The Brazilian Renewable Energy Incentive Program – The Second Phase of the PROINFA: Assessing Policy Efficiency And Barriers in Long-term Scenarios

Thiago Guilherme Ferreira Prado, M.Sc. e-mail: thiago.prado.br@gmail.com
Marco Aurélio Gonçalves de Oliveira, PhD e-mail: mago@ene.unb.br
Ivan Marques de Toledo Camargo, PhD e-mail: ivancamargo@ene.unb.br

Renewable Energy Sources Research Group
University of Brasília / Technology School / Electrical Engineering Department
Campus Universitário Darcy Ribeiro - Caixa Postal 4386
70.910-900 - Brasília – DF – Brazil

Abstract – The PROINFA is a Brazilian government policy which is divided into two phases and whose objective is to promote the expansion of power generation through renewable sources. This paper aims to assess the efficiency of the second phase with regard to long-term scenarios (2009-2030), identifying gaps and barriers, and proposing policy options to address them. In the first phase, the Program calls for the generation of 3,300 MW of renewable energy with a national business participation rate of 60%, aiming to maximize the country's regional potentials, create jobs, reduce CO2 emissions through thermal (fossil) displacement, and promote energy contracts with differentiated conditions for conventional sources, as well as specific tariff/MWh for each source. The second phase fixes a 90% nationalization rate and a 10% Brazilian electrical energy annual consumption rate to be supplied by these sources. The goals of this phase are expected to be reached within twenty years, and the price will be a weighted average between competitive hydroelectric and thermoelectric (natural gas) prices.

Index Terms— Barriers, Long Term Energy Planning, Policy Options, Renewable Energy, PROINFA.

This paper assesses the PROINFA second phase efficiency in long-term scenarios (2009-2030), identifying gaps and barriers to be overcome. The results address these issues, and propose alternatives and changes to the existing policies, as well as parallel government actions or new regulations.

A. INTRODUCTION

The Brazilian economy is growing rapidly and continuously which implicates a greater demand for energy. However, the world must face the effects of climate changes, in a context of high energy prices and a strong dependency on non-renewable energy sources, without disregarding the geopolitical instabilities involving important energy supplier countries. In South America, many countries are reviewing their contracts and agreements in the energy sector.

Most of the large economies have some type of dedicated renewable energy (RE) policy for the electricity sector. There is a rapidly increasing number of countries which have exclusive policies – mostly small-scale – for the transportation sector with a focus on biofuels. Many countries around the world have renewable energy policy targets (of different natures).

In 2008, two broad categories of renewable energy policies can be distinguished worldwide:

1. Deployment policies:
   - Market framework - Market entry rules: access to grid and off-take, local approval rules, grid connection; price regulations or quantity obligations; standards and certificates; technical infrastructure modifications; and,
   - Fiscal incentives.

2. Basic or supplemental policies:
   - Information networks, awareness and capacity building, R&D, industrial capacity building; public investment.

However, there are no general physical and technical constraints regarding renewable energy to meeting foreseeable energy demands in the short, mid- and long terms. There is sufficient overall technical RE potential in each region, although some regions present particular efficiencies in comparison with others, such as seasonal variations, for the establishment of an optimal electricity generation mix.

Thus, it is possible to conclude that the use of RE is not a question of energy potential and technology level but a matter of price signals and a set of policies aimed at exploiting these sources on a competitive basis. It must be pointed out that these policies must consider both technical infrastructure and capacity building in each country.

B. THE BRAZILIAN RENEWABLE ENERGY INCENTIVE PROGRAM – PROINFA

The PROINFA is a Brazilian government policy aimed at promoting the expansion of distributed power generation through renewable sources, and diversifying primary sources of electricity, thus improving the long-term supplying conditions of the national system. It is divided into two
phases. The Program is currently in the first phase, and has the following main objectives:

- the installation of 3,300 [MW] of generating capacity from renewable energy (RE) sources, distributed equally between wind (1,100 [MW]), modern biomass (1,100 [MW]) and small hydro resources (1,100 [MW]);
- a nationalization index of 60% for all technologies adopted in the Program (a US$ 5.5 billion investment in industry, equipment and materials). This aims to stimulate technology transfers to Brazilian industry, especially wind energy technology;
- to maximize the country’s regional potentials through State quotas;
- to introduce new job profiles on the energy market, and create jobs in different regions of the country (150,000 new jobs are estimated);
- to promote CO2 emissions reduction through thermal (fossil) displacement (merit dispatch, since dispatch is compulsory), to attain greenhouse gas emissions reductions in compliance with the Kyoto Protocol (reduction of CO2 emissions – 2.8 million tons/year);
- to promote energy contracts with differentiated conditions for conventional sources, and explicit tariff/MWh for each source;
- special funding to be provided by the Brazilian National Development Bank;
- mandatory environmental license requirements for eligibility, respecting each State’s environmental regulations;
- the establishing of technical, legal, fiscal, economic and financial requirements for bidders; and,
- the sharing of the cost of this new energy supplied through an interconnected system by all consumers, except for those with low levels of consumption, or who are classified as a low-income consumers.

