

Roadmap for Electricity Access as a Development Driver in the Legal Amazon

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1 Background and Roadmap Key Messages

Initially, the main goal of the roadmap was to focus on the central policy and regulatory issues to explore fully RAP expertise and experience. Hence, the first phase was to conduct remote interviews with experts and stakeholders in Brazil and review various reports, laws, decrees and regulations relevant to promoting clean energy in the Amazon. Reports and policies from other parts of the world were also reviewed to find successful, transferable ideas that could work in the Amazon region. The primary outcome of this phase was an initial internal roadmap to guide the activities of the second phase.

The second phase started with a review of the internal document and RAP's participation in the Second Energy and Communities event in the city of Belem in Pará state, part of the Legal Amazon region in Brazil. The event gave the RAP team a better understanding of the main problems, the varying agendas and the real needs and demands of local communities. It also enabled the team to connect with Brazilian stakeholders, from ministries to local community representatives, particularly with the non-governmental organization (NOG) ecosystem whose members have been working in the region for decades.

Input from these Brazilian stakeholders helped RAP to improve the initial roadmap, and fruitful discussions from the Belem event and the contributions of some NGO peer reviewers were incorporated into an updated version. Stakeholder connections also led to an initial proposal for a contracting scheme for the Ministério de Minas e Energia (MME) to guarantee electricity access in remote regions in Brazil.

As a result of this stakeholder input, the RAP team realized that the focus of the roadmap should change from guaranteeing electricity access as an end in itself to treating electricity access as a driver for development. Although this change might sound minor to some audiences, electricity access is one of the crucial problem agendas in the region: it is a means to an end, but it is not the final goal for local development in the Legal Amazon. With this new perspective, it is possible to create a typology of problems and solutions, organize networks and stakeholders around them and identify the main activities needed in each sector or policy area.

As a result, the new roadmap continues to focus on the electricity sector, but it now also indicates interaction points with other policies and sector areas. Below, before introducing the roadmap, we discuss electricity access in a Brazilian context in the Legal Amazon region. We also discuss the challenges and opportunities for improving electricity access and explore the main aspects of electricity as a driver for development.

1.1 Roadmap Key Messages

Brazil has excellent experience with electricity access policy. The Luz para Todos (LpT) program was enacted in 2003. Several iterations of improvements and new instruments have been implemented, including specific rules for contracting projects and other related programs such as the very recent Energias da Amazonia. This great experience allows us to explore the challenges and opportunities to improve electricity access sustainably for the Legal Amazon region.

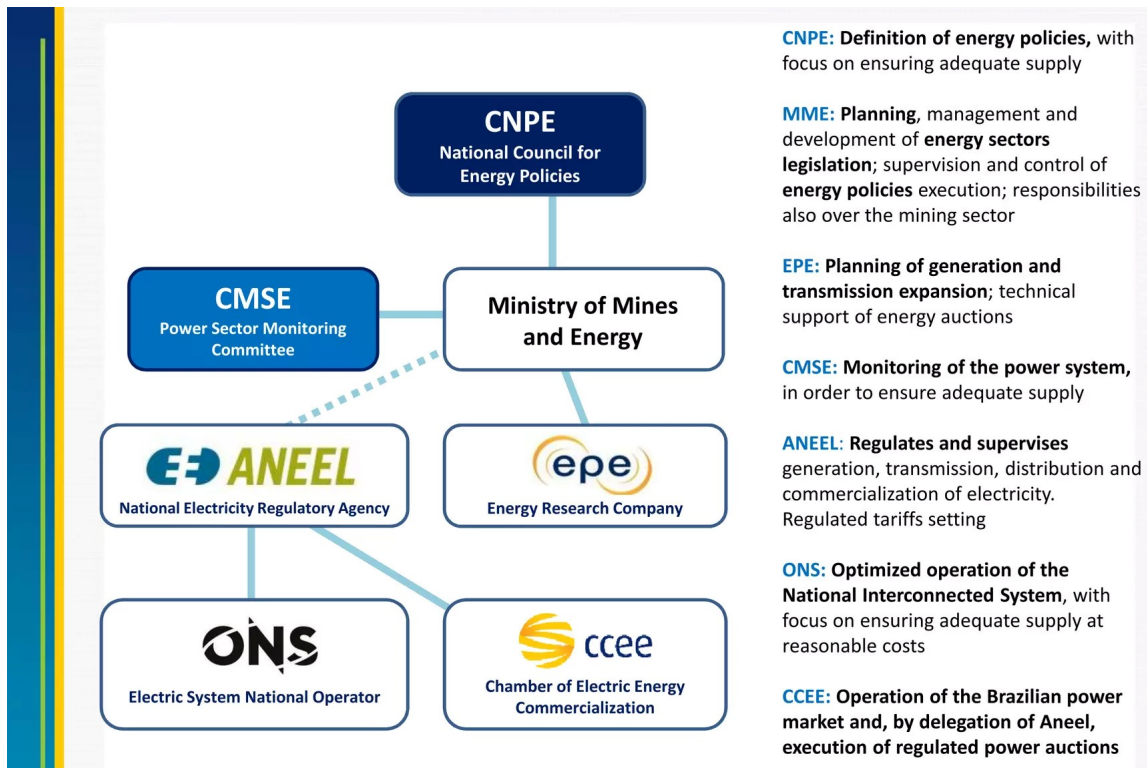
- Although Brazil has great experience with electricity access policies, several challenges persist: the centralized system planning logics (for instance, hampering the development of microgrids); distance, isolation, and small scale of communities; the need to develop local supply chains; the need for adaptation of regulatory frameworks; and the unclear interaction with other policy goals and instruments.
- These challenges and the extraordinary capacity of Brazilian players also produce several opportunities: the great window of opportunity of the new Brazilian government and several initiatives in the region (conservation plan, rebirth of Amazon fund, and new ministry for indigenous people); the idea of seeking and seizing policy convergence (including for developing local supply chains); and the modernization of the power sector and the possibility of the Legal Amazon region to be a testbed for regulatory sandboxes.
- These challenges and opportunities indicate the need to reinterpret the electricity access problem as a developmental goal instead of only a power sector issue, integrating several initiatives to improve effectiveness.
- The RAP roadmap for electricity access as a development driver in the Legal Amazon region discusses five main axes:
 - Policy convergence — promoting alignment between different sectoral policies' goals, instruments and incentives.
 - Participation — considering local communities' involvement seriously and promoting participatory mechanisms.
 - Innovative frameworks — improving and developing innovative frameworks for contracting and regulating.
 - Capacity building — developing a network of social entrepreneurs, helping communities to understand, operate, and maintain the systems, developing local productive arrangements, and promoting knowledge exchange mechanisms.
 - Robust evaluation — redesigning evaluation, including making changes for innovative frameworks and implementing enforcement mechanisms.

2 The Brazilian Context and Main Problems of Electricity Access in the Legal Amazon

2.1 Brazilian Power Sector Institutional Framework

Electricity access policies and regulations in Brazil are under the governance of the electricity sector. The current institutional framework of the Brazilian power sector dates back to 2004 (Figure 1).¹ Changes in the power system and markets — such as the expansion of distributed generation, unclear price signals for reliability, the need for more granularity in prices and the evolution of subsidies and charges — have led to calls to update market rules and the institutional framework. The last phase of updates started in 2019, with the modernization of Brazil's power sector: the aim was to open the market, expand sustainability and drive efficiencies in risk and cost allocation. The reforms have also created the opportunity to review policies on electricity access.

Figure 1. Brazilian power sector governance



Source: Altieri, R. (2015). *Brazilian electricity market*

¹ Altieri, R. (2015, August 31). *Brazilian electricity market* [Presentation]. Câmara de Comercialização de Energia Elétrica. <https://www.slideshare.net/CCEEOficial/brazilian-electricity-market-business-france>

2.2 Typology of Systems Without Connection

Under this institutional framework, there are rules for the operation and planning of power systems that define typologies for Brazil's consumers and grids. At this point, it is worth highlighting that the Brazilian transmission system is almost totally interconnected. The National Interconnected System (SIN) refers to the transmission system from 230 kilovolts and above, which covers over 99% of the power system load. The first type of grid connection is to the SIN, whether by generators, transmission and distribution grids, or consumers.

There are two other types of systems not connected to the SIN, as defined by Law 12,111/2009,² Decree 7,246/2010,³ changed by Law 9,047/2017 and the MME Ordinance 59/2022:⁴

- Isolated systems: the electrical systems of public electricity distribution services that, in their standard configuration, are not electrically connected to the SIN for technical or economic reasons.
- Remote regions: small groups of consumers located in an isolated system, away from the municipal headquarters, and characterized by the absence of economies of scale or density.

