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Expanding the Access to Electricity In Brazil

Sub regional technical report by CentroClima/COPPE, Federal University of Rio de Janeiro and CENBIO/IEE, University of São Paulo, Brazil

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EXPANDING THE ACCESS

TO ELECTRICITY IN BRAZIL

José Goldemberg

Emilio Lèbre La Rovere (COPPE/UFRJ)

Suani Teixeira Coelho (CENBIO/USP)

Osvaldo Soliano Pereira (UNIFACS)

Maria Silvia Muylaert (CentroClima)

André Simões (CentroClima)

Roberto Zilles (IEE/USP)

Patricia Guardabassi (CENBIO/USP)

Carlos Eduardo M. Paletta (CENBIO/USP)

Prepared for the "Energy Access Working Group"

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CENTROCLIMA – Centre for Integrated Studies on Climate Change and the Environment

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IEE – Institute of Electrotechnics and Energy

USP – University of São Paulo

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Introduction

The Brazilian electrical service sector initiated a restructuring process by unbundling the generation, transmission, and distribution components of the existing companies some years ago.[1] This ultimately led to the privatization of most of the service distribution assets and some of the service generation assets. ANEEL (Agencia Nacional de Energia Eléctrica), the power sector's regulatory agency, was established in 1996 to regulate the overall operations of the sector. However, little attention was paid in the process to the expansion of the services to low-income and rural areas.

Sponsored by international donors and implemented mainly through concessionaires, a series of pilot experiences of off-grid electrification that used PV (photovoltaic), wind, or hybrid systems in very remote villages resulted in the creation of PRODEEM (Programa de Desenvolvimento Energétio de Estados e Municípios) in 1994 by the federal government. This programme currently managed by MEE (Ministério de Mins e Energia) and aims to promote the off-grid electrification of those villages that use PV systems. Partnerships have been established with the state ministries of energy and with utilities to ensure the installation, operation, and maintenance of the systems. However, there has always been a question mark over the sustainability of this programmeme, which was aggravated by the privatization of distribution utilities.

The difficulties related to servicing the low-income markets, either urban or rural, are intrinsically characteristic of these markets: low consumption per unit significantly reduces the recovery time for initial investments and it is aggravated in the case of rural markets by high dispersion implying higher initial investments. This situation, which was already difficult under state-owned companies, has become more serious due to a privatization process intended to maximize the value of assets to be sold and to minimize obligations to future concessionaires. Once private distribution companies were in place, the weaknesses in the recently created framework became evident. There was a lack of incentives and obligations to implement rural electrification programme, to improve supply to low-income consumers, and sustain existing off-grid projects.

Consequently, both the executive and legislative branches of the federal government have jointly started parallel initiatives to create incentives and obligations for the new concessionaires to invest in rural electrification and to supply such services to low-income consumers. Eletrobrás,[2] under the aegis of MME launched an ambitious programme, Luz-no-Campo, to finance the electrification of 1 million new rural consumers over a three-year-period and to focus exclusively on grid extension. Concurrently, budgets for PRODEEM have been continuously increased. The Brazilian Congress passed Law 10 438, in April 2002, with provisions for the reduction of tariffs to low-income consumers, the establishment of targets for concessionaires and 'permissionaires'[3] to provide full coverage, and the creation of a national fund CDE (Conta de Desenvolvimento Eń ergetico) to promote universal access to electricity and the use of innovative sources of energy. ANEEL is expected to pass regulations implementing the Law, whereby concessionaires must provide full coverage under a target plan. On parallel lines, MME is preparing a programme to accelerate universal access to electricity by ensuring additional resources, and particularly by creating rules for use of CDE resources.

[1] Law 8621 (1993) was the starting point of the process.

[2] Eletrobrás is a state-owned company – Centrais Electricas Brasileiras S A - and a holding company of other federal companies, which owns important generation and transmission assets.

[3] "Permissionaires" are awardees of permission to distribute energy. Permissions are awarded to rural electrification cooperatives, and constitute more precarious contracts.

It is recognized that power sector restructuring and privatization of the distribution utilities have not *yet* provided any benefit to expand the access to energy services. It can even be argued that privatization has served to reduce the pace of rural electrification and to increase the cost of grid extension, due to new standards introduced, and the freeze of incipient renewable energy projects based mainly in SHS (solar home systems). Thus, a concerted effort of the MME, ANEEL, and Eletrobrás are vital to overcome this impasse.

This work aims at the following:

- Identify and characterize the main policy, institutional, and regulatory barriers that have a negative impact on the supply of electricity to low-income consumers in rural and urban areas.
- Analyze the impact of the power sector reform.
- Assess existing institutional arrangements which may facilitate/impede the implementation of the full coverage of energy needs.
- Prepare a set of preliminary recommendations for feasible developments in policy, regulatory, and institutional arrangements that would facilitate the expansion of electricity supply to low-income users.

1.0 Background on Energy Services for the Poor in Brazil

1.1. Electricity in Brazil at a glance

Based on the year 2000 - figures, the Brazilian Energy Balance has a large fraction (63%) of renewable resources in the supply of domestic energy (This section is largely based on ESMAP 2002). The main sources are hydroelectric energy, wood, and sugarcane products. Hydroelectric energy covers 42% of the supply and wood covers 10%. Industrial, transportation, and residential sectors demand 38%, 20%, and 16% respectively of the total energy consumption. Electricity accounts for 40.9% of this demand, and oil and petroleum products for another 35.4%. Brazil imports 18.9% of its energy, mainly oil and petroleum products (a fourth of Brazil's oil demand) and coal. Extrapolating the current trend, Brazil could reach self-sufficiency by 2005. With regard to the power sector, Brazil has an installed capacity of 67.7 million kW, about 92% of which is hydropower. Brazil's remaining electricity generation capacity comes from coal and an ever-increasing amount of natural gas. Brazil's small northern and larger southern electrical grids were consolidated in January 1999, into one grid that serves 98% of the country. Brazil's domestic supply is augmented by imports from neighboring Argentina. The main characteristics of the Brazilian electricity sector are summarized in Tables 1 and 2.

Table 1 highlights the increase of electricity supply in Brazil from 1986 (202,128 10^3 MWh) to 2001 (322,361 10^3 MWh) and a marginal reduction in the participation of the public sector power generation during the same period 95%: from in 1986 92% to 2001.

Table 1 Electricity generation in Brazil, from 1986-2001, by the private and public sectors

	1986		1990		1995		2000		2001	
	10^3 MWh	%	10^3 MWh	%	10^3 MWh	%	10^3 MWh	%	10^3 MWh	%
Total Production	202 128	100 %	222 820	100 %	275 601	100 %	347 733	100 %	322 361	100 %
Public Power Plants	191 473	95%	210 913	95%	260 678	95%	322 464	93%	296 237	92%
Captive generation	10 655	5%	11 907	5%	14 923	5%	25 269	7%	26 124	8%

Source : Brazilian Energy Balance, 2002 (Table 2.25)

Table 2 shows the share of self-generation in 1970 (355+594 MW = 949 MW which is 8.6% of the total 11048 MW) and in 2000 (902+ 2540 MW = 3442 MW which is 4.8% of the total 72937 MW). The share of self-generation was mainly increased by thermopower generation.

Table 2 Installed power capacity (MW)

	1970	1980	1990	1998	1999	2000
TOTAL	***11 048***	***33 472***	***53 050***	***65 209***	***68 181***	***72 937***
Hydropower	8835	27649	45 558	56759	58 998	61324
1) Public generation	8480	27081	44 934	55857	58 086	60422
2) Self-generation	355	568	624	902	912	902
Thermopower	2213	5823	7 492	8450	9183	11613
1) Public generation	1619	3484	4827	5455	5874	9073
2) Self-generation	594	2339	2665	2995	3309	2540

Source Ministry of Mines and Energy, National Energy Balance, Synopsis 2000

Table 3 Sectorwise consumption of electricity (GWh) in the period 1985-2000

Consumption by sector	1985	1990	1995	2000
Energy sector	6224	6837	8299	10592
Residential	32634	48666	63581	83494
Commercial	18473	23822	32291	47437
Public	14377	18133	23079	29712
Agro pasture	4477	6666	9173	13275
Transportation	1146	1194	1211	1265
Industrial	96233	112339	127171	145821
Total	*173564*	*217657*	*264805*	*331596*

Source National Energy Balance, Synopsis 2001 (Based on Table 2.25, pg. 41)

Table 3 shows the importance of the industrial sector in terms of consumption-around 50%- from 1985 to 2000. During this period, the residential sector consumption has increased its participation in the total; from 18% in 1985 to 25% in 2000.

The residential consumption of electricity per person also shows differences in regional terms (Table 4). Although energy consumption is not always a reliable indicator of the quality of life, as inefficient use of energy can account for higher consumption, it can, however, indicate some important regional differences in prosperity. Table 4 illustrates massive difference in the per capita electricity consumption between the southeast (678 kWh) and the northeast (262 kWh) of Brazil in the year 2000.

Table 4 Regional analysis of residential consumption in the year 2000

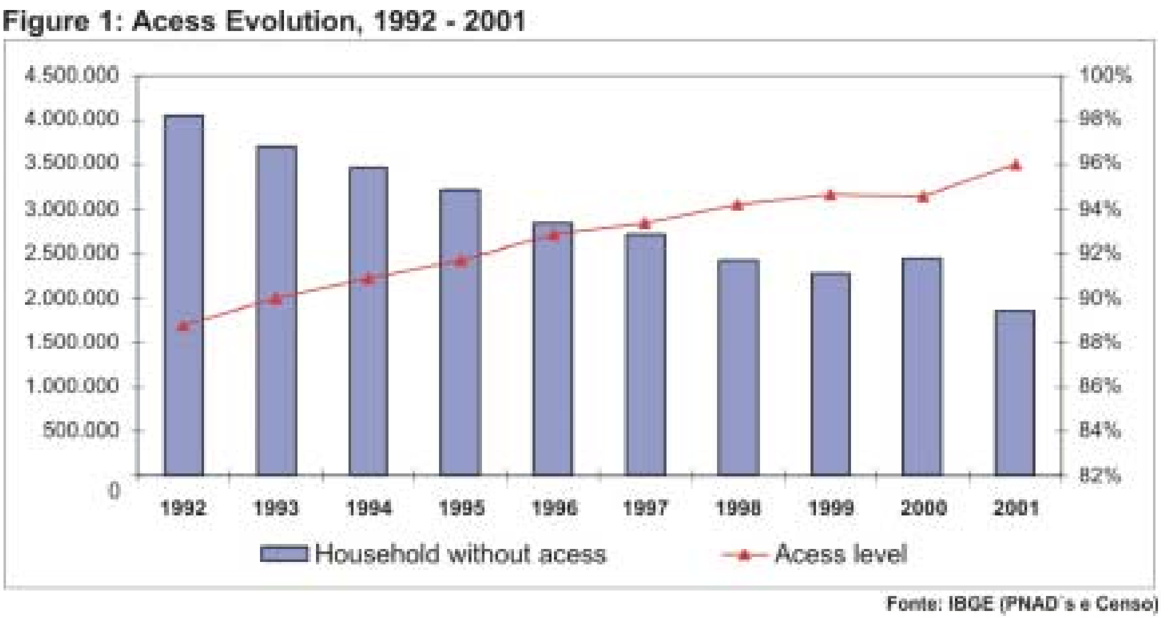
Region	Population (million)	Residential consumption of electricity (GWh)	Residential consumption per capita (kWh)
North	12.6	3,888	309
Northeast	47.2	12,378	262
Southeast	71.1	48,159	678
South	24.8	13,031	526
West-West	11.5	6,038	524
Total Brazil	167.2	83,494	499

Sources National Energy Balance, Synopsis 2001 and Expansion Plan 2001-2010, MME, 2000

1.2. Status of the access to electricity in Brazil

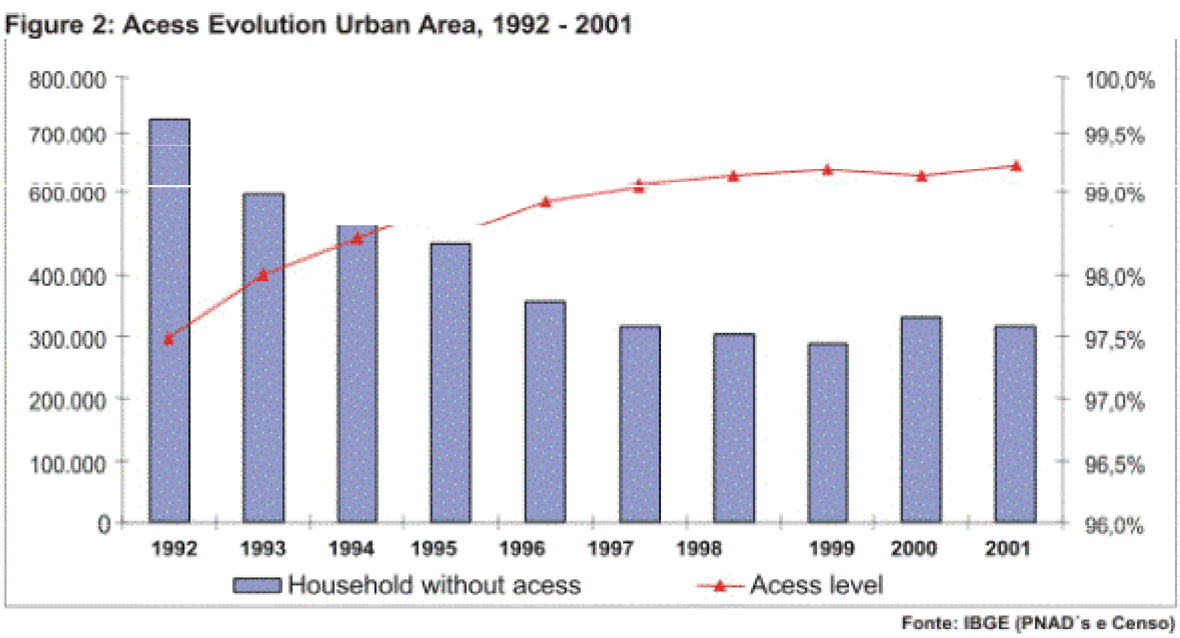
1.2.1. Current picture according to latest surveys

Access to energy services in Brazil has evolved in terms of households covered, from 89% in 1992 to 96% in 2001 (Figure 1).



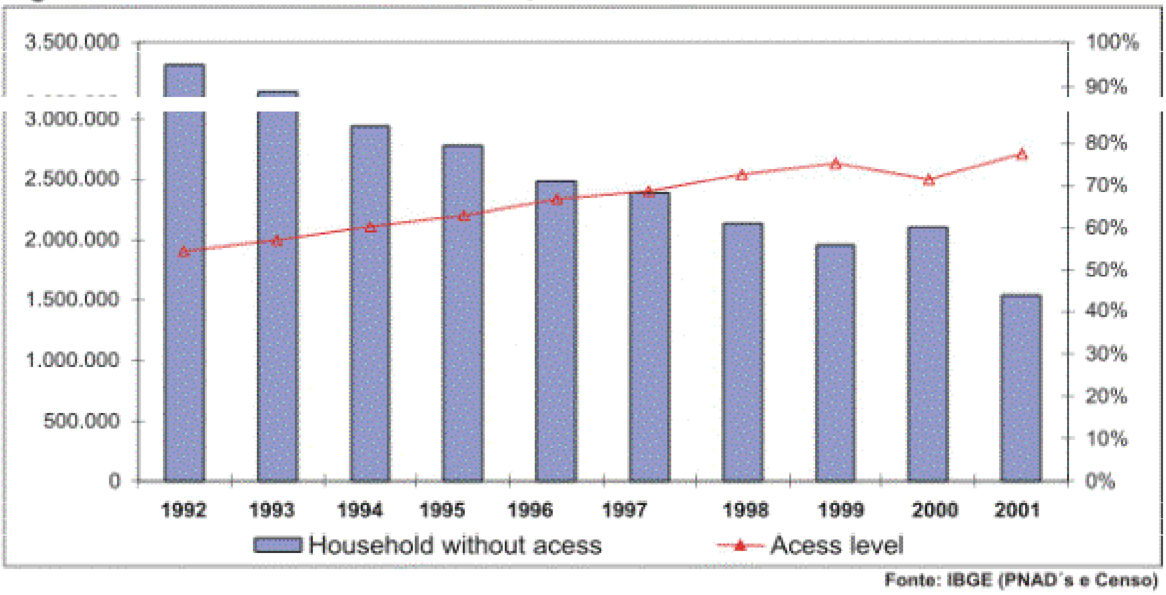
Source: IBGE (Census 2000 and PNAD's).

Figures 2 and 3 show the evolution of the urban and rural environments. It can clearly be seen that most of the problems of lack of access to electricity in Brazil are to be found in the rural environment.



Source: IBGE (Census 2000 and PNADs).

Figure 3: Acess Evolution - Rural Area, 1992 - 2001



Source IBGE (Census 2000 and PNAD's).

According to IBGE (Instituto Brasileiro de Geografia e Estatistica) in the year 2000 Brazil had a population of 168.45 million living in permanent private[4] households[5] of these, 157.46 million had access to electricity and around 11 million people were not attended by the service. Table 5 shows in detail the access to electricity of the urban and rural population.

4A private housing unit is a household composed of one person or a group of persons, where relationships are established by family ties, domestic dependence or the rules for living together. The private housing unit is classified as permanent when it is a house, apartment or room (PNAD 1992, 1993, 1995, 1996).

[5]Households have been defined as a living space, structurally separated and independent, consisting of one or more rooms. Separation is established when the living space is limited by walls, fences, etc., covered by a roof and allows its dwellers to isolate themselves and bear the costs of part or all their food and housing expenses. Independence is established when the living space has direct access, allowing its dwellers to enter and leave, without having to cross through the living space of other people (PNAD, 2001).

Table 5 Permanent private residences and permanent population in urban and rural areas (in millions) in the year 2000

	Permanent private households			Permanent population		
	Total	Urban	Rural	Total	Urban	Rural
Total	44.78	37.37	7.41	168.45	136.98	31.47
With electric lighting	42.33	37.04	5.29	157.46	135.74	21.72
Without electric lighting	2.45	0.33	2.12	1,099	1.24	9.75
Electrification level (%)	94.5	99	71	93	99	69

Source Demographic Census, 2000, IBGE

Another more recent source of data PNAD (Pesquisa Nacional por Amostra de Domicilios)[6], 2001 shows different figures of access to electricity in the urban regions in Brazil, demonstrating progress in the electrification of the urban environment (Table 6).