The contracts are signed with ELETROBRÁS, a state-owned company, and has many special conditions. For example, it guarantees that 70% of the contractual revenue, during the period the funding contract is effective, shall be refunded either in case of a positive balance, or at the end of the contract. ELETROBRÁS also represents producers at the Electrical Energy Commercialization Chamber (CCEE) for the sale of the energy generated by the Program to the Distribution Utilities and to Free Consumers connected to the National Interconnection Grid.

The following legislation pertain directly to PROINFA and was established by Ministry of Mines and Energy (MME) through Law 10.438, of April 26, 2002; amended by Decree 4.541, of December 23, 2002; revised by Law 10.762, of November 11, 2003; amended by Decree 5.025, of March 30, 2004; and regulated by MME Norm number 45, of March 30, 2004.

### Table 2

<table>
<thead>
<tr>
<th>Source</th>
<th>$(US)/MWh</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small Hydro</td>
<td>71.5</td>
<td></td>
</tr>
<tr>
<td>Wind</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sugarcane Bagasse</td>
<td>57.3</td>
<td></td>
</tr>
<tr>
<td>Rice crust</td>
<td>61.45</td>
<td></td>
</tr>
<tr>
<td>Biomass</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wood chips</td>
<td>61.94</td>
<td></td>
</tr>
<tr>
<td>Landfill gas</td>
<td>100.27</td>
<td></td>
</tr>
</tbody>
</table>

(Values updated with IGP-M)

PROINFA contracts and economic values are shown on tables 1 and 2.

To understand the scale of this program, Fig. 1 shows a comparison between large hydropower plants and the results obtained in the first phase of the PROINFA. Considering the installed capacity, PROINFA’s results are equivalent to the 5th largest power plant in Brazil.

Considering the seasonal variation in the energy offer by various sources in Brazil, regardless of the region characteristics and integration of the transmission network, this behavior allow optimal energy use over the country.
and Wind present a strong complementation when associated with small hydro plants. [4]

The result presented in Fig. 2 can be extended to large-scale power generation, since the hydrology conduct is maintained over time. This means that distributed generation based mainly on biomass and wind sources in Brazil should increase actual water storage capacity of the hydrothermal power system.

C. ANALYSIS OF THE FIRST PHASE OF PROINFA

In order to understand the results of the first phase, an analysis of each technology context in Brazil is necessary.

Small hydro technology installed throughout the country exceeds 1,300 MW, with more than 260 power plants currently in operation. The production chain is very similar to that of large hydro plants, which are well established in Brazil, and there are currently no technological barriers to their development.

The available biomass technology is conventionally co-generated with high pressure steam turbines, and Brazil has ample experience with this type of technology. Over 270 plants generating more than 3,400 MW are currently installed. Sugarcane bagasse generates more than 2,300 MW at 225 power plants. Also, modern biomass technologies, such as gasification and combined power cycles are under development without a base industry to support them. Another interesting point regarding the results of the first phase was that only 61% of the initial limit of 1,100 [MW] was reached. This point will be addressed later.

In Brazil, bagasse production occurs exactly when hydrology is not favorable for power generation, and thus plays an important role as a source of energy for the Brazilian electricity market. Unfortunately, its limited participation in said governmental program is due to price constraints and to the concentration by the government of revenue related to carbon credits (CDM, Clean Development Mechanism). The Brazilian government requires that the revenue of all facilities comprising the CDM program be managed by ELETROBRAS. At that time, this revenue capture by the government was justified as a path to a tariff more equitable.

Wind technology is still considered in the technology acquisition stage. Brazil presents an excellent wind potential, more than 75,000 MW [5], and a large industrial capacity. However, there is only one installed supplier to meet the country’s demand. Other products related with this technology chain also require additional incentives to reach maturity. As occurs with biomass, wind energy has a strong potential of being a complementary source to hydro power plants. Both trends are shown in Fig. 2. Other relevant facts are that the national industry did not have, in 2004, the capacity to produce all the equipment necessary to meet the demand and, as a result, the commercial operation deadline was postponed; and the lack of market confidence regarding the continuity of PROINFA, which was considered a “stop and go” situation.