These rules describe how institutional and market players should organize themselves and define their responsibilities. Operador Nacional do Sistema Elétrico (ONS) oversees one-year load forecasting and operation planning. Empresa de Pesquisa Energética (EPE) is responsible for five-year planning. Distribution utilities must send EPE their 10-year market forecast: the first five-year period is used for planning, and the subsequent years for the monitoring system for isolated systems. The supply is contracted via auctions conducted by Agência Nacional de Energia Elétrica (ANEEL) and EPE. In contrast, for remote regions, the supply is contracted under the electricity access programs described below. In both cases, utilities oversee the generators.

2.3 Electricity Access Policies and Regulations

The Ministry of Mines and Energy (MME) ran the two main programs aiming to achieve universal access to electricity, among them Luz para Todos (LpT, Light for All). LpT was enacted in 2003 and initially aimed to connect 2 million dwellings (around 10 million people) in rural Brazil by 2008. These targets were accomplished — 16 million people had been connected by April 2017. New studies have shown a need to maintain the program,

² Lei No. 12.111, de 9 de Dezembro de 2009, Diário Oficial da União [D.O.U.] de 10.12.2009 (Braz.). https://www.planalto.gov.br/ccivil_03/_Ato2007-2010/2009/Lei/L12111.htm

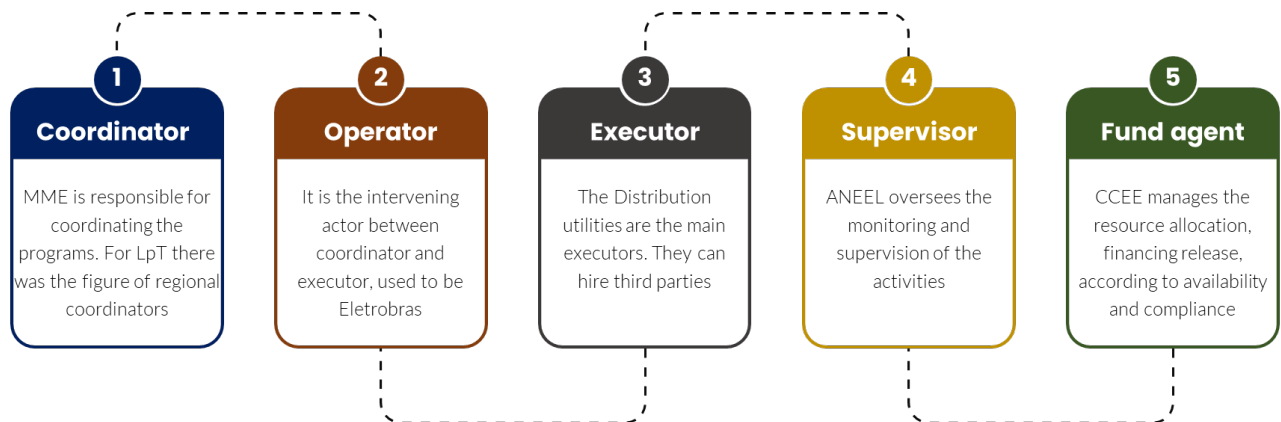
³ Decreto No. 7.246, de 28 de Julho de 2010, Diário Oficial da União [D.O.U.] de 29.07.2010 (Braz.). https://www.planalto.gov.br/ccivil_03/_ato2007-2010/2010/decreto/d7246.htm

⁴ Portaria Normativa No. 59/GM/MME, de 26 de Dezembro de 2022, Diário Oficial da União [D.O.U.] de 27.12.2022 (Braz.). <https://www.gov.br/mme/pt-br/acesso-a-informacao/legislacao/portarias/2022/portaria-normativa-n-59-gm-mme-2022.pdf>

which has been extended until the end of 2026, with the last policy enacted in August of 2023.⁵

The latest LpT incorporated the MLA established in 2020 with slightly different goals. First, it focuses only on the Legal Amazon region. Second, it encompasses only renewable energy sources; that is, it aims to replace diesel and gasoline generators. Another critical difference was that MLA allows communities to ask ANEEL to intervene if the distributor does not act on a request within 30 days. They can also, in theory, arrange for a third party to construct the infrastructure and get reimbursed by the utility later. This latter option requires the community to finance the work temporarily. This is not an insurmountable barrier, however, since reimbursement of the funded work is guaranteed through MLA. Both programs follow standard procedures defined by their operation manuals. These relationships and roles are detailed in Figure 2.

Figure 2. Implementation rules for electricity access in Brazil



In 2004, ANEEL published the first regulation to define rules for utilities developing universalization plans,⁶ regulating the use of intermittent power generation individual systems (SIGFI) as part of their strategies. SIGFI aimed to address the regions and consumers for whom expanding distribution grids was not an option. These regulations were reviewed over the years, and their final version was published in 2021.⁷ A significant change occurred in the 2012 revision,⁸ which included the definition of isolated microgeneration and distribution systems (MIGDI), providing one more alternative for the universalization strategies. Another essential definition contained in these regulations was the minimum electricity generation levels allowed for SIGFI and MIGDI. In 2004,

⁵ Decreto No. 11.628, de 4 de Agosto de 2023, Diário Oficial da União [D.O.U.] de 7.8.2023 (Braz.). https://www.planalto.gov.br/ccivil_03/ Ato2023-2026/2023/Decreto/D11628.htm

⁶ Resolução Normativa No. 57, de 12 de Abril de 2004, Diário Oficial da União [D.O.U.] de 13.04.2004 (Braz.). <https://www2.aneel.gov.br/cedoc/ren2004057.pdf>

⁷ Resolução Normativa ANEEL No. 1.000, de 7 de Dezembro de 2021, Diário Oficial da União [D.O.U.] de 21.01.2022 (Braz.). <https://www2.aneel.gov.br/cedoc/ren20211000.html>

⁸ Resolução Normativa No. 493, de 5 de Junho de 2012, Diário Oficial da União [D.O.U.] de 08.06.2012 (Braz.). <https://www2.aneel.gov.br/cedoc/ren2012493.pdf>

regulations allowed systems supplying 12, 20 and 30 kilowatt-hours/month/consumer. The current regulation establishes a minimum of 45 kWh/month/consumer.

Also significant is ANEEL resolution 950/2021,⁹ which defines the rules for monitoring and supervising the utilities' universalization plans and states that utilities must send a quarterly report to ANEEL. Finally, another set of documents that regulate the technical conditions is the LpT manuals — these have evolved over time, as shown in Figure 3.¹⁰

Figure 3. Timeline of main electricity access policies and regulations



2.4 The Legal Amazon Region: A Definition and the Energy Transition There

The Legal Amazon region (see Figure 4¹¹ on the next page), established in 2007, is the administrative area of the Superintendence of Amazon Development (an agency linked to the Ministry of National Integration and Regional Development). The area encompasses 772 municipalities, eight states, around 2 million people, and 58.9% of Brazil's territory (5 million km²). The main goal of the area is to promote inclusive and sustainable development and the competitive integration of productive systems into national and international economies.

⁹ Resolução Normativa ANEEL No. 950, de 23 de Novembro de 2021, Diário Oficial da União [D.O.U.] de 01.12.2021 (Braz.). <https://www2.aneel.gov.br/cedoc/ren2021950.pdf>

¹⁰ For more details about these policies and respective regulation, see Gomes, R. D. M., Oliveira Martins Varella, F. K. de, & Vilela, I.N.R. (2022, October). *Universal access to electricity in Brazil: evaluation of SIGFIs and MIGDIs*. International Energy Initiative Brasil (IEI). <https://iei-brasil.org/2022/10/06/universalizacao-acesso-sigfis-miqdis/>

¹¹ Tyukavina, A., Hansen, M., Potapov, P., Stehman, S., Smith-Rodriguez, K., Okpa, C., & Aguilar, R. (2017). Types and rates of forest disturbance in Brazilian Legal Amazon, 2000-2013. *Science Advances*, 3(4). <https://doi.org/10.1126/sciadv.1601047>

Figure 4. The Legal Amazon region

Source: Tyukavina, A., et al. (2017). Types and rates of forest disturbance in Brazilian Legal Amazon, 2000-2013

Recently, the Brazilian government, via MME, has launched two new programs: the Pro-Amazonia Legal,¹² aimed at reducing the energy and navigability costs, and the Energias da Amazonia¹³ program, aimed at decarbonization of power systems of the Legal Amazon

