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Power sector reforms in Brazil and its impacts on Energy Efficiency and Research and Development activities

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Power sector reforms in Brazil and its impacts on Energy Efficiency and Research and Development activities[1]

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Abstract

Since the mid nineties Brazil has implemented significant changes in the country's power sector, including privatization, introduction of competition and the creation of regulatory agency. As reform started in Brazil traditional support to energy efficiency and energy research and development suffered a discontinuation, budget cuts and re-definition of roles of the public agents in charge. At the same time, new regulatory measures and the creation of a national public interest fund have helped to maintain and potentially enhance the country's effort to promote energy efficiency and investments in energy R&D. This paper analyses the impacts of theses changes in the areas of energy efficiency and energy research and development.

Keywords: public benefits, power sector reforms, energy efficiency, energy R&D

Introduction

During the last decade several countries started the introduction of structural reforms within their electricity industry. The international experience has demonstrated that these changes towards a more competitive and market oriented industry has strengthened the trend of falling investments in energy efficiency and research and development, at least in the early stages of reforms (Shioshansi, 1995, Surrey, 1996, Dooley, 1998, Dooley and Runci, 1998, Kammen and Margolis, 1999). Very few countries have included provisions to secure and enhance activities and resources in these areas (USAID, 1997, Dubash 2002, IEI 2003).

For developing countries in particular, reforms have created new challenges to the public sector, which has to understand how markets operate, seek funding mechanisms and develop criteria for allocating funds (both public and private). This process meant a re-definition of the role of public agents and sometimes required the creation of new institutional structures. All this demands that energy policy makers understand how energy efficiency and R&D activities take place in the supply and demand side of the energy system, which has now several operators, including private entrepreneurs. New energy policies need to take these changes into account and create regulatory incentives and other mechanisms to support activities related to energy efficiency and R&D.

Brazil started its power sector reform in the mid nineties implementing changes in the management, organisation, ownership and decision-making of its electricity sector. Privatisation was one of the initial steps of the process which

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aimed to attract private investments and create competition within the industry. As these changes have taken place it was observed that public interest activities related to energy efficiency and R&D undertaken in the past by state-owned utilities also changed.

Traditionally, the country has shown support towards energy efficiency and energy R&D with the creation of research centre for the power sector CEPEL in the seventies and a national electricity conservation programme PROCEL in the mid eighties. These initiatives were mostly financed and managed within the structure of the large state-owned ELETROBRAS.

As reform started in Brazil these initiatives suffered a discontinuation, budget cuts and re-definition of roles. At the same time, new regulatory measures and the creation of a national public interest fund have helped to maintain and potentially enhance the country's effort to promote energy efficiency and investments in energy R&D.

This paper intends to analyse the Brazilian experience in implementing provisions in regulation and legislation to promote energy efficiency and R&D in a more competitive environment.

Power sector reform in Brazil

Motivation for reforms

The traditional model of centralised power sector planning, financing and decision-making together with the strong participation of vertically integrated state enterprises, started to present signs of exhaustion during the eighties. This period, in particular, staged several macro-economic policies aimed to control inflation and kept electricity tariffs under control. The resulting effects were that the existing tariffs were not sufficient to cover the increasing investments required for system expansion, to meet annual running costs and also to pay the increasing external debt contracted by the power sector especially during the early seventies. The situation only got worse in the beginning of the nineties. In spite of the increasing demand for electricity, which amounted to 2,500 MW/year on average during 1991-94, the expansion of generating and transmission capacity was only 1,080 MW/year (ANEEL/ANP 2000). Several utilities that embraced ambitious expansion plans during the seventies and eighties were not able to pay the loans contracted. Others companies lacked more professional management, and had high running costs that also could not be met with their revenues.

The prevailing institutional and regulatory framework was also not adequate at the time to solve financial transactions within generating and distributing companies, and the huge debt that was accumulated by the companies.

The recognised difficulty for the government to promote the much needed investment in the expansion of the power sector was one of the main drivers to promote radical reforms in the power sector, together with the pursuit of improved economic efficiency and attraction of private capital. The proposed power sector reforms were conceived under the same general framework that also guided the privatisation of other sectors such as telecommunications, transportation, water services, and other industrial segments considered strategic in the past such as steel industries and petrochemicals.

The old and the new model: Energy Sector Framework Description

The restructuring process started in the country without a prior establishment of a clear regulatory framework and at the same time the tradition of centralised planning ended. Centralised government planning previously required that ELETROBRÁS, the state national holding electrical utility, organised, planned, financed, built, and operated the entire electrical power system. The 2015 Power Sector Plan (ELETROBRÁS 1994) was the last edition of a periodically updated document that served in the past to focus ELETROBRÁS' 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 which ELETROBRÁS is directly responsible for the implementation.

The new system is based on the premises that it should foster competition where possible (generation and commercialisation of electricity) and regulate where necessary (transmission and distribution – monopolies with open access).

The restructuring process started with de-verticalisation and the privatisation of distributing utilities. By 2001 more than 80% of the electricity sold in the country is done by privatised distributing companies. This contrasts with the situation found in the generating side, which is still dominated by state owned companies and only 30% of generating capacity is done by private enterprises.

The new system re-defined the role of the public sector which is no longer the main financial agent, planner, but now responsible for the indicative planning for generation and normative for transmission and regulator.

Reforms included the creation of the National Energy Policy Council (NEPC) 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. However, although created in 1997, NEPC only had its first meeting in year 2000, and has met only to decide on specific actions since then. It has not set out a national energy policy that should guide long term actions for the sector. NEPC is responsible for macro-energy policies, including division of federal/state responsibilities. The committee includes a wide range of ministries representatives and is chaired by the Minister of Mines and Energy.

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 electric 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 responsible for setting up the regulatory regime necessary to provide the right signals to the market and other measures in accordance with national energy policies that should be promulgated by NEPC. ANEEL regulates the power sector, sets guidelines for tariffs and rate-making, 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 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.

Power sector reforms also included the creation of a National System Operator (ONS) and a wholesale electricity market (MAE)

After six years of the first privatised utility Brazil faced a severe electricity shortage and had to implement a rationing plan during June /2001-February/2002 (Table 1). This crisis resulted largely due to the absence of national energy planning and energy policy guidelines that should shape clear regulation which are needed for private investors to assess their risks and returns on investments. The end result was the lack of investments in generation and transmission lines that have not come in the expected speed and amount.

Energy efficiency and R&D investments after reforms

Since the early start of privatisations, in 1994, concession contracts contained clauses that obliged the utilities to invest in energy efficiency and R&D activities. However, up to 1998 these contractual clauses were often too generic and hard to monitor; therefore utilities' performance was difficult to be verified by the granting authorities.

