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Distributed electricity generation in Brazil: An analysis of policy context, design and impact

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ABSTRACT

This paper analyzes the policy landscape of a new configuration for the electricity sector, distributed electricity generation, DG, which was introduced in 2012 and regulated in Brazil by the National Electricity Regulation Agency (ANEEL) through a net-metering regulation. The present analysis focuses on the landscape surrounding the policy problem definition and the subsequent policy goals which were established by the national regulator as primarily related to removing barriers to grid access. The policy context surrounding DG in Brazil is analyzed within the broader scope of electricity planning goals, which is a responsibility of the Ministry of Mines and Energy and still shows strong preference to the centralized regime. The design of the net-metering mechanism and the impact of ANEEL's resolution in terms of the number and spatial distribution of the projects across states are also explored. Lastly, an econometric approach is taken by creating a linear regression model to decipher the determinants of successful policy deployment between states. The analysis shows that the electricity rates have an important impact, while the application of a state tax ICMS has negative effects on project uptake. The strength of solar resources was not a significant variable.

1. Introduction

Distributed Electricity Generation, DG of modern and renewable energy technologies, also referred to as decentralized, localized generation or on-site is a new configuration for the electricity sector. It is stark contrast to the centralized and distant generating stations that produce electricity on a large scale, with associated transmission and distribution infrastructure. In Brazil, as in the case with many countries, there are examples of small hydroelectric or thermoelectric stations used to serve exclusively and specific industries, but the historical tendency has resulted in a sector with consolidated generation via large hydroelectric dams, complemented by thermoelectric stations and some nuclear facilities. The following paragraphs will offer a brief historical summary of electricity planning in Brazil with the objective of describing the current regime features.

Electricity became a government priority in Brazil in the 1930's, during the military and later democratically elected administrations of President Getúlio Vargas (1930-1945; 1951-1954) and his national industrialization projects. In 1934, the Brazilian central government took charge of all of the phases of the electricity industry (Tolmasquim, 2011). Electricity policy and investment, as part of a larger, central government strategy for industrialization and growth continued into the Kubitschek administration (1955-1961), absorbing a large quantity of his economic development plan. Kubitschek also created the Ministry of Mines and Energy (MME) in 1960 (Leite, 2009). Centralized control of the industry continued during the two decades of military rule in Brazil, 1964-1985. During this period, the country embarked on a large nuclear program and other large-scale hydroelectric undertakings, such as the Itaipú, Tucuruí and Balbina dams, causing important environmental and social impacts (Sewell, 1987). These large-scale megaprojects were not exclusive to Brazil, but were part of a global trend in the 1970's in resource development, which involved huge monetary sums for investments (Sewell, 1987).

With the return to a democratic government, Fernando Henrique Cardoso's (FHC) two consecutive administrations (1995-2002) are most noted for the *Plano Real* (designed to stabilize the country's currency and control inflation) and the partial execution of the National Privatization Program. During FHC's government, the electricity sector underwent “institutional reform and

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simultaneous privatization of state-controlled companies with the objective of introducing competitive markets" (Leite, 2009, p. 23). In 1996, in anticipation of the re-structuring of the electricity sector, the National Electricity Regulatory Agency, ANEEL (*Agência Nacional de Energia Elétrica*) was created. Its objective is to regulate generation, transmission, distribution and commercialization of electricity in Brazil.

Some attempts were made during this period to electrify rural areas, namely the *Luz no Campo* program offered grid-expanded connection to farms that contributed to the investment costs, while in 1994 the PRODEEM (Program for Energy Development of States and Municipalities) focused on remote access, mainly through photovoltaics. However, "PRODEEM ended far from meeting its goals and the need to reach universalization of electricity access remained" (Bulut, 2012, p. 11).

Access to Electricity in Brazil has improved significantly since 2003 when the Federal programme Light for All (*Luz para Todos*) was introduced during the first administration of President Lula (2003-2011). To date, the program has provided electricity to over 15 million Brazilians through the extension of the centralized grid (MME, 2014). According to the latest household survey conducted by the Brazilian Statistical Agency (IBGE) there are approximately 234,000 households without electricity access in Brazil but the overall electrification rate is 99.7% (PNAD, IBGE, 2015).

At the beginning of the Lula administration (2003-2011), the electricity sector underwent yet another set of reforms under the title of the New Model for the Electricity Sector (*Novo Modelo do Setor Elétrico*). The main changes are summarized by Tolmasquim (2011) as: 1) return of energy planning to a central and government-led role through the creation of the Energy Research Company, EPE and 2) the creation of the Electricity Sector Monitoring Committee, headed by the Central Ministry of Mines and Energy. The EPE produces annual energy planning documents, which prioritize centralized hydroelectric generation (EPE/MME, 2014c).

