Energy efficiency and restructuring of the Brazilian power sector[1]

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Since the early nineties Brazil has initiated a program of reforms in its electric sector which includes utility privatization and de-verticalization. The main objectives were to promote a market-oriented energy industry attractive to private investments. This has led to the loss of sponsorship for the public-interest programs formerly undertaken by the state utilities. In particular, of significant concern are the programs for promotion of energy efficiency, renewable energy technologies, rural electrification and environmental protection. In the midst of the privatization effort, the National Agency for Electrical Energy (ANEEL) was created (end of 1997). One of the tasks of the regulatory agency is to provide funds and incentives for energy conservation. In this paper I review the role of ANEEL in promoting energy efficiency investments in the context of a market-oriented sector, its limitations and prospects.

1. Introduction

The international experience shows that restructuring towards a less regulated and more market-based environment has strengthened the trend of falling investment in energy efficiency and the use of renewable energy [Shioshansi, 1995; Surrey, 1996]. Hagler Bailly [1997] reviewed the promotion of energy efficiency in five countries other than the US which were undergoing such reforms in electricity markets. They observe that in each of the five countries, energy efficiency suffered a setback as a result of the reform, and that only in the US has the reform process explicitly included provisions to protect public goods such as energy efficiency, renewables and the environment. In the US there was preoccupation with defining the public benefits associated with the energy industry that required special attention and protection during the early stages of restructuring (e.g., in California, see CPUC, 1997).

Brazil is implementing significant changes in the management, organization and decision-making of its electricity sector by transferring the ownership of its utilities from the public sector (state and federal governments) to private entrepreneurs. Privatization is one of the initial phases of the restructuring process of reforms that aims to create greater competition within the energy industry. In addition to privatizing existing utilities, contracts for new electric installations are now to be open to competitive bidding, pending concessions are being canceled and re-tendered for competitive bids, independent power producers are being introduced, and large electricity consumers have access to a competitive market for power. As these changes are implemented, we can expect that the public interest tasks undertaken by this industry in the past will also change.

The challenge is whether, and if so how, the new institutional arrangement will address and incorporate important public interest tasks such as energy efficiency and secure investments towards options that are environmentally cleaner and more sustainable in the long run. Also, there can be an additional adverse impact of privatization on rural communities currently served by subsidized power from previously state-owned utilities. These communities will be susceptible to a decrease in the quality of the service while unserved rural communities may wind up even further behind if profit-seeking utilities use a conventional approach to the problem (i.e., grid extension).

2. Objective

The objective of this paper is to analyze recent trends in the restructuring of the country's electrical sector and how it has affected the progress of energy efficiency efforts. We first review briefly the situation of electricity supply and demand and the existing electricity conservation agency PROCEL. Afterwards we present the main characteristics of the sectoral restructuring and discuss in more detail the mechanism implemented to channel investments in R&D and end-use efficiency. We also discuss the role of some international agencies in assisting the sector reforms.

3. Electricity supply and demand in Brazil

Installed electricity capacity in Brazil now stands at slightly more than 65 GW. Overall electricity consumption has been growing at a rate of about 5-6% annually. The installation of new generation capacity has been lagging behind this growing demand. Shortages have therefore become common throughout the country and particularly in the city of Manaus, the capital of the state of Amazonas and home to 1.2 million residents. Power shortages in large cities such as Rio de Janeiro in 1997 were also considered early signs of the supply crisis.

