Brazil

Background Study for a National Rural Electrification Strategy: Aiming for Universal Access

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Preface

The Brazilian government has established the goal of *universal access* to electricity services over the next decade as a key element in its national poverty alleviation strategy. This includes electrifying over 12 million, mostly rural, people currently without service. To that end, Law 10.438 of 2002 requires the existing concessionaires to reach universal coverage in their respective service areas by 2015 at the latest, with varying deadlines (based on current coverage) set by the national regulator. In 2003, the Ministry of Mines and Energy (MME) initiated a national program to accelerate further electrification efforts and provide universal service coverage before 2010.

Based on close collaboration with the Brazilian government and local stakeholders this Energy Sector Management Assistance Program (ESMAP) study analyzes issues and options as well as providing background information for this new national electrification strategy. The report starts with an overview of Brazil's *power sector* and *current status of rural electrification*. Drawing on a *stakeholder workshop,*[1] the study then identifies existing *barriers* to rural electrification along the basic market structure: *demand*, *supply*, and the *institutional*, *regulatory*, and *financial frameworks.*

Finally, the study provides a list of *options* and *recommendations*, including the following:

- The regulation and enforcement of Law 10.438;
- The consolidation of the new national strategy for electrification;
- The establishment of a virtual umbrella fund with a central management and monitoring unit to increase efficiency by integrating electrification initiatives on all levels;
- The creation of appropriate incentive schemes for cost reduction;
- The key role of future off-grid solutions to reach remote and dispersed users in an efficient and sustainable way;
- The potential for productive uses, public services, and multi-sectoral approaches to increase impact on local development; and
- The need for demonstration projects to quickly negotiate the learning curve for the more difficult areas and increase the efficiency of the new universal access program.

[1] The ESMAP-funded rural electrification stakeholder workshop took place in Brasilia in June 2002. Sixty high-level participants (including key government officials, private-sector investors, university representatives, national equipment suppliers and service providers, donor agencies, rural financing institutions, NGO representatives, and representatives of potential pilot communities) identified and discussed the key barriers for rural electrification in Brazil and options to overcome these barriers. A summary of the three work groups formed during the workshop and one of the overview presentations can be found in annexes F and G.

Acknowledgments

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Abbreviations and Acronyms

ABEER	*Associação Brasileira de Energia Renovável* (Brazilian Association of Renewable Energy Companies)
ABRADEE	*Associação Brasileira de Distribuidores de Energia Elétrica* (Association of Distribution Concessionaires)
AC	Alternating current
ANEEL	*Agência Nacional de Energia Elétrica* (National Electrical Energy Agency)
APAEB	*Associação dos Pequenos Agricultores do Estado da Bahia* (Association of Small Agriculturists of Bahia State)
APL	Adaptable Program Loan
ASTAE	Asia Alternative Energy Program
BDS	Business Development Services
BNB	*Banco do Nordeste* (Northeast Development Bank)
CBEE	*Centro Brasileiro de Energia Eólica*
CCC	*Conta de Consumo de Combustíveis* (Fuel Compensation Account)
CCPE	*Comitê Coordenador do Planejamento da Expansão dos Sistemas Elétricos* (Expansion Planning Coordination Committee)
CDE	*Conta de Desenvolvimento Energético* (Energy Development Account)
CDM	Clean Development Mechanism
CEMIG	*Centrais Elétricas de Minas Gerais* (Electric Company of Minas Gerais)
CEPEL	*Centro de Pesquisas de Energia Elétrica*
CEPISA	Electricity Company of Piauí
CERPCH	Reference Center for Small Hydropower
CNPE	*Conselho Nacional de Política Energética* (National Energy Policy Council)
COELBA	*Companhia Elétrica do Estado da Bahia* (Electric Company of Bahia State)
COFINS	*Contribuição para o Financiamento da Seguridade Social* (Contribution for the Financing of Social Security)
CPMF	*Contribuição Provisória de Movimentação Financeira* (Provisional Contribution for Financial Operations)
CT-7	*Comissão Técnica sobre Acesso Universal* (Technical Committee on Universal Access)
DC	Direct current
DisCo	Distribution Company
DME	Department of Mines and Energy, South Africa

DRE	Decentralized Rural Electrification
EDF	*Electricité de France* (French utility company)
EJSEDSA	*Empresa Jujeña de Sistemas Energéticos Dispersos SA* (off-grid rural electricity concessionaire, Argentina)
ESCO	Energy Service Company
ESD	Energy Services Delivery Project, Sri Lanka
ESMAP	Energy Sector Management Assistance Programme
FECOERPE	Rural electrification cooperatives of the State of *Pernambuco*
GEF	Global Environment Facility
GTZ	*Gesellschaft für Technische Zusammenarbeit*
GVEP	Global Village Energy Partnership
HDI	Human Development Index
IBGE	*Instituto Brasileiro de Geografia e Estatística*
IBRD	International Bank for Reconstruction and Development
ICMS	*Imposto sobre Circulação de Mercadorias e Serviços* (Tax on the Circulation of Merchandise and Services)
ICT	Information and communication technology
IDB	Inter-American Development Bank
IDEAAS	*Instituto para o Desenvolvimento de Energias Alternativas e a Auto Sustentabilidade*
IDER	*Instituto de Desenvolvimento Sustentável e Energias Renováveis* (Institute for Sustainable Development and Renewable Energies)
IDTR	Decentralized Infrastructure for Rural Transformation
IEE	*Instituto Eco-Engenho*
IGP-M	General Index of Prices
IPI	*Imposto Sobre Produtos Industrializados* (Tax on Manufactured Products)
IPP	Independent Power Producer
JBIC	Japanese Bank for International Development
JSF	Japan Social Fund
KfW	*Kreditanstalt für Wiederaufbau*
MAE	*Mercado Atacadista de Energia Elétrica* (Wholesale Electrical Energy Market)
MFI	Multilateral financial institution
MME	*Ministério de Minas e Energia* (Ministry of Mining and Energy)
MRE	*Mecanismo de Realocação de Energia*
MSB	Micro- and Small Business
NGO	Nongovernmental organization
NPV	Net present value
OBA	Output-based aid
OED	Operations Evaluation Department of the World Bank
OM&R	Operations, management, and replacement

ONS	*Operador Nacional do Sistema Elétrico* (National Electricity System Operator)
PCF	Prototype Carbon Fund
PER	*Programa de Electrificación Rural* (Rural Electrification Program, Chile)
PERMER	Renewable Energy for Rural Markets Project, Argentina)
PIS	*Programa de Integração Social* (Social Integration Program)
PNAD	*Pesquisa Nacional por Amostra de Domicílios (*National Sample Survey of Households)
PNAEEX	Group of rubber tapers in the Amazonia region
PNU	*Programa Nacional da Universalisação* (National Electrification Program)
PPA	Power Purchase Agreement
PRODEEM	Programa de Desenvolvimento Energético de Estados e Municípios *(Energy Development of States and Municipalities Program)*
PROINFA	Programa de Incentivo às Fontes Alternativas de Energia Elétrica (Program to Support Renewable Energies)
PV	Photovoltaic
PV GAP	Photovoltaic Global Accreditation Program
RERED	Renewable Energy for Rural Economic Development, Sri Lanka
RET	Renewable Energy Technology
RGR	*Reserva Global de Reversão* (Reversion Global Reserve)
SDG	Solar Development Group
SELF	Solar Electric Lighting Fund, U.S.
SHP	Small hydro plants
SHS	Solar Home System(s)
SME	Small and medium-sized enterprise
TA	Technical assistance
TOR	Terms of Reference
UBP	*Uso de Bens Públicos* (Use of Public Assets)
UFSC	*Universidade Federal de Santa Catarina*
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
UFSC	*Universidade Federal de Santa Catarina*
UNIFACS	*Universidade de Salvador*
VN	Nominative value

Units of Measure

km	Kilometer (1km=1,000m)
kW	Kilowatt (1kW=1,000W)
kWh	Kilowatt-hour
MW	Megawatt (1MW=1,000kW)
MWh	Megawatt-hour
Wp	Watt-peak (SHS Rating at Standard Testing Conditions)

Currency Equivalents

June 2001:	US$1 = R$2.37
June 2002:	US$1 = R$2.70
June 2003:	US$1 = R$2.89

1

Executive Summary

Aiming for Universal Access

1.1 More than 12 million Brazilians in about 2.5 million households have no access to electricity. Vast differences remain between rural and urban populations, and among states and income levels, with lack of service affecting the poor rural populations in the north and northeast of Brazil the most (see table 1.1). In 2003, the Brazilian government made universal access to electricity by 2010 a priority among its national goals and established a new national program for universal electricity access, with an estimated total investment cost of about US$2 to 3 billion[2].

Table 1.1 Permanent Private Households Without Electricity in Brazil, 2002

	Urban	*%*	*Rural*	*%*	*Total*	*%*
Brazil	505,023	1.2	1,979,249	27.0	2,484,271	5.2
North	56.195	2.4	447,124	59.7	503,319	16.1
Northeast	201,642	2.2	1,110,339	34.4	1,311,981	10.7
Southeast	166,565	0.8	206,214	11.9	372,779	1.7
South	49,011	0.8	125,235	10.3	174,246	2.3
Midwest	31,610	1.0	90,336	21.5	121,946	3.5

Source: MME, based on the 2000 Census and projections for December 2002 using data from *Luz no Campo*, the old national rural electrification program.

1.2 The Brazilian government's decision to aim for universal access — through a combination of obligations to the existing, mostly private, distribution companies (DisCos) and a new public incentive program — is of great interest to infrastructure policymakers worldwide for a variety of reasons: (a) rural electrification is explicitly prioritized as a key element of Brazil's overall poverty alleviation strategy; (b) the emerging strategy will focus on services and end uses, not just access; (c) overall

[2] Total costs will depend strongly on the technology mix—see section 1.4 on the importance of harvesting the potential for cost reductions on the way toward universal access.

sector revenues allow for the ambitious goal of universal service coverage in about a decade; (d) existing electrification programs will have to be adjusted very quickly to ensure efficiency and equity on the way to universal access; and (e) topology and demand patterns of remaining rural users require that decentralized service solutions be mainstreamed fast to minimize investment costs.

1.3 Following the approval of Law 10.438 in 2002, rural electrification in Brazil has been characterized by ever-increasing change. The Law obliges all regulated agents—concessionaires and *permissionaires*[3]—to provide full electricity coverage following specific schedules (defined in 2003 by the federal regulatory agency ANEEL), without financial contribution by the new consumers toward initial investment. The initial investments are to be recovered through tariffs (with social tariffs for low-income consumers). However, the competing policy goals covered by this law (rural access, power generation from alternative national resources, social tariffs and "emergency generation") have created uncertainties regarding the future availability of funding for electrification. The translation of the new government's national energy sector priorities into concrete rules and incentive schemes was still in flux in August 2003.

1.4 To reach the policy goal of universal electricity access, new solutions for the more challenging regions will have to be demonstrated and replicated fast—to avoid a future time lag (and equity issues) once all the "low-hanging fruit" would have been picked and only the most difficult areas would be left behind. Already, connection costs under the existing *Luz no Campo* program for some of the more difficult user segments (such as "dispersed" households in Bahia with more than four poles per user—see table 1.3) have risen beyond US$4,000 per household—well above international benchmarks and the *Luz no Campo* average (about US$950). In addition, lack of coordination among funding sources has sometimes prevented an efficient allocation of public funds in the past. The current institutional, regulatory, and financial frameworks for rural electrification warrant improvement, and many DisCos need strengthening.

The Situation

1.5 Brazil has made significant progress in power sector reform over the last decade. However, during the initial privatization process, the issue of rural electrification was essentially overlooked.[4] As a result, rural electrification is lagging behind. More than 12 million Brazilians in about 2.5 million households[5] are without access to electricity today. Table 1.1 shows that while 99 percent of the urban population has access to

[3] The *"permissionaire"* is a unique legal figure in Brazil's energy sector. Permissionaires are essentially independent operators working inside a concession area. ANEEL could grant new permissions to such independent operators where concessionaires fail to meet their obligations in a specific area.

[4] See Estache, Foster, and Wodon (2002) for more details on the link between poverty and infrastructure reform in Latin America.

[5] This number does not include illegal connections and self-generation. Households with poor service quality (such as village grids with few hours of operation per day) are included.

electricity, the percentage drops to 73 percent in rural areas. This compares to around 85 percent rural electricity access in Argentina, Chile and Mexico.

1.6 As suggested by table 1.1, the substantial variations among regions and states lead to social exclusion issues. Only 84 percent of the population in the northern region has electricity access, compared to 98 percent in the southeastern states. Seven states have rural coverage rates of less than 50 percent, 16 states under 80 percent. Furthermore, there are important variations among income levels. The 2000 Census indicates that 78 percent of the households without electricity have monthly incomes less than twice the minimum wage.[6] States with low electrification rates tend to be those with low a Human Development Index. This inequality of electricity access has negative impacts on both equality and growth.

1.7 Over the last decade, the national *Luz no Campo* program has shown impressive success in grid extension and has been the main contributor to rural electrification in Brazil. Financial resources are channeled through Eletrobrás (a state-owned company) and execution is under the responsibility of regional DisCos, which propose electrification plans. The government subsidizes these plans through soft loans in local currency. This allows the DisCos to extend electricity service while keeping tariffs at reasonable levels. Between 2000 and 2003, about 600,000 new users were connected. The main funding source for this past success was the Eletrobrás-managed *Reserva Global de Reversão* (Reversion Global Reserve, or RGR), which was created in 1993 and extended to 2010. Funding for RGR is provided by annual levies on concessionaires' investments. By law about one-fourth of available funds are committed to providing electricity to low-income consumers and rural areas. *Luz no Campo* has used about R$500 million per year. However, as a result of provisions in Law 10.348, the future uses of RGR are currently under discussion. Many weaker concessionaires are not eligible for financing from RGR. There is uncertainty regarding the repayment of some RGR loans and state governments may take up the debt.[7]

1.8 Other important rural electrification efforts are:

- The *Programa de Desenvolvimento Energético de Estados e Municípios* ((Energy Development of States and Municipalities Program, PRODEEM), a small separate arm of the national rural electrification effort, has used a top-down approach to identify sites and install off-grid equipment, with a focus on schools, health facilities, and other community installations. From 1996 to 2001, PRODEEM provided off-grid systems to about 5,000 villages. In the past, the program's main problems included installations made in unprepared and unorganized communities, the lack

[6] Minimum wage (*salário mínimo*) corresponds to the minimum payment in return for work, on a *monthly* basis. It is defined for the whole country by the federal government and approved by Congress. It is currently R$240 (about US$80).

[7] The successful *Luz no Campo* has been largely driven by relatively stronger distribution companies in relatively better-off states, which have focused the program almost exclusively on grid extension to users living close to one another and to an existing grid (see section 1.4 for details).

of a cost recovery scheme (resulting in unsustainable service and a shortage of funds for maintenance), a lack of coordination with grid expansion programs, and an unclear division of responsibility for equipment maintenance between the communities and states.[8]

- The *Ministry of Agriculture*, using funds from the Federal Budget, provides grants to municipal administrations to finance grid extensions for productive use.
- Operating under a different name in each state, the *Poverty Alleviation Program*, sponsored by the World Bank, provides grants to local associations to finance projects that have been previously approved by the Municipal Committee. These community-driven projects include grid-connected rural electrification projects and off-grid solar systems, in addition to a variety of other rural development projects.
- The Fuel Compensation Account (*Conta de Consumo de Combustíveis*, CCC) supports *isolated diesel plants* to supply remote areas, particularly in the Amazonia region, with a history of ongoing fuel subsidies. There are 219 public service diesel plants with installed capacities under 10MW (136 are under 1MW) totaling 293MW. Independent Power Producers (IPPs) have assumed generation, introducing modern diesel generators, accessing CCC funds and selling electricity to distribution concessionaires. Throughout the Amazonia region, there are another estimated 600 diesel systems, managed by state concessionaires or municipal governments. The cost of the electricity produced by these diesel units in off-grid systems is relatively high.
- There are surprisingly few *mini-* or *micro-hydropower plants* operated by distribution concessionaires supplying electricity to small villages or towns (a potential in need of further analysis under the new government program), and a negligible number of *renewable-hybrid systems.*

The New Paradigm

1.9 Law 10.438, approved in 2002, was a key step in shaping the legal framework for future electrification efforts in Brazil. This law obliges concessionaires and permissionaires to provide "universal electricity service coverage," without financial contribution by the new consumers toward initial investments (which are to be fully recovered through tariffs). The law is not a pure "rural electrification norm," though, as it covers a series of (competing) policy goals, namely rural access, power generation from alternative national resources (renewable energies, natural gas, and coal), social tariffs, and "emergency generation." This created some uncertainties regarding the future

[8] A recent evaluation of the program's first phase surveyed its impact on 43 villages in 10 states. Of the 79 systems surveyed, only 44 (56 percent) were actually operating, albeit with disparities in evidence among the different states. A second phase of *PRODEEM* plans to focus more on private productive uses of energy.

availability of sufficient funding for electrification. For example, the significant subsidies needed to keep tariff increases at a reasonable level for "low-income" captive consumers currently have no secured source. Under the initial definition for "low-income" consumers (all users below 80kWh per month and even users up to 220kWh under certain conditions) up to one third of all residential users may belong to this category!

1.10 Law 10.438 created the new Energy Development Account (*Conta de Desenvolvimento Energético*, CDE), which is financed through (a) annual payments for the use of public assets (Uso de Bens Públicos, UBP), (b) ANEEL's fines and (c) annual quotas to be paid from 2003 on by all agents selling electricity to final consumers. Preliminary estimates of the UBP fund show scarce resources up to 2008. The current Presidential Decree regulating the law restricts funds for universal electrification to UBP and ANEEL´s fines, which are negligible, such that funds earmarked for universalization would be under 10 percent of CDE's overall funds. Based on these preliminary estimates, significant additional funding would be needed to achieve the ambitious mandated increase in electricity access - this key issue needs to be resolved. The pending clarification of funding sources should clearly reflect a prioritization of national energy policy goals.

1.11 Although Law 10.438 includes urban and peri-urban households, the main thrust will be toward *rural* users. The immediate policy tasks at hand for a successful rural electrification strategy all revolve around the implementation of this law, and the clarification of its implications. ANEEL should soon establish operational rules and appropriate tariff-setting and quality standards for rural electrification (including new solutions for remote and dispersed users). Clearly prioritized energy policy goals need to be defined in a coherent national electrification strategy and translated into sustainable and efficient incentive schemes so that the universal access obligations can be met and, ideally, accelerated by all concessionaires and permissionaires, including the relatively weaker ones.

1.12 The first step toward the implementation of Law 10.438 was the establishment of long-term obligation targets by ANEEL. For the least electrified areas, full coverage is mandated by 2015 at the latest. Table 1.2 shows the targets set by ANEEL. These relatively long-term targets are less ambitious then the deadlines that had been under discussion among some of the stakeholders, reflecting the somewhat unclear funding situation for the universal access mandate in 2003. It is important to note that the majority of Brazil's states fall under the last category (coverage at or below 80 percent).

Table 1.2 Maximum Targets for "Universal Electricity Access"

Current coverage in concessionaire's (or permissionaire's) area:	*Based on current coverage, concessionaire (permissionaire) has to reach "universal electricity coverage" at the latest by:*
Coverage > 99.5%	2006
98.0% < Coverage = 99.5%	2008
96.0% < Coverage = 98%	2010
80.0% < Coverage = 96%	2013
Coverage = 80.0%	2015

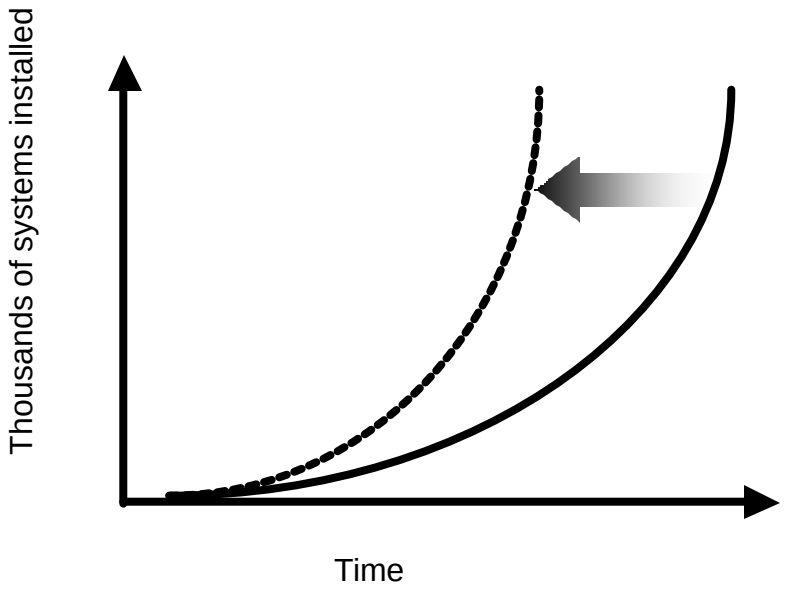
Source: Targets defined by ANEEL in 2003.

1.13 These long-term targets could be anticipated if federal, state, and municipal governments allocated additional funds in a coherent and efficient way. This is a primary objective of the new National Electrification Program, which the MME is launching in 2003. This translation of national energy sector priorities into concrete rules and incentive schemes—and the fast implementation envisioned by MME—is clearly the most important and most challenging rural electrification task for Brazil.

1.14 The new Brazilian Rural Electrification Strategy faces a number of key challenges. The main challenges arise from the fact that successful past rural electrification efforts (namely, *Luz no Campo*) have focused by and large on the "low-hanging fruit" in the form of grid extension to densely populated areas in relatively better-off states. In contrast, serving the remaining users on the way toward universal electrification will become more and more challenging and require new approaches suited to meet the different set-ups encountered in poorer states with weaker DisCos and dispersed, remote, and low-income users.

1.15 Therefore, the new national electrification strategy will need to integrate two quite different approaches: (a) a scale-up of the successful *Luz no Campo* approach under a slightly improved framework, and (b) greater effort to demonstrate new solutions for the more difficult areas and the timely adoption of a market framework to allow for fast replication of these new solutions. Finding the right balance between those two approaches will be difficult. However, clearing this hurdle is as important as fixing the remaining regulatory issues in the main power sector that currently impede an accelerated rural electrification effort by more DisCos. Well targeted demonstration projects for public-private business models will be needed to shorten the learning curve on the way towards universal access.

Figure 1.1: Targeted demonstration projects for the more difficult remaining areas (such as remote villages and/or weak DisCos) will be needed to accelerate the learning curve on Brazil's way towards universal access.



Source: **World Bank staff 2003**

Recommendations for the New Rural Electrification Strategy

Box 1.1 Recommendations for Brazil's Way Towards Universal Electricity Access

1. Prioritize policy goals
2. Secure funding
3. Ensure efficient and effective allocation of subsidies
4. Create an umbrella fund
5. Create a central monitoring and evaluation unit
6. Complement and coordinate regulation and incentive schemes
7. Introduce solutions for weak distribution companies
8. Reduce costs
9. Introduce specific regulation to allow for low-cost solutions
10. Develop markets for off-grid energy services
11. Increase development impact via productive uses and a multi-sectoral approach
12. Address peri-urban issues
13. Attract new players
14. Train small-scale suppliers
15. Continue donor coordination

1.16 Based on this report's analysis of existing barriers to rural electrification, a set of 15 recommendations can be drawn for Brazil's new national electrification strategy currently under consideration (See box 1.1). These recommendations are summarized below:

1.17 *Prioritize policy goals.* The first step toward any successful rural electrification effort at the national level is a clear definition of electrification priorities, and their place in the country's overall energy sector policy and rural development priorities. There are important tradeoffs between policy goals,[9] and their prioritization has to be defined in advance to allow for efficient incentive structures and regulation—and to send clear and reliable signals to the private sector. In this context, the development of the National Electrification Program by MME is a commendable key step. Under the overarching theme of universal access to electricity services, a series of objectives have emerged: (a) increase efficiency and equity; (b) increase productivity, develop demand, and realize cross-sectoral synergies to increase development impact; (c) mobilize private participation with public incentives; and (d) ensure social, economic, financial, and environmental sustainability. Once defined, the key objectives of the strategy will need to be translated into clear and achievable targets, and reached via appropriate incentive schemes, regulation, and implementation procedures.

1.18 *Secure funding.* Providing electricity to Brazil's rural users will require an investment of about US$2 to 3 billion (depending on the success of cost reduction strategies and on policy decisions regarding rural service quality). As most remaining

[9] Typical examples for such tradeoffs are implementation speed versus efficiency, efficiency versus equity, competitiveness versus social inclusion, cost reduction versus quality requirements, least cost supply versus diversification of the national energy mix, and short-term versus long-term optimization.

users cannot afford to pay the full cost of service through tariffs (typical willingness to pay for electricity in the remaining rural areas is under US$5 per month), investments cannot be recovered directly through tariffs, and will need to be subsidized. MME is currently in the process of preparing an estimate of the total subsidy needs and the possible impact on tariffs, as well as a proposal for a suitable subsidy allocation scheme. The funds for Brazil's universalization efforts could come from the distribution companies, RGR, CDE, and the state governments. If CDE is used as the main source to finance the new social tariff for low-income captive users, as currently discussed, not enough funds will be left to reach the targets proposed by MME. It will be paramount to achieve the significant potential for cost reduction in light of the huge investment needs and the goal to reduce impacts on tariffs. The investment costs could be reduced significantly by increasing the menu of technology options, allowing for alternative business models and service levels adapted to rural demand, and improving the coordination between existing and planned incentive schemes and existing and planned regulations. Whatever the resulting investment needs, without a sustainable funding source, Brazil's national electrification program will lack the long-term stability needed for significant private participation at a reasonable risk premium.

1.19 *Ensure efficient and effective allocation of subsidies.* While the allocation procedures applied by Eletrobrás for the RGR funds used in *Luz no Campo* appear to have worked quite well in the past, future electrification of the less accessible states and users will require new incentive schemes with appropriate procedures for efficient subsidy allocation to more players, including grant mechanisms and . Apart from the specific issue of addressing the existing weaknesses of many distribution companies, some general rules for efficient allocation of rural electrification subsidies will guide the design of these future incentive schemes, including: (a) strong incentives for cost reduction, (b) linking subsidies to performance where possible, (c) an appropriate balance between indirect subsidies (for market development and training) and direct subsidies (to address affordability issues) and between implementation speed and equity considerations, (d) a transparent coordination of access subsidies, price signals and social tariff considerations, especially in less developed regions, and (e) facilitation of consumer finance, where needed. Linking subsidies to performance includes establishing access targets and service quality while recognizing the tradeoffs between increased control and increased working capital costs. Potential incentives include the possibility of competition for grant funds. To address equity issues, competition could be limited to parallel groupings of distribution companies ("competition by clusters"), according to their different characteristics—that is, financial strength or number and income of remaining users.[10]

[10] While any potential consumer can ensure an early connection, there is a lack of financing options for low-income households, especially with regard to volume, interest rates, credit period, and also lack of financial intermediation. Transaction costs are very high for rural people. Microcredit organizations often consider SHS as "consumptive" technologies and do not finance them. Equipment is often not recognized as collateral.

1.20 *Create an umbrella fund.* A comprehensive approach to organizing, managing, and monitoring the current initiatives, programs, and funding sources on all government levels (federal, state, and municipal) would serve as a key step toward reducing transaction costs and increasing the efficiency and transparency of subsidy allocation for electrification (for example, "one stop shopping" for the private sector).[11] A national electrification plan would therefore need to integrate all of the various programs, agents, and technological alternatives. To increase development impact, energy services should be accompanied by cross-sectoral activities. In this context, a national effort should be made to integrate programs and establish more effective partnerships. Ideally the national electrification strategy should integrate these existing efforts under a "virtual umbrella fund" for electrification. For example, a unit within MME could manage the main umbrella fund (possibly with the participation of Eletrobrás and ANEEL) and report to a steering committee involving all main stakeholders (Casa Civil, MME, relevant coordinating ministries, state governments, ANEEL, Eletrobrás, private-sector representatives, etc.). State-level implementation units would allow an appropriate interface to the decentralized tasks of implementation. An umbrella fund could eliminate the lack of interaction between PRODEEM (directly managed by MME) and *Luz no Campo* (managed by Eletrobrás). As it stands now, there is little interaction between these two institutions and the Brazilian Congress regarding the funds for rural electrification allocated through the Ministry of Agriculture. In addition, there has been weak interaction among *Luz no Campo* and related development programs, such as Family Agriculture, Poverty Alleviation, and Land Reform.

1.21 *Create a central monitoring and evaluation unit.* An efficient monitoring and evaluation process will be needed for successful implementation of the ambitious electrification targets for a variety of reasons:

- Monitoring performance is key for ANEEL's general regulation mandate (regulation by law) and for potential additional control of performance targets in the case of specific output-based subsidy schemes (regulation by contract).
- The transaction costs of monitoring in remote rural areas can be very high, so reducing costs is as crucial (and as difficult) as providing the service itself—and it requires specific instruments (such as using local proxies for initial mediation of potential conflicts, or applying low-cost communication tools for reporting in dispersed areas).
- The improved coordination of the various electrification initiatives mentioned above requires a continuous joint evaluation.
- To meet the currently envisioned, ambitious schedule for universal electrification, it will not be enough to demonstrate new solutions for the weaker states and the more dispersed users: to allow for fast scale-up, it

[11] In addition, rural electrification efforts should always be coordinated with other governmental programs, to increase development impact (see below).

will also be necessary to learn quickly from these demonstration projects and then to diffuse lessons to stakeholders in other states with similar set-ups.

1.22 A central monitoring, evaluation, and promotion unit for the PNU could be located inside the management unit of the virtual umbrella fund described above. This unit could also coordinate the off-grid-specific capacity-building efforts on all levels (see the recommendation on training small-scale suppliers below).

1.23 *Complement and coordinate regulation and incentive schemes.* Rewards and penalties need to be adjusted and complementary according to the mandate of Law 10.348 for universal electrification. This adjustment is in flux and will go beyond the framework for rural electrification, as it is closely related to the overall power sector[12] (mainly regarding the tariff setting for distribution companies; however, success of the main sector reform is also key to avoiding transmission and generation bottlenecks) and non-electrical energy (especially in rural areas, successful future off-grid service models may well entail supply of electrical and non-electrical energy by the same provider). Some additional issues relating to rural electrification are as follows:

- Anticipating the long-term targets established by ANEEL will require appropriate incentive schemes. ANEEL's ultimate penalty of revoking the concession is not enough (the regulator can step in and re-award the concession through a tender mechanism that has already been applied). Given that typical, low-demand rural users are only marginally profitable, distribution companies must perceive clear advantages of financing schemes for "accelerating access" beyond their obligation. It is not clear yet how those incentives for acceleration will work with the existing longer-term obligations.
- The treatment of large consumers in light of Law 10.348 should be analyzed, as should the relatively high current threshold for the second group of low-income captive consumers (up to 220kWh per month).
- Given the low willingness to pay of most of the remaining users, subsidies will be needed to achieve universal access. In most cases, subsidies are disbursed on the basis of a subsidy contract, with specific obligations (regulation by contract). Such specific rules in potential subsidy contracts will need to define clearly their relation to general sector regulation (regulation by law), for instance regarding service quality, maintenance, and future tariff adjustments.
- In standalone off-grid systems based on renewable energy, the battery is often the "weakest link" and battery misuse (such as starting a car) should be avoided to ensure user satisfaction and decrease lifecycle costs. While the law clearly stipulates that users may not make any contribution to

[12] For a recent analysis of regulatory issues concerning the overall power sector, see World Bank (2002).

upfront investments, experience elsewhere has shown that ownership improves battery treatment. It is unclear how this issue can be solved by the PNU. This is one of several examples of how the inherently decentralized character of off-grid systems requires specific rules and regulations in some aspects.

1.24 *Introduce solutions for weak distribution companies* (DisCos). The PNU will need to address the unresolved issues regarding incentives and tariff schemes for weaker distribution companies (DisCos), and find ways to improve their internal efficiency. Many DisCos lack the financial strength to finance new investments from equity or commercial debt. They are also not eligible for RGR. Many of the same DisCos operate far from the efficiency frontier. Any new grant mechanism planning to allocate funds for new connections to financially troubled DisCos would have to pay attention to mitigating the risk of their using the funds for other purposes. One element of mitigation might be to disburse tied funds only in the framework of a procedural agreement (including clear milestones) that would bring the DisCo back on course. Another key element would be to provide specific technical assistance (TA). Strictly performance-based *ex post* allocation of funds allows for better control of their use—however, it does not solve the problem of working capital for these weak concessionaires. Yet another option, therefore, could be to force severe cases to choose suitable subcontractors through which to allocate grant funds for rural electrification. ANEEL's ultimate penalty to enforce electrification targets is the option to assign the task of (and funds for) universal access to new permissionaires or other third parties (see box 1.2). Assuming a technically sound DisCo with the required financial strength to invest in rural electrification in a state with low electrification rates, it is unclear how the additional costs of increasing access could be rolled over into tariffs, given that (a) the impact of existing power sector costs on tariffs for up to one-third of the population (defined as low-income) has been mitigated in 2002 and 2003 with temporary measures, without a sound solution for the medium term; (b) especially in the weaker states, increasing access would significantly increase the number of such consumers falling under the currently defined low-income groups, thus aggravating the impact of additional costs on the tariffs of consumers remaining above the low-income level; (c) policy objectives and rules for potential solutions (cross-subsidization between stronger and weaker states) are still unclear; (d) the clear directive of Law 10.348 to exempt users fully from investment costs of new connections increases the initial investment cost pressure on DisCos; (e) low-cost off-grid alternatives for new connections in remote areas are currently discouraged; and (f) pending clarification of energy policy priorities (see above), potential new investors will shy away from commitments to access-related endeavors.

Box 1.2: The Status of Concession Agreements

A recent master's thesis[13] has compared the concession agreements signed between ANEEL and the new concessionaires. Fifty contracts include provisions for the concessionaire to supply its market without exclusion of low-income population and sparsely populated areas, but only five include some targets and deadlines. Only two contracts do not include this requirement. Thirty-eight contracts contain clauses stating that the concessionaires do not have the exclusivity to provide services in market areas where rural electrification cooperatives exist. Thirty-five contracts include provisions on rural electrification that obligate the concessionaires to participate in federal or state programs with the option of submitting within a 90-day period counterproposals that would offer alternatives for meeting the demand needs. Finally, 11 concessionaires are obliged to supply the consumers according to the state government's guidelines (which mainly require them to use the least costly technology). In turn, the government is obliged to pay the difference between the investment cost and the compulsory participation of the concessionaire in the total investment.

1.25 *Reduce costs.* A strong emphasis of the new strategy needs to be on cost reduction, to minimize the impact on tariffs. The first step will be to intensify the ongoing analysis of past programs, especially the successful *Luz no Campo*, to identify concrete cost-efficiency measures based on standard approaches.[14] Apart from competition, many additional measures can be introduced to bring down costs. One promising option currently under discussion would require distribution companies that apply for any kind of public financing to present several low-cost alternatives whenever the cost per connection exceeds a benchmark. Mainstreaming off-grid energy supply options as an integral part of a technology-neutral electrification strategy would be a key step toward controlling costs for the more remote and dispersed households (see the recommendation below on developing markets for off-grid energy solutions). For remote areas, transaction costs and challenging logistics are key cost drivers for both grid and off-grid solutions (for example, costly household visits for collection often exceed the actual monthly fee). Transaction costs can be reduced by minimizing household visits (for instance, by having rural users visit central service representatives set up in existing small businesses, or through user associations) and introducing an additional layer of local extension agents into the service supply chain (for example, training local technicians who are closer to the market). Initial analyses for grid extension (table 1.3) and for current off-grid systems suggest a significant potential for cost reduction. For example, a 50Wp solar home system (SHS) currently costs about US$700 in Brazil, but less than US$400 in China, at comparable quality.

[13] Oliveira (2001).
[14] Case studies from several countries can be found in ESMAP (2000a, 2001a).

Table 1.3: Costs of New Grid Connections in Bahia[15]

Bahia	*Grid extension costs per consumer in US$*					
	(broken down by distance from existing grid in km)					
Utility poles per consumer	*0-1*	*>1–5*	*> 5–10*	*> 10–20*	*> 20–50*	*> 50*
= 0.5	105	145	202			
> 0.5 – 1	322	324	357	373		
> 1.1 – 2	632	642	646	711		
> 2.1 – 4	1,179	1,184	1,208	1,325		
> 4	4,166	4,343	4,763	6,530	6,818	28,219

Source: UNIFACS; Barreto and others (2003).