¹²Decreto No. 11.059 de 03 de Maio de 2023, Diário Oficial da União [D.O.U.] de 3.5.2023 (Braz.). https://www.planalto.gov.br/ccivil_03/_ato2019-2022/2022/decreto/d11059.htm

¹³Decreto No. 11.648, de 16 de Agosto de 2023, Diário Oficial da União [D.O.U.] de 17.8.2023 (Braz.). https://www.planalto.gov.br/ccivil_03/_ato2023-2026/2023/Decreto/D11648.htm

region. While the former is already running, the second is still under implementation. Both have the main goal of reducing costs and subsidies for energy costs of isolated systems, increasing energy efficiency and promoting renewables in the region. The specific goals of Energias da Amazonia Program detail an it more and include replacing fossil fuel with renewables to mitigate greenhouse gas emissions, improve energy quality and security, and reduce the expenditure with the CCC (fuel consumption account), the charge responsible for paying for diesel generation in the isolated systems. Moreover, the program defines some alternatives through which these goals will be worked out: the interconnection of transmission and distribution grids with the National Interconnected System (SIN), renewables power generation, storage, management, and smart energy systems, among others. The program also defines some mechanisms, such as transmission and generation auctions and the subrogation of CCC.

Although this policy focuses on isolated systems, not remote ones, its guidelines encourage interactions, stating that the program should seek integration with other policies and programs developed for the region. Technological innovation, community engagement, and participation are also basic guidelines for the new policy. Therefore, it is reasonable to say that electricity access policies in the Legal Amazon should align with the Energias da Amazonia program.

3 Challenges and Opportunities for Improving Electricity Access in the Legal Amazon

3.1 Challenges

The challenges discussed here derive from the RAP team's analysis, stakeholder contributions during interviews, discussions from II Forum Energia e Comunidades in Belem in May 2023 and from experts who kindly reviewed the first draft of this document.

The Centralized Logic of System Planning and Expansion

According to the Brazilian power sector rules, electricity access and supply problems can be categorized as the supply for isolated systems and the supply/access to remote regions. Although policies and regulations define the main rules for addressing these problems, the type of solutions and the ways of understanding each problem are singular. The regulations for supplying isolated systems follow the logic of centralized auctions: utilities must make their forecasted demand known to MME/EPE, who will then define the parameters of the necessary auctions. For remote regions operationalized via the LpT, the logic for planning the expansion and operation of these systems is more decentralized, and the institutional

framework may not provide adequate incentives for utilities. Therefore, utilities face more challenges to operationalize it.

The Misleading Idea of 99% Access

Brazilian statistics report near-universal access to electricity¹⁴ but this is somewhat misleading, leaving an estimated 1 million people¹⁵ invisible. In addition, many more customers can access very limited or unreliable electricity — for example, they may have just enough lighting for a few hours a day. The misleading idea of 99% may create a perception of it being a smaller problem than it is in reality, and risks making the issue a low priority for institutional players.

The Distance and Isolation of Communities

Remote regions are often far from urban areas and the SIN, with limited transportation to reach them. Travel by boat is often the only reasonable option. This situation creates significant logistical challenges for installing, maintaining and fueling any energy infrastructure — and increases the costs of doing so.

The Small Scale

Many communities in the Amazon are very small, creating diseconomies of scale for extending the SIN or installing new isolated systems. They face many of the same challenges that populations on small islands face — and the same high electricity costs. It may be helpful to look at successful island power systems running on clean energy sources as models for the Amazon region.

Affordability

Many people in the region live subsistence lifestyles or experience poverty. They may have little ability to pay for electricity services or prices that reflect the actual service costs. And yet, access to energy offers them a path to higher income and/or a better quality of life (e.g., health care, refrigeration, telecommunications, etc.).

System Reliability

Where isolated systems have already been installed, service is sometimes unreliable. People in remote communities may hold perceptions based on past experiences that are no longer accurate. For example, they may believe diesel generators are reliable and solar panels are not — a perception that would make them skeptical of clean energy solutions to meet their needs. Maintaining clean energy systems is complicated by the lack of trained

¹⁴ International Energy Agency. (2023). *SDG7: Data and Projections, Access to electricity*. <https://www.iea.org/reports/sdg7-data-and-projections/access-to-electricity>

¹⁵ Instituto de Energia e Meio Ambiente (IEMA). (2020, October). *Exclusão elétrica na Amazônia legal* [Electrical exclusion in Legal Amazon]. <https://energiaambiente.org.br/produto/exclusao-eletrica-na-amazonia-legal-quem-ainda-esta-sem-acesso-a-energia-eletrica>

technicians in communities with isolated systems. In contrast, technicians capable of maintaining diesel systems are more widely available.

Decarbonization of SIGFI and MIGDI

Traditionally, diesel fuels power in remote regions, which means complicated logistics are entailed (diesel to move diesel). Recently, hybrid schemes incorporating renewable resources have been considered as solutions. However, this alternative may hamper other issues, such as supply chain connectivity, higher capital expenditure and a lack of skilled people to maintain and repair equipment.

Capital Needs (CAPEX)

Electric power systems tend to be capital-intensive and require financing. Clean energy systems with no fuel inputs tend to have higher upfront capital costs than diesel systems (although they have lower operating and maintenance costs). Adding energy storage to ensure the availability of electricity at all hours raises the capital needs even higher. Distribution utilities are financially stressed and depend on government programs for the capital required to build isolated systems. In many cases, customers cannot pay for the total costs of their electricity service (in terms of both capital and operating costs) at retail rates.

Clean Energy Supply Chain

Brazil has made significant progress in establishing photovoltaic (PV) and wind supply chains in recent decades. Still, as is the case in other countries, companies with expertise in solar energy are just beginning to form partnerships or build their capacity to incorporate PV and energy storage into isolated systems. The supply chain serving remote regions of the Amazon is not as robust as in urban areas. It faces higher costs and more significant logistical challenges, as noted above. In addition, auction rules for supplying energy to isolated systems create barriers to entry and innovation for new clean energy companies.

Workforce Development

As mentioned, there is a shortage of trained workers in the Legal Amazon region who can maintain isolated systems incorporating PV or PV plus storage systems, especially in remote areas. Furthermore, there is a classic "chicken and egg" problem. It may be hard to find skilled workers to maintain PV systems, while these systems might need only a few days of yearly maintenance. There might not be enough work to justify the expense of training these new workers. Still, the lack of maintenance workers hinders deployment.

The Subsidy Problem

LpT is paid for by the Energy Development Account (CDE). The main goal is to reduce this subsidy once all consumers pay it in the regulated market. However, the paradox is that the desire to mitigate total CDE spending may slow down universal service programs like LpT.

Hence, to debate which programs are funded by CDE and how they interact with other policy areas seems crucial. In addition, many in the Amazon region cannot afford to pay cost-based (unsubsidized) electricity rates. The idea of reducing subsidies is valid from the economic perspective. Nonetheless, it might be worth considering phasing out subsidies only once universal service goals are achieved to not hinder socioeconomic development in the region. Currently, the universalization goals have not been fulfilled yet.

The Taxation Problem

Despite recent changes in regulations and discussion of tax reform in Congress, taxation policy in Brazil offers an advantage to diesel-fueled generation over renewable generation. Independent power producers (IPPs) can recover some of the tax on their customers' fuel costs but not capital costs. Diesel systems typically have lower capital costs than PV systems but incur fuel costs. Tax policies that allow generators to avoid fuel taxes make diesel generation appear less expensive than it is from the IPPs' perspective. Also, the state-level tax on diesel represents a critical revenue stream for local governments.

Small Communities' Information and Lack of Participation

Many of the documents reviewed highlighted the lack of objective, comprehensive and publicly available information about the actual energy needs of communities, the adequacy of current levels of energy service in remote systems, the potential benefits of increasing access to clean energy, and the comparative costs of different resource alternatives. Moreover, while all remote regions face similar electricity access and supply challenges, they may have cultural differences and other energy needs that require different solutions. For example, the needs and culture of a remote community based on extractive industries are likely to differ radically from those of Indigenous or quilombola communities.¹⁶ These issues reflect the current lack of participation of local communities and the need to improve communication with them.