D. METHODOLOGY AND RESULTS FOR THE ELECTRICITY DEMAND SCENARIOS: THE LONG-TERM PERSPECTIVE

Besides providing a broader view of PROINFA’s structure and existing first-phase gaps/barriers, the long-term scenarios are also fundamental in taking the first steps to support this analysis.

There are three international scenarios in which Brazil can be inserted, considering the conditions of the external environment. Each scenario has two derived situations: the first regards whether the country’s internal management is effective, and the second whether it is inefficient (higher and lower boundaries). These extreme views depend on how Brazil addresses its competitive advantages and weaknesses given the intrinsic interference of the external environment (world) on its behavior.

The external economic scenarios can be summarized as the international capacity of mediating conflicts, the structure of economic and political power, and the level of globalization. Likewise, the internal scenarios deal with a market with a high growth potential, the abundance of biodiversity and exploitable natural resources, the potential use of renewable energy at costs lower than those of other sources, and highly competitive sectors of the economy (agriculture, metallurgy and cellulose, etc.). On the other hand, there are restrictions regarding Brazilian infrastructure, excessive concentration of income (a large part of the population with low purchasing power), conflicting environmental regulations, a poorly qualified labor force, a small long-term credit market, and high opportunity costs compared with the world market.

The scenario model considers both micro and macroeconomic aspects, demographic and housing growth, energy efficiency, and the evolution of relevant sectors of the economy which are expected to affect electrical power consumption on a yearly basis up to 2030. The estimated average world GDPs considered in this study are 3.8%, 3.0%...
and 2.2% varying from the most optimistic to the most pessimist scenarios. The Brazilian GDP considered for all scenarios were 5.1%, 4.1%, 3.2% and 2.2%.

It is necessary to understand and consider that electrical energy growth, between 1970 and 2007, was above the average of other energy sources: approximately 6.3% per year. The oil price crisis on the international market contributed to this high rate, because at that time the consumption of this product mostly originated from imports.

This high external dependence scenario affected the commercial trade balance, contributing towards a high growth of alternative sources of energy for the period considered. The requirement to substitute imported sources of energy, which were highly priced on the international market, generated programs such as the PROALCOOL, which promoted the expansion of ethanol in Brazil. These programs were introduced to address the oil crises of the 70s, along with policies and incentives to promote fuel and electric power in substitution of other oil-derived products.

However, in historical terms, the electricity demand growth rate trend is expected to drop for the 2010-2020 period, recovering in the following decade. Fig. 3 presents the evolution of the demand for electricity between 1970 and 2030.

In spite of the high growth for the period analysed, it is necessary to highlight the rationing that took place in 2001. In said year, as a result of various factors, the country faced a serious electric power supply crisis. The rationing program was characterized by a set of measures defined by the Federal Government aimed at administering a period which was extremely critical with regard to electric power supplies in the Southeast and Northeast regions of the country. The rationing took place between June 1st, 2001 and February 28th, 2002 in the Southeast and Northeast regions. In the North, rationing ended on January 1st, 2002, having begun on August 15th, 2001 for large consumers and on August 20th for all other consumers.

The projection of the electrical energy demand in the long term are based mainly on the following factors affecting present growth:

• the relative participation, in GDP terms, of the services sector, since the demand for electricity by this sector was responsible for more than 80% of the total demand for energy;
• the evolution of the consumption of electricity by the residential sector, due to increases in the levels of income and an improvement in its distribution on a per capita basis;
• the degree of the country’s agricultural modernization, since a large number of rural properties increased their technological levels to address competition by the international market, which brought about specific changes in the consumption of electricity by this sector;
• the contribution of the “other industries” sector to the total added value of the industry, where electricity was responsible for more than 50% of the final consumption of the industry; and,
• the relative participation of the big industrial consumers of energy.

The Brazilian demand for electricity was studied according to four growth rate scenarios: 5% - 4.3% - 3.9% – 3.5% per year.

Considering the current external (financial crisis) and domestic scenarios (development), the authors chose, as presented in the Fig. 4, those reference scenarios in which the average rate of growth rate for the final consumption of electricity increased by 4.3% and 3.9% per year (higher and lower boundaries) between 2007 and 2030.