1.26 *Introduce appropriate regulation to allow for low-cost solutions*. A key step toward reducing service costs in rural areas is to introduce appropriate regulation. Flexible service standards can be implemented without signaling the creation of "second class" service, whenever they aim at meeting the real demand patterns of rural users. Flexible regulation can include more appropriate technical equipment specifications, service quality requirements (hours of daily operation, frequency and duration of outages), and reporting or billing requirements for rural users. In some cases, offering users a menu of quality levels may be appropriate. Current regulation fails to establish such clusters for differentiated market segments that would allow for low-cost technologies. There are no real incentives to promote the electrification of more remote areas. As a result, companies stick to the marginal approach and expand the grid. There are no restrictions on the standards proposed by concessionaires to connect new consumers (for example, price caps for different market segments). Therefore, concessionaires try to maximize initial investment ("gold plating"), frequently fully covered by the state governments, with the establishment of very sophisticated standards (such as tri-phase lines with multiplexed cables) to postpone future investments and minimize their operation and maintenance costs. Brazil does not have an adequate regulatory framework for off-grid systems. Moreover, there are no clear signals to date as to whether village micro-grids or standalone systems based on renewable energy technologies will be considered as "electrification" as defined by Law 10.438—that is, as an adequate way to fulfill the universal access obligations of concessionaires in remote areas. Appropriate rules are required to make such systems fulfill the requirements of service sustainability over time, and to send the right signals to the private sector. ANEEL has initiated the preparation, with MME, of a new regulatory framework for off-

[15] *Note:* U.S. dollar estimates are based on Universidade de Salvador (UNIFACS) data and a 2002 exchange rate of 2.70 R$/US$.

grid rural electrification, to fill the current regulatory gap that makes private players reluctant to enter this market segment. A parallel ESMAP activity on off-grid regulatory issues is cooperating with MME and ANEEL to exchange lessons learned with other countries preparing such off-grid regulatory frameworks. Based on the results of this initial work, a suitable regulatory framework needs to be implemented.

1.27 *Develop markets for off-grid energy services*. Beyond adjusting the regulatory framework, aggressive market development efforts for decentralized off-grid solutions will be needed to achieve Brazil's universal access targets at a reasonable cost. Off-grid electricity includes electricity for village mini-grids (powered by hydro-, solar, wind, diesel-battery, or hybrid solutions) and standalone systems (AC or DC power from pico-hydro, wind, diesel and/or PV generators for multifunctional productivity platforms, home systems, or battery charging stations), as well as non-electrical energy solutions for domestic, public, and productive uses (such as process heat, cooling chain, efficient cooking).[16] The potential for off-grid solutions in Brazil is huge, but largely untapped. Existing isolated diesel systems are often inefficient, unreliable, expensive to run, and a continuous drain on government funds (that is, CCC). Grid extension is not an economically viable option for many remote and dispersed users (for example, users in Amazonia). The already high marginal costs of grid extension of *Luz no Campo* projects which need more than two poles per household (see table 1.3) indicate the need for alternatives. Costs per household can easily rise beyond US$2,000—while many rural households use far less than 50kWh per month even after connection (see data from Bahia). For such dispersed settings, off-grid solutions can provide more flexible energy services, fitting the varying demand patterns of rural users and uses. A significant fraction of the remaining market (about one-fourth) could be attended more cost-effectively through off-grid systems, with strong regional variations (for example, Amazonia). However, early off-grid pilot projects in Brazil have not focused enough on sustainable service models and productive uses, creating the wrong impression of high operation and maintenance costs and limited benefits. Experience in other countries has been more encouraging, and should be analyzed and adapted to Brazil. To bring off-grid solutions into the Brazilian rural electrification mix, all market levels—including demand-side (surveys, promotion, training, microfinance) and supply-side (strengthen DisCos, local technicians and new players)—will have to be developed fast and the market framework will need to be completed.[17] Regarding the institutional framework, it is key that off-grid solutions not be covered by entirely separate funds and structures (and hence perceived as an add-on to "real rural electrification"), but instead fully integrated into the existing framework as just another supply option among many. This is another

[16] For details on off-grid electrification and rural energy, compare: Barnes (1988); World Bank (1988); Foley (1995); Cabraal, Davies, and Schaeffer (1996); World Bank (1996); van der Plas and Hankins (1998); Kammen (1999); Loois and van Hemert (1999); Reiche, Martinot, and Covarrubias (2000); ESMAP (2001b); Martinot et al (2002a, 2002b).

[17] It is important to build capacity on all levels early on, to avoid an "overextension" of the grid by existing players, because of inertia effects (lack of knowledge and risk prime on unproven alternatives). Such "overextension" of the grid to typical off-grid areas seems to have occurred lately to some extent in Brazil, Chile, Bolivia, and other Latin American countries.

reason why the proposed umbrella fund would be beneficial. It would allow for an efficient and seamless integration of off-grid alternatives. Grant funds for market development for alternative off-grid solutions can be sought from international donors and specialized grant programs, such as the Global Environment Facility (GEF) and Prototype Carbon Fund (PCF). A series of initial recommendations for off-grid market development in Brazil are given in this report.[18]

1.28 *Increase development impact through productive uses, non-electrical energy, and a multi-sectoral approach.* Experience has shown that related complementary services are important for a successful national energy strategy to meet rural demand and maximize development impact. Many rural electrification programs have failed to deliver on their promised impacts[19] because they failed to focus on such complimentary services and therefore failed to unlock the full potential of the energy source in the area and to increase demand. In this context, the PNU should explicitly facilitate and, where needed, ensure financing solutions for (a) productive and public uses of electricity, (b) non-electrical energy solutions for productive and domestic uses, and (c) bundling energy services with a few, well-targeted complementary services that have been identified by market studies as suitable for increasing local development impact.

[18] The key issues for off-grid marker development in Brazil will be as follows:

- Renewable energy-based productivity platforms can provide important services at the village level and allow an increase of the development impact via productive and public uses (public uses have multiplier effects and are key to reaching the lowest income strata). Retrofitting existing remote diesel systems could improve financial and environmental sustainability.
- Future guidelines for distribution companies could ask for presentation of alternative low-cost off-grid solutions wherever the cost per user exceeds a certain threshold (say, US$1,500 for remote households).
- The community-driven approach to municipal energy development (as taken by the ongoing World Bank Poverty Alleviation project) has been successful in several Asian countries, and existing energy-specific training manuals could be translated as a first step toward a more informed and more participatory village decision process for energy.
- There is currently a lack of knowledge transfer among the ongoing projects and chances are that old errors will be repeated.
- New off-grid business models have been developed that allow for control of long-term maintenance at relatively low costs. International capital costs for AC solar home systems have come down steeply - for example, in China, medium-sized, AC-based solar home systems that allow for lighting, radio, color TV, and a VCR now cost less than US$500 per household, including the appliances.
- Given the existing framework in Brazil, the concession model as basic approach for remote off-grid areas (in combination with private-sector subcontractors and community-driven solutions) seems to be the clearly favored service model (as opposed to the dealer model successfully implemented for SHS in Asia).

Other important general lessons learned from successful off-grid programs include the following: (a) Address information deficit and lack of capacity; (b) Make new technology available locally and profit from international price reductions; (c) Facilitate commercial financing to rural users (microcredit) and providers (for example, through matching grants and guarantee schemes); and (d) Standardize equipment and system quality.

[19] A World Bank Operations Evaluation Department (OED) review of Asian rural electrification programs noted that most of them had higher costs and yielded fewer benefits than expected (World Bank 1995).

1.29 Regarding *productive uses,* ANEEL and MME may want to analyze options for the financing of equipment and services "beyond the meter"—such as internal installations, or provision of productive and energy efficient equipment—through the electricity bill (or specific funds) to increase rural demand and development impact. Productive loads in remote areas could be served by community productivity platforms, as piloted in Africa. Recent studies (by GTZ, MME, GVEP and others) have started to analyze the potential of off-grid energy services for specific productive uses in Brazil. To identify promising solutions, it is important to analyze the impact of an improved energy input on the production function (reduced cost, increased quality, or improved product mix). As energy is a necessary but not a sufficient input for improved productivity, additional bottlenecks of each enterprise will have to be addressed by parallel business development services.

1.30 In the context of *complementary services* in general, it is important to analyze the tradeoffs of integrating several services separately for each level of the service supply chain (from the government level through all supply chain sublevels to the end user), as integration may make sense on one level (for instance extension agents in remote areas who are collecting fees and servicing end users for more than one company), but not on all. For example, joint tenders of energy and information and communications technologies (ICT) are interesting for the suppliers—as they promise economies of scope—but are often difficult to implement owing to differing regulations and bidding schedules.[20] These complementary, but crucial, issues could be addressed either directly (through specific programs or steering committees) or indirectly (by relying on the private sector to do whatever makes sense) accompanied by information campaigns and training. In either case, it would be a key obligation of the proposed new umbrella fund to ensure efficient coordination with other ministries and players to maximize overall long-term benefits of the electrification strategy.

1.31 *Address peri-urban issues.* The main thrust of Brazil's national electrification program will be toward rural users. However, many of the un-electrified users in Brazil live in peri-urban settings and face challenges that are quite different from those of rural users. More detailed demand analysis will be needed to target the different demand segments efficiently. For the "densification" of areas with existing grid coverage, a series of cost reduction strategies have been tested in other countries that may be of some worth to these user segments. Such strategies include the use of cutoff and prepayment meters, more flexible quality standards for rural grids, and improved customer management and billing methods. Examples are given in two recent ESMAP reports (2001a, 2001b).

1.32 *Attract new players.* Law 10.438 extends the RGR, previously restricted to the concessionaires, to *permissionaires* and rural electrification cooperatives. However, ANEEL still needs to clarify how these entities can access the specified resources. The

[20] Compare Motta and Reiche (2001); Goldmark, Durand, and Reiche (2002); and ESMAP (2003b) on this issue.

law authorizes ANEEL to award permissions to new agents inside existing concession areas when coverage cannot be guaranteed by the existing concessionaire in a reasonable timeframe. Thus, in theory, new private companies and rural cooperatives can make the investment to provide access ahead of the targets defined by ANEEL, and these investments should be reimbursed once the original target date has been attained. But any new agent interested in participating in a local electrification market (by trying to get permission to operate inside an existing concession) will face disputes with the existing concessionaire, which will need to be mediated by ANEEL (unless the new player decides to operate at the fringes of the market, without protection from the regulatory agency). Thus, these new entrants' role, areas of action, funding, and incentives need to be defined for rural electrification cooperatives. These rules should be established by ANEEL soon, as this is a key moment to support the minimization of the risk for off-grid investors in case of subsequent grid electrification. Provided that ANEEL can begin public bidding to award permissions inside the existing concession areas, the agency needs to define criteria, corresponding areas to bid out, bidding processes, contracts, and procedures for the implementation and monitoring of these permissions. Clear rules are needed to minimize future disputes, and to ensure the financial sustainability of these new agents (through access to RGR and CDE resources). Alternatively, the sub-concessionaire could be regulated. These new agents could operate on behalf of the concessionaire, supporting it to fulfill their electrification targets. The concessionaire would continue to be responsible for the concession. In some countries, retail arrangements for grid-based power have increased user density and reduced technical losses and operation and maintenance costs in low-demand areas.

1.33 *Train small-scale suppliers*. Brazil has more than 60 distribution companies and 200 cooperatives. New players will have to enter the rural electrification supply chain to allow for cost-efficient and successful implementation of the off-grid service schemes needed for many of the remaining remote markets (see above), most probably as subcontractors. Based on experience elsewhere, the small service suppliers can profit immensely from well-targeted training programs. Usually, the best way to approach such training needs is a mix of (a) bottom-up technical assistance requests (sometimes combined with matching grant schemes for greatest efficiency) to ensure the relevance of training topics and methods, with mandatory, top-down capacity improvement targets; and (b) “curricula” (to ensure that the weaker players eventually advance toward the efficient frontier). A specific survey of the universe of small-scale service providers in Brazil would be the first step in designing such a capacity-building program. Specific training material for off-grid energy solutions has been prepared for other countries, and could be translated to help create such a future off-grid training curriculum for small-scale suppliers. In this context, GVEP, which is also assisting the Brazilian government in the preparation of a national energy action plan, would be a possible source of information on lessons learned in other countries.

1.34 *Continue donor coordination*. Given the strong interest of donors in the new national electrification program, and its ambitious targets, MME will need to maintain good donor coordination on all levels. The lessons from the World Bank Rural

Poverty Reduction Project, which has successfully applied a community-driven approach to install off-grid electricity in several municipalities, could serve as a valuable starting point for replication on a larger scale by the national electrification program. The ongoing World Bank TA loan could be used by the MME for several immediate preparatory studies (such as demand surveys. Divided into seven regions, an ongoing United Nations Development Programme (UNDP) study on delivery models for decentralized rural electrification (DRE) based on renewable energy will provide proposals for improved delivery models for all types of energy supply in early 2004, on the basis of a critical analysis of 24 pioneer projects in Brazil. A KfW loan and a GTZ technical assistance operation under preparation are both aimed at increasing the share of PV systems in Brazil. A parallel ongoing ESMAP activity on regulatory issues for DRE is focusing on Brazil as one of its target countries. Finally, for the prioritization of energy policy goals and their long-term implementation in a national energy strategy, MME has sought funding from the GVEP initiative.

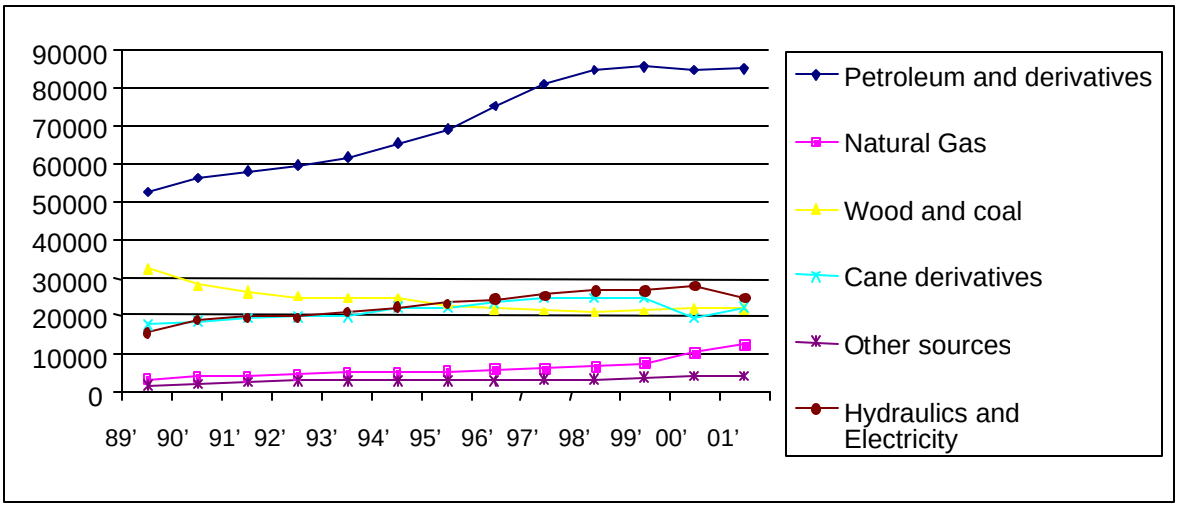
2

The Brazilian Power Sector

The Energy Sector at a Glance

2.1 Table 2.1 presents the main characteristics of Brazil's electricity sector. Renewable resources power a large part of the internal supply of the Brazilian energy balance (38.6 percent). The main sources are hydroelectric energy, wood, and sugarcane products (see figure 2.1). Hydroelectric energy covers 13 percent of supply, while wood covers 11.6 percent. Figure 2.1 shows gross internal energy supply with an important and increasing role played by hydroelectricity. Industrial, transportation and residential sectors demand 35.4 percent, 28.6 percent, and 11.6 percent, respectively, of total energy consumption. Electricity accounts for 14.8 percent of this demand and oil and derivatives another 49.5 percent. Brazil imports 17.2 percent of its energy, mainly oil and derivatives (a fourth of the country's oil demand) and coal. Extrapolating from the current trend, Brazil could reach self-sufficiency by 2005. Brazil has an installed capacity of 75.5 million kW, about 82.2 percent of which is hydropower (2001). Brazil's remaining electricity generation capacity comes from coal and an ever-increasing amount of natural gas. The country's small northern and larger southern electrical grids were joined in January 1999 into one grid that serves 98 percent of the country. Imports from neighboring Argentina augment Brazil's domestic supply.

Figure 2.1: Gross Internal Energy Supply in Brazil



Source: UNIFACS.

Table 2.1: General Power Industry Statistics

Electricity as % of total energy demand (2001)	14.8%
Approximate installed capacity (2002)	75,5GW
Electrical power market (2002)	310TWh
Estimated to 2011	595,4TWh
Estimated annual growth	6.7%
Per capita power demand (2000)	146kWh/month
Average consumer tariff (2003)	R$224,65
Total number of consumers (2001)	41,027,000
Percentage of residential consumers	85.6%

Source: Eletrobrás/SIESE.

Organizational Structure and Agents

Government Agents

2.2 The effort to reformulate and strengthen the government's regulatory role has resulted in a new regulatory framework vital to the new model's successful implementation. In 1995, the federal government significantly altered the structure of the electricity sector's institutional model with reforms aimed at stimulating competition and attracting private sector investors. Table 2.2 compares the characteristics of the model before and after the reforms.

Table 2.2: Electricity Sector before and after Reforms

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

2.3 The new institutional structure includes three new agencies: the National Electrical Energy Agency (ANEEL), the National Electricity System Operator (ONS), and the Wholesale Electrical Energy Market (MAE). The new model includes the Expansion Planning Coordination Committee (CCPE) and several types of well-defined sector agents. The CCPE is part of the Ministry of Mines and Energy (MME) and advises

the government on national energy policy issues. The National Energy Policy Board (CNPE) provides market agents with indicative projections for their investment plans and establishes the transmission system expansion program. The roles of ANEEL, ONS, and MAE are summarized below.

2.4 In the process of transition from the old model to the new, several points were reviewed, and what was originally forecast for the sector after the reform has never been implemented. Thus, only one of the four federal generation companies, Eletrosul, has been privatized. Among the distribution concessionaires, two of the most important are still owned by state governments—CEMIG (*Centrais Elétricas de Minas Gerais*) and COPEL (*Companhia de Energia Eletrica do Parana*). Most of those providing service in Amazonia have been taken over by the federal government—namely, CEAM, CER, CERON and Eletroacre. It should be noted that MAE has never operated in a fully satisfactory way; in 2001, the country's power shortage averaged 20 percent; and a new model is currently under elaboration by the new government. Its main directives are based on the following:

- A planning entity will be established to guide investments in generation, transmission, and distribution. The share of each production source—hydroelectric, thermal, and others—is to be determined after public hearings.
- A new entity will be created to manage contracts between IPPs and DisCos, replacing MAE.
- ANEEL will no longer bid out concessions.

Regulatory Agency (ANEEL)

National Electric Energy Agency (ANEEL)
(Law 9427/96)

- Regulator and supervisor
- Holds 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 ONS activities

Operational Agencies (ONS and MAE)

National Electricity System Operator (ONS) **(Law 9648/98)**	**Wholesale Electrical Energy Market (MAE)** **(Law 9648/98)**
• Physical dispatch of generation • Optimizing generation • Optimizing transmission • Accounting for energy generated, delivered, and transmitted • Indicative studies on expansion and reinforcement of transmission systems	• 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

Market Agents

Generators

- Generators are all market agents that produce energy from any source, hydroelectric, thermal, and other alternative sources.
- Generators are now IPPs that sell energy to distributors, retailers, and free consumers.
- Long-standing generators are now public service generation concessionaires.
- Self-producers are those that produce energy for their own consumption and sell any surplus electricity.

Commercialization of Generation

- Commercialization occurs through compulsory purchase and sales agreements between companies, financially administered by MAE.
- These are now obligatory, as 85 percent of consumption/demand is contracted in advance.
- MME has proposed to increase the amount of electricity covered by bilateral agreements to 95 percent owing to the 2001 energy crisis.

Distributors

- Distributors are responsible for transporting energy from delivery points through the high-tension system and to points of delivery to end consumers.

- In this area, the process of privatizing the electricity sector has made most progress: 23 electricity concessionaires have been sold for a total of R$24,665,500.
- This segment includes rural electrification cooperatives.
- Three possible types of distribution agents are regulated by ANEEL:
  - *Concession*: According to the concession law, new concessions are awarded by public bidding. Existing concessions were extended for 30 years, and most of the companies holding those 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 cooperatives 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 cooperatives that provide electrification service for private uses only (that is, supplying only members of the cooperative, and not all consumers in the area of authorization).

Retailers

- Retailers are those agents that buy electricity generated by the production segment and resell it to distributors and free consumers.

Free Consumers

- Free consumers can buy energy from any generator by paying a fee to the local concessionaire for using the distribution system.
- They use more than 3MW, at a voltage equal to or greater than 69 kV.
- These consumers have not received electricity from the local concessionaire within a maximum of 180 days, counting 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 50kW in an isolated system (that is, a system that serves a limited number of users).
- ANEEL may change these amounts in the future.

Captive Consumers

- These consumers must buy electricity from the local distribution concessionaire.
- Tariffs are regulated by ANEEL.

'Revitalization Committee for Electricity Sector Model'

- The committee is part of the follow-up to Brazil's 2001 Energy Crisis.
- It coordinates and develops proposals to improve the model's operationalization.
- It has completed two progress reports, proposing the implementation of 33 corrective measures aimed at improving established mechanisms and rules.
- It has signed the General Agreement on the Electricity Sector with all concessionaires. The aim of this agreement is to distribute rationing costs by charging all Brazilian electricity consumers an additional tariff to cover concessionaire's deficits during the rationing period.
- The committee charges consumers an additional tariff to cover the costs of the emergency purchase of energy.
- It has prioritized rural electrification.

Prices and Tariffs Regulated by ANEEL

Generation Tariffs

- Generation tariffs have a ceiling price called nominative value (VN) based on the long-term marginal cost of energy, which varies according to the energy source.
- The VN for each contract is adjusted by a range of indicators (price index, exchange rate, and price of natural gas).
- The calculation of VN is under review to establish a ceiling price for generation. The Energy Development Account (CDE) may subsidize VN variations for different energy sources.

Transmission tariffs

- These tariffs include two cost components—locational pricing (30 percent) and node (70 percent)—and are expressed in R$/kW/month. They are set on a state-by-state basis.
- The locational component varies according to the location of the generator or transmission charge and system conditions at each point.

- The node component is a fixed price shared by all system users, no matter where they are located.
- The methodology for calculating these tariffs should be reviewed to better incorporate the electrical system's characteristics and physical and operational limitations.

Distribution Tariffs

- Distribution (or supply) tariffs include the acquisition costs for energy and transmission and distribution systems, as well as sectoral and other taxes.
- They are established for each distribution concessionaire on the basis of a cost planning sheet that breaks down the respective supply tariffs, distribution and marketing activities, and tariffs per 138kV to 69kV bus, on the basis of the nodal methodology;
- There are cross-subsidies for different types of consumption, inherited from the former model. High-voltage tariffs, particularly for industry, are still lower than the cost of service provision, which penalizes other consumers, particularly residential consumers.
- There is also a social tariff that gives a discount to low-income consumers with single-phase circuits who consume less than 80kWh/month, or those who consume between 80 and 220 kWh/month, regulated by ANEEL, in 2002.
- Certain components of the tariffs are reviewed annually, but on top of this concession, contracts establish a periodical revision of tariffs when productivity gains can be incorporated. This period varies from four to eight years, according to what is defined in the concession contract.

2.5 Law 10.438, enacted in April 2002, has introduced a series of long-awaited measures to promote the use of new and renewable energy sources, provision of full coverage, subsidies to low-income consumers, and emergency generation based on small thermal plants to avoid new shortages. To cover the costs of these new initiatives, three main tools can be used: increases in the tariffs; the existing RGR fund, which was extended to 2010; and CDE resources, a fund created by the law. Both RGR and CDE are also transferred to the tariffs.

2.6 These initiatives are expected to result in strong burdens on electricity tariffs to final users, particularly on those concession areas with many low-income consumers and low rates of electrification. In addition, 2003 witnessed a series of periodic tariff revision of several concessionaires, after four to five years. Average increases were over 20 percent. Table 2.3 presents some examples of these increases. The Energy Development Account is the only available source to mitigate these increases.

Table 2.3: Tariff Increases for Concessionaires

Concessionaire	*Index of tariff increase*
CEMAT (MT)	26%
ENERSUL (MS)	32.59% [a]
CEMIG (MG)	31.53%
CPFL (SP)	19.55%
COELCE (CE)	31.29%
COELBA (BA)	28.61% [a]
ENERGIPE (SE)	29.71% [a]

a. Divided into two stages

3

Rural Electrification in Brazil

Coverage and Existing Programs

Coverage

3.1 Official electricity coverage numbers from the Brazilian Institute of Statistics are based on the 2000 Census.[21] The final census figures, from 2001, are presented in table 3.1. They show that 94.5 percent of the Brazilian population has access to electric lighting.[22] Based on these figures, MME has produced more recent data taking into account the impressive achievements of the *Luz no Campo* program—more than 550,000 new consumers over the last two years. This information is presented in table 3.2, which shows that compared to 98.8 percent in urban areas, only 73 percent of the people in rural areas have access to electric lighting. This means that more than 10 million Brazilians have no access to electricity today. There are substantial variations among regions. Only 83.9 percent of the population in the northern region has access to electricity, compared to 98.3 percent access among the southeastern population. Furthermore, there are important variations between income levels. The census shows that 17 percent of the families with monthly income up to one minimum wage[23] have no electricity service, compared to only 0.15 percent for those with income above 20 times the minimum wage. Furthermore, 78.2 percent of non-supplied households have monthly incomes under two times the minimum wage.

[21] See <http://www.ibge.gov.br/home/estatistica/populacao/censo2000/default_tabulacao.shtm> (IBGE 2002).

[22] This information refers solely to access to electric lighting without regard for the source or quality of the service. The numbers do not include the activities implemented by *Luz no Campo*, which are not negligible, as it will be presented later.

[23] For the definition of minimum wage, see footnote 6.

Table 3.1: Access to Electricity in Brazil

Unit of measure	**Total**
Number of households	44,776,740
Electric lighting	42,331,817
Rate of electrification	94.5%

Source: 2001 Census.

Table 3.2: Rate of Non-electrification by Region

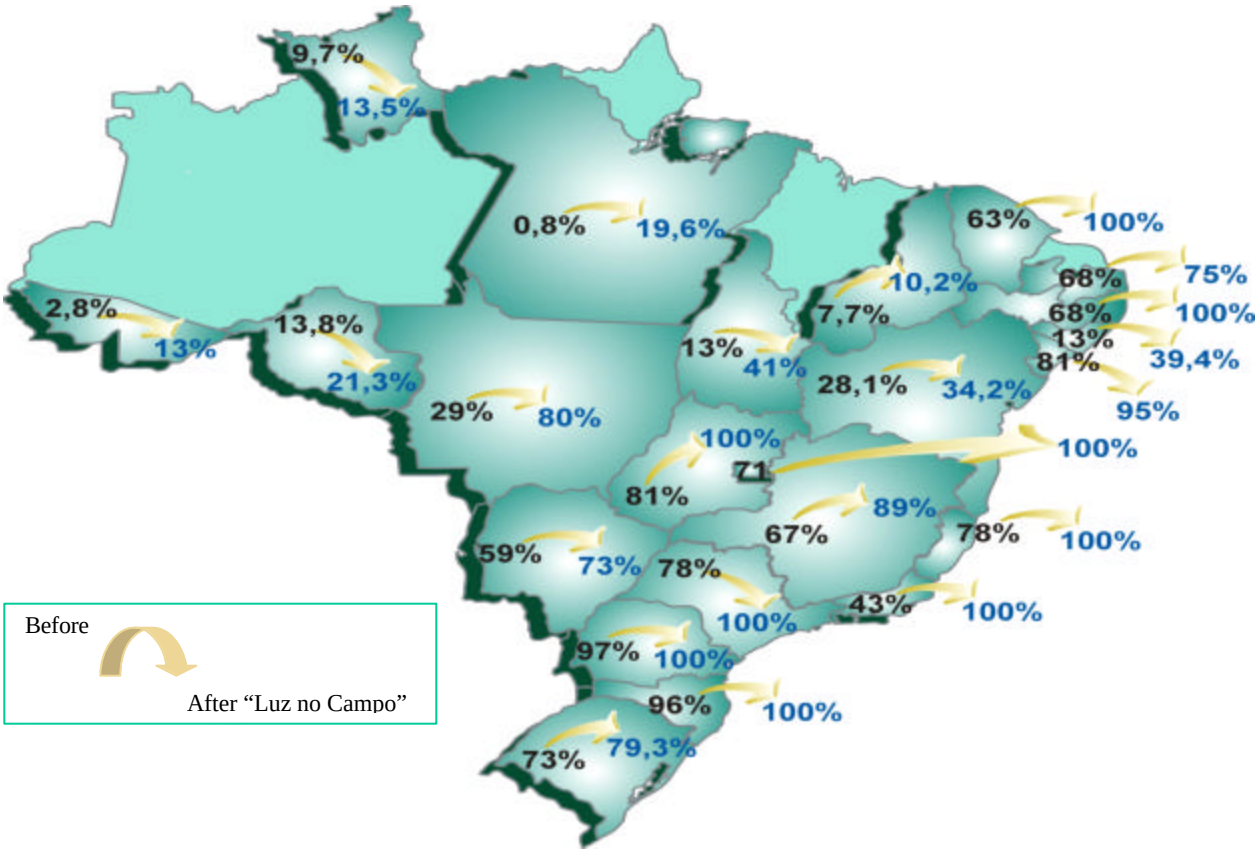
Brazil and regions	*Permanent private households **without** electricity(Dec. 2002)*					
	Urban	*%*	*Rural*	*%*	*Total*	*%*
Brazil	505,023	**1.2%**	1,979,249	**27.0%**	2,484,271	**5.2%**
North	56,195	**2.4%**	447,124	**59.7%**	503,319	**16.1%**
Northeast	201,642	**2.2%**	1,110,339	**34.4%**	1,311,981	**10.7%**
Southeast	166,565	**0.8%**	206,214	**11.9%**	372,779	**1.7%**
South	49,011	**0.8%**	125,235	**10.3%**	174,246	**2.3%**
Midwest	31,610	**1.0%**	90,336	**21.5%**	121,946	**3.5%**

Source: MME–PNU (data from Census 2000, projection for December 2002, including the achievements of *Luz no Campo*).

3.2 Another important source of information is the 1996 Agriculture Census,[24] which focuses only on agricultural businesses. According to this census, by 1996, some 3 million Brazilian farms had no access to electricity. Eletrobrás has consolidated data from the National Research by Household Sample (PNAD 98)[25] and the Agriculture Census to determine the targets for the *Luz no Campo* Program. These results are presented in figure 3.1, which shows the status of rural electrification for each state when the program was launched (black numbers), and the *Luz no Campo* program targets (blue numbers). The results revealed huge disparities in the rural electrification rates among states, which varied from 96 percent in Santa Catarina to 0.8 percent in Pará.

[24] IBGE (1996).
[25] PNAD (Sample Survey of Households) and IBGE (*Instituto Brasileiro de Geografia e Estatística*).

Figure 3.1: Brazilian Electricity Coverage Rates (Before / After *Luz no Campo*)



Source: Luz no Campo (not an official geographical map)

A Short Assessment of Existing Rural Electrification Programs

3.3 The Brazilian government and a variety of donors support a range of initiatives designed to promote rural electrification. The federal government supports two major programs: *Luz no Campo* (managed by Eletrobrás), which focuses on grid extensions and PRODEEM (managed by MME), which focuses on solar photovoltaic technology for remote community applications. In addition, there are rural electrification activities under several non-sectoral and decentralized initiatives such as those of the Ministry of Agriculture, the Northeast Development Bank, and the World Bank Poverty Alleviation Program, which has also been active in the northeastern region. Some states have access to bilateral funds to finance their rural electrification programs—the one in Tocantins, for instance, has support from the Japanese Bank for International Development (JBIC). Several new programs are under preparation (for example, KfW's solar home system project).

Luz no Campo

3.4 *Luz no Campo* is the single largest rural electrification program implemented in Brazil with the aim of connecting nearly a million rural households between 1999 and 2002. When the program was launched in December 1999, its target was to supply electricity to 930,000 households to benefit 4.4 million people at an average cost of R$2,423.00 per connection (under US$1,000). The northeastern region would account for nearly 45 percent of the new consumers, with an average cost per connection of R$1,600.00 (ca. US$700).

3.5 Rural consumers are typically expected to pay the full cost of the connection, albeit spread over a number of years. However, the program has assumed individual characteristics in each state, with varying support given to new consumers by the state government. In certain states, *Luz no Campo* is also financing the internal installation of households, going beyond the simple connection and installation of the meter.

3.6 So far, the program has focused on grid extension. As of February 2003, 554,628 connections had been made, and another 80,708 were in progress. An additional 252,983 new customers have signed contracts, but have not yet been connected. Only 2,000 off-grid connections were made under the program, from a total of 9,000 planned by the *Companhia Elétrica do Estado da Bahia* (COELBA), as required by the government of the State of Bahia. This can partly be attributed to the relative low cost of grid extensions, averaging about US$950 per connection.

3.7 There are no incentives in the *Luz no Campo* program to create low-cost grid connections or off-grid projects except in two projects in Minas Gerais and Amazonas:

- The *Casa das Máquinas* pilot project in Minas Gerais aims to provide information to rural producers about the use of efficient technologies to increase agriculture output through electricity. Provided the installation costs of single-phase earth return lines (R$7,000/km with the distribution system) are much lower than the cost of tri-phase lines (R$12,000-15,000/km without the distribution system), the project intends to use and promote the installation of *single-wire earth return* lines whenever possible, to promote this technology to reduce connection costs in areas where there is a limited level of productive applications requiring tri-phase power. The project also sponsors the establishment of productive community centers to boost development impact by stimulating demand through productive uses.
- The *Comunidades Ribeirinhas* project was conceived to provide the program with experience on the use of renewable energy systems in remote areas of the Amazonia region by implementing pilot projects based on simple cost recovery mechanisms. At this point, 51 PV installations

have been implemented, with service fees set at R$25 (US$10) per month. This experiment contributed to the preparation of the larger-scale *Luz na Amazonia* project in 2003, financed by the KfW (US$10M of concessional loans), aiming at the electrification of 6,000 households under the same fee-for-service scheme.

3.8 A performance evaluation of *Luz no Campo* is in progress. A questionnaire is being randomly distributed to nearly 12,000 customers, who are being visited one year after service begins. A subsequent visit is anticipated for the third year. According to preliminary data, user expectations focus on the use of televisions, refrigerators, and agricultural equipment.

PRODEEM

3.9 Experience with *off-grid electrification* in Brazil has been very limited and subject to a variety of sustainability problems. The main government-sponsored off-grid electrification program is called *Programa de Desenvolvimento Energético de Estados e Municípios*—(Energy Development of States and Municipalities Program, *PRODEEM*). It was established by Presidential Decree in December 1994. By 2000, PRODEEM had purchased about 3MWp in PV panels for a total investment of R$21 million, financed from National Treasury funds. According to its own estimates, from 1996 to 2000, PRODEEM provided equipment to 3,050 villages, and benefited 604,000 people,. In 2000, another 1,050 systems were installed and were expected to benefit an additional 104,000 people. The total budget was R$60 million for 2001, when 1,086 systems were installed, and another 3,000 community systems were tendered through international bidding, with a winning bid of R$37 million for equipment and installation, plus operation and maintenance for three years. More recently, PRODEEM and ANEEL have begun sponsoring mini-grid pilot projects (with hydro- and biomass generation), to test different service provision models.

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

3.11 The main problems of the program appear to include the following:

- A top-down approach, with occasional installations in unprepared and unorganized communities;
- No cost recovery schemes, which results in unsustainable service and a lack of funds for maintenance;
- Lack of responsibility of local communities and states for the equipment (even under the new system requiring operation for three years); and

- Occasional lack of coordination with grid expansion programs.

3.12 A recent evaluation of the first phase of the program[26] surveyed its impact on 43 villages in 10 states. Of the 79 systems surveyed, only 44 (56 percent) were actually operating, albeit with disparities in evidence among the states.[27] A more recent survey by the General Accounting Office (*Tribunal de Contas da União*) has also indicated serious problems on the operation and maintenance of the project, recommending a complete review of its practices.