Lack of Interest and Incentives for Distribution Utilities

Electricity access programs appear to have been hampered partly because they put distributors at the center of implementation despite their financial difficulty. The current rules either require utilities to actively survey remote communities to identify demand or communities to contact utilities with their needs to be included in the universalization plans. The lack of incentives for utilities to provide adequate estimates regarding demand has left an unknown number of people in the region without electricity — Instituto Energia e Meio Ambiente (IEMA) estimates 990,000.¹⁷

¹⁶ Comissão Pró-Índio de São Paulo. (n.d.). *Quilombolas communities in Brazil*. <https://cpisp.org.br/direitosquilombolas/observatorio-terras-quilombolas/quilombolas-communities-in-brazil/>

¹⁷ Instituto de Energia e Meio Ambiente (IEMA), 2020.

Lack of Compliance and Enforcement

Although there are rules for monitoring and supervising programs, there is evidence that utilities may not have fully complied with the requirements. For instance, International Energy Initiative (IEI) showed that utilities must provide quarterly reports to ANEEL. However, according to IEI, there is no public evidence that these reports have been handed over nor that sanctions have been imposed as a result.¹⁸ More transparency in this regard would strengthen the incentives provided to utilities.

Unclear Interaction With Other Sectoral Policies and Lack of Integrated Planning

Many remote communities' needs for energy services relate to several different activities, such as education, health, connectivity or even production systems. The current universalization policies aim to connect these communities to energy via the grid or off-grid. We could find no evidence, however, that additional efforts were made to understand their specific needs further. The lack of community participation or coordinated sectoral policies hinders understanding and limits the scope of electricity universalization and local development policies. Moreover, electricity is only one infrastructural development; communities may also require cooking fuel, sanitation, jobs, energy for productive activities, poverty alleviation or other services. This situation may create a perception among power sector stakeholders that CDE is paying for more than energy development.

3.2 Opportunities

This long list of challenges demonstrates that the issues interact at different levels and indicates that electricity access is only a part of the problem. As discussed, the Legal Amazon region was created to promote development with specific regional development plans. Electricity access for remote areas is part of the region's broader sustainable development plan. It should not be seen as an isolated policy. Taking a systemic and integrated perspective on electricity access policies reveals several opportunities.

Exploring the Current Window of Opportunity

The new Brazilian government prioritizes sustainable development by shifting the environmental, climate and social agenda. This agenda is evident in the Amazon region, which has seen the relaunch of the Amazon Fund and the announcement of COP30 in Belem. The commitment has also been reinforced by creating new ministries covering rural development, native people, racial equality and social development. This is an important window of opportunity for developing an integrated and systemic policy mix for the region, in which electricity access is an essential infrastructural factor.

¹⁸ Gomes et al., 2022.

Seeking Convergence and Coherence of Policies

Suppose there is an opportunity to develop an integrated set of policies for sustainable development in the Legal Amazon region. In that case, it will need active and informed participation from policymakers. It is crucial to articulate and identify the points of interaction and synergies between energy supply (electricity and fuels), local development and poverty alleviation, local productive systems, and environmental conservation. This approach underpins the Amazon region's recently launched environmental conservation plan.¹⁹

It is important to highlight that the plan has established specific objectives for the energy sector in its axis for sustainable, productive activities:

- Expand the local renewable energy infrastructure to foster sustainable production systems.
- Foster the use of forestry biomass for power generation and cogeneration.
- Develop and review the agroecological zoning for bioenergy production (sugarcane, soy, palm oil and corn).

These objectives are translated into some specific targets:

- Implement 55 projects to foster local and sustainable production systems, including renewable energy, among other areas.
- Serve 120,000 consumer units with access to public electricity distribution service, including socio-productive projects to stimulate socio-biodiversity chains in the Legal Amazon region.
- Develop bioenergetic zoning.

This convergence can be achieved across several areas. The intersection between energy efficiency, hybrid systems and biofuels in the energy sector is already an established goal. Developing an integrated energy resource plan for the region is another possibility. In addition, it is possible to bring together poverty alleviation schemes and the social tariff for other sectors, and health service access may be merged with digital technologies and energy management. The Energias da Amazonia program guidelines explicitly reinforce this convergence and call for coordination with other policies and programs. This convergence is also a key highlight in the World Resources Institute Study (WRI) for the New Amazon Economy (NEA), in which integration of policy areas is a critical task.²⁰

¹⁹ Ministério do Meio Ambiente e Mudança do Clima (MMA) [Ministry of Environment and Climate Change]. (2023). *Plano de Ação para Prevenção e Controle do Desmatamento na Amazônia Legal* [Action plan for prevention and control of deforestation in Legal Amazon]. <https://www.gov.br/mma/pt-br/governo-lanca-plano-de-combate-ao-desmatamento-na-amazonia-e-anuncia-atos-ambientais>

²⁰ Nobre, C., Feltran-Barbier, R., de Assis Costa, F., Haddad, E., Schaeffer, R., Domingues, E.P., Medeiros Rocha Frasson, C., Camuri, P., Genin, C., Szklo, A., Lucena, A., Araújo Fernandes, D., Silva, H., Ventura, R., Theophilo Folhes, R., Fiorini, A.C., Rocha, A.M., Santos, A.J.L., Barreto da Rocha Klautau Junior, A., Souza Magalhães, A., et al. (2023). *Nova Economia da Amazonia*. WRI Brasil. <https://www.wribrasil.org.br/nova-economia-da-amazonia>

Developing Local Production Systems for Renewable Energy in the Legal Amazon Region

These objectives and targets align entirely with existing projects and initiatives in the region. For instance, IDEAAS (<http://www.ideaas.org.br/>), a renewable energy NGO, has developed a model for local productive arrangements for renewable energy in the Amazon region. The aim is to promote capacity building, support local entrepreneurs and facilitate production arrangements that supply equipment and services for remote areas.²¹ These local productive arrangements can work as social franchise models for specific types of projects.

Exploring Existing Networks

A network of NGOs focused on the renewable electrification of remote communities already exists: Rede Energia e Comunidades (Energy and Communities Network). Many solid and capable NGOs are engaged in the network, collaborating and sharing information and strategies. There is an opportunity to support and strengthen this network and its member organizations. They will ultimately help to drive the integrated sustainable development transformation.

Improving Current Contracting Models

The existing government goal of universal access and successful programs like LpT provide a solid foundation on which to build new models that address the implementation hurdles observed. Within the proposal sent to MME, RAP followed the similar operationalization model already developed for LpT, including local entrepreneurs in partnership with communities and developers. The proposal also suggests using a service contract instead of an implementation one. In this way, local entrepreneurs are incentivized to continue maintaining the system's operation. A centralized equipment purchase policy would help increase scale and reduce costs.

The Legal Amazon Region as a Sandbox for the Power Sector

There is an opportunity for experimentation with innovative schemes in the region. Given the unstructured electricity system and market in some areas, there is scope for fostering digital systems, DC systems, the development of modular and scalable distributed energy resources (DER), new market designs such as peer-to-peer or energy as a service, system management with batteries, association with IT companies, integrations with health systems, remote assistance and several other possibilities. Another exciting idea is to create a region for performance-based regulation — such an initiative could be replicated across the Brazilian power sector. It would not cover the whole region but could foster innovation and be linked with sustainable development strategies in some areas.

²¹ This idea was developed during the project Luz para uma vida melhor [Light for a better life]. http://www.ideaas.org.br/?page_id=262

Improving Participation of Local Communities

Communities often complain about poor energy services, unreliable and poor-quality electricity access and high electricity tariffs. A key aspect of successful electric access policies is the full participation of local communities. They understand their own current needs and the future energy services they will require, and they must also be involved in operation and maintenance because some communities are very remote.