In April of 2012, the National Electricity Regulation Agency, ANEEL published a Normative Resolution No. 482/2012, creating a new class of generators/consumers: distributed micro and mini generation. It also established corresponding interconnection standards streamlined for these projects. In essence, small-scale electricity generation (solar, wind, hydro, biomass and Combined heat and power, CHP) can connect to distribution systems across the country through a net metering mechanism without the cumbersome need to register as an energy market participant with the CCEE (*Câmara de Comercialização de Energia Elétrica*). The net-metering regulation does not allow for the commercialization of energy.

Previous works on DG in Brazil have focused largely on the technical aspects of the Normative Resolution 482/2012 (Pinto and Zilles, 2014), while Afonso (2013) focused on the economic viability of the current net metering, NM mechanism versus other forms of incentives for distributed generation. Jannuzzi and de Melo (2013) provided a prospective analysis of grid-connected solar-PV systems in households, showing that the technology offers a good opportunity for Brazil to diversify its energy matrix. However, the authors also highlighted the main challenges to the adoption of the technology are the lack of long-term energy policy objectives and additional support mechanisms. In their more recent study comparing energy governance in Brazil and de Melo et al. (2016), the authors illustrate how in the Brazilian case, non-conventional energy sources, which offer an opportunity for the country to reduce its dependence on fossil fuel and hydroelectrical power plants, require a comprehensive legal and regulatory framework and long-term energy planning.

The present analysis, by contrast, focuses on the landscape surrounding the policy problem definition related to distributed generation in Brazil and the subsequent policy goals established in response. The policy context surrounding DG in Brazil is analyzed within the broader scope of electricity planning goals. The design of the NM mechanism and the impact of the Resolution in terms of the number and spatial distribution of the projects across states are also explored. Lastly, an econometric approach is taken by creating a linear regression model to decipher the determinants of successful policy deployment between states. The linear regression shows that the electricity rates have an important impact, while the application of a state tax ICMS has negative effects on project uptake.

2. Analytical framework and methodology

A simplified version of the analytical framework that has been widely applied to policy analysis (Auld et al., 2014); (Pal, 2010); (Howlett and Lejano, 2013), is used in this paper. The framework breaks down policy analysis into three components: policy context, design and evaluation, as shown in Fig. 1. The evaluation of the policy deals with impacts achieved at the time of the three-year anniversary of ANEEL's Normative Resolution 482/2012 (i.e. April 2015).

Data was collected from documents relevant to various normative resolutions published by ANEEL, supporting technical notes and submissions provided by stakeholders during public consultations. This analysis was complemented with semi-structured and in-depth interviews with the electricity industry stakeholders and decision-makers at the Brazilian Federal government. Finally, for the policy evaluation section, data on DG projects was collected from ANEEL's Generation Database, BIG (*Banco de Informação de Geração*) and analyzed through exploratory statistics and an econometric approach of linear regression using the Stata software.

2.1. Policy context

He process of regulating DG in Brazil was initiated and led by the department responsible for distribution services (*Superintendente de Regulação dos Serviços de Distribuição, SRD)* of the national electricity regulator, ANEEL. In 2010 SRD published the Technical Note, TN No.43/2010, to open a formal process of public consultation (*Consulta Pública* 15/2010) for discussing possibilities for regulating access to the distribution grid by small-scale generation projects. The NT explained that there already existed a patchwork of norms for small-scale generation in Brazil, but that they were not sufficient to address the needs of a simplified and streamlined process that would reduce transaction costs and be technically appropriate for the case of the distributed generation. The context

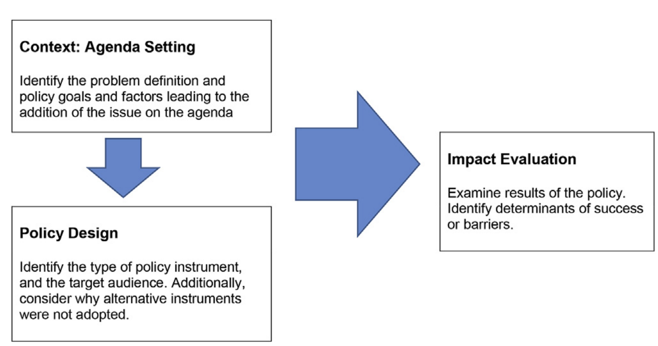

Fig. 1. Analytical framework for policy analysis, adapted from Auld et al., 2014.