household with income SM6 might not have the typical appliances for this category or a household with SM2 has bought much second hand equipment and can only operate them with *gatos*.

In order to define household categories for the CDM, it is important to choose those variables that distinguish the energy behaviour best. Employment type has strong implications for energy behaviour but the differences between household categories

are gradual and households D contains 22 % heads of households with signed work documents. Therefore employment type can not be used only. Electricity bills vary between months and this parameter is influenced by the *gatos* practices and thus difficult to operate.

The most stringent distinction between households is their access to credit. A household with bank accounts and credit cards can manage its economic situation better than a household with cash constraints across a month. This ability also influences the need to switch off a refrigerator to keep the electricity consumption bill under a certain limit. In addition the parameter access to credit also has the advantage of operational ease, because bank accounts can easily be documented by a household.

The following conclusion is valid across all Favelas:

HH with formal employment and access to credit = usage unaffected by bill

HH income below SM2 = usage constrained by bill

This distinction is will be used subsequently for the design recommendations for refrigerator CDM in Favelas. It does not cover the whole range of energy behaviour but this distinction is a minimum definition of the principle difference.

It can be used giving the first precedent over the second. This to say any household with formal employment and credit access is treated as such irrespective of the actual income. A household without formal employment or without access to credit is still considered as such if its income is >SM5. Only <SM2 formal employment and credit is not taken as such.

With respect to the design of a CDM project the 4 household categories can be divided into 2 objectives. In order to correspond closely to the household's interest, a CDM can be designed for either of these two. While they overlap, the households of one objective are better of when no households with the other objectives are represented. In other words, when the refrigerator choice, the participation conditions and the monitoring are chosen to achieve one goal for all participating households, then the participation brings maximum benefits to these households.

Objective 1: maximum reduction of the electricity bill

Objective 2: maximum inclusion of old refrigerators

These 2 objectives are set apart by the household behaviour and by the billing. C and D households employ various strategies to have some refrigeration services with minimum expenditure. Households C and D are targets for low-income tariff setting and a CDM can take into account that the 80 kWh/mo. rule does not fit all such households. Households A and B can satisfy their refrigeration needs and a more

efficient refrigerator does lengthen the time period of their economic behaviour. They can contribute to part of the refrigerator costs.

Comparing the socio-economic factors of a Favela, one can devise a comparison variable suitable for the objective 1 and a different comparison variable for objective 2. For the objective 1, the number of households who are not registered is a negative factor, whereas for objective 2, the number of un-registered households is a positive factor as there is a larger population to tap.

Favela comparison variable for households A and B:

$$\frac{\text{electricity bill} \times \text{income} > \text{SM3} \times \text{Favela size}}{\text{unpaid bills}} = \text{max. bill reduction}$$

Favela comparison variable for households C and D:

$$\text{bills} < \text{SM3} \times \text{incomes} < \text{SM3} \times \text{Favela size} = \text{max number oldest refrigerators}$$

Each of these comprises the size of electricity bills, the share of the concerned households and the total number of households. The unit of these multiplications' result is in R$ corresponding to the total amount of household expenditure concerned. These two are suitable variables for the comparison of CDM locations. Assuming that the technical efficiency gains are the same, all factors reflecting the economic interest of a CDM owner are accounted for. The result correlates directly with the volume of CERs obtainable via the emissions factor.

These two variables are also suitable to evaluate CDM results between organisations. That is to say two Favelas with the same value for these variables are equal opportunities and when one CDM implementor obtains better results then this can be attributed to the organisational capacity of the implementor.

The result of this multiplication corresponds to a part of the utility's income in the Favela but using not the utility's billing but the best available income distribution information (Fundacao Pinheiro) to calculate the amount of this income. This is the best basis for a decision which Favela to choose among the large number of potential CDM locations, whether objective 1 or objective 2 is more suitable for the design in a particular Favela and for defining a minimum size of a Favela below which the additional costs do not warrant the potential CER generation.

Finally, there is one additional element to consider with respect to the electricity tariffs used at present. An important element in the impact of the new refrigerator is the threshold for the low-income tariff, at 80 kWh/month. With a number of assumptions, we can predict what part of the population is in that category. First it is necessary to convert the expenditures in TABLE 5 into consumption with tariffs, and

secondly to convert the average refrigerator age in TABLE 6 into estimated consumption reduction using the linear approximation from TABLE 7. Utilities generate that data certainly and revise it internally, but using IBGE statistics should also lead to representative results. Expenditure statistics also have the advantage of avoiding utilities' accounting habits.

TABLE 9: Average consumption based on expenditure data for income groups

	Electric power consumption per month according to household expenditure data (kWh)							
	SM1	SM2	SM3	SM4	SM5	SM6	SM8	SM10
Manaus	102	144	184	287	319	332	526	1012
Belem	70	106	149	190	260	226	375	490
Average gain	*22,3*	*10,9*	*17,9*					
Sao Luis	59	83	126	189	226	242	325	380
Recife	61	81	121	167	202	285	407	413
Fortaleza	70	126	180	174	252	278	419	496
Salvador	64	97	131	164	208	248	348	486
Average gain	*15,0*	*15,0*	*16,5*	*15,3*				
Brasilia	186	223	196	268	228	269	346	376
Cuiaba	149	180	210	320	365	424	531	593
Average gain	*19,9*	*16,7*	*14,7*					
Vitoria	106	169	213	235	303	334	384	516
Belo Horizonte	95	116	151	215	228	302	335	345
Sao Paulo	131	152	211	241	284	316	400	441
Rio	217	229	334	366	414	434	544	574
Average gain	*20,4*	*20,5*	*20,4*	*19,0*				
Curitiba	154	174	234	284	313	338	392	435
Porto Alegre	148	201	229	263	297	355	401	448
	40,8	*37,3*	*24,9*					

Source: IBGE and own calculations

The average gain listed here is the result of the linear approximation and the average ages of refrigerators in the whole region according to Elétrobras 2005 survey data, and so at best it reflects the statistical average of all households. In the northeast the average gains brings the average SM2 household under the 80 kWh threshold.

In the 4 cities this part of the population is, Sao Luis 20,6%, Recife 20,6%, Fortaleza 21,4% and Salvador, 18,6% of the total population.

In the central region average SM1 consumption is too high to bring it below 80 kWh. Likewise the south region is too high for SM1 (around 150 kWh). While in the southeast region average SM1 households are brought under the 80 kWh in Vitoria and Belo Horizonte but not in Sao Paulo and Rio de Janeiro. In Vitoria and Belo Horizonte SM1 contains 14 % of the total population.
These results can not be used to design a CDM since the averages do not allow to predict what the distribution of refrigerator efficiencies are. However, such an analysis can serve to predict whether there is a larger part of the population in household category D.