3.13 A second phase of PRODEEM—currently in the initial stages of implementation—plans to focus more on private productive uses of energy. The Japanese JSF Fund and the Inter-American Development Bank (IDB) have provided funds to develop some pilot models to be implemented through a variety of possible service providers, including cooperatives, concessionaires, permissionaires, multiple purpose rural companies, or nongovernmental organizations (NGOs). The main objective of this new program is to facilitate business development for agents interested in buying and selling services. The project is managed by UNDP, and is being implemented in three stages. From September to December 2002 a comprehensive survey of all decentralized renewable energy initiatives was developed by seven teams, which identified 149 programs or projects. During the second stage, starting in June 2003, 24 of those pioneer experiences will be scrutinized to understand their weaknesses and strengths, resulting in a series of recommended interventions to improve performance and ensure sustainability. In the last stage, some of these pilot projects will receive technical assistance, based on recommendations from previous phases, to produce replicable sustainable delivery models.

Nonsectoral or Decentralized Initiatives

3.14 In addition to *Luz no Campo* and PRODEEM, there are nonsectoral or decentralized initiatives. For example, the Ministry of Agriculture uses funds from the federal budget to provide resources to municipal administrations to finance grid extensions for productive uses; these funds are nonrefundable. The Northeast Development Bank provides loans to small entrepreneurs to install SHS in remote villages. Operating under a different name in each state, the World Bank–sponsored Poverty Alleviation Program provides grants to local associations to finance projects approved by the municipal committee. These projects include grid-connected rural electrification projects, off-grid solar systems, and a variety of other rural development projects. In Bahia, the program includes the electrification of more than 500 villages, 22 infrastructure projects, 141 productive projects with grid connection, and more than 350 villages with solar off-grid systems. The program has sponsored more than 16,000 SHS in Bahia.

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[26] Ribeiro, Cláudio, and Dutra (2000).

[27] In São Paulo and Minas Gerais, for example, nearly 100 percent were working, but no systems were operating in the States of Ceará and Alagoas. In Bahia, only a third of the systems were operating.

3.15 Sustainability remains a key issue of these decentralized initiatives, however. A recent survey to assess the performance of PV systems[28] identified as main problems the poor quality of installations, reflecting poor technical standards, and a 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.

3.16 A key issue of all existing rural electrification programs appears to be the lack of coordination. The programs operate in their own particular niche, and, although they complement each other, implementation has suffered from a lack of coordination, thereby restricting the scope for optimizing the allocation of public funding.[29]

Demand

3.17 The issue of coverage is controversial in Brazil, since data from the 2000 Census are based on access to electrical lighting. Data available from concessionaires cover only connected consumers, and ignore users with other forms of supply or illegal connections. Therefore there is a gap between census data and sector statistics. A study done by UNIFACS for ANEEL[30] demonstrates this issue. To overcome this baseline problem, ANEEL has recommended that the concessionaires elaborate a detailed description of the methodology to be used in identifying the nonserved markets, before the submission of their rural electrification targets. The MME is currently preparing a more detailed analysis of coverage by state. Owing to this current lack of more precise information on market size, this section will mostly focus on existing surveys to identify the market segments for future rural electrification in Brazil.

Residential Markets

3.18 Table 3.3 gives estimates of the remaining potential for rural electrification in Brazil, either conventional (through grid extension), or decentralized (through village mini-grids or individual systems).

Table 3.3: Remaining Potential for Rural Electrification

	North	*Northeast*	*Midwest*	*Southeast*	*South*
Number of rural households not connected to the grid	503,319	1,311,981	121,946	372,779	174,246

Source: 2000 Census.

3.19 A recent study in the State of Bahia indicates that among 409 off-grid households, 87 percent were interested in individual PV systems, even if the system

[28] Universidade de Salvador (UNIFACS) (2002).
[29] Additional information on this initiative is presented later on this chapter.
[30] Valente and others (2002).

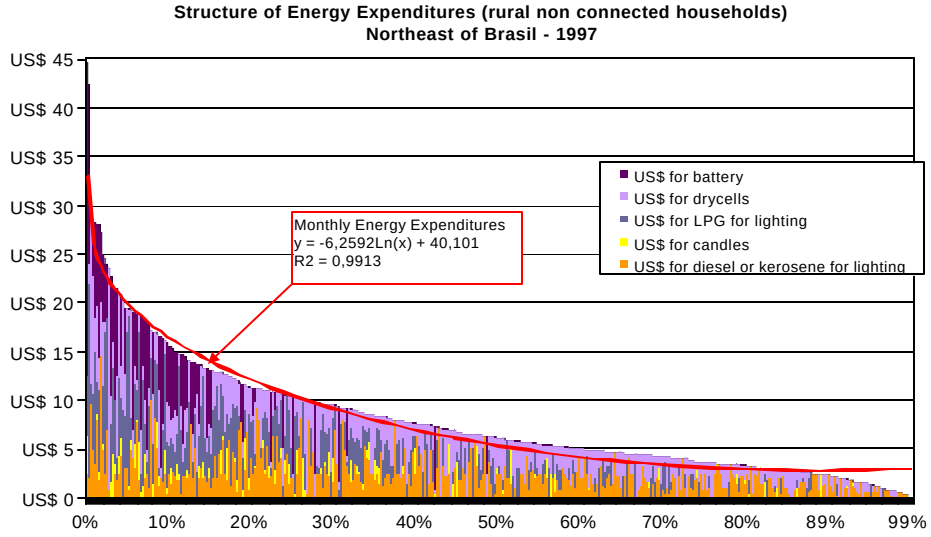
would provide a more limited service than a grid connection, while another 10 percent noted that their interest would depend on the price of the service and 3 percent suggested that they were interested exclusively in grid extension. In this demand survey, as in several recent World Bank surveys, current energy expenditures for services substitutable by renewable energy technology systems were used as an estimate for the minimum capacity to pay.[31]

3.20 Another study[32] presented the results of surveys in the three States of Bahia, Ceará, and Minas Gerais, based on representative samples totaling more than 600 rural households, 465 of which were off the grid and 150 of which were connected. The objective of these surveys for off-grid households was to identify the order of priority for the purchase of equipment that might be activated by a decentralized energy system. The market penetration of electrical devices in socioeconomically similar electrified areas was used to infer future dynamics that might result from electrification in off-grid areas. It also showed an order of magnitude of externalities in terms of sales increase for the electro-domestic device industry. Typically, about 60 percent of households bought a black-and-white television once electrical service was provided. Data from the 2000 Census show that the level of penetration of televisions and refrigerators is currently 87 percent and 83 percent, respectively.

3.21 As in market analyses in other countries,[33] this market study for northeastern Brazil observed that there is a very strong and simple correlation between the energy expenditure level and the cumulative percentage of households when aggregated by decreasing energy expenditures (see figure 3.2). Some postevaluation studies in other countries have demonstrated the elasticity of capacity to pay against quality of service. This correlation model provides a satisfactory conservative estimate of the willingness to pay for energy services of nonconnected rural households in the States of Minas Gerais, Ceará, and Bahia. The survey indicated that, of the rural households in Minas Gerais, Ceará, and Bahia, 10 percent, 30 percent, and 43 percent, respectively, spend more than R$10.00 per month (1997 value).[34] In Bahia, 10 percent spend more than R$20.00 (1997 value).

[31] See ESMAP (2002) for an overview of methodologies.
[32] ESMAP (2000b).
[33] For example, in Argentina, Bangladesh, Cape Verde, and Nicaragua (see Gouvello and others 2002).
[34] US$1.00 = R$1.10 (1997 values).

Figure 3.2: Current Household Energy Expenditures and Willingness to Pay



Source: *ESMAP* (2000b)

3.22 In the case of PV systems, the surveys indicate that market size depends directly on the tariff level to be charged for each system and on the capacity to pay of the corresponding target group.

3.23 Law 10.438 created a subsidy for low-income consumers in two usage categories—under a monthly consumption of 80kWh and between 80 and 220kWh per month—for those registered with one of the existing social programs. This has helped to reveal the market profile of those companies that incurred substantial revenue losses. The number of consumers with monthly consumption under 220kWh represents a 30 to 50 percent share in several companies. In the case of Bahia, 26 percent of the state's 2.6 million residential households consume less than 30kWh/month. The average consumption of this group is 12.5kWh/month. This clearly shows that a significant share of these consumers could be supplied with PV systems without compromising on monthly energy consumption. Among the population without access (on average poorer) the share would be higher still.

3.24 A recent study by UNIFACS and COELBA, analyzing the achievements of *Luz no Campo* in Bahia, extrapolates its findings to the remaining population not yet supplied.[35]

3.25 Table 3.4 shows that more 120,000 consumers were connected by *Luz no Campo* with nearly 75,000 situated at less than one kilometer from an existing grid. On the other extreme, 70 new consumers were situated at more than 50 km from the grid.

[35] Barreto and others (2003).

The table also shows five levels of dispersion[36] of new consumers. Around 25 percent of connected villages presented a dispersion of more than four utility poles by consumer. About 10 percent of consumers were connected in these villages, as shown in table 3.4. This profile of connection is reflected in the huge variation of the costs per consumer, as presented in table 3.5.

Table 3.4: New Customers Connected by *Luz no Campo*

BAHIA	Numer of consumers						Number of
Degree of dispersion	Distance from Grid in km- (LD; MP)						Consumers
(post/consumer) - RU	0 - 1	> 1 - 5	> 5 - 10	> 10 - 20	> 20 - 50	> 50	serviced
<= 0,5	38.458	6.283	264				45.005
> 0,5 - 1	13.625	8.078	1.648	77			23.428
> 1,1 - 2	9.881	8.282	2.673	852			21.688
> 2,1 - 4	7.566	5.433	3.069	1.367			17.435
> 4	4.757	2.801	3.005	1.847	130	70	12.610
Total	74.287	30.877	10.659	4.143	130	70	**120.166**

Source: UNIFACS.

Table 3.5: Costs of New Grid Connections in Bahia

BAHIA	Costs of grid per consumer - R$					
Degree of dispersion	Distance from Grid in km- (LD; MP)					
(post/consumer)	0 - 1	> 1 - 5	> 5 - 10	> 10 - 20	> 20 - 50	> 50
<= 0,5	282,23	391,82	545,48			
> 0,5 - 1	868,30	874,56	963,81	1.006,97		
> 1,1 - 2	1.705,45	1.734,53	1.744,83	1.920,20		
> 2,1 - 4	3.182,91	3.197,77	3.261,31	3.576,98		
> 4	11.248,70	11.727,19	12.859,73	17.631,10	18.409,39	76.192,16

Source: UNIFACS.

3.26 The average cost of connecting consumers who are close to the grid and highly concentrated (less than 0.5 poles/consumer) is less than US$100.[37] As dispersion increases, these costs surge with dispersed consumers costing more than US$4,000 for the same distance (less than one km) to the grid. All villages with dispersion below two poles per consumer, even with distances reaching 20km, present average costs per consumer under R$2,000 (US$700), below the average costs of *Luz no Campo* for the whole country. However *above this level of dispersion, costs are over US$1,000/consumer, justifying the search for supply alternatives*.

3.27 Although it did not include an analysis of the level of consumption, which represents another important component in the decisionmaking process for decentralized supply, the study concludes that about 10 percent of the non-connected population could

[36] This is based on the number of poles divided by the number of consumers for each group of consumers (according to UNIFACS, 3,316 groups of consumers—villages or rural areas—were connected.)
[37] See table 3 for costs in US$

be served by alternatives such as PV systems. This conclusion is not odd, considering that more than two-thirds of the non-connected population has a monthly income under twice the minimum wage. As mentioned above, *more than 600,000 consumers in Bahia consume less than 30kWh/month, with an average consumption of about 12.5kWh/month*—an energy demand that could be more cost-effectively supplied via PV in remote areas and to dispersed households.

Market for Community Applications

3.28 It is difficult to estimate the number of isolated communities without electricity. The companies and agencies in charge of providing infrastructure to rural communities only catalogue requests. This frequently results in underestimating the real needs. Nevertheless, the information gathered from field surveys (see above) and from different government agencies (data, literature, and interviews) allow for fairly realistic estimates of collective uses in rural communities in the three main northeastern states (Ceará, Bahia, and Minas Gerais). Some of these uses seem to be less important in terms of installed power, but can be easily integrated with other more attractive services to provide a "multiservice station," and thus gain economies of scope. According to these surveys, and considering realistic assumptions about the implementation rhythm by government agencies, the total photovoltaic market in the three northeastern states mentioned above would be about 10MWp over the period 1997–2005. Including water-pumping and public-lighting systems, schools, health centers, and community buildings, this would allow the implementation of 31,500 community systems. According to PRODEEM, there are about 100,000 small communities that require community systems for schools, clinics, and water supply—a market that surpasses 100MW.

Market for Productive Uses

3.29 At the present early stage of Brazil's PV market, it is difficult to identify productive uses for which PV-based electricity is sufficiently mature. The market size for PV-based productive uses in the three states has been estimated only for micro-irrigation and electrical fences. The *Casa das Máquinas* Program has identified two types of grid-connected projects: simplified transformation (mostly for self-consumption) and mini-agro-industry with collective production and transformation. Pilot projects installed in Minas Gerais include mini-irrigation, solar dryers for fruits, refrigeration for milk production, and cereals and rice processing equipment. There are no precise figures on the size of this market. These findings are presented in table 3.6.

Table 3.6: Assessment of the Potential for Decentralized Rural Electrification,1997–2005

Number of DRE systems (thousands)

	Bahia	*Ceara*	*Minas Gerais*	*Total*
Small irrigation	8	3,2	8	19,2
Electric fence	1,6	1	0	2,6

Source: Gouvello and others (2002).

3.30 In the northeast region of Brazil, goat breeding is expanding, and electric fences are more cost-effective than conventional wooden fences to separate animals and crops. Electrical fences are well suited for PV, as they require continuous voltage at low energy consumption. For other potential uses, such as fruit drying, water pumping, and small fish breeding, decentralized renewable energy options may also be competitive, but more detailed market characterization studies need to be done.

Supply

Actors Involved in Rural Electrification

3.31 Brazil's power sector is federally regulated. ANEEL is the national regulatory agency for electricity. Any public distribution service must be provided within the scope of either a concession or permission. Concessionaires and permissionaires can contract companies to develop a series of services such as installation, construction, and the operation and maintenance of their systems, outsourcing to contractors their activities. The ultimate responsibility is with the concessionaire or permissionaire. A third possibility is the authorization for private service, normally provided by rural electrification cooperatives to their members. ANEEL can delegate some of its legal responsibilities to the state regulatory agencies, through agreements.

3.32 The country is already fully covered by either private or state-owned concession areas. Some smaller areas are covered by rural electrification cooperatives, which are currently in the process of becoming permissionaires or authorization holders. So far, rural electrification cooperatives are consumers of concessionaires, with tariffs defined by ANEEL. The regulatory framework is the same for private and state-owned concessionaires. Currently there still are six concessionaires under the control of Eletrobrás, mainly in the Amazonia region, and five controlled by state governments, in addition to more than 40 private concessionaires.

3.33 The profile of the rural electrification cooperatives is quite diverse and ANEEL is elaborating the rules to classify existing cooperatives either as "permissionaires" or authorization holders. Some cooperatives operate as small concessionaires, covering all consumers within their areas—in some cases even with their

own generation assets. Other cooperatives function as contractors for the distribution companies. Their main activities are the distribution of electricity bills, collection of payments, sale of electrical equipment and appliances, projection and construction of grids for their members, and financing of new connections. A third type of cooperative provides services just for members and does not cover the whole area. Cooperatives in this group will be classified as "authorization holders," and not as permissionaires.

3.34 At the same time, rural cooperatives offer a variety of services and are not restricted to rural electrification. Telephone service, Internet access, and rural development services (such as rural extension, commercialization, and so on) are commonly offered by the same cooperative in several parts of Brazil, particularly in the south. Some of these cooperatives can potentially become "permissionaires," since they conduct activities and own assets that may allow for greater profitability from developing their electricity business.

3.35 Another possibility, the *subconcession*, was created by Law 8,987, but has never been regulated: The subconcession must be authorized by ANEEL, and the selection of the subconcessionaire must follow a competitive bid process. Concessionaires could use this possibility to outsource the provision of the service inside their concession areas. This delivery modality would be particularly suitable for devolving activities with which concessionaires are not very familiar, such as the provision of service through decentralized renewable energy, particularly SHS. This would allow concessionaires to involve other private-sector agents and follow an output-based approach.

3.36 Since it is not a regulated, Brazil's market for SHS is a "gray zone." Photovoltaic retailers have so far developed it in a rather sporadic way: governmental projects maintained by local associations, a few pilot projects cosponsored by NGOs or rural cooperatives, and some pilot projects implemented by concessionaires (CEMIG and COELBA). COELBA has started a pilot solar home system program, which aims to install 9,000 units, using resources of the state treasury. COELBA considers that there is still no legal framework to absorb these systems as an alternative to fulfilling the universal access targets. Lacking a final decision from ANEEL on how these alternatives should be treated, COELBA sees itself just as an installing agent for the state government, without maintenance responsibilities. CEMIG has developed a similar initiative and assumes full responsibility for the operation and maintenance of installed equipment. Five thousand solar home systems and 500 community systems are currently under installation.

3.37 Today, several NGOs play a significant role in the provision of electricity to rural areas through the use of Renewable Energy Technologies (RETs). Besides acting as field intermediaries for future "permissionaires," several NGOs in the area of rural development have played an important role in the dissemination of low-cost grid connections and efficient equipment, and use of RETs. They have also provided capacity building and raised funds for the installation of small demonstration projects.

3.38 Distribution company contractors, which currently build (and in some cases maintain) distribution systems for concessionaires, are spread throughout the country. In parallel, PV systems are disseminated through a network of small dealers operating under the supervision of a regional representative, who reports to a national distributor. More recently, several DisCo contractors have launched activities related to the PV market.

3.39 Municipal governments have the responsibility of granting water supply services. These services can be implemented through cost recovery mechanisms that create an additional source of income to local "permissionaires." State authorities can also play an important role by reducing taxes on equipment and energy for remote areas. They can absorb a part of the investment for remote areas through programs such as the Poverty Alleviation Program by reducing the permissionaires' capital expenditures. PRODEEM could involve the same private agents and permissionaires in the operation of water-pumping systems and collective electricity systems (investment made by PRODEEM and operated by the private sector).

Delivery Mechanisms Based on Renewable Energy Technologies Realized in Rural Brazil

Photovoltaic Systems

3.40 In parallel to the regulated main market, PRODEEM, and the Poverty Alleviation Program, a small niche of the remote rural market is already being supplied by means of RETs, typically implemented by NGOs. Programs in this group include the following:

- The *Instituto Eco-Engenho* (IEE), an NGO based in Maceió, in the State of Alagoas, has established (with Northeast Development Bank), the *Luz do Sol* program, which provides a credit line to finance small entrepreneurs who develop solar home system businesses in small villages. These entrepreneurs charge a monthly service fee. IEE claims to have more than 2,700 systems installed to date by 90 micro-entrepreneurs operating under this leasing model. Currently the program faces great difficulties, and users stop paying the entrepreneurs, who transfer the default to the Northeast Development Bank. IEE is trying to revamp the program and convert it to a fee-for-PV-service system.
- The *Associação dos Pequenos Agricultores do Estado da Bahia* (Association of Small Agriculturalists of Bahia State, APAEB*)* is an association of small farmers concerned with industrialization and diversification of the sisal crop. It has established a credit cooperative and runs a revolving fund that replicates the use of photovoltaic systems for domestic use (five-year loan, one-year grace period and no interest), and electric fences (eight-year loan, one- to two-year grace period and no interest) indexed to the price of goat meat. It also transfers Northeast

Development Bank credit lines to its members to finance PV panels. APAEB has financed or sold more than 500 PV systems.

- The *Instituto de Desenvolvimento Sustentável e Energias Renováveis* (Institute for Sustainable Development and Renewable Energies, IDER*)* is an NGO that designs, installs, and maintains RETs. It cooperates with the U.S. Solar Electric Lighting Fund (SELF), and supports local associations with revolving funds for replication of PV lighting systems. The scheme involves a down payment and a monthly payment.
- *Instituto para o Desenvolvimento de Energias Alternativas e a Auto Sustentabilidade* (IDEAAS) is an NGO based in Rio Grande do Sul. It has been implementing some projects to demonstrate the economic, financial, and technical viability of photovoltaic solar energy to bring electricity to isolated rural communities (often low-income) or those located in large voids of electricity distribution in Brazil. Another project aims to develop business and management models to refurbish and integrate deactivated mini-hydropower plants. For example, it is sponsoring a pilot project under development in the municipality of Putinga/RS with the support of MME and the Putinga City Council.

3.41 Some pilot projects are being installed by concessionaires or PV distributors in partnership with NGOs or universities or managed directly by the concessionaires. Among them are the pilot projects sponsored by El Paso, in Rio de Janeiro, and BP Solar in Bahia, Ceará and Amapá.

3.42 Finally, there is the retail market for PV, which, according to ABEER, has been estimated at about 3MWp per year. Of course, these retailers provide equipment to the high-income rural market on a cash-basis or short-term financing schemes in addition to the associations market under the Poverty Alleviation Program. The Brazilian Energy Initiative presented in Johannesburg estimated total installed capacity of PV systems in Brazil at about 14MW. It should be kept in mind, however, that more than 30 percent of the systems is not fully operational.

Other Renewable Energy Technologies

3.43 A recent comprehensive survey developed by PRODEEM, looking for decentralized renewable energy initiatives, identified more than 100 programs and projects, excluding PRODEEM initiatives. Of these projects, 32 have other technologies beyond PV systems, including micro-hydros, biomass, wind, and hybrid systems. Most of them are pilot initiatives operated by local associations and supported by universities, research centers, and NGOs.

Technology Options and Potential in Brazil

3.44 There are several technical options for rural electrification: (a) extension and "densification" of the *interconnected grid*; (b) installation of *village mini-grids*

supplied by diesel generators, renewable energy sources (wind, water, biomass), or a "hybrid" combination of these; and (c) *standalone systems* for isolated users, based on solar home systems, or wind, water (pico-hydro), or diesel/gasoline generation (see box 3.1). The distance from the existing grid, the density and number of customers, the specific demand and willingness to pay, and locally available resources are among the main factors determining which of these options is the most cost-effective.[38]

3.45 In addition to grid extension, Brazil has used diesel plants to supply remote areas, particularly in the Amazonia Region. These are called "isolated systems," and have a long history of using subsidies through the mechanism known as the Fuel Compensation Account (*Conta de Consumo de Combustíveis*, CCC). There are 219 public service diesel plants with installed capacities under 10MW, adding up to 293MW; 136 of these plants are under 1MW and supply only villages or small towns. More recently, IPPs have assumed the generation component introducing modern diesel generators, accessing CCC funds, and selling electricity to distribution concessionaires. There are another 600 diesel systems spread over the Amazonia region, managed by state concessionaires or municipal governments and other entities, without access to CCC funds. The cost of the electricity produced by such diesel units in off-grid systems is high, in some cases costing as much as US$200/MWh.

[38] World Bank (1996); Cabraal, Davies, and Schaeffer (1996); Reiche, Martinot, and Covarrubias (2000).

Box 3.1: Balancing Technology Options

Currently, rural electrification in Brazil is implemented almost exclusively through grid extension. Wherever viable, grid extension is indeed the preferred option for electrification because of its potentially very low marginal cost per kWh and unlimited energy. In countries that do not target full coverage in a foreseeable timeframe (such as many African countries with national coverage of about 10 percent), rural electrification programs focus on grid extension to achieve maximum access growth rates. However, Brazil is targeting universal access in about a decade from now. As marginal grid extension costs increase exponentially toward the last percentiles of unelectrified remote, rural users (see Chile), the strategy has to be more balanced: markets for decentralized technology options have to be scaled-up in parallel, to match the low demand of dispersed rural customers (below 50kWh per month) in a more cost-effective way (for example, US$500 initial investment per user), and low-cost grid extension (single wire) for rural users with moderate power demand has to be mainstreamed. To reach universalization in a reasonable time frame, the three basic rural electrification technology options will have to be combined in a more balanced way: (a) traditional grid extension and densification (wherever economically viable given distance to grid and specific local demand); (b) isolated mini-grids with local generation (based on diesel generation, renewable energy sources, or hybrid combinations of these); and (c) standalone single-user systems for dispersed loads. The tradeoffs between these technologies and the main barriers to off-grid solutions in Brazil are explained in this report. Each technology has different requirements regarding business models, regulations, and financing schemes. As the nascent markets for alternative approaches to rural electrification in Brazil suffer from typical lock-in effects and information asymmetries, it will be crucial to accompany direct subsidies with additional market development programs focusing on business development services, as well as promotion and training campaigns on all levels. Funds for such market development for alternative solutions are available from international donors and specialized grant programs, such as the Prototype Carbon Fund (PCF) and the Global Environment Facility (GEF). This report estimates that a significant fraction of the remaining nonsupplied market could be more cost-effectively attended through off-grid systems, with strong regional variations (for example, Amazonia). Failures of past pilot projects in this area (mainly sustainability issues due to incomplete service models) have certainly not helped to increase private-sector interest. To profit from cost effective off-grid solutions in the future, there is an immediate need to demonstrate more successful service models and to build the necessary implementation capacity on all market levels.

3.46 There are several small thermal units in operation in Amazonia that use sawmill residue, with no information consolidated in the ANEEL database. According to an MME estimate, these systems might number about 300. The range of installed capacity would be from 150 to 500kVA.

3.47 By contrast, there are very few cases of mini-hydropower plants operated by distribution concessionaires supplying electricity to small villages or towns. A series of decentralized mini-hydros were installed and are operated by the Army on the Brazilian border in the Amazonia region. There are six mini-hydro plants supplying military bases and nine neighboring villages, adding 480kVA of installed capacity.

3.48 More recently, a series of pilot systems were installed under different sponsorships that used a variety of technologies such as solar-diesel and solar-wind-

diesel hybrid systems, small thermal units burning vegetal oils and sawmill residues, mini-hydro plants, biodigesters, and in one case, fuel cell, to supply remote villages.

3.49 PRODEEM has sponsored micro-hydro pilot projects in the States of Rio Grande do Sul and Mato Grosso. These projects were installed as part of a partnership between the federal and state governments, in remote areas, mainly surrounded by reserves. Eletronorte in the States of Mato Grosso, Maranhão, Tocantins, and Acre has identified 10 other projects, two of which are still in the contracting phase. The range of capacity is from 20kW (benefiting 200 people) to 430kW (benefiting 5,000 people). Once built, the plants are donated to the local association to operate. The estimated cost of investment is about R$2,000/kW. These costs coincide with those incurred by the Army, which varied from R$3,000 to 5,000/kW.

3.50 The potential of small hydropower plants is significant, but no precise figures are available. The Ministry of Mining and Energy has recently contracted the University of Itajubá to inventory out-of-service small and mini-hydropower plants. According to preliminary information from the University, this figure may surpass 1,000 units. In the small State of Rio de Janeiro, the Reference Center for Small Hydro Power (CERPCH) has identified 59 plants under 30MW with a total capacity of 600MW. Four additional rivers have not yet been analyzed. The Electric Company of Minas Gerais (CEMIG) estimates that there are 1,300 mini- and small hydropower plants, but these are mainly located in areas that are already fully electrified.

3.51 Two types of technology have been used in biomass decentralized generation projects in Brazil: direct combustion of residues (sawmill residues, rice husks, and forest residues) and vegetal oils, either in imported Elsbett motors or adapted diesel motors. CEMIG has used a gasifier for village supply. The system, installed in Formoso, has 250kW of installed capacity, but it is currently used as back-up to the recently installed grid. Two projects, both using Elsbett technology for multi-vegetal oils, were tested in the Amazonia region. They used andiroba and palm oils, but the main conclusion from the experiments was that the technology is too expensive to be used in remote areas, and it would be more convenient to adapt conventional diesel motors, either through indirect injection with the introduction of a precombustion chamber or direct injection with major modifications in the combustion chamber. The potential for this type of application is particularly high in the Amazonia Region.

3.52 Several hybrid projects have been tested in Brazil so far; these were solar-diesel or solar-wind-diesel combinations. Technically, the performance of these projects was satisfactory, particularly because they were assumed by distribution companies or local universities. The main constraint was related to their initial investment, about seven times the cost of a diesel system, according to data from the University of Pará, which installed and has been surveying three of these systems.

3.53 An analysis of a system installed in Campinas demonstrated substantial improvements in the residents' quality of life. Access to electricity increased from 6 to 18

hours per day. The local population grew by 30 percent. The system, which was supposed to reduce diesel consumption, resulted in an increase owing to the increase of the number of hours and local population. Total generation surged from 90kWh/day to about 424kWh/day. This project demonstrated the importance of the suppressed demand of these small villages supplied on a part-time basis by diesel systems.

3.54 Solar resources are unlimited in Brazil, particularly in the northeast with an annual average of 7.32 hours of insolation per day. Average daily solar radiation is over 5 kWh/m^2. Even in the southern region, which presents the lowest levels of solar radiation, the average daily insolation is over five hours. More precise data can be obtained from the Brazilian Solar Atlas.[39]

3.55 The windiest regions of Brazil are located on the coasts of the northeast and northern regions, from Rio Grande do Norte to Amapá, but there are also good wind power potential in the central regions of the States of Bahia and Minas Gerais, as can be observed from the Brazilian Wind Atlas.[40]

3.56 Brazil has a huge potential to use local resources (solar, wind, biomass, and mini-hydro) to supply electricity to remote areas. There is national expertise on this subject and technology is easily available, with the exceptions of small wind turbines, gasifiers for the generation of producer gas, and equipment for burning vegetal oils.

3.57 Despite these excellent conditions, it appears that, from the viewpoint of the distribution utilities, there are only two options under consideration for electricity supply to remote populations: grid extension or diesel systems. Both are normally built or installed, operated, and maintained by concessionaires—and users pay regular tariffs. Small and mini-hydro systems are, with very few exceptions, connected to the grid. The situation is not different in the case of rural electrification cooperatives, which are being converted to permissionaires.

3.58 Based on a sample of 92 conventional rural electrification projects completed in Brazil's northeast region, an analysis of the competitiveness frontier between grid expansion and individual solar systems indicates that there is a very good correlation between the average investment cost per consumer connection and the distance to the existing grid. This conclusion is based solely on the consideration of projects related to the number of consumers in communities of similar sizes. Gathering projects according to the sizes of the electrified communities allowed for a discrimination of the impact of distance on the cost and the scale effect related to community size.[41]

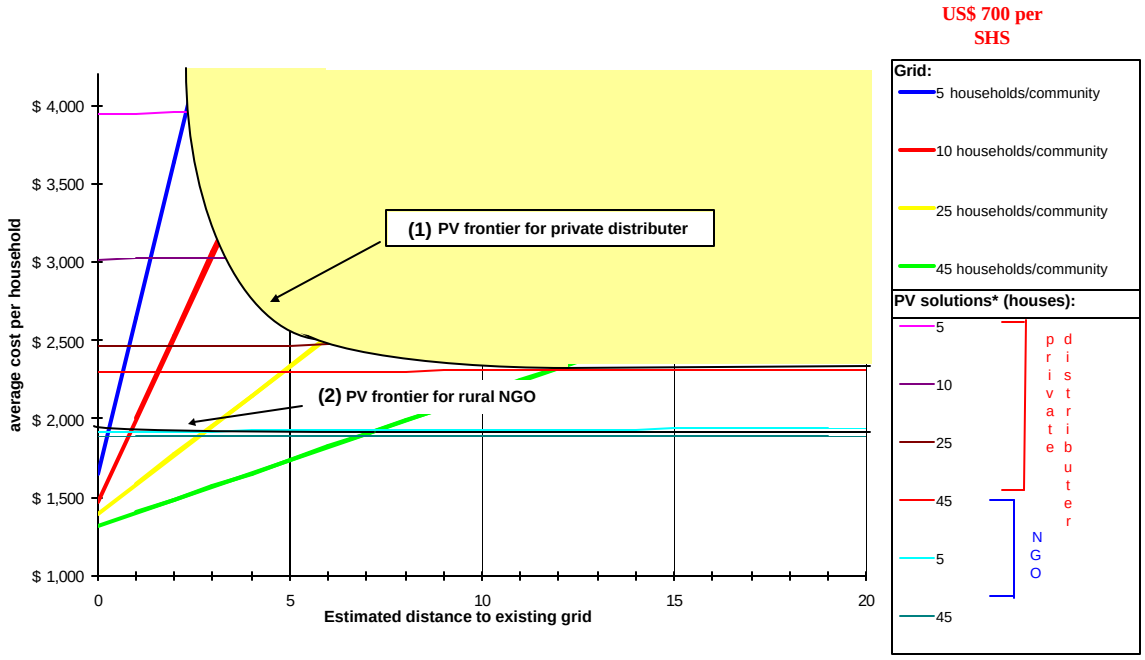
3.59 Dissemination costs of decentralized renewable energy systems are not fully insensitive to dispersion, even though they are far less sensitive than the conventional grid. Previous studies have shown that delivery costs are highly dependent

[39] CEPEL (1997); UFSC (1998).
[40] CBEE (1998); CEPEL (2001).
[41] ESMAP (2000b).

on the type of organization in charge of installation and maintenance. Different configurations have been studied:[42] a local rural NGO installing the systems one by one according to the demands of dispersed households, private central or regional dealers installing whole systems in rural communities, and a regional operator working together with a network of local rural NGOs installing whole systems in communities.

3.60 Assuming a cost of US$700 before installation for a standard 50Wp system, figure 3.3 shows the frontier of PV technology competitiveness for different sizes of communities and different distances. The results are that, in the case of a private distributor, PV is competitive for communities larger than 45 households when the distance to the present grid is more than 11.5km. This distance decreases to 6.5 km in the case of systematic PV rural electrification by a regional operator that works with local NGOs. Of course, all distances decrease further when considering a lower SHS cost (economies of scale), for example, for large decentralized renewable energy projects. For a price of US$425 per solar home system before installation, the break-even distance decreases to 3km. Today, average prices of SHS including installation in other countries can be as low as US$600 for 50Wp in Bolivia and US$390 for 40Wp in Indonesia. In a recent bid of 9,000 solar home systems in Bahia, the installed cost was below US$700 including operation and maintenance for three years.

Figure 3.3: Cost-Effectiveness Frontier between Grid Extension and PV



Source: Gouvello and others (2002).

[42] Gouvello and others (2002), as previously noted.

3.61 Based on these studies (and a similar one developed by Costa, Federal University of Pernambuco), Fontoura (2002), in simulations for his thesis, estimates that 20 percent of Bahia's nonsupplied households[43] should be supplied with PV, which would be the least-cost option for the concessionaire. It represents a market of 120,000 consumers in Bahia alone. Fontoura does not consider mini-grids in his study, but a limited part of this market could be supplied by other alternatives, since most of them are in the semiarid region of Bahia, with limited access to mini-hydro or biomass plants. Access to biomass resources would be different in the Amazonia and Midwest regions. Similar figures are not available for Brazil as a whole, but from Fontoura's conclusions (and taking into consideration that Bahia represents 20 percent of the nonsupplied market in Brazil), it is possible to estimate that between 20 and 30 percent of the market could be supplied by off-grid solutions.

3.62 Based on the above, there appears to be a lack of political support for renewable energy technology alternatives. In view of the large number of unelectrified households, distribution companies prefer a marginal approach by focusing exclusively on grid expansion. There are no real incentives to promote electrification of remote areas or introduce new technologies. Most pilot projects are developed without evaluating the managerial aspects, resulting in an impression of unreliability and unsustainability of the proposed technologies that differs from other countries' experiences (see Sri Lanka project summary in annex C). Distribution concessionaires fully dominate the two existing technologies of grid extension and diesel systems, while new options require additional efforts of capacity building. They therefore tend to be overly conservative in the introduction of these new alternatives.

Regulatory, Institutional, and Policy Framework

Regulatory and Institutional Development

3.63 This section first describes, in chronological order, how Brazil's Constitution and laws treat the rural electrification issue.

3.64 *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. Rural electrification and irrigation, for example, are issues outlined in the Constitution that are directly linked to the country's agriculture policy.

3.65 *Law 8171 (1991)*, known as the Agriculture Law, established rural electrification policy as a government responsibility to be implemented in partnership with farmers, cooperatives, and related associations. It further stated that the government should create incentives for rural electrification, such as facilitating financing through official banks, providing technical assistance in the implementation of projects, levying

[43] Census 2000 recorded almost 605,000 households with no access to electric lighting in Bahia.

tariffs compatible to the costs of services, and building small hydro and thermal plants. *Law 8490 (1992)* gave the Ministry of Agriculture the responsibility for rural electrification issues. However, the federal government has never allocated funds to the Ministry to develop programs in this area.

3.66 *Law 8987 (1995)*, which deals with concessions and permissions, did not address the rural electrification issue. This oversight was corrected in *Law 9074 (1995)*, which establishes rules for the awarding of concessions and permissions and for regulating extensions of the existing ones. The law further required concessionaires and permissionaires to provide comprehensive services to the market, which does not specifically exclude rural areas. Additionally, the regulation created the Independent Power Producer (IPP) as an entity and gave it permission to provide service to any consumer not accommodated by a concessionaire once a six-month period had lapsed following a request for service. However, this provision did not address the practical issue of dealing with the substantial number of potential consumers who would be required to justify any investment by an IPP.