In 1998 the regulatory agency ANEEL established a rule which defined more clearly the amount of annual investment, procedures for submission, approval and verification of utilities' programmes. This measure had the initial objective to avoid the risk that the new companies, mostly owned by foreign investors, would transfer all their R&D efforts elsewhere, a trend already noted by analysts (e.g. Bourgeois and Jacquier-Roux, 2001).

Since then, ANEEL revises annually the criteria for approving energy efficiency and R&D programmes, which are conceived and implemented by utilities. It was established that 1% of the annual net revenues of the privatised utilities had to the invested in annual programmes, both for energy efficiency and R&D (Table 2). At this time only utilities had resources to invest in energy efficiency and R&D programs. In spite of their programmes being supervised by the regulator there was the threat of not addressing some important public interest areas. This mechanism privileged the screening of opportunities according to the utilities' perceptions; areas that potentially could yield greater societal benefits might not receive adequate priority and might be under-funded. In other work (Jannuzzi and Gadgil et al. 1998, Jannuzzi 2000, Kozloff, Cowart et al, 2000, Jannuzzi, 2003) this was discussed extensively.

The prevailing rationale at this time was that utilities were more capable to detect the best opportunities for cost-effective investments in energy efficiency and R&D (Jannuzzi, 2000). This period also coincides understandably with the sharp decline of PROCEL funding (Table 3) and its downsizing. As shown later, the Brazilian experience showed the need to create a new funding source to complement the utilities regulated investments in energy efficiency and R&D.

In fact, in year 2000 the Bill 9.991/00 approved by the National Congress made explicit provisions for a public benefit fund CTEnerg. This Bill allocates part of the 1% annual utilities' revenues for CTEnerg and other part remains with utilities (generation, transmission and distribution), being spent in efficiency and R&D programs. Electric utilities remain responsible for the design and implementation of these programs under the Regulator's supervision, as previously. Table 2 presents the evolution of the funding resources allocation for energy efficiency and R&D since 1998. Bill 9.991/00 extended the 1% obligation to transmission and generating companies and is applied to private and state-owned companies.

The percentage of annual revenues that is dedicated to R&D varies from 0.5% (distributing utilities) to 1% (transmission and generating utilities). Half of these values are spend by the utilities themselves in internal R&D projects; the other half is collected by the CTEnerg fund (which is also in charge of funding public-interest energy efficiency programmes). Distributing utilities have to invest 0.5% of their annual revenues in end-use energy efficiency projects. Therefore, end-use efficiency programmes are only implemented by distributing utilities (Table 2).

In 1998 about 0.4% of electricity sales was invested in energy R&D programmes, with the approval of Law 9.991/00 and the creation of CTEnerg fund, this percentage in year 2003 raised to 1.1% (ABRADEE, 2003).

The CTEnerg is managed by a board of 9 members representing the Ministry of Science and Technology and its funding agencies (3 members), Ministry of Mines and Energy, the Regulator (ANEEL), 2 representatives from the academic community and 2 from the private sector. The Board has the mandate to define annual budget allocation, investment portfolios in energy efficiency and R&D and multi-annual programmes. The CTEnerg White Paper (CTEnerg, 2002) establishes the general philosophy and directives that guides investments. It has been defined as a fund to support public interest energy research and development and energy efficiency and is intended to have investment strategies that complement the activities initiated by the utilities' regulated programmes.

Activities funded by CTEnerg have the objective to provide contributions to the main country's energy challenges, stated as (CTEnerg, 2002):

a) The supply the increasing demand for energy services, including in rural and isolated areas of the country;

b) The diversification of the electricity generation matrix, currently concentrated on hydroelectricity;

c) The development of energy-efficient technologies with low environmental impact, high social use, efficient;

d) Investments must ensure that public interest characteristics of energy services are preserved in an increasing competitive environment (investing in areas where market agents have less interest)

The fund can solicit bids on research topics it considers relevant or contract projects directly. The fund has the obligation to invest 30% of its annual budget in programmes benefiting research institutions located in the North, Northeast and Centre-West regions[3].

CTEnerg had originally the support of a Technical Secretariat hosted at the Centre for Management and Strategic Studies (CGEE), a non-governmental agency contracted by the Ministry of Science and Technology to provide technology foresight studies and evaluation of the research programmes[4] funded. The Technical Secretariat produced documents, including the fund White Paper and technology assessment reports to subsidise Board decisions.

The evolution of Energy Efficiency after reforms

Energy efficiency investments done by utilities

The regulation introduced since 1998 increased several times the amount of investments in energy efficiency traditionally done by PROCEL. Comparing the information on Table 3 and Table 4, it can be seen that in year 2000, regulated investments were nearly 6 times higher than PROCEL's expenditures n efficiency programmes. Even with changes in the legislation that has reduced the percentage of sales revenues dedicated to efficiency programs (Table 2), which explains in part the reduction observed in year 2001[5] (see Table 4), regulated investments are several times higher than the amounts previously invested by PROCEL.

During the first years as part of the regulated investments could be used in supply-side efficiency programmes. Since utilities were responsible for the selection of programmes, their design and implementation, a significant amount was used to reduce utility's energy losses, including commercial losses. From Table 4 it can be seen that in the first cycle of efficiency programmes, a total of 68% of the approved regulated investments were for supply-side energy-efficiency programmes. Figure 1 presents the breakdown of investments in supply-side programmes, which shows the high proportion of loss-reduction programmes. As pointed out in some other articles (Jannuzzi, 2000, Jannuzzi, Gadgil et al 1998) these both features of utilities illustrated an apparent misunderstanding of the role of the role of public interest policies (implemented by the regulator) and the operation of markets, which produced a redundant regulation. Profit-seeking utilities should not need regulation to avoid commercial losses. In the 1998-99 cycle more than half of energy efficiency investments were used in loss reduction projects alone compared to 36% invested in all end-use programmes (Table 4). Over the following years,

[3] These regions are comparatively less developed than the South and Southeast regions.
[4] CGEE assisted CT-ENERG Board since its creation until March/2003. CGEE also hosted the Technical Secretariat of 13 other public R&D funds created as result from the structural reforms implemented during the second half of the nineties in several sectors of the Brazilian economy (telecommunications, roads, oil and gas, minerals).
[5] The other reason is the effect of the electricity shortage suffered during 2001-2002 (Table 1).

ANEEL gradually restricted the percentage allowed for supply-side efficiency investments, as can be seen from Table 4, and created rules to limit the approval of loss reduction projects (no programmes that targeted the reduction of commercial losses were allowed) under the 1% regulation. Since year 2000, all regulated investments for energy efficiency have to be used for end-use programs. All supply-side efficiency improvement is now understood as part of the business strategies of more competitive utilities.

