The Strategic Value of Evaluation for Brazil and Neighboring Countries: The Experience of Procel

Karla Kwiatkowski Lepetitgaland, Eletrobras, Rio de Janeiro, RJ, Brazil Luiz Eduardo Menandro de Vasconcellos, Eletrobras, Rio de Janeiro, RJ, Brazil Leonardo Pinho Magalhães, Eletrobras, Rio de Janeiro, RJ, Brazil Ana Lúcia dos Prazeres Costa, Eletrobras, Rio de Janeiro, RJ, Brazil Leonardo Fellipe de Toledo Costa, Eletrobras, Rio de Janeiro, RJ, Brazil Rafael Friedmann, Pacific Gas and Energy, San Francisco, SF, United States of America

ABSTRACT

Evaluation is an important and necessary component of any energy efficiency program, which is still undervalued in Brazil and elsewhere in Latin America. It integrates a non-linear process in a systematic way, playing the role of the fundamental gear to the continuous improvement of a program and/or portfolio of programs. In addition, evaluation influences decisions about program and/or portfolio design and implementation, clarifying key assumptions on which the program is based, and validating their impacts and relevance. This information is important to sponsors and regulators, and enables continuous improvement by highlighting lessons learnt, confirming their implementation and effectiveness.

In Brazil and other countries in Latin America where energy efficiency efforts are growing, evaluation does not yet receive the attention and resources required. It is mostly used to audit results of a program and its implementers and/or designers. This leads to a less than ideal relationship between the evaluators and the evaluated, resulting in competition and mutual distrust within the energy efficiency community instead of cooperation and complementation.

Evaluation is an underutilized tool in Brazil. Unless a program is required to evaluate its savings and cost-effectiveness, evaluation will not be a priority, and likely not carried out at all. Sometimes, when evaluations are done, they occur too late to provide useful feedback to program design and/or implementation.

This paper draws on the 25-year-old experience of PROCEL (Brazil's Federal Electricity Conservation Program) to highlight the difficulties faced to carry on energy efficiency program evaluations in Brazil. It also shows the benefits of using evaluation strategically to support the systematic improvement of programs, and its relevance to portfolio planning. These issues will be addressed through a case study of one of Procel's program's evaluation. Preliminary evaluation results have shown that in order to develop a nationwide energy efficiency program, it is necessary to go beyond equipment labeling, standards and funding. We must also encourage technology development and improvement and the reviewing of simple specific protocols informed by ongoing evaluation efforts.

Introduction

Background on Brazil's Energy Use and Energy Efficiency Framework

Brazil is considered South America's largest electricity market. Brazil is a large country and thus demands a huge infrastructure of electricity. The capacity installed is comparable to the UK as well as Italy but it possesses a much larger transmission network Brazil has the world's largest water storage capacity,

which explains why its electricity sector is dependent upon the hydroelectric power generation. This generation meets more than 80 % of the demand for electricity. Although hydroelectricity meets a large portion of electric consumption, its production can be severely curtailed as happened during the 2001-2002, drought. There are more than 24 hydroelectric power plants of more than 1 GW capacity. As of 2007, there are a total of 633 plants. Of these hydroelectric power plants, Itaipu dam facility, with a capacity of 14 GW, makes up 25% of the total electricity generated by hydroelectric power plants for the national grid station. The power generation through this reliable means results in an overall decrease in the generation cost.

Eletrobras, the leading company in the Brazilian electric sector, is behind all of this. Presently Eletrobras has an installed capacity of 39,453 MW, including 50% of Itaipu, and has approximately 60,000 kilometers of transmission lines. Eletrobras also supports government strategic programs, such as the program that fosters alternative electric power sources (Proinfa), the National Program for Universal Access To and Use of Electric Power (*Luz Para Todos*) and the National Program for Electric Power Conservation (Procel).

All this electricity is used according the distribution chart below.