Hydroelectricity has always been an important energy

Table 1: Evolution of the country's total capacity and shares of hydroelectricity

Year	Total capacity (GW)	Hydroelectricity (as % of total)
1960	4	72
1970	10	80
1980	30	83
1990	50	86
1995	59	87
1998	65	87
2005	85-105[1]	80-85
2010	130-175[1]	80-85

Sources: MME, 1999; ELETROBRAS, 1994

Note

1. The range refers to different scenario assumptions.

Table 2. Trends in supply and demand for electricity in Brazil

Electricity supply	1990	1995	1998
Total produced (TWh)	222.8	275.6	321.6
Shares (%) of: Coal	1.7	1.5	1.5
Oil	2.1	2.4	3.1
Natural gas	0	0.2	0.3
Nuclear	1.0	0.9	1.0
Hydroelectric	92.8	92.1	90.6
Other	2.4	2.9	3.5
Imported electricity (TWh)	26.5	35.4	39.4
Electricity demand (% share of overall)			
Industrial	52	48	44
Residential	22	24	26
Commercial	11	12	13
Energy sector	3	3	3
Other[1]	12	13	14

Source: MME, 1999

Note

1. Includes public lighting, rural and transportation sectors.

source in the country. In 1960 about 72% of the country's capacity came from hydro sources, and peaked in 1995 at 87%. However, the trend is reversing towards more fossil-fueled production as can be seen from Table 1, which shows the official projections up to 2015. It is expected that privatization will bring new natural gas-fueled thermal plants.

4. Restructuring: energy efficiency, planning and regulatory context

The restructuring process started in the country without the prior establishment of a clear regulatory framework and at the same time the tradition of centralized planning ended. Centralized government planning previously required that ELETROBRÁS, the state-owned national holding electrical utility, organized, planned, financed, built, and operated the entire electrical power system. The current 2015 Plan [ELETROBRÁS, 1994] is the latest edition of a periodically updated document that served in the past to focus ELETROBRÁS's resources and those of its subsidiaries. Now, however, the Plan is only indicative of the course that overall system expansion may follow, not a plan for whose implementation ELETROBRÁS is directly responsible. The expansion of the installed capacity will evolve as the result of on-going privatization legislation and decisions of the new regulatory agencies and investment decisions of privatized utilities, Brazilian and foreign investors, development and commercial financing agents, and private power developers. Thus, the execution of electricity expansion plans is no longer led by ELETROBRÁS; from now on these decisions are being made by the private sector in a market subject to growing competition.

More importantly, the restructuring process in Brazil comes at a time when the experience with energy efficiency is in its infancy and the public debate is non-existent, or poorly informed about the complex issues surrounding energy matters, restructuring and privatization. We are not stating that the public ownership of the power sector implies necessarily that certain public benefits, such as energy efficiency, are provided. Indeed, it is relevant to observe that while utility structure and ownership are important, they do not fundamentally determine the success of demand side management (DSM) efforts. It has been shown [Boyle, 1996] that when adequate policy and economic incentives to the utility and other actors are present, DSM can occur under many diverse circumstances. A recent study [Gouvello et al., 1998] compared the development of DSM efforts in the public-dominated electricity systems of France and Brazil, and showed that the relatively better performance of energy conservation efforts in Brazil can be credited to the experience of ELETROBRÁS in coordinating multi-actor initiatives which are necessary for implementing energy efficiency. For these two countries it was also shown that energy efficiency efforts received attention much later and played only a marginal role in comparison with other countries. This also happens when the model of supply-side optimization (nuclear in France and hydroelectric in Brazil) together with public macro-economic policies has shown signs of exhaustion. Therefore, public ownership does not necessarily mean that investments in energy efficiency will take place. In the case of Brazil, efforts made in the past towards greater efficiency were not enough to ensure that these values would remain important to consumers, businesses and policy-makers.

4.1. Energy sector framework description

Although they are subject to continuing reforms, we list below the key energy institutions positioned to define and implement Brazilian national goals and that would be critical to any commitment to clean and efficient energy

production and use. Institutional key actors in Brazil's energy policy are listed below.