[6] PNAD – The objective of the PNAD is to produce basic information for the socio-economic development study of the country. This survey is carried out every year throughout the country, with the exception of the rural areas of the states of Amapá, Amazonas, Acre, Rondônia, Roraima and Pará (nearly half of the country's area).

Table 6 Access to electrical lighting in urban regions in the year 2000

Total urban[7] households	39,610,581
Urban households with electricity	39,299,308
Urban households without electricity	311,273

Source Authors' estimate based on PNAD data (2001)

The PNAD-2001 data for the rural environment are less comprehensive than the Census ones, since some rural areas of some states are not included in their survey, thus leading to lower figures (Table 7).

Table 7 Access to electrical lighting in rural regions, 2000

Total rural households	6,893,598
Rural households with electricity	5,353,064
Rural households without electricity	1,540,534

Source Oliveira, 2003, based on PNAD (2001) data

The Census (2000) show data that 64% of the households without access to electric lighting have a family income of two minimum[8] wages. If these households are clubbed along with these households are clubbed along which report no income and those with an

[7] Households are classified as either urban or rural, according to their localization. This classification is based on legislation that was in force during the 1991 Demographic Census. Urban areas are those that correspond to cities (centres of municipalities), villages (centres of districts), or isolated urban areas. The rural area includes all the area outside these limits. This criterion is also used in the classification of urban and rural populations (PNAD, 1999). However, Decree No. 3653 dated 7 November 2000, establishes that a consumer unit situated in a rural area, where activities related to farming are carried out, including processing or conserving agricultural products originating in the property itself, will be classified as a rural unit. Also included in this class is the residential consumer unit used by the rural worker. In addition, a consumer unit localized in a rural area and involved in agro-industrial activities is also classified as rural. Agro-industrial activities include industries that transform or process products coming directly from farming, if the power at its disposal is less than 112.5 kVA.

[8] Minimum wage is 240 reals (73 dollars, April 2003). It means that 64% of the families without electricity have a monthly family income *below 1*46 dollars.

income of under three minimum wages, then it is seem that 89% of the total households have no access to electric lighting.

Another important source of information is the Agricultural Census (IBGE 1996), which focuses on agricultural businesses only. By 1996, some 3 million Brazilian farms had no electricity.

There are substantial variations among the different regions of the country in the access to electricity, (Table 8). Only 68% of the rural population in the northeast region has the same access as compared to a 98.7% access among the urban population of the southeastern. However, these figures refer solely to the accessibility to electric lighting regardless of the source or the quality of service. It is evident that the regions with the lowest rates of access – the north and the northeast — are the poorest in the country.

Table 8 Access to electricity in the different regions of Brazil

Regions	**Non-connected** private permanent households – December 2002					
	Urban	%	Rural	%	Total	%
Brazil	774,355	1.9%	1,942,012	24.3%	2,716,368	5.5%
North	78,068	3.5%	464,449	56.1%	542,517	17.6%
Northeast	264,644	2.9%	1,119,783	32.0%	1,384,427	11.1%
Southeast	267,855	1.3%	144,121	7.7%	411,976	1.9%
South	106,499	1.6%	137,283	10.0%	243,782	3.1%
Mid-West	57,290	1.9%	76,375	17.5%	133,666	3.9%

Source Estimate of Ministry of Mines and Energy based on Census 2000 and PNAD 2001, taking into consideration the achievements of Luz-no-Campo Programme

Eletrobrás has consolidated data from PNAD (1998)[9] and the Agriculture Census (1996) to determine the current status of rural electrification for selected states (Table 9). Huge disparities can be seen in the rural electrification levels among states, varying from 96% in Santa Catarina state to 0.8% in Pará.

[9] A survey based on statistical samples of Brazilian households *with nearly national coverage(* only three states out of 27 are not covered).

Table 9 Brazilian Rural Electrification levels for selected states in the year 1999

States	% of Coverage
Pará	0.8
Roraima	9.7
Acre	2.8
Rondônia	13.8
Mato Grosso	2.9
Mato Grosso do Sul	58.0
Paraná	97.0
Santa Catarina	96.0
Rio Grande do Sul	73.0
São Paulo	78.0
Rio de Janeiro	43.0
Minas Gerais	67.0
Espírito Santo	78.0
Tocantins	13.0
Ceará	63.0
Piauí	7.7
Paraíba	68.0
Pernambuco	68.0
Alagoas	13.0
Sergipe	81.0
Bahia	28.1

Source ESMAP, pg 29

1.2.2. Estimates of recent evolution

Electricity generation in the isolated areas of Brazil, especially the north (basically the Amazon region), is largely based on diesel oil, making use of internal combustion engines of small capacity and, in general, of low efficiency. The diesel oil is subsidized through a fund called CCC (Conta de Consumo de Combustíveis) with resources collected from electricity consumers.

CCC is funded by energy utilities from special taxes on electricity bills for households in the interlinked system. ANEEL Resolution 245/99 determined conditions and time frames for the sharing of projects in isolated electricity systems that substitute totally or partially oil-fired thermoelectric generation (diesel generators). This scheme is applicable until May 2013.

Law 9648/98[10] extended to renewable sources in isolated communities the subsidies already existing for diesel thermoelectric generation in the north of Brazil through CCC.

Besides this, BNDES (Banco Nacional de Desenvolvimento Econômico e Social) is structuring credits to finance electrical connections to rural households that are already running expenses on kerosene and batteries and can afford electricity bills of 12 reals (around 4 dollars) per month.

[10] It is important to emphasize that there is a huge difference between Laws and Decrees. A Law needs the approval of the Senate and Deputy Chamber; a Decree needs only the approval of the Executive Power

Table 10 Energy access in 1991 in the urban and rural areas of Brazil and its northern region (isolated systems)

Energy Access			
	Coverage (%)		
State	Urban	Rural	Total
Acre	95%	13%	70%
Amazonas	96%	16%	79%
Amapá	94%	42%	89%
Pará	91%	37%	71%
Rondônia	90%	20%	68%
Roraima	97%	30%	82%
Tocantis	81%	14%	64%
Region Average	92%	54%	75%
Brazil	97%	49%	87%

Source IBGE, 1991

Table 10 shows that, in 1991, before the introduction of CCC, 87% of the Brazilian — 97% in urban areas and 49% in rural areas— households had to energy access. In the north, of the households 75% in urban areas and 54% in rural areas.

Table 11 Energy access in 2002 in the urban and rural areas of Brazil and its northern region (isolated systems)

Energy access			
	Coverage (%)		
State	**Urban**	**Rural**	**Total**
Acre	98.5%	32.6%	80.4%
Amazonas	97.8%	27.2%	85.4%
Amapá	99.3%	52.0%	95.6%
Pará	97.6%	39.0%	82.2%
Rondônia	98.5%	58.8%	85.7%
Roraima	98.9%	42.4%	88.6%
Region Average	98.5%	48.6%	88.1%
Brazil	**98.8%**	**73.2%**	**94.8%**

Source MME, 2003[11].

Note It was considered the Demographic Census 2000 population and electricity access data projected to 2002 according to historical growth rate of each municipality

Table 11 carries a comparison of energy access in 2002 of the states in the north of Brazil with that of the cumulative figures for Brazil, after more than 10 years of CCC policy. According to ANEEL (Agencia Nacional de Energia Electrica) the north has an installed capacity of 1690 MW from diesel generators.

Table 12 shows the installed capacity, electric energy generated, and the diesel oil consumed in the northern region. No similar figures exist for 1991, but the data obtained

[11] Personal information – Secretary for Energy Development, MME, 2003.

from the last IBGE census are proof to the increase of electric energy access in isolated communities[12].

Table 12 Installed capacity, electric energy generated and diesel oil consumed the different states of the northern region (isolated systems)

	Diesel oil generation		
	Northern region 2002		
State	**Installed capacity (MW)**	**Energy (MWh)**	**Consumption (m^3)**
AC	176.89	467021	144567
AM	890.68	517068	160310
AP	138.72	282971	86939
PA	85.92	226414	68559
RO	209.06	857286	255749
RR	189.23	99622	29866
BRAZIL	**1690.49**	**2450383**	**745990**

Source ANEEL, 2002

Tables 10,11, and 12 illustrate that, in 2002, the share of electric energy access in isolated systems was still quite low as compared to the countrywide figures for Brazil. Moreover, energy access in urban areas was substantially higher than in rural ones, despite the CCC policy.

[12] These are the official figures from the local utilities, not including the informal generation in the thousand small villages spread over the Amazon.

However, the increase in electric energy access for isolated communities can be illustrated by comparing the figures for 1991 with those of 2002.

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Table 13 presents the influence of the CCC policy on diesel consumption and electricity generation in isolated systems. It is evident from the data that due to the CCC policy, energy supply in isolated systems has increased significantly since 1993.

Table 13 Electricity generation and diesel consumption in isolated systems in the years 1993 and 2000-03

Utility	Electricity generation (1000 MWh)				Diesel consumption (10^6 litres)				Installed capacity (MW)		Installed capacity (MW / ANEEL, 2001)			State
	1993	2000	2001	2002	1993	2000	2001	2002	1993	2002	Ther-mal	Others	Total	
1 CEA	13.3	41.9	45.0	11.0	4.2	19.9	13.7	37.8	2.8	11.4	11.9		11.9	Amapá
CEAM	266.8	517.0	580.2	754.2	91.9	160.3	177.6	257.8	99.8	200.9	202.6		202.6	Amazonas
CELPA	206.7	216.7	193.8	63.0	65.9	65.7	59.0	207.1	100.6	66.1	17.3	30.3	47.7	Pará
CEL-TINS	9.1	5.1	721		3.8	1.7	226		18.7			66.3		Tocantins
CEMAR	2.9	2.1	1.3	212	1.1	653	417	661	4.1	184	872			Maranhão
CER	17.0	27.4	26.4	14.6	6.0	10.4	10.2	39.7	9.1	20.7	18.2	5.0	23.2	Roraima
CERON	333.1	215.0	225.4	65.4	104.1	65.7	69.0	220.8	131.6	76.8	37.3			Rondônia
ELE-TRO-ACRE		97.0	104.6	33.3		29.4	31.0	116.6		29.1				Acre
EACRE	52.2				17.0				17.4					Acre
Boa Vista		332.0	190.7			117.0	67.9			129.0	166.7			Roraima

ENOR-TE														
Rio Branco	187.6				58.9				64.4					Acre
Porto Velho	4.6				1.6				152.8					Rondônia
Boa Vista	165.3				67.7				65.0					Roraima
Macapá	58.2				25.7				108.0					Amapá
MANA-US Energia	716.0	1,717	2,616	997.9	228.4	450.0	707.6	3,189	536.0	989.0	267.8	250.0	517.8	Amazonas
ELE-TRO-NORTE														
Macapá		241.1	203.2	70.4		67.0	52.4	260.0		202.0	127.0	68.0	194.9	Amapá
Porto Alegre		642.3	533.0	261.0		190.1	145.0	848.2		531.2	178.6	216.0	394.6	Rondônia
Rio Branco		370.1	399.9	132.0		115.0	122.6	435.1		151.6	169.7			Acre
JARI CELU-LOSE		18.0	18.2	4.4		6.1	6.2	13.7		16.0	69.5			Pará
2 TOTAL	2,032	4,442	5,138	2,407	676.4	1,299	1,462	5,626	1,309	2,423	1,267	635.6	1,392	

Source www.eletrobras

Average diesel consumption: 3.3 MWh/1.000 l

1.3. Evaluation of existing rural electrification programmes

The federal government and other donors support a variety of initiatives designed to promote rural electrification. The federal government supports two major programmes:

Luz-no-Campo managed by Eletrobrás and PRODEEM (Programa de desenvolviments Energetico de Estadose Municipios) managed by MME (Ministerio de Minase Energia) Luz-no-Campo focuses on grid extensions which focuses on solar energy (PVs) for remote community applications. In addition, there are rural electrification activities under several non-sectoral and decentralized initiatives.

1.3.1. Luz- no- Campo

Luz-n—Campo meaning 'light in the fields' was launched in December 1999, by the federal government address to the stagnation in rural electrification after the restructuring of the power sector. Aimed at connecting nearly a million rural households in the three-year period from 1999-2002, Luz-No-Campo is the single largest rural electrification programme implemented in Brazil. Initial estimates forecasted an investment of around 1 billion dollars, that is nearly 1000 dollars per new consumer.

As of September 2002, 480000 connections had been made, and another 125000 were in process. A total of 823000 new customers have signed contracts. So far, no off-grid connections have been made under the programme, even though this option was considered. This can partly be attributed to the relatively low cost of grid connections, averaging 970 dollars per connection.

Rural consumers are typically expected to pay the full costs of the connection, albeit spread over a number of years. Luz-no-Campo lends 75% of the investment to concessionaires on easy terms —a 6% rate of interest, two-year grace period, and a five to ten year repayment period. Concessionaires finance rural consumers on similar terms, but in some cases the state governments provide partial subsidies, assuming the consumer's contribution.

The lacuna in the programme is the lack of incentive to make low-cost grid connections or take on off-grid projects, except for a couple of specific cases in Minas Gerais, Bahia, and Amazonas.

1.3.2. PRODEEM

PRODEEM is the main government sponsored off-grid electrification programme. It was established by Presidential Decree in December 1994. From 1996-2000, PRODEEM provided 3 MW power in PV panels to 3050 villages benefiting 604 000 people, for a total investment of 21 million reals($), financed from the national treasury funds. In 2000, another 1050 systems were installed that were supposed to benefit an additional 104 000 people. The total budget was 60 million reals($) for 2001, when 1086 systems were installed, and another 3000 community systems were tendered through international bidding, with a winning bid of 37 million reals for equipment and installation, along with operation and maintenance for three years.

PRODEEM is a centralized project, which uses a top-down approach to identify sites and install equipments. One of the difficulties faced by the project is identification of suitable locations for equipments that have been purchased in bulk. Under this programme, the central government procured PV panels that were then allocated free of charge to municipalities upon demand. Rather than electrifying individual households, the programme focuses on schools, health facilities, and other community installations.

A recent evaluation of the first phase of PRODEEM (Riberio and Dutra 2000) surveyed its impact on 43 villages in 10 states. Of the 79 systems surveyed, only 44 (56%) were actually operating, albeit with disparities evident among the different states[13]. In 2003, the MME (Secretariat for Energy Development) undertook an exercise in analyzing the programme and discussing the means to expand it, according to the recent law for Universal Access to Energy.

More recently, PRODEEM and ANEEL have started to sponsor mini-grid pilot projects (with hydro and biomass generation), to test different service provision models.

The main problems of the programme appear to be

- Top-down approach with installations sometimes made in unprepared and unorganized communities
- No cost recovery schemes leading to a lack of funds for maintenance and resulting in an unsustainable service.
- Lack of responsibility of local communities and States for the equipment.
- Occasional lack of co-ordination in grid expansion programmes.

1.3.3. Non-sectoral or decentralized initiatives

The amendments included in the national budget by Congressmen, through the MA (Ministerio de Agricultura Pecuaria e Abastecimento), are important source for rural electrification. These funds are provided by the federal budget to the municipal administrations under a non-refundable status and are subject to a certain level of political bargaining. The funds finance grid extensions for productive uses.

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[13] In São Paulo and Minas, for example, nearly 100% were working, but no systems were operating in the states of

Operating under a different name in each state[14], the PAP (Poverty Alleviation Programme) sponsored by the World Bank, has been another important source of investments. The focus of the programme focuses on the states in the northeastern region and the drought-prone area of the state of Minas Gerais. The programme provides grants to the local associations to finance their projects, which have been previously approved by the municipal committee. These projects include grid-connected rural electrification projects, off-grid solar systems, in addition to a plethora of other rural development projects.

Ceará and Alagoas. In Bahia, only a third of the systems were operating.

[14] São José, Ceará; Produzir, Bahia; Comunidade Viva, Maranhão, etc

A key issue of these decentralized initiatives, however, remains sustainability. Unless the associations are strongly organized, their projects are difficult to maintain. The case of grid-connected systems is less troublesome as they are absorbed by concessionaires, who are obliged to maintain them. A recent survey to assess the performance of PV systems identified as the main problems[15]

- Poor quality of installations reflecting poor technical standards.
- Lack of mechanisms for maintenance and replacement of equipment with very few associations having working systems for fee collection.

However, few cases of absolute failure were found.

The key issue concerning rural electrification programmes is the lack of co-ordination. Each programme operates in its particular niche. It can possibly be argued that they complement each other since Luz-no-Campo targets the grid extension; PRODEEM, the community systems of remote areas; PAP, SHS (solar household system) of the poorest villages; and the MA targets, grid extension for productive uses. However in reality, the situation is quite different. There is a total lack of coordination among these various programmes, which seriously restricts the scope for optimizing the allocation of public funding.

1.4. Evaluation of electrification programmes for the urban poor living in shanty-towns

Since the 1980s, some utilities have been carrying out electrification programmes directed at supplying regular connections to the grid of households located in favelas (shanty-towns) of large Brazilian cities. Particularly remarkable were the programmes

[15] UNIFACS (Universidade Salvador) 2002

implemented by Light, in Rio de Janeiro, and the case of Eletropaulo, in São Paulo, which will be presented here.

According to Nova and Goldemberg (1999) in São Paulo city, the largest Brazilian metropolis, in 20 years the number of dwellers in favelas grew at an average annual rate of 18% and now represents approximately one fifth of the city's total population. The population of *favelas* is basically formed by low-income workers and their families. Most households are wage earners or self-employed. In the recent years, however, unemployment rates have increased in the whole metropolitan area of São Paulo.

Until the late 1970s, only 17% of *favelas* in São Paulo had regular connections to the electricity grid. For 49%, access to the grid was through illegal connections, and the remaining 34% did not have any access to electricity services.

In 1979, the city administration and the electric utility signed an agreement for the installation of electricity services in *favelas*. The city administration was to be responsible for selecting the *favelas* to be connected to the grid, guiding the establishment of local electricity commissions, and carrying out preparatory work. Eletropaulo, the utility, would take charge of providing individual connections for each shack, with the use of simplified technology kits, which were subsidized by the utility.