Figure 1: Brazil's Energy consumption in 2010 (Source: EPE 2011)

Despite all the natural resources available, environmental issues have posed a challenge for the electric sector for a long time. The concession of environmental licenses for electric undertakings is a factor that generates strong conflicts with environmental agencies and with the impacted communities, resulting in considerable delays and even work halts. This situation tends to worsen for two basic reasons: on one hand, the strong necessity of expansion of the electric sector in order to meet the expected growth in the Brazilian economy, and, on the other hand, the intensification of world discussions and impasses associated with climate change and global warming, with the Brazilian government pursuing a world leadership role in the search for solutions.

The climate for Brazilian energy efficiency is improving according to energy efficiency industry representatives, industrial associations, NGOs and public officials. The improved climate results from a number of drivers including:

• Rising energy prices especially electricity prices;

• Privatization of many state electricity distribution companies and the resulting end of subsidies, especially for industrial and commercial companies;

• Increasing concern about the reliability of the electricity system as demand growth outpaces supply growth in terms of both peak capacity and annual energy;

• Increased interest by the Government of Brazil in energy efficiency as a mitigating factor in the looming electricity shortage problem;

• Federal government initiatives to encourage energy efficiency such as the obligation of utilities to spend one percent of their revenues on energy efficiency and research and development, a Presidential decree to reduce energy use in public buildings by 20 percent, and a street lighting efficiency program; and

• A growing energy efficiency industry composed of energy service companies and energy efficiency equipment manufactures.

That is why energy efficiency is gaining place at the government agenda, even though it is much more slowly than it should. Some initiatives have been created and supported along the last 25 years, such as Procel, the Federal Electricity Conservation Program and the Energy Efficiency Program (PEE); the latter established by the national utilities regulator. Procel and PEE are the two main Brazilian energy efficiency programs.

The Utilities Program – Dedicated Resources to Energy Efficiency

The utilities programs must follow the instructions of the Energy Efficiency Program Guidebook of ANEEL – Agência Nacional de Energia Elétrica (the acronym for the National Electricity Regulator). Utilities must submit end-use energy efficiency programs for residential, industrial, commercial and public sectors (Januzzi 2007).

Since the creation of regulatory measures to ensure mandatory investments in energy efficiency programs in 1998, investments have been made in programs for low-income families. Since 2005 it is mandatory that 50% of the resources allotted to energy efficiency programs must be invested in low-income programs (ANEEL 2005). About 37% of the Brazilian residential consumers are considered low-income consumers and receive subsidies amounting to around R\$ 120 million per month. Low-income programs include the following activities: information on energy efficient use, upgrades of existing dwellings' electrical installation, donation of energy efficient appliances, replacement of electric showers with solar heaters, and installation of solar heaters to supply pre-heated water to electric showers. ANEEL also allows specific educational efforts towards these communities. The regulator has also approved in the past the use of the resources allocated to energy efficiency projects to purchase meters and regularize the connection of low-income households to the grid (Januzzi 2007).

Procel – Brazil's Key Player in the Pursuit of Energy Efficiency

Procel (Federal Electricity Conservation Program) is a program of the Brazilian Federal Government, established in 1985 by the Ministry of Mines and Energy, and since then it has been implemented by Eletrobras (Brazilian Electricity Holding), a public-private company. Procel's goal is to lead Brazilians to save electric energy through the adoption of efficient products and practices in homes, industries, commerce, and institutions.

Since its launch, Procel has helped Brazil save 38 TWh of electricity, corresponding to 10% of the total volume of national residential energy consumption in 2009. These results have been achieved by Procel and the market partners affected by the program. Procel's main goal is to make energy efficiency happen in Brazil, as seen in Figure 2:



Figure 2: Procel's Framework (Source: Procel 2006)

More than R\$ 1 billion has been invested in energy efficiency at a cost-benefit ratio of 24:1 since 1986. This means that for every R\$ 1 invested, the country was able to postpone R\$ 24 in expansion projects in the Brazilian National Electric System. Figure 3 shows the amount invested by Procel and others in the last five years to promote energy efficiency in Brazil:



Figure 3. Yearly Investments by Funding Source (R\$ million¹)² (Source: Eletrobras-Procel 2010)

 1 1 US\$ = R\$ 1.627

 $^{^{2}}$ RGR is a fund administered by Eletrobras to fund energy R&D and energy efficiency activities. It is funded by a surcharge on utility bills. Some of PROCEL's activities are supported by the RGR. Due to its limited life, the RGR is not seen as a long-term source of investment capital in energy efficiency. GEF stands for the Global Environment Facility.