Figure 2 shows the evolution of the expenditure on end-use programmes. Improvements in public illumination systems (mostly changing incandescent lamps for mercury vapour and mercury for sodium high pressure lamps) have represented almost half of the investments in end-use programmes. These have been the most cost-effective investments for utilities so far. Initially, marketing was also another area that attracted utilities' investments until year 2000, after that this type of projects has not been allowed as part of the regulated energy-efficiency programmes. Over the years, ANEEL have determined varying expenditure shares for residential, commercial, industrial programmes. This procedure which fixed percentage expenditure shares has to be observed by all utilities in the country and has not considered local market specific characteristics, missing some opportunities and sometimes forcing the expenditure on less cost-effective programs.

An analysis of the programs during 1998-99 points out the following characteristics (Kozloff, Cowart et al. 2000):

- High costs for conserved electricity (R$/kWh);
- Hard to verify the program performance in terms of amount of saved energy;
- Most efficiency programmes depend on continuous financing, no strategy for market transformation;
- Duplication of programmes over the years and amongst concessionaires;
- Expenditure patters:
    - High proportion of expenditure on marketing;
    - High proportion of expenditure on small and uncoordinated projects;

Some of these issues have been solved or improved over time. ANEEL requires now an ex-post evaluation plan for each of the project submitted and allows for multi-year projects, which has permitted larger and more cost-effective programmes. Expenditure on marketing programs is not allowed since year 2000. Also, as part of the ex-ante evaluation procedure economic criteria (using cost-benefit ratios) are required and ANEEL tries to ensure that programs are cost-effective. PROCEL has participated in the ex-ante evaluations of utilities programmes, as part of its new role. However, ANEEL has not addressed several utilities' disincentives that hamper the performance of programmes. The main one is the impact of reducing sales. Also, the lack of a more comprehensive studies of the existing potential for the introduction of energy efficiency measures in the Brazilian market together with better programme evaluation procedures, in our view, have limited the potential electrical system-wide benefits from these programmes. ANEEL's role as the supervisor of utilities programmes could be further enhanced with more coordination amongst individual programmes.

Also, these activities impacted positively utilities' behaviour towards energy efficiency. Some utilities have detected business opportunities and created their own ESCOs. This is an unregulated activity (differently from the electricity sector) and they can operate in other concession areas and capture economic returns on their investments in energy efficiency[6]. Many utilities have also used programmes as part of their strategies to retain their large (and non-captive) consumers.

Energy efficiency investments done by CT-ENERG

CTEnerg's white paper (CTenerg, 2002) defines the scope of investments in energy-efficiency as complementary to the utilities' regulated programmes. This fund has the objective to support energy-efficiency programmes and initiatives which would not be considered by utilities or market agents, such as the development of energy efficiency-standards, consumer training courses, promotion of events, scholarships or research grants directed to projects that have contributions towards improvement of energy production and use. The fund has also the objective to support regional initiatives to develop local capacity and projects. An extensive study was done during year 2002 to identify regional expertise and areas for investments in end-use analysis, and R&D (CGEE, 2003).

In 2001-2002 about 4% of CTEnerg budget was invested in energy efficiency training programs and events (a technological fair and national contest). Great part of the 33% invested in research laboratory infra-structure (Table 8) had the objective to up-grade facilities to be capable to perform energy efficiency measurements and support the implementation of the energy efficiency law[7]. A continuation of investments in studies and laboratory infra-structure to support the creation of energy efficiency standards was proposed by the Technical Secretariat to the CTEnerg Board in 2002 (CGEE, 2003).

The evolution of R&D activities after reforms

R&D investments made by utilities

As mentioned, since 1998 the regulator determined that privatised utilities invested part of their annual revenues in R&D programs carried out in the country (Table 2). The regulator so far, has not set research priorities or compulsory areas for investments. In the case of efficiency programmes, ANEEL has determined specific investments levels for residential, commercial, and other sectors, but this has not been the case for the R&D regulated programme: there is no specified priority or investment required by research topics, or broad thematic areas. The regulator reviews all projects and then

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[6] ANEEL started to introduce accounting procedures to ensure that economic benefits from investments done under the 1% obligation are also returned to consumers, at the time utilities' tariffs are reviewed.

[7] The Brazilian law 10.295/2001 set the principles for the "National Energy Conservation Policy and Rational Use of Energy". The law requires the development of energy standards for all of energy consuming equipment commercialized in the country.

authorizes the utilities' investments in new R&D programs, similarly as the energy efficiency programmes.

Initially the ex-ante evaluation of utilities' programmes was done by ANEEL staff; on a second phase ANEEL contracted the National Research Council (CNPq) to review the proposals. More recently (2003), ANEEL contracted Universities and Research Centres for this task.

The total amount of resources has expanded significantly. As concession contracts were revised, some changes in ANEEL's resolutions were introduced and the Bill 9.991/00 was implemented, the number of utilities (private and state-owned) that now have regulated R&D programs have increased fivefold since 1998, from 13 in 1998 to 63 in 2003. Resources available to energy R&D have boomed. The total amount jumped from R$ 12 millions to R$ 433 millions in nominal terms during this period, a 36-fold increase. This was a result of increased electricity sales, increased number of participating utilities and changes in the participation of R&D allocations in the 1% obligation as shown in Table 5.

Table 6 shows the evolution of the number of participating of agents contracted by utilities to carry out regulated R&D programmes[8]. The amount of resources also stimulated the participation of private firms to engage in applied R&D projects, increasing the changes of commercialization of the most successful results. Brazil has a strong tradition of University led R&D, which still absorb most the resources available and conduct most of the larger programmes, however it is noticeable the appearance of smaller technological-based firms in several parts of the country (ABRADEE, 2003).

During the period 1998-2000, therefore before the creation of the CTEnerg Fund, electrical utilities had the obligation to invest a minimum of 0.1% of their annual revenues in R&D programs. An evaluation of their activities during this period confirmed their major interest in commercial R&D and the need to fund other types of programs that had potential of providing greater societal benefits (Jannuzzi, 2000, Kozloff, Cowart et. al, 2000, Jannuzzi and Gomes, 2002). Figure 3 presents the regulated utilities investments and the relative concentration on commercial or corporate topics in the initial years, denominated "strategic research" by the ANEEL R&D Programme Guidelines (ANEEL, 2002). Since 2001 there has been more diversification of topics as can be seen from this figure also. Similar to the findings with efficiency programmes, an analysis of the research projects shows concentration on similar problems, low risk and short-term projects (Jannuzzi & Gomes, 2002). Opportunities to cooperate, sharing resources and results, are gradually being perceived more recently by some of the larger and mid-sized utilities, and the regulator has facilitated the formal submission arrangements so that joint programmes can be now proposed.