No meters were installed as ut was bit cibsudered cist-effectiuve to installed then in shacks, where the consumption was expected to be very low. So, consumers were charged a subsidized flat rate, which was equivalent to the monthly consumption of 50 kWh, corresponding to monthly electricity bill of 1-1.5 dollars, in the early 80´s, and 1.75 dollar in 1999[16].

Average consumption thus reached levels much higher than the ones actually paid fir through the subsidized flat rate. For its residential consumers, the utility had a progressive tariff system: the higher the level of consumption, the more the rates per kWh[17]. According to this system, a consumption equal to the average found in *favelas* —175 kWh— would have a bill of 9.4 dollars plus taxes. However, since their consumption was not regularly verified, the *favelas*' dwellers continued to be charged the minimum standard, that is to a 50 kWh consumption at the fixed rate of 1.75 dollars.

At the end of 1997, Eletropaulo registered 137000 consumers in the city of São Paulo and 243000 persons in the whole supply area, in *favelas* regularly connected to the grid. An estimated 687000 favelas dweller live in the city of São Paulo, and 1215500 in the whole area supplied by Eletropaulo. As such, Electropaulo has registered around 5% of all its residential consumers of electricity.

While only very rough cost estimates are available, it is clear that the cost of infrastructure for expanding the electric grid are definitely lower in shanty-towns than elsewhere. Subsidized kits for connecting *favelas* dwellers, for the total area under the supply of Electropaulo, would mean costs of around 36 million dollars in 18 years in addition to the cost of providing electricity. On the other hand, some 73000 households regularly pay their bills, affording the utility an income of roughly 130000 dollars a month. If *favela*

[16] In April 1999, three months after the Brazilian currencys devaluation, values registered in a former version of this report (BÔA NOVA and GOLDEMBERG, 1998) prepared before the devaluation, have been updated here.
[17] In Brazil, the regulation of the electric tariff systems lies under the jurisdiction of the federal government, but utilities have some degree of freedom in establishing their own tariff.

dwellers were charged for their actual consumption and non-payment rates were reduced substantially (for example, to only 10%) this amount could reach 2 million dollars.

2.0 Rationale and Motivation

2.1. Consumption of lectricity

A minimum electricity service may be based on the per capita consumption for which consumers can benefit from social tariffs for their electricity consumption in representative developing countries. A frequently mentioned figure for a decent consumption level is 600 kWh per household per year (or 50 kWh per household per month).

The World Energy Council proceeds on the basis of consumption levels of 500 kWh per year. The World Bank differentiates between urban and peri-urban areas on the one hand, where annual minimum consumption is assumed to lie between 420 and 480 kWh per year. On the other hand, in the rural areas a consumption level of 300 kWh per year is deemed sufficient. The joint UNDP (United Nations Development Programme)/World Bank ESMAP (Energy Sector Management Assistance Programme) reports of existing household consumption in countries such as Burkina Faso, India, Indonesia, Nepal, and Vietnam being occasionally as low as 25 kWh per month or 300 kWh per year.

Within the global context, it is important to understand that the basic consumption needs–evaluated at 1 kWh per family per day–require the provision of additional power generation capacity of 60 GW, which corresponds to only 2% of the currently installed global capacity.

In the case of Brazil, a recent study by FGV considers a poverty line of 26 reals 9 dollars, as the value needed to buy a basket of goods and services including food to meet the minimum intake level of 2288 kcals/day/capita recommended by the WHO (World Health Organization). Different electricity consumption levels have been proposed as the adequate minimum standards to be targeted for the Brazilian poor, and a recent legislation suggests a consumption level of 200 kWh/month for households below this level to be entitled to subsidies in the electricity tariffs.

2.2. Basic energy needs and poverty in Brazil

A wide ranging consensus is emerging in Brazil on the imperative need to supply electricity to the whole population as a basic public service. In the Brazilian context, meeting basic energy needs of the whole population essentially means providing access to electricity in rural areas. The supply of modern fuels such as kerosene and LPG (Liquified Petroleum Gas) or biofuels can play a complementary role in meeting demand; mainly for cooking as space heating needs are limited or non-existent in most regions of the country. Access to electricity enhances the quality of life if it is accompanied by the acquisition of appliances that bring the basic amenities of modern life, such as high quality lighting, clean water, healthcare, radio, TV, communications, etc. The urban population in Brazil has a high access to electricity, while the rural areas have acute limitations in accessing electricity. The overwhelming barrier to expanding the access to electricity is poverty, which in the Brazilian context is exacerbated by the skewed income distribution.

Several studies of poverty can be found in the international literature showing that a great complexity surrounds the definitions of this concept. They differ among the world regions and between the urban and the rural populations. There is an important distinction between ‘absolute poverty’ and ‘relative poverty’. Absolute poverty is theoretically associated with the vital minimum. The concept of relative poverty incorporates the concern with inequality or relative deprivation, where the bare minimum is socially guaranteed (Rocha 1997). The concept of relative poverty uses different social indicators comparing items such as income and a basket of basic needs, including the access to electricity.

2.2.1. Access to electricity and poverty in Brazil

Of the 5507 Brazilian municipalities, only in 214 100% of the households have electricity. In the Northeast, only three municipalities - of them: Ouro Velho in Paraíba, Fernando de Noronha and Toritama, both in Pernambuco – can claim this status. In the state of Rio de Janeiro, only in the municipality of Iguaba Grande do 100% of the households have electric energy. In the capital city of Rio de Janeiro, about a 1000 of the 1.8 million homes lack electricity.

Table 14 shows the percentage of households without electricity in each Brazilian state. It also shows the same percentage for the most critical municipalities of each state.

Table 14 Percentage of households without electricity in each state and in the most critical municipalities

State / region	Households without access to electricity (%)	Critical municipality	Households without access to electricity (%)
Piauí/NE	24.1	Novo Santo Antônio	91.9
Tocantins/CO	22.1	Centenário	72.0
Acre/N	21.1	Jordão	82.3

Pará/N	21.0	Chaves	76.5
Maranhão/NE	20.3	Fernando Falcão	83.8
Bahia/NE	17.5	Caraíbas	72.0
Amazonas/N	15.5	Careiro da Várzea	68.2
Rondônia/N	15.2	Vale do Anari	66.2
Roraima/N	13.0	Uiramutã	69.2
Ceará/NE	10.7	Salitre	62.2
Mato Grosso/CO	10.4	Nova Bandeirantes	60.2
Alagoas/NE	9.1	São José da Tapera	47.8
Sergipe/NE	7.6	Gararu	43.2
Minas Gerais/SE	5.8	Monte Formoso	64.7
Rio Grande do Norte/NE	5.6	Venha-Ver	47.3
Paraíba/NE	5.1	Santa Inês	53.4
Amapá/N	4.9	Mazagão	40.6
Mato Grosso do Sul/CO	4.3	Japorã	50.7
Pernambuco/NE	4.0	Santa Cruz	47.5
Goiás/CO	2.9	Cavalcante	61.8
Rio Grande do Sul/S	2.2	Santa da Boa Vista	37.9
Paraná/S	2.1	Rio Bonito do Iguaçu	50.3
Santa Catarina/S	1.4	Entre Rios	33.9
Rio de Janeiro/SE	0.5	Trajano de Moraes	12.8
São Paulo/SE	0.4	Barra do Turvo	32.5

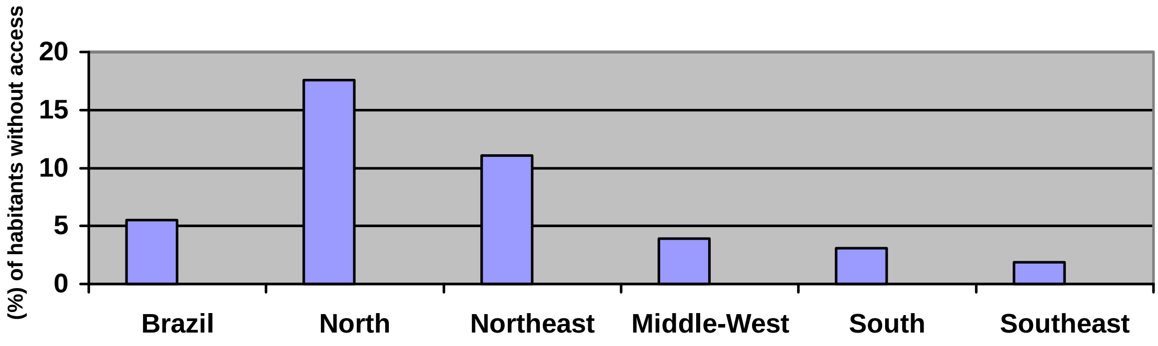
Source ANEEL, based on information from the IBGE Census 2000

Note NE -Northeast; N-North; CO -Mid-West; S- South; SE- Southeast

From Table 14 if it clear the regions in the north and northeast of the country are the ones that have the maximum number of households without electric lighting. On the other hand, the south and southeast have the smallest rates of 'electrical exclusion'[18]. Figure 4 illustrates the lack of access to electricity in the different regions of Brazil and the country as a whole, based on the data given in Table 14.

[18] Electrical exclusion is the term that the current president of the Republic of Brazil, Mr Luiz Inácio Lula da Silva, often uses when dealing with the issue of access to electricity in Brazil.

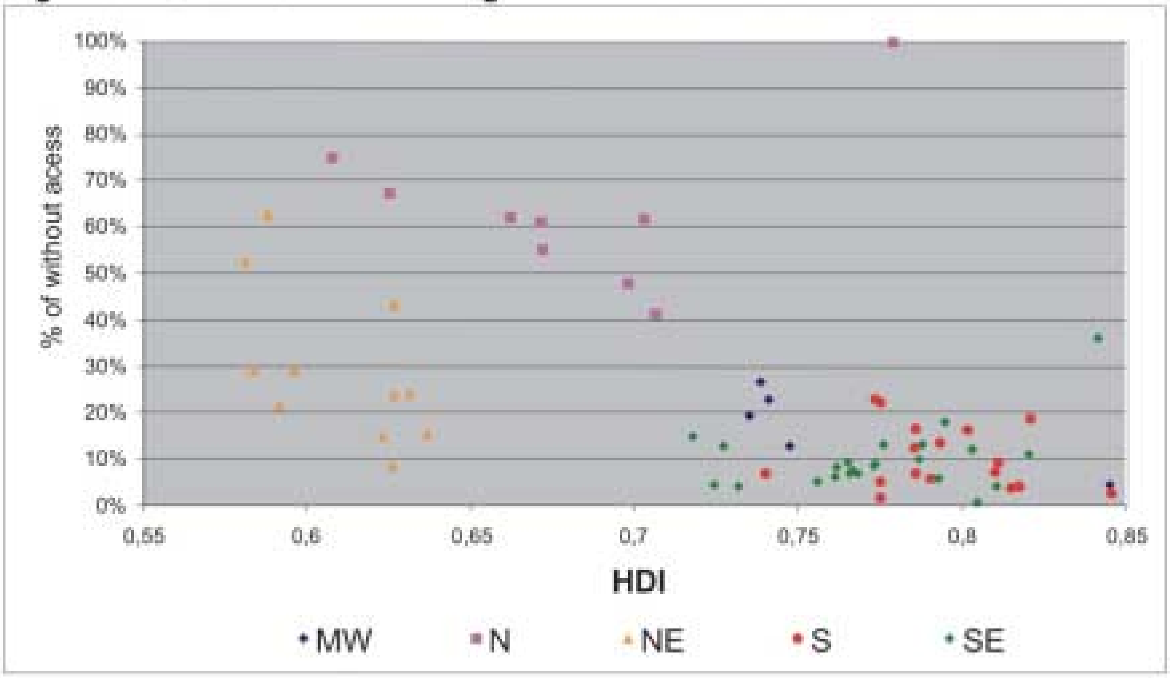
Figure 4 Percentage of population without access to electricity in the different regions of Brazil, and in the country as a whole



Source MME, 2003

It is interesting to note that the regions of the north and the northeast with the least access to electricity are those the worst HDIs (human development indices) of all the Brazilian regions, as seen in Figure 5. This figure reveals the close relationship between the living conditions and the access to electrical energy.

Figure 5: Acess level in Brazil's regions x HDI



Fonte: IBGE (Censo 2000 e PNDAs).

In fact, the issue of the access to electricity in the north and northeast is part of a much broader and complex issue of uneven regional development, historically observed in Brazil. Thus, it is not only in the question of access to electricity that the regions have a negative performance, there are several other factors confirm the impression that the north and northeast are the regions to have benefited the least from the fact that the Brazilian economy is among the 15 largest in the world[19]. This is illustrated by the data in Table 15 which shows an unmistakable concentration of illiteracy in the aforementioned regions.

[19] Brazil ranks the twelfth in the world, in terms of GDP (Gross Domestic Product).

Table 15 Illiteracy Rate of 15 year old + population (%)

Brazil and geographical regions	Year							
	1992	1993	1995	1996	1997	1998	1999	2001
North	14.2	14.8	13.3	12.5	13.5	12.6	12.3	11.2
Northeast	32.8	31.8	30.5	28.7	29.4	27.5	26.6	24.3
South	10.2	9.8	9.1	8.9	8.3	8.1	7.8	7.1
Southeast	10.9	9.9	9.3	8.7	8.6	8.1	7.8	7.5
Mid-West	14.5	14.0	13.3	11.6	12.4	11.1	10.8	10.2
Brazil	17.2	16.4	15.5	14.6	14.7	13.8	13.3	12.4

Source IPEA, 2003

As has been discussed, the issue of access to electricity in Brazil is more of a problem in the rural areas than in the urban areas. It was also found that the north and the northeast are the regions with the worst levels of access. A strong correlation exists between poverty and the of access to electricity.

In this context, it can be seen that the rural areas are also more deprived of other key services to meet the basic human needs, as illustrated in Table 16. Therefore, governmental action to extend the access to general infrastructure including electricity services should focus on rural areas.

Table 16 Percentage of basic services coverage in urban and rural households in 1998

	Indoors water supply (%)	Sewage system (%)	Electric lighting (%)
Urban areas	93.3	97.1	99.2
Rural areas	51.9	67.1	75.4

Source: Oliveira (2001)

Note The rural areas of the states of Rondônia, Acre, Amazonas, Roraima, Pará and Amapá

Table 17 In the rural area , the classes with the lowest monthly incomes are also those that have the highest rates of households without electric lighting (Table 17). That is, access is directly related to the buying power.

Table 17 Percentage of rural households without electric lighting classified as per of income in 2001

	With no access to electric lighting (total 22.3%)	
Class of monthly household income (in terms of the number of minimum wages*)	Up to 1	35.3
	Between 1 and 2	23.1
	Between 2 and 3	17.7
	Between 3 and 5	11.5
	Between 5 and 10	7.4
	Between 10 and 20	4.8
	More than 20	5.9
	No income	28.4
	No information	29.4
	Total	**22.3**

Source IPEA, 2003; World Bank, 2003

Note One monthly minimum wage in 2001, was worth 160.77 reals *87.84 dollars) at the year 2000 prices

On comparing Tables 22 and 23, it is seen that the metropolitan regions situated in the north and northeast are not only the ones with the largest number of poor people, but also the ones with the smallest average monthly electricity consumption per household. Furthermore, the poorest populations of the metropolitan regions being analyzed are also the ones that consume the least electricity (Table 18). It is worth emphasizing that the direct relationship between poverty and low electricity consumption is parallel to the (inverse) relationship between poverty and access to energy in Brazil, as is to be expected.

Table 18 Average monthly electricity consumption per household according to metropolitan region and class of income in 1996 (kWh/month)

	Class of income (in terms of the number of minimum wages*)					
Metropolitan Region	Up to 2	Between 2 and 3	Between 3 and 5	Between 5 and 10	More than 10	Average
Belém	104	127	158	196	278	173
Fortaleza	89	113	147	173	244	153
Recife	121	144	174	213	288	188
Salvador	119	147	164	208	281	184
Curitiba	146	144	178	241	334	209
Porto Alegre	141	173	213	274	357	232
Belo Horizonte	123	153	169	243	309	199
Rio de Janeiro	195	205	226	273	364	253
São Paulo	152	156	175	240	311	207

Brasília	131	176	186	271	349	223
Goiânia	139	166	185	260	336	217
Average	133	155	180	236	314	203

Source IPEA, 2003; World Bank, 2003

Note * One monthly minimum wage in 1996 was equivalent to 143.59 (78.4 dollars) the year at 2000 prices

Table 19 Percentage of poor people in the selected metropolitan regions of Brazil

	1992	1993	1995	1996	1997	1998	1999	2001	Poverty Line (*)
Metropolitan Brazil	30.1	32.6	22.0	21.6	22.5	22.4	24.6	26.0	143
Metropolitan Region									
Belém	40.6	37.3	26.8	32.8	33.4	31.6	35.6	41.0	131
Salvador	43.5	48.5	43.5	41.7	40.3	37.6	41.5	41.6	144
Fortaleza	45.5	49.4	38.0	38.4	38.1	38.9	42.1	40.9	116
Recife	57.4	59.8	47.1	46.4	48.9	48.5	50.9	48.1	153
Distrito Federal	28.5	27.0	17.7	20.1	17.4	18.6	21.8	23.8	127
Belo Horizonte	27.	30.	17.	19.	18.	20.	20.	19.	115

	4	3	9	6	8	5	4	9	
Rio de Janeiro	24.7	31.8	20.7	19.6	19.5	18.8	18.3	22.8	147
São Paulo	24.2	24.9	14.1	13.9	15.8	15.8	19.5	20.3	147
Curitiba	29.2	24.7	15.9	12.8	17.2	17.4	20.4	19.6	135
Porto Alegre	29.6	32.3	21.2	22.3	22.7	22.3	24.2	23.0	163

Source National Household Sample Survey (PNAD/IBGE).

Note [1]The survey was not carried out in the year 1994 and 2000.

Note [2]* Amounts expressed in reals are from November 2002/month.

Complementing the data on the relationship between poverty and the access to electricity in Brazil, Table 20 presents the monthly average household electricity expenses classified as per income levels. The figures are rough estimates based upon the average tariffs, and do not reflect the huge sectoral and regional disparities. However, these estimates reveal the average burden of electricity on household budgets, if no differentiation were to occur across industrial, commercial, and residential sectors.