3.67 *Law 9074* recognized the existence of the rural electrification cooperatives[44] and allowed ANEEL to adjust the areas of concessions and those of existing rural cooperatives. The law also allows rural cooperatives to become permissionaires when they provide service to any type of consumer in their service areas.

3.68 *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. Regulations based on this law have never been issued. Operational procedures still require concessionaires to invest a preestablished amount based on costs, which were determined several years ago under the old service regime. Thus, current concessionaires' average participation in the *Luz no Campo* program is about 10 percent. This practice will disappear with the enforcement of Law 10.438 and ANEEL´s Resolution 223/2003.

3.69 *Law 9478 (1997)* aims to identify the most suitable solutions for supplying electricity to the different regions of the country. The law also establishes the National Energy Policy Council (CNPE), a Presidential advisory board composed of several ministries and some national experts. One of the responsibilities of CNPE is to propose measures to the President that ensure the supply of energy to remote areas of the country. In turn, the President is mandated to submit to Congress any requests for necessary subventions. Currently CNPE operates through a series of technical committees that are created as the need arises. One of the technical committees created in 2002, for example, was for the Universal Electrification of Electricity Services, but it was activated only in June 2002 (see discussion on CT-7 below).

[44] ANEEL estimates that rural electrification cooperatives provide service to about 500,000 consumers.

3.70 ANEEL's *Resolution 333 (1999)* established rules to distinguish permissionaires, which provide public service, from authorization holders, which provide service for private use. Currently, rural electrification cooperatives are fulfilling the requirements to be classified by ANEEL in one of these two categories. In this process, potential disputes with the concessionaires are also to be resolved. This resolution was revised by *Resolution 12 (2002)*, which still leaves a series of impasses and points without clarification. These include (a) ensuring the economic and financial sustainability of permissionaires; (b) the precise limits for permissionaires and authorization holders; (c) the length of contracts the two groups (30 years, same as for concessionaires, and without requiring competitive bids, which is not the current understanding of the resolution); (d) rules for authorization contracts (defined only by a resolution, a precarious legal instrument); (e) criteria for definition of areas (a potential conflict with concessionaires in certain areas, requiring mediation by ANEEL); and (f) awarding of new permissions with the current tariff definition scheme.

3.71 Several legal and regulatory instruments were created to improve the environment for the establishment of rural electrification programs and initiatives, but they often were not enforced. No firm obligation of full coverage has been included in the contracts between ANEEL and the new concessionaires. The glaring omission is that the agreements contain no enforceable requirements. An analysis of these agreements raises a series of observations and doubts (see box 1.2):

- Despite the obligation included in most contracts, no targets or deadlines were established, thereby giving the concessionaire the decision on when or how to supply the nonserved market.
- The clause regarding the obligation of the government to contribute to the investment conflicts with provisions in Law 9478, mentioned above. Furthermore, it is not clear how these private companies would internalize these governmental funds.
- The mandate to use the lowest-cost suitable technology has no teeth. There is no real evidence that concessionaires will pursue these options.

3.72 The final report developed by Coopers and Lybrand[45] recommended three specific actions to support the future expansion of rural electrification:

- Establishment of specific obligations;
- A revenue-cap economic regulation form with a clear incentive for expansion of rural electrification that would be based on the number of new customers in a way that no discrimination could be established between renewable energy or grid extension; and
- An effective mechanism of cross-subsidy between customers of the same area or even other concessionaires if the previous situation would result in

[45] Coopers and Lybrand (1997).

excessive prices to the customers. These subsidies would be directed toward low-income customers, rural electrification cooperatives, and rural areas.

3.73 None of these suggestions has been implemented so far, and once the state companies were privatized, federal and state governments realized the difficulty involved in expanding the service to remote areas. Although this was the rationale for establishing *Luz no Campo*, the program was created without a policy framework.

3.74 In practical terms, Brazil has not had a national rural electrification policy for some time. Rural electrification policies traditionally have been defined at the state level, using state treasury resources and having programs implemented by concessionaires that are controlled by state governments. The issue was not addressed sufficiently during the restructuring process, despite the recommendations of the special report on Rural Electrification Cooperatives. A rural electrification program was established but no national strategy for rural electrification was outlined until the recent approval of Law 10.438, which will be detailed later in this chapter.

3.75 The analysis above makes evident that the rural electrification issue suffers from two key problems: lack of consistency between certain legislative provisions and prevailing practices, and lack of enforcement of existing legislation. Therefore an immediate and unequivocal implementation of Law 10.438 is needed.

The Regulatory Framework and Incentives for Renewable Energy Technology

3.76 *Law 9648* and some resolutions by ANEEL create a series of incentives for small hydro-projects—such as small hydro plants (SHP) and other sources of renewable energy generation, either grid-based or off-grid—but nothing has been established so far to regulate the individual home systems, such as solar home systems. Among the incentives offered to SHP are the following:

- "Small hydro" classification up to 30MW of installed capacity;
- A simple process of authorization following the request by interested parties and subsequent announcements, thereby eliminating the need to obtain bids and to award concessions (plants under 1MW require registration only for statistical purposes);
- A reduction in wheeling fees of at least 50 percent;
- Exemption from payment of royalties to municipal and state governments;
- Permission to sell the energy directly to consumers with installed capacity over 500kW;

- Access to Department of Exterior Relations (MRE)[46] and CCC benefits in the case of isolated plants.

3.77 The same law extends the benefits of access to CCC to alternative sources of energy, which replace the use of oil products for electricity generation in isolated systems.

3.78 Two resolutions by ANEEL create special incentives for renewable energy technologies. Resolution 233 (1999) established different price caps on electricity generated from different sources to be passed on to consumer tariffs. The resolution requires the entrepreneur to define three pondering factors to enjoy future adjustments. These factors are related to the General Index of Prices (IGP-M), fuels, and currency exchange rate variation. This resolution was revised by *Resolution 488 (2002)*, which defines a form to review monthly these values, based on the reference value defined for January 2001. These so-called normative values by generation source are shown in table 3.7.

Table 3.7: Normative Values, 2001 and 2003

Source	*VN (R$/MWh)*	*VN (R$/MWh)*
	January 2001	*March 2003*
Competitive [47]	72.35	125.44
Small hydropower	79.29	137.48
Biomass	89.86	155.80
Wind	112.21	194.56
Solar photovoltaic	264.12	457.94

Source: ANEEL.

3.79 *Resolution 245 (1999)* established the conditions under which renewable energy technologies can access the same subsidies given to fossil fuels, through the CCC mechanism, when those technologies are replacing fossil fuels in isolated systems[48]. The

[46] Considering that the Brazilian system is operated in a centralized way, in order to optimize the dispatching, the Mecanismo de Realocação de Energia (MRE) was created to compensate the owners of hydro plants for the loss of autonomy on the operation of their plants.

[47] Includes hydropower and natural gas.

[48] Projects must fulfill the following conditions: NPV of monthly payments (72 months in the case of small hydropower and 96 months in the cases of other renewable sources) cannot surpass 75 percent of installation costs; and monthly values to be paid is calculated by formula taking into account the specific consumption (diesel: 0.3 l/kWh, fuel oil: 0.38 kg/kWh and 0.34 l/kWh for new markets) and the CIF price of replaced fuel, the equivalent value of hydropower electricity (this is the threshold for paying the subsidy, and is given by ANEEL), and a factor linked to the start date of the project.

resolution allows for the use CCC funds, either for partial or total replacement of fossil fuels or for system improvements responding to market expansion.

3.80 *Resolution 245* was revised in December 2002 by *Resolution 784*, which increases the incentives substantially. Up to 75 percent of the investment can be paid in monthly installments, calculated by the formula defined in the resolution. Very few projects have been implemented making use of these incentives except those that were in the process of being developed. Incentives were indeed offered to the generation company, but the distribution companies very rarely signed the Power Purchase Agreements (PPAs), since this more expensive energy would affect their final tariffs. No incentives or obligations were offered to or imposed on the distribution companies. In the northern region, renewable energy entrepreneurs had to compete with the subsidized prices of electricity offered by Eletronorte, which are currently below generation costs. With the inherent learning costs, this represents a false incentive since there are no real incentives to migrate from a conventional technology to a new one. As a result, the playing field was not equal for the new technologies.

3.81 It is still necessary to shorten the learning curve, to accelerate the migration to new sources. Key requirements are the implementation of off-grid projects, the training of concessionaires and users, and the creation of credit lines offered under facilitated conditions to operators.

Import Taxes on Renewable Energy Technologies

3.82 The current tax structure applied to industrialized products, including electricity generation projects, results in a cumulative figure of about 31 percent. Taxes include the Value Added Tax (ICMS—a state tax of about 17 percent), tax on industrialized products (IPI—a federal tax, averaging 10 percent), bank operations (CPMF—0.38 percent) and contributions to social funds (0.65 percent to the Social Integration Program [PIS] and 3 percent to COFINS). Table 3.8 presents the current tax structure for generation equipment.

Table 3.8: Tax Structure for Generation Equipment after May 2001

Equipment	*Percentage*	
	IPI	II [a]
Solar water heating [b]	0	22,5
PV generator under 750 W [b]	0	20,5
Solar cells, not assembled [b]	0	15
Windmills for water pumping [b]	5	14
Wind generators [b]	0	14

Turbines, water wheels, and electric generators	0	13
Boilers, motors, gas turbines, heat exchanger	0	13

a. Import tax.
b. Equipment exempted of ICMS (Tax on the Circulation of Merchandise and Services, 17%).
Note: All equipment will pay toward the social funds COFINS and PIS, and the Provisional Contribution for Financial Operations (CPMF).

3.83 Solar and wind energy equipment is currently taxed at the lowest rates ever. In May 2001, a Presidential Decree substantially reduced these general taxes in response to the energy crisis, aiming to create incentives for electricity generation. These reductions were maintained up to the end of 2002. The Tax on Manufactured Products (IPI) was reduced to zero on solar water pumping systems up to 2 horsepower, PV modules up to 750W, PV cells, solar water heating, windmills for water pumping, and wind generators. An agreement between federal and state governments reduced ICMS on these products to zero as well. Import taxes were not changed.

3.84 Entrepreneurs in the renewable energy industry are concerned with two issues: The exemptions are not extended to peripheral devices, such as controllers, inverters, and batteries that pay cumulative taxes of 37 percent, 43 percent, and 50 percent, respectively. The main components of these taxes are the import taxes, but since this equipment could be produced domestically, and have applications in other sectors, the exemption is more questionable. On the other hand, the importation of assembled wind generators is levied lower taxes than that of locally assembled generators with some imported components, clearly a huge distortion.

3.85 There are some distortions in the tax structure affecting renewable energy equipment, but the main components are currently less affected than before. The taxes affecting equipment, even taking into account the import taxes, are in certain cases lower than those affecting conventional energy industry equipment (wires, transformers, and the like). A reasonable strategy for the country, as advocated by the renewable energy industry and several segments of the energy sector, academia, and nongovernmental sectors, could be to extend exemption for a term of five years, until the consolidation of this young industry is realized, in addition to a reduction of import taxes, and other lesser taxes such as PIS and COFINS.

The Sector's New Framework after Law 10.438

3.86 Several pending problems, previously mentioned, will be solved if Law 10.438 is properly regulated. In addition to establishing clear rules to strengthening the universal service obligations of distribution concessionaires, the law introduces a series of changes in the structure of the Brazilian energy sector, including the following:

- A definition of the *low-income consumer* with monthly consumptions *up to 80kWh*, plus a second group up to 220kWh under special conditions to be defined by ANEEL;

- The establishment of the *Energy Development Account* (*CDE),* with procedures for the collection and allocation of resources to be defined by the federal government and ANEEL;
- An *extension of RGR* until the end of 2010 to ensure resources for the continuation of the *Luz no Campo* program. State and municipal governments, concessionaires and permissionaires, rural electrification cooperatives and infrastructure cooperatives for land reform projects, and intermunicipal 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); development of solar, wind, biomass, and small hydropower projects; and for specific promotion programs to increase individual or collective use of solar energy conversion to generate electricity;
- An *extension of the CCC for isolated systems* for 20 more years, and an extension of the benefits of this fund to electricity from solar, wind, biomass, small hydropower, and natural gas plants;
- The establishment of the Program of Incentives to Electricity from *wind, biomass, and small hydropower plants* to be connected to the national grid. The first phase of the program will consist of the acquisition of 3,300MW by Eletrobrás through 15-year contracts to IPPs. Eletrobrás should pay a tariff that must be above 80 percent of the average national tariff to the final consumer. These installations must be operational before December 2006. In the second phase, Brazil must reach *10 percent of its annual consumption* from those sources in a period of 20 years. The same type of contract must be signed between Eletrobrás and the entrepreneurs, but the tariffs to be paid by Eletrobrás must be the average cost of the competitive sources (hydro over 30MW and natural gas power plants). Entrepreneurs must make up the difference between the economic value of the electricity of their source and the price paid by Eletrobrás and covered by a fund also established by the law. The federal government will define the economic value of the electricity of each one of those alternative sources; and
- An *extension to wind and biomass plants of the benefits currently given to small hydropower* plants. These include 50 percent reduction on wheeling fees, access to MRE, and direct sale to consumers over 500kW (see above).

3.87 In addition, the law stipulates the following key issues in its articles 14 and 15, which are directly related to rural electrification:

- ANEEL is appointed to impose targets for full coverage on concessionaires and "permissionaires." Consumers falling under these targets would be required to pay nothing on top of the tariffs.

- Potential consumers will be able to accelerate their service connections by paying a part or all of the full investment, and the concessionaires will be required to reimburse them when the target deadline for electricity has been met. 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 are to be surveyed by ANEEL during the revision of the tariff process.
- ANEEL will 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.
- ANEEL will define tariffs for concessionaires, permissionaires, and rural electrification cooperatives classified as permissionaires with annual consumption below 300GWh/year, in order to recover investments.
- Permissionaires *will be able to use either conventional grid or established partnerships with renewable energy dealers, distributors, or IPPs*. The permission allows the provision of services under specific conditions and forms of supply compatible with chosen technology.

3.88 The next step after the approval of the law was the issuance of regulations through a Presidential Decree clarifying some points regarding implementation and a series of resolutions by ANEEL, establishing rules for concessionaires and permissionaires.

3.89 The Brazilian Congress has fully delegated to ANEEL the regulation of the law. The fact that *no maximum period for achieving the "universalization" of service was defined in the law* has since impeded implementation. While the new law provided specific and well-defined implementation periods and tariff increases by consumption class, no clear targets were established for rural electrification. *The Law gave ANEEL one year to define the universalization targets for each concessionaire,* but no detailed studies exist to date on the impact of this obligation on tariffs.

3.90 The implementation and enforcement of the new law is a key issue since, *under the current arrangement, concessionaires contribute only 10 percent of the total investment in rural electrification,* which they remain reluctant to implement. Under the new law—under which they are supposed to finance the full investment—pressure for substantial tariff increases is expected (with a parallel financing mechanism for special conditions).

Subsequent Legal Resolutions

3.91 *Resolution 246/2002* established the operational criteria to provide all low-income consumers (with an average monthly consumption under 80kWh per month, over

the last 12 months) with one-phase power. Immediately after the enforcement of this resolution, the number of low-income consumers increased by 24 percent in Brazil, and 52.4 percent in the northeastern region.

3.92 *Presidential Decree 4336/2002* defined how RGR could be used to finance the immediate losses incurred by distribution concessionaires with the enforcement of Resolution 246, and also how consumers with average monthly consumption between 80 and 220kWh/month could be considered low-income consumers. These criteria include monthly income per capita under one half the minimum wage, and registration in one of the federal government's social programs, such as "Bolsa Escola" or "Bolsa Alimentação."

3.93 *Resolution 485*, based on what was established in Decree 4336, clarifies the operational conditions required to have consumers with average monthly consumption between 80 and 220kWh/month classified as low-income consumers. The resolution allowed a certain period during which concessionaires could survey their consumers and register those who qualified under this new scheme. Preliminary estimates show that at the end of the process Brazil will have more than 14 million low-income consumers, representing of 34 percent of residential consumers. Full coverage will substantially increase these figures, as more than 75 percent of non-supplied households have income less than twice the minimum wage.

3.94 *Law 10604* provided that subsidies for low-income consumers should come from the surplus from the commercialization of electricity through public generation companies in public auctions. However, because of the oversupply of electricity in the national interconnected system during 2003-04, that surplus is uncertain. The law also stated that, for 2002 and 2003, resources from RGR could be used to cover the subsidies in case the surplus was not enough. It is clear that RGR, which has financed the *Luz no Campo* program, will be under pressure to cover the subsidies. Under an ideal situation, RGR should have grace periods and rates of interest differentiated to minimize the impacts on the tariffs of less electrified concession areas. Thus, this new subsidy creates strong pressure on the same sources that might sponsor universal access.

Technical Committee on Universal Access (CT-7)

3.95 Despite having been created in December 2001 by a resolution of the National Energy Policy Board (CNPE), CT-7 was effectively established in June 2002, with the objective of proposing targets and best tools to achieve, as soon as possible, universal access, taking into account the current situation of electrification, the costs involved, and available resources.

3.96 CT-7 has had a very broad range of stakeholders—with representatives from other Ministries, State Ministries of Energy, Eletrobrás, ANEEL, development banks, associations of concessionaires of distribution and rural electrification cooperatives, trade association of renewable energy, universities and research centers,

and NGOs. These stakeholders have worked over a period of six months in four subgroups: Market, Targets, Technologies, and Resources.

3.97 The committee, after six months of work, produced a set of recommendations to CNPE, including the following:

- While recognizing that Law 10.438 defines universal access as the provision of service to any consumer, including requests for load increases, without charging for investment costs, the committee recommended that the main concern of the public policies and provision of incentives, through CDE, had to be on the provision of the service to low-voltage consumers (with demand under 300V).
- Considering a nonsupplied population of about 3 million households and an average cost of supply of R$3,000.00, the total required investment would be in the range of R$9 billion. To fulfill this requirement, the committee recommended the maintenance of the historical commitment of RGR to the *Luz no Campo* program (about R$500 million per year), the use of a substantial part of CDE resources (including UBP and ANEEL's fines), and the balance of the third source of CDE (the annual levy paid by all agents selling electricity to final users) that would not allocated to the Program to Support Renewable Energies (PROINFA) national coal and natural gas projects. Considering that RGR is a loan to the utilities and that CDE is a grant provided by a national fund, CT-7 recommended that RGR and CDE be distributed in a way to minimize the impact of universal access on tariffs, avoiding the fact that less electrified concession areas have higher increases in their tariffs. CT-7 also recommended the use of CDE to stimulate other supply alternatives, such mini-grids based on renewable fuels and solar home systems, when grid extension costs go beyond certain limits.
- CT-7 also prepared Terms of Reference (TOR) for a study of the impacts of universal access on the tariffs of each concession area. The results of this study would provide recommendations for a better allocation of RGR and CDE resources.
- CT-7 recommended an effort to integrate PRODEEM and other available resources, such as those available from the Ministry of Agriculture, to accelerate universal access. Eletrobrás could play this role of integrator, by revamping the *Luz no Campo* program to be compatible with the new requirements of the full coverage strategy. A managing council should be created to support Eletrobrás's decisions.
- Finally, CT 7 issued some recommendations to the team elaborating the Presidential Decree on the implementation rules for CDE resources. These suggestions were not taken into consideration when Decree 4541 was enacted. Among the suggestions were limiting the concept of universal access for the purposes of CDE use, and using at least 10 percent of the

annual levy paid by all agents selling electricity to final users to universalize access (in addition to UBP and ANEEL's fines) for sponsoring universal access.

3.98 CT-7 perceived a certain lack of entities advocating the expansion of access. While universal access is a goal of MME and Eletrobrás, there is not much lobbying by civil society. The Brazilian Congress passed the law mandating full access without user contributions , but no agents are pushing its enforcement. There are some entities advocating the use of renewable energy, but the DisCos lack knowledge on such alternatives. In sum, the constituencies for both renewable energy and universal access are not effective on the political or DisCo level.

Presidential Decree 4541/2002

3.99 On December 23, 2002 Presidential Decree 4541 was enacted. It established rules for the implementation of articles 3 and 13 of Law 10.438. These articles created PROINFA and CDE, respectively. The Energy Development Account's (CDE) resources are the main source for universal access. Two main problems were introduced with this decree: its concept of universal access was vague and too broad, and it created a direct link to the subsidies to low-income consumers. As a result, CDE resources could potentially be claimed to cover these subsidies, which are estimated in the range of R$500 million per year. In addition, the balance of UBP and ANEEL's fines not used on universalization could be used to cover other expenses under CDE, but the resources of the annual levy—that is, the third component of CDE—could not be directed toward universalization even though preliminary estimates show that a substantial part of the funds would not be used in the initial years of the existence of the account.

3.100 The decree makes evident a potential conflict between the several destinations of CDE resources. When the decree was enacted, it was clear that universal access was not a national priority. As demonstrated by table 3.9, the resources forecast from UBP and ANEEL's fines during 2003–06 would be negligible compared to the demand on resources mentioned above. According to the decree, even if these limited resources were not used, their balance could be transferred to the other uses of CDE. On the other hand, if earmarked resources for PROINFA, gas and coal, are not used, the decree does not allow redirecting these resources to universal access.

3.101 Preliminary estimates indicate that PROINFA's resources from natural gas and national coal will not be fully used over the period 2003–06, resulting in a cumulative balance in the range of R$3 billion. If the Presidential Decree were revised, these resources could be transferred to universal access. This decision might face opposition from several industries but since the decree does not need Congressional approval, its revision depends on the political priority assigned to universal access and not much else. In short, the decree has created a situation in which there might not be substantial funds secured for universal access, and in response ANEEL has established, in Resolution 223/2003, the deadline of 2015.

Table 3.9: Preliminary Estimates of the Energy Development Account (CDE)

(R$ Millions)

	2003	*2004*	*2005*	*2006*
Total CDE Resources	1048,08	949,13	1.450,56	2.015,74
(–) UBP + fines: Universal access	86,94	90,76	95,51	101,21

Source: MME for CNPE/CT-7.

ANNEL's Resolution 223/2003

3.102 In April 2003, ANEEL passed Resolution 223 (based on Law 10.438), which established the general conditions for the elaboration of universal access plans and the responsibilities of distribution concessionaires and permission holders. The resolution was published after a public hearing on the draft.

3.103 ANEEL recognized that the allocation of CDE resources should follow directives to be produced by MME. According to the resolution, universal access corresponds to the supply of service or load increases following a request by a new consumer, with no investment contribution paid by the solicitant. The served consumer is only considered as such if supplied by a concessionaire or permission holder. The request is submitted to the General Conditions of Supply of Electricity, established by ANEEL, through Resolutions 24/2000 and 456/2000.

3.104 The main points established by the resolution are as follows:

- Any request for electricity or load increase, if it can be provided by a low-voltage (below 2.3kV) grid connection, must be attended to without financial contributions by the solicitant, even if the installation or replacement of a transformer is necessary. The resolution implies an immediate implementation of this service.
- Any request that can be provided by a primary-voltage-distribution (greater than or equal to 2.3kV) grid connection, and fulfills what is provided in each plan for universal access, submitted to ANEEL by concessionaires and permission holders may not include financial contributions by the solicitant.
- Concessionaires should submit their plans to ANEEL according to the following schedule: (a) up to August 31, 2003, the component of their plans to be executed during 2004; (b) up to April 30, 2004, the component to be executed between 2005 and 2008; and (c) up to October 30, 2004, the plan to reach full coverage in their concession areas.
- The plans are composed of the concessionaires' annual expansion plans and should include the targets expressed in number of kilometers of grid

extension, number of units supplied, average costs for urban and rural units through grid connection, quality standards, and marketing plans..

- Universal access must be reached by each concession area according to its rate of electrification, as estimated by the 2000 Census. Table 3.10 presents the deadlines for the concession areas based on those rates of electrification. In addition to deadlines established for concession areas, concessionaires should meet deadlines at the level of each municipality, once again using the rate of electrification in 2000 as a baseline. Table 3.11 presents the deadlines for each municipality.

Table 3.10: Targets for Reaching Universal Access (by Concession Area)

Current coverage in concessionaire's (or permissionaire's) area:	*Based on current coverage, concessionaire (permissionaire) has to reach "universal electricity coverage" at the latest by:*
Coverage > 99.5%	2006
98.0% < Coverage = 99.5%	2008
96.0% < Coverage = 98%	2010
80.0% < Coverage = 96%	2013
Coverage = 80.0%	2015

Source: ANEEL.

Table 3.11: Targets for Reaching Universal Access (by Municipality)

Current coverage in Municipality:	*Based on current coverage, Municipality has to reach "universal electricity coverage" at the latest by:*
Coverage > 96.0%	2004
90.0% < Coverage = 96.0%	2006
83.0% < Coverage = 90.0%	2008
75.0% < Coverage = 83.0%	2010
65.0% < Coverage = 75.0%	2012
53.0% < Coverage = 65.0%	2014
Coverage = 53.0%	2015

Source: ANEEL.

3.105 ANEEL estimates that these deadlines could be met sooner if federal, state, and municipal governments allocate resources. Since ANEEL currently has no information on the total amount of resources that will be made available (e.g. by MME using CDE funds), a change in Decree 4341 increasing CDE resources would allow meet these targets before time. An interesting strategy that MME could implement on a pilot basis would be to allocate CDE funds to municipalities with the lowest electrification rates. This would anticipate the general targets and create incentives for concessionaires to look for alternative sources, since the status of the grid in these municipalities would be precarious.

3.106 ANEEL's resolution faced strong opposition from the Association of Distribution Concessionaires (ABRADEE), with the association's members stating that the elimination of the financial participation of the potential consumer would lead to

increased use of CDE resources. This argument seems misleading. According to Law 9427, concessionaires are expected to recover their investments through tariff increases, which can be requested when the financial-economic equilibrium is broken. The association claims that ANEEL needs to define how CDE must be used for universal access, while MME views this as its own responsibility. The association also claims that the resolution does not take into account the technical and economic ability required to reach the targets. Based on these claims, the association is currently asking that the enforcement of the resolution be postponed pending further clarification of the points raised. One thinkable way to solve this impasse would be for MME to define the share of CDE to be allocated to universal access.

3.107 ANEEL´s resolution established the limit of 12 years for all concession areas and thus precluded permissionaires from exploring areas with longer-term electrification targets. On the flip side, ANEEL did allow permissionaires to have a certain flexibility regarding level and quality of service, tariffs, and supply conditions. However, this leeway was limited by the lack of precise rules regarding off-grid alternatives as options to universal access. The flexibility of tariffs raises questions regarding national rules for low-consumption consumers who enjoy subsidized tariffs. Mechanisms to allow permissionaires and authorization holders to dilute part of their costs over the rest of the consumers of the concession area (or the country) have been discussed.

Regulation of Solar Home Systems

3.108 A cost-effective implementation of the universal access program will require developing off-grid rural electrification for remote populations. At the moment there is no provision in the current regulation for off-grid systems, either regarding the service quality or the tariff structure to be enforced for such services. As long as the regulatory framework remains incomplete, no concessionaire will take the risk of implementing off-grid programs. ANEEL has been demonstrating interest in establishing rules to allow concessionaires and permissionaires to have PV systems considered as an option of supply.

3.109 In August 2003, it authorized COELBA to install 9,000 solar home systems under the following conditions:

- If the investment was made by the state government of Bahia, the amount invested would be registered in a separate account that would not affect the concession's tariffs.
- COELBA was allowed to charge only for maintenance costs. This amount would be defined jointly by COELBA, the state government, and ANEEL, taking into account the ability to pay of the consumers and maintenance costs.
- The indicators of frequency and duration of outages of the concessionaire should not be affected by outages of these systems.

- COELBA should maintain the systems and minimize the outages up to the standards defined by ANEEL's resolution regulating the use of these systems.

3.110 As part of the same authorization, ANEEL informed COELBA that a public hearing to discuss this issue would take place later. Parallel to this, ANEEL hired two consultancy studies to support the elaboration of the rules to be applied in the supply of electricity using PV.

3.111 One of these studies was conducted by UNIFACS, in order to define quality standards for electricity supply. The study aims at an analogous treatment of PV systems and resolutions for grid extension, via similar limits for frequency and duration of outages. The country is divided into clusters in which similar rates are acceptable, and targets are established for subsequent years. UNIFACS has shown, based on monitoring of some pilot projects installed in Bahia, that the existing levels of collective frequency and duration of outages are not suitable to PV systems, and has proposed limits for individual frequency and duration of availability of a pre-established amount of energy. Following the UNIFACS study, systems should be designed to satisfy, at least, the average consumption of the group of customers using up to 30kWh/month, the lowest step of consumption in the Brazilian system of electricity tariffs. A second study is under development at the University of São Paulo. In addition to dealing with quality of supply, this study intends to explore classes of consumption for consumers supplied by photovoltaic systems, establishment of a new tariff group for these consumers, and billing mechanisms.

3.112 It is expected that ANEEL will soon adopt minimum standards for quality of PV installations, the minimum amount of energy to be supplied, mechanisms to survey performance indicators, and special tariffs for photovoltaic systems. These aspects will be discussed in a public hearing. The standards, which include an option to use photovoltaic systems, would have to be followed by all concessionaires and permissionaires.

3.113 Given that the electricity sector is completely regulated in Brazil, there are few opportunities for the PV dealer model; one path would be for dealers to form a partnership to work for the concessionaires. The concessionaires could outsource partially or totally their responsibilities of installation, operation, maintenance, and billing of the PV systems.

National Electrification Program for Universal Electricity Access

3.114 Under the new government the technical committees of CNPE are not operational to date, but MME has created a group to develop a national strategy to achieve universal access. This group comprises MME and Eletrobrás staff, and external experts.

3.115 The group has developed a series of studies, leading to the following:

- A refinement of the numbers of the nonsupplied population;
- The identification of the rate of electrification for each municipality in the country, with a comparison to the Human Development Index (HDI);
- Preliminary estimates of the funds potentially available from CDE, considering not only UBP and fines but also the balance of the third component;
- Preliminary estimates of investment costs by concession area, based on costs under *Luz no Campo* and the number of nonsupplied people, resulting in a potential impact on the tariffs of each concession area;
- Initial proposal on the allocation of CDE and RGR resources by concession area;
- Recommendation of a focus on rural areas for use of CDE and the promotion, when feasible and necessary, of alternatives of supply;
- Identification of pilot projects in areas with potential of diversifying the alternatives of supply;
- Concern not only with access but also with the use of energy, with special emphasis on synergy with other governmental initiatives; and
- Indication of a feasible deadline for universal access by 2010.

3.116 The Ministry has presented an initial draft of the program to key stakeholders, including representatives of state governments and other ministries. According to this draft, the program could reach 1.4 million households, raising the rate of rural electrification to 90 percent by 2006. Funds would come from distribution concessionaires, RGR, CDE, and matching funds from state governments.

3.117 The Ministry of Mines and Energy is committed to supporting the development of specific projects that would address the difficulties related to more dispersed communities and households, weaker stakeholders (indebted concessionaires and inexperienced contractors), poorer consumers, and existing constraints of the current financial framework cutting off stakeholders' access to existing funds. Key activities that go beyond conventional approaches will require upgrading the implementation capacity of current actors, to introduce new off-grid electrification, finance beyond the meter, and create funds to boost alternative forms of supply. Concerns must be concentrated on weak northeastern states, dispersed communities in Amazonia, and large-scale decentralized electrification in areas without experience in such projects.

3.118 Furthermore, an effort to aggregate the contributions of different stakeholders will demonstrate the power of integrating activities, resulting in a higher development impact. These pilots follow the new directive of the government to integrate

efforts by different stakeholders to minimize social exclusion, and align with the government's central program—*Programa Fome Zero* (the Zero Hunger Program).

The Status of Decentralization Efforts

3.119 Law 10.438 made advances in decentralizing decisions in the electricity sector. It established that bids for awarding permissions could be executed through delegation by the convened State Public Services Agencies, and through the utilization of standardized edicts elaborated by ANEEL. Given that ANEEL defines future targets of electrification, there is little room for action.

3.120 Some state regulatory agencies are multisector regulators, so they could facilitate the *bundled provision of rural services,* and reduce the high transaction costs through economies of scope. Several rural cooperatives are already practicing bundled rural services provision, combining rural electrification and telecommunications services. More recently, some have introduced provision of Internet services. Other cooperatives have included water provision in the bundled service. The difficulty of such bundling is the establishment of relationships with three different granting entities and the requirements to maintain separate accounts for each regulated service. Water is a municipal concession. Electricity and telephone concessions and permissions are awarded by the federal regulatory agencies ANEEL and ANATEL, respectively. In the case of telephony, the cooperative normally has a franchise from the regional concessionaire or from the authorization holder to explore the service in a restricted area. At the village level, the supply of electricity through individual systems, which is still not regulated, could be one of the services of such bundled service providers. It should not be difficult to get a municipal concession to explore the water service or a franchise of the telecommunication company.

3.121 Allowing public bids to award permissions inside the concession areas was another important step for the decentralization efforts. Such permissionaires can now tap different resources—including CDE, RGR, CCC—and credit lines available from the Northeast Development Bank (BNB), besides support on business development by funds such as the Solar Development Group (SDG) and the recently established B-REED (Brazil Rural Energy Enterprise Development Fund). The permission would certainly reduce the risk of potential entrepreneurs who would be interested in the rural energy markets, but whose business could be easily jeopardized by a concessionaire's grid expansion.

3.122 More and more financial resources from the central government are being directly transferred to municipal governments, particularly for health and education. The Poverty Alleviation Program, with some possible inherent sustainability issues, is making a huge effort to transfer the resources for infrastructure to the community level. In a similar decentralization effort, Congressional amendments are transferring resources for rural electrification through the Ministry of Agriculture directly to the local governments. A parallel effort to allocate community computer services (telecenters) in all towns and

large villages aims to channel resources from the federal government directly to communities through NGOs. This route of fund flow has been partially copied by PRODEEM, and is contemplated for PRODEEM's second phase (Productive PRODEEM). Experience in other countries (such as Bolivia) has shown that the benefits of decentralization (local ownership and process orientation) should be well balanced against the inherent drawbacks, such as (a) the loss of economies of scope (particularly important for grid-based infrastructure), (b) lack of local capacity resulting in lack of sustainability (particularly important for more complex investment decisions such as energy projects—and difficult to address owing to frequent turnover), and (c) lack of coordination between central and decentralized levels. Clear rules for coordination between all levels, and the use of intermediary levels (for example, *mancomunidades*) have been suggested to mitigate these risks.

3.123 However, it is important to emphasize that the Brazilian concession/permission model does not provide much space for decentralized initiatives. Areas managed by either concessionaires or rural electrification cooperatives (to be classified as permission or authorization holders), already cover the entire country. Several individual initiatives by NGOs or even big programs such as Poverty Alleviation suffer from a lack of sustainability, and have little chance of being absorbed by concessionaires in the scope of the universal access obligation. On the flip side, these initiatives do not access the mechanisms of subsidies available to low-income consumers or cross-subsidies of the tariff system of concessionaires. Thus, small private companies that could efficiently provide electricity service under an output-based approach face strong difficulties in accessing this potential market. The World Bank can support efforts to overcome this challenge.

Energy Pricing Policy

3.124 Brazilian electricity tariff structures have several peculiarities. Residential 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 2.3kV pay substantially less (53 percent) than the residential, commercial, and industrial consumers who are supplied at low voltage. Table 3.12 presents the tariffs for the concessionaire of the State of Bahia. Table 3.13 presents the final averages for Brazil and its regions, which show that rural and public buildings and services are also substantially subsidized.

Table 3.12:. Conventional Tariffs by Class of Consumption, COELBA

Class of consumption	*Power (US$/kW)*	*Energy (US$/kWh)* [a]
Consumers on 30 to 44kV	3.8	0.046
Consumers on 2.3 to 24kV	4.0	0.047
Residential		0.089
Residential low-income		
Up to 30kWh/month		0.031
From 31 to 100kWh/month		0.053
From 101 to 140kWh/month		0.080
Rural		0.056
Rural electrification cooperative		0.039
Irrigation		0.051
Other classes (commercial, industrial, public services, public buildings)		0.089
Public lighting		0.045

a. About 20 percent of taxes must be included (ICMS).