Applied research has received the majority (about 60% of annual investments) of investments and basic research less, which is expected from R&D projects

[8] Utilities have preferred to contract projects instead of building-up in-house research facilities and personnel.

proposed by utilities. Demonstration projects have represented about 30% of annual R&D regulated expenditures (Figure 4). This breakdown has not changed significantly during the period 1999-2003.

It is important to note the evolution of the learning experience of Brazilian utilities in the management of their R&D programmes. The sequence of figures (Figure 5-Figure 8) shows that over time there has been a trend of implementing larger and longer-term programmes. The three categories of projects (Directed basic research, applied research and demonstration projects) have shown an increase in their average investment cost (Figure 5) and increased their duration, which in 1999/2000 averaged 15 months for projects in the category of Directed Basic Research and in 2002/2003 the average was 24 months. The average duration of Experimental Development and Applied Research have also increased (Figure 7) during the period.

The distribution of the number of projects according to their total cost confirms a clear trend of increasing the number of larger projects being implemented over time (Figure 6) and the trend of having of projects with larger duration (Figure 8).

Investments made by the public interest energy fund CTEnerg

According to the current CTEnerg guidelines, it is intended to provide funds for R&D and energy efficiency in areas considered socially desirable and are consistent with the national development plans and goals. The resources collected by CTEnerg can be transferred from year to year, when not used in the current fiscal year, and offer the possibility to invest in long-term and projects with higher degree of risk. This way, CTEnerg offer a more stable source of public support to energy R&D for projects that do not attract interest from private investors but are also considered important for the society. If operated complementarily to the utilities' regulated programmes and other private investments it has the potential to provide greater stability to the final commercialisation of R&D results in the future.

In 2001 CTEnerg invested R$ 50 millions in electricity related programs and for year 2002 it will dedicate nearly R$ 20 millions, although its official budget is R$ 70 million (Table 7). These numbers have been much less than the amount invested by utilities, and theoretically the residual is being accumulated for future use. Current provisions in the legislation and formal procedures used to plan national budget (CTEnerg Fund annual expenditure needs to be approved by the National Congress) have hampered the management of the resources and the fulfilment of its original objectives to provide a stable source for long term programmes.

CTEnerg projects are in general larger and have longer realization periods compared to the ones being implemented by utilities. In year 2002 CTEnerg Technical Secretariat conducted a study to propose a national R&D programme for Fuel Cells (CGEE 2002). This was an example of initiative that envisaged a combined effort of existing fuel cell projects being financed by utilities and other agents (including other Ministries and international organizations), establishing targets and a 10-year horizon for achieving results suitable for the Brazilian conditions and market. This proposal became an official programme from the Ministry of Science and Technology in November 2002 and awaits its implementation.

Two other initiatives initiated by the technical Secretariat were an evaluation (ex-post) of the projects financed by the fund and a comprehensive technological foresight for a 20 year-period ahead. These initiatives were interrupted after the changes in the government and Ministry of Science and Technology in early 2003. However, the foresight exercise was initiated in August/2003 by the Centre of Management and Strategic Studies, with CTEnerg funds. This study is a Delphi exercise which should have its results available by April 2004 (Macedo and Jannuzzi, 2003, CGEE 2003).

Lessons learned

It is very unlikely that initiatives in energy efficiency and R&D would have taken place without the regulators' enforcement in 1998 and later with the implementation of Bill 9.991/00 by the National Congress. Power sector reforms in Brazil provided the opportunity to enhance support and in fact increase significantly the level of funding in these areas.

However, provisions in legislation alone are not sufficient condition to ensure that resources are being used efficiently to maximize the public interest of energy-related services. Analysing the country's experience since 1998, it was observer an important learning process within the regulator and also amongst the utilities. Some utilities are perceiving the strategic importance of pursuing activities in R&D, such as the technical improvement of their own staff, some small companies are appearing as results of some more successful projects and a better relationship between research centres and universities is being developed (ABRADEE, 2003). This is a significant change in the relationship with utilities and research establishments in the country. It also helped to promote interesting spill over effects inducing the creating of new businesses represented by small consulting firms and ESCOs.

The experience with the public benefit fund CTEnerg is more recent. However it is illustrative that it has invested much less than the amounts invested under the regulated utilities efficiency and R&D programmes. The federal government has limited annual spending in order to comply with macro-economic targets for public spending and CTEnerg has been affected by these types of interventions. The management of this fund is done by representatives from government, academia and private sector, and this has been a novelty in the administration of public funds in Brazil, and has contributed for a better screening of investment options, during the period 2001-2002. This model, however, needs yet to be consolidated and CTEnerg has to demonstrate a higher degree of consistency and predictability over time. Interesting enough, legislation gives conditions for a more stable operation, but indigenous institutions have not been able to implement these conditions.

The provisions to ensure funding support for energy-efficiency and energy R&D had an important impact for the institutional learning both in the public sector and utilities.

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Tables

Table 1: Electricity consumption in Brazil TWh (1994-2002)

sector	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*	*2001*	*2002*
residential	55.957	63.579	68.581	74.089	79.340	81.249	83.494	73.770	72.660
industrial	116.759	111.632	117.128	121.717	121.979	123.560	131.195	122.629	127.690
commercial	28.885	32.277	34.388	38.198	41.544	43.562	47.437	44.517	45.256
other	34.026	35.598	37.234	39.276	41.659	42.739	44.621	42.882	44.924
total	235.627	243.086	257.331	273.280	284.522	291.110	306.747	283.798	290.529

Source: ELETROBRAS (2003)

Table 2: Legal annual investment requirements in energy efficiency and energy R&D by electricity utilities in Brazil (as % of their annual net sales revenues)

Sector/types of utilities	**Year**	**Legal instrument**	**Energy Efficiency (Regulated programmes)[a]**	**Energy R&D**		
				Total	**Regulated programmes (Utilities)**	**CTEnerg [c]**
Generation [b] and Transmission	≥ 2000	Bill 9.991/00	-	≥ 1,00%[d]	0,50%	0,50%
Distribution	1998-1999	ANEEL resolutions	≥ 0.25% end-use, ≥ 0.65% supply-side	≥ 0.10%	≥ 0.01%	-
	2000- 2005	Bill 9.991/00	≥ 0,50%	≥ 0,50%	0,25%	0,25%
	≥ 2006	Bill 9.991/00	≥ 0,25%	≥ 0,75%	0,375%	0,375%

Notes: ([a]) Since year 2000 only end-use energy efficiency projects can be financed (Bill 9.991/2000). ([b]) Generators using renewable resources (solar, wind, small hydro plants and biomass) are exempted from these requirements. (c) also include public interest energy-efficiency investments.