4 Roadmap for Electricity Access as a Development Driver in the Legal Amazon Region

Brazil has a massive window of opportunity to become a reference point for improving electricity and energy access in remote areas. The recently announced initiatives, such as the recovery of the Amazon Fund, the Action Plan for the Prevention and Control of Deforestation in the Legal Amazon (PPCDAM), new LpT and Energias da Amazônia may trigger some of the essential activities. In addition, the opportunities previously discussed reveal the potential that a coherent set of policies and actions may deliver. Therefore, we understand that the overarching policy goal in Brazil is ***to achieve universal electricity access with high quality and reliability levels to support local development based on sustainable resources and minimize total energy costs and cost volatility.***

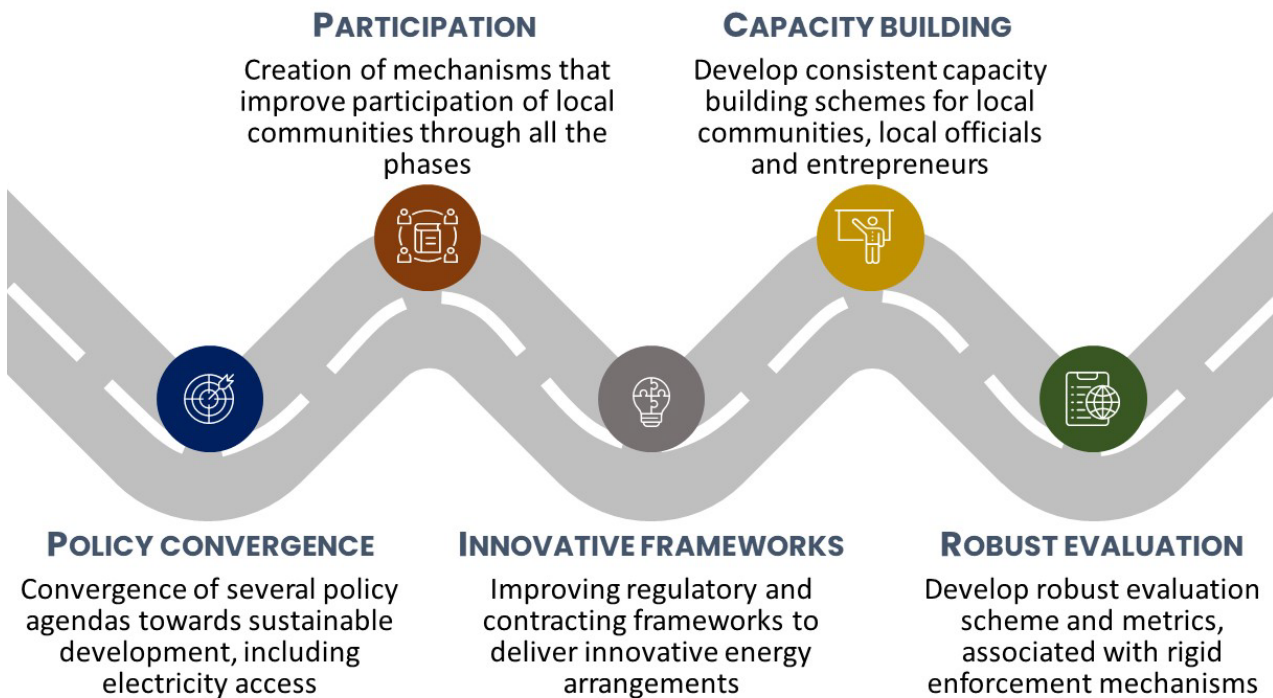
The roadmap presented below aims to contribute to the definition of a public agenda that delivers this overarching goal. We suggest some axes for actions, activities and goals. The main objective here is not to be exhaustive but to stimulate public debate, inform the public agenda and define future project opportunities.

We believe five key areas should initially guide electricity access strategies (see Figure 5, next page).

- 1. Policy convergence** — As energy is a vector for development, electricity access should be understood within a broader scope of developmental actions and policies. This axis promotes alignment between different sectoral policies' goals, instruments and incentives.
- 2. Participation** — Any successful initiative in the Legal Amazon region must consider local communities' participation seriously. It includes surveying energy needs to discuss priorities, lifestyles, future perspectives, essential services and productive schemes. The promotion of participatory mechanisms is the primary goal of this axis.
- 3. Innovative frameworks** — Brazil has successful policy and regulatory frameworks in the power sector and for electricity access. However, the Legal Amazon region poses challenges that other structures must address. There is room for improving and developing innovative frameworks for contracting and regulating.

4. **Capacity building** — Capacity-building schemes should be implemented across all strategy phases. Capacity building is also crucial for developing a network of social entrepreneurs, helping communities understand, operate and maintain the systems and creating local productive arrangements. However, several areas also need capacity building for local government officials, who are on the ground and can quickly identify opportunities or problems.
5. **Robust evaluation** — Electricity access policies and programs have already developed evaluation schemes with metrics, methodologies and processes. However, the current monitoring and evaluation scheme has been unable to effectively enforce the performance of utilities, which often do not comply with the evaluation requirements.²² The evaluation needs to be redesigned, including making changes for innovative frameworks and implementing enforcement mechanisms.

Figure 5. Main axes of the roadmap for electricity access as a development driver in the Legal Amazon



4.1 Policy Convergence

Regarding sustainable development, the policy mix around electricity access needs to be convergent and coherent. It does not mean redesigning all policy goals and instruments across several policy areas; it means aligning goals and instruments so that the incentives reinforce each other instead of creating hurdles. Several policy areas and programs are to

²² Gomes et al., 2022.

be analyzed, and the recent PPCDAM sets the main guidelines for that coordination. Its four axes highlight the main areas of analysis: sustainable, productive activities; environmental monitoring and control; land and territorial ordering; and normative and economic instruments. When it comes to electricity access, PPCDAM sets an ambitious target of improving the connection of 120,000 consumers, implementing local and sustainable production systems and developing bioenergetic zoning. The WRI study also indicates a similar pathway.²³

Alignment With Climate Policies and Carbon Markets

In 2022, the government intensified discussions about carbon markets in Brazil. In 2023, an agroecological transition plan was announced for the second semester. The Brazilian government must discuss carbon market instruments, which can be a crucial tool in accelerating the shift from fossil to clean energy, even in the Legal Amazon region. Together with tax reforms, they can also foster the development of low-carbon local supply chains.

Tax Harmonization

The Brazilian government is discussing major tax reforms in Congress. These reforms create another promising window of opportunity to discuss how taxation rules apply to different sources and technologies to net metering customers throughout Brazil, such that only net excess generation (rather than all generation) would be subject to ICMS (a tax on commerce and some services, such as a VAT-like tax). It is also an opportunity to balance tax incentives for local productive arrangements in priority areas like the Legal Amazon region. With a more balanced tax system, it may be possible to have more competitive development of local clean energy supply chains and projects.

Alignment With Other Energy Policies

Integrated energy sector planning can support better-quality electricity systems. For instance, aligning electricity access and energy efficiency policies is possible, as is already done with appliances. It would be helpful to analyze how far innovative energy efficiency instruments can be relevant in auctions, as in Roraima state.²⁴

Integration with fuels and biofuel policies is also relevant. As the PPCDAM seeks to identify bioenergy areas in the region, it would be interesting to explore joint efforts for producing biodiesel or biogas to generate electricity or replace diesel.

²³ Nobre et al., 2023.

²⁴ Consultas Públicas No. 047/2019, Diário Oficial da União [D.O.U.] de 19.12.2019 (Braz.). https://antigo.aneel.gov.br/web/quest/consultas-publicas?p_auth=xy9pZWek&p_p_id=participacaopublica_WAR_participacaopublicaportlet&p_p_lifecycle=1&p_p_state=normal&p_p_mode=view&p_p_col_id=column-2&p_p_col_pos=1&p_p_col_count=2&participacaopublica_WAR_participacaopublicaportlet_ideParticipacaoPublica=3394&participacaopublica_WAR_participacaopublicaportlet_javax.portlet.action=visualizararticipacaoPublica

Integration With Other Policy Areas

Several discussions during the interviews conducted to create this roadmap, which took place at the II Forum Energia e Comunidades, drew attention to the combined problems of electricity access and sanitation systems, which may represent critical loads. Other discussions focused on the integration of connectivity and electricity. There is room to explore a combined expansion of IT and electricity services with optimal resource allocation. Health services were mentioned several times; integrated planning can lead to more effective resource allocation. Lastly, public security is an issue in several areas: electricity investment can be subject to theft or other types of insecurity, which must be addressed.

4.2 Participation

People living in isolated communities and remote regions are not isolated solely in terms of geography. Historically, isolated communities worldwide have been the last to "hear the news"; the last to benefit from new technologies, ideas and services like electricity; and it is common that governments do not make these remote areas policy priorities. Fortunately, two of the newest ubiquitous global technologies — mobile phones and the internet — can connect isolated communities to the rest of the world in real time. With this power comes the ability to make utilities and government agencies more transparent and accountable to those communities. There is no longer any reason for people in isolated or remote regions to literally or figuratively be "in the dark."

Engaging With Local Communities

National and local government authorities should engage with the people living in isolated and remote communities to understand their needs and search for improvements. This should encompass not only minimum domestic electricity needs, but also explore how higher levels of electricity service can promote a better quality of life and support community economic development.