Table 3.13: Average Tariffs by Class of Consumption

Class of consumption	*North R$MWh*	*Northeast R$MWh*	*Southeast R$MWh*	*South R$MWh*	*Midwest R$MWh*	*Brazil R$MWh*
Residential	198.17	173.99	241.26	231.82	207.70	223.30
Industrial	65.79	86.55	107.29	122.27	108.90	100.94
Commercial	182.82	167.35	206.01	207.58	187.31	197.34
Rural	134.90	104.20	135.10	110.99	134.94	121.19
Public sector	197.03	176.58	202.45	220.30	192.52	195.53
Public lighting	118.16	105.56	126.47	123.46	112.22	119.35
Public service	108.86	99.66	111.19	130.83	105.52	109.60
Self-consumption	191.35	174.23	94.13	78.58	202.47	99.18
Total average tariff	131.33	167.00	168.33	117.41	166.72	157.41

Note: Tariffs refer to January 2003. Doesn't include 20 percent ICMS.

3.125 While industrial customers paid US$0.047 per kWh, the retail tariff for residential customers in 2003 is US$0.089 per kWh. In terms of the underlying cost structures, although residential customers, because of their smaller loads, are somewhat more expensive to serve than industrial customers, price differences of this magnitude cannot be justified. An illustrative study recently conducted by ANEEL suggests that for one particular distribution concessionaire, residential tariffs should be lowered by 10 percent and industrial tariffs raised by 20 percent.

3.126 The cross-subsidies will be phased out gradually. Based on a number of underlying cost principles, a rigorous methodology has been developed to allocate costs among customer groups. As each distribution concessionaire periodically reviews tariffs, ANEEL plans to rebalance the tariff structure on the basis of these new principles, thereby unwinding the existing cross-subsidies. The implication is that in most cases the cross-subsidies will be gone by 2004.

3.127 Similarly, the fuel sector has been eliminating the subsidies on diesel, the bottleneck of the Brazilian refining structure, to support transportation-sector demand substantially based on diesel. The sector is also currently in transition after the end of Petrobrás' monopoly on refining. Private companies can now import fuels directly and pass them through to their dealers. The elimination of subsidies in the fuel sector, therefore, is in more advanced stages than in the electricity sector.

Conclusions on the Regulatory Framework

3.128 It is clear that the restructuring process of the Brazilian power sector is not yet in its final stages. Brown (2001) concludes that the sector's experience over the last decade was really about "government accounting," the lesson being that social impacts are an inherent part of the electricity restructuring process and cannot be ignored.[49] Thus, if this issue is not tackled at the beginning of the process, it will lead to impasse and a late effort to revert to previous contracts already signed, ultimately yielding blocked social and environmental achievements.

Financing

Reversion Global Reserve (RGR) Fund

3.129 Law 8631 (1993) and subsequent Decree 774 ensure financing for rural electrification programs through the Reversion Global Reserve (RGR),[50] a fund managed by

[49] Brown, Ashley (2001).

[50] Reversion Global Reserve is provided by Article 4, Law 5655, dated May 20, 1971, the final version given by Article 9, Law 8631, dated March 4, 1993, and due by concessionaires and permissionaires.
The Reversion Global Reserve is included in electric energy tariffs, with the following structure:

- Yearly reversion quota to be levied on concessionaires' and permissionaires investments is determined up to 2.5 percent, as defined in Article 9, Law 8631, dated March, 4, 1993, holding harmless the 3 percent limit of annual income.
- From funds collected under the provisions of this law, at least 50 percent of the total amount is to

Eletrobrás, with compulsory contributions by all concessionaires. These contributions are included in the tariffs imposed by concessionaires.

3.130 In 1996, Law 9427, which created ANEEL, also decreed that 50 percent of the resources of RGR should be directed to the north, northeast, and midwest regions and that 50 percent of such resources should be allocated to programs for rural electrification, energy efficiency, and electrical power for low-income users. Twenty-five percent of RGR resources are legally bound to supply low-income consumers and rural areas of those regions, in addition to some resources for energy efficiency projects.

3.131 The Reversion Global Reserve Fund generated R$1.15 billion in 2001 (see table 3.14), but total investments from the fund were only about R$584 million, not very different from the previous year's figure.

Table 3.14: RGR Turnover

	RGR turnover (million R$)			
	1999	*2000*	*2001*	*2002*
Initial balance	12.4	198.6	362.1	905.0
Inputs	983.3	1,102.7	1,151.5	
Collection of quotas	723.9	951.4	1,015.7	
Loans	749.0	586.7	552.0	

Source: CNPE data, 2003.

3.132 The total investment of Eletrobrás in the *Luz no Campo* program, making use of RGR funds, is expected to reach R$1.5 billion (US$500 million). As previously mentioned, Law 10.438 extended the existence of this fund to 2010. Under this new format, RGR can finance the expansion of the system of concessionaires, permissionaires, rural electrification cooperatives, distributed generation, and solar energy programs.

3.133 The Reversion Global Reserve Fund is expected to generate resources of about R$1.2 billion up to 2010. This implies a figure of R$300 million a year to be invested in the electrification of rural and low-income areas of the north, northeast and

be directed to electric sector investments in the northern, northeastern and central western regions, of which half will go to rural electrification, conservation, and electric energy rational use, and half will go to low-income community programs.

- Funds may be lent directly to states, municipalities, and electric-energy public-service concessionaires.
- Funds earmarked for the semiarid northeast are to be invested under financing rates no higher than those provided for funds referred to in §159.c, in the Federal Constitution.

midwest regions, besides energy efficiency projects. Total disbursement in the *Luz no Campo* program up to the end of 2001 was R$485 million.

Fuel Compensation Account (CCC)

3.134 Initially established to support thermal generation, which is mainly based on diesel and concentrated in the Amazonia region, the *Conta de Consumo de Combustíveis* (Fuel Compensation Account, CCC) is a levy on all Brazilian consumers. This benefit was extended to rural electrification technologies when replacing diesel systems a few years ago, as described previously. Table 3.15 presents the increasing amounts of CCC over the last five years for isolated systems. Consumption has increased concurrently with fuel costs.

Table 3.15: Volume of CCC Resources for Isolated Systems

Year	*R$*
1998	365,749,108
1999	510,679,066
2000	653,192,688
2001	878,068,665
2002	1,366,077,597
2003**	1,858,292,156

a. This figure can go up by the end of the year.
Note: The data include the cities of Manaus, Rio Branco, Porto Velho, and others.
Source: CNPE data, 2003.

Energy Development Account (CDE)

3.135 Law 10.438 (2002, see above) created the *Conta de Desenvolvimento Energético* (Energy Development Account, CDE). Its resources come from annual payments for the use of public assets (UBP), ANEEL's fines to concessionaires and permissionaires, and annual quotas to be paid from 2003 by agents that market electricity to final consumers, progressively replacing the levy to subsidize thermal generation in the interconnected system, now under extinction. Article 13 requires that CDE promote universal electrification in the entire country, and that the priority in using its first two sources of funds listed above be universal electrification efforts. CDE is expected to last for 25 years, but its total budget is not yet clear. Preliminary estimates of UBP shows scarce resources up to 2008 (around R$16 million), surging to R$246 million in 2012. Table 3.16 displays preliminary estimates of total resources available under CDE, and the estimated component of UBP and ANEEL´s fines. Given that PROINFA does not become operational before 2006, and natural gas and national coal plants do not demand substantial overlays, the same estimates forecast the amount of resources not used, over

the initial years, to be about R$3 billion, or nearly R$700 million per year. This could be directed toward universal access if Decree 4541 is reviewed, and universal access is considered the initial priority of CDE resources. It is evident that there is a positive balance at the beginning of CDE's existence, which can be used for universal access purposes. The main disbursements for renewables and national coal will start from 2006 and 2005, respectively.

Table 3.16: Energy Development Account (CDE) Estimates

	CDE estimates (million R$)							
	2003	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*
CDE: Total resources	1.183	971	1474	2040	2147	2248	2549	2698
(-) UBP + ANEEL's fines	108	113	118	126	132	138	332	347

Source: CNPE data, 2003.

3.136 Other important resources for rural electrification are the federal and state treasuries. The former channels its funds through PRODEEM and the Ministry of Agriculture. Since its beginning, PRODEEM has invested over R$80 million in PV systems, and the budget for 2002 was originally at R$170 million, but a substantial amount was frozen because budgetary constraints. Members of Brazil's Congress, through various amendments to the National Budget for the Ministry of Agriculture, also channel resources to rural electrification. These funds amounted to R$25.5 million in 1996 and R$37.5 million in 1997. The funds available for 2001 represented nearly 15 percent of the total budget of the Ministry of Agriculture and totaled close to R$80 million. These funds are provided by the federal budget to the municipal administrations, nonrefundable, and often subject to political bargaining.

3.137 At the state level, the largest source of funds for rural electrification is a loan from the World Bank to the northeastern states. Total investment over the last five years has totaled over R$115.6 million. The largest investments are in Paraíba, Bahia, Sergipe, and Maranhão. The Japanese Bank for International Development (JBIC) has also lent funds to support the rural electrification program of the State of Tocantins. Other state treasuries have different arrangements with the concessionaires. Such is the case with Minas Gerais, whose concessionaire, CEMIG is still state-owned. Instead of providing profits to the state, CEMIG reinvests its profits in rural electrification and other social projects. Under the new regime established by Law 10.438 these investments would have to be reimbursed to state governments, which is an issue still to be regulated by ANEEL.

3.138 Finally, it is important to emphasize the credit line of Northeast Development Bank, which finances small entrepreneurs investing in the exploitation of PV business at the community level. Nearly 3,000 systems have been installed under this scheme in the northeast. This credit line has reached these small entrepreneurs with capacity-building support provided by NGOs and cooperatives.

3.139 This analysis on available resources clearly shows that they are significant in total volume, but highly dispersed. There is a lack of coordination and no common strategy. Total amounts of funds from the different sources are not clear, and no optimization in the allocation of public funds is achieved. With the obligation of full investment for rural electrification now made the responsibility of concessionaires and permissionaires, there will be a strong rationale to look for cheaper sources of funding and the most cost-effective supply options. Care must be taken to avoid unwanted transfers of this burden that would stimulate inefficiencies. The establishment of an umbrella management scheme should be created to optimize the allocation of resources. This management unit should be placed at the MME and the management of funds could be placed under the responsibility of Eletrobrás.

4

Barriers

Introduction

4.1 Brazil currently faces a transition in the restructuring of its electric sector. The process initiated in 1995 is far from complete, and the lingering problems have become more evident with the recent crisis of Brazil's energy sector in 2001.

4.2 As in many countries, un-electrified rural areas in Brazil were initially overlooked by the restructuring process, which prioritized the maximization of privatization proceeds to the detriment of obligations to new agents. No targets or deadlines were established in the scope of the concession agreements. Subsequently the Brazilian government realized that rural electrification would not advance under the new scheme and initiated the *Luz no Campo* program; a loan to the concessionaires, which, in many states, will be paid back by the state treasuries; and Law 10.438, after important contributions from the Brazilian Congress. These initiatives responded to the growing recognition that market forces alone would not be the answer to the remaining lack of basic infrastructure in remote and less affluent areas, and that a minimum level of accompanying public facilitation and "smart" investment subsidies continues to be necessary to overcome the main barriers to increasing access in these areas. Those main barriers are as follows:

- Low population density in rural areas resulting in high transaction costs per household;
- Low demand and willingness to pay (on average) in rural areas resulting in low volume of sales and low return markets;
- Rural electrification's dependency on upfront subsidies and consequent susceptibility to political changes;
- High initial investment costs of conventional alternatives and alternative off-grid technologies that would allow lower lifecycle costs *and match rural demand profiles in a more flexible way (owing to the low liquidity of typical rural households, this leads to users opting for solutions that will have a higher NPV over 15 to 20 years, just because they cannot finance the high initial costs of the better suited ones); and*

- The perception of relatively new markets with information asymmetries for private-sector participation and alternative technology options and delivery mechanisms as high-risk.

4.3 Despite initial steps mentioned earlier and a growing recognition of the importance of continued improvement for the reform process, the list of remaining issues to be solved is long. These issues are presented in this chapter, along with the contributions of key stakeholders invited to discuss a preliminary version of this report in an ESMAP workshop (held in Brasilia on June 18, 2002). During the workshop, the participants were split into three working groups, focusing on (a) grid extension, (b) isolated village mini-grids (diesel and renewable energy systems), and (c) standalone single-user systems (solar home systems or PV water pumping). The following represents a synthesis of the outcomes of the workshop and some initial proposals by consultants. In most cases, the barriers are directly related to rural electrification itself, but in other cases they are peculiar to one of the three alternatives listed above. (See annex D for the minutes of the workshop.)

Lack of Political Commitment and Corresponding Regulation

4.4 Lack of clear political commitment to tackle the problem of providing service to unserved areas. The need to provide service to remote areas was overlooked during the privatization process. The federal and state governments did not move to ensure the expansion of services to remote areas. Congress and the Executive failed to establish clear deadlines for the approval and enactment of Law 10.438, transferring this burden to ANEEL, which had to reconcile the interests of the regulated entities, the consumers, and the nonsupplied areas. ANEEL faced strong pressure from the concessionaires in opposition to the establishment of tight schedules, the delegation to other agents (permissionaires), and tariff increases. These concerns needed to be balanced against user interests. Eight months after the enactment of Law 10.438, the government withdrew funds from RGR and CDE, which had been designated as the main resources for universalization, to cover the new subsidies (created by the same law) to existing low-income consumers, while the nonsupplied population continue to pay much more in $/kWh for poor service from batteries and kerosene lamps. Decree 4541, issued in December 2002, leaves limited resources for universal access in its current version.

4.5 *Lack of a reliable and binding electrification plan, with clear targets.* Brazil does not have a master plan for rural electrification integrating the different programs, agents, and technological alternatives. This barrier is expected to be overcome with the regulation of Law 10.438 and the Universalization Program under elaboration by the new government.

4.6 *Lack of national entities pressuring for full coverage.* Despite the approved law, ANEEL faces strong pressure from concessionaires, and since the nonsupplied population cannot lobby as effectively, this is not a dispute between equal forces.

4.7 Lack of coordination between institutions and organizations involved in rural electrification; lack of coordination among different programs and initiatives. There is a lack of interaction between PRODEEM (directly managed by MME) and Luz no Campo (managed by Eletrobrás). In addition, there is little interaction between these two institutions and the Brazilian Congress regarding the significant amount of funds for rural electrification that are allocated to the Ministry of Agriculture. Similarly, the Poverty Alleviation Program has no real interaction with the other initiatives. This lack of interaction is found at the state level as well. On top of this, interaction between rural electrification programs and other development programs, such as Family Agriculture, Poverty Alleviation, and Land Reform is weak. Of course, electricity provision is often a component of (or precondition for) such programs, in which case the transfer of energy sector best practices needs to be ensured . Again, the new universalization program under elaboration by the new government has raised expectations; the program's focus is on integrating the efforts of all stakeholders interested in rural development. Available funds could be better managed under the same umbrella.

4.8 *Lack of regulation and enforcement of existing laws.* Historically, there was a series of inconsistencies between some legislative provisions and prevailing practices. An example is the practice of charging the new consumers part of the investment, despite its preclusion established by Law 9478 in 1997. Another example is the allocation of matching funds to CDE by states and municipal governments as a subsidy to universalization, despite the fact that the same law establishes that any resource provided, even by the public sector, to promote the extension of grids, must be reimbursed by the concessionaire. Unless an immediate regulation of Law 10.438 is put in place, inconsistencies will remain.

4.9 *Lack of incentives to rural electrification cooperatives and other decentralized agents.* The Brazilian power sector is very centralized and operates under a concession scheme, leaving very little space for action to rural electrification cooperatives, and precludes initiatives by small companies or the local private sector. There are still several pending issues regarding the definition of rules for the operation of existing rural electrification cooperatives, which will be classified as either permissionaires or authorization holders.

4.10 *Uncertainty in the availability of funds from RGR and CDE.* It is still not clear how load increases and connection of big consumers are to be treated, given that the law does not provide for financial participation of the consumer. Should CDE be used under such conditions? It also is uncertain how subsidies on tariffs of low-income consumers will be covered. There are some risks that CDE could also be used for this purpose. A recent report by the *Tribunal de Contas da Uniã*" (Federal Account Court) suggests that the volume of subsidies is exaggerated. Available resources for universal access under the current version of Presidential Decree 4541 are limited.

4.11 *Potential legal dispute between ANEEL and ABRADEE*. The Association of Distribution Concessionaires (ABRADEE) has an understanding of the obligation of

investment to be recovered through tariffs that differs from ANEEL's. ABRADEE claims that its participation in the investment should be limited to its historical financial participation, and CDE funds should be used to fill the financial gap. This is not ANEEL's understanding of the law, made evident with Resolution 223. This potential dispute will probably be left to the courts, delaying the final decision.

Specific Barriers Related to Mini-Grids and Standalone Single-User Systems

4.12 *Lack of support to decentralized alternatives and grid-oriented standards*. The regulation fails to establish clusters for differentiated markets that would be compatible with low-cost technologies (such as the number of hours of daily operation; and the frequency and duration of outages). There are no real incentives for promoting the electrification of more remote areas (such as flexible standards and tariffs, or special incentives for developing the nascent market). Companies stick to the marginal approach and expand the grid. There are no restrictions on the standards proposed by concessionaires to connect new consumers (for instance, price caps or definition of flexible standards and tariffs matching the varying demand profiles in rural niche markets). In general, concessionaires try to maximize their initial investment, normally fully covered with the participation of the interested party (frequently the state governments), and they introduce extremely sophisticated infrastructure (such as tri-phase lines with multiplexed cables) to postpone future investments and minimize their operation and maintenance costs. Resolution 223 only refers to grid extension, sending a signal to concessionaires that the grid is the only acceptable alternative for universal access purposes.

4.13 *Lack of institutional models to ensure the sustainability of off-grid solutions such as solar home systems.* ANEEL has never given indications to market agents that an off-grid solution would be accepted as an option for rural electrification. For example, no flexible rules were established to make off-grid systems fulfill the requirements of service sustainability over time. The situation is similar for mini-grids. Once this hurdle is cleared, other issues need to be dealt with, such as the ownership of the equipment, tariffs, operation and maintenance requirements, standards, low-cost monitoring and enforcement of regulation in remote areas, and resolution of potential disputes between agents.

4.14 *Lack of standardization.* There is a great diversity of system designs and standards for mini-grids and PV systems. The Industry Trade Association, which may help with standardization, is in its infancy. This can generate problems of maintenance and availability of spare parts, and—even worse—lead to system failure owing to poor quality, which (if it becomes a regular occurrence) can destroy consumer confidence quickly. Rural electrification programs in other countries have successfully addressed this issue by establishing national standards (on the basis of readily available international standards such as the Photovoltaic Global Accreditation Program (PV GAP), IEC and IEEE) and national testing and accreditation facilities.

4.15 *Isolated initiatives and donations.* Government energy policies related to isolated systems can often be confusing to market agents, when punctual and isolated stimuli fail to trigger sustainable market development (creating a "roller coaster" effect). There are many government bodies sponsoring pilot projects all trying to do the same job, and players have repeatedly addressed a need for one-stop shopping for finance.

4.16 *Donations and lack of sustainability.* Many projects have been based on equipment donations, with well-known problems regarding long-term market development and service sustainability. This arrangement distorts local markets, lacks local ownership (literally), and where funds are committed to buying hardware only, with no provisions made for operation, maintenance, and replacement, service often stops after about three years.

4.17 *Environmental issues.* It is difficult to obtain environmental licenses for small hydro plants (SHP).

Information Deficit and Capacity Building

4.18 Lack of national market data. A professional and detailed rural energy demand survey needs to be implemented and made available to all interested agents.

4.19 At the beginning stages, market actors are not well informed about the issues and options of rural electrification. This is true for suppliers, users, and government entities. Some examples of these issues are the technical and economic potential of renewable energy; technology options; definition of rural areas; precise size of nonsupplied or undersupplied markets, particularly in the northern region; seasonality of income and willingness to pay of potential users; and so on.

4.20 Lack of diversification among renewable energy technology options (with pilot projects focusing mainly on PV). PRODEEM has recently tried to diversify its portfolio of RETs, with the construction of four micro-grids. No wind or biofuels have been tested yet. The Ministry of Science and Technology and ANEEL have developed other pilot renewable energy technology projects, but these focus exclusively on technology demonstration.

4.21 *Lack of effective incentives for agents to learn about and opt for alternative electricity supply technologies.* Rural electrification agents still tend to consider grid extension in most parts of Brazil (and diesel micro-grids in Amazonia) as the only supply option.

4.22 *Lack of emphasis on rural electrification inside concessionaires.* Rural electrification is considered a less important issue by the companies, reflecting the perception of professionals working in this area. Energy to rural areas is not seen as an input that increases production and provides market transformation.

4.23 *Lack of culture of paying for public services.* Several communities are extremely resistant to the idea of paying fees for service, based on an expectation that public services must be free. This is aggravated by the frequent donations of governmental projects, particularly during pre-electoral periods.

Specific Barriers Related to Mini-Grids and Standalone Single-User Systems

4.24 *Lack of resource databases for several renewable energy resources*, such as inventories of hydraulic and wind resources. This leads to a dearth of estimates for market potential and scope for larger-scale projects involving these technologies, and as a result, socio-technological and managerial challenges are barely known (this is somewhat different for PV).

4.25 *Utilization of biofuels (vegetal oils) is in a very preliminary stage of experimentation* in the country, with initial projects adopting a very expensive imported technology, instead of opting for adapting conventional diesel sets.

4.26 *Lack of information on renewables.* Renewable energy technologies, particularly PV and wind, are far beyond the reach of rural communities, and local suppliers and installers often tend to keep things that way. This "pride in exclusive knowledge" is absolutely counterproductive, since whenever a new technology is applied, training users is a fundamental prerequisite for a successful outcome. Not only end users, but often also concessionaires, rural electrification cooperatives, and IPPs are not aware of the potential that particular rural electrification technologies offer in their particular case.

4.27 *Lack of training, dissemination of information on human resources, and capacity building.* There is no skilled labor to ensure appropriate maintenance of mini-grids. Training provided to users of single-user systems is frequently insufficient or unsuitable.

4.28 *Pilot projects and sharing of off-grid electrification experiences.* Thousands of small renewable energy systems have already been installed in Brazil. Various pilot off-grid rural electrification projects that require the financial participation of beneficiaries have been, or are currently being implemented. A lot of problems have arisen regarding management design and payment collection, among others. But these projects have been managed in isolation and since lessons learned are not disseminated among other projects and stakeholders, new projects will probably experience the same errors. In addition, there is still a lack of suitable pilot projects to test management and economical designs that would apply to the different configurations.

Lack of Participation and Bundled Services

4.29 *Decentralization issues.* Decentralization efforts in Brazil have not been aligned well enough with specific local rural infrastructure needs. Coordination between all levels needs to be improved.

4.30 *Lack of social organization in most decentralized infrastructure provision efforts.* In contrast to the apparent success of decentralization efforts in the health and education sectors, the results are disappointing in the infrastructure provision sector when local communities are responsible for operations and maintenance—owing to a lack of community participation in the decisionmaking process, lack of involvement in the operation of the systems, and lack of capacity building. These projects generally provide funds for equipment acquisition but no funds are reserved for the involvement of the community in the equipment's design and maintenance. No firm commitments are required from the community regarding the establishment of revolving funds for the repair or replacement of spare parts. Very few projects are monitored afterwards, and the few ex post evaluations that have been done have produced extremely frustrating results, for the reasons mentioned above. A community system can only function in a functioning community.[51] These sociotechnical issues concerning solar home systems and especially micro-grids have to be addressed in future projects.

4.31 *Lack of specific support for productive uses of electricity.* Rural electrification programs, either grid-connected or off-grid, are not integrated to income-generation programs, and concessionaires do not exploit the market transformation power of electricity.

4.32 *Very few success stories on decentralized rural systems.* This is most evident for solar home systems (a technological solution adopted by several pilot projects), with PRODEEM and the Poverty Alleviation Program being the most concrete examples of pilot projects lacking sustainability. Research centers and universities have tested other technologies, with limited scale for comparison. Lack of sustainability on most of these programs was due to their having been developed without evaluating the managerial aspects of the projects (sustainable service provision models), which led to the proposed technologies being wrongly perceived as unreliable.

4.33 *Problems of sustainability of single-user systems.* These include a lack of dialogue with future users and their local representatives, lack of solutions to fill the gap between the costs of PV electrification and the ability to pay of low-income rural users, and lack of proven models of management that would ensure the economic viability of projects.

4.34 *Lack of attention to bundled services*. There are no available examples of integration between the different sectoral programs. Most of the sectoral development programs in rural areas (water pumping, health service, education services, telecommunication, and so on) require energy provision. Better integration should be explored, since it can help at the same time to guarantee a share of expected revenues and help gather a bigger public share in the financing of projects, making it more attractive to the private sector.

[51] Reiche (2002).

Lack of Locally Available Technology

4.35 *Lack of incentives for national producers of renewable energy technology.* Recent tax incentives were given to distributors of certain equipment, with no incentives for local production. With solar and wind energy, the country could benefit from local, large-scale production. However, investors will only be interested in establishing manufacturing plants in Brazil if large-scale markets are secure, which is not the case so far, owing mostly to the unsustainable outbursts of demand induced by government programs (that is, donations), which do not develop a real market. The industry is eager, but continuity and volume manufacturing is a must.

4.36 *Lack of locally available technology* for exploiting wind resources for mini- and micro-grids.

4.37 *Lack of spare parts.* Failures resulting from the absence of maintenance and replacement of spare parts after the first few years following installation compromise the operation of the systems, particularly those donated by international organizations.

Financial Viability of Rural Electrification

4.38 *Current financial situation of concessionaires*. Following the losses incurred by concessionaires resulting from the energy shortage, and subsequent market reduction caused by the incorporation of practices during the shortages, concessionaires have their capacity of investment substantially reduced. Currency devaluation also had a negative impact on some concessionaires, as did several of the recent measures introduced by Law 10.438 (for instance the subsidies to low-income consumers, the emergency supply to avoid new shortages and the obligation of universalization).

4.39 *Lack of attractive financing conditions*. Apart from resources available from RGR, the market offers capital with too many unattractive conditions attached: interest rates for commercial lending is still very high; a large collateral amount is required; and the mandated minimum volumes generally preclude the financing of small projects, particularly those from small and mini-entrepreneurs and farmers. Project financing in the conventional energy field employs scales that presently do not apply to Renewable Energy Technologies (RETs).

4.40 *Lack of special treatment for renewable energy technologies.* Energy projects in general are not taking lifecycle cost analysis into account. Since renewable energy technology projects are much more capital intensive and less operations, management, and replacement (OM&R) intensive than conventional energy projects, they are obviously at a disadvantage in the decisionmaking process. Externalities or indirect costs of conventional energy technologies are hardly ever considered. This results in a lack of rural financing for off-grid electricity.

4.41 *Lack of financing possibilities for low-income households*, especially with regard to volume, interest rates, credit period, and also lack of financial intermediation.

The transaction costs are very high for rural users. Microcredit organizations often consider solar home systems to be “consumptive” technologies and do not finance them. Equipment is often not recognized as collateral.

4.42 *Lack of commercial financing for rural electrification providers.* Commercial debt is often required for financial closure (as equity), as user payments and subsidies do not cover the initial investment. The local banks' lack of experience with rural electrification increases the perceived risk and, in turn, the interest rates.

4.43 Price relations are distorted, particularly on volumes of subsidies for grid extension and diesel prices under CCC. The incentives established by the formula that calculates the volume of subsidies given to renewables when replacing diesel are not enough to make agents to make the change from a conventional technology to a new one. The playing field is not level for the new technologies. Preliminary studies have demonstrated that the volume of subsidies needed for renewables could be between 30 and 55R$/MWh, substantially lower than the amount paid for diesel (80 to 120R$/MWh).

Risks and Private-Sector Participation

4.44 *Private-sector participation* in rural electrification is hampered by many constraints, some of which were mentioned above. These include the lack of appropriate access to financing, lack of suitable pilot projects demonstrating clearly that rural electrification can be economically viable, largely indefinite regulation of rural electrification (which accentuates the perception that rural electrification is a highly risky activity at the moment), and so on. But some additional specific limitations have to be stressed here.

4.45 It is necessary to distinguish between private participation in the extension of the conventional grid by concessionaires, and private participation in off-grid rural electrification projects.

4.46 Conventional grid connection by concessionaires is fully regulated; however, tariffs do not generate enough revenue to make private investment attractive, and the current legislation forbids the integration of the share of the assets corresponding to the public subsidization of initial cost in the basis for tariff calculation.

4.47 Private participation in off-grid rural electrification, by contrast, is still a very incipient market, requiring regulation of the new permissionaires inside concession areas, and after that the creation of incentives to make this new business sustainable.

4.48 A key issue is how to overcome the numerous difficulties that any new activity has to face to become attractive for private investment, especially when such activity needs to be subsidized and when the access to subsidies remains difficult.

4.49 Perceived risks include the following:

- *Risk for investors in rural electrification in the case of subsequent grid electrification.* Areas that are reserved for permissionaires are yet to be defined. This barrier is expected to be eliminated with the regulation of Law 10.438, which is currently the main challenge for ANEEL.
- *Lack of risk management, proven risk-sharing schemes, and risk-mitigation instruments (such as guarantees).* See box 4.1 for a systematization of the multitude of risks associated with nascent markets for innovative rural electrification solutions:

Box 4.1: Risks associated with nascent markets for innovative rural electrification solutions

Commercial risks
1. The risk of over-estimating the market
2. The risk of a market that develops more slowly than expected
3. The risk related to market segmentation projections
4. Risk of skimming by unregulated unauthorized competition

Risks associated with customer behavior
5. The risk of improper use of equipment and system fraud
6. Perverse incentives resulting from a poorly adjusted pricing structure
7. Risks of unpaid bills
8. The risk of an uncontrolled expansion in demand
9. Changes in the willingness to pay and acceptance of the technology

Operating risks
10. Delivery delays
11. Installation pace not keeping up with demand
12. Under-estimation of operating costs
13. Technical-statistical risks concerning replacement parts

Theft, intentional damage and robbery
14. Risks of sudden jump in thefts and/or intentional damage, beyond the level built into the business plan
15. Risk of an increase of robbery beyond the level built in to the business plan

Macroeconomic risks
16. The risk of inflation
17. The risk of a serious crisis in the regional rural economy
18. Exchange rate risk

Political risks
19. Risks of non-compliance with the delegated management contract (in the case of a delegated management model). The main risks are related to non-compliance or to a distorted application by the government of clauses related to: (a) the payment of subsidies, (b) a price increase (according to a formula that takes into account changes to predefined economic parameters over time), (c) the triggering of penalties, and (d) the end of the contract.
20. Risks of securing financial resources: The political risks related to the involvement of local authorities associated with the project (provinces, states, municipalities), can represent an

obstacle to securing financial resources from commercial banks or private investors through financing arrangements.
21. Risks attached to changes in the local or national tax system
22. Risks of changes to regulations governing public services
23. Public commercial risks: The government is also a potential customer of dealers through the electrification of public facilities (health centers, schools, police stations, and the like). In this framework, the operator runs the risk that public authorities will not comply with the terms and conditions of payment for services.
24. Risks of "political" unpaid bills: It is important to guard against pressure that local "populist" politicians can apply to protect bad debtors and prevent the application of contractual clauses, such as the removal of necessary equipment components.
25. Other political risks: (a) the risk of expropriation, (b) the inability to transfer money outside the country and/or the non-convertibility of local currencies, (c) the risk that the contract will be unilaterally breached, and (d) the risk of war and civil conflicts.

"Force majeur"

26. Like all physical equipment, Decentralized Rural Electrification (DRE) is of course exposed to major risks. Depending on the region, certain climate-related risks are well known and must be taken into account. These risks include very strong hail floods and storms that exceed known extremes.

Conclusion on Barriers

4.50 Despite the success of *Luz no Campo* and the enactment of Law 10.438, several barriers will constrain an efficient and sustainable future expansion of rural electrification in Brazil. Most of these barriers arise directly from the fact that a large fraction of the population remaining without electricity service is more dispersed and poorer, and lives in remote areas. The stakeholders are weaker (indebted concessionaires and less articulated contractors) and consequently the existing financial framework faces difficulties in financing them. The current main source of funding is RGR, but indebted companies are not eligible for RGR loans. At the same time, CDE is under pressure for different competing uses.

4.51 The way toward universal access in Brazil will not be possible without significant subsidies. Historically state treasuries have invested in rural electrification. The most successful stories of the *Luz no Campo* program involves financial support of state treasuries, either by reimbursing RGR loans (COELBA) or allowing controlled concessionaires (CEMIG) to reinvest due profits to the state treasury. With Law 10.438, the situation has changed. The law establishes that concessionaires must invest according to a target plan to reach full coverage of their concession areas, and they are to recover their investments through tariffs. Governments can anticipate the targets, but must be reimbursed when the original date has been reached. It is evident that this will have an impact on the tariffs, which are already under the strain of trying to cover losses incurred by the companies during the energy crisis, the emergency thermal generation to reduce risks of new shortages, and the subsidies to low-income consumers. The Energy Development Account (CDE) is also covered by tariffs. Thus, an evaluation of the total

impact on tariffs of these new obligations is vital, taking into consideration the elasticity of electricity demand in different income classes.

4.52 Barriers that will continue to exist even after the regulation and implementation of Law 10.438 include those related to information deficit and capacity building, unavailability of local technology, limited commercial financing to rural electrification providers, unfavorable credit conditions for operators and for users (very high interest rates due to risk premiums), lack of incentives for diversifying the supply options, overextension of grid and diesel solutions in the Amazonia region, lack of coordination among different institutions and governmental programs, and lack of flexibility on quality standards and standardization of equipment and systems for off-grid supply.

4.53 There is still a strong prejudice against renewable energy technologies; they are perceived as very risky owing to the stigma brought on by a series of frustrating past projects with poor design. Early lessons are that careful and comprehensive planning, local involvement, technical expertise, premarket surveys, and a fee-for-service system are elements of successful rural electrification projects.

4.54 Finally, it is still not clear whether there is a role to be played by new agents operating off-grid systems—and under which conditions PV-based standalone systems or other decentralized renewable energy systems will be accepted by ANEEL for universalization purposes, and by MME for funding under CDE and PNU.

5

Options

Introduction

5.1 The most immediate and important challenge to ensure the expansion of electricity service in Brazil's rural areas is the enforcement of Law 10.438. With the establishment of a national strategy for universal access, integrating dispersed efforts and managing available funds under the same umbrella will enable the government and private companies to meet the targets established by ANEEL. However, despite ANEEL´s support for awarding permissions inside concession areas, pending rules on rural electrification cooperatives limit the potential role of permisionaires—owing in particular to the lack of instruments to make these new agents sustainable.

5.2 In parallel, considerable effort should be made to address the market entry barriers and demonstrate the viability of alternative technology options—particularly renewable energy technologies. This effort should include some concrete incentives for large-scale decentralized electrification in areas where the grid is seen as the only supply option, as well as for dispersed Amazonian communities. In either case, the effort should address the challenge of supplying dispersed households and communities.

5.3 Financial mechanisms should not channel funds exclusively to rural electrification providers. They should include microcredit schemes targeting users, preferably matching the schedules for the future reimbursements which need to be made by the concessionaires to reward the anticipation of electrification targets. Financial mechanisms should also allow consumers to have internal installation and productive applications financed, resulting in more developmental impact and ensuring earlier returns to investors. This is a potential role for technical assistance and financial support by the World Bank.

5.4 Coordination of the activities of different institutions and programs and articulating income generation, poverty alleviation, infrastructure provision, and rural electrification programs round out the list of most urgent actions to promote full coverage. This effort should result in an umbrella management scheme, bringing common rules to the use of RGR, CDE, PRODEEM, and extra-sector funds, overcoming limitations to the current financial framework.

5.5 A list of options and recommendations is presented below (based to a large extent on the stakeholder consultations during the preparation of this report), detailing these topics and other measures to address barriers to rural electrification in Brazil.

Political Commitment and Corresponding Regulation

5.6 Brazil needs to define a comprehensive rural electrification strategy to optimize the use of RGR and CDE funds. It should also take into consideration various initiatives such as PRODEEM, the Ministry of Agriculture's funds for rural electrification through the annual national budget, the Poverty Alleviation Program, participation of state governments, Northeast Development Bank credit line to micro-entrepreneurs, and so on. This strategy should try to optimize the allocation of public resources, which must be used to leverage the private funds raised by the concessionaires and new agents. This strategy must be flexible enough to take into consideration the diversity of realities existing in the country, such as the existing rates of electrification, the wealth of the states, the efficiency in the use of public resources, the use of local energy resources and the level of effort required to integrate different programs, among other issues. An umbrella management scheme could coordinate these efforts from a project coordination unit in the Ministry, with units at the state level. Decentralization of decisionmaking must be the bedrock of this strategy, while always keeping in mind the inherent risks regarding economies of scope and coordination.