- The Ministry of Mines and Energy (MME)
- Secretariat of Energy (SEN)
- National Energy Policy Council (NEPC)
- National Agency for Electric Power (ANEEL) and selected state regulatory agencies
- National Agency for Petroleum (ANP)

Figure 1 displays the current relationship between these key institutional players. In the following paragraphs we describe the functions of NEPC and ANEEL. Geller et al. [1999] provide a good account of the recent developments at the National Electricity Conservation Agency (PROCEL).

4.2. The National Energy Policy Council (NEPC)

The National Energy Policy Council is designed to be the most important body to determine overall energy policies that can shape the future development of the sector and its commitments towards sustainability, but as of 1999 it has not been made operational. NEPC will deal with macro-energy policies, including division of federal/state responsibilities. The committee will include a wide range of ministries' representatives and be chaired by MME. SEN will be NEPC's executive secretariat. The key role of both SEN and NEPC is to establish a coordinated policy framework for Brazil's energy resources and to advise on aspects related to the energy sector. Once operational, specific responsibilities of MME/NEPC/SEN with regard to the restructured electricity sector will be to:

- formulate policies and regulations to implement and disburse national subsidies for rural energy development;
- provide inputs to the Ministry of Environment for establishing environmental policy for the sector;
- establish policy on electricity conservation (implemented through regulation and sponsored projects);
- sit on the governing bodies of federal holding, sector financing, indicative planning, independent system operator, and sector services organizations;
- propose changes in sector legislation for approval by Congress;
- nominate the Board of Directors of ANEEL for approval by the Congress;
- nominate directors for the federal holding, sector financing and indicative planning organizations; and
- exercise ownership functions for federal shareholdings

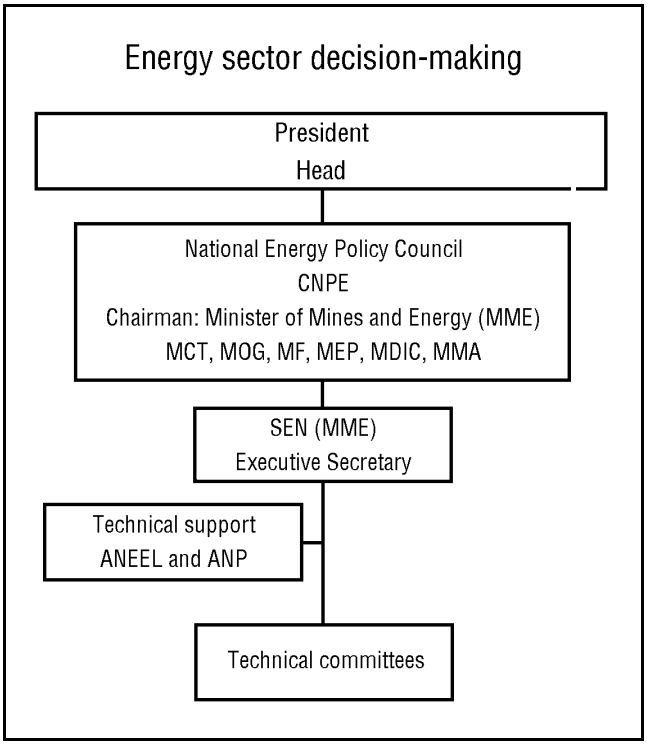

Figure 1. Structure of the National Energy Policy Council
Abbreviations used: MCT, Ministry of Science and Technology; MOG, ; MF, Ministry of Finance; MEP, Ministry of Planning; MDIC, Ministry of Industry and Commerce, MMA, Ministry of Environment.

The President: decides ultimately on matters of national energy policy, appoints members of the NEPC and defines its operation.

National Energy Policy Council (NEPC): has the overall responsibility of ensuring secure supply of energy to the country, promote the rational use of energy resources, and periodically review the structure of the national energy matrix. It also has the duty to promote specific programs for natural gas, alcohol, coal and nuclear energy. It ensures proper financing of the national system of fuel reserves, and sees that the annual plan of strategic fuel reserves is applied.