Sources: Jannuzzi & Gomes (2002).

Table 3: Investments and results obtained by PROCEL (1994-2000)

Results	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*
Approved investments (R$ millions) *	9.5	30	50	122	50	40	26
Saved electricity (GWh/year)	344	572	1970	1758	1909	1862	2300
Avoided demand (MW)	70	103	293	976	532	418	640

Source: PROCEL, 2003.

Table 4: Total investment in regulated energy efficiency utilities' programmes (1998-2002)

Cycle	*Number of utilities*	*Investments (R$ millions)*	*% Supply-side programmes*	*% End-use programmes*
1998/1999	17	198.2	68%	32%
1999/2000	42	220.1	60%	40%
2000/2001	53	102.6	6% (a)	94%
2001/2002	60	165.9	1% (a)	99%
Total	-	686.8	40%	60%

Source: Jannuzzi & Gomes (2002) and ANEEL 2003. Note: (a) After year 2000 (Bill 9.991/00) only supply-side programmes that had been previously been approved by ANEEL were allowed to be continued.

Table 5: Total investments in regulated utilities' R&D Programmes (1998-2003)

Cycle	*Number of utilities*	*Number of projects approved*	*Total invested (R$ millions)*
1998/1999	13	63	12.9
1999/2000	43	164	29.7
2000/2001	67	439	113.3
2001/2002	72	535	156.2
*2002/2003**	*67*	*442*	*121.1*
Total	-	*1643*	*433.3*

Source: ANEEL 2003

Note: * until November 2003.

Table 6: Agents contracted by utilities' R&D programmes (1999-2003)

Agents	***1999/2000***	***2000/2001***	***2001/2002***	***2002/2003***
Private firms	55%	28%	31%	45%
Foundations	3%	17%	18%	17%
Research Centres	10%	11%	14%	7%
Universities	28%	41%	35%	29%
Other	3%	3%	2%	3%
Total	29	64	114	200

Source: ANEEL (2003)

Table 7: Estimated and actual budget/expenditures by the CTEnerg Fund (2001-2004) in R$ millions

	2001	***2002***	***2003(2)***	***2004(2)***
Projection based on electricity sales		175.6	145.0	150.8
Original official budget	106.8	139.5	70	
Expenditure	70.7	108.3(1)	20	
20% allocated to CT-INFRA	14.1	35.1	29.0	30.2
Available for R&D investments	56.5	140.5	116.0	120.6

Source: CTEnerg (2003)

Note: (1) – Expenditures up to July 2002. (2) - 2003 and 2004 are author's projected values.

Table 8: Investments in energy programs by CTEnerg during 2001 and 2002

Energy topics	**2001-2002**
Research Laboratories (upgrade)	26
Fuel Cells	14
Hydro-meteorological studies	8
Thermoelectricity (conventional)	18
Biomass	4
Energy efficiency training programmes and events	4
Other	26
Total	100%

Source: Authors' compilation based on CGEE, 2003.

Captions to illustrations

Illustrations

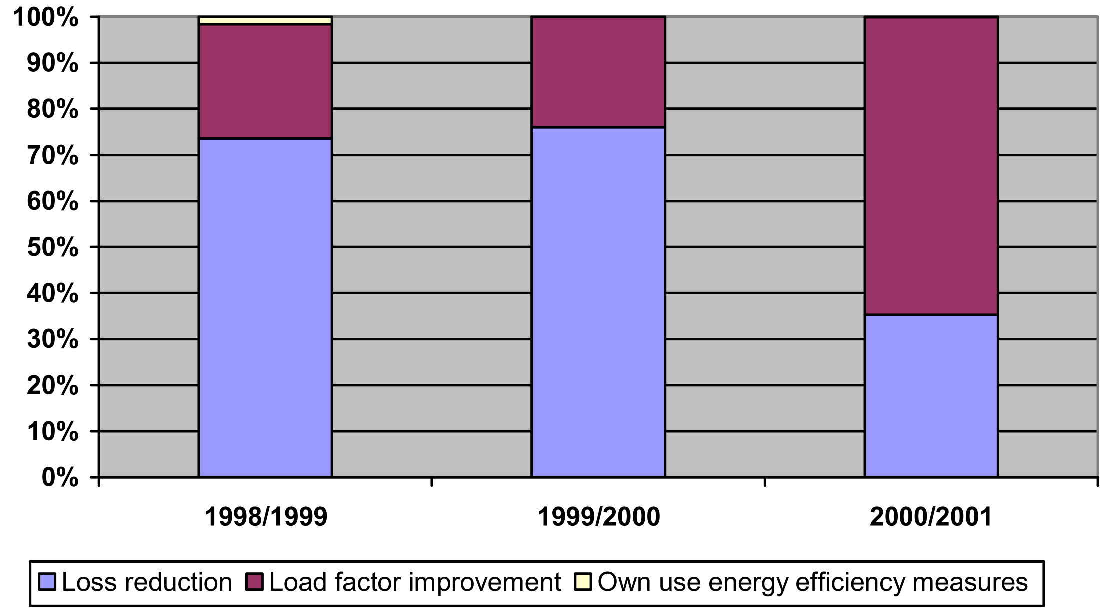

Figure 1: Breakdown of expenditures on Supply-side Energy-Efficiency Utilities' Programmes (1998-2001)

Source: Jannuzzi & Gomes (2002), ANEEL 1999, 2001 and 2003.
Notes: Since end of year 2000, supply-side efficiency programmes were not included in the regulated programmes. The 2000/2001 column represents the programmes that were already submitted and approved by ANEEL by that date.

