SOLAR PHOTOVOLTAICS IN BRAZIL: WHAT IS PREVENTING THE DEPLOYMENT OF ITS SMALL DG GENERATION?

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--Recibido para revisión 2014, aceptado fecha, versión final 2014--

Abstract—**The Brazilian power sector is going through a severe crisis. There are important problems associated with the marginal costs of electricity generation expansion and the risks of shortages that the country is facing. We show that distributed generation (DG), in particular micro and mini solar photovoltaic systems, could provide an important contribution to mitigate those problems. Moreover, we explore the reasons that are preventing its deployment.**

Keywords— **Solar Photovoltaics, DG generation, Technology Adoption, Diffusion Processes, Energy Policy**

1. OVERVIEW

The Brazilian power sector is going through a severe crisis. There are important problems associated with the marginal costs of electricity generation expansion and the risks of shortages that the country is facing. Supply problems are aggravated by the constant demand increase. There is a growth trend of the electric intensity of residential and commercial sectors. According to the Energy Research Company (EPE), this year consumption grew by 4.9% in January and 8.6 % in February compared to the consumption in the same months of 2013. A closer look at the residential and commercial sectors shows that in February 2014 consumption grew of 13.3 % and 16.6 %, respectively, the largest expansion in the past decade (Brasil Energia, 24.04.2014). That growth has caused the displacement of peak consumption hours from 18:00-20:00 to 14:00-16:00, time of intense heat at which air conditioners are working at full power. This new period of peak consumption happily coincides with the peak sun power generation.

Only recently in 2012 Brazil has started to regulate mini and micro DG connected to the distribution network, through the issuance of Resolution 482. However, little has been done in terms of diffusion of those systems even though the solar photovoltaics (PV) technology has already achieved tariff parity with respect to the price of electricity charged by the distributors. It was believed that thanks to their advantages (complementarity with hydro generation, urban integration, speed of installation, etc.) the source would experience a rapid growth. However, this was not observed.

In December 2013, the country had only 131 micro and mini PV systems, revealing an extremely slow pace of adoption of PV systems. Given that there are no major technical or economical barriers its seems that the main problems are related to the current institutional framework and cultural factors determining the adoption of a new technology. Our study identified several regulatory barriers and has designed solutions to help policymakers to overcome them.

Differently from wind power, which met great success in Brazil, distributed solar PV in mini and micro generation can be considered as an innovation for the power sector and for its consumers. It represents a break from the paradigm of centralized generation in Brazil whose consumers are extremely passive. Therefore, to address properly its deployment it is important to analyze the diffusion of innovation process that according to Rogers (2003) begins slowly and then starts growing exponentially until saturation and stabilization take place. Given the timidity of the advancement of PV technology integration in Brazil, we can assume that the country is stuck at the stage of "knowledge", and well-designed policies are required to unlock the path for small PV deployment in Brazil.

2. METHODS

In order to address the major barriers to small PV deployment in Brazil, we present a grid parity analysis for each of the country's regions and show that in several geographical regions the grid parity is already attained. Contrasting with these results we find that the deployment of solar PV systems is evolving very slowly, reflecting the fact that the adoption of new technologies does not depend only on a rational choice, as expected in traditional neoclassical models. Since we are treating the adoption of an

innovation, we enrich our analysis with the perspective of diffusion of innovations to help design adequate policies to match Brazilian electricity sector specificities.

We have analysed Agent-Based Model literature (Rai and Robinson, 2014) and got important insights from its theoretical framework to enrich our analysis. However the small number of PV systems and insufficient data available did not allow us to develop an empirical study.

3. EXPECTED RESULTS

We analyze the evolution of the institutional framework regulating small PV DG generation. Considering the traditional four steps for market creation (market preparation; market creation; market expansion and market saturation) we show that Brazil still lacks market preparation and market creation policies aiming at reducing the risk associated with the investment and enabling the technology diffusion process to overcame the stage of "early adopters" and move on to the "early majority" stage (Rogers, 2003), creating an important market for the PV sector in Brazil.

The present paper shows important results. In most of the country we found that there is grid parity between the distributed micro PV generation and the price of electricity charged from the local utilities. Since we did not find major technical or economical barriers, we focused our analyses on the institutional barriers that are preventing its deployment. It turns out that the electricity sector has been experiencing important regulatory changes that altogether bring instability and increase the risk related to the investment in the new technology. Furthermore, behavioral aspects of new technology adoption were neglected in the present regulatory framework.

4. CONCLUSIONS

The present study reveals the major barriers preventing distributed photovoltaics generation to attend its full potential in Brazil. In order to overcome those obstacles and accelerate its pace of diffusion, policymakers must design an institutional framework where the adoption of PV panels is treated as an innovation process diffusion.

With adequate institutional and regulatory framework the small solar PV generation should experience an important growth. More DG would help to stabilize the electricity system; reduce impacts of residential peak consumption; reduce the losses associated with electricity transport; besides postponing investments in the grid and increasing its security of supply through the adoption of new renewable generation.

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