Legal Framework and Options Regarding Regulation

5.7 With the recent enactment of Law 10.438, a new legal framework was put in place. Further regulation was provided through Presidential Decree 4541 and Resolution 223, from ANEEL. A key change introduced with the new law obliges regulated agents (concessionaires and permissionaires) to provide full coverage of electricity services, under a schedule to be defined. The rural electrification targets were established by ANEEL; however, it the established schedule stops short of more ambitious goals discussed amongst several stakeholders. In addition, the new law established that potential consumers do not need to cofinance initial investments. As described above, this is currently strongly opposed by ABRADEE. The regulated agent will recover investments through tariffs. However, a potential consumer can ensure an early connection by lending funds to the regulated agent. ANEEL can also review final targets if substantial volumes of CDE funds are allocated to universal access.

5.8 The law also authorizes ANEEL to award permissions to new agents inside existing concession areas, when coverage cannot be guaranteed by the existing concessionaire in a reasonable timeframe. A new agent interested in participating in a local rural electricity market (by trying to get a permission inside an existing concession) may end up in a dispute with that area's concessionaire. ANEEL would mediate such a dispute, unless the new agent decides to operate at the fringes of the market, without protection from the regulatory agency. Thus, role, areas of action, funding, and incentives

must immediately be defined for rural electrification cooperatives. Another possibility is to have these new agents working for the concessionaires, supporting them to fulfill their electrification targets. Again, operator credit must be available to these new agents.

5.9 Under this new legal framework, the following main points still need to be regulated:

- Given that ANEEL can start public bidding to award permissions inside the existing concession areas, the agency needs to define areas to be bid out, bidding processes, contracts, and procedures for the implementation and monitoring of these permissions. ANEEL must create rules to minimize future disputes, and ensure the financial sustainability of these new agents, through access to RGR and CDE resources. Alternatively, the subconcessionaire could be regulated. These new agents can operate on behalf of the concessionaire, who will continue to be responsible by the concession.
- Energy Development Fund resources must be primarily used to support universalization, provided that the other uses of CDE will not be demanding substantial resources in the initial years of the account. MME and ANEEL *need to define transparent and efficient disbursement procedures***.** It is recommended that the government propose that Congress review the article of Law 10.438, which states that even load increases and connection of big consumers are covered under the universal access principle without financial participation. A potential solution would be to limit the benefit to those that will end up as captive consumers.
- Permissionaires can supply electricity using different technologies, under specific conditions and forms of supply compatible with the selected technology. ANEEL should work on the definition of rules for the acceptance of these different forms of supply, including PV, hybrid systems, low-cost grids, and the like. An apparent ambiguity of the new law is that *only permissionaires are allowed to use this flexibility in choosing among technologies. This needs to be clarified and the conditions to have solar home systems or other decentralized renewable energy systems accepted by ANEEL for universalization purposes, and by MME for funding under CDE schemes***.**
- RGR Resources should be committed to supporting universalization and solar energy programs. This benefit, restricted to concessionaires to date, should probably be extended to permissionaires, rural electrification cooperatives, and others. However, ANEEL still needs to clarify how these entities can access those resources.
- ANEEL also needs to *define the tariffs for permissionaires and rural electrification cooperatives with consumption up to 300GWh/year*, and conditions and terms for these contracts ensuring the economic and financial sustainability of the agents. Through these tariffs ANEEL could

potentially dilute the costs of supply of new consumers, to be supplied by permissionaire and rural electrification cooperatives, among all consumers of the concession area. The distinction between permissionaires and authorization holders is not completely clear. In addition, authorization holders should not have authorization periods that are shorter than those of concessionaires.

- National tariffs will increase to cover new investments by concessionaires. To minimize these increases, concessionaires must receive incentives to efficiently choose supply technologies and lower service provision costs, where possible. It may be counterproductive in terms of increased efficiency if concessionaires are able to transfer the new burden to all other concessionaires of the country. On the other hand, states with very low rates of electrification cannot afford to pay the highest tariffs, so a compromise must be found. This is one of the new challenges facing rural electrification in Brazil. Among the options available to concessionaires and permissionaires to minimize their own investments is the use of more cost-effective technologies, including low-cost grids (wood poles, low power transformers, single-wire earth return lines and aluminum cables) and decentralized rural electrification (mini-grids based on renewable energy technology, SHS, and so on). They can minimize the financial cost by maximizing the use of available subsidy sources such as CDE, RGR, PRODEEM, and the Ministry of Agriculture. Furthermore a solution must be found to cover the subsidies of low-income consumers. The figure reaching consumers with consumption up to 220kWh/month should be reviewed. The Executive should propose that Congress reduce this limit. A limit between 30 and 50kWh/month seems reasonable.

Definition of Standards

5.10 ANEEL should define a set of transparent, flexible standards for rural electrification that ensure minimum service quality through grid-based, mini-grid, and PV systems, that match rural demand profiles, allowing for low-cost solutions where appropriate**.** This could include price caps, which would be accepted by ANEEL to pass-through to the tariffs (set at a normative value for supply costs). Costs beyond these limits would not be transferred to the tariffs. These standards would be compatible with the different market clusters. ANEEL also needs to establish standards for equipment and systems to accept solar home systems as an alternative supply. Existing requirements on quality and conditions of supply preclude the solar home system as an option. The extremely high cost of visiting remote rural households needs to be taken into account concerning both service standards (such as reaction time in case of failure) and regulatory oversight (regulators have to be able to finance their own increased costs incurred by frequent audits and visits to remote places).

Improvement of the Efficiency of Government Funds

5.11 An effort should be developed to *establish partnerships and integrate programs*, by mapping the objectives of the initiatives of the Ministry of Agriculture, PRONAF, INCRA, PRODEEM, and the interests of municipal governments, NGOs and rural extension offices, looking to optimize the allocation of these different programs and initiatives. Concessionaires are the main interested parties in accessing these funds.

5.12 To boost development impact (that is, effective rural transformation), demand must be developed by financing mechanisms going beyond the meter, including internal installation and productive uses. Complementary community services such as telecommunications, health centers, and schools complete the impact on domestic and productive uses of electricity.

5.13 It will be a challenge to integrate off-grid rural electrification into the universalization targets of the concessionaires, making an effort to incorporate those systems already installed, by different programs, and avoiding conflicts and creating synergies between entrepreneurs running independent projects and the concessionaires.

Improvement of Existing Programs

5.14 Funds from PRODEEM and the Poverty Alleviation Program are directly transferred to the communities or municipal governments, but these programs suffer from a lack of sustainability.

5.15 The main issues of improving PRODEEM include (a) training operators and users, (b) stimulating a participatory process, (c) establishing flat fees, (d) ensuring long-term service quality, and (e) adjusting the program to the existing legal framework and integrating the universal access effort.

5.16 The Poverty Alleviation Program, for its part, suffers from the following problems: (a) installations that are sometimes made in unprepared and unorganized communities, (b) lack of cost recovery schemes resulting in unsustainable service and a lack of funds for maintenance, (c) lack of stringent standards to ensure the quality of projects, and (d) no monitoring after installation (not even on a sample basis). A certain part of the initial investment should be allocated to supporting the local organization and establishment of monitoring systems. Since this program makes use of World Bank resources, a challenging pilot program could be the establishment of a company that would operate and maintain all systems and apply to become an authorization holder, accessing additional subsidies using an output-based approach. This model could be replicated in several states in Brazil.

Options to Overcome the Information Deficit

Market Survey

5.17 With more than 2.5 million households without access to electricity in 25 different states, Brazil represents a large market for both grid extension and decentralized rural electricity. However, the relative proportions of each socioeconomic segment of this market may change dramatically from one state to another, altering considerably the economic parameters of DRE projects in these different states. This hinders increased private-sector participation.

5.18 As a consequence, while some very detailed market information is already available for certain regions in three or four states, there is still a pressing need for additional information to be made available to reduce uncertainties and attract private investors. Projects in other countries have shown that it is difficult to ask future private project developers to assume the cost of these preliminary studies, if the studied markets are then bid out. *It is recommended that ANEEL and Eletrobrás, with international development help, invest in market studies to evaluate the precise share of the markets for low-cost grid extensions, micro-grids, and PV systems.* The teams must be multidisciplinary to avoid favoring a specific technology. The studies should imply local potential for productive and public applications, as well as bundling with other services.

5.19 Preliminary studies for Bahia indicate that 20 percent of nonsupplied markets could be supplied by single-user systems. The studies are not as clear for mini-grids in Bahia. The situation is the reverse in the Amazonia region. *This report estimates that between 20 and 30 percent of the nonsupplied market could be more cost-effectively attended through off-grid systems, with regional variations. This represents a market of about 700,000 households. Refining these figures will be vital to developing the market and attracting potential investors.*

5.20 Community-driven projects with mechanisms for disclosure of preference and transference of costs must be combined with top-down market analysis and supply-side market entry decisions. End-users' purchase power in rural areas is not only low, but quite often seasonal. Future demand studies should address this factor.

Training and Support for Planning, Operations, and Maintenance

5.21 *Training programs targets.* Whenever a new technology is applied, training users is a fundamental prerequisite for a successful outcome. End users and local technicians should be identified and trained to minimize the operations and maintenance costs. Finally, IPPs and even concessionaires are not aware of the potential that particular renewable energy technologies have for their particular case, and this information needs to be disseminated.

5.22 *Capacity building for banks.* Bank officials should be trained in suitable financing schemes for projects of different sizes and alternative schemes—such as venture capital and revolving funds.

5.23 *Support to bundled services. Luz no Campo,* PRODEEM, and the Poverty Alleviation Program should facilitate the conversion of some rural electrification cooperatives into multiservice entities (electricity, telephone, and water), for example, through specific credit lines and capacity-building efforts, including coordinated regulation and tariff definition. This is a model with strong potential for replication, and it could make permissionaires more viable.

Options That Directly Improve the Financial Viability of Rural Electrification

Tariffs

5.24 Considering that nonsupplied populations have the lowest income levels, full coverage will not be attained without the public sector partially subsidizing the initial investments. Tariffs need to be compatible with the income of the target families (most of which earn below US$100/month). Considering the total amount available, subsidies need to be low enough to remain efficient and to meet the rural electrification targets. International best practices recommend the introduction of the mechanism through an output-based approach to the allocation of subsidies.

5.25 ANEEL must proceed with a detailed study of the impact of the obligation of universalization on consumer tariffs. Two questions need to be answered: What would be the impact on the tariffs under different service quality / technology / schedule scenarios? And are these tariffs acceptable? Different sensitivity analyses need to be applied to evaluate the distribution of this impact among different consumer classes—not penalizing only captive consumers. This cross-subsidy should be as transparent as possible for all concerned.

5.26 ANEEL could also allow concessionaires to sell additional services to boost demand, such as internal installation and energy-efficient or productive equipment. In parallel, off-grid schemes could offer the replacement of batteries as a service in addition to the installation of suitable equipment such as more efficient lamps and the like.

Incentives for the Diversification of Supply

5.27 In accordance with ANEEL, Eletrobrás, as manager of the two main funding sources must create incentives in the use of RGR and CDE to encourage concessionaires and permissionaires to diversify their supply alternatives (including low-cost grid connections, renewable energy technologies in micro-grids, and solar home systems). Projects making use of those technologies should access the two funds under differentiated conditions (lower interest rates, longer grace and financing periods). The cost of funding could be made higher for conventional grids and diesel systems.

5.28 Treasuries in several states still pay for most of the investments on grid extension, while mini-grids or solar home systems do not receive similar subsidies. Similarly, CCC subsidizes diesel systems more than it does RETs. ANEEL needs to prepare a detailed analysis of the subsidies given to diesel under the CCC scheme and compare them with those given to renewable energy technologies, in an effort to level the playing field. It is also worthwhile to make the volumes of subsidies allocated to grid extension and the costs paid per connection more transparent.

5.29 An evaluation of the volume of funds available from CDE and RGR, and of the total demand for universalization, is necessary to assess the need for additional resources. Rules must be established to allow funds from PRODEEM, the Poverty Alleviation Program, and the Ministry of Agriculture to leverage those resources. *Luz no Campo*/Eletrobrás (which finances mainly grid extension, with a 6 percent interest rate, two-year grace period, and a 5- to 10-year repayment period), and the Northeast Development Bank (which finances mainly PV systems created by small entrepreneurs) offer good conditions for financing; however, larger volumes must be allocated for financing renewable energy technology. Any other credit lines aimed at universalization should not go beyond these conditions, but rather be oriented toward those offered by commercial banks.

5.30 Considering that potential consumers can accelerate their service connections by paying a part or all of the investment, the concessionaires can be required to reimburse them when the target deadline for electricity has been met—and banks can create credit lines under extremely favorable conditions, reducing interest rates and extending grace periods, since the operation is guaranteed by the concessionaires. This could be tailored so that the concessionaire pays back the loan to the bank.

Taxes and Import Duties and Fiscal Incentives

5.31 It is worth investigating a medium-term policy to support the initial dissemination of renewable energy technology through tax exemptions extended to peripheral devices such as controllers, inverters, and batteries (which pay cumulative taxes of 37 percent, 43 percent, and 50 percent, respectively), and through the extension of current tax exemptions (that apply to PV, solar thermal, wind energy, and so on) for a term of, say, five years, until the consolidation of this nascent industry is realized. This policy could be in addition to a reduction of import taxes and other small taxes such as PIS and COFINS. A problem to be solved here concerns the importation of assembled wind generators, which is subject to lower taxes than the local assembly of imported components.

5.32 Incentives need to be provided for the emergence of PV and wind energy companies in the country. However, this will require firm signs of a promising large-scale market in the country for these energy sources, which is not yet the case.

Incentives Related to the Carbon Market through the Kyoto Protocol

5.33 The use of renewable energy technologies and the substitution of diesel-based isolated systems by gas or renewable energy-based systems contribute to reducing or avoiding greenhouse gas emissions.

5.34 Renewable energy technology projects should be packaged in a way that exploits the opportunities offered by the United Nations Framework Convention on Climate Change (UNFCCC), through the Clean Development Mechanism (CDM) established by the Kyoto Protocol. When this protocol is ratified, the projects that reduce or avoid emissions will be awarded in corresponding amounts of emissions reduction credits. The value of these credits will be determined by the prices observed on the international market of such credits that will be created by the Kyoto Protocol in 2008. CDM projects can begin in 2000. Studies integrating the specific parameters of rural electrification in Brazil should be undertaken, and the diffusion of the results organized, to help the private sector to explore this new opportunity.

5.35 *An immediate step is a national effort to access available international grants such as those offered by PCF and GEF.*

Options Regarding Institutional Setup

5.36 Every Brazilian state has a Ministry of Energy and an energy regulatory agency. One of the two could assume the additional role of a regional energy agency in areas with low coverage. The alternatives are the establishment of a regional energy agency inside the regional development bank, or inside a separate body (see annex C).

5.37 The main tasks of the agency would be the following:

- Facilitation, coordination, and channeling of different activities regarding rural electrification;
- Support for productive uses of electricity;
- Information generation in several fields: technical and economic potential, technologies, electrification plan, definition of rural areas, and so on;
- Information coordination; and
- Dissemination of existing information: Technical and administrative know-how to plan, build, and maintain decentralized systems; explore potential and existing financing possibilities; and so on.
- Two other possible tasks are financial intermediation (including reduction of transaction costs for rural users) and bid implementation to award permissions inside the concession areas. These latter tasks could be handled better by a separate entity.

Risk Reduction

Reduction of Risk for Off-Grid Investors in Case of Subsequent Grid Electrification

5.38 Law 10.438 allows private companies and rural cooperatives to anticipate the investment before the periods defined by the rural electrification targets, and these investments should be reimbursed once the target date for their electrification has been attained. These rules have to be established by ANEEL soon. This is a key moment to support the minimization of the risk for off-grid investors in case of subsequent grid electrification. The changes in this regard could include the elaboration of Standard Power Purchase Tariffs and Standard Power Purchase Contracts for mini-grids, and buy-back-guarantees for solar home systems, among other security clauses.

Reduction of Other Risks for Investors

5.39 Additional options to reduce and cover part of the risks mentioned above include the following:

- Decentralized rural electrification is an innovative activity in a number of ways and, accordingly, requires a major effort at creative design and implementation of locally adopted contractual forms, organizational and partnership models and the related technical mechanisms, and commercial formulas that will bring the costs and risks down to acceptable levels. *Indirect subsidies* are needed to cover technical assistance activities addressing these barriers in a nascent market.
- There are several families of instruments that reduce or cover a part of the risks associated with delegated-management of decentralized rural electrification. These instruments can be technical mechanisms related to the energy systems themselves, diversification in the types of customers (pumping, public services, manufacturing uses), manufacturers' warranty clauses and supplier contracts, self-insurance provisions and mechanisms, external insurance policies, guarantees, clauses included in user contracts, contract-based solutions with user associations, and contractual clauses with the state.
- Most of the risk-mitigation measures depend on *contractual arrangements.* This assumes that if it becomes necessary to initiate proceedings, these different clauses will turn out to be compatible with the legal means available locally to apply them. It is important not to develop clauses that are simply coercive; an effort must be made to provide incentives to the parties involved. In addition, legal recourse—which is often ineffective—should not be the only form of pressure that can be applied, especially regarding remote rural users. The problem can be addressed primarily through incentives (for instance, for well-maintained batteries of solar home systems), and pressure applied by local social

groups (the effectiveness of which has been tested extensively in the area of solidarity rural credit).

- Finally, *certain risks cannot be controlled at all*, either because certain parameters cannot be known with any certainty—owing to the very innovative nature of the project (for example, the psychological dynamic of subscription and evasion when there is a large number of users)—or because they depend on variables external to the project. Unless new approaches can be developed to handle them, these risks, if they materialize in serious proportions, can affect the project's basic assumptions, which are presented and discussed as part of the delegated management contract concluded with the authorities. In particular, these risks can hinder the remuneration or, in extreme cases, the recovery of part of the capital that the private operator may commit to the initial investment.

Conclusions on Options

5.40 The key issue at hand regarding rural electrification in Brazil under this new situation is the consolidation of a national strategy for universal access, bringing together all dispersed efforts under an umbrella management scheme, which can effectively boost development impact by integrating the contributions of all stakeholders.

5.41 Legal mechanisms are in place with Law 10.438, but its enforcement must be ensured by the regulatory agency, ANEEL. Analysis shows that targets for 2015, defined by ANEEL, could be met earlier and more efficiently by shortening the learning curve. *Luz no Campo* was a good starting point, but CDE and other additional resources can accelerate its pace.

5.42 It is also vital to *consolidate the participation of the new agents in the rural electrification market*, either under the permissionaire scheme, or as a subconcessionaire, working for the concession holder. These new agents are better suited to implementing off-grid rural electrification, particularly based on renewable energy technologies, a market that still needs help to mature. Facilitated financial conditions, access to subsidies, standards for equipment and systems, flexible rules on supply quality, and capacity building of local technicians and final users will accelerate this process. However, current regulations for off-grid systems do not stimulate concessionaires and permissionaires to diversify supply alternatives. New rules regarding service quality and tariff structure must be enforced for such services.

6

Conclusions and Recommendations

6.1 According to data from the 2000 Census, about 27 percent of Brazil's rural population still lacks access to electricity. This represents more than 2.5 million households. In comparison, the same statistic is about 20 percent in Argentina, Chile, and Mexico. The figure includes the achievements of the *Luz no Campo* program, which will complete its first implementation phase with more than 600,000 new connections, but also users with precarious or illegal access to electricity. One important message from the census data is that the absence of a basic and modern energy source affects particularly low-income families, which end up paying a much higher price for energy service per kWh (because they use batteries) and living with poor quality lighting (from kerosene or LPG lamps), or both.

6.2 Brazil's restructuring of its electricity sector, which was initiated in 1995, is still in flux. Two of the original assumptions—that the government would be able to convert its investments in the energy sector to more social agendas and that competition would bring tariffs down—remain to be proven.

6.3 The supply of electricity to rural areas was somewhat penalized in the restructuring process, which prioritized the maximization of privatization proceeds to the detriment of obligations to new agents. No targets or deadlines were established in the scope of the original concession agreements. When the government realized that rural electrification would not advance by itself under the new scheme, it launched the *Luz no Campo* program, an RGR-funded loan scheme for concessionaires. In many states the pressure on the state treasuries was only postponed, however, since they assumed the responsibility to pay back the loan, bypassing a constraint of increasing their debts. In other words, the burden was transferred to consumers, thus benefiting mostly better-off populations.

6.4 An apparent solution to the problem was achieved with the approval and enactment of Law 10.438, which obliges concessionaires or permissionaires to invest according to schedules established by ANEEL, to reach full coverage in their concession areas, and to recover their investments through tariffs. However, tariffs, which have substantially increased along the restructuring process, are already under pressure from (a) the need to cover losses incurred by the companies during the 2001 energy crisis, (b) the costs of the emergency thermal generation installed to reduce the risks of new

shortages, and (c) the subsidies to low-income consumers—all introduced by the same law. ANEEL needs to reconcile the interests of the regulated entities, the consumers, and the nonsupplied population. Meanwhile the Agency faces strong opposition from concessionaires to the definition of tight schedules, pressure from the government and consumers to minimize the increase in tariffs, and social pressure to accelerate universal electrification. However, the constituency base for universal access seems to be less effective than the high priority of electrification for the rural population would suggest. This might have to do with the overall marginalized situation of those without access.

6.5 Eight months after the enactment of Law 10.438, the government has withdrawn funds from RGR (which was supposed to be the main funding source for universalization) to cover subsidies to low-income consumers. CDE funds are still under dispute between powerful lobbies, and Decree 4541 is ambiguous about the use of CDE funds for universal access.

6.6 Against this background, the most relevant and pressing options to overcome existing barriers are summarized below.

6.7 *An immediate responsibility of ANEEL was the definition of clear electrification targets*, rules for the anticipation and reimbursement of resources from interested parties, and procedures for the monitoring of concessionaires' targets. In doing that, ANEEL has not yet proposed a methodology for defining zones where the grid is likely to be economically viable in the medium term (in contrast to zones where mini-grid or single-user systems are probably the most viable option). The final resolution regulates only the grid extension for the concessionaires, even though it allows the use of alternative technologies to rural electrification cooperatives. By declaring 2015 as the deadline for achieving universal electrification, ANEEL tempered the more ambitious goals envisioned by MME.

6.8 ANEEL may want to consolidate the possibility of awarding permissions inside the concession areas by defining bidding processes, contracts, and procedures for the implementation and monitoring of these permissions. In this context, it will be important to create transparent rules to minimize future disputes, and to ensure the financial sustainability of new agents. This should include adequate rules for the alternative providers of mini-grids and single-user systems.

6.9 Given that there is no interest in creating pockets within less attractive markets or stimulating disputes between concessionaires and permissionaires inside the concession areas, a viable alternative to awarding permissions inside the concession areas might be to regulate a secondary market with agents working for the concessionaires, supporting them to fulfill their electrification targets. These "subconcession contracts," which could be used in zones where grid extension is unlikely to be viable, would be an instrument for allowing a smoother entry of alternative providers. They would operate on behalf of the concessionaire, which would continue to be solely responsible for their concession.

6.10 Considering that even public funds used to anticipate electrification targets must be reimbursed and that concessionaires must invest their own resources (to be recovered through tariffs), *MME would need to define transparent and efficient procedures for the disbursement of CDE*, or assure alternative funding sources. Since CDE is an energy *development* account, it should probably be used to encourage concessionaires and permissionaires to diversify their supply alternatives—including low-cost grid connections, renewable energy technologies in micro-grids, and single-user systems. This would help to reduce the overall investment costs and long-term costs (e.g. diesel) of Brazil's progress toward universal access. RGR, which is a soft loan, might remain directed to more conventional forms of supply, such as grid extension and diesel sets.

6.11 *A sustainable long term source for financing the cost of the universal access policy is needed*. As a first step, a definition of the amount of funds available from CDE and RGR, and of the total amount of investments needed for universalization, is necessary to assess the need for additional resources. The total amount of investments needed for universalization will strongly depend on the technology mix to be applied; therefore a sensitivity analysis should explore the effect of different penetration levels of off-grid alternatives on overall investment costs and lifecycle costs (and hence on tariffs). Rules must be established to allow for the funds of PRODEEM, the Poverty Alleviation Program, and Ministry of Agriculture to leverage those resources. An effort should be developed to *establish partnerships and integrate programs*, by mapping the objectives of the initiatives of PRONAF, INCRA, and the interests of state and municipal governments, NGOs, and rural extension offices, to optimize the allocation of these programs and initiatives. These key elements are being taken into consideration by the new government, but will require inputs from all of these stakeholders before being consolidated. A key recommendation is the establishment of an *umbrella management scheme* to coordinate these dispersed efforts. MME could host such a Project Coordination Unit.

6.12 *Luz no Campo* (which finances mainly grid extension, charging a 6 percent interest rate with a two-year grace period and a 5- to 10-year repayment period) and the Northeast Development Bank (which finances mainly PV systems to small entrepreneurs) offer good conditions for financing; however larger volumes should be allocated for financing renewable energy technologies. Development Banks and multilateral agencies may choose to create new credit lines (or efficient guarantee instruments) aimed at universalization, but in doing so, they should take great care not to distort the conditions of the *Luz no Campo* program. Projects making use of renewable energy technologies should be able to access funds under differentiated conditions initially (lower interest rates, longer grace and financing periods), to offset lockout effects and shorten the learning curve. Pilot schemes should be financed to boost universal access in weak northeastern states, dispersed communities in Amazonia, and large-scale decentralized electrification in niche markets where the grid is not feasible.

6.13 Financing mechanisms should be accessible not only to rural electrification providers, but also through micro-credit schemes to users**,** preferably matching the periods of reimbursements to be made by the concessionaires for the anticipation of electrification targets. Such mechanisms may want to develop demand by going "beyond the meter" (that is, by financing internal installation, using energy efficiency-equipment, and offering productive uses and other complementary services). When doing so, financing entities should make sure that all users clearly understand their choices.

6.14 ANEEL and Eletrobrás, with international development help, should invest in *market studies* to evaluate the precise local market shares for low-cost grid extensions, micro-grids, and PV systems. The survey teams have to be independent and multidisciplinary to avoid favoring a specific technology. The studies should imply local potential for productive and public applications, potential synergies from bundling with other services, and impacts on tariffs under different scenarios for service quality, technology, and penetration schedule (including the question pf whether the resulting tariffs would be acceptable). Various sensitivity analyses need to be applied to evaluate the distribution of this impact among different consumer classes. *Refining these figures is vital to the consolidation of the market and for attracting investors.* Also, this would allow for the allocation of potential cross-subsidies to be transparent ex ante to the whole society.

6.15 Among the options available to concessionaires and permissionaires to minimize their own investments (and the subsequent impact on tariffs) are the use of *more cost-effective technologies*, including low-cost grids (wood poles, low power transformers, single-wire earth return lines, and aluminum cables) and decentralized rural electrification (mini-grids based on renewable energy technologies, solar home systems, and the like). However, there is a lack of support for these alternatives. The existing regulation fails to establish clusters for differentiated markets that are compatible with low-cost technologies, taking into account issues such as quality requirements, ownership of the equipment, tariffs, potential disputes between agents, equipment and systems standards, and so on. An estimated 20 to 30 percent of the currently non-supplied market could probably be more cost-effectively attended through off-grid solutions, with regional variations. Obviously this estimate depends highly on the definition of minimum service quality levels.

6.16 *Whenever RETs are applied, a training component must be included in the package*, since training users is a fundamental prerequisite for sustainable service over time. Local technicians should be identified and trained to minimize the operations and maintenance costs.

Conclusions from Case Studies

6.17 The case studies analyzed during the preparation of this report, as well as the discussions during the stakeholder workshop in Brasilia, have produced the following conclusions:

Success factors for future rural electrification projects in Brazil:

- Need for careful and comprehensive planning and coordination;
- Need for right incentive structure and cost efficiency;
- Need for long-term service sustainability;
- Need for clear project selection rules;
- Need for local involvement (communities, universities, small IPPs);
- Need for training and control of technical expertise; and
- Need for demand surveys.

Specific barriers preclude renewable energy technologies from improving electrification:

- Information and capacity deficits;
- Lack of coordination among different institutions and governmental programs;
- Limited commercial financing offered to providers, with unfavorable conditions (high interest rates);
- Lack of flexibility on quality standards and standardization of equipment and systems for off-grid supply as well as a lack of information and resulting prejudice against renewable energy solutions;
- Lack of incentives to diversify the options of energy supply;
- Strong focus on grid extension and use of diesel sets in the Amazonia region; and
- Local unavailability of alternative technologies.

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Annex A

Rural Services and Uses: An Overview Matrix

USES→ SERVICES	*Household, social, and community uses*	*Productive uses (Micro- and Small Business, MSB)*	*Education uses*	*Health uses*	*Public administration uses*
Electricity	Improved quality of life (light, TV, radio). Light: children and women gain additional time at night (reading, homework). Improved light quality (200 times brighter) and cost per lumen. Reduced cooking times and easier cleaning owing to illuminated room. Increased productivity for consumption. Safety: Street lighting allows children and women to socialize at night. Facilitates community activities (light, TV, radio, discotheques). Potential effect on birthrates?	Raises productivity, which leads to increased profit and employment. For instance, light extends work time; electricity allows applications such as water pumping (irrigation), soldering, motive applications (drilling, sawing, mills), cold chain (for example, for small shops and restaurants, milk processing, beef storage), fish ponds, electric fences, video cinemas, and so on. Permits use of ICT.	Studying at night; adult education; allows for ICT (see below); allows for retention of qualified teachers. Schools serve as anchor clients for service providers. Subsidizing public services is an efficient way of targeting subsidies with reduced free-rider effects.	Light for emergencies, childbirths; vaccine fridges; HIV. Domestic light seems to be correlated with more whitewashed walls and fewer bugs (for example, Chagas).	Allows for more efficient public administration. Connections to ICT possible (see below).
Other energy (such as liquefied petroleum gas (LPG), traditional fuels)	Clean cooking.	Rural industries are often energy intensive, which leads to more efficient production methods, which in turn lead to increased profit.	Being too cold or too warm significantly decreases capacity to study.	Tool sterilization; vaccine fridges.	More efficient services. Improved heating and cooling leads to labor efficiency
Water	Clean drinking water. Reduction in water transport time.	Irrigation.	Access to clean water improves children's health and increases opportunities for education (for example, it increases class attendance).	Reduction of infectious and intestinal diseases.	
Rural telephony	Social inclusion; social capital (maintaining contact with relatives), coordination of remittances.	Facilitates contact with customers and suppliers; increases market potential; decreases downtime.	Qualified personnel more likely to come to rural areas.	Emergency communication .	Better and cheaper communication between centralized and rural public administrations.

Other ICT (fax, computer, Internet)	Inclusion, access to information. Allows clustering of currently isolated civil society bodies for stronger voice and political inclusion (grassroots movements, remote polling, e-mail opportunity, and so on). "Global village"—international e-mail friendships, employment opportunities, and so on. Remittances; remote order of goods paid for by better-off relatives; direct donations from individual private donors through the Web.	Access to new customers and new suppliers; potential for online commerce (B2C, B2B, and B2G); basic business software and expert systems supporting planning, marketing, financial and managerial accounting, and inventory management. Quality control (for instance, organic food with specified origin); customer-specified handicraft; online training. ICT can improve the quality of Business Development Services (BDS) to small and medium-sized enterprises (SMEs).	Distance learning: computer literacy; individual, interactive learning; "*talent scouting*" through interactive "online-tests."	Telemedicine. Health databases and expert systems. Health Education. Epidemiology.	E-government, both at central and local levels. Increased administrative efficiency; facilitated transactions between government, businesses, and citizens; enhanced decentralization, transparency, and accountability. Decentralized census, tax payment, business registration, licensing, certificates (such as birth, marriage, and death certificates, driver licenses).
Business/ management development services		Increase MSBs' growth and profitability, for instance, through planning and budgeting, marketing, reporting, financial accounting, operations (such as inventory and supply chain management), market and product diversification.	Management tools may improve schools' efficiency and effectiveness, for example through strategic planning, budgeting, accounting, and performance evaluation.	Improve efficiency and effectiveness of hospitals and local health units, for example through strategic planning, budgeting, accounting, and performance evaluation.	Improve efficiency and effectiveness of public administration, for example through strategic planning, budgeting, accounting, and performance evaluation.
Micro-finance	Opportunities to improve living conditions, for example, credits for housing improvement, connection to water and electricity.	Opportunities to improve MSBs' growth and profitability, for example, productive credit (investment and working capital).	School loans.	Insurance. Credit to small pharmacies.	

Source: From Motta and Reiche (2001).

Annex B

Benefits of Rural Electrification

A.B.1 Rural electrification can have a dramatic impact on the development of a region. Access to electricity directly raises the living standard of rural households and communities; it allows improved public services, can increase income and create employment by enhancing rural productivity. However, the extent to which these potential impacts have materialized in past rural electrification programs has varied greatly. Success factors are emerging and will be analyzed and applied to the situation in Brazil throughout this document. This annex describes some of the possible benefits of rural electrification in Brazil.[52]

Economic Diversification, Growth, and Employment

A.B.2 Rural electrification can improve existing businesses and create new possibilities for income generation through productivity increases and diversification of the rural economy. These economic benefits occur on the national, regional, and local levels. Eletrobrás has estimated a total volume of more than R$3,000 of sales directly resulting from rural electrification programs; R$2,329 average sales of electrical equipment and supplies for grid construction, per newly electrified farm; R$349 average spending on new equipment for productive uses (mainly motorized electrical devices); and R$464 average sales of household equipment per connected user.. Hence, rural electrification will benefit private entrepreneurs on the electricity demand side by increasing productivity, and on the electricity supply side by expanding the markets for local electricity service. It will also expand demand for electrical appliances, components, and equipment. Furthermore, there will be indirect benefits for the government in increased tax revenues from purchase of equipment, increased economic activity, and more taxable income and benefits. For example, Eletrobrás estimates that the *Luz no Campo* project will generate an annual increase in taxes (ISS, ICMS, and IPI) of R$2,000 per rural property.[53]

A.B.3 On the local level, productivity increases resulting from expanded supplies of electricity may sometimes result in less low-wage employment. However, in the context of Brazil the output of the rural worker is generally limited by labor availability. Thus, electricity supply is expected to contribute to much-needed productivity increases

[52] The matrix in annex A gives an overview of *rural services and uses*.
[53] Eletrobrás' *Luz no Campo* program (*Programa Nacional de Eletrificação Rural*), March 1999.

(rather than replacement) in human work required in small-scale agriculture and cattle breeding. Although increases in labor productivity for small-scale agriculture depend on access to water[54] and mechanical force (for instance, mills, which can also rely on fossil fuels and animal force), significant productivity gains can be achieved through substitution of these traditional energy forms by electricity. In addition, many other technologies used in agriculture and livestock farming rely on electricity supply: for example, equipment for the cold chain (that is, milk tanks, meat refrigeration, and others), milk processing equipment, electrical fences, pumps and lighting for fish farms, or heating installations for chicken breeding.[55] As a result, agricultural production and sales usually increase with electricity access: According to the Eletrobrás studies, rural electrification programs in Brazil increase farm incomes by 100 percent, on average.[56]

A.B.4 Aside from the benefits for the agricultural sector, electricity facilitates the diversification of the rural economy. Many economic activities related to trade, handicraft, commerce, and services (such as retail, trade, and tourism) could profit from electricity as a crucial input for productivity increase.[57] Furthermore, the availability of light allows extending income-generating activities into the evening hours (for example, small shops, restaurants, "TV bars"). Electricity is also a necessary condition for the development of telecommunication applications in off-grid areas to ensure the operation of repeaters, satellite receiving stations, fixed rural telephones, Internet connections, and the like (for example, in basic "telecenters"), which in turn can be key to the improvement of many rural businesses through increased information flow.

Quality of Light

A.B.5 In general, there is an important positive effect of the introduction of electricity in the form of improved lighting and the use of electrical devices. In unelectrified areas, people use substitutes for electricity (namely candles, kerosene, and batteries), but the lighting provided by electricity is far superior. The kilolumen output of candles and kerosene lanterns is only 5 to 10 percent that of a 60W incandescent bulb and less than 3 percent that of a 60W fluorescent bulb.[58]

Education and Information

A.B.6 The far superior quality of electrical light directly improves the conditions for reading both at home and in schools. Households gain access to the information flow through television and radio, which are important links to the external world for the rural

[54] Water is needed for several productive applications in agriculture such as irrigation and cattle watering.

[55] For the final strategy study it would be advisable to check the substitution effect and the additional penetration of devices due to rural electrification. One method of investigation can be a survey in areas electrified for a few years to register systematically the cases of substitution and measure the rates of penetration of electrical devices, as a proxy to measure the externality in terms of productivity gains.

[56] *Luz no Campo*, March 1999.