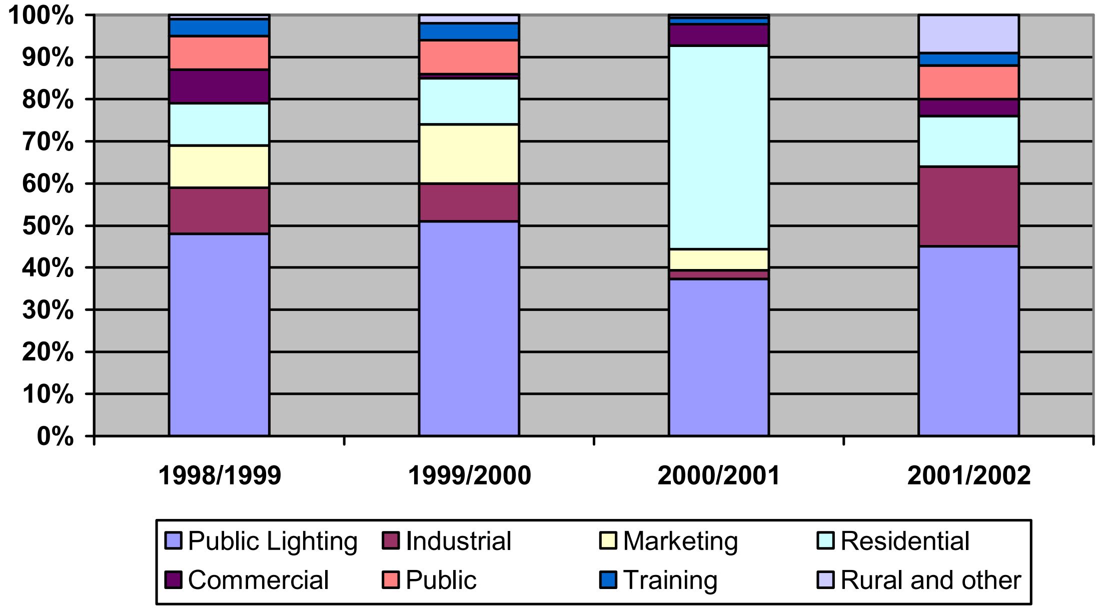

Figure 2: Breakdown of expenditure on regulated End- Use Energy-Efficiency Utilities' Programmes (1998-2002)

Source: Jannuzzi & Gomes (2002) and ANEEL, 1999, 2001 and 2003.

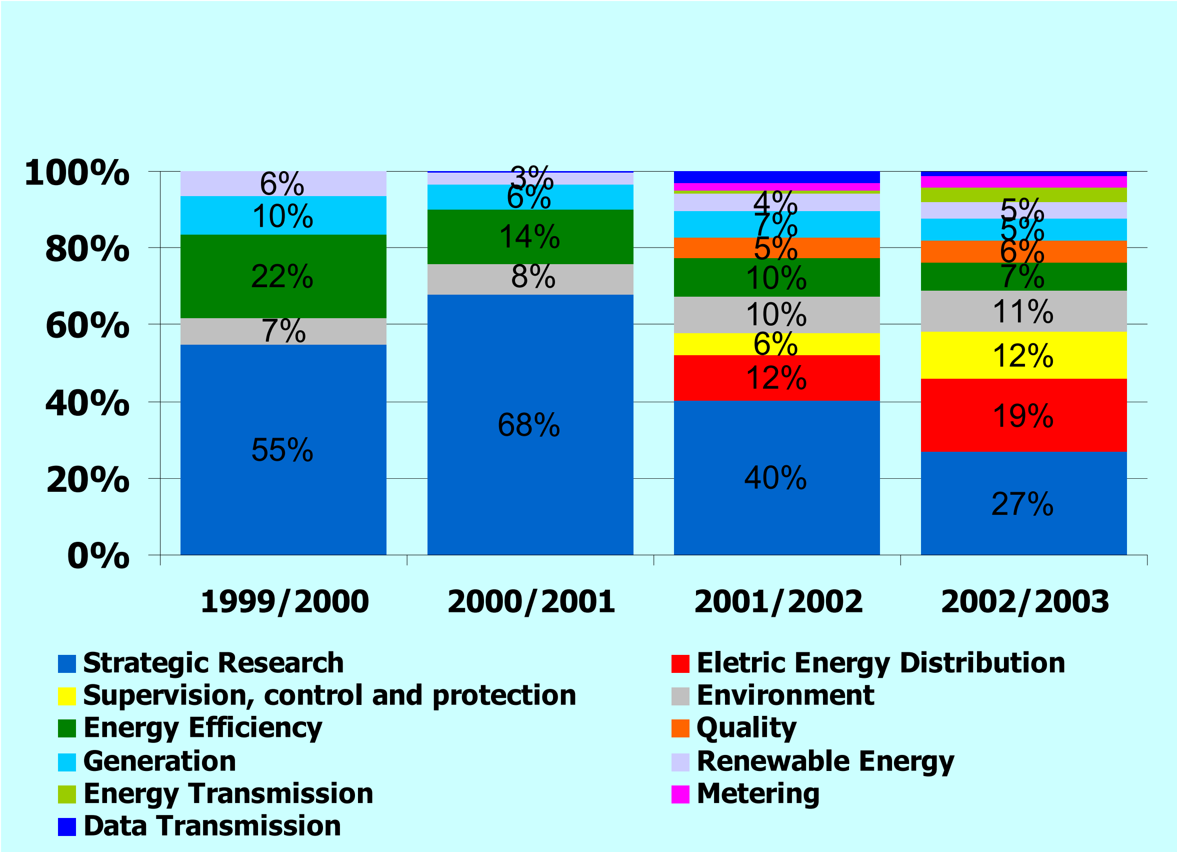

Figure 3: Distribution of R&D investments of utilities regulated programmes according to main subject area (1999-2003)

Source: ANEEL (2003)

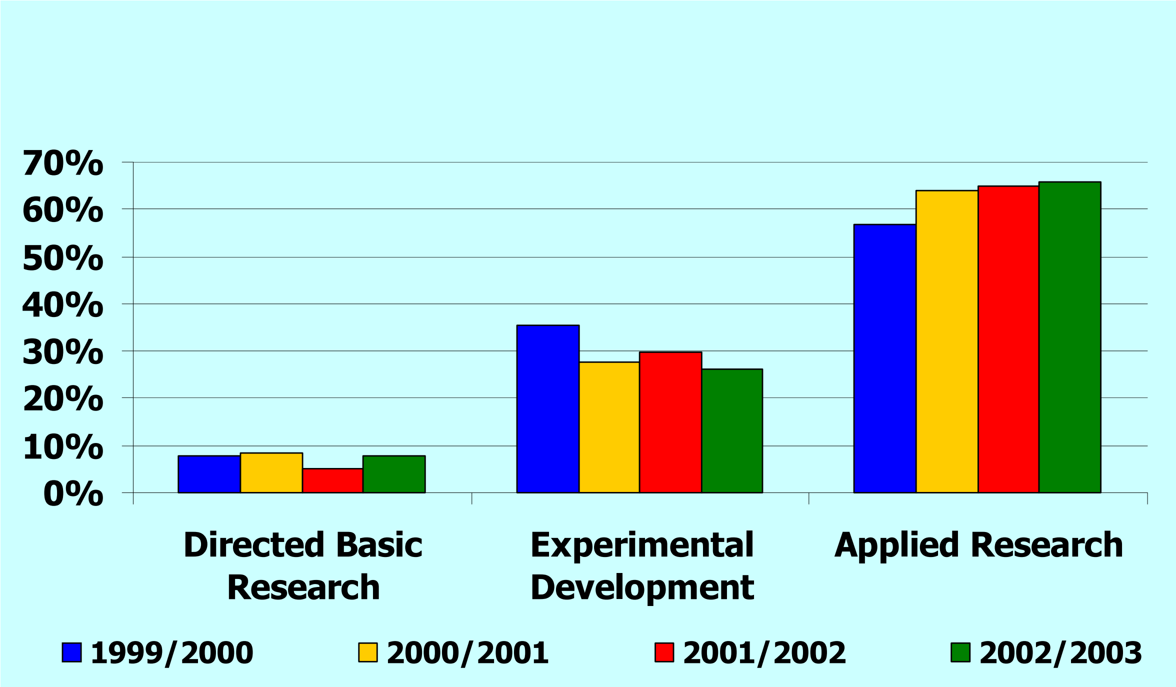

Figure 4: Breakdown of investments in R&D by main category: Basic Research, Experimental Development and Applied Research (1999-2003)

Source: ANEEL (2003).