In 2010, Eletrobras, through Procel, leveraged savings of approximately 6.2 TWh (see Figure 4). This result is equivalent to approximately 1.5% of total electric power consumption in Brazil during the period, corresponding to the annual energy consumption of about 3.3 million homes in Brazil, or the energy supplied in one year by a hydroelectric plant with a capacity of 1.5 GW. This energy savings is equivalent to avoided emissions of 316,000 tCO2 equivalent, which corresponds to the emissions produced by 108,000 vehicles over one year (see Figure 5).



Energy Saved (million of kWh)
Peak Demand Reduction (MW)
Hydroelectric Plant Equivalent (MW)

Figure 4: Annual Energy Savings of Procel for the Past 5 Years (Source: Eletrobras-Procel 2010)



Figure 5: CO2 Emissions Avoided in the Past 5 Years (Thousand tCO2e) (Source: Eletrobras-Procel 2010)

Since 2000, Procel has carried a variety of actions and led initiatives to promote the adoption of energy efficiency in Brazil and build an autonomous, market-based infrastructure. It includes running market

surveys, offering funding to laboratories, improving building projects, supporting energy efficiency potential studies, and establishing partnerships with market actors, among others. These actions were developed under Procel's subprograms to make it easier to achieve specific targets in industry, municipalities, buildings, and education; as these represent the major electricity consumption segments (see Figure 1).

Energy efficiency labels and minimum energy performance standards have been a key policy instrument to promote energy efficiency. In 1986, Procel supported Inmetro in the launching of the National Energy Conservation Label and, in 1993, it introduced the Procel Seal Program, as a voluntary labeling program designed to identify and promote energy-efficient products and reduce the environmental impacts related to energy consumption (see Figure 6). Refrigerators and freezers were the first labeled products, and the label was then expanded to additional appliances and other equipments, such as air conditioners and electric motors. Currently, the Procel Seal is found on major appliances and home electronics, applied to 31 categories, from 206 companies, totaling 3,770 products. The overall energy results achieved in 2010 are mainly due to the results of Selo Procel ("Procel Seal") during the year, demonstrating the emphasis that Eletrobras/Procel have placed on end consumers, by encouraging the purchase of more efficient equipment through this energy efficiency label.



Figure 6: Procel Seal (Source: Procel 2006)

Two key laws provide the funding and set the policy goals of the energy efficiency effort in Brazil. In 2000, Procel supported the enactment of Federal Law 9.991/00, whereby 0.5% of corporate net operational revenue earned by energy distribution utilities would be destined to develop energy efficiency projects and R&D studies. In 2001, the Energy Efficiency Law (Number 10.295/01) was promulgated in order to restrict and discourage sales of less energy efficient equipment.

Procel has promoted ever more stringent minimum energy performance standards. Figure 7 shows how in the case of window air-conditioning units, the latest two revisions to these standards have reduced energy used by these units by 1/3.



Figure 7. Evolution of Energy Use in Window Air Conditioners Due to Standards Revisions (Source: Eletrobras-Procel 2010)

One of the most important of Procel's longer-term subprograms is Procel Education, which aims to insert energy efficiency concepts in school curriculum to improve awareness among students, changing society's energy consumption culture. This program has benefited about 20 million students all over the country so far. Key elements are shown in Figure 8.



Figure 8: Procel Education's Framework (Source: Procel 2006)

Evaluation in Brazil

Evaluation is an important issue in Brazil nowadays, with heightened awareness among all the main players. For this reason, a plethora of resources are now being invested in evaluation studies and monitoring.

Impact evaluation is an essential gear for the operation of energy efficiency programs anywhere in the world. It is particularly relevant in developing countries like Brazil and neighboring countries in South America, since evaluation validates programs and justifies their budgets in a severely resource-constrained environment with competing basic needs. Figure 9 shows the importance of evaluation in energy efficiency programs and policies.



