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The last mile in the Brazilian Amazon – A potential pathway for universal electricity access

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HIGHLIGHTS

- There are important challenges to provide universal electricity access in the Amazon.
- We propose a pathway to facilitate universal electricity access in remote areas of the Amazon.
- The pathway allows a transition to a more knowledge-driven and participatory system.

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ABSTRACT

The Brazilian rural electrification initiative *Luz Para Todos* – LPT (Light for All) has attracted attention internationally due to its ambitious targets and significant achievements in the last decade. The initiative has proved effective in its first phase, which has been developed through the extension of the grid. Yet, there are still important challenges to provide the service to inhabitants of remote areas in the Brazilian Amazon. We identify these challenges within institutional, technology, and funding structures operating within LPT. In line with these challenges, we propose a pathway to facilitate the achievement of universal electricity access in remote areas of the region. The proposed pathway is based on three key leverage points: (i) rules guiding the relationship among new agents and communities; (ii) the implementation of small-scale power generation technologies based on local resources; and (iii) optimized subsidies. It has the potential to allow (i) a better dimensioning of off-grid solutions considering local resources and realities, (ii) the creation of adapted institutions capable of implementing and operating the required systems and, (iii) an effective operation of off-grid solutions.

1. Introduction

The Brazilian rural electrification initiative *Luz Para Todos* – LPT (Light for All) has attracted attention internationally due to its ambitious targets and significant achievements in a relatively short period. During the last decade, more than 14 million people have benefited from the rural electrification program (MME, 2013a). LPT has proved effective in pursuing electricity access during its first phase, mainly characterized by three attributes. First, the recognition of electricity access as a civil right defined the basis for electrification goals in Brazil. Second, the recognition of the role that electricity access plays in addressing and achieving human development goals has been important for the mobilization of political will and definition of policies to promote full coverage at national and regional level. Third, a grid-extension approach has been central to the achievement of electrification goals (Gómez and Silveira, 2010).

However, the initiative has not been equally successful along the national territory. During initial phases of electrification, the extension of the grid was relatively easy and a significant number of people could benefit but, as the grid reached its physical and economic limits, extension has become more difficult and even unfeasible in some areas. As a result, remote areas of the Amazon region[1] are yet to be supplied with electricity services (IBGE, 2011). This situation is recognized as the "last mile" or the final stage in

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[1] For the purpose of this paper, the Brazilian Amazon is represented by the North region. The North region comprises the states of Acre, Amapá, Amazonas, Pará, Rondônia, Roraima, and Tocantins.

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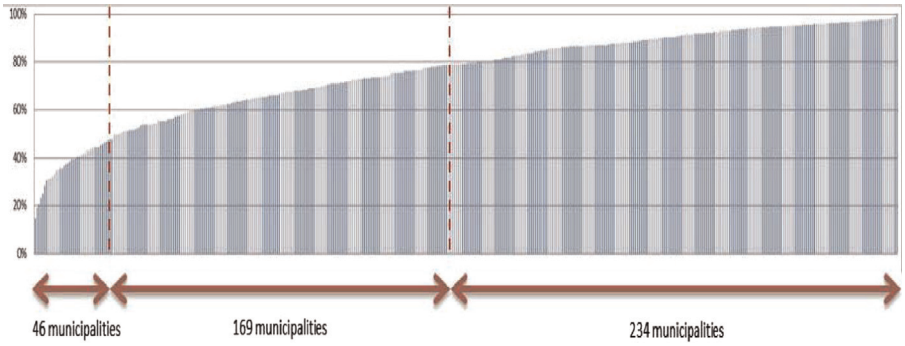

Fig. 1. Electricity coverage in rural areas at municipal level in the Amazon Region, in percentage, 2010. *Source*: IBGE (2011).

the process of providing electricity access to final users. Official statistics indicate that the last mile in the Amazon region amounts to approximately 930,000 people. While about 50% of the municipalities in the region have achieved levels of electricity coverage above 80% in rural areas, rural electricity coverage is below 50% in 10% of the municipalities (see Fig. 1). Obviously, inhabitants of remote areas have not equally benefited from the national rural electrification initiative, and are still waiting for electricity access (IBGE, 2011).

From an energy access perspective, we define remote areas as those that (i) are not connected to a centralized electricity system, (ii) are scarcely populated, and (iii) are classified under a low human development category, that is, their Human Development Index (HDI) is significantly lower than the national average. Lack of connection to a centralized electricity system usually means that the community is located in a remote area and depends on diesel for electricity generation. Unless the community identifies and explores local energy resources to install and operate off-grid systems, this dependence is likely to continue (IEA-RETD, 2012).

In the Amazon region, remote areas have a complicated topography with plenty of mighty rivers and dense forests. Fig. 2 shows typical isolated households in the state of Pará. These households can only be reached by boat, after long journeys from the closest city. There are no roads. In some cases, houses are close to each other, and the use of a small-scale power generator and a mini-grid can provide the necessary electricity services. However, smaller villages consisting of groups of less than 10 houses are, in many cases, scattered in a large area, which makes the use of mini-grids difficult.

Off-grid systems providing electricity access in remote areas of the Amazon include power generation facilities in the order of tens to hundreds of kW that supply communities or households. Off-grid systems' arrangements comprise (i) mini-grids connected to small-scale power generation units that provide electricity to small and remote villages, and (ii) stand-alone systems that provide electricity to household units. These diesel systems impact upon a very sensitive ecosystem (IPCC, 2014). Often, local communities operate diesel generators that, depending on the power capacity and maintenance routines, can provide electricity for a period of up to 5 h per day (Pinheiro et al., 2011).

This paper proposes a pathway to assist policymakers, technology providers, project developers, researchers, and communities in general as they seek to cover the last mile in the Brazilian Amazon, and improve welfare in the region. The relevance of this pathway lies in participatory interactions that encourage reflection on the role of participants in the process of providing electricity access, and the type of knowledge they hold. In this way, it promotes the preparation of activities to systematize existing information, share, and build knowledge based on skills, experiences, and understanding of the agents involved in the initiative. The question that guides the pathway is how LPT's structures can be improved to effectively implement and operate off-grid solutions in remote areas?

In pursuing answers to this question, we address the main challenges for achieving universalization goals, and identify leverage points that can help to overcome them. According to Meadows (1999), leverage points are "*places within a complex system (a corporation, an economy, a living body, a city, an ecosystem) where a small shift in one thing can produce big changes in everything.*" In Section 2, we describe the methodology that guided our study. Section 3 describes the structures within LPT and identifies challenges that LPT is facing in remote areas within the structures that support its implementation. Section 4 discusses leverage points that can help LPT to overcome the identified challenges. In Section 5, we conclude by answering our research question and proposing a potential pathway for LPT to cover the last mile in the Brazilian Amazon.

2. Methodology

The process by which the national policy for electricity access is

Fig. 2. Typical remote households in the Brazilian Amazon.