Ministry of Mines and Energy (MME): chairs the NEPC, conveys the policy proposals to the President and appoints members of the technical committees.

Executive Secretary (SEN): coordinates the Technical Committees' activities, monitors the progress of the guidelines set by the NEPC and organizes its meetings and agenda.

Other ministries: deliberate national energy policy matters and creation of technical committees at NEPC meetings.

Technical support: is provided by the two energy regulatory agencies, ANEEL (electricity) and ANP (oil).

Technical committees: are responsible for the technical analysis of energy issues and represent the interested parties on related matters. They are nominated according to the existing demand and for a limited period of time.

Main tasks of key actors in national energy decision-making

Table 3. Projected marginal electricity generation costs (US$/MWh)

	2000	2008
South	77	24
Southeast/center-West	70	25
North	65	35
Brazil	74	30
Total installed capacity (GW)	65	100 (18 GW thermal power)

on behalf of the Ministry of Finance.

4.3. The National Electricity Regulatory Agency – ANEEL

In late December 1996 the Brazilian Congress passed a law creating the Agência Nacional de Energia Elétrica (ANEEL). Until then all utilities being privatized were regulated only by the terms of the contract at the time of the sale of assets by the public utility. This new agency has been entrusted with regulatory oversight of the restructured Brazilian electricity industry. Initially ANEEL relied on the structure of the previous DNAEE, or National Department of Electric Energy, a now-extinct MME department, and started to function only in December 1997. ANEEL is establishing the regulatory regime necessary to provide the right signals to the market and other measures in accordance with national energy policies that will be promulgated by NEPC.

ANEEL regulates the power sector, sets guidelines for tariffs and laying down rates, approves tariffs, and has the authority to grant concessions to service providers. Such an authority resembles a licensing or authorization power to grant a private agent the right to use public resources to generate, transmit, or distribute power. ANEEL is also charged with establishing competition among the actors, as well as reliability and cost effectiveness of service, including that to rural areas. ANEEL has decentralized its activities, transferring regulation oversight to some state public utility commissions that are better positioned to monitor the performance of distribution utilities. Several Brazilian states (Pará, Ceará, Rio Grande do Sul, Rio de Janeiro, São Paulo and Bahia) are establishing state regulatory agencies.

ANEEL is still being structured, hiring and training personnel, and defining its activities without policy guidelines from the national government. At the same time it has to provide clear rules so that investors can be interested in the Brazilian energy market, and also has to ensure that customers are being well served. A good example to illustrate the current stage of the regulatory ''learning process'' is a case from January/February 1998, when customers in Rio de Janeiro suffered severe, long-lasting, and abnormally frequent power interruptions. Only after strong public protests were echoed and magnified nationally by the press did ANEEL step forward to verify the causes of the blackouts and the responsibility of the two privatized companies in that State[3]. ANEEL imposed a heavy fine on one of the utilities, but wanted to keep confidential the historical records of ''coefficients of performance'' of those utilities. However, as a result of the continuous pressure of customers and the media, ANEEL back-tracked and finally disclosed these records to the public.

Nevertheless, it is fair to say that a great deal of effort is being invested by the newly created regulatory agency in order to create competition on the generation side and ways to ensure that future energy prices will drop. (See Table 3.) This preoccupation has dominated most of the activities undertaken by ANEEL so far.

5. The 1% charge for end-use efficiency, R&D and supply-side efficiency

Several authors have discussed the market barriers to promoting investments in energy efficiency [Howarth and Andersen, 1993; Golove and Eto, 1996]. In the context of a reformed energy sector with greater participation of private companies it is even more important to secure investments in these areas to promote the provision of public benefits associated with the energy industry. This has been the initial motivation and justification for the creation of a 1% charge on electricity producers and distributors.

Since 1998 the regulatory agency ANEEL has been enforcing the application of at least 1% of the previous year's revenues in energy efficiency measures and research and development. These funds are allocated to end-use efficiency measures (0.25% of total operational revenues) and research and development (0.1%), the rest going to the improvement of supply efficiency.