Figure 9: The Importance of Evaluation in Energy Efficiency Policies (Adapted from Harmsen 2008)

Evaluation of Utilities' Programs

According to Januzzi past programs managed by utilities have not been subject to rigorous ex-post evaluation (Januzzi 2007). The low-income programs completed to date range from the legalization of consumers through the installation of meters and adequate electrical connection, to lamps and refrigerator replacement and educational programs (Pires 2006). But, it is difficult to compile relevant data and results that can indicate best practices across these intervention strategies to maximize energy savings results.

Some utilities already have a wealth of experience with lower income customers and it would be beneficial to tap into this knowledge base to gather recommendations about their best practices. For example, within the Brazilian Association of the Power Distribution Utilities (ABRADEE), based on the national experience with low-income energy efficiency programs, there is now a recommendation that these consumers should pay for some of the energy-efficient equipment costs (Mascarenhas 2006).

The utilities' annual energy efficiency programs could contemplate similar, parallel pilot projects to allow collecting homogenous information from the different regions of the country and optimize future efforts. This effort would also support the creation of a multi-utility team that could share experiences and negotiate with suppliers. Thus, it is highly desirable to promote more cooperation and coordination amongst

utilities' programs. These pilot projects could be undertaken during a one-year period to provide information that would support a larger scale, nationwide program, which could be combined with development of a public policy to determine an effective strategy for removing or phasing out the current program of energy subsidies (Januzzi 2007).

Evaluation of Procel's Actions

Eletrobras is working on studies to incorporate new equipment into the energy efficiency evaluation process. In 2010, the Selo Procel was approved for microwave ovens and table fans, which will soon be included in the program.

In light of the importance of improving the methodologies for evaluating the energy results of Selo Procel, Eletrobras has partnerships with several Brazilian universities, which develop specific projects and studies. In 2010, the review of the methodology related to ceiling fans was initiated and incorporated into the results evaluation for that year. In addition, Eletrobras has the support of manufacturers and their associations, who participate actively in the energy efficiency discussions.

With respect to the testing laboratories network for conferring the Selo Procel, a systematic monitoring of the tests is done by means of a specific computational tool. This network consists of more than 20 laboratories in research centers and universities, involving more than 150 professionals, where Eletrobras has invested close to BRL 16 million. In 2010, over 4,900 energy efficiency tests of equipment were conducted.

There is an increasing interest in bolstering the evaluation effort within Procel, with a substantial amount of its budget now (a raise from 5% to 10%) assigned to evaluation studies, pilots and monitoring activities.

Evaluation Issues in Brazil and Neighboring Countries

Through the past few years one can observe some issues in the way that evaluation has been implemented in Brazil, and replicated in neighboring countries, such as:

- **Too much focus on impact** In general, Brazilian evaluations focus on impacts. In these cases, the evaluation is seen as one of the activities in a program. It is not designed to provide formative feedback that could help improve the program. This issue of focusing on longer-term indicators is of importance in other countries of Latin America. Chile and Uruguay for example have been trying the same educational program approach as Brazil. Given the importance of evaluation to guide and continuously improve energy efficiency interventions, Procel is engaged in an effort to bolster the diversity of its evaluation team and examine a broader array of evaluation methodologies and intervention strategies. This is an ongoing incremental review, with the broad participation of the energy efficiency community, including utilities, planners, academia and others.
- Wrong measures Another problem is which metrics are used to track the success of programs or interventions. Most often these indicators focus on measuring savings. The metrics used are not always measurable. Often logistic difficulties or the impossibility of isolating the effects caused by the program from the other variables are not taken into account when setting up indicators of program success. Other potential indicators of success that look at broader market benefits and evolution are also not tracked. Thus indicators such as enhanced public image of the institutions (co-branding), social and cultural impacts, increased product sales, are not measured nor valued as additional program benefits in Brazil.

• Evaluation for last - Given the complexity and rapidly evolving nature of the Brazilian context, it is also important that evaluation be open to examining unintended results of the energy efficiency interventions. Evaluations tend to seek to verify the expected results of the program. At times, flexibility in the evaluation process is needed, to avoid "blinding" the research team from noticing amazing, unintended results. These could lead to improved programs.