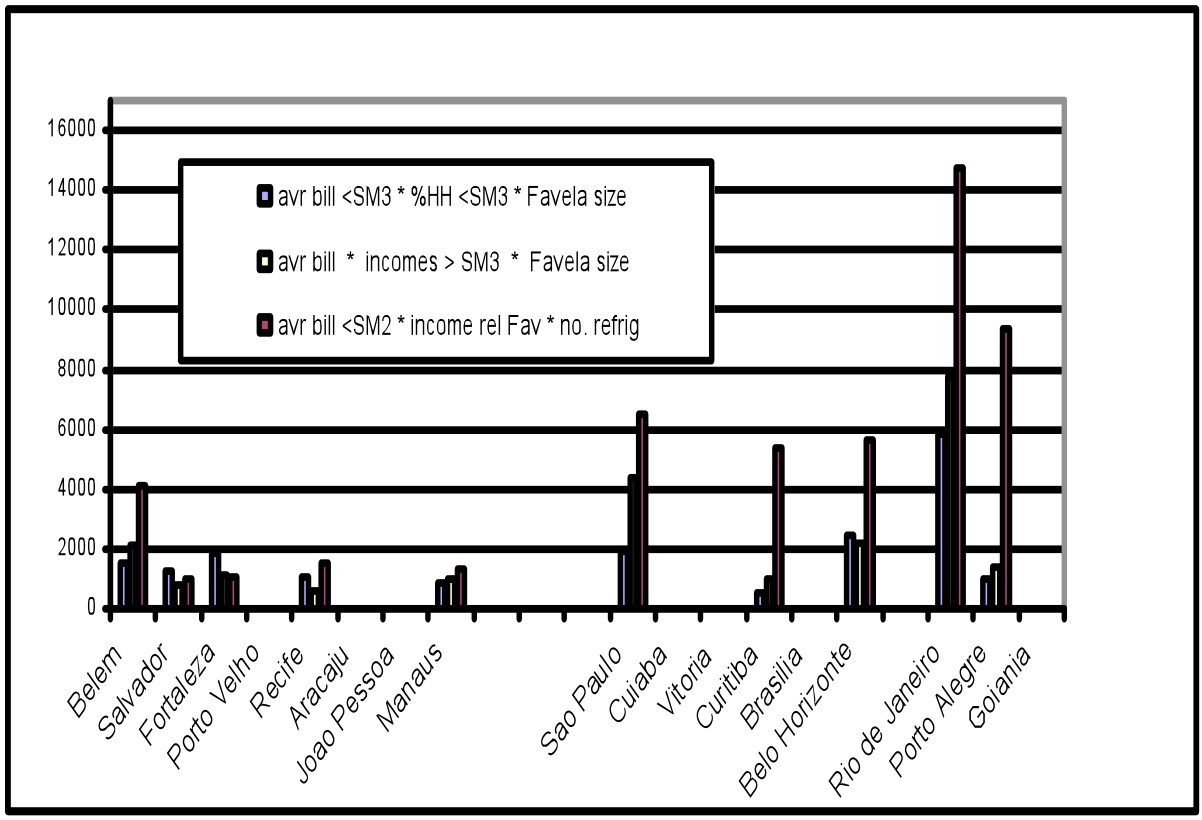
3.4 Comparing socio-economic factors

Figure 2 shows the results for CDM objective “Max. bill reduction” and “Max. no. of oldest refrigerators”. As stated above the unit of these to comparison variables is the same, total electricity bills from the concerned households. For the first objective “Max bill reduction”, it would be preferable to divide by the number of unpaid bills but this is not done here because that data is not available or unreliable.

The blue columns versus the yellow columns show that in Belo Horizonte, Recife, Fortaleza and Salvador, a CDM designed for the second objective would bring higher impacts, whereas in the other cities and CDM designed for the first objective would be larger. For the relative size between Sao Paulo, Belo Horizonte and Fortaleza offer similar potential for objective 1 and only Rio de Janeiro has a much larger potential. For the objective “Max. no. of oldest refrigerators”, Rio and Sao Paulo are far larger, while Belem and Belo Horizonte are half that size and the other cities about one fourth.

To verify these relative results, a third column (brown) is added in which the size of the Favelas is calculated using the ratio between Favela households and total population as well as the average GDP of the city. Thereby the relative affluence of the city as a whole is reflected. Porto Alegre then becomes more attractive as Sao Paulo but besides this, the relative potential between the northeastern and the southeastern cities does not change.

FIGURE 2: Comparison variables for CDM projects



Based on these results from the aggregate data for major cities, it can be concluded that the 2 proposed comparison variables for households A and B, and households C and D does results in realistic results. It remains to assess whether these variables are also suitable for individual Favela data.

3.5 Emission factors

The Brazilian Designated National Authority (DNA) is located in the Comissão Interministerial de Mudanca Global do Clima, CIMGC. It was created in July 1999 and the most influential members are the Foreign Ministry, the Ministry of Science and Technology and the Ministry of the Environment. Of all DNAs in the developing countries, the Brazilian DNA is credited with being the most thorough and science-

based one. This partly reflects the origin of the current CDM in the “Brazilian Proposal” to the Kyoto negotiations that started as the “Clean Development Fund” and then turned into the mechanism.

The DNA issued a new regulation regarding the calculation of the emissions factor on 15th June 2007. According to the rules produced by the UN-FCCC, a CDM proposer has the choice of 4 types of calculations of the emissions factors, the Simple Operating Margin, Simple adjusted Operating Margin, Dispatch Data Analysis and the Average Operating Margin. A CDM proposer has to justify the choice of the calculation submitted. The practice has been widely scrutinized and the general conclusion is that the choice should reflect the future development of the electric power grid in a country. With that conclusion, it is necessary to give the national government, in the form of the DNA, some degree of freedom to change the emissions factors calculation in view of the energy policy pursued in a country. By deciding how to calculate emission factors, the government does in effect possess a new policy tool to shape the electric power grid.

All CDM submitted in Brazil until June 2007 used the Simple adjusted Operating Margin calculation and the publicly available data from power plant output and fuel consumption. While the UN-FCCC rules in fact indicate that a Dispatch Data Analysis is superior especially for countries with dominant Hydro-power capacity, no Brazilian CDM could do so since dispatch data between the power companies in Brazil is not publicly available. Dispatch data reflects commercial agreements between different public and private power companies operating power plants and these commercial agreements contain clauses of confidentiality.

Therefore the Brazilian DNA requested that the power grid operator (ONS) calculates the emission factors based on their knowledge of dispatch data. Being in charge of regulating and managing the power grid in Brazil, ONS is the only public body that collects and distributes dispatch data. The DNA publishes the results of ONS calculations from the preceding year on the DNAs website.

This changes the CDM practice considerably because the new emission factors are much lower than those used before, because these vary between 4 regions and because nobody can control these calculations since the dispatch data continues to be confidential. While these three changes might be reflecting energy policy or climate policy decisions, they are difficult to interpret in light of UN-FCCC regulations. The emission factors are low for the north, the north-east and the central regions and only higher for the southern region of Brazil. This implies that per kWh the southern region emits 10 times more CO2 than the other regions, or that this reflects the Brazilian power grid of the future.

For such an interpretation to be plausible based on technical conditions it would imply that the three regions would build additional hydro power plants in the future, whereas in the south much more fossil fuel plants will be build. The current power grid in Brazil is actually divided into two parts not four, and between these the only connection is too low in voltage so that power is not transferable between the two. This connection lies between the north and northeast on one side and the central and southern regions of the other, and between the states of Goiás and Tocatins. In order for the power grid to fall into four regions, rather extensive changes to the grid structure would be necessary and these are implausible. This leads to speculation

that these four regions reflect the relations between the power companies buying and selling electricity between each other.

Nonetheless, given the sovereignty of ONS and of DNA, this regulation remains in vigour for the foreseeable future.