Agencies should engage with these communities proactively, thoroughly and meaningfully. The needs of the public should be the primary driver for all public utility services. It would be unwise to assume that all isolated and remote communities need the same level of electricity service for the same end-uses as people served by the SIN. They may require

The needs of the public should be the primary driver for all public utility services. It would be unwise to assume that all isolated and remote communities need the same level of electricity service for the same end-uses as people served by the SIN. They may require similar services in many cases, but consultation is necessary.

similar services in many cases, but consultation is necessary. The power systems serving those communities can and should be planned, designed and constructed to meet their articulated needs, and those doing the planning, design and construction should listen to and be open to suggestions from the people they serve.

The Brazilian government has excellent experience developing participatory processes and should use them to improve electricity access. It can also be supported through other avenues:

- Brazilian NGOs have already done work to proactively identify, map and quantify community needs and have suggested ways to simplify the processes through which remote communities request electricity service.²⁵ Using these networks can be very helpful.
- The government should provide remote learning opportunities to people in isolated and remote communities. It will enable them to participate in electricity service planning decisions.
- There should be increased representation of isolated and remote communities on the institutional committee and councils of the power sector that set priorities for works projects funded by LpT. It would not appear to require any legislative or regulatory changes, as the coordinators of these committees already have the authority to define their composition.

4.3 Innovative Frameworks

Recent developments in the electricity access universalization goals show that improvements can be made to the existing frameworks. There is now an opportunity to improve the frameworks in ways that deliver the universalization goals while fostering innovative schemes for the Brazilian power sector.

New Logic of System Planning

Brazilian power system planning follows the traditional logic of system planning, which is based on centralized generation and consequent grid expansion. However, the effectiveness of this conventional system planning mode has been questioned by the evolution and growth of distributed generation and energy resources, which enable new solutions and functions for agents such as the prosumer. Although DER is beginning to gain attention and a share of generation capacity, the Brazilian power system has given only marginal consideration to DER, active distribution systems and microgrids²⁶ in grid

²⁵ For instance, Instituto de Energia e Meio Ambiente (IEMA), 2020 (<https://energiaambiente.org.br/produto/exclusao-eletrica-na-amazonia-legal-quem-ainda-esta-sem-acesso-a-energia-eletrica>) and Gomes et al., 2022 (<https://iei-brasil.org/2022/10/06/universalizacao-acesso-sigfis-migdis/>) works have demonstrated these points.

²⁶ Ghadi, M.J., Rajabi, A., Ghavidel, S., Azizvahed, A., Li, L., & Zhang, J. (2019). From active distribution systems to decentralized microgrids: a review on regulations and planning approaches based on operational factors. *Applied Energy*, 253. <https://www.sciencedirect.com/science/article/abs/pii/S0306261919312176> and Kristov, L. (2019) The Bottom-Up (R)Evolution of the Electric Power System: The Pathway to the Integrated-Decentralized System. *IEEE Power and Energy*, 17(2), 42-49. <https://ieeexplore.ieee.org/abstract/document/8643617>

planning. In remote regions like the Legal Amazon, the costs for grid expansion are enormous. It is therefore an excellent opportunity to improve electricity access and decarbonize isolated systems to serve as a testbed for a new logic of system planning that incorporates microgrids and other decentralized alternatives.²⁷ In addition, this decentralized logic of system planning mitigates the potential risk of environmental impacts derived from grid expansion, such as fishbone deforestation patterns.²⁸ This new logic of system planning was explored in the WRI NEA study,²⁹ demonstrating decentralized systems' potential, costs and benefits.

Mechanism to Decarbonize Isolated Systems and Remote Regions

There are several pathways to foster the decarbonization of isolated systems and remote regions. For instance, it is recommended that renewable energy bids are forcefully required to meet the total capacity needed for an isolated system. Those bids should be accepted if they can partially meet the need and thus reduce the size of any necessary fossil generation without increasing costs. Fossil capacity can then be procured to meet the residual demand. In this way, hybrid systems are enabled.

It is also recommended that all bids submitted in the supply auctions for isolated systems should estimate the carbon emissions associated with the generation resource. There is a need to reform auction rules to add an imputed/assumed carbon cost to each bid from a carbon-emitting resource. The winning proposals in every auction should be the resources that have the lowest total cost, with the carbon price considered, but this would be a "shadow" price. It would affect the decision about which resources are least costly. Even so, contracts with winning bidders would be based solely on the generator's bid, not including carbon costs.

Support for the Development of Local Supply Chains

Developing bidding rules that create advantages for bidders with a commitment to local supply chains is possible. This mechanism associated with a policy of local production systems can work on renewable energy projects' demand and supply sides and support cost reduction in the region. This type of mechanism also avoids the risk of future uneconomic assets. As an example of how these can arise, the most recent auction guidelines allowed generators to rely on LNG terminals not yet in commercial operation. Permitting this contingency in accepted bids creates an incentive to build such terminals, which makes another unsustainable long-term commitment to fossil fuels, risking the creation of an asset that becomes uneconomic before it is amortized, potentially leaving a future government to raise funds to pay off debt and decommission. These initiatives to

²⁷ It does not mean that expansion or modernizing or reinforcing transmission and distribution grids are not necessary. It only advocates for new tools, practices and models for system planning that incorporate more explicitly decentralized alternatives.

²⁸ Although fishbone deforestation patterns are associated with roadways (<https://iopscience.iop.org/article/10.1088/1748-9326/acd408/meta>; <https://www.servicemap.com.br/blog/desflorestamento-em-forma-de-espinha-de-peixe-na-amazonia/>), it is uncertain the impacts of transmission lines (https://web.bndes.gov.br/bib/jspui/bitstream/1408/2923/2/BS%2032%20Estudo%20de%20caso%20sobre%20impactos%20ambientais_P.pdf).

²⁹ Nobre et al., 2023.

support local value and supply chains should be integrated with regional policies such as PPCDAM, LpT and Energias da Amazonia. For instance, isolated system auctions with a renewable focus can support the development of local renewable supply chains that would be useful to integrate with more decentralized supply chains for remote systems.

Promoting Energy Efficiency

It would also be constructive to revise the planning guidelines to require distributors to fully develop technically feasible alternatives for effective local end-uses and describe their energy efficiency programs, plans, and estimated future energy savings (in kW and kWh) using publicly vetted benefit/cost assessments. In addition, it is recommended that energy service companies are allowed to submit bids to provide supplemental energy efficiency savings (beyond the utilities' plans) or demand response savings as part of the supply auctions.

Long-Term Contracts

Supply contracts for winning bids in the auctions to serve isolated systems that span over 15 years would be attractive. Longer supply contracts for independent power producers (PIEs) using PV or wind turbines (with or without battery energy storage) and techniques for evaluating competing proposals with varying contract lengths can be advantageous if correctly managed. Researchers studied solar panel performance in 40 countries and found that median output slowly degrades, at just 0.5% to 1.0% annually.³⁰ It means that even after 25 years, photovoltaic panels typically generate 82.5% to 93% of their initial output. Long-duration contracts are essential for technologies where most lifetime costs come with the upfront investment and operating costs are comparatively minimal. Long-duration contracts allow for lower prices per kWh generated and assure investors that they will eventually recoup their costs and earn a profit, so long as their equipment is maintained correctly and doesn't fail.³¹ For PV systems, contracts of at least 20 years (and probably longer) can be justified. In the United States, contracts for small-scale solar power typically cover 20 to 25 years.³²

Innovative Frameworks for Maintenance and Repair

Utilities, IPPs and government authorities could be more innovative in looking for ways to address maintenance and repair challenges for clean energy technologies:

- Create online and hybrid training programs.

³⁰ Jordan, D., Kurtz, S., VanSant, K., & Newmiller, J. (2016). Compendium of photovoltaic degradation rates. *Progress in Photovoltaics*, 24(7), 978-989. <https://onlinelibrary.wiley.com/doi/full/10.1002/ppp.2744>

³¹ Actions 1B and 3E of the roadmap are intended to better ensure proper maintenance of PV systems installed in remote regions. Without good maintenance, which may be more challenging in remote locations, longer-duration contracts could be hard to justify. But with good maintenance, the expectation should be that PV systems can continue to generate near their design capacity for 20 to 25 years.