Education Program Results: An Example of Mistaken Evaluation

An interesting case that exemplifies the challenges faced by evaluation in Brazil occurred with Procel's Education subprogram. The focus on energy savings impacts downplayed the benefits achieved by an intervention that sought to improve students' energy efficiency consciousness. In this program, there was no visibility given in the evaluation to the impacts derived from the training of teachers and other staff in the community, who not only did what they were supposed to do within the program, but were also engaged in environmental causes, promoting important events, and mobilizing local leaders and politicians to care about energy efficiency, reaching 15,000 people in towns with about 20,000 inhabitants in each event.

On the other hand, a similar intervention that also included a donation of efficient light bulbs to students was deemed successful by the evaluation focused on direct and immediate energy savings. In reality the families receiving the efficient bulbs were poor and sold the bulbs at the school exit to get cash to buy food or even drugs, according to implementers.

Conclusions and Recommendations

It is important to point out that evaluation should not be conducted at any time and at any cost. Depending on the phase where the program stands, the data may not clearly reveal the program's real impact, and/or not be timely to allow implementers to take corrective measures. In this case, the evaluation work would be useless.

Evaluation has to be carefully planned and conducted before or during the program, and not just after the intervention has ended. Moreover, evaluation has to be the basis for a discussion among performers, evaluators and policy makers to reach a consensus on how to proceed with an intervention. Evaluation should not be used as an audit tool for "inspecting program operations" as in that role it puts implementers and evaluators at odds, instead of in a collaborative space.

It is also important that the indicators tracked reflect what the interventions sought to do, while also allowing for unexpected benefits to be counted. Thus, there is a need for some flexibility in the evaluation design to allow the program to include and accept other, unforeseen results and enhance future success.

Finally, evaluation has a strategic value to an energy efficiency program, especially in places where the theme competes with several other more urgent public priorities such as basic education, health and poverty eradication. It is strategic because it shows the benefits of the program, proves its effectiveness and allows ongoing enhancements to be made.

Evaluations planned and conducted considering the minimum elements mentioned here, ensure more successful programs in terms of impact and learning, attracting more resources and partners, and increasing the viability and success of changes in the energy consumption of developing countries, especially Brazil and its neighborhood. Too often evaluation resources are inadequate and their full value is underestimated; leading to less successful energy efficiency programs.

References

Eletrobras-Procel. 2010. Procel 2009.

Eletrobras website (www.eletrobras.com).

[EPE] Empresa de Pesquisa Energética. 2011. Balanço Energético Nacional 2010.

- [IEA] International Energy Agency. 2005. Implementing Agreement on Demand-Side Management Technologies and Programmes. Evaluating Energy Efficiency Policy Measures & DSM Programmes, Volume 1, Evaluation Guidebook. Paris: International Energy Agency.
- Harmsen R. 2008. Why evaluation is so important. Paper presented at the Meeting energy efficiency goals IEA/Paris, February 28-29.
- Jannuzzi, G. M. 2007. Energy Efficiency Programs for Low-income Household in Brazil: Considerations for a Refrigerator-Replacement Program. Research Report.
- Mascarenhas, A. C. R. 2006. Impactos das mudanças legais e estratégicas na execução dos programas de eficiência energética. Belo Horizonte, XVII Seminário Nacional de Distribuição de Energia Elétrica SENDI.
- Pires, L. M. 2006. Projetos de Eficiência Energética para clientes de Baixa Renda:Modelos de Execução e Resultados. SENDI - Seminário Nacional de Distribuição de Energia Elétrica, Belo Horizonte, CEMIG.
- [PROCEL] Centro Brasileiro de Informação de Eficiência Energética, Eletrobras/Procel. 2006. http://www.procelinfo.com.br/main.asp.
- [WEC] World Energy Council. 2008. "Energy Efficiency Policies around the World: Review and Evaluation". <u>http://www.worldenergy.org/publications/energy_efficiency_policies_around_the_world_review_and_evaluation/default.asp/energyefficiency_final_online.pdf</u>
- [WEC] World Energy Council. 2010. "Energy Efficiency: A Recipe for Success Executive Summary". www.worldenergy.org/documents/fdeneff_v2.pdf.