Schaetter, Almeida, show that, in 1996, this burden was rather uniform for low-and high -income classes, ranging from 8.0%—8.8 %. This demonstrates the balancing of consumption levels introduced by progressive electricity tariffs in Brazil.

Table 20 Monthly average household electricity expenses per income class

		Income classes (in minimum wages)					
		0 to 2	2 to 3	3 to 5	5 to 10	More than 10	Average
1996	(US$ PPP-2000)	19.65	22.94	26.62	39.24	52.24	33.85
	(R$ 2000)	17.44	20.36	23.63	34.83	46.37	30.05
2000	(US$ PPP-2000)	13.22	25.51	29.31	50.35	82.86	38.72
	(R$ 2000)	11.73	22.64	26.02	44.69	73.55	34.37

Note A monthly minimum wage in 1996 was equivalent to R$ 143.59 in 2000 constant prices and US$ (PPP-2000) 161.77 (IPEA, 2003; World Bank, 2003)

Households in the metropolitan regions only are considered for the year 1996.

Source Schaeffer, R. et al., CEPAL, 2003.

2.3. Electricity and rural development in remote areas of Brazil

Electricity is crucial to the development of the rural regions in isolated communities. However, the supply of electricity by itself is not sufficient to ensure the development of a region or a city. Therefore, it is also necessary to create appropriate economic conditions for the local population to have access to energy and to use it in a productive way, in order to be able to afford the high cost of electricity supply.

This is the situation of isolated communities in Brazil, located mainly in the Amazon region.

The Legal Amazon[20], covering 5217423 km^2 and with an extremely low population density of 4.04 hab/km^2 (compared to the national average of 19.92 hab/km^2, [IBGE, 2000]) is by far the largest region not connected to the national electric power transmission system. Within the Amazon Region, two states, Amazonas and Roraima, have the fewest number of people per area at 1.79 e 1.45 hab/km^2 (2000), respectively.

As mentioned, electric power in these sparsely populated regions is provided by diesel generators, resulting in an enormous consumption of diesel, not only for the generation of electricity, but also for the transportation of the fuel within the region, which is done almost exclusively by boat.

The electrification of such small isolated communities using conventional supply presents huge barriers such as the high costs of the transmission lines (mainly through the Amazon region), transportation of diesel oil, and the very low income of the community residents. It is seen that not only is the electricity consumption low, it is still lower in the rural areas.

Several researchers on alternative energy sources argue that the viability of an alternative source implementation can be based on cost savings from foregone fossil fuel purchases in the future.

However, it is necessary to understand that, when considering an alternative energy solution to electric energy supply for the excluded population, it is not adequate to use the value of the saved costs when the local population is no condition to afford the purchase;

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[20] The Brazilian Legal Amazon was instituted by the government, aimed at improving the economic planning of the Amazon Region. Nine states belong to Legal Amazon: North Region States, Mato Grosso, and Maranhão States (www.cenbio.org.br)

the diesel oil for the engines, candles, stacks, etc, is only consumed1 when there is money to accomplish its purchase. When the local population does not have the resources, it is simply deprived of this consumption.

Thus, the value of saved costs can be used only in the cases where the consumption of energy sources is used for a productive activity. It is not enough to simply offer a more correct energy alternative in place of the existing alternative; it is necessary to provide conditions to the population to acquire the preffered alternative.

3.0 Evaluation of the Impact of Energy Reform on the Access to Electricity

The Brazilian electrical service sector initiated a restructuring process by unbundling the generation, transmission, and distribution components of the existing companies some years ago. This ultimately led to the privatization of most of the service distribution assets and some of the service generation assets.

3.1. The power sector reform

In 1995, the structure of the electricity sector's institutional model was significantly altered by the federal government's reforms aimed at stimulating competition and attracting private-sector investors. (This chapter is largely based on ESMAP [2002]). The new model proposed for the sector had the following characteristics:

Pre-reform	Post-reform
A few state-owned companies Vertically bundled industry Regional/state monopolies for generation, transmission, and distribution Ban on foreign investors Centralized planning Equalization of tariffs Captive market	Privatization and a large number of agents Vertical unbundling of the industry Competitive generation and distribution Regulated monopolies on transmission systems and shared distribution Restrictions on foreign investors lifted Indicative planning Regulated prices and tariffs Gradual easing of restrictions on consumers

In order to implement these principles, a new institutional structure was established by creating three new agencies. The main objective was reformulating and strengthening the government's regulatory role by establishing a new regulatory framework that is vital to the new model's successful implementation and is still being adjusted: ANEEL (Agencia Nacional de Energia Electrica), ONS and MAE .

(Established vide Law number 9427/96) as a regulatory agency has the following many roles.

- Regulates and supervisors
- Issues tenders for generation, transmission, and distribution
- Grants concessions for hydroelectric plants
- Supervises concession agreements

- Regulates tariffs
- Establishes terms of access to transmission and distribution systems
- Sets rules for participation in MAE and approves Market Agreements
- Authorizes NOS activities

NOS (established vide Law number 9648/98) as an operational agency has the following roles:

- Physical dispatch of generation
- Optimization of generation
- Optimization of transmission
- Accounting for energy generated, delivered, and transmitted
- Undertakes indicative studies on the expansion and reinforcement of transmission systems

MAE - (established vide Law number 9648/98) as an operational agency has the following roles.

- Energy spot market
- Accounting for financial agreements on purchase and sale of energy
- Currently on hold for administrative reasons
- Rules of operation – Market Agreement – being revised

In addition to these three new agencies CCPPE and several types of well defined sector agents. CCPE is part of the structure of the MME (Ministerio de Minas e Energia) and advises the government on the National Energy Policy issues. CNPE (Conselho Nacional de

Politica Energetica) provides market agents with indicative projections for their investment plans and establishes the transmission system expansion programme. The new context of the market agents is :

(a) Generators

- Generators are all market agents who produce energy from any source – hydroelectric, thermal and

  other alternative sources.
- Generators are now independent energy producers who sell energy to distributors, Retailers, and free consumers.
- Long-standing generators are now public-service generation concessionaires.
- Self-producers, or those who produce energy for their own consumption and sell surplus electricity

The commercialization of generation has the following aspects:

- Through compulsory purchase and sale agreements between companies, financially administered by the MAE.
- These are now obligatory, as 85% of consumption/demand is contracted in advance.
- That amount will be reduced by 25% per year as of 2003, and will be brought to an end in 2006.
- MME has proposed to increase the amount of electricity covered by bilateral agreements to 95% due to the 2001 energy crisis.

(b) Distributors

- They are responsible for transporting energy from delivery points via the high-tension system to the points of delivery to end consumers.
- The process of privatizing the electricity sector has made most progress in this area: 23 electricity concessionaires have been sold.
- This segment includes rural electrification co-operatives.

Three possible types of distribution agents are regulated by ANEEL:

- *Concession* According to the concession law, new concessions are awarded through public bidding. Existing concessions were extended for 30 years, and most of the companies holding these concessions were privatized. Contracts signed between ANEEL and the concessionaires define the regulations of the new relationship.
- *Permission* According to the concession law, permissions are also awarded through public bidding. Existing rural electrification co-operatives can be converted into permissionaires, if they provide a public service. There are no distribution permissionaires in Brazil to date.
- *Authorization* This legal figure will be awarded to those existing rural electrification co-operatives, which provide electrification service for private use only (i.e., supplying only members of the co-operative, and not all consumers in the area of authorization).

(c) Retailers

Retailers are those agents who buy electricity generated by the production segment and resell it to distributors and free consumers.The main new characteristics of the consumers are:

(D) Free consumers

- They can buy energy from any generator by paying a fee to the local concessionaire for using the distribution system.
- They use more than 3 MW, at a voltage equal to or greater than 69 kV.
- ANEEL may change these amounts as of 2003.
- Free consumers are all those who do not receive electricity from the local concessionaire within a maximum of 180 days, starting from the date of the order.
- They receive electricity from small hydroelectric plants, wind turbines, biomass plants, and cogeneration of over 500 kW.
- They use over 50 kW in an isolated system.

Captive consumers

- They must buy electricity from the local distribution concessionaire.
- The tariffs are regulated by ANEEL.

Table 21 illustrates the main results of the Brazilian power sector reform in terms of the privatization of utilities. Both federal and state-owned utilities were privatized from 1995-2000.

Table 21 Brazilian power sector reform— privatization of utilities

Utility acronym	Privatized utilities	State	Date	Price in US$ million
FEDERAL UTILITIES				

Escelsa	Espírito Santo Centrais Elétricas S/A	Espírito Santo	11/07/95	519
Light	Light Serviços de Eletricidade S/A	Rio de Janeiro	21/05/96	2509
Gerasul			15/09/98	880
STATE GENERATION UTILITIES				
Cachoeira Dourada			05/09/97	714
Paranapanema (CESP)		São Paulo	28/07/99	682
Tietê (CESP)		São Paulo	27/10/99	472
STATE DISTRIBUTION UTILITIES				
Eletropaulo	Eletropaulo Metropolitana Eletricidade de São Paulo S/A	São Paulo	15/04/98	1777
CPFL	Companhia Paulista de Força e Luz	São Paulo	05/11/97	2731
Elektro	Elektro Eletricidade e Serviços S/A	São Paulo	16/07/98	1273
Coelba	Companhia de Eletricidade do Estado da Bahia	Bahia	31/07/97	1598
Cerj	Companhia de Eletricidade do Rio de Janeiro	Rio de Janeiro	20/11/96	587
Coelce	Companhia Energética do Ceará	Ceará	02/04/98	868

Cemat	Centrais Elétricas Matogrossenses	Mato Grosso	27/11/97	353
Enersul	Empresa Energética de Mato Grosso do Sul S/A	Mato Grosso do Sul	19/11/97	565
Cosern	Companhia Energética do Rio Grande do Norte	Rio Grande do Norte	12/12/97	606
Celpe	Companhia Energética de Pernambuco	Pernambuco	18/02/00	1004
Energipe	Empresa Energética de Sergipe S/A	Sergipe	03/12/97	520
Cemar	Companhia Energética do Maranhão	Maranhão	15/06/00	289
Celpa	Centrais Elétricas do Pará S/A	Pará	08/07/98	388
Saelpa	S/A de Eletrificação da Paraíba	Paraíba	30/11/00	185
CEEE (N/NE)	Companhia Estadual de Energia Elétrica (Norte/Nordeste)		21/10/97	1486
CEEE (CO)	Companhia Estadual de Energia Elétrica (Centro/Oeste)		21/10/97	1372
EBE			17/09/98	860

Source BNDES, 2002- “Privatização no Brasil, 1990/2002”

(www.bndes.gov.br/conhecimento/publicacoes/Priv_Gov).

3.2. Evaluation of the impact of energy reform on rural electrification through the extension of the grid

The Brazilian Constitution (1988) considers the distribution of energy to be an essential public service for which the federal government assumes full responsibility, either directly or through designated concessionaires or ‘permissionaires’. The Constitution further states that these public services can only be granted through public bidding.

Law 8631 (1993) and subsequently Decree 774, assure financing for grid expansion and rural electrification programmes through RGR (Reversion Global Reserve – RGR)[21], a fund managed by Eletrobras, with compulsory contributions by all concessionaires. These contributions are included in the tariffs imposed by concessionaires. In 1996, Law 9427, which created ANEEL, also decreed that 50% of the resources of RGR should be directed to the northern, northeastern, and mid-western regions and the rest of the other 50%
should be allocated to programmes for rural electrification, energy efficiency, and electrical power for low-income users. Such an initiative reflected the concern for the supply of electricity to the rural and low-income populations, and also the need for regional concentration of investments to provide adequate funds.

[21] Reversion Global Reserve is a yearly reversion quota (up to 2.5%, limited to 3% of the annual income) to be levied on ‘concessionaires’ and ‘permissionaires’ investments, and transferred to electricity tariffs.

On the other hand, Law 8987 (1995), while dealing with concessions and permissions, has not addressed the low-income consumers and rural electrification issues. This oversight was corrected in Law 9074 (1995), which established rules for the award of concessions and permissions and for regulating extensions of the existing ones. This law determined that concessionaires and 'permissionaires' must provide comprehensive services to the market, without excluding low-income populations and rural areas.

Law 9427 (1996) mandated that concessionaires and 'permissionaires' be responsible for the total cost of providing service to any new consumer. At the same time, the consumer was only required to pay the tariffs. In the case of installations, which were of mutual interest to both, any participation in the investment by the consumer had to converted into participation in the concessionaire's capital. This aspect of the laws was not regulated up to April 2002, when a new Law – 10438 created more stringent procedures aimed at universal access to electricity.

Law 9478 (1997) stated that national energy policies must aim to identify the most suitable solutions in supplying electricity to the different regions of the country. The law also established CNPE, an advisory board to the president that is composed of several ministers and few national experts. One of the responsibilities of CNPE is to propose measures to the president that assure the supply of energy to remote and hard-to-reach areas of the country. In turn, the president is mandated to submit to the Congress any requests for necessary subventions. It initially took more than three years for CNPE to become operational.

On the one hand, several legal and regulatory instruments were created to improve the environment for the establishment of rural electrification programmes and initiatives, but they often were not enforced. On the other hand, no firm obligation of full coverage has been included in the contracts between ANEEL and the new concessionaires. The glaring omission is that no enforceable requirement has been indicated in such agreements.

Several pending problems, as mentioned previously, are expected to be solved, if the recently approved Law 10438 (April 2002) is regulated properly. Besides establishing clear rules for strengthening the universal service obligations of distribution concessionaires, the law introduces a series of changes in the structure of the Brazilian energy sector which includes the following:

- A definition of the low-income consumer with monthly consumptions of up to 80 kWh, plus a second group with consumption up to 220 kWh under special conditions to be defined by ANEEL.
- The establishment of CDE (Conta de Desenvolvimento Energetico); to promote universal access and generation of electricity from renewable sources of energy.
- An extension of RGR until the end of 2010 to ensure resources for the continuation of the Luz-no-Campo programme. State and municipal governments, concessionaires and 'permissionaires', rural electrification co-operatives and infrastructure co-operatives for land reform projects, and inter-municipal consortia are now allowed to borrow resources from RGR. These resources can be used for the expansion of distribution services, particularly in low-income urban and rural areas, and for specific promotion programmes for individual or collective use of solar energy for the generation of electricity.

Moreover, this law stipulates the following key issues in its Articles 14 and 15, which are directly related to rural electrification:

- The appointment of ANEEL to impose targets for full coverage on concessionaires and 'permissionaires'. Consumers falling under these targets would be required to pay nothing besides tariffs.
- Potential consumers would be able to accelerate their service connections by paying a part of or the full investment, and the concessionaires would be required to reimburse them later. Even accelerating investments by public entities will have to be reimbursed. ANEEL must establish rules for this anticipation and subsequent reimbursement.
- The achievements of targets would be surveyed by ANEEL during the revision of the tariff process.
- ANEEL would be able to initiate open bidding within the concession areas to award permissions in an attempt to accelerate full coverage, whenever no exclusive provisions are present in contracts with existing concessionaires. ANEEL can delegate the bid process to state regulatory agencies.
- 'Permissionaires' would be able to use either conventional grid or established partnerships with renewable energy dealers, distributors, or IPPs (independent power producers). The permission allows for the provision of services under specific conditions and forms of supply, compatible with the chosen technology.

The Brazilian Congress has fully delegated to ANEEL the definition of the rules for implementation of the law. ANEEL had one year to define the targets for each concessionaire. However, no detailed studies exist on the impact of this obligation on the tariffs. This needs to be one of ANEEL's next initiatives.

The implementation and enforcement of the new law is a key issue. Under the new law, in which they are supposed to finance the full investment, pressure for substantial tariff increases is expected (with a parallel financing mechanism for special conditions).

According to local rural electrification experts, full coverage should be achieved in a period of not more than 10 years. Sauer (2003) considers that 4-6 years is a feasible term for universal access. The Universal Access Committee, created to support CNPE, has proposed a 2010 deadline. In some states, this deadline might even be significantly lower, for example, up to two years, since their rates of electrification are close to 100%.

The Decree 4336 (2002) has authorized the use of RGR resources to be lent to concessionaires to cover their losses due to the introduction of the subsidies for lifeline tariffs to low-income consumers. The loans would take place up to the date of the periodic revision of the tariffs of the concessionaires. This decree would result in an annual reduction of 500 million reals in the RGR funds, reducing significantly the resources available for Luz-no-Campo. Law 10604 has minimized this impact, with the identification of other sources to cover the subsidies to low-income consumers, but RGR can still be used as a backup source for these subsidies.

Decree 4541, which established rules for the use of CDE, has disappointedly left very limited resources from that account for promoting universal access. However, all analyses of the amount of resources that will be collected in that account show that these funds will not initially be spent in other programmes that the account is supposed to promote (for example, renewable sources and natural gas) and could be reallocated to promote universal access.

Thus, the next steps required to accelerate universal access to energy are the establishment of the rules for implementing Law 10438 through a review of Decree 4541, assuring additional resources for promoting universal access and clarifying some points of its implementation, and a series of resolutions by ANEEL, which will establish rules for concessionaires and ‘permissionaires’.

3.3. Evaluation of the impact of energy reform on the electricity consumption levels of the poor urban and rural households

3.3.1 Energy pricing policy

Brazilian electricity tariff structures have some peculiarities. Domestic and commercial customers cross-subsidize rural consumers, public lighting, and low-income consumers. High voltage industrial consumers are heavily subsidized by the other classes of consumption, and even industrial consumers supplied at 2.3 kV pay substantially less (55%) than the domestic, commercial, and industrial consumers supplied at low voltage. Taking into consideration all levels of voltage, when averages are calculated for the whole country, it becomes evident that domestic and commercial consumers substantially subsidize high voltage industrial customers. Rural and public buildings and services are also substantially subsidized.

Hence, the average retail tariff for residential customers in January 2003 was 0.067 dollar per kWh, while industrial customers paid 0.030 dollar per kWh. Although residential customers, because of their smaller loads, are somewhat more expensive to serve than industrial customers price differentials of this magnitude cannot be justified in terms of the underlying cost structures.