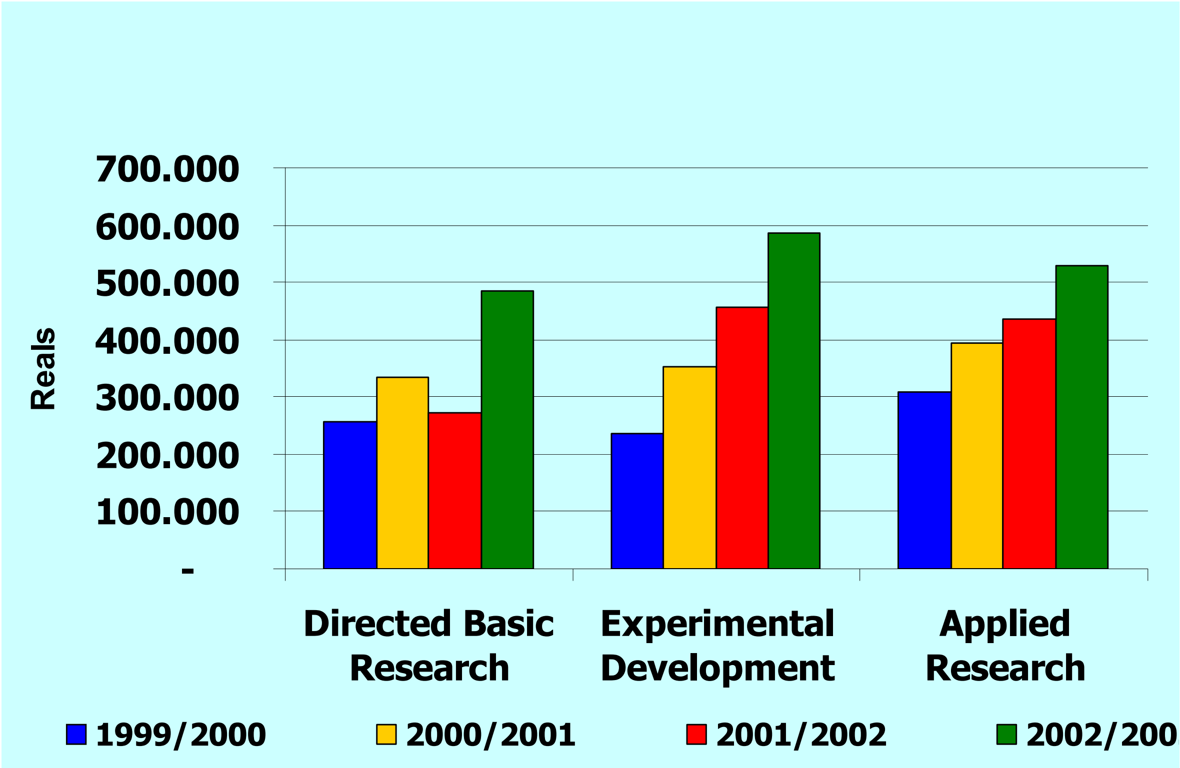

Figure 5: Average expenditure per project by research category (1999-2003)

Source: ANEEL (2003)

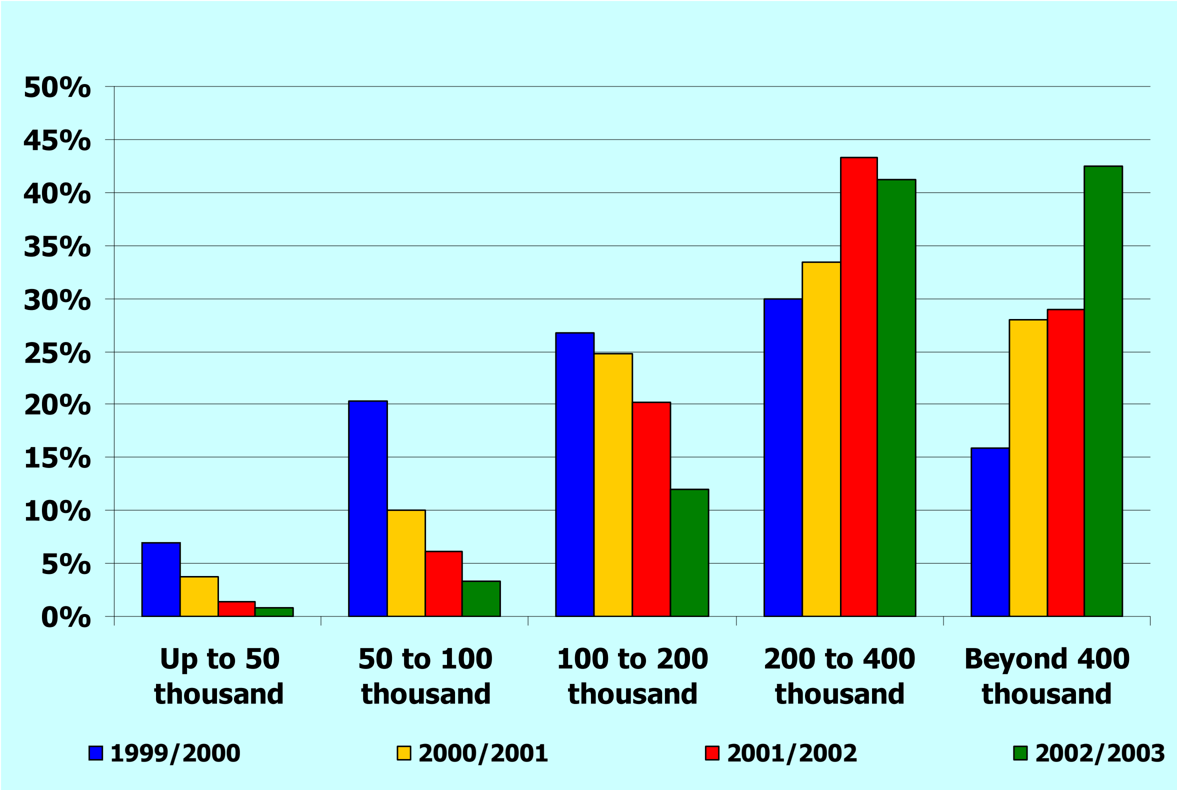

Figure 6: Distribution of R&D projects according to total cost (1999-2003)