TABLE 10:

	Monthly Operating Margins for 2006 ton CO2e / MWh											
	Janeiro	Fevereiro	Março	Abril	Maio	Junho	Julho	Agosto	Setembro	Outubro	Novembro	Dezembro
Norte	0,0057	0,0003	0,0001	0,0005	0,0009	0,0035	0,0079	0,0188	0,1472	0,1251	0,0506	0,0443
Nordeste	0,1548	0,1519	0,1671	0,1437	0,1334	0,1244	0,1233	0,0602	0,0789	0,0593	0,0094	0,0096
Centro	0,1586	0,1802	0,1349	0,0782	0,1256	0,1178	0,1539	0,1657	0,1607	0,1456	0,1104	0,1569
Sul	0,9074	0,9663	0,9719	0,9648	1,0027	0,9771	1,0236	1,0110	1,0273	0,8161	0,9667	0,8620

Source: www.mct.gov.br/index.php/content/view/50958.html

3.7 Curitiba

Curitiba is the capital of Paraná and the seventh largest city of Brazil. The metropolitan region has a population of 2.8 mio. The population doubled between 1970 and 1991. The city is considered a model of municipal management and its transport system, the planning tools and the low-income housing programmes are considered the most advanced. Curitiba comprises 25 municipalities. Key actors in town planning are the Instituto de Pesquisa e Planejamento Urbano de Curitiba, IPPUC, and Cohab-CT, a public-private company which implements all Favela development efforts from state and federal programmes.

IPPUC estimates that in 1997 there were 245 Favelas in Curitiba with an estimated 52,716 families living in them. The metropolitan planning agency COMEC published a count of 330 Favelas and 58,530 families in 2002. Favela development efforts concentrate on upgrading the settlements because there is no suitable land to relocate the population. In recent years new Favelas have appeared in environmental fragile areas and so far in 2007 three new Invasão occured.

TABLE 11 : Favela population in Curitiba's adjacent municipalities, 1998

Municipality	Informal dwellings	Person / HH	population	Percent of total	Growth 1992-1998	Percent <SM0.5
Adrianopolis	93	3,93	365	22		55.5
Almirante Tamandaré	4.785	4,27	20.430	28	25.5	25.3
Araucária	1.552	4,23	6.565	9	26.1	18.7
Bocaiúva do Sul	127	4,10	521	17		35.3
Campina Grande do Sul	584	4,24	2.476	10	25.4	23.5
Campo Largo	730	4,27	6.995	11	32.4	18.1
Campo Margo	1723	4,06	3.117	26		21.7
Cerro Azul	42	3,89	163	4		60.6
Colombo	6,253	4,19	26.200	17	13.6	18.8
Contenda	66	4,08	269	5		31.1
Fazenda Rio Grande	1.557	4,29	6.680	15	28.8	21.6
Itaperucu	572	4,26	2.437	25		41.2
Mandirituba	31	4,29	133	2	8.1	30.7
Pinhais	2.293	4,17	9.562	11	7.6	14.6
Piraquara	4.199	4,17	17.510	56	84.6	24.9
Rio Branco do Sul	817	4,26	3.480	23		35.4
Sao José dos Pinhais	3.838	4,09	15.697	9	45.9	15.4
Tunas do Paraná	22	4,10	90	8		52.2
total	29.284	4,19	122.692	10,6	8.76	
Curitiba municipality	52.042		218.576		3.08	9.1

Source: IPPUC, COMEC and IBGE

The Favelas of Curitiba are comparatively recent. Zumbi dos Palmares in the municipality of Colombo was created in 1990, Jardim Alegria in Sao José dos Pinhais in 1992, and Guarituba in the municipality of Piraquara was established in 1994. Piraquara is the municipality with the highest Favela population, more than 50 % of the total population.

The Favela Guarituba lies in a watershed that supplies the city and because of the soil type (mostly peat) it is not possible to protect the surface water from waste water. From a sample of 137 HHs out of 3,400 in total, the metropolitan planning agency COMEC found in 1998 35% with unemployed heads of HHs, 55% employed. From the total sample, 22% had income between SM1 and SM3, and 24% <SM1. 65% come from the rural areas of Paraná. World Bank data shows that the poverty is lower, 87% of the heads of HHs are below SM5. Although 80% of these HHs have documents showing that they bought the land they use, none of these is legally binding since the sellers were fake. The future of the area is politically controversial between a more environmental argument that it is necessary to clear the area and municipal management position that those who live there should receive services and pay taxes. Cohab-CT relocated a small number of HHs but these efforts are too limited to affect the Favela as such. Environmental and land regulations are not suitable or strong enough to solve this conflict.

Financing for the Favela population from federal programmes offers them 10% down payment with 6 % interest over 20 years. For those between SM3 and SM8, housing loans amount to R$6,000 to 8,000. Another federal programme offers houses with 40 square meters in Favelas for monthly payments of R$140 for the first 12 months, thereafter tied to inflation for a period of 15 years, with the option of purchase, for families between SM4 to SM6. These conditions are available for 10 to 15 % of those listed in Cohab-CT's waiting lists.

The 245 Favelas are spread across the city, as illustrated on the following page. The largest Favela areas are in Cajuru, Uberaba and Cidade Industrial neighbourhoods. Comparing the location with the average income map on the following page, the largest Favela areas coincide with the grey areas where average income is below SM3. As in the outer municipalities of Colombo and Piraquara, the Favelas within Curitiba municipality lie in environmentally fragile areas around surface water areas. The main difference is that those within Curitiba do not grow any more, at less than 1.000 households each, and those in the outer municipalities expand already above 4.000 households each.