ANEEL is responsible for the definition of investment priorities and approval of the annual plans submitted by the energy companies. PROCEL is giving technical support to analyze the energy efficiency plans. Table 2 presents the current (1999) guidelines for utility investments using their 1% revenues.

Instead of collecting 1% of utilities' revenues and administering a general fund, ANEEL preferred to let each utility specify its own investment plans for energy efficiency and R&D. ANEEL'S understanding is that utilities have a better knowledge of customers' behavior, are more capable of designing efficiency programs and know what is best to achieve in their respective markets. Very little debate has been promoted to decide on important issues of governance, administration and public policy strategies associated with the use of such funds.

It is true that currently ANEEL's regulation provides a window of opportunity for investments in energy efficiency and energy R&D, but in our view presents serious distortions that reveal an apparent misunderstanding of the role of public interest policies and the operation of energy markets. It seems that common sense would indicate that profit-seeking utilities would not require any legislation to direct investments to reduce commercial losses which currently may take a preponderant share of the 1% charge, for example. Although ANEEL is ultimately ressponsible for approving the utilities' plans, the promotion of alternative plans that may yield greater societal benefits but

Table 4. Regulated investments in energy efficiency and R&D (minimum levels of total annual revenues)

% of total annual revenues	Areas of expenditure	Details of suggested limits and investment priorities
a) ≥ 1.00%	End-use efficiency, R&D, supply-side efficiency	Listed below
b) ≥ 0.25%	End-use efficiency	Up to a maximum of 0.125% to be invested in public lighting, marketing Minimum of 0.025% to be invested in the industrial sector Minimum of 0.025% to be invested in the residential sector Minimum of 0.025% to be invested in the public sector
c) ≥ 0.1%	Research and development	Energy planning, alternative energy sources, improvement of the quality of service, cogeneration
d) (a) - (b) - (c)	Supply-side efficiency	Load factor improvements (minimum of 30% to be invested in regions S, SE and CW, minimum of 10% in regions N and NE). Energy losses (technical and commercial)

Sources: ANEEL, 1999a and 1999b.

Note

Generating companies that do not own distribution networks have a minimum of 0.25% to be invested in R&D.

are less financially interesting to the utilities will have lower priority or will not even be considered. This may well be the case of public interest R&D which may offer relatively long pay-back periods.

6. Some examples of international assistance during restructuring

International agencies and multilateral banks are participating actively in the restructuring of the energy sector mainly by providing training and consulting services to the newly created regulatory agencies. Some of them are particularly involved in the enhancement of renewables and energy efficiency in the present context of privatization. Below is presented some information on selected agencies.

- Germany's GTZ has provided support for the installation of projects involving photovoltaic (PV) pumping systems in remote villages of the state of Ceará and Minas Gerais. GTZ is working closely with local cooperatives, NGOs and the regional electricity utilities.
- The European Union (EU) has been focussing its development efforts on supporting the Brazilian states during restructuring of the national energy sector. Initial efforts have involved workshops and regulatory assistance in the state of Bahia through ANEEL, the National Agency for Electric Power. The EU has also been involved in preparing feasibility studies for the World Bank energy efficiency loan (ALURE-PROCEL). Through these activities, the EU hopes to increase European trade to Brazil in energy technologies. The total aid package has amounted to $3.4 million. The second phase of the EU's program is under development, and is anticipated to involve $5 million in assistance. The EU will form a partnership with COELBA, the state of Bahia's energy utility, to promote renewable energy, especially solar power.
- The Inter-American Development Bank (IDB) has been mainly involved in two initiatives with the Brazilian government. The first activity involved a $150 million loan to ELETROBRÁS to support the construction of a north-south power transmission line to connect the north/northeast power grid to the south/southeast grid. This connection will allow transmission at 500 kV of optimal power supplies with less seasonal fluctuation, as hydropower generated during the rainy season in one region can be shared with the other region during its dry season. Within this loan, $1.5 million has been designated for institutional capacity-building, to be administered through the independent system operator, the independent planner, and ANEEL. Training activities will require $650,000 of the institutional capacity-building funds, and the remainder will be used for technical analyses of tariff structuring and free access. The second focus involves linking IDB's Sustainable Markets for Sustainable Energy program with an IMF loan to create a program to promote renewable energy entrepreneurship amongst small and medium businesses.
- The United Nations Development Program (UNDP) has been very instrumental in the past in helping finance several of PROCEL's projects, and it is expected to continue to support its activities.
- The World Bank is currently developing two loans to support the privatization of the energy sector in Brazil. One loan, which promotes energy efficiency programs, will fund up to a total of $150 million, and will disperse funds through either ELETROBRÁS or PROCEL to energy utilities. The second loan, called the Integrated Commercial/Social Power Loan for the northeast of Brazil, focuses on bringing renewable energy, primarily off-grid solar residential power, to isolated rural communities. Funds will total $100 million,