Residential low-income customers currently benefit from discounts on their electricity tariffs. The discount is tapered according to the consumption level, so that those consuming up to 30 kWh per month pay only 35% of the overall tariff, while those consuming up to 100 kWh per month pay only 60% of the overall tariff, with the discount declining to zero for those consuming more than 220 kWh per month. The third class of discount is around 10%, which benefits those consuming up to a regional limit defined by ANEEL (for example, 140 kWh/month in the state of Pernambuco) [22], and are still classified as low-income consumer. The overall tariff and regional limit vary from concession to concession.

3.3.2 – Tariffs evolution and the access to electricity

Restructuring of the Brazilian power sector began in 1993 by the enforcement of Law 8621 (that legalized privatizing the state companies of the sector). The consequences have been disparate to consumers and shareholders. While consumers suffer from high tariffs and the lowering of the quality of services, shareholders can be seen as the big beneficiaries of the process. The new management adopted a generous policy of profit sharing with shareholders in parallel to the ever-growing tariffs.

In the context of this study, it should be stressed that these tariff increases tend to inhibit the access of the population to electricity, especially the lower-income groups (concentrated in the countryside and in the very poor outskirts of big cities).

[22] Residential tariff in the state of Pernambuco is around dollar 0.1/kWh

Thus, in a way the expansion of access to electricity has been jeopardized by the increase in tariffs recorded after the reform of Brazilian power sector. The following paragraphs provide some data to back this analysis.

According to ANEEL, the average price of electricity has increased 102.4% from January 1995 to October 2001, or 13.5% above inflation (78.3% by IPCA – Extended price index to consumer, from IBGE) in the period. It should be noted that the residential consumer had an average raise of 132.6%, or 30.5% above inflation.

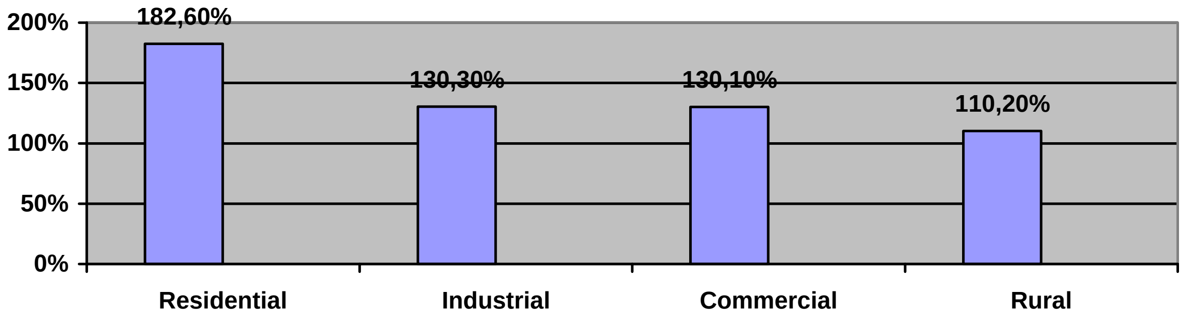
The situation has worsened after 1999. From this year onwards, the general price index, applied to the revision of electricity prices, overcame the consumer price index, as captured the strong devaluation of Brazilian currency in this period. The tariffs of Eletropaulo increased 68.5% between 1999-2002 (excluding the compensation of losses of the enterprises due to the power shortage) against 19.8% from IPC - FIPE - Economic Research Institute Foundation, a real increase of 40.7%.

As electricity accounts for 3.85% of overall IPC calculated by FIPE, a 15% increase in electricity tariffs (as observed in 2001 and 2002) translates into a 0.65% increase in the overall expenses of households with an income between 1 -20 minimal wages. On the other hand, the average income of the working population has decreased by 5% in real terms between 1998-2000, according to DIEESE (Departmento Intersindical de Estatistica e Estudos Socio Ecnomicios). Within this context, the increase of electricity prices (as well as of other public tariffs, such as telephone and transport services) has caused a heavy burden on the low-income population budgets.

A study by DIEESE (1999) demonstrates that domestic consumers were more penalized in the preparation for privatization, having had a substantial increase in the tariffs in the year 1995. Sauer (2003) demonstrated that tariffs for domestic consumers increased 182.6% from 1995-2002, which contributed to aggravating the social exclusion. The Brazilian Congress extended the range of low-income consumers, in order to compensate for this collateral effect of the restructuring process.

Figure 6 , shows the electricity tariff evolution per sector in Brazil for the period 1995 - 2003. It can clearly be seen that was the residential sector the most affected sector.

Figure 6 Percentage increase (in nominal values) of electricity tariff per sector accumulated over the period 1995–2002



Source www.aneel.gov.br/tariffs (in force until November 2002) and www.fipe.com

The issue of electricity tariffs is embedded within a context of social and regional disparities. An equal tariffs regime, established through decree-law 1.383 issued in 1974 prevailed in the 1970 that combined the adoption of the same tariff level for all states across the country, and cross-subsidies the poorer regions[23]. In 1993, this system was

[23] This strategy allowed for extending to the rest of the country the benefits of tapping huge hydropower resources available at that time in the southern and southeastern regions (BNDES, 1998).

abolished to allow for better profitability of utilities due to different cost structures of utilities and the existence of very heterogeneous markets.

3.3.3. Discounts for low-income populations and survival of distributors

The precise definition of low-income consumers was clarified under Law 10438. It included all consumers with a monthly consumption of upto 80 kWh, supplied by a one-phase system, and those consuming between 80 and 220 kWh/month, also supplied by a one-phase system, registered to social programmes, and under a regional limit defined by ANEEL. This limit coincided with the 220 kWh/month threshold in some cases. In certain states, over 50% (e.g. Piauí) of the domestic consumers were classified as low-income consumers after enforcement of the law.

In July 2002, ANEEL extended the deadline for re-registering people who fell under the low-income category, in order to obtain discounts of up to 65% in the conventional electricity tariff. Registration of units with an average monthly consumption of 80-220 kWh was extended upto 31 December 2003. Previously, registration had been extended for three months to meet the request of consumer protection agencies. According to ANEEL, the new extension was implemented until the setting up of firm guidelines regarding government procedures to unify the registers of people to be included in public social assistance programmes. One of the prerequisites to obtaining a discount in the electricity tariffs was to be registered in one of the federal government's social programmes. ANEEL stated that, in addition to the upcoming government changes to try and unify the social assistance programme records, it was also seen that some consumers, who had a right to the tariff discount because of their low-income category, had been having difficulty in fulfilling another requirement, that is, registering themselves for the federal government social programmes, such as the *Bolsa Escola*, *Bolsa Alimentação* or *Auxílio-gás* (that is, education assistance, food stamps, or cooking gas subsidy respectively) that entitled them to the discount. Furthermore, consumers in the range of 80- 220 kWh who did not sign up for these programmes would now have to sign up in the single register for federal government social programmes in order to be able to receive the discount. ANEEL established that the 12 million energy consumers in the country who used on an average, from 0-80 kWh a month would not need to register to receive the discount but would get it automatically. With the extension of the deadline for registration, the country's 64 electricity distributors had to keep in place, until 31 December 2003, the low income tariff discounts for units that consumed from 80- 220 kWh a month, and fell under the current criteria. Among the criteria for the discount werea maximum monthly per capita income of half-a-minimum wage and meeting the requirements of the federal government's social programmes. According to a survey carried out by ANEEL, at the last deadline extension of the registration of low income consumers, 430000 electricity users had already signed up to continue receiving the discount in their monthly bills. Legislation requires distributors to mention on the bill the amount of discount given due to the consumer's low income.

In a way, this entire situation affects the 'financial health' of the distributors, particularly the smaller ones. The scenario points to a greater number of consumers paying reduced tariffs. Nevertheless, in a country 'thirsty for access' (to electricity, health services, education, basic sanitation, etc.) this aspect is relegated to the background.

3.4 Comparative analysis: pre and post-reform

Table 22 shows some key indicators for the Brazilian power sector in 1994 (before the reform) and in 2000-2002 (after the reform). It is too early to evaluate the implications of the power sector reform for expanding the access to electricity in the country.

Electrification levels in rural areas have progressed by 6 % in a six-year period. On the other hand, the most striking change is the increase in the electricity tariffs, which have more than doubled in the period, and have thus limited the increase the average consumption to 13 %.

Table 22 Comparative analysis: pre-and post-reform

Indicator	1994 — Pre-reform year	2000 —Post-reform year
National electrification levels (%)		
Total electrification levels	92	95
Electrification levels in rural areas	68	74
Electrification levels in urban areas	98,5	99,2
Electricity consumption (kWh/year)		
National average per capita electricity consumption	442 (residential sector)	499 (residential sector in 2000)
Average per capita electricity consumption by the rural population	390 (residential sector)	440 (residential sector in 2000)
Average per capita electricity consumption by the urban population	560 (residential sector)	576 (residential sector in 2000)

Electricity tariffs		
Average tariffs (US$/kWh)	0.09816 (residential sector in 1996)	0.17898 (residential sector in 2000)
Connection fees & charges (US$/connection)	810	970 (2002)

4.0 Potential of New Renewable Energy Technologies to Expand the Access to Electricity

4.1. Current status of power generation using new renewable energy technologies in Brazil

To understand the need for the use of RETs (renewable energy technologies) in Brazil, it is important to present the general benefits of renewable technologies (Goldemberg's 2003):

- Diversifying energy carriers for the production of heat, fuels, and electricity.
- Improving access to clean energy sources.
- Balancing the use of fossil fuels, and saving them for other applications and the future generations.
- Increasing the flexibility of the power systems as the electricity demand changes.
- Reducing pollution and emissions from conventional energy systems.
- Reducing dependency and minimizing spending on imported fuels.

Comprehensive data on the potential of renewable energy to supply electricity to remote rural communities are not available in Brazil. General figures report the overall national potential and further studies are required to disaggregate it. An overview of the power generation plants using new RETs in the country is provided in Appendix A.

4.1.1. Photovoltaic solar energy

The concerns of putting in place a new, consistent and sustainable RET lead to the mobiolization of efforts in 1994 to establish a national policy in this direction.

Although the PV (phovoltaic) technology use in Brazil for almost two decades, only in the last few years actually it has been recognized as having the potential help the country overcome the challenge of improving quality of life of the citizens living far from the urban centres. Used predominantly used by the telecommunications and military sectors uptil now, PV is finally being seen as an alternative source for electricity generation to meet the basic needs (lighting, water pumping, refrigerators, etc.) in remote areas. Government programmes (as discussed above), electricity distribution utilities, private entrepreneurs, and a few NGOs (non-governmental organizations) are gradually paving the road lead to a broader dissemination of the PV technology.

Initially stimulated by international co-operation agreements (rural electrification pilot projects implemented through bilateral co-operation programmes summing up to approximately 250 kWh, distributed in 10 of the 27 Brazilian states and almost 2000 systems), PV dissemination in Brazil is finally taking off. Tremendous initiatives are underway but they need to be monitored closely in the initial stage. Nowadays, around 12 MWp are installed.

Owing to the availability of high levels of solar radiation and the country’s large size, Brazil is one of the most suitable countries in the world for the use of especially energy solar. In

Brazil, the introduction of the solar PV technology has not differed greatly from the experience of other countries. Initially, the spread of PV technology took place in rural areas, either through government initiatives or through power companies financing the installation of autonomous PV systems such as SHS (solar home systems) or water-pumping systems.

It was only by the second half of the 1990s that the first experiences related to the connection of PV systems to the conventional power grid began to accumulate, thus confirming the international trend in Brazil towards the increasing application of the technology. Table 23 presents a brief summary of the connection experiences carried out in Brazil to date.

Table 23 Characteristics of the PV systems connected to the power network as installed in Brazil

System	Installation (yr)	PV Power
CHESF	1995	11 kW_p Polycrystalline
Lab. Solar [3,4,5]	1997	2 kW_p Amorphous
LSF[3,6]	1998	750 W_p Monocrystaline
COPPE	1999	848 W_p Monocrystaline
Lab. Solar	2000	1 kW_p Amorphous
LSF/USP	2001	6 kW_p Monocrystaline

Source Zilles, R. (USP), 2003

The connection of the PV systems to the grid in a decentralized form is one of the applications of solar PV technology, which has developed significantly over the last few years. However, the main practical applications of this technology have been in remote systems, capable of supplying loads away from the conventional power distribution network.

To realize the full potential of grid-connected PV systems in Brazil, there is need to take appropriate actions aimed at helping to consolidate this application that would make it a source of competitive sustainable electricity.

4.1.2. Biomass energy sources

As a large tropical country, Brazil has a high potential for the use of biomass. The main modern biomass sources are sugarcane products (ethanol and bagasse) and wood from reforestation. Sugarcane products are today the most economically important biomass source, totaling 19.5 M tep in 2001.

With the alcohol programme, started in 1975 with 0.9 billion litres, the participation of biomass in the Brazilian Energy Matrix reached 19% in 2000, corresponding to 14 billion litres per year of ethanol produced from sugarcane. The use of bagasse for electricity production in sugar mills yields a considerable energy surplus potential of up to 4000 MW. However, this potential is available only in the regions connected to the interlinked system due to geographical constraints.

On the other hand, in isolated regions, all sources of residue from agricultural activities, forest residue (branches, leaves, etc), and sawmill residue (sawdust, wood chips, etc) can be used as fuel to generate electricity with the technologies commercially available in the country.

However, there are still some difficulties related to the technical availability of small-scale systems, such as small-scale steam cycles. However, now prototypes are being under developed to solve this problem.

Another huge opportunity for biomass use is the electricity generation from *in natura* vegetable oils. The Amazon region in Brazil has an enormous diversity of native oil plants, and favourable conditions of soil and weather exist for the culture of highly productive exotic oil plant specimens with ambient environmental and social advantages. The main plants from which vegetable oils are derived in Brazil are palm oil (or dende — *elaeis guinneensis*), macauba (*acronomia aculeata*), and buriti (*mauntia flexuosa*).

Two important projects have been developed in Brazil, both generating electricity for small communities, which themselves produce the vegetable oil. One is a palm oil-fuelled engine in Vila Boa Esperança, in the state of Pará (Amazon region), and the other is an andiroba oil-fired unit in an Indian village (Reserva Extrativista do Medio Jurua) in the state of Amazonas. In both cases, a multi-fuel diesel engine is used, burning *in natura* vegetable oil. Funds for the oil extraction plant of Vila Boa Esperança came from the federal Ministry of Science and Technology, while the project in the Indian village was funded by ANEEL and is managed by the University of Amazonas.

There is widespread potential for small communities to extract oil from locally available nuts or other vegetable sources. For wideranging applications in power generation, palm oil is the most readily available source. This is because palm is currently the only crop, among those considered as fuel sources, that is already being produced on a large commercial scale on plantations for oil extraction, with reliable yields and standardized production.

The use of animal wastes and other residue is a technically and economically viable option to produce renewable energy, mainly in the regions with lack of energy supply. It also helps reduce pollution.

The biogas produced can be utilized as an energy source for heating, refrigeration, illumination, incubators, feed mixers, electric energy generators, etc.

The biogas produced in the digester can be used in conventional Otto engines adapted to this fuel or used in gas engines. Nevertheless, these technologies are still not adequately commercialized in the country, despite the fact that it is already being used in Brazilian farms, mainly in the Southern Region.

4.1.3. Small hydropower plants

In the case of isolated/rural communities, the mini hydro is the most promising options. Mini hydroelectric plants (of less than 30MW capacity) accounted for more than 1000 MW authorized and 465 MW under construction in 2002. There are 297 plants operating in Brazil, totaling 802 MW. The mini hydro option reduces adverse environmental impacts significantly as compared to large hydro plants and helps in the recovery of areas alongside rivers.

According to Eletrobras, the mini hydro represents a potential of 9456 MW, corresponding to 12% of the total installed power in the country. This value can be higher considering the lack of information still existing about mini hydro.

To tap the larger share of Brazil's non-tapped hydropower potential (100 GW), of small - and medium-sized plants will have to be built. Half of this potential is located in the northern region, home to the Amazon forest. Mini hydro schemes, below 10 MW, present an important potential when the reduced socio-environmental impacts are considered.

The Brazilian Government has established PNCE. This initiative is overseen by Eletrobras, and aims to provide better conditions for building small power plants all over the country.

4.1.4. Wind Power

At present, there exists 21.2 MW of installed wind power capacity that corresponds to only 0.03% of the total capacity installed in Brazil (Waschsmann and Tolmasquim 2003). In 1999, the first Brazilian Wind Energy Atlas was completed. It shows a very good wind energy potential on the coast line of the northeast, the south and the southeast of Brazil. Until now, most by the focus had been on the state of Ceará mainly because it was the first to carry out precise and reliable wind data collection.

Wind energy can also be used to allow the energy access in isolated communities. One example is Fernando de Noronha Archipelago, an isolated group of volcanic islands, situated at a distance of 345 km from the Brazilian coast, with a population of 1700 inhabitants and approximately 1000 tourists per year. Its power system consists of one power station with two diesel generators of 1 MW each (installed in 2001) and a 225 kW wind turbine, operating at reduced rating (150 kW), plus the first wind turbine (75 kW) that was installed in 1992. The two wind systems are responsible for 25% of the electricity consumed in the island. Due to these two projects, today Fernando de Noronha has the largest Brazilian hybrid wind-diesel system.

Until 2001, there were no significant incentives for alternative energies in Brazil, and therefore it was difficult for the operators of small renewable energy projects to become established in the Brazilian energy sector. With the increasing gravity of the energy crisis since January 2001, Brazil had to look for new possibilities to solve the problem. Taking the first important step with the enactment of Resolution No 24 of 5 July 2001 through (PROEÓLICA) Brazil decided to intervene in the market by a price regulation model.

Later on, with the enactment of the PROINFA law, a general policy to implement 'renewable in electricity' in the interlinked system started.

According to a study of the Brazilian Centre of Wind Energy (CBEE), the cost of wind power generation in Brazil lies between US$ 39/MWh (R$(2001) 101.40/MWh) and US$ 84/MWh (R$2001 218/MWh). Therefore, a reference price of R$ 72.85 reals cannot cover the emerging costs of power generation by this energy source.