[57] Electricity enables the use of electrical equipment such as refrigerators, clothing irons, sewing machines, soldering irons, electric saws, welding equipment, drilling machines, and so on.

[58] de Gromard (1991); van der Plas and de Graaff (1988).

population. Furthermore, in rural schools and other community facilities, access to electricity allows training courses at night for adults; the use of computers, the Internet, and videos for teaching purposes; and ventilation to improve learning conditions during the hot season. In addition, the availability of electricity and the resulting improvements in the quality of life make it more attractive for qualified teachers to live in remote areas, which improves rural education significantly.

Health Effects

A.B.7 The health benefits of electrification can also be significant:

- Electricity is crucial in health stations and hospitals in rural areas. If electrical light is available in rural health stations (instead of kerosene lamps, for instance), the treatment of patients is easier and more sanitary—especially with regard to emergency treatment and births at night. The benefits of the use of electrical appliances such as sterilizers for instruments and refrigerators for the conservation of drugs and vaccines are numerous. In addition, access to information (telemedicine) increases the quality of rural health services.
- On the household level indoor air quality improves with the substitution of kerosene for lighting by less polluting energy sources. Reducing overall indoor air pollution also requires nonelectrical modern energy solutions for cooking.
- Access to good quality water (through pumping from deep wells and water treatment) reduces diseases and infant mortality.
- Owing to electric lighting especially childcare is easier at night; accidents caused by burns from kerosene lamps and candles decrease; and indoor and outdoor security improve.

Community Activities

A.B.8 Electricity can significantly improve community life: cultural, political, and social events at night become more attractive and easier to organize. Adults can participate in adult classes, for example to reduce illiteracy or disseminate information on health issues. Children can become involved in organized sports or just play outside. The availability of electrical devices such as TV, VCR, or computers (to access the Internet) can make some of these activities more effective and enjoyable. Public lighting increases street safety at night, and can help to ease additional constraints in tropical regions (where the sun sets early), which limit community activities.

Gender Aspects

A.B.9 The possible economic and social transformations of rural areas that result from electrification have a particularly strong impact on the life of women and children:

- Access to water near the house (instead of remote sources) saves time, which can be used for a variety of other domestic or productive activities.
- With economic diversification and increased potential for in-home income generation activities (made possible by extended work hours), women have new opportunities to participate in other economic sectors, such as trade, handicraft, and services (such as tourism).[59]
- Electrical devices such as electric sewing machines and irons facilitate household chores.
- Improved indoor illumination improves overall household hygiene.
- The care for older people, children, and babies becomes easier.
- The improvement of indoor air quality and reduction of accidents related to burns and bad lighting affect especially women and children who are often the most highly exposed as they tend to stay indoors.
- Children especially benefit from improvements in the quality of education and learning.
- Public lighting gives women and children increased freedom of movement in public after sunset.

Benefits for Low Income Groups

A.B.10 Poverty alleviation is the major goal of development assistance. Therefore, the effects of electrification on poorer households deserve special attention. In Brazil, both intra- and inter-regional inequality are very high. Poverty rates are much higher in rural areas (51.3 percent) and poverty continues to be highly concentrated in the northeast: 63 percent of the country's poor live in the nine northeastern states.[60]

A.B.11 Poverty is not only a measure of monetary income. It includes the question of access to individual and collective utilities. Poor households will benefit significantly from access to collective utilities, such as electricity in schools, hospitals, community centers, and last but not least, public lighting. Low-income households that can afford electricity but have low consumption levels can benefit from the potential cost savings owing to the substitution of traditional energy systems[61] and improved access to collective and individual utilities. However, this will only be the case if poor people have access to collective utilities. These effects on rural development will also reduce the

[59] An empirical study should evaluate the impact of rural electrification on gender differentiation in terms of access to these utilities and, especially, consequences in terms of the occupational evolution of women in Brazil.

[60] See World Bank (2000, p. 4).

[61] The total amount spent by households for traditional energy solutions such as kerosene lamps, candles, and batteries is in many cases higher than the costs for electricity supply. However, owing to the option to purchase traditional energy solutions on a daily or weekly basis, compared to the higher upfront amounts needed for connection fees or the purchase of an SHS, this advantage in lifecycle costs is not realized by the rural households.

economic and social gap between rural and urban areas and can result in a reduction of rural-urban migration.

Additional Benefits of Renewable Energy Technologies

A.B.12 On the national level, increased use of renewable energies helps to control fossil fuel imports, which will result in positive effects on the trade and payments balance. Furthermore, large-scale implementation of renewable energy technology projects in Brazil will result in capacity building for end users, private-sector companies, utilities, and government and regulatory agencies. It will contribute to a suitable institutional framework, more effective delivery mechanisms, more efficient equipment maintenance and eventually lower the final cost of decentralized small renewable energy technology systems. This will in turn result in new economic activities and job creation. For example, RET's will increase the demand for technical skills (installation of systems and system maintenance), which can be recruited locally. The involvement of local players such as rural communities, cooperatives, NGOs, the local private sector, and others can increase local economic benefits; a higher share of local jobs and profits of electricity generation may remain in the region. Rural communities can become independent of possible shortages in diesel supply in the case of diesel generators for power generation or power cuts in the case of grid electrification. Additionally, thanks to declining costs, renewable energy technologies can have significant cost advantages in off-grid areas over traditional diesel-generation (which involves high fuel-transport and maintenance costs).

A.B.13 Last but not least, the use of renewable energy technologies for rural electrification is related to significant benefits for the environment on the global, national, and local levels, as they use nonexploited natural resources (mainly sun, hydroelectric resources, wind, and biomass). Renewable energy projects avoid emissions of greenhouse gases by reducing thermal power generation and kerosene combustion. Furthermore, renewable energy technologies reduce other impacts on air, water, and land of thermal power generation, indoor kerosene combustion, and dry cell usage (such as particulates, sulfur dioxide, nitrogen oxides, toxics, and other compounds that are hazardous to human health and local ecosystems).[62]

Importance of Additional Inputs

A.B.14 These benefits of rural electrification do not occur automatically with the availability of electricity. Electricity is a necessary condition for many development impacts, but not sufficient in itself. The benefits of access to electricity depend on additional inputs. Some examples:

- Employment generation and improved incomes depend on existing knowledge and access to new information,[63] quality of the transport

[62] Previous field surveys in the States of Bahia, Ceara, and Minas Gerais have verified and quantified the quantities of fossil fuels that can be substituted by solar home systems (kerosene and diesel).

[63] For example, transaction costs and lack of information can limit the adoption of new productive

infrastructure, sound business practices, access to electrical equipment, loans, and other financial facilities.

- Improved education requires schools, qualified teachers, and well-nurtured pupils, as well as the availability of evening classes, TV, and computers to maximize the benefits for the electrified rural population.
- Improved healthcare depends on the presence of qualified personnel and the existence and condition of a health station.

A.B.15 A previous study in three northeastern states of Brazil[64] evaluated the needs of electricity in rural schools, rural health centers, public lighting, and rural public phones and found that effective demand for electricity in public services depends on specific programs to provide corresponding devices and expanding activities that make use of these devices. The lack of the above inputs and policy framework is an important reason for the slow growth of rural electricity demand after the initial connection. In areas considered for electrification, a certain level of development should already exist to ensure a maximum benefit for the population (and to increase the probability of self-sustaining energy service businesses). See chapter 2 for more on the potential increase of development impacts through bundling or integration of more than one rural service.

Benefits as an Incentive for Government Intervention

A.B.16 Since all rural development activities require energy in one form or another, it is clear that modern energy is a critical input to rural development, even if methodological obstacles often make a quantitative assessment of causalities difficult.[65] Given the right supporting conditions, electricity can play an important catalytic role in economic modernization and growth. Furthermore, the rural populations view electrification as a direct measure of progress.

A.B.17 The global- and national-level benefits are related to externalities and, hence, can be the rationale for government intervention to support rural electrification efforts. On the local level, the beneficiaries will in general value direct and immediate benefits caused by better lighting and access to electrical devices and, thus, only these effects will be reflected in their willingness to pay. Hence, some of the local benefits will not be included in the consumers' willingness to pay. This is due to several reasons: (a) there may be a lack of knowledge and information; (b) not all members decide on the

applications that might become attractive for small rural producers after electrification.

[64] World Bank (2000).

[65] Several empirical reviews have been carried out in recent years on the impacts of rural electrification on rural development. The lack of clear definition of objectives and terminology and difficulties with measurement are common constraints expressed by the reviewers. Other difficulties cited include the timing and frequency of assessments carried out, and the general problem of isolating rural electrification impacts from other factors, particularly in situations where no clear causality is indicated. In the context of Brazil, empirical research is recommended on the community level to validate the actual direct and indirect benefits in grid electrified areas and collect data in off-grid electrified and also unelectrified areas to compare the differences in economic activities and the quality of life.

family's willingness to pay for electricity supply and, therefore, willingness to pay may not reflect all emerging benefits for the family; (c) health and education effects are medium- and long-term benefits and, owing to the high time preference rate of poor people, their willingness to pay often reflects only short-term benefits.

A.B.18 Thus, because of positive externalities on the global, national, and local levels; because of national and social equity issues; and because of existing market barriers that derive from (a) high infrastructure investment needs, (b) insufficient investment capacity and ability to pay of rural households, (c) unattractiveness of rural markets for private investors, and (d) the nascent stage of markets for alternative "off-grid" technologies, public intervention is still required to promote rural electrification in Brazil.

Annex C

International Lessons Learned on Rural Electrification

A.C.1 The World Bank is currently assisting a number of client governments in the preparation and implementation of new national rural electrification programs, with an increasing emphasis on decentralized off-grid electrification projects. A 1995 review by the Operations Evaluation Department of the World Bank (OED) of Asian rural electrification programs[66] noted that most of them had higher costs and yielded fewer benefits than expected. More recent reviews, reports, and project experience of countries with rural electrification and renewable energy development programs provide a broader base to understand what makes rural and renewable energy programs successful.[67] The countries in these studies are Argentina, Bolivia, Bangladesh, Chile, Costa Rica, Cote d' Ivôire Indonesia, Laos, Mexico, Nepal, the Philippines, Sri Lanka, Thailand, Tunisia, Uganda, Vietnam, and South Africa. This annex summarizes the studies' emerging lessons, focusing on innovative off-grid alternatives, and describes 10 particularly interesting cases of rural electrification programs.

Rural Electrification Best Practices

A.C.2 Government facilitates, private sector implements, user participates. In many developing countries, traditional, purely government-driven rural electrification programs with top-down implementation have failed to increase access and ensure sustainable service. On the other hand, experience from power sector reforms in Latin America has shown that the private sector by itself will not significantly expand rural access without contractual obligations (for example, as part of new concession contracts) or additional incentives (for example, with the effort financed from part of the privatization proceeds). This is because rural areas are considered high-risk, low-return markets, and existing concessionaires prefer to focus on their core markets. Therefore, modern rural electrification programs are designed around public-private partnerships, where the government plays the role of a market enabler (for instance, through appropriate regulation and a level playing field) and incentive provider (for instance,

[66] World Bank (1995).

67 Barnes and Halpern (2000); Martinot and others (2000); Reiche and others (2000); ESMAP (2002); Martinot, Cabraal, and Mathur (2002a); Cabraal, Davies, and Schaeffer (1996); Barnes (1988), Barnes and Foley (2002).

through direct subsidies on investments and indirect subsidies for promotion and information campaigns), while the private sector delivers the services efficiently and at least cost, and shares risk and investment costs with the government and the users. A systematic comparison of existing national approaches to public-private partnerships for rural electrification is given in annex E.

A.C.3 *Tariffs.* For rural electrification programs and businesses to be sustainable, it is paramount that rural tariffs be high enough to cover recurring costs. Where this is not the case, recurring costs are often subsidized, which places a heavy burden on the public budget and decreases funds available for new connections. Many rural users are indeed able to pay a substantial fee: demand studies in numerous countries have shown that a significant fraction of rural users already pay around $5 per month for noncooking energy that could be substituted. If tariffs do not include a significant profit margin on top of the costs (as is often the case if close to 100 percent of the investment costs are subsidized), there is no incentive to extend electricity to new customers. Tariffs below real costs will result in a dangerous downward spiral: Low service quality leads to lower customer satisfaction, which leads to less willingness to pay, which leads to less income and no capital for new connections or investments to improve service, which leads to lower service quality. Tariffs often need to be regionally differentiated.

A.C.4 *Subsidies.* As a general rule, subsidies should not be higher than the total investment costs. They should be well targeted, transparent, and aimed at keeping distortions at a minimal level by, first, minimizing existing energy sector distortions. Targeted and efficient "smart subsidies" should be sustainable and transparent (that is, they should avoid implicit "hidden" cross subsidies), secure funding over time, and define an exit strategy. To increase efficiency, the subsidy amount and a balance between direct and indirect subsidies need to be adapted to the market development stage. Subsidies should be linked to performance indicators wherever possible (this is termed "output based aid," or OBA), while matching the financial situation of potential suppliers. To ensure good governance, administration and oversight need to be clearly defined. Incentives should be given to minimize provision costs over time and improve service quality where possible.

A.C.5 *User fees*. Users should pay for the service (thus cementing ownership) and, as a general rule, cover at least the operations and maintenance costs of the service. In addition, local participation is crucial to ensure ownership (see more below under off-grid rural electrification best practice).

A.C.6 *Effective institutional structures and clear criteria*. Independence from short-term political influence is crucial for rural electrification institutions. Clearly defined and transparent criteria need to be defined to rank projects and areas in order of priority for electrification, so that the decisionmaking is fair. Where projects are selected purely on a bottom-up basis (one example is Bolivia's decentralization law), local priorities decide. At the national level, private-sector interest, capital investment costs, the level of local contributions, numbers and density of consumers, and the likely demand for electricity are among the factors normally taken into account for project ranking. In Costa Rica, the ranking of communities is based on their population density, level of

commercial development, and potential electricity load. Thailand developed a numerical ranking system taking account of a variety of factors such as level of income, the number of existing commercial enterprises, and the government's plans for other infrastructure investments in the area. In the case of the private-sector-led program in Chile, the program administering the rural electrification subsidies had a formal methodology for evaluation whether or not the proposed expansion to particular villages was financially or economically viable.

A.C.7 *From projects to multiparty programs with bottom-up ownership.* Well-planned, carefully targeted, and effectively implemented rural electrification programs provide enormous benefits to rural people. However, the "first generation" of rural electrification programs in the 1970s and 1980s did not lead to the expected overall development impact and usually proved to be very expensive, with crippling effects on the government-owned utilities that undertook them, effectively blocking expansion of access to the excluded population. Also, large-scale rural electrification has proven to be a relatively complex business with many different organizations, different technologies, and multiple sources of funds involved. Creating a focused rural electrification program within this complexity requires time to establish an effective institutional structure, build the human capacity base, and design a broad-based strategy. Rural electrification should be based on commercial viability, with some generally accepted subsidies, decentralization of decisionmaking, and demand-driven selection criteria for service expansion—rather than top-down "Rural Electrification Master Plans." Countless failed initiatives show the futility of premature rural electrification. Providing an electricity supply will only make significant contributions to sustainable rural development when the other necessary conditions are present. Traditional thinking in many utilities is often oblivious to the importance of local community involvement. In such cases rural electrification is seen simply as a technical matter of stringing lines to grateful consumers.[68]

A.C.8 *The Rural Electrification Agency and the Rural Electrification Fund.* A rural electrification agency that facilitates and intermediates among players is an important success factor. A rural electrification fund is the main financing mechanism that channels the incentives to private-sector players (or users). Its funds can come from privatization proceeds, sector fines, sector levies, or tax revenues. The agency and the fund should be separate, to avoid confusion of roles. The rural electrification fund should only provide grants—if concessional financing or partial guarantees are part of the program design.

A.C.9 *Leveling the playing field.*[69] It is beneficial to create a level playing field for private-sector participants, and for all types of technologies. It is also beneficial to

[68] This has been shown in off-grid concessions; they should go ahead only after full institutional, organizational, and regulation has been put in place, and after successful projects have attracted interest from investors. A sufficient number of investors should be convinced that profit is to be made in the rural electrification business to participate in competitive bidding. If this is not done, no party might be willing to bid on the projects.

[69] Taken from an internal World Bank draft for the Uganda Energy for Rural Transformation Project..

establish a market/sector structure that permits private-sector entry for supply of electricity generation, transmission, distribution, and retailing. This would include the interconnected grid system and standalone, independent mini-grid systems. However, the introduction of technologies with an environmental benefit should receive additional support to achieve a level playing field,[70] taking best practices for support into account.[71] This would ensure fair competition for all suppliers with respect to the state-run power utility or its successors. In particular, all necessary steps should be taken to ensure that the state-run power utility does not have an unfair advantage over potential private-sector participants in competing for the distribution and retailing of electricity purchased in bulk from the grid system operated by the state-run power utility. For example, the state-run power utility should not have an unfair advantage of offering relatively low retail tariff areas for a new distribution area, funded by an implicit cross-subsidy from the state-run power utility's existing retail operations.

A.C.10 *Matching local demand*. Energy demand profiles in rural areas vary. Demand surveys have to be conducted to (a) match service types and levels to demand (willingness to pay), and (b) attract the private sector. When servicing low-demand, rural customers it is essential to (a) distinguish among $/kWh, $/HH, and $/service (for example, lumenhours, liter of water pumped, and so on)[72], and (b) weigh all three against the typical demand and limited willingness to pay of rural market segments

A.C.11 *"Light-handed regulation.*. Distribution costs should be kept low, especially in areas with low electricity consumption. This requires more flexible quality standards. Therefore, it is key to adapt regulation, service standards, technologies, and delivery models to local needs and conditions. Rural electrification often follows urban technical quality standards and perceptions of needed electricity services. This has resulted in expensive systems that are underutilized. There are major opportunities to reduce the construction and operating costs of rural electrification in most countries. In many cases, careful attention to system design enables construction costs to be reduced by up to 30 percent, contributing significantly to the scope of the rural electrification program. Also, local investors tapping into local resources to generate electricity often

[70] For example, for renewable energy systems in the form of mandated market programs. Lessons learned indicate mandated market policies should ensure that (a) a competitive environment is developed in the renewable energy segment to reduce technology and project development costs; (b) flexibility is maintained with respect to changing market conditions, for example, in terms of restructuring and deregulation of power sectors; (c) reliance on administrative procedures is minimized; and (d) exit strategies are developed and implemented as soon as barriers are removed.

[71] For example, for solar systems. A key lesson learned is that initial solar market development is often rather slow, as it takes time to develop and fine-tune effective business models (operations, servicing, and financing) for operating a solar PV business in rural areas. Some of the ways to accelerate implementation are to (a) provide flexibility in project design in terms of delivery mechanisms/model and technical specifications about size and nature of systems supported; (b) focus initially on cash sales, as credit collection can be costly and risky;(c) introduce systems of various sizes, so that consumers have a choice of models; (d) and provide business development assistance to solar PV dealers.

[72] ESMAP (2002).

have to negotiate agreements with the buyer similar to those signed for large-scale, urban operations.

A.C.12 *Monitoring and supervision mechanisms.* Sector regulations need to include monitoring and regulation to ensure proper accountability and channels for the complaints of the two parties (providers and users), especially in remote areas where the regulator is not easily accessible.

A.C.13 *Supporting public and productive uses.* Productive uses allow for increased impact of electrification (income, employment), and at the same time are important anchor clients with high demand—they make the business model of local providers more sustainable. Public uses increase development impact, and are accessible to all rural users, so that even the poorest segments (which may not be able to afford household access, even when subsidized) profit from rural electrification.

A.C.14 *Bundling*. Combining the provision of several services has the potential to boost living standards far in excess of the individual impacts of each service—it promises economies of scope on the supply side and higher efficiency on the implementation side, while increasing the poverty alleviation impact on the demand side:

A.C.15 On the *demand side*, recent evidence has shown a more-than-linear increase in benefits for the poor, when bundling several services together.[73]

A.C.16 On the *supply side*, the low demand and high cost of business in rural areas suggest *"bundling"* of services to profit from economies of scope. The concept of "multi-utilities" is of special interest to remote rural areas, where the main cost savings would stem from leveraging the high costs of accessing the dispersed clients. While some services may allow for such "bundling" through one provider (for instance, provision of electricity, water and telephony, as in the case of many rural cooperatives), this will be difficult in many cases owing to differing regulatory frameworks and schedules for tenders. However, even without the formal formation of *"rural multi-utilities,"* supply-side synergies can be realized: An interesting example of such a benefit from synergies on a more decentralized community level can be found in Jujuy (Argentina), where the local operators of remote village mini-grids collect the fees for both energy service and domestic satellite TVs—for two separate companies. The costs and benefits of horizontal integration should be assessed for each specific situation, and for each level of the delivery chain. A first step toward letting the markets decide on this cost-benefit assessment case by case would be to level the playing field for such integration on various levels.

A.C.17 On the *implementation level*, a common project coordination unit and joint tenders may allow for additional synergy effects. In particular, indirect subsidies for market development (such as rural market surveys) show a high potential for leveraging costs. However, it has to be noted that projects covering more than one sector will most probably need higher supervision budgets, which raises transaction costs and will have to be weighed against the advantages of integration by donors and client governments.

[73] World Bank (1999b).

While experience has shown that the higher cost of coordination between sectors (on all implementation levels) may easily outweigh potential cost savings owing to synergies (for example, the failure of the integrated rural development projects of the 1970s), it is hoped that through the bundling of just two or three concrete services (that match the specific local demand) this coordination problem can be controlled.

A.C.18 *Low-cost technologies.* Opportunities to reduce construction and operating costs should be harnessed for grid extension, mini-grids, and isolated systems.[74] An important example is single-wire grid extension. In many cases, careful attention to system design enables construction costs to be reduced by up to 30 percent, contributing significantly to the pace and scope of the program. Where the main use of electricity is expected to be for lights and small appliances, typical of many rural areas, there is no need to apply the design standards used for much more heavily loaded urban systems. In Thailand, materials were standardized and manufactured locally, reducing procurement, materials handling, and purchasing expenses. In Costa Rica, the Philippines, and Bangladesh, the adoption of the proven single-phase distribution systems, used in the U.S. rural electrification program of the 1930s, brought major savings over the three-phase system still widely used in Africa and elsewhere. These case studies show that careful and critical analysis of design assumptions and implementation practices invariably reveals potential for significant cost savings.

A.C.19 *Technology choice.* Historically, rural electrification projects have often been technology driven. They have provided access exclusively through either grid-extension, diesel-mini-grids, or SHS. The World Bank has tried to make its current generation of projects more technology neutral—to respond to a specific local demand for energy service, private-sector players are free to choose the technology best suited for a given village or productive use on a least-cost basis. Such an approach requires a greater emphasis on the tools and planning skills needed to find least-cost solutions. While scarce resources in countries with low electrification rates should be used to invest in the relatively inexpensive "low-hanging fruit" connections first (for example, the suggested increase in local penetration of existing grids), the exclusive focus on grid extension of many government-executed rural electrification strategies can lead to a neglect of alternative solutions, such as off-grid electrification. As a result, grid extensions are often pushed to low-demand rural customers where investment costs are already rather high (sometimes up to more than 2,000$ per customer), long past the stage at which diversification in technology options would have been warranted. To avoid this pitfall, rural electrification strategies have to start early to build up the local market for such off-grid options, in parallel to grid extension.

A.C.20 *Output-based aid.* To increase the effectiveness and efficiency of rural infrastructure projects, various countries have recently chosen to adopt output-based subsidy schemes, in which payments are tied to specific outputs instead of inputs (for instance, labor and materials). With the traditional approach, results have often been disappointing—incentives for efficiency and innovation have been weak; accountability

[74] For the cost reduction potential of mini-grids, see ESMAP 2001b.

for performance has been dismal; and opportunities to leverage public resources through private financing have been limited. Output-based aid seeks to address these weaknesses by delegating service delivery to third parties under contracts that link payment to the outputs or results delivered. The basic principles and features of output-based schemes are shown in annex table C.1.

Table C.1. Output-Based Aid Schemes

Basic principles	Basic design steps
• Targeting of development outcomes • Accountability for results • Incentives for efficiency • Opportunities for innovation • Mobilization of private financing.	• Clarifying the role and sustainability of public funding • Deciding who will be eligible to receive subsidized services • Choosing the market environment (competition versus monopoly) • Defining performance • Linking payment to performance • Shaping other aspects of the contract (form and duration, dispute settlement etc.) • Structuring the administration of the scheme

Off-Grid Rural Electrification Best Practice

A.C.21 *Off-grid technologies* can provide an alternative solution for many remote, low-demand rural users, at lower costs than grid extension.[75] Power for off-grid areas may be supplied through two basic options—village mini-grids (serving tens to thousands of users) or isolated systems (serving just one or two users)—and power may be generated from a variety of resources such as diesel-, biomass-, wind-, PV-, or small hydro-generators, or hybrid combinations of these. Depending on the characteristics of a specific use (that is, ability and willingness to pay and load profile) and the local supply options, the most suitable solution for a rural off-grid system may consist of any combination of the above options. Renewable energy technologies are increasingly used for the off-grid electrification of remote, low-demand rural users. Thanks to declining costs, renewable energy technologies can have significant cost advantages over traditional diesel-generation in remote off-grid areas (while the initial investment is higher for renewable energy technologies, the lifecycle costs can be lower owing to the high fuel-transport and maintenance costs of diesel generation in remote areas), especially where low demand and 24-hour service requirements come together. These technologies also have additional environmental benefits. For photovoltaic technologies, the price per peak wattage has declined from about $40 in 1970 to under $30 in 1978 and less than $5 in 1993.[76] There are lessons to be learned on off-grid electrification from projects in Argentina, Bangladesh, China, the Dominican Republic, Morocco, Sri Lanka, and others. Many of these projects are testing new project design approaches for the first time. Their emerging lessons are summarized next.

[75] Foley (1995); World Bank (1996); Reiche and others (2000)

[76] Acker and Kammen (1996).

A.C.22 *Market development.* Except for diesel, all off-grid technologies are relatively new, therefore markets are nascent and there is a lack information about these new options on all levels (government, users, suppliers). Consequently most off-grid rural electrification programs aim at developing sustainable local markets that will persist beyond the development assistance phase. It follows that off-grid programs should help to overcome existing market barriers on the demand side (for instance, awareness campaigns, training, participatory project design) as well as the supply side (business development services, market surveys, databases on renewable energy resource availability), with appropriate financing mechanisms (for instance, national grant funds, local micro-finance facilitation, consumer credits) and institution building (government, regulator, certification institutions).

A.C.23 *Delivery mechanisms.* New emerging approaches to decentralized service delivery promise to improve rural access at lower costs and with more flexibility to match local demand. Decentralized "micro-infrastructure" technologies require innovative service delivery mechanisms that allow for sustainable operation over time. Different service delivery models may be best suited for different regions or projects and should be adapted to local conditions. The best model for a specific project depends on a variety of factors, such as market size, transaction costs, electrification target, total funds available for subsidies, existing suppliers, and potential economies of scale and scope. The two main groups of emerging business models for off-grid energy service provision are equipment dealers and rural utilities:[77]

- *Equipment dealers* (cash sales or finance leasing) where the market is ready on the supply and demand sides and the potential overall sales volume is large enough (such as the case with Sri Lanka and Indonesia); and
- *Rural utilities* or locally based *cooperatives*, working with licenses or exclusive area concessions. Wherever such rural service providers maintain the ownership of the equipment and charge fees against the actual service provided over time (operate leasing), they are often called rural ESCOs (Energy Service Companies). As exclusive concessions do not allow for competition in the market (as the dealer models do), competition for the market is important: therefore, wherever possible, these concessions are bid out for a minimum subsidy, minimum tariff or maximum number of beneficiaries.

A.C.24 *Participation.* Rural electrification programs benefit greatly from the involvement of local communities—or suffer because of their absence. While participatory processes are important for any development project, they are especially important for rural areas. The further away from existing infrastructure networks (national road system, communication infrastructure) a rural service is provided, the more crucial user participation becomes. Individual solar home systems are a good example:

[77] For details on the different business models, see for example, International Renewable Energy Society (2001); Reiche, Martinot, and Covarrubias (2000).

Every visit by a technician or salesperson is costly, and the user is the only person close to the system all the time. Increased user participation will be key to reducing the cost of both service provision and regulation. In the case of an Argentine off-grid rural electricity concessionaire (*Empresa Jujeña de Sistemas Energéticos Dispersos SA*, EJSEDSA), various degrees of user responsibilities have evolved. The type of participatory process applied is different for community systems (such as mini-grids) and individual systems. Wherever new technologies are applied, training users is essential for the successful adoption of these innovations.

A.C.25 *Equipment standards.* Crucial success factors for sustainable SHS market development are well-designed procedures for quality assurance of components and service. This includes developing codes and standards and establishing certification, testing, and enforcement institutions: The PV GAP (Photovoltaic Global Accreditation Program) manuals, developed under the guidance of the Bank's Asia Alternative Energy Program (ASTAE) will be a good starting point for a national strategy for solar home system quality control.

A.C.26 *Demand- and supply-side BDS*. Business development services help suppliers, utilities, and co-ops to develop business plans, and train them in the specifics of alternative off-grid technologies. At the same time, facilitating business development services on the demand side will address additional bottlenecks that may prevent local small businesses from using electricity to increase their productivity (and in turn to increase their electricity demand).

A.C.27 *Involving local subcontractors.* Local entrepreneurs are closer to the users and communities. This allows them to meet local demands better and faster, reduce transaction costs and nontechnical losses, and increase user satisfaction. As an example, see the Argentina Renewable Energy for Rural Markets Project (PERMER).

A.C.28 *Integrating off-grid policy* into the overall energy sector policy, instead of creating separate rules and institutions.

A.C.29 The remaining best practices can be outlined as follows:

- Ensure that the program does not crowd out existing small and medium-size service providers.
- *Adapt regulation* to the special requirements of off-grid service quality.
- Answer the specific social challenges of mini-grids (allocation of limited power and energy).
- *Choose promising pilot sites* for the first phase (to attract private sector with success stories and to reduce perceived risk and hence interest rates for commercial credit), and ensure the replicability of pilot phase design.
- *Design suitable credit mechanisms for solar home systems* to finance high upfront costs. Facilitate microcredit for solar home systems and for productive uses.
- *Offer several service levels* and include small SHS system sizes.

- Conduct consumer awareness and marketing programs for new technologies (SHS).
- *Train* users and suppliers.
- *Design battery-recycling programs* and ensure that mini-hydro sites are environmentally sound.
- *Demand Side Management (DSM).* In every off-grid system design, first identify the service demand, then minimize power needed to satisfy demand, and based on this demand curve, design the supply system.

Ten Typical Rural Electrification Projects

A.C.30 *Argentina* has made significant progress in its efforts to reform the power sector. While it had a relatively high overall rate of electrification in 1999 (over 95 percent), substantial numbers of the rural population still remained without electricity services (over 25 percent). The ongoing Renewable Energy for Rural Markets Project (PERMER), financed by the World Bank and GEF, aims to provide about 35,000 remote rural households, 1,750 public services (rural schools, health posts) and 500 productive uses with electricity through provincial "off-grid concessions" that are negotiated or bid out for minimum subsidy and regulated by independent provincial regulating agencies. The concessionaire is free to choose the least-cost technologies applied to meet its universal service obligation. Initial investment costs are divided up between the user (about 10 percent of investment costs paid upfront as a connection fee), the concessionaire (30–40 percent, depending on the service level), and an upfront subsidy. This project's subsidy is about 50-60 percent and paid partly at the time of procurement of a new lot of systems and partly against met installation targets, to balance the advantage of a direct control of outputs with manageable working capital costs to the concessionaire. Installations, service quality, and customer satisfaction are verified ex post by the regulator. The monthly user fees pay for operations and maintenance costs (typically about 50 percent of lifecycle costs) and for recovering the concessionaire's share of investment costs. In some cases, provincial subsidies are applied to further lower the monthly user fees out of social considerations (for example, "Ley de Puna" in Jujuy), based on customers' ability and willingness to pay. The most advanced PERMER concessionaire, EJSEDSA, has been operating since December 1996 and was delivering sustainable electricity service to about 4,000 rural households and schools by 2002 (up from about 1,500 users in 1997), by means of mini-grids for agglomerated households (powered by micro-hydro, diesel, or PV-wind-diesel-hybrid systems) and solar home systems for dispersed households, against monthly user fees reflecting the service levels. Ownership of the SHS module, charge controller, and battery in this fee-for-service approach lies with EJSEDSA. The user or local government pays for and owns the internal installation (payment in rates is possible). This allows for repossession of SHS in case of default on user fees (following a previous notice). Reconnection costs are set at triple the initial installation fee. About 40 solar home systems have been de-installed over the last five years because of payment default.

A.C.31 In *Bolivia*, a 10-year World Bank Adaptable Program Loan (APL) starting in 2003 (Decentralized Infrastructure for Rural Transformation, IDTR) will spend about $60 million to increase access in rural areas to electricity services and information and communications technologies. The program will use innovative, decentralized business models and focus on productive uses and training of suppliers and users. Phase One of the project focuses on grid densification and PV systems for households, rural enterprises, and public uses (street lighting, school, clinics). Phases Two and Three will include village mini-grids. Output-based subsidies for innovative "Medium-Term Service Contracts" aimed at local market development will be competitively awarded in tenders. Extending cellular phone, TV and radio coverage to rural areas will increase the demand for PV systems.

A.C.32 *Brazil.* A project negotiated in the State of Bahia illustrates the difficulties involved in the permission approach in Brazil at that moment. The project was based on the fee-for-service principle and was developed in an off-grid area of COELBA's concession area. The project proposal was led by the French utility EDF (*Electricité de France*). The project's objective was to electrify approximately 15,000 off-grid households. Under this project proposal the Bahia government would enter into a negotiated contract with a private operator to supply off-grid electrification services to the population over a period of 15 years. The operator would be responsible for procuring the equipment, ensuring the promotion of the service to the target population, installing the SHS, collecting monthly payments, and maintaining the equipment. The permission contract would stipulate the obligations of the operator in terms of quality of service, monthly tariffs, and connection rights to be paid by the users. It would also stipulate the conditions of payment of the subsidy by the government, the compensation clauses in case of overlapping between the grid and the project, the formula for tariff increase, and early termination clauses. The project's preparation was cofinanced by the private operator (60 percent), the *Fonds Français pour l'Environnement Mondial* (32 percent), and the State of Bahia.. The total cost of the project is US$15 million. Because of its innovative character the project has faced difficulties in its preparation phase (four years), and final agreements have not been reached, owing mainly to the lack of definitions of the role to be played by PV systems and the relationship between the permission holder and the concessionaire.

A.C.33 *Chile.* In 1994 the Chilean government initiated a concerted effort to increase rural electrical coverage from approximately 50 percent to 75 percent by the year 2000, implying the provision of new service to approximately 120,000 households. This initiative, called the Rural Electrification Program (*Programa de Electrificación Rural*, PER), established goals on both the regional and national levels with respect to electrification coverage and concurrently attempted to rationalize the use of government subsidies to achieve these goals. Subsidies are distributed through the application of an evaluation methodology that systematically prioritizes potential electrification investments based on long-term benefit/cost analyses from both economic and financial perspectives. The program, which was designed to run until 2004, has increased the coverage of electricity systems in rural areas from 53 percent in 1992 to 76 percent at the end of 1999, exceeding the 75 percent target set for 2000. It has shown that it is possible

to create market incentives that lead to efficient private rural electrification solutions—an important lesson at a time when so many developing countries are reforming their power markets and privatizing their state-owned electrical utilities. At the same time, the proportion of the state subsidy has declined over time in PER. The new administration of President Ricardo Lagos has extended it, with a new goal of 90 percent rural electrical coverage by 2005. To reduce the risk of politicization, minimize project costs, and encourage innovation, competition is used at as many levels and stages as possible: among projects proposed by different rural communities, among distribution companies interested in supplying these communities, and among regions requesting funds from the central government. Most of the projects have involved extension of the grid, a solution that usually means a lower cost per connected dwelling and a higher quality of service. Other projects have relied on alternative technologies, primarily one-house photovoltaic systems. These systems have been installed in isolated areas in the northern part of the country (for nearly 1,000 dwellings), which has some of the strongest solar radiation in the world. Micro-wind, biomass, and hydropower generators have also been used, mainly in the southern part of the country. Wind and biomass technologies have been used in experimental projects and usually with technical assistance from international organizations, given the lack of experience with them in Chile and the need for further research on the availability and sustainability of these energy sources. Recent evidence seems to indicate that the overall cost efficiency of the program can be further improved and that the original design did not pay sufficient attention to the integration of off-grid solutions early on.