and will be programmed.
- USAID is very active in promoting assistance and partnership between US and Brazilian businesses and consultants. USAID is interested in disseminating clean technology options and providing assistance to Brazilian regulators. Through these activities, the US government hopes to increase trade in energy technologies, technical and consulting services.

6. Conclusions

The introduction of fair competition in the Brazilian market will take time to be effectively in place and will dominate the agenda of the regulatory body if the current trends are maintained. The public authorities in charge of restructuring the energy sector are now focusing on large bureaucratic regulatory issues, and so far have not been able to protect public goods effectively. The lack of a national energy policy setting broad guidelines and defining which are the public interests that need to be maintained is largely responsible for the omission and/or incomplete formulation of regulatory measures.

The important step taken by ANEEL to create funds for energy efficiency and R&D is still an initial achievement that needs to be improved. The formulation of energy efficiency and R&D plans by the interested utilities severely limits the scope and the opportunities to invest in programs that have the potential to yield greater societal benefits. It is very likely that only programs that present favorable cost-benefit ratios from the utility point of view will be proposed and implemented by the utilities, unless ANEEL has a clearer and more objective prescription of allocation of resources that gives prominence to the public perspective of energy investments.

The present regulation has the following main impacts.
- It will limit R&D to short-term and proprietary research, preventing investments in public interest research.
- It will aggravate regional disparities. The larger and more profitable utilities are concentrated in the Southeastern portion of the country, which also presents higher per capita incomes. End-use efficiency programs tend to be more costly to operate in other areas of the country, but could have greater societal benefits. These regions (especially North and Northeast) also present characteristics that are less investigated by research and development programs and would therefore require more funds than in the more developed South and Southeast regions.
- Some of the priorities laid down by ANEEL will be adopted anyway by profit-seeking utilities and would not require this kind of charge. This charge should be directed to the investments that would not be otherwise made via market forces.

Unlike the much longer and solid tradition in North America, customers in Brazil were only very recently exposed to other practices of supplying energy services through energy efficiency programs, and are seldom aware of the environmental problems caused by the expansion of conventional electricity supply. As the literature has demonstrated [Caldwell, 1976; Gormley, 1986; Energy Foundation, 1996], we are convinced that as a response to the privatization of the energy sector, consumers must take on a more active advocacy role with regard to complex issues at the technical and political levels of energy efficiency and environmental issues. A better educated public will be able to demand actions from competent authorities to protect public benefits and commonly-held values. With this in mind, we are independently evaluating projects funded from the 1% tax approved by ANEEL in the current year and being implemented by utilities in order to analyze their nature, quality and objectives. ■

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Notes

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3. The city of Rio de Janeiro is served by one distributing utility (Light) and the rest of the state by another distributing utility (CERJ).

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