As seen, there are several and large regions in the country that, typically, have favorable wind conditions and are naturally appropriate for developing wind farms. The installation of these systems on sites with high annual yield factors would allow them to reach competitive generation costs. The seasonal complementarities between wind and hydro regimes could be a systemic advantage worth exploring. Under these conditions, and because of the shortage of power supply, particularly in the northeastern region, wind generation becomes an important cornerstone of universal access to electricity services in Brazil. With this in mind, the Chamber for Power Crisis Management of the Presidency of the Republic enacted Resolution No 24, on 5 July 2001, which determines implementation of 1050 MW by the end of 2003. ANEEL (Agencia Nacional de Energia Electrica) will be responsible for authorizing new wind energy projects. Even before the aforementioned Resolution was published and aware of the growing domestic energy market, some private sector 'actors' (concessionaires, permissionaires, etc) obtained, in 2001, ANEEL authorization to implement wind energy projects of about 3020 MW, mostly located in the northeastern region.

4.2. Replacement of diesel generators in off-grid power systems

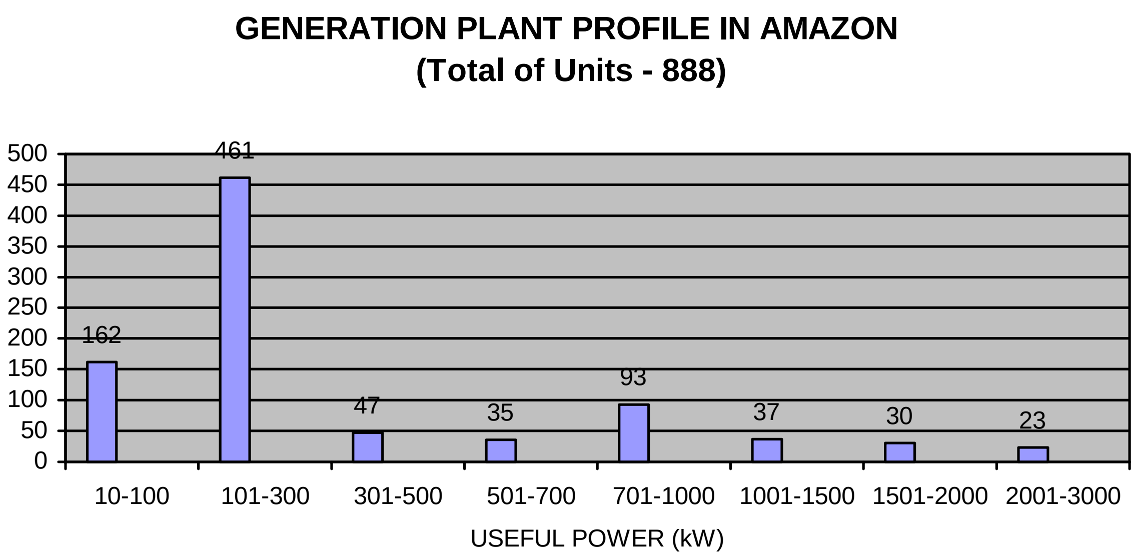
Brazilian power sector is divided into two large systems, the interlinked system and the isolated system. The interlinked system (with 88% of its installed capacity from

hydropower) includes the large transmission system, from the northeast to the southeast and south of the country, except the Amazon region, in north Brazil (isolated systems).
The isolated system includes small local grids mainly in the northern region (Amazon region); statistics are available for these systems, which are operated by utilities, mainly Eletronorte.

In Amazon, the energy supply of off-grid systems is based on diesel generators, corresponding to a massive consumption of diesel oil, not only for electricity generation, but also due for transportation in the region, which is almost exclusively by boat.

Figure 7 shows that there are nearly 1000 power plants supplying electricity to isolated cities and villages in the Amazon using mostly diesel oil. Almost 700 units have an installed power lower than 500 kW.

Figure 7 Diesel generators in the Amazon



Source Goldemberg, 2000

The cost of the electricity produced by such diesel units in off-grid systems is high, achieving in some cases as much as 200 dollars /MWh, being partially covered by the CCC (Conta de Consumode Combustoveis), a subsidy funded by overcharging electricity sold to all regions of the country covered by the national grid. Two years ago, the subsidy was provided essentially to power plants burning diesel and oil. New legislation has extended this subsidy to renewable fuels too.

Besides these systems, there are also a huge amount of smaller diesel generators all over this region, that are operated by local communities. Studies recommend the replacement of old diesel' based units with renewable energy, mostly biomass-powered units, considering the high potential of residue existing in the region(Goldemberg 2000). However, up to now such replacement has occurred only in very few situations.

4.3. Barriers against the use of RETs in off-grid power systems

4.3.1 Technical Barriers

The existing technical barriers for renewable energy use in isolated villages (CENBIO, 2000) can be surmounted by adapting technologies already in use in other developing countries such as India and China and by using the experience from projects presently under development (PROVEGAM, GASEIFAMAZ, CENBIO, 2002). This has to be done by keeping in mind the key characteristics of the isolated areas — their small demand, the lack of skilled people, and difficulties in operating and maintaining power equipment. Cconsequently, power systems for these markets should be of small capacity and be as simple as possible.

4.3.2 Political and institutional barriers

Regarding political and institutional barriers, the main drawback is the lack of medium-to long-term energy policies, a constraint that is more acute in the case of renewables. Energy policy, planning, and regulation are still almost completely dissociated, when existent.

In general regulatory actions by ANEEL address important points but there are many doubts concerning their effectiveness as tools for fostering renewable electricity in Brazil. The CCC policy, in fact, contributed to expanding the energy access in isolated communities, but a number of difficulties still prevail, such as a high extra-diesel consumption for boat transportation of diesel oil higher costs difficulties in guaranteeing the supply, increase in diesel oil import dependence, and pollutant emissions.

The recent expansion of the CCC policy for renewable energy aims to reduce these difficulties. Renewable energy sources, such as PV, biomass, small hydro, and others, can be provided with local resources, can guarantee the supply (once they use local resources), have much lower environmental impacts, and contribute towards energy self-sufficiency, among other advantages (Goldemberg 2002).

An indirect barrier to the implementation of renewables is the current environmental legislation for stationary sources. The legislation for these sources has established limits only or SO_2 and particulate specific emissions, and not for NOx (nitrogen oxides) emissions. This is a cause for concern because the expansion of the power sector is expected to rely on natural gas-fired power plants, and for this NOx emissions must be controlled. If not, conversion systems will be installed with no reduction in emissions, corresponding to lower installations costs. Consequently, this appears to be an indirect subsidy to fossil fuels, mainly outside the state of São Paulo.

4.3.3 Financial and economic barriers

Due to the lack of incentives for promoting renewables in Brazil, the economic and financial constraints have not been addressed effectively so far. The main economic barriers to renewable energy projects, the World over, include high initial costs and the small scale production equipment and systems. To overcome these barriers the creation of a mandatory market of minimum size is essential.

It is important to understand that in case the mandatory market is approved with no corresponding action regarding the economic, and the science and technology policies, an external dependence on equipment suppliers will be created.

The Ministry of Science and Technology has special programme aimed at stimulating research and technological innovation in new sources of electricity generation at lower costs and developing the national technology industry and human resources.

Brazil has never implemented financial and tax measures to foster small-medium-sized energy projects, including renewables. An additional drawback to renewables is that the risk perception for investors is greater, inducing financial agents to boldly refuse projects or to require higher rates of interest for loan approvals.

The BNDES (Banco Nacional de Desenvolviments Economic e Social) has launched several programmes, allowing special credits for biomass power plants that will generate electricity and sell the surplus electricity to utilities or engage in its direct commercialization.

However, this kind of programme can be better used by industries/entrepreneurs, and it is not adequate for rural areas/isolated communities. In such cases, special funds to provide the investment must be facilitated by donors. In the case of Indian villages, O&M (operation and maintenance) costs are not covered by the community, even when the energy system is provided.

Globally, the successful experience with the use of renewables has been based on tax incentives. The Brazilian government has never defined a comprehensive long-term policy for renewables and energy efficiency with these kinds of incentives. Instruments like tax reduction for imported devices of higher efficiency, credits on taxable income, and accelerated depreciation have also been instrumental elsewhere (CENBIO 2000).

5.0 Summary of Key Findings

According to the data from MME (Ministerio de Minas e Energia) nearly 6% of the total Brazilian population and 25% of the rural population has no access to electricity services. Low-income population in peri-urban areas also suffers from insufficient coverage of electricity needs; 90% of non-supplied Brazilians have a family income of under three minimum wages. As a result, the poorest in Brazil either have to pay the most expensive kWh (from batteries) or have very poor quality lighting.

Energy reforms in Brazil are still in the implementation phase. However, it is clear that two of its purported goals have not been achieved: tariffs have not been reduced due to competition (on the contrary, substantial increases are heavily affecting the poor consumers) and the federal and state governments could not stop investing in the energy sector to channel public resources to other more pressing development needs. As a matter of fact, the energy reform has penalized the supply of energy to rural and low-income areas, due to its emphasis on the maximization of privatization proceeds.

Some attempts to overcome the difficulties of expanding access to electricity must be acknowledged: the implementation of the Luz-no-Campo programme, the increase of the funds to PRODEEM (Programa de Desenvolvimento Energetico de Estados e Municipios), and the enactment of Law 10,438, which will oblige agents to provide universal access to electricity in a horizon to be defined by the regulatory agency – ANEEL(Angenica Nacional de Energia Electria).

However, due to the difficulties that the power sector is claiming to have after the power shortage in 2000-2001, a dispute for RGR (Reserva Global de Reversao) and CDE (Conta de Desenvolvimento Energetico) resources can postpone the enforcement of the Law. Within this context, the most pressing needs to expand the access of the poor to electricity are:

- Definition of a comprehensive national strategy for universal access.
- Assurance of RGR and CDE funds for promoting universal access.
- An immediate definition of electrification targets for universal access, with a possible deadline in 2010, and rules for anticipation, reimbursement and award of permissions within concession areas.
- Establishment of incentives to assure the sustainability of new agents working on behalf of the concessionaires or operating the permissions, within concession areas.

- Creation of incentives to stimulate concessionaires and permissionaires to diversify their supply alternatives, optimizing the use of available resources;
- Development of a concerted effort to get complementary resources from other social programmes in order to create a sustainable service, attractive to potential investors.

6.0 Prospects for Improving the Regulatory Framework and Recent Developments

6.1. Main flaws in the regulatory framework and the need for its improvement

As regards the objectives of achieving full coverage of electricity needs, experience to date reveals a number of fundamental problems in the Brazilian regulatory framework. These can be summarized as follows:

- Lack of enforcement of existing legislation.
- Lack of clarity in universal service obligations faced by distribution concessionaires. This is expected to be solved with the establishment of rules for the implementation of Law 10438.
- Lack of financial incentives for distribution concessionaires to undertake rural electrification, which can be solved with the allocation of CDE (Conta de Desenvolvimento Energetica) funds for universal access.
- Lack of mechanisms to ensure efficient technology choices between grid-based and off-grid solutions to rural electrification.
- Lack of institutional models to assure sustainability of off-grid solutions, such as solar home systems. ANEEL (Agencia Nacional de Energia Eletrica) has never given any

indication to the market that this solution could be accepted in the targets of full coverage.

- Lack of differentiation between the quality of service standards and other regulatory parameters that apply to off-grid systems.
- Lack of clarity regarding the potential role to be played by agents, other than the distribution concessionaires, in reaching universal coverage.
- Lack of focus on maximizing the social and economic benefits to communities by promoting productive uses of energy.
- Lack of political commitment to tackle the problem of providing service to remote areas.

A similar effort allocated to resolve the shortage of energy in the country, affecting mainly the urban areas, could be adopted as a lesson to solve the absolute lack of energy in rural areas.

A compromise must be found to overcome the paradoxical situation of states with very low rates of electrification having to assume the highest impacts on their tariffs and the simple transfer of their new burden to all other concessionaires of the country without assuring mechanisms towards increased efficiency.

Under the new legal framework, the following points need to be considered:

- An immediate responsibility of ANEEL is the definition of electrification rules for anticipation and reimbursement of resources from interested parties, besides procedures for monitoring of concessionaires' targets.

▪ANEEL should define a set of transparent, flexible standards for rural electrification through grid, mini-grids, and PV(photovoltaic), that match rural demand profiles, allow for low-cost solutions where appropriate, but assure minimum service quality. This could include price caps, which would be accepted by ANEEL to pass-through to the tariffs. Costs beyond these limits would not be transferred to the tariffs. These standards would be compatible with the different market clusters. The extremely high cost of visiting remote rural households needs to be taken into account for both service standards (e.g. , reaction time in case of failure) and regulatory oversight (i.e., regulators have to be able to finance their own increased costs incurred by frequent audits and visits to remote places).

▪ANEEL must carefully assess the impact of universal access to electricity on the consumer tariffs, particularly to avoid penalizing captive consumers. This cross-subsidy should be transparent to the whole society.

6.2. Recent developments

6.2.1. Targets and timetables established by ANEEL for extending access to electricity to all municipalities

An important initiative of ANEEL was Resolution 219, approved in April 2003, offering a discount of 50% for the tariffs of electricity generated by wind and biomass. This benefit was already regulated for PCHs (mini hydroelectric units) through Resolution 281 of 1999.

The other important initiative related to the public discussion being carried on (29 April 2003) through the ANEEL website (www.aneel.gov.br) to improve the regulation of the voltage-level oscillations established by the Resolution 505 of 26 November 2001.

Finally, ANEEL released Resolution 223 in the first week of May 2003, regulating aspects of Law 10438/2002 related to targets for universal access to electricity in Brazil. Expenses related to the connection to the grid will be borne, by the utilities, and not the consumers. All utilities are to submit to ANEEL, within the determined deadlines, their programmes to expand access to electricity. Targets were defined in order to reach full coverage of consumer connections within a term set according to the current levels of electrification. Targets were established for the areas serviced by each utility and for municipalities (the closest target prevails in the case of conflict), as shown in Tables 24 and 25.

Table 24 Electrification targets to be reached by utilities in their concession areas

Current coverage level in the area serviced by the utility	Target year for universal access
> 99.5 %	2006
> 98 % and < 99.5 %	2008
> 96 % and < 98 %	2010
> 80 % and < 96 %	2013
< 80 %	2015

Source ANEEL

Table 25 Electrification targets for municipalities

Current coverage level in the municipality	Target year for universal access
> 96 %	2004
> 90 % and < 96 %	2006

> 83 % and < 90 %	2008
> 75 % and < 83 %	2010
> 65 % and < 75 %	2012
> 53 % and > 65 %	2014
< 53 %	2015

Source ANEEL

Financial resources from CDE can be granted to accelerate the achievement of targets. ANEEL will monitor the progress achieved by utilities in the implementation of electrification programmes and the results achieved. Those not meeting the targets will be subjected to sanctions, and mainly to a reduction in the tariffs increase, on the occasion of the periodic review of tariffs by ANEEL. According to the number of municipalities lying below the target, tariff increases can be reduced from 3%- 10 %, during the period in the years of non-compliance with the targets.

Starting January 2004, utilities must start implementing their plans to provide universal access to electricity, according to ANEEL Resolution No. 223. Of a total of 5507, 2400 municipalities will be fully covered in 2004. However 336 municipalities mainly located in the northern and northeastern regions may have to wait until 2015 to be supplied; i.e,

2 million Brazilians may have to wait until 2015 to get access to electricity, if ANEEL targets are met. Appendix B presents the electrification level in the area covered by each utility. It clearly shows that the main gaps to be filled in order to ensure universal access to electricity are located in the states belonging to regions in the northern and northeast of the country.

6.2.2. Government programme under preparation for accelerating universal access to electricity in rural areas

The Brazilian government is soon to announce (before the end of 2003) a programme to bring electricity to 1.4 million households by 2006, in rural areas throughout Brazil, as yet unconnected to any transmission grid. It is, without a doubt, an important step towards achieving the much-longed for dream of universal access to electrical energy services. After all, as mentioned in Section 1.2 where most of the population without access to electricity lives in the rural areas.

According to MME (Minsterio de Minas e Energia), this programme will be implemented through partnerships among the federal government, state governments, and the concessionaires. Included in the universal access programme for the rural area is the goal of bringing forward the targets established by ANEEL (Resolution No. 223). In this regard, according to MME, the year 2010 would be ideal for the country.

The programme under review will concentrate its attention on the most critical regions of Brazil, in terms of electricity. According to MME, these regions include the states of the north and northeast; the Jequitinhonha Valley, in Minas Gerais; Paraíba Valley, between Rio de Janeiro and São Paulo; Pontal do Paranapanema, in São Paulo; and half of Rio Grande do Sul. That is, the aim is to concentrate efforts (and investments) in around 1.9 million households of the rural area with no access to electricity services. To fully implement this programme, the federal government intends to invest 6.5 billion, reals.

6.2.3. Need to minimize defaults and increase universal access

As mentioned before, resources from CDE may allow the targets established by ANEEL (Resolution No. 223) for universal access to electricity services in Brazil to be reached earlier than planned say, around the year 2010. In spite of the assistance of CDE, huge investments will be required from the distributors, particularly in the case of the municipalities whose current rates of electrification are below 75%.

The loss of income from defaults on energy bills is one of the main concerns of the distributors. After all, this loss tends to reduce the distributor's capacity to invest. Consequently, the universal access targets defined by ANEEL become increasingly difficult to achieve.

In the ‘war’ against defaults, distributors have adopted various strategies: from creating a discount card in accredited establishments for consumers who pay their energy bills on time, as is the case of Light (operating in the state of Rio de Janeiro), to increasing the frequency of energy cutoffs, as announced by the company RGE (Rio Grande Energia), operating in the state of Rio Grande do Sul). In the case of RGE, increasing cuts was the way to reduce defaults, which reached 6.7% of their total sales over the past five years — a loss of 70 million reals. Cut-offs should affect about 30000 consumption points over the next 30 days. In addition to combating defaults, RGE also increased their ‘specialized inspection’ teams to combat illegal connections.

Between January and June 2003, RGE experienced additional loss of 11 million reals in defaults from their customers, totalling an accumulated debt, since 1997, of 46 million reals only for the residential supply. According to RGE, when customers default for over 90 days, the chance of recovering the debt is only 10%. About 50% of the current defaulting customers are in this situation (60% are repeat offenders). In addition to the specialized street teams, the distributor also sets collection agents in action. In 2002, the total sales of RGE amounted to 1 billion reals, buying energy from six or seven suppliers.