E. RESULTS AND THE AMOUNT OF ENERGY NECESSARY TO MEET THE SECOND PHASE DEMANDS OF PROINFA

With the long-term scenarios outlined above, it is possible to determine the amount of electric energy corresponding to 10% of the annual Brazilian electric power consumption required by the second phase of PROINFA for a 20–year time frame.

Based on the methodology presented above, Fig. 5 shows these second phase needs (TWh) up to 2030. The results shown below (Fig. 5), consider that PROINFA’s second
phase will start at the beginning of 2009. For this to take place, all 144 power plants from the first phase must be commercially operational.

First issue: wind, modern biomass and small hydro technology based projects currently exist in sufficient number to meet demand.

According to the National Electrical Energy Agency – ANEEL, and The Brazilian Association of Small and Mid-sized Electricity Producers [6] it is estimated that Brazil has a small-hydro potential of about 26 GW (river inventory). Estimates made by the National Electrical Energy Research Center – CEPEL [5] for wind technology indicate a potential capacity greater than 143.6 GW. The Energetic Research Company – EPE [8] estimates that the Brazilian biomass potential is about 25.19 GW, considering only the currently-known technological routes used to produce electricity. All above-mentioned potential capacities do not consider the possible energy gains resulting from the proximity of these sources to loads.

The second issue: since the price of energy is a weighted average between competitive hydroelectric and thermoelectric (natural gas and fuel oil) prices, should these renewable sources be competitive with them?

The second issue: since the price of energy is a weighted average between competitive hydroelectric and thermoelectric (natural gas and fuel oil) prices, should these renewable sources be competitive with them?

Since auctions aim to meet the energy demands of the regulated Brazilian electricity market, Table 3 results show that renewable energies under second phase PROINFA can be competitive with the aforementioned price mix, justified by a price difference of about 12% at some cases. In addition, biomass proved to be a highly competitive source of electricity with prices reaching 46% of the hydro/thermo price mix.

Wind energy has yet to participate in any auction - prices surpass 140.00 R$/MWh.

A final issue: it is necessary to review the first phase of the PROINFA and address the technology aspect, given the increase in the nationalization index for the second phase from 60% to 90%, and considering the current barriers to achieving the current index (60%) for wind technology.

Since the commercial operation deadline was reviewed three times, and given the incapability of national industry to meet the Federal Government requirements, this review is considered necessary.

It is important to point out that all stakeholders can participate in these auctions, except when they existent power plants or sales to free consumers on the non-regulated market. Energy may be purchased from distribution utilities and other power plants.
agents, with an autonomous generation capacity of under 500 GWh/year, limited to 10% of their respective market/demand, as long as the plant is directly connected to the utility grid (Article 14/15 Decree 5163/04). This Decree assures to both the generation and distribution utilities the right to absorb in their costs a discount in transmission or distribution tariff (depending where the generator is connected) up to 50%.

F. CONCLUSIONS

The results reflect the barriers that exist mainly with regard to wind energy. If the Brazilian Government is interested in ensuring the feasibility of the second phase PROINFA program, directions and specific policies need to be addressed. The first regards national industry incentives towards the production of wind equipment at levels compatible with the energy demand.

Biomass proved to be competitive with other energy sources. The small hydro sources were not as competitive due, among other reasons, to the distance from the transmission system and to logistics associated with the construction of small hydro plants (infrastructure failure and small scale projects), despite the national industry having the necessary technology.

A summary of what can be improved to promote better conditions for renewable energy in Brazil is as follows:

• Policies: the establishing of specific RE goals, laws, regulations;
• Money: the provision for targeted incentives (for startup and production);
• Climate Change: the support of climate-change assistance programs (CDM);
• Resource Information: the improvement of the quality (breadth and depth) of resource information;
• Human and Institutional Capacity: the support of programs aimed at building awareness, knowledge, and management skills; and,
• Markets: working with power utilities to influence market signals for power projects.

Another point that should be addressed is the lack of funding for project preparation given the high up-front capital costs. However, long-term financing terms are offered by ELECTROBRAS that reduce long-term exposure to risk. Also to be considered are the disproportionately high transaction costs, particularly between small-scale projects and conventional power projects.

Based on a long-term perspective of current renewable technology policies and infrastructure, the authors point out that certain gaps and barriers still exist and that specific actions are necessary, such as parallel government actions between the Ministries of: Mines and Energy, Science and Technology and Development, Industry and Foreign Trade, aimed stimulating a healthy environment for the renewable source industry, particularly wind and small hydro technologies.

G. REFERENCES