Source: ANEEL (2003)

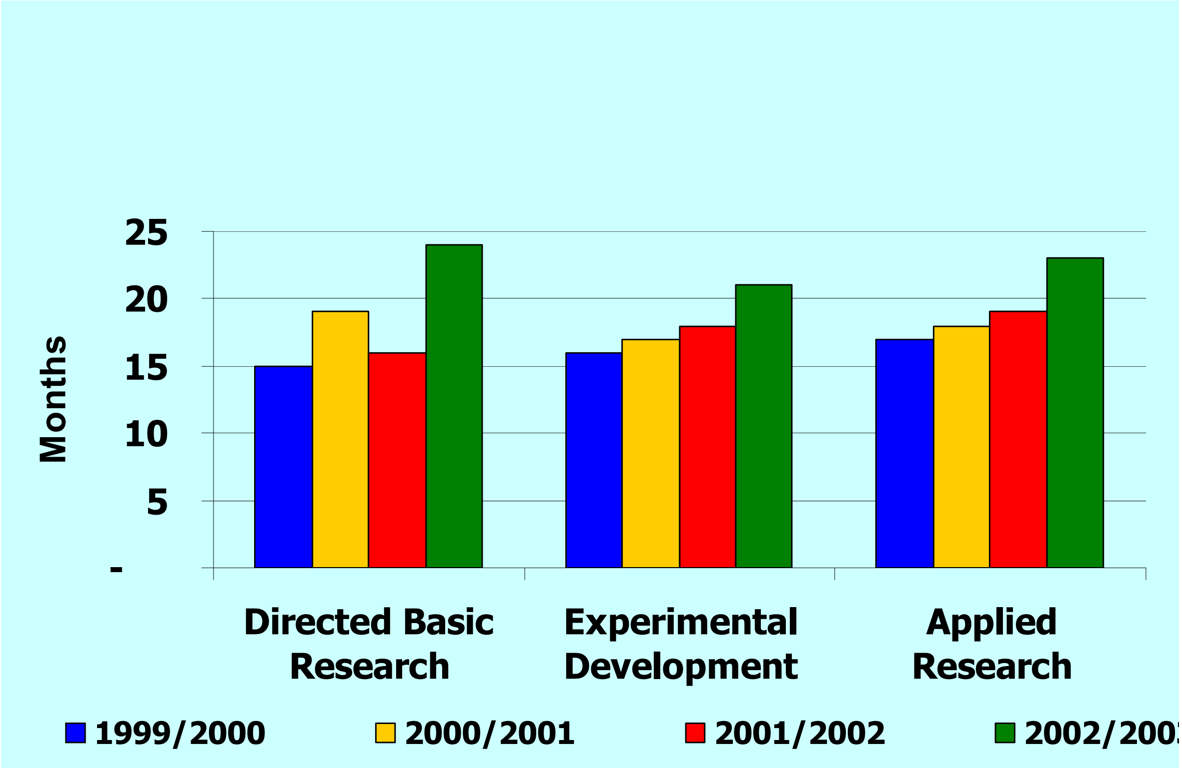

Figure 7: Average duration of R&D projects by research category (1999-2003)

Source: ANEEL (2003)

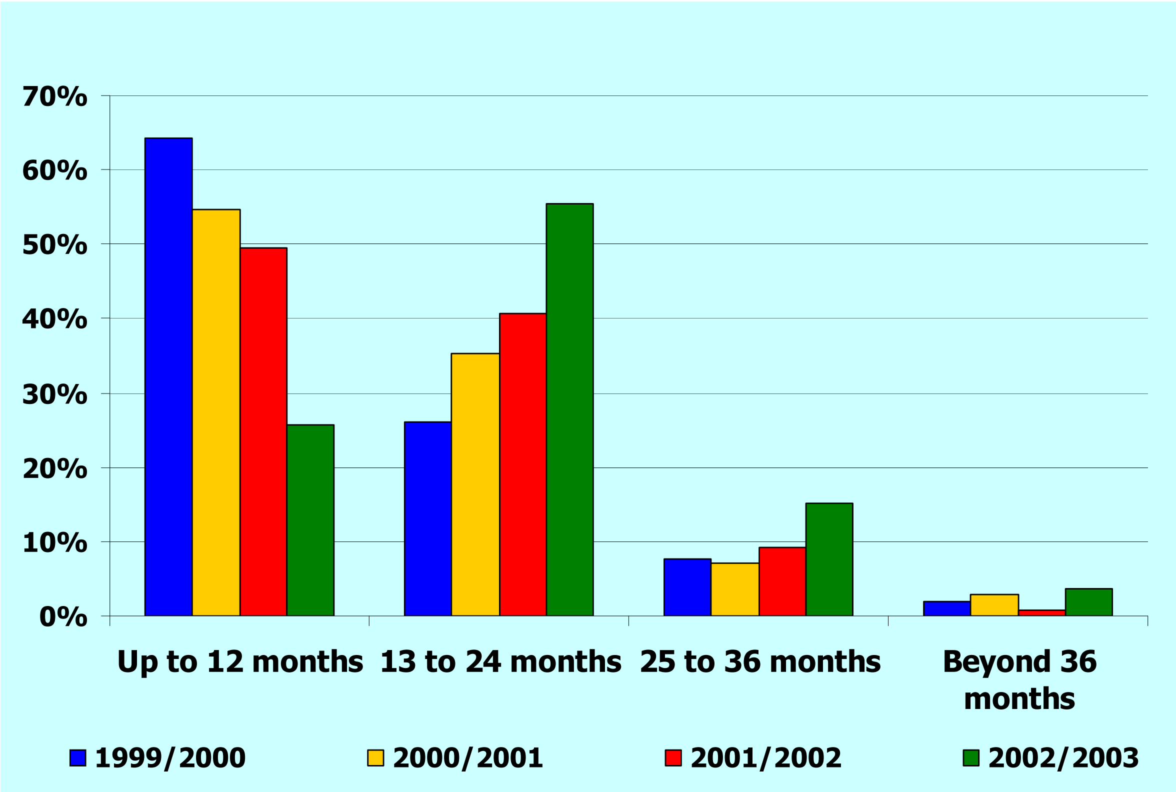

Figure 8: Distribution of R&D projects according duration (1999-2003)

Source: ANEEL (2003)