While RGE promises to increase cut-offs in energy supply to reduce defaulting, Coelba is already seeing the results of the initiatives to discourage payment delays. Coelba operates in Bahia, where 88% of the consumers are residential. One of its main results has been a reduction in the number of supply cut-offs due to unpaid bills. The distributor had 32% of the bills paid rigorously on time and 53% paid up to 10 days late. Around 15% of the consumers delayed for more than 10 days. Today Coelba believes that only 2.2% of late bills are not recoverable.

In the case of residential consumers, another initiative undertaken by Coelba was to inform them of the possibility of choosing another date for paying the bills. This trivial measure proved to be very effective in combating defaults. It turned out that several consumers delayed payment because the payment date was not appropriate.

In São Paulo, Elektro opted for a special promotion to reduce defaults. The company created the Money in Your Hand campaign which every month, since March 2003, gave 36 customers who paid on time a cheque for 562 reals. During the first campaign month, timely payments from residential customers went up from 43.45% to 47.95%. The group that enthusiastically joined the campaign was that of low-income consumers, whose expenditure was up to 50 reals a month, that is, 62% of Elektro's customers. In this range of consumers, the company managed to reduce defaults by 16%.

The strategy employed by Light to prevent an increase in defaults was to create a club of associates. If the customer paid the previous bill by the due date, in his next bill he would receive a card that entitled him to discounts and special promotions in partner companies, such as household appliance stores, drugstores, eyeglass stores, restaurants, and so on over the next 30 days. In addition, the company would also cut off supply of up to 200000 points a month. For those consumers who defaulted and possibly had their supply cancelled, the company encouraged paying back of past debts. There are no specific programmes to prevent commercial or industrial customers from defaulting, but the company states that it is studying a club of associates exclusively for these segments.

The distributors' programmes for preventing defaults, however, do not affect their worst customers: the public sector. According to the data of the Brazilian Electricity Distributors Association (Abradee), the default of the public sector corresponds to approximately 800 million reals. The amount is equivalent to the income of the companies in three months of supplying energy to the entire Brazilian public sector. The supply to federal, state, and municipal governments accounts for 6.5% of the total sales of the distributors and amounts to about 3 billion reals a year or 260 million reals a month. It is known that the public sector debt corresponds to a significant amount of receivables. In the São Paulo Company Eletropaulo, for example, defaults correspond to 1.87% of the sales and 1.37% corresponds to the public sector. According to Abradee, the average default period of the public sector is three months, but it can drag on for much longer. Collecting these arrears is, however, not the easiest of tasks: while the non-payment of a single invoice is sufficient to cut off the energy supply to a private consumer—Abradee states that companies on an average cut the supply of 3% of the Brazilian consumers —cutting off the supply to public facilities is usually not done.

7.0 Policy Options to Improve the Access of the Poor to Electricity

7.1. General policy options to improve the regulatory framework

The definition of a comprehensive national strategy for universal access to electricity is needed. This national strategy to be established by MME (Ministerio de Minas e Energia) must include the definition of the volume of available resources from RGR (Reserva Global de Reversao) and CDE (Conta de desenvolviments Energetico) funds, the deadline for universal access in the whole country, the maximum impact in the tariffs that would be acceptable, and how those available funds would minimize this impact.

The most immediate and important challenge to assure the expansion of electricity services for the low-income and rural areas is the regulation of Law 10438, through the definition of targets and deadlines for full coverage, assurance of resources from RGR and CDE for concession and permission holders, consolidation of the possibility of awarding permission inside the concession areas, and creation of instruments to make these new agents sustainable.

At the same time a considerable, effort into coordinating the actions of different institutions and programmes, articulating income generation, poverty alleviation, infrastructure provision, and rural electrification programmes completes the list of the most urgent actions to promote full coverage. This concerted action should take into consideration the different initiatives, like Luz-no-Campo, PRODEEM (Programa de Desenvolvimento Energetico de Estadose Municipios), MA's (Ministerio de Agricultura, Pecuaria e Abastecimento) funds to RE (Renewable Energy) through the annual national budget, PAP (Poverty Alleviation Programme), Northeast Development Bank credit line to micro-entrepreneurs, etc. This strategy should try to optimize the allocation of the public resources, which must be used to leverage the private funds raised by the concessionaires and the new agents.

Existing programmes should create conditions to make feasible the conversion of some rural electrification co-operatives into multi-service entities (electricity, telephone, and water), for example, through a specific credit line and capacity building effort, including co-ordinated regulation and tariff definition. This is a model with a strong potential for replication, and it could make permissionaires more viable.

Provided that national tariffs will increase to cover the new investments by concessionaire, they must get incentives to efficiently choose the supply technologies, and lower service-provision costs whereever possible. Among the options available to concessionaires/permissionaires to minimize their own investments are the use of more cost-effective technologies, including low-cost grids (wooden poles, low power transformers, single-wire earth return lines, and aluminium cables) and decentralized rural electrification (mini-grids based on RET[renewable energy technology], SHS[solar home system] etc.). Besides, they can minimize the financial cost by maximizing the use of available subsidy sources such as CDE, RGR, PRODEEM, MA etc. An effort to stimulate concessionaires to diversify technologies and sources of resources must be part of the national strategy to be launched.

An additional challenge is to integrate off-grid rural electrification into the targets to provide universal access to electricity to the concessionaires, making an effort to incorporate those systems already installed by different programmes (e.g., PRODEEM, PAP), in order to avoid conflicts and create synergies between entrepreneurs of independent projects and the concessionaires.

MME as ultimately responsible, by definition, for policies affecting the use of the main power sector funds (RGR and CDE), must create incentives in their uses to stimulate concessionaires and permissionaires to diversify their supply alternatives (including low-cost grid connections, RETs in micro grids, and SHS). Projects making use of these technologies should access those funds under differentiated conditions (lower interest rates, longer grace, and financing periods). The cost of money could be higher for conventional grids and diesel systems. Alternatively, CDE, which is a non-reimbursable grant, could be directed mainly towards new technological alternatives. RGR, which is a soft loan, could be directed to the more conventional forms of supply, such as grid extension and diesel sets.

Banks can create credit lines under favorable conditions, reducing interests and enlarging the grace periods to enable potential consumers can accelerate their service connections by paying a part of (or the full) investment, to enable since the reimbursement to consumers is guaranteed by the concessionaires. This could be tailored such that the concessionaire pays back the loan to the bank.

The use of RETs and the replacement of diesel-based isolated systems by gas or renewable energy based systems contribute to reducing or avoiding GHG (greenhouse gas emission), and can, thus, access the incentives from the carbon market through the Kyoto Protocol. An effort to this end can be made by the authorities in charge of the national climate change policy.

Brazil is a large market for both grid extension and distributed RETs. However, existing information on the market is very inaccurate. A definitive quantifying census that would include sample surveys to more precisely define how the market could be split between these alternatives is vital. This would certainly reduce uncertainties and attract private investors.

7.2. Expanding the use of new RETs

The most significant prospects to increasing energy access in isolated systems includes the use of renewable energy sources. As mentioned in Chapter4, renewable energy sources, such PV (photovoltaic), biomass, mini hydro, and others, can be provided with the help of local resources to isolated communities. This can guarantee supply (as local resources are used), have much lower environmental impacts, and make for energy independence, among other advantages (Goldemberg 2002).

Renewable energy is a basic ingredient for sustainable development. Such sources can supply the requisite energy for indefinite periods of time and cause far less population than fossil or nuclear fuels.

The multiple benefits of the increased use of renewable energy technologies, which in general are coupled with efficient end-use devices, are the following (Goldemberg and code no. 2003):

- Protection of the local, regional, and global environment, as well as reduction of indoor air pollution, acid rain, deforestation, and GHG, as it is well known that fossil fuels together with the primitive unsustainable use of fuel wood are the main contributors to these problems.

- Promotion of energy security through the diversification of energy sources, taking into account the decentralized nature of most renewable energy options.
- Creation of jobs and income-generating activities through the use of local resources, i.e. mainly biomass.

The decisions emanating from the WSSD (World Summit on Sustainable Development) held in Johannesburg in 2002 reflect a growing interest in renewables exerted by the European Union, the Latin American and Caribbean countries, several United Nations Reports, and several NGOs(non-governmental organizations).

In its original formulation, the Brazilian Energy Initiative, presented at WSSD, proposed an increase in 'the use of new renewable sources to 10% as a share of world's energy matrix by 2010'. 'New renewable sources' include modern biomass, mini hydropower, geothermal energy, wind energy, solar energy (including PV), and marine energy. 'Modern biomass' excludes traditional uses of biomass as fuel wood and includes electricity generation and heat production from agricultural and forest residue and solid waste. With such caveats 'new renewable energy sources' could be labeled as 'sustainable renewable energy sources'. Large hydro power plants were not originally included in the proposal but were included later provided they were 'socially and environmentally acceptable'.

The Brazilian Energy Initiative required that all countries reach a fraction of renewables in their energy mix by the year 2010 and not only Annex I countries as proposed by the Kyoto protocol. Such goals are to be achieved 'individually or jointly', which opens the way for flexible mechanisms and trading of renewable energy certificates. It, thus, recognizes that 'one size fits all' and that different countries will pursue distinct trajectories, targets, and timeframes, which could merge with the regional or global targets. In principle, this could remove one of the main objections of the United States to agreements of this type.

Partnerships, in the form of Type 2 WSSD Initiatives, are some of the most important ways to implement the decisions made at the summit.

One example of these initiatives is the REEEP (Renewable Energy and Energy Efficiency Partnership) that aims to: lower market barriers to the deployment of renewable energy and energy efficiency systems; improve access to financing for sustainable energy technologies; and raise awareness and build capacity across all stakeholder groups. REEEP also aims to accelerate and expand the global market for renewable energy and energy efficiency technologies.

The Latin American and Caribbean Regional Meeting of REEEP took place in São Paulo state, from 12 -13 August, 2003. One of the results is the project proposal aimed at promoting regulatory information exchange across Latin America and the Caribbean region.

This type of initiative can help to increase energy access in developing countries.

7.3 Universal access to electricity and impacts on climate change

The Third IPCC (Inter-govermental Panel on Climate Change) Assessment Report, in three volumes, concluded at the end of 2001, delivers a clear message: research and intensive monitoring of the climate allows scientists to have greater confidence with regard to understanding the causes and consequences of global warming. The Assessment Report presents a convincing vision of the conditions that will most probably be seen on earth at the end of the twenty-first Century, when a global warming of 1.4 -5.8 ^{o}C (2.5-10.4 ^{o}F) will influence meteorological patterns, water resources, seasonal cycles, ecosystems, extreme meteorological events, and many other greater transformations that are expected in the distant future.

Climate change is, by its very nature, a global process. GHG emissions from any country will have impacts on the global climate system. Under the mantle of climate change mitigation, governments need to act quickly to develop and implement national policies that incorporate climate change aspects. IPCC's assessment confirms that well designed policies aimed at the equitable development of man can reduce emissions and the costs of adapting to the inevitable impacts of climate change, while at the same time generating economic benefits. These benefits include more efficient energy systems, faster technological innovation, reduction of expenditures from inappropriate subsidies, and more efficient markets. Emission reduction can also reduce the damage caused by local environmental problems, including the effects of air pollution on health.

In this regard, the programme for achieving universal access to electricity implemented by the Brazilian government can include in its core the concern for climate change. That is, the Brazilian policy directed towards universal access can be steered in such a way as to mitigate the increase of GHG emissions arising from the expansion of the consumption of electricity required to meet this objective. Reduction of damage (to health, and to the economy, for example) generated by environmental problems will depend on this type of steering.

The energy issue stands out because it is one of the central points in the discussion on climate change. Thus, the role of Brazil is relevant. After all, the country has the advantage of having a ‘clean’ energy supply mix—production of electricity is currently based on 92% of hydropower generation and 2.5% nuclear energy. The remainder comes from thermopower plants that operate on charcoal, oil derivatives, and natural gas. Furthermore, Brazil stands out in the use of biomass, not only in its traditional use, but also in new ways, such as biofuels.

In the context of universal access to electricity in Brazil, it is expected that there will be increased pressure on the environment, including the climate system, due to, GHG emissions generated by new hydropower reservoirs (particularly methane) and new thermopower plants that use fossil fuels (decentralized electricity generation, particularly from diesel oil). So, both the expansion of power generation and the distribution networks needed to achieve universal access to electricity in Brazil are related (even if not in such an obvious or expressive way) to the climate change issue.

7.4 Clean Development Mechanism and universal access

Since universal access to electricity is a long-term objective (2010 or 2015) for Brazilian development, it should encompass climate change issues. Ideally, it is expected that this development occurs in the most sustainable manner possible.

In this context, the CDM (Clean Development Mechanism) can and should be used as a market instrument to allow for a more important role for renewable energies in universal access. This strategy would naturally include lower levels of GHG emissions. As a result, mitigation of emission growth is induced. In this case, the most important aspect would be the good example set for other developing countries.

Universal access is extremely important for Brazil as it will help the country become a fairer and, more equitable one. With respect to universal access, it is not unlikely that there will be a certain increase in GHG emissions. This increase is ‘ethically admissible’ in so far as universal access can effectively change the reality of millions of Brazilians who are still at the very edge of what can be considered a fair level of survival. In a developing country such as Brazil, satisfactory levels of health, education or access to electricity (which is directly related to the expansion of health and education services) have still not been reached. The fact is that in the search for equity, Brazilian economic development has had a tendency to be faster than in the other developed countries. In this regard, key environmental issues such as protection of the earth's atmosphere have not been given the requisite priority for government actions.

On the other hand, CDM provides an opportunity for increasing the use of renewable energies to achieve the goal of sustainable universal access to electricity in Brazil. sustainably. This use would bring along with it several benefits for the country, of social, environmental (local), economic and technological natures, while at the same time reducing the growth of GHG emissions.

8.0 Final Considerations and Recommendations

The inclusion of government planning for universal access to electricity at the same level as current social programmes being implemented by the federal government is in effect a major step forward. The government’s Programme Zero Hunger and the Universal Access Programme should be given similar impulses so that national development can become sustainable and make for a more fair and equitable society. In this sense, there is a close relationship between universal access and social justice.

Community participation in electricity management is an essential feature for the success of isolated generation projects. Top-down approaches with the installation of equipment in unorganized communities leads to abandoning the equipment, and a retraction in the process of universal access, which is happening to PRODEEM (Programa de Desenvolvimento Energetico de Estados e Municipios).

Even so, there is no ANEEL (Agencia Nacional de Energia Electrica) directive that provides for the participation of the community, nor provisions for inspection of the targets for universal access.

The complete lack of interest of the concessionaires in rural electrification must once again be stressed. This disinterest is based on the fact that Law No. 10438 places the financial burden of this expansion on the concessionaires themselves. CDE (Conta de Desenvolvimento Energetico), therefore, becomes an essential instrument of universal access, since it allows raising the low-income population to the rank of consumers. There are, however, some reservations in CDE covering 100% of the costs of universal access.

The universal access programme should, in its initial stages, prioritize the regions where access is notoriously precarious, that is in the rural areas of the north and northeast of Brazil. In these areas, the current low level of access aggravates various social shortcomings such as non-existent or insufficient healthcare services and education. That is, medium-and long-term solutions are not acceptable.

As to renewable energies, the government needs to define its role more clearly in the planning of universal access to electricity in Brazil. Resolution No. 223 does not establish as a prerequisite, a share of renewable energies in the universal access process, leaving it to the discretion of the concessionaires. From a sustainable development perspective, the decentralized generation by an alternative renewable source should have a more important role. Renewable energies can and should be more deeply explored in the search for universal access.

The use of renewable energies in the Luz-no-Campo programme would be opportune. This programme, an important cornerstone of universal access, has been facing numerous difficulties mainly related to the high average cost of transmission lines, around 12,000 reals /km (approximately 4000 dollars in 2003 prices).

On the other hand, CCC (Conta de Consumo de Cumbustiveis), another mechanism for subsidizing isolated electricity generation systems, has enough funds to make it possible to use various types of energy from biomass to replace diesel. For example, the use of animal wastes could solve the environmental problem of appropriate waste disposal and contribute to solving the problem of the need to expand the supply of electricity in the rural areas.

There is still the question of the MA’s (Ministerio de Agricultura, Pecuaria e Abasteciments) grants given to states and municipalities. Should they be made available to the concessionaires, they would have a better cost-effectiveness, since they cost less than outsourcing.

With respect to the quality of the energy supplied, ANEEL (Agencia Nacional de Energia Electrica) should accelerate the regulation of the quality of access. Since if this issue is not defined, universal access faces the risk of not contributing to the sustainability of national development. The government of the State of Bahia, for example, established a partnership with the state electricity company, Coelba, to implement PV (photovoltaic) systems. The degree of desired quality and the respective responsibility are issues that are still pending. ANEEL has also not decided whether the supply would be three-phase or single-phase energy, whereby the consumer would have the right to require three-phase energy.

9. Next Steps of the Study

For the future stages of this study, the following directions are foreseen:

- Planning regional solutions to the question of access to electricity in Brazil by making use of the energy resources of each region with non-existent or precarious access.

- Focus case studies on rural areas of the northern and northeastern regions of the country, seeking to propose emergency measures to combat electrical exclusion and to detail, at the municipal level, the how grant of universal access to electricity.

- Undertake a case study of the Bahia State (northeastern region), home to a regional programme combining grid extension and PVs (photvoltaics) to extend coverage of electricity supply in rural areas.

- Deepen the understanding of the impacts on GHG (greenhouse gas) emissions arising from granting universal access to electricity in the country. In this regard, plan the expansion of the use of renewable energies and assess the opportunities provided by the CDM (Clean Development Mechanism).

- Plan capacity building of the new users of electricity services and the dissemination of efficient end-use technology. It is important that the potential offered by electricity is disseminated to the population with recent access. Policies should be formulated to combat poverty from the viewpoint of making 'intelligent' use of the electricity supplied.
- Analyze the new model of the Brazilian electricity sector, under implementation, from the viewpoint of universal access. Will the new model be effective in bringing forward the deadlines established in Resolution No. 223. Will the minimum energy consumption level required for meeting basic needs and the quality of the access be ensured in this new model? What will be the financial implications (electricity tariffs, cross-subsidies needed) of granting universal access to electricity to the Brazilian population?