FIGURE 4: Favelas in Curitiba municipality

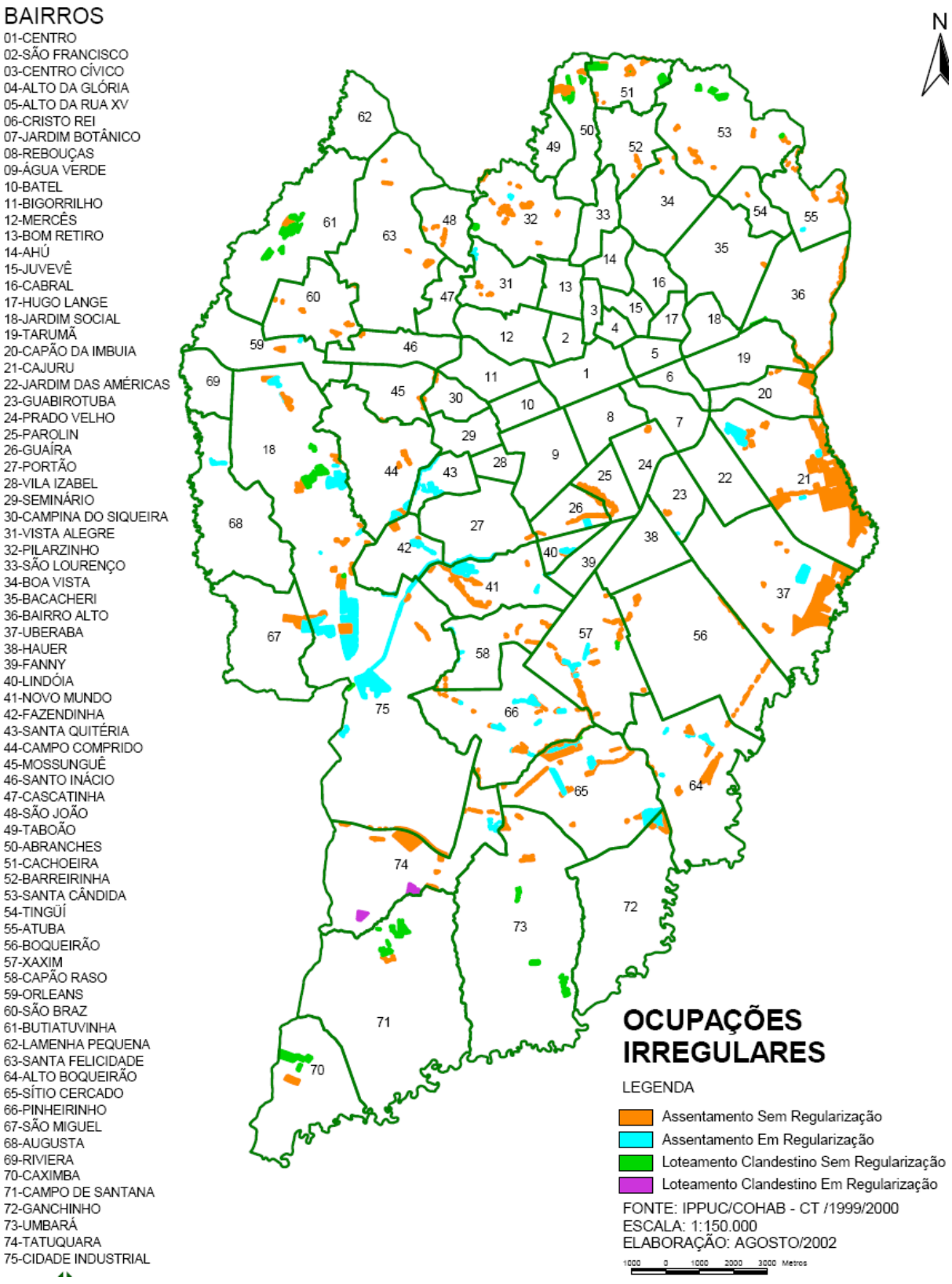
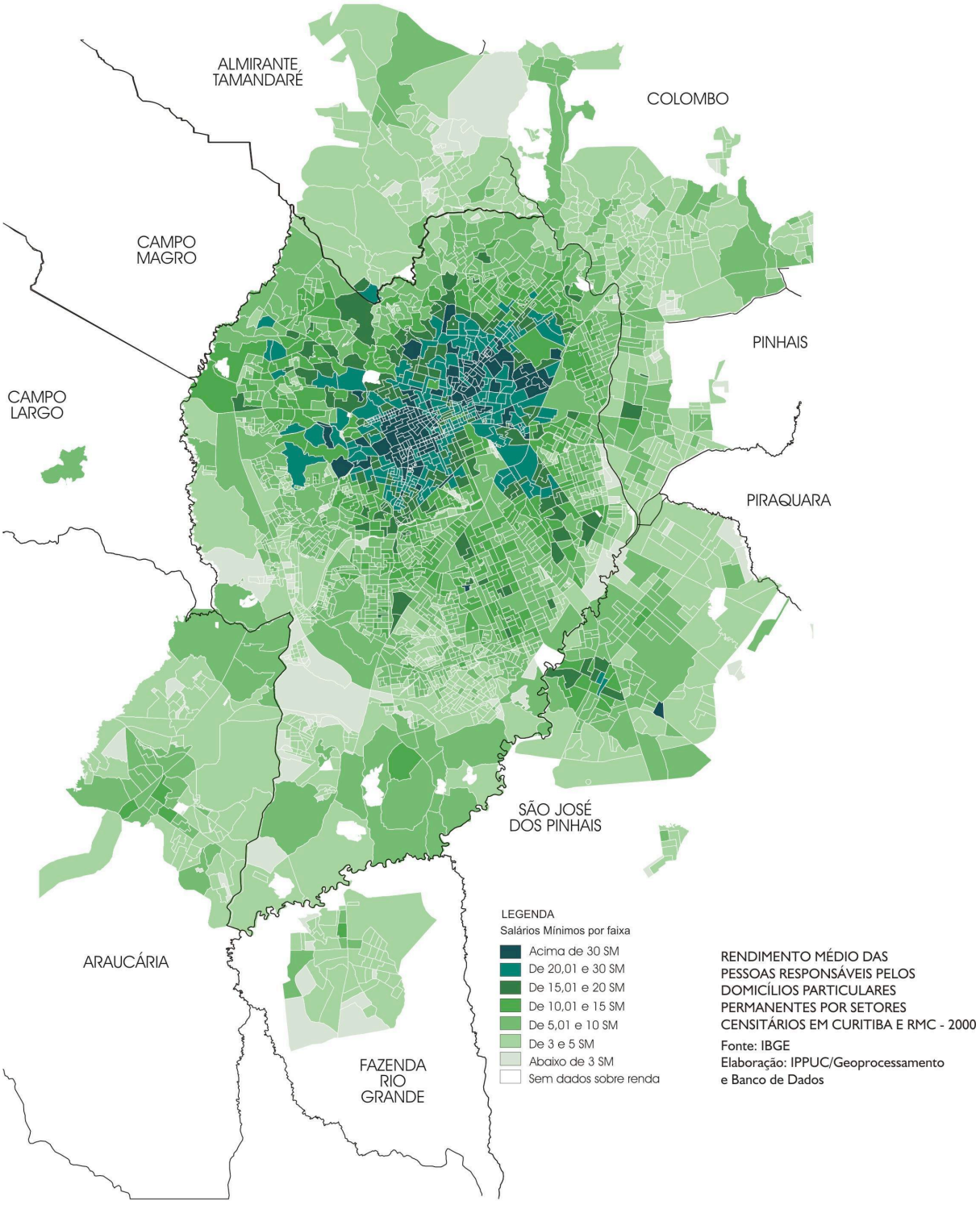


FIGURE 5: Average household income in Curitiba neighbourhoods

Rendimento Médio das Pessoas Responsáveis pelos Domicílios Particulares Permanentes por Setores Censitários em Curitiba e parte da RMC - 2000



Fonte: IBGE - Censo Demográfico 2000

Comparing Income distribution in Rio de Janeiro and Curitiba

Household income varies considerably between the Favelas in Rio de Janeiro described above. Curitibas' Favelas are at the lower but of the Rio range but not outside of the Rio range.

TABLE 4:

	Percentage of HH income			
	<SM1	<SM2	<SM3	
Caju	12	28	36	
Jardim Ocident.	30	27	9	
Lixao	28	22	11	
Mangueira	25	11	45	
Mata Machado	15	23	25	
Parque 2 Irmaos	33	31	21	
Parque Mare	37	30	21	
Vidigal	19	17	36	
Vila Brasil	24	32	28	
Vila Moretti	42	13	39	
Augusta	8,11	22,85	19,2	
Butiatuvinha	7,69	15,58	13,45	
Cachoeira	8,73	19,79	16,96	
Cajuru	8,46	17,7	14,68	
Caximba	8,89	23,19	21,05	
Cidade Industrial	7,91	19,12	17,51	
Ganchinho	11,92	24,69	20,57	
Lamenha Pequena	6,56	23,53	18,12	
Lindoia	7,48	14,05	15,39	
Parolin	12,6	18,07	11,01	
Pinheirinho	8,07	18,09	17,05	
Prado Velho	15,1	22,62	14,04	
Sao Miguel	10,4	29,38	22,96	
Tatuquara	9,46	27,16	21,6	
Uberaba	7,34	16,53	14,53	
Umbara	7,74	19,12	19,18	

In this Table 3 income groups are listed which cover the largest part of the range, only the poorest and richest groups are excluded because data errors are possible. Below SM1 there is almost a net division, all of Curitiba is below 15%, all of Rio above 15%, with the exception of Caju and Mata Machado. To the contrary, Rio and Curitiba have the same range between SM1 and SM2. Curitiba has the least (Mangueira) and the most (Vila Brasil) SM2 household share of all Favelas. Above SM2 Rio's Favelas are also at the higher part above 20% and only Jardim Ocidental and Lixao are at the lower end.