A.C.34 *Dominican Republic and Honduras.* The company Enersol has developed both leasing and Energy Service Company (ESCO) operations for solar home systems in the Dominican Republic and Honduras. The principle of operation is the provision of the systems through long-term lease contracts, or medium-term microcredit. Under the leasing scheme, users pay a monthly fee to use a solar home system; the equipment remains the property of Enersol. The main limitation of this project is the dispersion of the customer base. Enersol estimates the break-even point at between 3,000 to 5,000 customers per service center. As this ESCO operates without subsidy, fees remain relatively high and the benefit is available only to a small portion of the population.

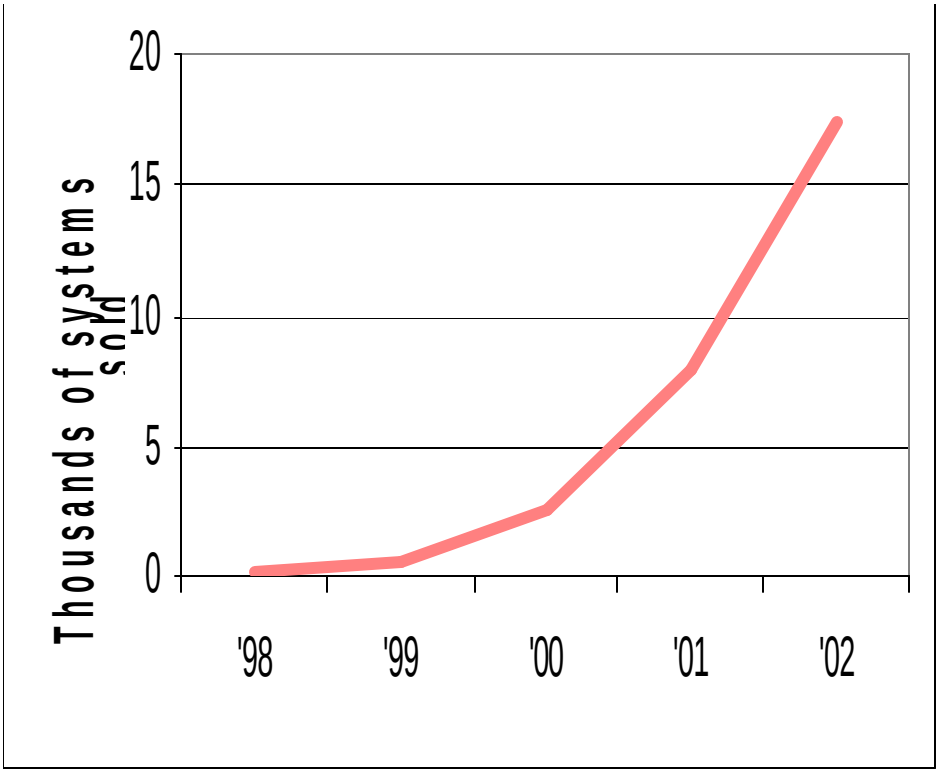
A.C.35 *Indonesia.* The $111 million Indonesia Solar Home Systems Project (funded by a $20 million International Bank for Reconstruction and Development [IBRD] loan, a $20 million GEF grant, and local funds contributing the rest) is the first standalone PV project financed by the World Bank. The project aims to provide solar home systems (averaging 50W per unit) to about 200,000 homes in rural areas through a commercial (vendor-based) approach . The project has run into implementation problems, owing mainly to the Asian financial crisis, but also to other structural implementation issues (for example, local operators were not willing to take the full project risk). However, Sudimara, a private company in Indonesia, managed to maintain sales operations in the country for many years. After the crisis, the project recovered and sales picked up. Purely commercial initiatives have also been successfully tested in *Kenya,* where the number of low-cost solar home systems (mainly amorphous Silicon modules) sold by private dealers has exceeded the pace of grid connection in some rural areas.

A.C.36 *Morocco.* The government encourages the participation of the private sector in off-grid electrification projects through a National Rural Electrification Project. A first project was implemented in May 2002 in the four provinces of Khemisset, Khourigba, Settat, and Khenifra not yet connected to the county's electrical grid. The project aims to provide solar electrification services to 16,000 rural families under a fee-for-service scheme over a period of 10 years. This project is led by a special purpose company, TEMASOL, whose shareholders are *Total Energie* (a French system integrator), the French utility EDF, the oil company TOTAL FINA ELF, and a local installer. In this project the government has chosen to buy the equipment and to lease the systems to the operator. This first phase of the project, which actually goes back to 1994, was a pilot targeting 1,500 households in 30 villages (PPER); the pilot was based on the same cost recovery principles as the main project. An evaluation of PPER has confirmed the sustainability of the concession approach in Morocco.

A.C.37 In *South Africa,* urban areas are electrified to levels as high as 80 to 90 percent while the impoverished rural areas are still well below 40 percent. In response the government launched, in 1998, a rural off-grid solar electrification program with a concession approach. The project aims to electrify 300,000 families with solar home systems in the next 10 years. In 1999 the Department of Mines and Energy (DME) selected six private sector consortia (most of the leading international PV companies are participants) and awarded them a regional concession area. Each has the responsibility of electrifying a population of 50,000 families for a period of 15 to 20 years under a fee-for-service scheme. The government will provide the necessary subsidies. The private sector (equity), the government (grant), and the users will share the investment cost. The government is in the process of consolidating the institutional framework for the project. Overall, the program was slow to get off the ground owing to foreign exchange issues and a lack of regulatory clarity. Initial experience with implementation of the fee-for-service approach has been mixed—some concessionaires face problems with operations and maintenance costs and payment morale, while others report fast growth in new installations in 2003 and satisfactory payment morale.

A.C.38 In *Sri Lanka,* the Energy Services Delivery Project and its follow-on project, Renewable Energy for Rural Economic Development (RERED) are the most successful national solar home system projects worldwide. These projects offer consumer financing through microfinance institutions to rural off-grid consumers, who obtain SHS products and services through a competitive network of private dealers. The project has resulted in over 35,000 systems being installed and the pace of installation is now about 1,200 per month. By the end of RERED, about 5 percent of total electrified households in Sri Lanka will have been served using such off-grid means. These projects are among the largest investments made by the World Bank in Sri Lanka. This model has now been replicated in Bank projects in Bangladesh, the Philippines, and several African countries.

Figure C.1. Sales of Solar Home Systems in the Sri Lanka Project



A.C.39 *Uganda.* To increase the development impact the new Uganda Energy For Rural Transformation Program is one of the first projects to combine the extension of rural access to electricity explicitly with a specific focus on fostering cross-sectoral applications (such as health and education). This recently approved project (financed by the World Bank and GEF) is the first phase of a 10-year program. It aims to accelerate rural access to electricity and ICT to help achieve "rural transformation," meaning significant improvement in the productivity of rural enterprises and in the quality of life and services in rural areas. To this end, the project will work with key potential rural users of electricity—focusing first on ICT, which needs electricity, and second, on small and medium-sized enterprises (SMEs), health, education, agriculture, and water. This will spread the benefits of electrification even to those who are not directly connected. The project plans to exploit synergies in service provision and development impact without requiring extensive coordination or letting problems in any one sector hold up other sectors, for example by working without a cross-ministerial steering board. Instead, mid-term plans of several ministries (such as health or education) will be analyzed regarding the role that energy and ICT could play to enhance these plans.

Annex D

Minutes of the ESMAP Stakeholder Workshop in Brasilia

Strategies for Rural Electrification in Brazil
Discussion of Options

Workgroup Reports

During the workshop in Brasilia, on June 18, 2002, participants were divided into three workgroups to debate the issues raised in the Background Report: Group 1: grid extension; Group 2: mini-grids for isolated systems (diesel and renewable energy systems); Group 3: individual systems (residential solar systems and pumping systems). Each group held several brainstorming sessions, followed by a final plenary discussion on their conclusions.

Group 1 – Grid Extension: Barriers and Options

Problems and Barriers

Problems of training and information access:

D1> High initial investments and low consumption resulting in low returns. A corporate vision is thus established that does not seek creative solutions.

D2> There needs to be a concessionaire's vision to explore energy as a product and its power to transform the market.

D3> Devaluation of the topic of rural electrification in the mindset of concessionaires reflecting the evaluation of professionals operating in this field.

D4> Lack of accurate information on the market and its various niches, which makes it difficult to choose the most efficient technologies and consequently the best allocation of resources.

Problems related to sector-wide policies:

D5> Lack of government interest, initially shown in the privatization process and in the dearth of mechanisms to quantify the social value of grid expansion. Private interests, that are averse to risk, are very different from public interests.

D6> Lack of integrated policies and interaction among the various programs, particularly integrating programs generating revenue and rural electrification programs.

D7> Rural electrification is very much dependent on subsidies and therefore vulnerable to political changes.

D8> Environmental requirements with regard to electrical grids.

Barriers related to the financing of the projects:

D9> High cost of the capital and unattractive financing terms.

D10> Current financial situation of the concessionaires, on the heels of losses resulting from energy cutbacks, the reduction in the level of consumption after the cutback and more recently the definition of the new low-income limit for residential consumers.

Regulatory problems:

D11> Lack of regulations and enactment of current laws.

D12> Failures of the regulations to establish clusters of differentiated markets, compatible with low-cost or alternative technologies.

D13> Current standards are expensive and obsolete.

D14> Imbalance between marginal income and marginal costs involved in grid expansion and the lack of mechanisms to redistribute revenue to the concessionaires.

Relevant experiences

D15> The National Irrigation Program (PROMI): Increased irrigated area from 300,000 hectares to 800,000 hectares and used a system for purchasing equipment in bulk, by means of international bids, including various concessionaires. The program demonstrated the viability of combining efforts in the fields of rural electrification and irrigation, incorporating actions of the two ministries that are involved and several concessionaires. Resources were financed by the World Bank and the program was implemented from 1985 to 1991.

D16> Proluz: This program introduced materials and low-cost systems, such as single-phase lines with return over land (MRT), low power transformers and low-cost keys. The cables that were financed were CAZ, but the rural electrification cooperatives preferred and install CAA cables and make up the cost difference in order to minimize subsequent operating costs. The program also financed internal facilities for less than R$ 150.00. The financial system was that of product equivalence, with the risk from the reduction of the farm commodity price assumed by an agricultural support fund (FEAPER), in this case the State of Rio Grande do Sul. The Program was financed by BNDES and established in the states of Sao Paulo and Rio Grande do Sul.

D17> The Electrical Energy Research Center (CEPEL) is currently testing various low-cost technologies for extension of the grid and developing more modern and cheaper standards. In Ceará, 50% of the high voltage (13.8 kV) distribution lines are MRT. COPEL also has a long history of using MRT systems, but is replacing CAZ cables with CAA cables.

D18> The Electric Company of Minas Gerais (CEMIG) has a great deal of experience in financing electrical equipment that helps to increase farm production, by stimulating the transformation of the market by introducing electrical systems. When PRONI [was developed], CEMIG financed motors and equipment for irrigation and with subsequent financing from the KfW, a German development bank, it was able to reduce interest rates from 6% to 2% with the commitment of financing domestic equipment to improve the living conditions of the electrified populations, with the negotiated margin of 4%.

D19> The Northeast Development Bank of Brazil – BNB, through a specific line of credit for rural cooperatives of the Rio Grande do Norte, financed the extension of the

electrical grid and the expansion of the farming activities of the electrified communities.

Options

Proposals with regard to training and access to information:

D20> Increased examination of the market profile, with regional diagnostics and availability of more reliable databases, from surveys aimed at universalizing and identifying the niches for various supply options.

D21> Promotion of community projects with methods to reveal preferences and transfers according to the declared cost.

Proposals with regard to the reduction in public programs and sector-wide policies:

D22> Focus on the creation of partnerships and integration of programs, mapping out the program goals of the Ministry of Agriculture, the PRONAF, INCRA, PRODEEM, *Luz no Campo*, the interests of the police departments, NGOs and the actions of the Ematers, capable of optimizing the allocation of resources from the various programs and initiatives and accordingly reducing disbursements. Potential for developing community volunteer construction efforts.

D23> Integrate end use actions to the programs of new connections, particularly from the agricultural industrialization of farm production, using farming cooperatives as agents to distribute the responsibility and developing awareness-raising programs of the collective use to transform and preserve goods and other energy uses.

D24> Government policies explicitly aimed at reaching the most needy population and other programs aimed at the producing class, eco-tourism, etc.

D25> Greater integration with the environment organizations.

Proposals in the area of financing

D26> Creation of easier lines of credit specifically aimed at universalization efforts.

D27> Micro-credit to finance the installation for the small consumer.

D28> Match the period in which financing is needed with the reimbursement period by the concessionaires to facilitate the financial portion of the projects.

Proposals regarding regulations

D29> Regulation of current laws, defining the criteria of redistribution of the investment among the other consumers (extension and form of crossed subsidy) and rules for the bidding of rural areas open to non-incumbents.

D30> Definition of cheaper construction standards, compatible with consumption needs.

Group 2 – Isolated systems forming mini-grids (Diesel and renewable energy systems)

Barriers

Barriers related to the financing of the projects and the economic sustainability

D31> Problems related to the posting of guarantees so banks agree to finance projects.

D32> Some additional difficulties with respect to the minimum volume to be financed and to the requirement that, in some cases, only companies (legal entities) are financed which does not make it viable to transfer the financing to small businesses, rural producers, etc. which particularly affects the situation of MCHes.

D33> There are many initiatives being developed in parallel by different government entities (MME, MCT, ANEEL, etc.) with different characteristics, financing conditions and rules; in this case it is necessary to develop standardized requirements and an integration of these efforts.

D34> The financing plans that are available are set up to comply with the conventional energy project the scale of which is not applicable to renewable energy technology projects.

D35> The subsidy of the Fuel Compensation Account (CCC) is poorly adapted to the investment financing needs of the midi-grids, that relay on renewable energies.

D36> Adequate lines of financing are needed for suppliers of energy services in rural areas (permissionnaires).

D37> The purchasing power of the end users in rural areas is low and also cyclical over the year.

D38> The external factors or indirect costs of conventional energy technology are almost never considered in the analysis of economic viability.

Barriers concerning training and the access to information

D39> There is no systematic compilation of information regarding the Northern Region, with regard to the unfamiliarity of the local powers and the energy needs of the riverside communities.

D40> Lack of information on the potential capacity of renewable energies at the local level.

D41> It has become indispensable to train communities with a low level of social organization considered with projects of renewable energies.

D42> There is a lack of qualified labor to maintain the mini-grid systems.

D43> The cultural differences among communities of different regions/countries can determine the success/failure of the implementation of the projects that cover the provision of the service.

D44> Many communities are very resistant to the concept of paying service fees; the predominating culture is that public services and equipment should be free-of-charge.

D45> Culture of donations, in particular in pre-electoral periods, render the concept of economically sustainable projects unviable.

D46> Renewable Energies, particularly photovoltaic solar and wind energies, are considered "exotic" for rural communities. Thus, local suppliers/installers frequently have to perpetuate this situation, proud of being the only ones with control over the technology.

D47> Lack of information on the technical/economic viability of renewable energies. Concessionaires, rural electrification cooperatives, etc. are not aware of the potential that renewable energies have for them.

Problems related to aspects of sector-wide policies

D48> The incentive schemes are ad hoc and spread out over various institutions.

D49> There are no energy governmental policies related to isolated systems, only isolated initiatives that tend to confuse those involved, with sporadic and isolated incentive schemes that fail to develop sustainable markets.

D50> The majority of the government projects are based on donated equipment, and the available funds only provide resources for the purchase of equipment, with no funds budgeted for operation, maintenance and replacement.

D51> There are no incentives and correlation between revenue improvement programs with rural electrification projects.

D52> Lack of support for multi-sector projects.

D53> Several agencies involved in the rural environment without an integration of efforts (governance).

D54> Lack of coordination among agents (e.g. among donors and private sector).

D55> Lack of integration of the social and environmental costs and benefits in the decision-making processes, which penalizes the sources of renewable energy.

D56> A lack of policy for developing national technologies; photovoltaic and wind equipment are all imported.

Barriers linked to regulations

D57> There are problems in obtaining environmental licenses for PCHs.

D58> There are no requirements in the standardization of the equipment and the quality of the service for mini-grids.

D59> There is a risk for energy service providers in the rural environment (permissionaires) upon the possible expropriation of decentralized systems.

D60> The lack of regulations can inhibit the market from developing new business models.

Projects in indigenous areas

D61> Difficulty of collecting fees.

D62> Negotiation of the impacts of projects that affect indigenous areas.

D63> Some NGOs oppose projects of renewable energy due to the cultural homogenizing effect that TV could have on the indigenous communities supplied with electrical energy.

Technological and logistical barriers

D64> Difficulties in logistics of transporting energy generation equipment and constructing grids in the Amazonia region.

D65> Long lead times in establishing projects with use of vegetable oils.

D66> Insufficiencies resulting from the lack of maintenance and replacement that – the first years after the facilities have been erected - compromise the operation of the systems, above all in projects funded by donations.

Options

D67> Funds available from various government agencies would be better used if used like Soft Funding to reduce the transaction costs (lower interest fees and longer periods of shortfalls, payment of fees and taxes) provide post-sale technical support and resources for OM&S), i.e., funds for enable the sustainability of the projects.

D68> Create a financial order in government-sponsored projects, implementing a coordinator of the financing policy (need for financial order).

D69> Studies on the payment arrangement – or lacking this – the seasonability of the purchasing power of the end users in the rural area should be included.

D70> Explore the concept of "pride of being owner" (though, according to the concept of service fee, the user is not owner of the energy generation system) that has made the difference between successful or failed projects – if the user pays, he will value the access to energy.

D71> Businesses and industry representatives prefer to receive money from private companies (cooperatives, installers or whoever is responsible for exploring the service) and not from the government.

D72> Pre-payment is considered the best alternative to recover the capital invested in the purchase of equipment in spite of there being few experiences in this regard at the global level.

D73> Incorporate in general the analysis of the life cycle cost in energy projects. As renewable technologies of energy are intensive in the use of capital and have lower maintenance and replacement costs, compared to conventional energy projects; these aspects penalize renewable energy projects in the decision-making process.

D74> Renewal energy technologies are very different one from the next and in comparison with conventional energy technologies; accordingly, these differences should be taken into consideration, particularly with regard to the size of the project.

D75> Always include a training component of users when introducing a new technology.

D76> Create mechanisms to enable the large-scale local production of solar and wind energy equipment.

D77> Provide training, distribution of information on energy renewal technologies, human resources and training not only for users, but also for Independent Power Producers (IPPs).

D78> Immediate regulation of Law 10.438/02 that has established incentives for renewable energies.

D79> Specific law to prevent licenses and unnecessary costs. Exemption of fees that represent a small benefit for the government can make projects work, creating new jobs and stimulating new industries.

D80> Successful projects must have the following components: careful planning, participation of the local community (including universities and IPPs), technical expertise, market research and payment for services.

D81> It is necessary to provide resources for this training in communities with a low level of social organization.

Case study: success and failures

D82> There are records of depreciated biomass projects were built which burned oil that could have higher prices (in other applications such as the chemical industry) than the value of energy that it generated. If sold to other applications, the income is normally sufficiently high to allow the generation of consolidated technologies (e.g.: diesel), in addition to mitigating environmental impacts (e.g., planting of forests).

D83> A project implemented in the Amazonia region and with the considerable potential of being reproduced was a project comprised of a hybrid diesel/solar project without storage, in which the solar system was added to a diesel system distributing energy, through a mini-grid, for approximately 60 residences. The profitability of this project can be improved, by using the CCC benefits. A local IPP, a multi-national company that bought the rights to explore the small generator systems with diesel in the Amazonia region with the privatization of the electrical sector, was unaware of this hybrid model, that was proposed and developed by the local university laboratory and by the UNDP fund.

Group 3 – Decentralized Rural Electrification: problems and options

Problems and Barriers

Economic sustainability:

D84> Lack of available solutions to fill in the gap between the rural solar electrification project cost and the insufficient payment of the low-income rural population.

D85> The activity is perceived as too risky by potential private investors, also due to the risk of nonperformance.

D86> Lack of proven management models that ensure the economic viability of the projects.

Technical sustainability:

D87> The inadequate selection of sources and technologies of renewable energy is problematic for the technical sustainability of the projects.

D88> Social sustainability:

D89> The lack of dialog with the future users and their local representatives (community associations, etc.) limits the social sustainability of the projects.

D90> Lack of training of the concessionaires in establishing this dialog.

Barriers related to the financing of the projects:

D91> There is a serious problem of access to financing for the small-range agent (see box 1.1).

D92> The types of available financing are not adequate for all financing needs. For example, the financing of the Northeast Development Bank for small businesses in the area of rural solar electrification are limited to R$ 30,000, and is restricted to developing the activity of these small businesses.

D93> The guarantee requirements are generally very high.

D94> The financial situation of the concessionaires is a barrier for new financing, particularly in foreign currencies.

D95> There are no tax incentives.

Barriers concerning the access to information:

D96> There is no systematic compilation of information regarding the market, including the social/economical characteristics of the demand (energy needs, capacity of payment, etc.) and the location (location of potential markets).

D97> The existing access to information is very limited.

Barriers related to the lack of training:

D98> A lack of information to future users and often the training given is insufficient or inadequate.

D99> A lack of training in the concessionaires to integrate innovations related to the rural electrification, particularly with regard to decentralized rural electrification.

Technical barriers related to the maintenance of the facilities:

D100> Often the location is distant and the dispersal of the decentralized rural electrification facilities is a barrier for the adequate maintenance of the facilities if solely based on the market agents.

D101> There is almost never a system for distributing replacement parts.

Regulatory problems

D102> There is no clear answer to the question: Is decentralized rural electrification part of the regulated sector or not?

D103> Accordingly, various matters need regulation, such as fees, ownership of the equipment quality requirements, solution of possible conflicts among agents, etc.

D104> There is the risk of an inadequate regulation slowing down development of the decentralized rural electrification.

Problems of coordination among agents

D105> There is no coordination of agents involved in different segments of the sector (manufacturer, distributors, project promotion organizations, public institutions, NGOs, etc.).

D106> There is a frequent lack of active user participation in the preparation and implementation of projects.

Technical barriers related to the characteristics of solar equipment

D107> No standardization of the equipment available on the market.

D108> A lack of quality control of the components and the systems installed.

Problems related to aspects of sector-wide policies

D109> There is a lack of political support for decentralized rural electrification.

D110> There is no national planning.

D111> A master plan for rural electrification integrating the various technical methods (grid, individual systems, mini-grid) is needed.

Options and solutions

Proposals in the area of financing:

D112> Create specific lines of credit/rotating funds (in local currency).

D113> Enable and stimulate banking sector agents to provide adequate financing for projects of different sizes (in local currency).

D114> Match the period of financing shortfall with the term of reimbursement by the concessionaires as defined in Law 10,438, to facilitate the financial setup of the projects.

D115> Clean Development Mechanism. create an assistance program to help decentralized rural electrification projects based on renewable energies to be registered with the MDL and to sell Emissions Reduction Certificates.

Proposals related to the training of agents:

D116> Create a registry of existing facilities, in view of distributing information on these systems to agents in the sector.

D117> Organize a system for distributing information, taking advantage of successful centers.

D118> User training: increase the community training component in the projects.

D119> Take advantage of training experience from other sectors (e.g., PRONAF)

D120> Set up a national training program of concessionaires and technicians in the field.

Taking advantage of existing experiences

D121> Preparation and implementation of a permanent program of evaluation and technical and social assistance of the systems installed in and outside the projects.

D122> Preparation and implementation of a restoration program of installed systems that are undergoing operating problems, and improve the perception of the solar technology by users and by the public.

D123> Systematization of methods for implementing projects, including models of user participation.

D124> Systematization of management models used in experiment pilot projects.

Proposals of technical regulation:

D125> Preparation of technical requirements for the components of the individual systems for decentralized rural electrification.

D126> Creation of a labeling system so the components comply with those requirements.

D127> Definition of installation standards.

Proposals in the area of regulation of universalization .

D128> Integrate the decentralized rural electrification in the universalization goals of the concessionaires.

D129> Make this integration possible even for systems that have not been installed by concessionaires, in order to prevent conflicts and to create synergies among businesses of independent projects and the concessionaires (experience of Senegal).

D130> Create a special class of consumer.

Relevant experiences

D131> There is a line of financing in the Northeast Development Bank to finance small businesses in the area of rural solar electrification. In principle, there is also the possibility of the BNDES to finance this type of project through its local partners in

the sector (regional development banks). But in the case of Rio Grande do Sul, the Development Bank of the State of Rio Grande do Sul was absorbed by BANRISUL, which no longer opens this type of line of credit. Accordingly, some projects were unable to secure financing in national currency and have begun incur exchange risks after taking out loans in foreign currencies from institutions like the Solar Development Group, for example.

D132> There are cases of concessionaires that already developed prior studies of rural solar electrification projects but that decided not to implement these projects due to questions related to the ownership of the assets, the quality requirements, the transfer of crossed subsidies by means of fee, etc. that were not answered.

D133> Insufficiencies of the PRODEEM projects in its initial phase and forecasts: PRODEEM was established in 1994 and all the phases were characterized by the donation of equipment to communities, either for lighting, pumping of water or other community applications. In the first phases, the solar systems were set up in local areas, and technical assistance was restricted to the installation, with no support after donation of the service. The program evolved to include local concessionaire companies in the installation and commissioning process of the systems, in view of improving the service. However, the communities still experience the lack of local trained operators to correct system defects and to provide maintenance, repairs and replacement of components, which has resulted in a high percentage of failures. In the current phase, suppliers and installers are being contracted by the Program to guarantee operation and maintenance for three years, in view of improving the performance of the systems, reducing the failure rate after installation of the equipment, through the system is still donated to the users, and there is no strategy for the period after the initial three years.

Annex E

Presentation by Mr. Christophe de Gouvello (Brasilia Workshop)

(Text translation – Original in Portuguese)

International links

Tuesday, June 18, 2002
Christophe de Gouvello – CIRED, Paris

Rural Electrification Strategies in Brazil
Workshop on the Discussion of Options
Hotel Blue Tree Park, Brasilia

Public Intervention
Two Concepts

I – Assisted marketing
- Develop the **market**
- Lower the cost for the consumer
- Standardize the product

II – Delegating the management of a public service
- Goal of **universalization** of access
- Regulation of prices and service to the user
- Guarantees for the operator

The lack of a model is the rule :
® *Spontaneous sale with no quality control*

I – Assisted Marketing

<table>
<tr><td></td><td rowspan="2">Banking institution
local or international
Opening of subsidized lines of credit
Management of rotating funds, etc.</td><td rowspan="2">Debt servicing</td><td>National public funds</td></tr>
<tr><td>Loans, payment of subsidies according to the number of installed systems, etc.</td><td>International cooperation
multilateral or bilateral (loans, donations)</td></tr>
<tr><td></td><td>Reimbursement of credit</td><td></td><td>Loans from the private or public banking sector</td></tr>
<tr><td>Private distribution and installation Company</td><td></td><td></td><td>Chile (Economic/technical classification of projects)</td></tr>
<tr><td>Direct sale</td><td>Spot Purchase</td><td></td><td>India</td></tr>
<tr><td></td><td colspan="2">Users</td><td>Indonesia</td></tr>
<tr><td></td><td colspan="2"></td><td>Sri Lanka</td></tr>
</table>

I – Assisted Marketing

<table>
<tr><td></td><td rowspan="2">Banking institution
local or international
Opening of subsidized lines of credit
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<tr><td></td><td>Reimbursement of credits</td><td></td><td>Loans from the private or public banking sector</td></tr>
<tr><td>Bangladesh (Grameen Shakti, Proshika, etc.)</td><td></td><td>Loan, donation</td><td></td></tr>
<tr><td>Bolivia (Model 3)</td><td></td><td>Micro-credit</td><td>Micro-credit NGOs
Credit to small- and medium-sized</td></tr>
</table>

			companies (Banks)
	Users Communities Individual entrepreneur	Reimbursement of micro-credit	

I – Assisted Marketing

	Banking institution local or international Opening of subsidized lines of credit Management of rotating funds, etc.	Debt servicing	**National public funds**
			International cooperation multilateral or bilateral (loans, donations)
Loans, payment of subsidies according to the number of installed systems, etc.			**Loans from the private or public banking sector**
	Reimbursement of credits	Micro-credit	
Private distribution and installation Company		Micro-credit entities and small companies	Sri Lanka
	Spot purchase	Micro-credit	Bolivia (Model 2)
Direct sale	Users Communities Individual entrepreneur	Reimbursement of micro-credit	

Lessons:

Short-term loans to users (maximum 2-3 years
Services > payment capacity
"screaming", the poorest are left out

Maintenance and replacement not included
No incentive for systematization
Technical sustainability problems

Public Intervention
Two Concepts

I – Assisted marketing
- Develop the **market**
- Lower the cost for the consumer
- Standardize the product

II – Delegating the management of a public service
- Goal of **universalization** of access
- Regulation of prices and service to the user
- Guarantees for the operator

II – Delegating the management of a public service

Reimbursement of the capital		**Contribution of the Private Operator's own capital**
	Debt servicing	**International cooperation** Multilateral or bilateral (loans, donations)
		National or local public funds (long-term loans from the Public sector
		Crossed subsidy from users connected to the grid
Private company (delegated operator)		Morocco
Installation and maintenance	Connection fees and tariffs	South Africa
		Argentina
Users and other clients		Senegal

II – Delegating the management of a public service

Reimbursement of the capital		**Contribution of the Private Operator's own capital**
	Debt servicing	**International cooperation** Multilateral or bilateral (loans, donations)
		National or local public funds (long-term loans from the Public sector
		Crossed subsidy from users connected to the grid
Private company (delegated operator)		**Donation or loans from the public sector or International cooperation**
Installation and maintenance	Connection fees and tariffs	
	Reimbursement of credit	**NGOs and micro-credit organizations** for initial payment, for internal wiring and equipment
Users and other clients		
	Loan	

II – Delegating the management of a public service

	Debt servicing	**National or local public funds (long-term loans from the Public sector**
Public-owned Company Owner of assets whose economic life > 20 years	Priority reimbursement	**International cooperation Multilateral or bilateral (loans, donations)**
Leasing of equipment	Fee corresponding to the leasing of corporate assets *(use of public assets)*	**National or local public funds (long-term loans from the Public sector**
	Debt servicing Reimbursement of own capital	**Crossed subsidy from users connected to the grid**
Private exploration company owner of the renewable assets < 20 years		**Contribution of the Private Operator's own capital**
Installation and maintenance	Connection fees and tariffs	
		Cabo Verde
Users and other clients		

	BT (Built & Transfer)	*Leasing*	*Cooperatives*	*BOOT (Built Own Operate Transfer)*
Ownership of assets	public authority	public authority	operator	operator
Financing of assets	public authority	public authority	users (savings and loan)	operator and/or publicly owed
Origin of revenue	public authority	Users	users	users
Payments between operator and public owner	public authority Operator (turn key)	public authority Operator (use of public assets)		public authority Operator (residual value of assets)
Territorial protection	no	yes/no	no	yes/no
Definition of tariffs	public authority	negotiated/regulated	users	negotiated/regulated
Examples	PRODEEM	Cabo Verde	Bangladesh	South Africa, Senegal, etc.

Lessons

Globalization of markets: Scale Effect
Reduction of territorial risks
Adaptation of the regulations over time

Importance of laws: bottleneck effects

Importance of a thorough knowledge of the market (size, payment capacity, costs)

Important of the bid and negotiation phases between Public Authorities and the Operators/Private investors

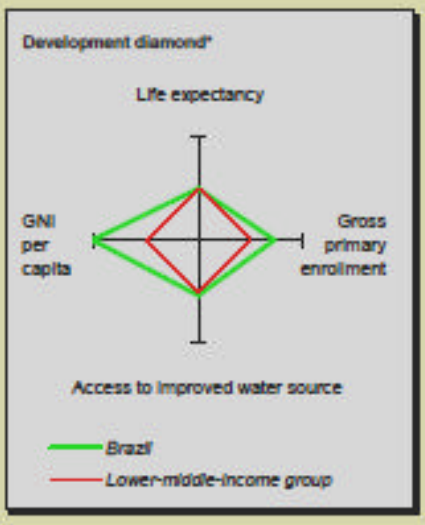
Annex F

Brazil—Country at a Glance

Brazil at a glance

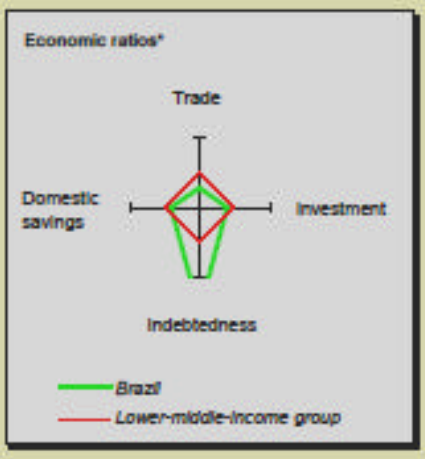
9/3/03

POVERTY and SOCIAL	Brazil	Latin America & Carib.	Lower-middle-income
2002			
Population, mid-year *(millions)*	174.5	527	2,411
GNI per capita *(Atlas method, US$)*	2,830	3,280	1,390
GNI *(Atlas method, US$ billions)*	494.5	1,727	3,352
Average annual growth, 1986-02			
Population *(%)*	1.3	1.5	1.0
Labor force *(%)*	1.7	2.2	1.2
Most recent estimate (latest year available, 1986-02)			
Poverty *(% of population below national poverty line)*	22	..	..
Urban population *(% of total population)*	82	76	49
Life expectancy at birth *(years)*	69	71	69
Infant mortality *(per 1,000 live births)*	30	27	30
Child malnutrition *(% of children under 5)*	6	9	11
Access to an improved water source *(% of population)*	87	86	81
Illiteracy *(% of population age 15+)*	12	11	13
Gross primary enrollment *(% of school-age population)*	162	130	111
Male	166	131	111
Female	159	128	110

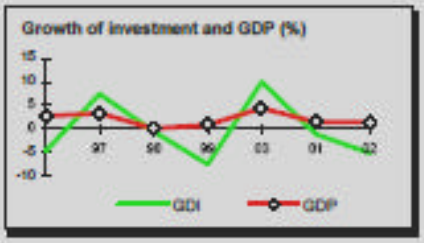


KEY ECONOMIC RATIOS and LONG-TERM TRENDS	1982	1992	2001	2002
GDP *(US$ billions)*	281.7	390.6	509.0	452.4
Gross domestic investment/GDP	21.1	18.9	21.2	19.3
Exports of goods and services/GDP	7.6	10.9	13.2	15.8
Gross domestic savings/GDP	20.4	21.4	20.2	21.5
Gross national savings/GDP	15.3	20.1	16.6	18.0
Current account balance/GDP	-5.8	1.6	-4.6	-1.7
Interest payments/GDP	3.4	0.7	3.0	3.0
Total debt/GDP	33.3	33.0	48.3	51.3
Total debt service/exports	81.9	21.1	76.4	70.2
Present value of debt/GDP	.	..	52.6	58.4
Present value of debt/exports	..	..	334.2	..

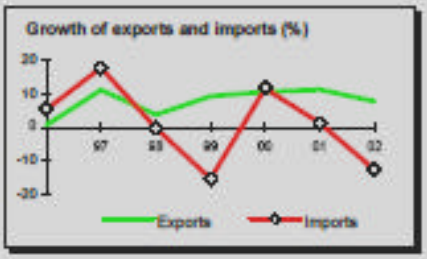
	1982-92	1982-02	2001	2002	2002-06
(average annual growth)					
GDP	2.6	2.7	1.4	1.5	3.4
GDP per capita	0.7	1.4	0.1	0.2	2.2
Exports of goods and services	6.9	6.5	11.2	7.8	5.4



STRUCTURE of the ECONOMY	1982	1992	2001	2002
(% of GDP)				
Agriculture	9.0	7.7	6.1	6.1
Industry	45.6	38.7	22.3	21.0
Manufacturing	34.6	24.7	14.0	13.2
Services	45.4	53.6	71.6	72.9
Private consumption	69.6	61.5	60.6	59.3
General government consumption	10.0	17.1	19.2	19.3
Imports of goods and services	8.3	8.4	14.2	13.6



	1982-92	1992-02	2001	2002
(average annual growth)				
Agriculture	2.5	3.5	5.7	5.8
Industry	1.6	2.3	-0.7	1.5
Manufacturing	0.5	1.8	1.4	1.4
Services	3.2	2.8	1.9	1.5
Private consumption	0.7	3.9	0.8	0.4
General government consumption	7.1	0.9	1.0	1.0
Gross domestic investment	4.1	2.1	-1.1	-5.2
Imports of goods and services	3.9	7.6	1.2	-12.8



Note: 2002 data are preliminary estimates.

* The diamonds show four key indicators in the country (in bold) compared with its income-group average. If data are missing, the diamond will be incomplete.