³² This is according to Sunrun, the largest installer of small-scale solar systems in the United States. Sunrun. (2019, August). *How does solar panel billing work?* <https://www.sunrun.com/go-solar-center/solar-articles/how-does-solar-panel-billing-work>

- Install technologies that allow utilities and IPPs to monitor system performance remotely and test system components. Some of these technologies are just beginning to appear in the clean energy market, while others are well-established. These components may add upfront costs to clean energy installations. Still, they can result in fewer and shorter outages due to early identification of problems. They can also lead to greater energy output over the system's lifetime, which can more than cover the higher upfront costs.
- Establish and fund a program that provides remote consultation and troubleshooting services for clean energy maintenance problems. All utilities that benefit could contribute to funding the program, potentially saving them all money through economies of scale. RAP has seen examples of solar installers and third parties offering remote consultation troubleshooting and technical assistance programs provided by governments or universities that do not serve this specific role but could be adapted to do so.
- Pilot test a "circuit rider" program, where clean energy maintenance and repair experts regularly travel from one isolated system to another to inspect and perform maintenance on clean energy systems. The circuit rider could build time into each stop to educate and train local workers so that, over time, the service would no longer be necessary.

For remote areas, RAP has submitted to MME a proposal for this scheme for contracting and operating these systems (presented in the annex).

Innovative Financial Mechanisms

International experiences demonstrate that innovative financing mechanisms can support electricity access. The WRI New Amazon Economy indicates³³ blended finance as one of the alternatives. However, there are other opportunities, including:

- Subscription-based community solar installations, with customer subscription payments attached to their electric utility bill and credits assigned to their bill based on a share of the total generation of the installation.
- "On bill financing" and "revolving loans" for customer-sited clean energy technologies, where the utility or a third party (e.g., a bank or state clean energy fund) pays for the upfront installation costs, and customers make payments on their electricity bill to repay the investment — but also retain all the benefits of the clean energy produced.
- Allowing customers to transfer funds used to subsidize their electricity costs (in this case, CCC and TSEE³⁴ subsidies) to subsidize investments in PV that further reduce their costs or provide better services.

³³ Nobre et al., 2023.

³⁴ Electricity Social Tariff.

Sandbox Projects

ANEEL already has great experience with strategic research, development innovation and sandbox projects. Allowing experimentation in the Legal Amazon region parallel to electricity access goals can benefit the Brazilian power sector. Some examples are:

- Hybrid system demonstration (pilot) programs could be funded through the CDE, with funds available to utilities to build and operate such systems and to access advice from external expert consultants. The use of CDE funds could be justified, perhaps even offset, by the possibility that hybrid systems will reduce utility generation costs in these isolated systems and thus reduce CCC subsidies.
- Digitalization and smart grid projects to support the mini-grid development, integration with electric vehicles or boats, improve management standards and protocols, or test new business models such as peer-to-peer and energy as a service.
- Performance-based regulation for some low-performance utilities to explore new regulatory models.

4.4 Capacity Building

RAP has been positively impressed with the high-level conversations held with Brazilian stakeholders with whom we have interacted, which showed in-depth knowledge and expertise in the sector. The quality of the analytical reports we reviewed and the policy/regulatory recommendations included in some reports is similarly excellent. Nevertheless, with a challenge as enormous as the one faced here, there is a need to build even more problem-solving capacity among the stakeholders involved. By investing in building the capacity of many organizations, we lay the foundation for long-term problem-solving and resilience.

Clean Energy Workforce Development Program

It would be beneficial for the government, in partnership with academic institutions or NGOs, and for distribution utilities and clean energy technology providers to establish and fund a clean energy workforce development program targeted to distribution utility employees and potential power system maintenance workers in isolated communities. It could be developed as a hybrid training program that combines remote learning with in-person, hands-on training. It is crucial to consider the engagement of local communities in this type of program.

Such a training program in Brazil can have different workstreams. For instance, it can emphasize PV and battery energy storage systems, work in MIGDI and SIGFI configurations, focus on developing local renewable energy production systems, or concentrate on social franchise models. This program will likely succeed if an adequate and willing organization is identified in Brazil to champion the idea.

Knowledge Exchange

Sharing lessons learned and good practices among local, regional and even international authorities and practitioners is always a win-win activity. Therefore, creating a portal, mobile app or other easy-to-access platform can address the information gap in several areas, such as technical expertise to standards, participatory mechanisms to governance arrangements. This type of initiative can also interact with the workforce development program.

International Collaboration and Exchange

Although the Legal Amazon region has unique characteristics, electricity access in remote areas is a common problem in several countries. Exploring international experiences in governance, mechanisms, contracting models, financing, engaging stakeholders, creating champions and informing decision-makers can support the goals in Brazil.

4.5 Robust Evaluation

Brazil already has a well-established process for monitoring and evaluating the evolution of electricity access. Whether the existing frameworks will deliver on the universalization goals is unclear.

Transparent Monitoring Processes

Transparency is an essential characteristic of good governance. In democratic societies, people reasonably expect to know what the government and public service providers, such as utilities, are doing and not doing ostensibly on their behalf. Transparency encourages ethical behavior, allows for the rapid identification of problems and informs everyone about progress (or the lack thereof) on agreed goals. In a word, transparency allows the people to hold accountable those who act on their behalf.

Transparency and accountability can come together when utility performance information is made publicly accessible online, for free, in a simple format. It is essential to improve accessibility to utility performance data. ANEEL or EPE can have a specific webpage with a plain structure and be updated promptly.

Creating Enforcement Mechanisms

It is crucial to hold stakeholders accountable; it is important to have agreement among stakeholders (including the utilities, the communities and customers they serve, and government officials) on objectives, performance metrics and targets with respective enforcement mechanisms. For instance, distributors with excessive technical line losses already reported as part of the planning process must specify their actions to address those problems and empower EPE to decrease the capacity procured through an auction if technical line losses are deemed excessive.

Acknowledgments

This project is funded by the Mott Foundation, which has supported the development of the Amazon region with a diverse range of projects for several years. These projects aim to leverage local development by supporting an ecosystem of initiatives that include local communities, researchers and local authorities. The Regulatory Assistance Project (RAP) roadmap aims to provide an overview of improving regional electricity access within this scope. We also must thank those who made comments during the peer review process, which significantly improved the report. We appreciate the time given by Rodolfo Gomes and Gilberto Jannuzzi (International Energy Initiative – IEI), Vinícius Silva (Instituto de Energia e Meio Ambiente – IEMA) and Ciro Campos (Instituto Socioambiental – ISA). Any remaining mistakes lie with the authors.

Annex I

A new scheme to ensure electricity access in remote regions in Brazil

Background

The Regulatory Assistance Project, a global NGO with 30 years of experience in providing advice to authorities and regulators tackling the challenges associated with a transition toward a clean, secure and affordable energy future, has worked during 2022 and 2023 to gather views of Brazilian experts on what are the challenges associated with electrification in the Amazon region.

This note presents a brief proposal to improve the existing legal frameworks. It aims to canalize the dynamism of isolated communities, NGOs and entrepreneurs to accelerate the deployment of smart electrification solutions and achieve full electricity access in Brazil.

Diagnosis

- After conducting interviews with Brazilian experts specializing in different aspects of the power sector, we have concluded that the current set of rules is reasonably adapted to supply energy in those urban centers close to the transmission grid, the backbone of the National Interconnected System (SIN).
- Nonetheless, these rules were crafted many years ago. Although they have done an excellent job in bringing electricity to most Brazilians, they can be further developed to advance electrification in remote systems of a very small scale.
- For this reason, these rules have not been sufficient to provide an adequate investment framework to supply electricity in those regions where the expansion of the grid is not economical and the communities' population is tiny.
- These rules haven't been able to account for the small scale and geographical isolation of settlements and the large number of them (about 5,000, according to some Brazilian experts) with populations ranging from a few households to hundreds of people. Moreover, as far as we know, utilities have no systematic process to collect data on their size, energy demand and resources.
- Under the current rules, distribution companies are in charge of proposing projects to expand electricity access.
- Distribution companies are large organizations not designed to address universalization issues. Given the current universalization rules, they are not interested in attending to these settlements, given their high cost and low revenue.
- Additionally, some incentives have been shaped such that companies are reimbursed for the installed assets (individual PV panels, for instance). Still, there is no incentive to maintain them.

- Finally, existing rules were not designed to consider the significant technological change during the last decade. Microgrids allow the utilization of multiple small-scale assets in a coordinated way. There is significant experience worldwide that enables us to take advantage of multiple technologies such as wind, solar, batteries and diesel plants to provide a reasonable electricity supply.³⁵

Proposed Scheme

The following proposal builds on the existing scheme's legal framework, which puts the distribution company as the leading actor in the electrification of remote communities. This central role, however, creates bottlenecks, which the proposed scheme addresses. Hence, the initiative should come from communities or entrepreneurs capable of advising and gaining community trust.

The proposal is as follows and is illustrated in Figure 6 on the next page.