The main conclusion is that Curitibas Favelas have a more uniform income distribution. All of Rio's Favelas have a higher share of very poor and a higher share of richer households compared to Curitiba. Only Mata Machado in Rio has a similar income distribution than Curitiba

3.8 Porto Alegre

Porto Alegre has a distinct history of urban planning and development. The central institution in this field is the Metropolitan and Regional Planning Foundation – METROPLAN, a department in the state government of Rio Grande do Sul. Since the first Urban Development Master Plan in 1970, the central part has been connected with surrounding regions based on zonal specialisation. Favelas have grown and continue to grow in those areas where public transport allows to commute. The migration to Porto Alegre has slowed since the 1990s, however, the infrastructure continues to fail a large part of the population.

The distribution of Favelas in Porto Alegre is similar to that in Curitiba. The 42.000 households in Favelas in Porto Alegre municipality are spread in many mid- and small-sized Favelas, which are more stable in size. The outer municipalities of Novo Hamburgo, Eldorado do Sul, Sao Leopoldo have more recent Favelas, rapidly growing above 4.000 households each. The following table summarises key parameters, indicating that the surrounding municipalities have similar Favela populations.

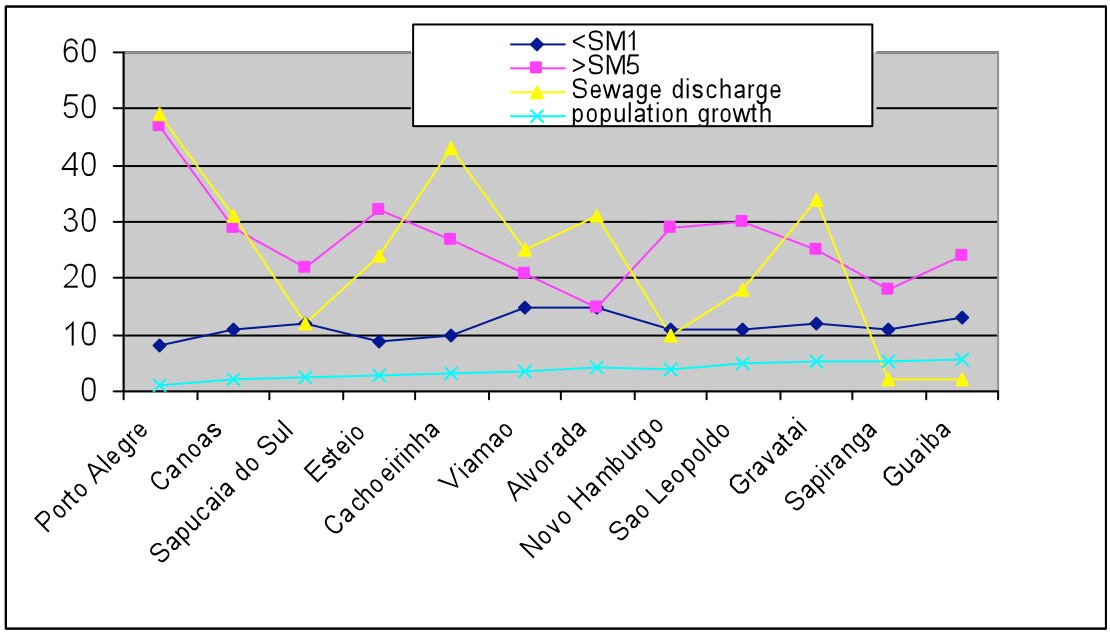
TABLE 12: Income distribution in Porto Alegre municipalities

	< SM1	**%**	**SM1 < SM2**		**SM2 < SM3**		**SM3 < SM5**	
Alvorada	7892	15	12969	25	8973	18	10215	20
Cachoeirinha	3244	10	5671	17	4694	15	7000	22
Canoas	9538	11	15699	17	13052	15	18335	20
Charqueadas	1146	14	1600	20	1172	15	1621	20
Esteio	2261	9	3690	16	3190	14	4883	21
Gravatai	8116	12	12946	19	10090	15	14351	21
Guaiba	3593	13	5524	20	4229	15	5673	21
Montenegro	2528	15	3716	22	2375	14	3082	19
Novo Hamburgo	7597	11	15726	22	11021	15	12842	18
Porto Alegre	35479	8	59291	13	45141	10	69278	16
Santo Antonio	3293	29	3075	26	1424	12	1410	12
Sao Leopoldo	6323	11	11193	19	8685	15	11080	19
Sapiranga	2262	11	6825	33	3387	17	3276	16
Sapucaia do Sul	4540	12	7287	20	7287	15	5612	23
Taquara	2621	16	4037	25	2551	16	2660	16
Viamao	9797	15	14901	22	10177	15	10378	19

	> SM5	%	Percentage of HH with sewage discharge	Population annual growth rates 1991-2000
Alvorada	7643	15	31	4,1
Cachoeirinha	8699	27	43	3.1
Canoas	25886	29	31	2.2
Charqueadas	7909	23	31	
Esteio	7667	32	24	3.0
Gravatai	16640	25	34	5.2
Guaiba	6500	24	2	5.8
Montenegro	16631	25	42	
Novo Hamburgo	20273	29	10	3.8
Porto Alegre	207546	47	49	1.1
Santo Antonio	1548	13	8	
Sao Leopoldo	17197	30	18	5.0
Sapiranga	3566	18	2	5.4
Sapucaia do Sul	8031	22	12	2.6
Taquara	3624	22	13	
Viamao	13737	21	25	3.4

Source: METROPLAN

FIGURE 6: Historical factors for municipal population



Ranking the municipalities from highest to lowest growth rates, it is evident that the higher the immigration, the higher the proportion of poorest households, < SM1. Growth and < SM1 are parallel curves in the Figure above. The municipalities with the highest growth are also those with almost no connection to the public wastewater system.

4. Participants Selection

Household CDM projects are marked by a principal – agent problem, the emission reducer (household) can not reap the CERs or sell them. The CDM owner does this and carries the risks of implementing and the risk of selling the CERs. On top of this principal – agent problem comes a local political process, the utility distributing electric power belongs to the state government (or is aligned with it), towards which the Favela population has a conflictive relation. A CDM project is automatically subject to this political process and certainly does not affect it, the question is thus what institutional arrangement allows a CDM to produce results in the local situation.

A priori, there are no obligatory participants besides the households. The CDM owner can be the utility company, the municipality, a Favela community association, an ESCO, an international investor, the refrigerator supplier, an international NGO, or a local NGO and so on. The legal requirements for the CDM registration can be realised by each of these organisations.