- A key component of the Kyoto Protocol, the CDM is expected to play a strategic role in mitigating climate change and supporting sustainable development by providing a new financing mechanism for energy projects in developing countries. However, there is lack of human and institutional capacity for the identification, development, implementation, validation, registration, monitoring, financing, and certification of CDM projects. So, it is very important to analyze in depth the potentialities of the CDM in the context of expanding the access to electricity in Brazil.

- Establishment of indicators to monitor the progress towards universal access to electricity in the different Brazilian states and regions, and its impacts (e.g., electrification levels, electrification rates, income/capita, access to other services, distance from the grid) and undertake data surveys to estimate the value for each indicator, in order to help improve the implementation of the programme.

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Appendix A — Overview of Power Generation Plants using New Renewable Energy Technologies in Brazil (MME, 2003)

Project/Programme/Sponsorship	State	Technology	Number	Beneficiaries
APAEB	BA	PV	250	14 municipalities
COELBA				
USDoE	BA	PV	209	14 municipalities/ 18 localities
FONDEM	BA	PV	27	27 localities
PRODEEM/Petrobrás	BA		31	
PRODEEM/Fase II	BA	PV	258	20

				municipalities
Luz no Campo (implantados)	BA	PV	450	
CAR	BA	PV	14.344	307 localities
CERB				
Bombeamento de água	BA	PV	180	
Luz no Campo (programmeados + implantados)	BA	PV		
BP Solar	BA		60	2 localities
PRONESE	SE	PV	1.400	47 localities
COHIDRO	SE	PV	47	
PRODEEM	SE	PV	44	44 municipalities/ 44 localities
ENERGIPE	SE	wind	2	4 localities
ESCELSA	ES		2	
Guaçu—Virá	ES	PV	2(1)	1 community with 30 families
Projeto Ocaruçu - Praia de Ponta Negra—Paraty	RJ	PV/wind	1	1 community with 30 families
Morro da Previdência	RJ	PV	1	
Praia do Aventureiro (Ilha Grande)	RJ	PV		4 households/ 1 FEEMA 's office1

				Communitary Center (?)
ElPaso —Paraty	RJ	PV		136 households 30 public lightening 3 cooling stations (18,45)
PRODEEM/RJ—Projeto GERA-SOL	RJ	PV	51	15 municipalities
Ilhas de Jaguanun e Itacuruçá—Mangaratiba	RJ	PV	150	
São João da Barra	RJ	PV	20	1 municipality
Vila de Pescadores— Ilha de ConvivênciaSão José da Barra	RJ	PV	1	1 locality with 30 families
Parque Municipal Ecológico da Prainha	RJ	PV	2	
CNBB/Pastoral da Criança	MG/BA/PI/MA/CE	PV	32	29 communities
Programmea Luz Solar/PRODEEM	MG	PV	672(2)	105 municipalities
COPASA	MG	PV	181	24 municipalities
Vila de Caraíva	MG/BA	PV	75	
MCH Turmalina	MG	MCH/PV	1 MCH 6 PV	16 households
Outras MCHs	MG/RJ/AL/GO	MCH		

Outras MCHs(3)	MG	MCH	144	
Assentamentos Januária, Vaca Preta, Veredas	MG/RS	PV	242	
PRODEEM/Projeto Alvorada	MG	PV	246	
COPASA II	MG	PV	100	
Banco do Povo	MG	PV	300	
Cachoeiras do Gibão	MG	MCH	1	1 municipality with 22 households
Araçuaí	MG	PV	2	53 families
Itamarandiba	MG	PV	1	450 families
PRODEEM/GO	GO	PV	98	27 Municipalities
PRODEEM/Projeto Alvorada	GO	PV	33	
Parque da Criança, Oxigenação de Lago	GO	PV/wind	1	
Energia Solar	GO	PV	2	
SW-Serviço de Instalações Elétricas Inds. Ltda.	GO	PV	2	
Projeto PE LEVE	AL	PV	17	14 household / 2 public lightning / 1 school
Projeto Luz do Sol (fase I)	AL	PV	20 ESCABs	1000 usuaries
Projeto Luz do Sol (fase II)	AL	PV		2.700

				households
Projeto PRODEEM FTV (fase II)	AL	PV	94	
Projeto Seinfra PRODEEM	AL	PV	85 water pumps 126 SHS	35 Municipalities
CEAL/PRODEEM	AL	PV		24 schools and 6 water pumps
BP/Prodeem Fase V	AL	PV		164 schools (11808)
Instituto Xingó/PRODEEM	AL	PV		8 schools in 3 Municipalities
Projeto Pixaim	AL	PV	27	27 households
Co-operativas RS	RS	PCH		
Emater RS	RS	Wind/MCH/ Biogas		
Fazenda Santa Anna	RS	Solar FV		1 household
Fazenda São José	RS	Solar FV		1 propriety rural
IDEAAS Putinga	RS	PCH		
Madem	RS	Thermay / Wood residues		Industry
MCH Jóia	RS	MCH		11 families
MCH Ravina/Ponte	RS	MCH		

PRODEEM RS	RS	FV, MCH/PCH	60	30 municipalities
Projeto Palmares	RS			420 families
Proluz I	RS			42 Municipalities
RGE / Ulbra	RS	PV, PV/ Wind	40 PV 12 híbrido	38 families
Soleco RS	RS	PV	500	6 municipalities
Sta Solar RS	RS	PV		6.100 families
Termo PTZ	RS	Biomass		
Cooperativas SC	SC	PCH		
Epagri SC	SC	Biogas	30	750 proprieties
Guascor— PM / Jaguari - PCH	SC / RS	PCH	7	
PRODEEM SC	SC	PV	62	64 schools
UFSC/Guascor	SC	PV/Diesel		
Geracoop	SC	PCH		
Cél. Hidrogênio	PR			
Ilhas do Paraná	PR	PV		
LACTEC/PM Londrina	PR	PCH		
PRODEEM PR	PR	PV		230 families
Termo Bgço Cana / Rsd. Madeira	PR	Biomass		
Prefeitura Municipal de Mirandiba	PE	Wind	3	1 municipality

e Associação de Agricultores				
Diaconia/PAAF	PE	PV	10	6 municipalities
PRODEEM - PE	PE	PV	34	30 municipalities
Naper/UFPE	PE	PV		50 municipalities
Programmea Xingó	PE/BA/AL/SE	PV	32	30 municipalities
CHESF/DEFA / PRODEEM	BA/SE/AL/PE/PB/ RN/CE/PI	PV	2320	500.000 people
SEMARH / PRODEEM	PB	PV		50 municipalities
SEMAR / PRODEEM	PI	PV		70 municipalities
CEFAS	PI	PV		2 municipalities with 7 communities
Programmea de Energia Solar do Ceará —PRODEEM/SEINFRA	CE	PV		68 municipalities
IDER	CE/PI/RN/PB	PV		
PRODEEM - RN	RN	PV		80 Municipalities
AACC— Associação de Apoio às	RN	PV		2 communities

Comunidades do Campo				
Programmea Trópico Úmido — UFAM/INPA/IBAMA	AM	Vegetable oil		28 communities
Programmea Trópico Úmido— Embrapa/CNPq/SUDAM	AM	Palm oil		70 households
Projeto Comunidades Ribeirinhas	AM	PV		2 municipalities with 5 communities
Programmea Trópico Úmido - INPA/USP/ULBRA/UFAM	AM	PV		5 municipalities with 111 families
Assentamento Iporá	AM	PV / MCH/ Charcoal		2 municipalities with 180 families
Associação Prod. Rurais do Limoeiro	AC	PV/Biogas		90 families
Casa Solar - SENAI/UFAM	AP/PA/RR/AM/AC/RO	PV		
PRODEEM/Eletronorte	MT	PV		87 municipalities with 974 communities

Aldeias Indígenas	MT	PV / Water pump	20 + 13 on implementation	
Micro Centrais Hidrelétricas	MT	MCH		59 Municipalities
GMR/MT/PNUD	MT	PV, Hydro Biomass		6 settlements
Prodeem Fase I	MS	PV	219	10 Municipalities with 15 communities
Prodeem Fase II	MS	PV	444	8 Municipalities with 20 localities
Postos de Saúde Vale do Ribeira - Pré-Prodeem	SP	PV	28	5 Municipalities
Estação Ecológica Juréia - Itatins - Pré-Prodeem	SP	PV	109	11 localities
Projetos Especiais em Parques				
Parque Estadual Ilha Anchieta	SP	PV	97	10 localities
Projeto Eldorado - Parques do Litoral Paulista	SP	PV	130	14 localities
Parque Estadual Ilha do Cardoso	SP	PV	213	19 localities
Prodeem Fase II - Projeto				

Bombeamento				
Assentamento Estância Palú	SP	PV	1	34 families (by the utility) / 10 families (PV)
Assentamento Maturi	SP	PV disable Chek??		171 families
Assentamento Primavera I	SP	PV disable		46 families
Assentamento Santa Isabel	SP	PV desable		46 families
Assentamento Pontal (antigo Santa Rosa II)	SP	PV desable		13 families
Assentamento Santana 1º	SP	PV		14 families
Assentamento Santana 2º	SP	PV desable		25 families
Assentamento Santa Cruz 1º	SP	PV desable		17 families
Assentamento Santa Cruz 2º	SP	PV desable		20 families
Assentamento Santa Maria	SP	PV desable		17 families
Assentamento Santa Rita	SP	PV desable		31 families
Assentamento Yapinari - 1	SP	PV		39 families

		desable		
Assentamento Yapinari - 2	SP	PV desable		
Projetos em Aldeias Indígenas – PRODEEM				
Aldeia Tembiguai	SP	PV	3	3 localities
Centros Comunit. Aldeia Rio Silveiras	SP	PV	6	6 localities
Residências Aldeia Tembiguai	SP	PV	14 ou 76	38 household
Proj. Escolas Rurais no Estado de SP – PRODEEM	SP	PV	33	10 municipalities
Aplicações Diversas Prodeem-SP	SP	PV	5	5 municipalities with 5 localities
PRODEEM I lhas	SP	PV	4	2 municipalities with 4 localities
Escolas rurais na Ilha do Cardoso	SP	PV	5	5 schools
Ecowatt	SP	PV		120 households
Projetos do IEE/USP	SP	PV		14 families
PRODEEM	PA	PV		22 municipalities - 214 localities
PRODEEM	TO	PV		26

				municipalities - 52 localities
PRODEEM	AP	PV		14 Municipalities - 21 localities
Programmea do Trópico Úmido—PTU				
Marapanim	PA	PV/wind / diesel		43 households
Ponta de Pedras	PA	wind/diesel		22 families
Maracanã	PA	wind		108 households
Melgaço	PA	PV		3 communities
Paragominas	PA	PV		100 inhabitants
Santo Antônio do Tauá	PA			2 municipalities
Moju	PA	Vegetable oil		
Orçamento Participativo da Prefeitura de Belém	PA	PV		3 localities
CTPETRO —Maracanã	PA	Wind/PV / wind		1 community
Doação Sistemas FV— BP Solar	AP	PV		7 localities
Gerenciado por aldeias indígenas	AP	PV		2 localities

PRODEEM	MA	PV		
Notas:				
(3) Inclui MCHs de potência superior a 100 kW.				

Appendix B Household electrification level for each utility in Brazil

Utility	State	Region	Number of households	Households with electricity supply	Coverage (%)	Target
Ceron	RO	North	347.193	294.326	84,77	2013
Eletroacre	AC	North	129.393	102.164	78,95	2015
Ceam	AM	North	243.726	160.238	65,74	2015
Boa Vista	RR	North	48.715	48.176	98,89	2008
Celpa	PA	North	1.308.511	1.034.075	79,02	2015
CEA	AP	North	98.521	93.745	95,15	2013
Celtins	TO	North	280.225	218.247	77,88	2015
Manaus	AM	North	326.837	323.141	98,86	2008
Cemar	MA	Northeast	1.235.523	985.241	79,74	2015
Cepisa	PI	Northeast	661.110	502.108	75,94	2015

Coelce	CE	Northeast	1.757.249	1.568.650	89,26	2013
Cosern	RN	Northeast	671.580	633.750	94,36	2013
Saelpa	PB	Northeast	731.290	689.710	94,31	2013
Celb	PB	Northeast	111.756	110.578	98,94	2008
Celpe	PE	Northeast	1.974.244	1.895.800	96,02	2010
Ceal	AL	Northeast	649.346	590.324	90,91	2013
Energipe	SE	Northeast	373.293	350.031	93,76	2013
Sulgipe	SE	Northeast	73.429	60.230	82,02	2013
Coelba	BA	Northeast	3.159.262	2.609.831	82,60	2013
Cemig	MG	Southeast	4.442.138	4.269.266	96,10	2010
Cataguazes-Leopoldina	MG	Southeast	262.796	255.026	97,04	2010
Poços de Caldas	MG	Southeast	39.670	39.630	99,89	2006
Escelsa	ES	Southeast	813.085	803.344	98,80	2008
Santa Maria	ES	Southeast	64.395	63.320	98,33	2008
Light	RJ	Southeast	2.943.410	2.939.144	99,85	2006
Cerj	RJ	Southeast	1.507.419	1.492.545	99,01	2008
Cenf	RJ	Southeast	53.536	53.071	99,13	2008
Elektro	SP	Southeast	1.362.762	1.345.220	98,71	2008
CPFL	SP	Southeast	2.328.121	2.323.047	99,78	2006
Bragantina	SP	Southeast	74.228	72.860	98,15	2008
Caiuá	SP	Southeast	143.618	142.193	99,00	2008
Jaguari	SP	Southeast	17.630	17.630	100,00	2006
Mococa	SP	Southeast	29.011	28.897	99,60	2006

CPEE	SP	Southeast	37.671	37.543	99,66	2006
Santa Cruz	SP	Southeast	130.474	129.179	99,00	2008
CSPE	SP	Southeast	47.165	46.558	98,71	2008
V. Paranapanema	SP	Southeast	115.903	115.118	99,32	2008
Nacional	SP	Southeast	70.665	70.465	99,71	2006
Eletropaulo	SP	Southeast	4.285.136	4.280.279	99,88	2006
Bandeirante	SP	Southeast	1.043.940	1.039.867	99,60	2006
Piratininga	SP	Southeast	890.504	888.452	99,76	2006
Copel	PR	South	2.627.572	2.571.537	97,86	2010
Cocel	PR	South	25.165	24.638	97,90	2010
Coronel Vivida	PR	South	6.405	6.176	96,42	2010
CFLO	PR	South	41.898	40.485	96,62	2010
Celesc	SC	South	1.434.917	1.415.807	98,66	2008
Urussanga	SC	South	5.194	5.179	99,71	2006
Xanxerê	SC	South	19.084	18.323	96,01	2010
João Cesa	RS	South	3.286	3.286	100,00	2006
Cooperaliança	SC	South	35.483	35.424	99,83	2006
Ceee	RS	South	1.059.544	1.039.912	98,14	2008
Aes-Sul	RS	South	933.817	913.125	97,78	2010
RGE	RS	South	949.472	925.542	97,47	2010
Eletrocar	RS	South	25.024	24.864	99,36	2008
Panambi	SC	South	11.596	11.347	97,85	2010

Nova Palma	SC	South	89.842	88.860	98,90	2008
Demei	RS	South	23.286	22.961	98,60	2008
Muxfeldt	RS	South	5.989	5.937	99,13	2008
Enersul	MS	MidWest	531.337	507.850	95,57	2013
Cemat	MT	MidWest	645.585	578.469	89,60	2013
Celg	GO	MidWest	1.376.251	1.337.061	97,15	2010
Chesp	GO	MidWest	30.462	29.439	96,64	2010
CEB	DF	MidWest	547.465	545.709	99,67	2006
CER	RR	North	25.686	16.558	64,46	2015

Source ANEEL, 2003

Appendix C— List of Acronyms

ANEEL - Agência Nacional de Energia Elétrica

(Federal Electricity Regulatory Agency)

BNDES – Banco Nacional de Desenvolvimen to Economico e Social

(National Bank of Social and Economic Development)

CCC - Conta de Consumo de Combustíveis

(Fuel Compensation Account)

CDE - Conta de Desenvolvimento Energético

(Energy Development Account)

CNPE - Conselho Nacional de Política Energética

(National Energy Policy Council)

CCPE - Expansion Planning Coordination Committee

CBEE – Brazil Centre of Wind Energy

CDM- Clean Development Mechanism

DIEESE - Departamento Intersindical de Estatística e Estudos Sócio Econômicos (Inter-Union Department of Statistics and Socio-Economic Studies)

Eletrobrás - Centrais Elétricas Brasileiras S.A.

(Brazilian Electricity Generation Company)

ESMAP (Energy Sector Management Assessment Programme)

HDI – Human Development Index

IBGE - Instituto Brasileiro de Geografia e Estatística

(Brazilian Institute of Geography and Statistics)

IPCC –Inter-governmental Panel on Climate Change

LPG – Liquefied Petroleum Gas

MA - Ministério de Agricultura, Pecuária e Abastecimento

(Ministry of Agriculture, Livestock and Food Supply)

MME - Ministério de Minas e Energia

(Ministry of Mines and Energy)

NGO – Non-Govermental Organization

PRODEEM - Programmea de Desenvolvimento Energético de Estados e Municípios

(State and Municipal Energy Development Programme)

PV - Photovoltaic

PNAD - Pesquisa Nacional por Amostra de Domicílio

(National Survey by Household Sample)

PAP- Poverty Alleviation Programme

RET – Renewable Energy Technology

REEEP – Renewable Energy and Energy Efficient Partnership

RGR - Reserva Global de Reversão

(Global Fund for Reversion)

SHS- Solar Home System

UNIFACS - Universidade Salvador

(Salvador University)

UNDP – United Nation Development Programme

WHO- World Health Organization

Appendix D- Exchange rates

Average – (real/dollar): 2000 = 1.8302

2001 = 2.3514

January - July 2003 = 3.120

UNEP

GNESD

GLOBAL NETWORK ON ENERGY FOR SUSTAINABLE DE-VELOPMENT

Facilitated by UNEP

Secretariat
Global Network on Energy for Sustainable Development (GNESD)
Risø National Laboratory
P.O.Box 49
DK-4000 Roskilde, Denmark

Phone +45 4677 5131
Fax +45 4632 1999
gnesd@risoe.dk
www.gnesd.org

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