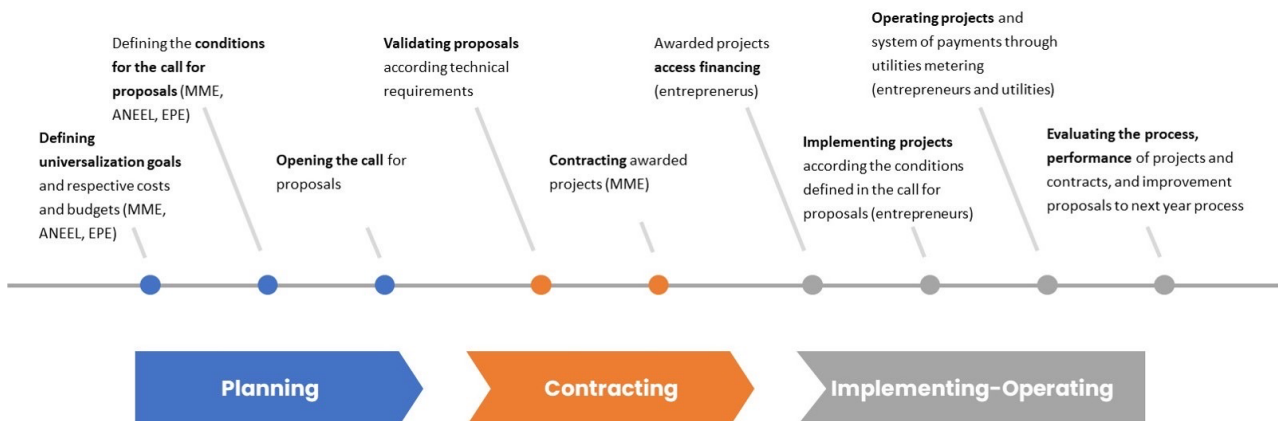
1. MME would publish an annual call for proposals for communities or social entrepreneurs with the communities' approval to propose projects providing electricity access to specific settlements.
2. To participate, the bidders would need to fulfill specific criteria, including:
 - a. The number of households or populations to be served.
 - b. Geographical coordinates of the community.
 - c. The technological solution proposed, with costs broken down into main assets.
 - d. Evidence of community engagement and acceptance of the project.³⁶
 - e. Description of the services to be provided, with the number of connections (school, households, productive activities, etc.), stating who will pay for each connection point.
 - f. Bid bond.
3. Projects should follow a technical and economic screening to reject those without the minimum preparation, similar to existing rules for other auctions.
4. Once analyzed, the selected projects will be awarded a contract according to transparent rules to maximize the number of households with access to electricity per spent real.
5. Awarded projects will be provided a contract allowing the communities or the social entrepreneurs to finance the project.
6. Distribution companies will reimburse entrepreneurs and communities for the electricity, which is effectively sold on a monthly basis, instead of payments for project implementation.

³⁵ The World Bank. (2019). *Mini Grids for Half a Billion People: Market Outlook and Handbook for Decision Makers*. <https://www.worldbank.org/en/topic/energy/publication/mini-grids-for-half-a-billion-people>

³⁶ Other Brazilian authorities could suggest simple means to show engagement with the community. This evidence is not meant to be an unnecessary constraint but rather a mean to measure the preparation of the project, which at the end will require the community's acceptance.

7. As the main responsible parties of distribution service, distribution companies will be the counterparts of these contracts. As such, they will be in charge of the following activities:
 - a. Metering of the produced and consumed energy — an activity that could be delegated to community members or third parties.
 - b. Billing and collection, following simplified procedures using telecommunications.
 - c. Paying the community or social entrepreneurs for the energy supplied.
 - d. Inspection of safety standards associated with the grid.
 - e. Transferring subsidies to consumers.
 - f. Contract management.
8. Contract payment updating.
 - a. Microgrids will likely have variable costs due to diesel or cost reduction of assets such as batteries. Distribution companies would be responsible for updating the payment following simplified rules.

Figure 6. Main steps of the proposed scheme



Relevant Points of This Scheme

- This scheme emphasizes the monthly payment and reimbursement. Many schemes in the world have tried to provide electricity access by reimbursing investment in individual solar PV or solar PV plus battery kits, neglecting maintenance and repair of equipment, a common complaint in the Legal Amazon. The payment by delivered energy provides the right incentives for communities and social entrepreneurs to:
 - Keep equipment well maintained.
 - Choose technologies that are less prone to failure or maintenance intensive.
 - In the case of social entrepreneurs, team up with the communities to provide maintenance and train them to do minor repairs.

- Some reimbursement of the investment could make sense to allow social entrepreneurs to engage in more projects, probably not larger than 30% or low enough to keep energy delivery as the primary source of reimbursement and aligned incentives.
- The figure of a social entrepreneur is different from that of a simple entrepreneur or company. This scheme would allow us to take advantage of Brazil's large supply of technical capabilities. Still, putting the communities at the center of the projects is crucial. Projects won't be successful without the communities' support and clear understanding of the agreement, how much they will pay and which kind of service they will have.

Implementation

- This is a scheme that will potentially engage hundreds of actors. Hence, it is reasonable to conduct a stakeholder consultation to streamline the process, make it successful and minimize costs. Launching a consultation in this regard will provide elements to the Ministry to make this proposal implementable quickly.
- A first small call for proposals could be launched to bring publicity to the scheme and to provide input for developing a larger process later.
- CGEE (Energy Efficiency Management Committee) and PROCEL have already used a similar scheme for energy efficiency.

Parallel Work to Maximize the Impact of the Scheme

There are several government initiatives to maximize the scheme's impact, minimize its cost and ensure it is sustainable over time. Although some would need to be implemented before the scheme's launch, many could be done afterward as part of a constant improvement process.

1. **Rates:** Regulators must decide if electricity rates for remote communities would be the same as for any other consumer in the distribution company's footprint. While electricity access is a constitutional right, there must be a clear decision on what subsidies are strictly needed to satisfy this legal guarantee, with consideration of the low revenues of remote communities and avoiding fostering unsustainable consumption patterns. Whatever the decision, the scheme above should be able to accommodate existing subsidies from special programs. It is also needed to define the rates for other final uses, such as schools and productive activities.
2. **Productive activities:** The use of productive activities increases the utilization of assets and makes the cost of microgrids cheaper.³⁷ But important decisions need to be made, particularly on rates. While electricity access is a constitutional right, subsidies for productive activities are not, so deciding on the rates for these services and the funding source is essential. The Brazilian government has many programs to support productive activities, and careful coordination to integrate them would be required. For instance,

³⁷ The World Bank, 2019.

proposals to define local productive arrangements for renewable energies would be essential in providing services and spare parts, and in fostering local development.³⁸

3. **Centralized equipment procuring:** The program's size is sufficient to take advantage of economies of scale. The price of solar PV panels and batteries to be used in the program should be negotiated directly by the Brazilian government to lower the costs.
4. **Hazardous and toxic waste disposal:** Environmental concerns arise regarding deploying lithium-ion batteries and solar panels, which can be toxic and hazardous waste with environmental consequences if they aren't properly disposed. Panels and batteries that are part of this program could be carefully inventoried, and part of the reimbursement should be given when they are properly disposed of in a certified facility at the end of their timeline. Anyone could receive this reimbursement, not necessarily from the original investor.
5. **AC or DC equipment:** A decision must be made regarding the type of devices consumers could use in these microgrids. DC-adapted devices reduce the costs of microgrids since they do not require inverters, which constitute a significant share of the cost of these assets. Nonetheless, although these devices exist, they are not common, and a considerable coordination policy would be required to establish standards.
6. **Technical standards:** Clear technical standards should be issued for the installation and reliability of the service. For example, although a three-hour interruption in service per year is a reasonable standard in an interconnected system, the cost of achieving this in a remote area is enormous. Probably a lower reliability standard, for instance, 90% of the time, would be acceptable in terms of cost.
7. **Innovative schemes:** The call for proposals may foster innovative solutions using digitalization, new payment methods and new distribution grid management and act as pilot initiatives for further improvements and reforms in the distribution institutional framework, as planned by the modernization of the power sector.
8. **Coordination with other policies:** A least-cost or maximum approach would coordinate other Brazilian government policies, including subsidies to productive activities, telecoms and banking access. As electricity is a development vector, integration and coordination with other public policies would avoid unnecessary subsidies to the electricity sector.

³⁸ Examples may be seen in IDEEAS' Luz para uma Vida Melhor. http://www.ideaas.org.br/?page_id=262



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