Given the principle – agent problem, a CDM with two partners, households on one side and a CDM owner on the other, is an unlikely solution. The probability is high that the differences in interest lead to blocked negotiations. The suitable approach is a third party, which is given an incentive to be a bridge.

The first question is thus who can be that third party in the local political process ?

When a Favela has been the site of some successful upgrading activity, the organization which implemented it is a suitable third party. “Local credibility or reputation” is a crucial element in the implementation of a CDM.

Implementing a CDM requires 2 contractual relations, CDM owner to implementor, and between imlementor and households. In addition, other participants can be integrated to some degree, in particular the local utility company and the municipal authority. Their participation is entirely open and can be shaped in many different ways. Finally, it is highly recommendable that an independent participant should be engaged that serves as a channel for upward participation by the households and at the same time serves in an educational role for the households.

That comes to a total of 6 functional definitions within a household CDM, 3 whose roles are constrained by CDM regulations, owner, implementor and households, and three whose functions are entirely open, utility, municipality and facilitator. In theory, the latter 3 can be integrated with the CDM owner, or the implementor or the households, but that should be realistic only in very exceptional cases.

Development efforts in Brazilian Favelas are taking place with a history of the bureaucracy of public administration. Distributing refrigerators is prone to clientelist habits because the value of energy efficiency via climate change is unknown to the households. Households can not meaningfully participate in the CDM

implementation beyond the decision to participate or not. From the household's perspective, a refrigerator CDM appears either as an unprecedented commercial relation, or a vaguely charitable form of assistance. Ideally, the implementor would be able to assure that households who decide to participate do so because they approve of the commercial relation, that means they see their commitment to reduce their electricity consumption against the property of the refrigerator. But the implementor can not be sure whether a household actually poses as a willing recipient of assistance.

The direct public interest concerns in the CDM are the improvement of the power grid via the reduction of voltage fluctuations and the alternative uses of the freed-up funds by the households. It should be clear to all participants that these public interest concerns have no relation to maintaining the CDM contractual engagement. The parties to the CDM should mutually engage only in reducing the electricity consumption against a share of the CER sales' income. That mutual engagement is the central characteristic for a successful implementation; its actual communication will most likely be limited since some aspects remain unclear.

Given the novelty of CDM, participants need ample opportunity to re-state their intentions and observe the behaviour of the other participants. In the Brazilian context, a few reasons for the participation ability of an organization can be formulated.

Choice of organizations in refrigerator CDM in Brazilian Favelas

Favela upgrading is a public policy matter under municipalities' jurisdiction. If current upgrading programmes allow, the CDM implementation can be organized in relation to them. Energy savings occur under the jurisdiction of the local utility company and the CDM can be part of a utility's service provision to its customers. Neither of the two are intrinsically necessary. When past Favela upgrading efforts or a utility's services are too rigid to implement a CDM, then it is preferable the exclude them from CDM implementation. The rigidity rests in the clientelist tradition but perhaps just as much in socio-cultural traditions of the Favela population.

> "Politicians' promises are well-known to community leaders, as some of the leaders are themselves on politicians' payrolls. As one project technician says, "There are some good neighbourhood associations, but others live off building platforms for politicians.
> During the community focus group discussions, it was observed that residents tended to speak little, generally tended to agree with the community leaders and did not voice their own opinions. There was a pervasive respect for hierarchy and a passive submission to the more dominant community members." (Imparato and Ruster 2003: 335).

As in this World Bank – funded upgrading effort in Guarapiranga, Sao Paulo, even very novel programmes remain constrained by the traditional relation between local government and Favela population.

This translates into a preference for an implementing organization that is already well known and credibly independent from the utility and from the municipality.

This is a first criterion for choosing the implementing organization, reflecting the external environment of the CDM.

The second criterion reflects the internal demands of the implementation. The implementor needs to understand the socio-economic conditions in a household, the needs for monitoring and the few technical aspects of the refrigerator. Since a CDM is quite an unusual phenomenon in Brazil, communication is the most important constraint. CDM monitoring (as required from the Designated Operating Entity) is also a very "extractive" way of gathering information, there needs to be a vehicle for information in the opposite direction, able to convey the CDM regulations and the nature of the Kyoto Protocol. The implementor will struggle with the difficulty of conveying this to the households while having the functional role of deciding whether a household can participate or not. This decision carries with it the suspicion of clientelist interest while the judgement by the implementor can not be fully formalized.

There is one precedent in Brazil, where a utility has hired an NGO to implement a refrigeration CDM, in Salvador, Bahia. Coelba is the investor-owned distribution utility in that state. It funded this CDM from a general power sector fund "RGR", with authorisation from a federal government agency. The CDM is one activity in a series of Favela oriented efforts of Coelba (doubling the number of regular customers in Favelas) and it cannot be assessed in isolation from them. This one precedent is therefore not a suitable pilot from which to draw general lessons about Favela focussed CDM. The utility Celpe in the state of Pernambuco is following Coelba but due to the size of the Celpe programme (number of refrigerators and Favelas), it cannot be considered a pilot.

Well aware of the obstacles, Coelba decided to hire an NGO, "Cooperation for Human Living and Development", for most tasks of CDM implementation. This NGO selected, contracted, trained and supervised the "Agente Coelba". Coelba thus chose to give its name to these Agentes but had them employed by someone else. This choice is very important. "Cooperation for Human Living and Development" is well known in Salvador and has political links to the state government. It has been working in social services in the poorest Favelas of Salvador since 1989, often in a dependent partnership with a prominent Italian NGO "AVSI", part of the Catholic church. Their reputation for competence and integrity has been a precondition for implementing this CDM. AVSI has a distinct approach to social development, influential in state government social policy. These two NGOs are international show-cases for slum upgrading in an holistic manner "according to the social teaching of the Catholic Church, with special attention to education and promotion of the global dignity of every person".

The Agentes were selected in competition among candidates who were nominated by community members or residential associations. The nomination was a tool for Coelba to get individuals for the implementation who have local reputations and their

employment by the NGO is an element intended to keep them unconnected to Coelba. On average there are 3 Agentes in a Favela, that is 1 Agente for 2,000 customers. In 2004, there were 100 Agentes in 65 communities with 200,000 households. Each Agente received a mobile phone and must wear hats or T-Shirts identifying him/herself as Agente. An Agente should visit each customer twice per year and plays a role in identifying the households. Agentes also schedule physical work undertaken by independent electricians. Agentes do not take meter readings, which remain the task of utility employees but they have significant flexibility to change bill payment schedules.

Coelba measures its success in terms of regularization of customers, reduction in individual household bills and increasing bill payments. Favelas with Agentes have a 50% higher number of debtless contracts compared to Favelas without Agentes. The role defined for the Agentes and AVSI's presence has added a new type of relation between Coelba and the Favela population.

Coelba' CDM design choices comprise the following elements for the implementor:

- previous social development record in difficult Favelas
- non-Brazilian origin
- religious affiliation
- keeping all technical work within utility, on-call by implementor
- follow the social development approach of the implementor by including possible income generation or health services
- giving implementor freedom to negotiate financial aspects, while keeping the control and accounting within the utility

When a CDM contains more of the utility's needs, the implementor's local reputation and recognition is more important than management competence and all technical capacity must be contracted in or provided to keep this local recognition.

There is no analysis or documentation of the Coelba case which would allow to infer whether the local reputation of an Agente was more important than his/her affiliation with AVSI or the changed service terms the Agentes offered.

4.1 Stakeholder participation

CDM regulations prevent households from shaping implementation because their behaviour is part of the baseline. Their influence on CDM success is limited to maintaining the refrigerator and allowing monitoring to take place. Another important indirect influence by households is their contribution to communication. Households can participate in the implementor's efforts to explain the commercial core interests within a CDM and the secondary public interests in infrastructure quality and economic development in the Favela. Participation by the households is an important part of assessing and improving the secondary public interest impact.

Impact on the grid can only be established by the utility, but the accuracy of this can be enhanced when it is combined with direct information from the households. The extent of households' active engagement within a CDM is likely to vary strongly between Favelas because the level of community organization in general is very uneven in Brazil. Engagement with a CDM can benefit from the resentment of the Favela population towards their difficulty of accessing infrastructure in general and energy most strongly, as it is a determinant of the process of social exclusion.

The implementor can enable the households to engage in 3 types of participation efforts, meetings, information generation and individual assistance. These 3 could be favourably integrated in most other on-going Favela upgrading programmes. Such on-going Favela programmes can be area-based or special interest groups.

Regular meetings in the Favela

Elect community representatives to gather specific data

example particular uses of electric power

perhaps to prevent "gatos" from their activity.

establish refrigerator maintenance quality

gender impact
new refrigerators can affect cooking in households
the impact on the household economics of female-headed households needs to be established separately. Female-headed households are likely to be concentrated among the lowest-income households in a Favela
Energy supply strengthens the woman's position in the household and eases their entry into the job market.
If an association in a Favela has undertaken a role in slum-upgrading in the past, this could have created some technical skills to contribute to planning or monitoring. The imlementor can consider to pay for this contribution.

On-demand meeting with implementor regarding tariff, refrigerator maintenance

Alternative financial parameters offer

4.2 Organizational capacity of NGO

Organizational capacity is the ability of an organization to use its resources to perform. In this chapter two tools are introduced to assess the capacity of a potential CDM implementing organization.

In the context of Brazilian Favelas, NGOs are the best candidates to implement a CDM project, when they provide local credibility and the ability to mediate between households and the CDM owner. The organizational capacity of the NGOs concerned is to:

- Employ operational personnel
- establish household characteristics
- explain CDM terms to households
- distribute new and collect old refrigerators
- maintain household data for CDM monitoring
- various communication services between households, municipality, utility and CDM owner

This set of tasks is clear and comprehensive. Predicting the capacity of a NGO to realise them is uncertain as there is no CDM experience.

It can be useful to identify from the start the important skills for implementing a CDM for which an NGO might have to learn new ways and what the possible remedies are for addressing them. Based on the current regulations for CDM verification and monitoring, it is possible to describe crucial aspects of the implementation and propose some criteria for assessing the capacity of an NGO. This is speculative without having a particular NGO in mind. Depending on the past operational experience, an NGO might be quick to learn CDM capacity needs or slow. However, some suggestions for criteria to assess NGO are helpful to make it clearer from the beginning what CDM owner and NGO expect or provide.

As NGOs are prominent channels for development assistance, a number of approaches to assess organizational capacity have been popularized in the last 15 years. The most important ones are:

PACT Organisation capacity assessment tool (OCAT)
WWF Organisational assessment process
McKinsey capacity assessment grid
IDRC Enhancing Organizational Performance
INTRAC Participatory self assessment
DOSA New directions in organisational capacity building
ISA Institutional strength assessment
CRWRC Organisational capacity indicator (OCI)

Each one of these approaches can be applied to a CDM implementor. In the particular situation of Brazilian NGOs and CDM, two tools which are a part of all of these approaches can be used in isolation as these are the most important capacity

aspects for a CDM implementor. These are Stakeholder Analysis and Human Resource Management. Stakeholder analysis is necessary to understand the position of an NGO in a Favela and how acting as CDM implementor might affect this position. Human resource management is important because the NGO employees relating to the households need the right incentives and support .

When assessing different NGOs present in a Favela, these can be asked to apply these assessment tools to themselves in light of a CDM. An NGO can produce these rather quickly and the result helps to predict CDM performance but the quality of the results itself also indicates whether the NGO is aware of the challenges it might engage in.

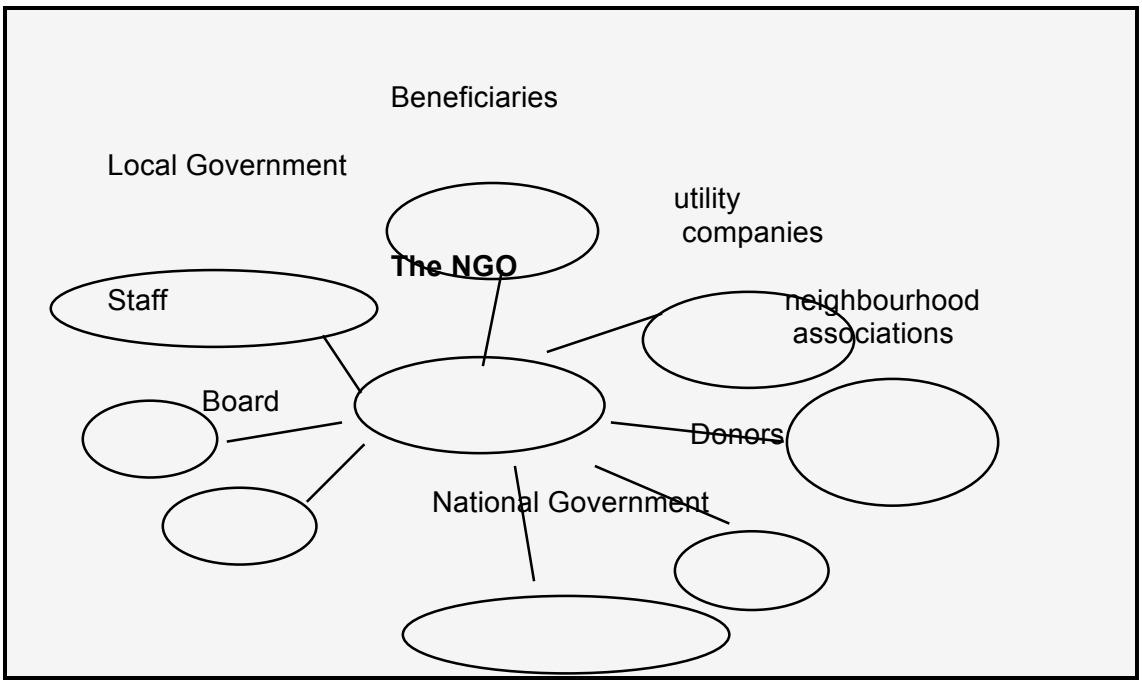
The Stakeholder Concept

This notion that NGOs are intermediaries between different primary stakeholders, the donors and the beneficiaries, and influenced by a number of other types of stakeholder has recently gained much influence in the NGO sector. In fact, some even define NGO management as being the ability to satisfy diverse stakeholders and Fowler (Fowler 2002) defines the NGO "bottom-line" as being the capacity to satisfy or influence their priority stakeholders. What are stakeholders and where did this idea come from?

During the 1970s the term stakeholder was introduced into management thinking as a bridge between the organization and environment to deal with concerns about strategic analysis. Stakeholders can be defined as **"all parties who affect or are affected by the organisation"** - those with an interest in the organisation.

Stakeholder analysis is increasingly used by NGOs because, as intermediary bodies, NGOs are subject to the influences of many stakeholders. Stakeholder analysis helps NGOs identify and define all the parties who have an interest in their work in a more systematic way than merely responding to the different and conflicting demands they make. It can also help identify any previously unrecognised influences. Stakeholders are often shown in a "spider diagram" showing those parties with an interest in the NGO:

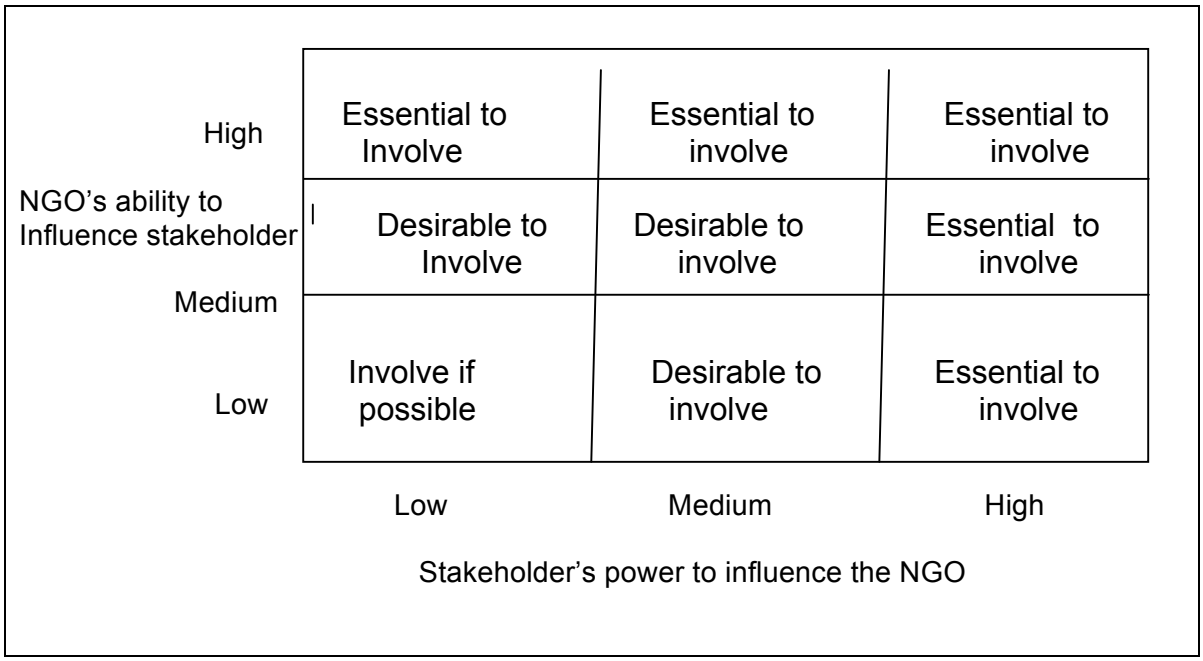
FIGURE 6:



Stakeholder analysis involves two stages:

1. Identifying the stakeholders
2. Assessing the stakeholders according to two dimensions
    - The power the stakeholder has to influence the NGO
    - The power the NGO has to influence the stakeholder.

The stakeholders can be plotted using the matrix below and decisions can be made about which stakeholders to involve more.



The input provided by an NGO can be interpreted as possible strength especially if it identifies:

socio-eonomic groups within a Favela and how its stands towards the NGO
political alliances in the municipal government
diverse economic linkages of Favela households

Human Resources Management

For the implementation of a household CDM considerable staff-time is required and the capacity to organize staff is an important success factor. Similar to the stakeholder "self-analysis" of an NGO described above, a questionnaire for staff management can be given to an NGO, as a guide on how to prepare a proposal to the CDM owner. The following questionnaire is an adapted version from IDRC's recommendation, which has been tested on a large scale in order to make it as effective as possible. Such a "self-assessment" type tool is often limited because of the social and political conditions in a NGO context which are quite difficult to judge from outside the NGO. The level of generality of the questionnaire has been chosen with that in mind.

Does the NGO have adequate staffing procedures to ensure its performance?
Is there a staffing system?
Are there job descriptions or equivalents to determine what it is staffing for?
Is there system for selecting candidates (for example: reviewing curriculum vitae, conducting interviews, checking references, competitive panels)?
Are individuals in charge of selection trained to carry out this function (interview and listening skills, politeness, good judgment)?
Do the recruitment and selection materials (ads, posting, interview questions) allow to recruit the best people from all available labour pools?
human resources development systems and approaches to ensure its performance?
Is there a training and development policy or a budget for training?
staff incentives for learning, by supporting training costs, etc.?
Is someone able to identify training needs?
Is training demand driven as opposed to supply driven ?
Are there plans for mentoring younger staff in their careers?
Do people see career opportunities?
when management changes (retirement, rationalization, etc.) is performance stable?
assessment and reward systems that are fair and motivating?
Is there a compensation policy that complies with the rules and regulations?
Are compensation packages externally competitive for the sector?
Are compensation differentials appropriate to motivate staff?
is staff offered both monetary and non-monetary rewards?
Are there grievance procedures?
Are there measures and procedures to deal with people in distress?
How do you increase the loyalty and the commitment of staff?
Are measures in place to deal with harassment in the workplace?
Are work-related accidents rare?

The Brazilian NGO environment

Specific CDM capacity is available among the Brazilian NGOs engaged in climate policy. The Federal government is strengthening their role by obliging all CDM proponents to inform the climate NGO network “Fórum Brasileiro de ONGs e Movimentos Sociais para o Meio Ambiente e o Desenvolvimento” (FBOMS, www.fboms.org.br) by receiving all Project Design Documents when they are submitted for approval. The 33 NGOs currently engaged in FBOMS thus have a guaranteed opportunity to comment. The Federal government has also proposed to give them a formal role in assessing the proposed Project Design Documents, for

example by controlling whether the methodology has been applied correctly, but these NGOs refused to have a bigger role citing lack of funds and expertise. They are certainly correct since the variety of CDM methodologies requires considerable staff time. So far, no Brazilian NGO has pursued a particular CDM and requested specific alterations.

The members of FBOMS have come a long way from the time when Tony Bebbington (Bebbington 1993) judged that NGOs in Latin America were patchy, recent and opportunistic. Among the 33 members are local branches of WWF and Friends of the Earth, but also genuine Brazilian NGOs with strong roots in national political history such as FASE or Vitae Civilis. 8 FBOMS members are registered as observers at the UN-FCCC. As always the case with ecological issues, FBOMS does not maintain a common policy on CDM. Differences concern the typical questions of the value of additionality, the quality of wider sustainability impacts, the division of CDM income, and the normative basis for a North-South instrument as such.

The environmental NGOs in Brazil do not have links to a Favela which would be strong enough to provide the local credibility. There might be rare exceptions which should be carefully considered. Since many Favelas are situated on marginal and environmentally degraded or fragile land, environmental concerns are rapidly interpreted as excuses for forced evictions. After many years of conflictive relations to municipalities, a CDM is not a suitable occasion to demonstrate that environment and growth concerns can be aligned.

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