XINGU INDIGENOUS TERRITORY CLEAN ENERGY PROJECT

How renewable energy can benefit the Indigenous Territory of Xingu

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iema
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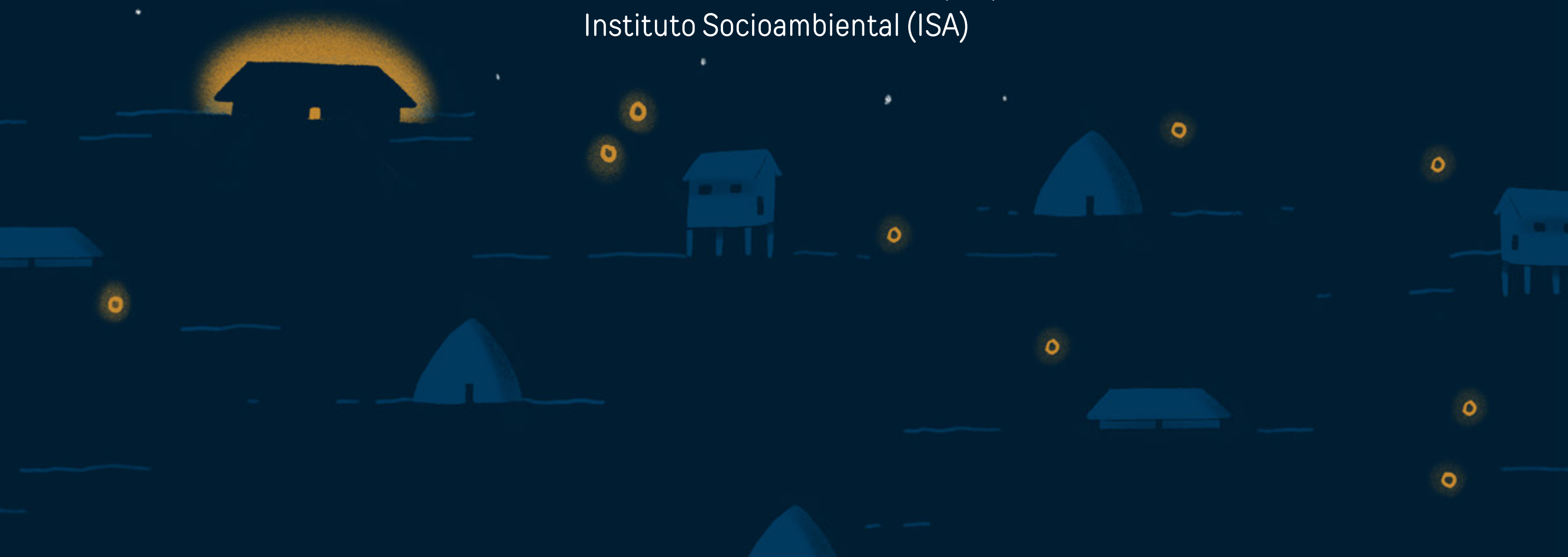


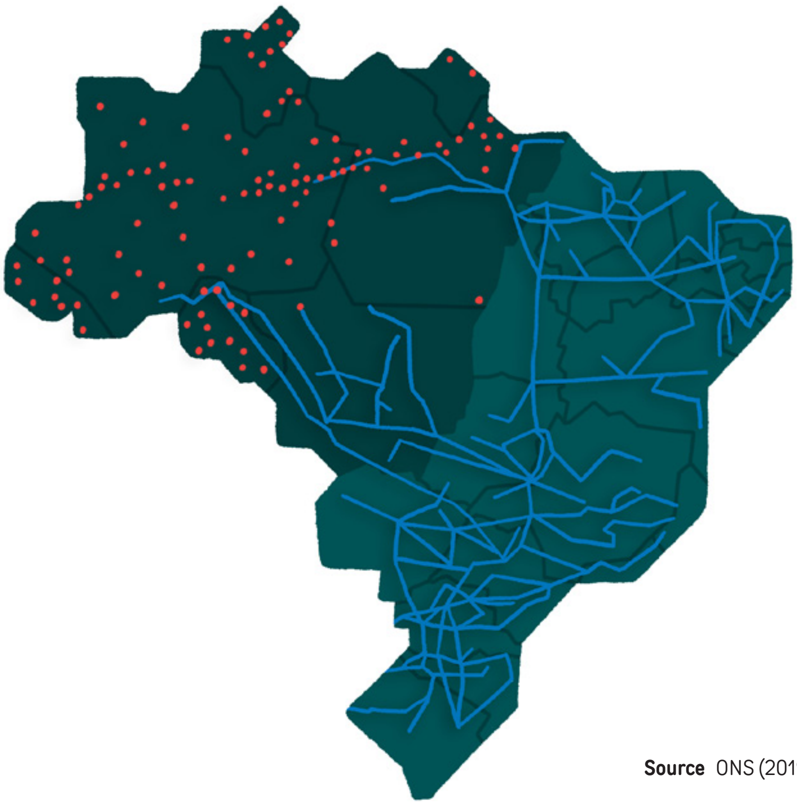
HOW ENERGY IS SUPPLIED TO BRAZILIAN HOUSEHOLDS

The electricity consumed by the majority of Brazilians (roughly 98% of the population) is supplied through the National Interconnected System (SIN), a combination of facilities and equipment that supply electric power. The SIN is currently present in all Brazilian states except Roraima (map bellow). In Roraima, electricity is supplied through Isolated Systems and a transmission line from Venezuela.

Map of locations served by the public electricity supply

Transmission network for the National Interconnected System (SIN)

Location of the Isolated Systems in the Brazilian territory



Source ONS (2019)

Isolated Systems are defined as public service systems for distribution of electric power not connected to SIN (Decree no. 7,246/2010). Most of them are located in the Amazon Region (map above). Over 3 million people are serviced by this network, 97% of the installed capacity comes from diesel generators. This causes the emission of three million tons of CO_2 equivalent per year, which is more than all automobiles in the city of São Paulo emit [1].

1. Inventory of Atmospheric Emissions from Passenger Road Transportation in the City of São Paulo (IEMA, 2017).

Although this is a responsibility of distribution companies, in 2003 the Federal Government implemented the "National Program for Universal Access to and Use of Electric Power – 'Luz para Todos' [Light for All]", with the purpose of accelerating universal access to electricity in the rural environment (Decree no. 4,873/2003). The program currently funds system installation, particularly in remote regions, but distributors remain responsible for system operation and maintenance.

In 2018, the Luz para Todos Program (LpT) was renovated for the 2019–2022 cycle, with the purpose of supplying electricity to up to two million people in the country who still do not have access to it. Indigenous and quilombola[2] communities and extraction reserves workers are top priority (Decree no. 9,357/2018).

2. These are ethnic groups composed mainly by African American population self-defined through specific relations with the land, family, territory, heritage, tradition and their own cultural practices.

IN THE DARK

There are people who have no access to electricity. This means that they are neither serviced by SIN nor Isolated Systems. Most of them live in small communities with low demand for energy, isolated from municipal headquarters, which characterizes them as "remote regions" (Decree no. 7,246/2010**). The obligation to provide these citizens with access to electricity is undertaken by distribution companies responsible for the concession area where these communities are located, as determined by** Law no. 12,111/2009**.**

98% of all electric power is supplied through the National Interconnected System

3 million people have access to electricity through Isolated Systems

97% of the installed capacity in Isolated Systems comes from diesel generators

HOW THE COST OF SERVICE IS DISTRIBUTED

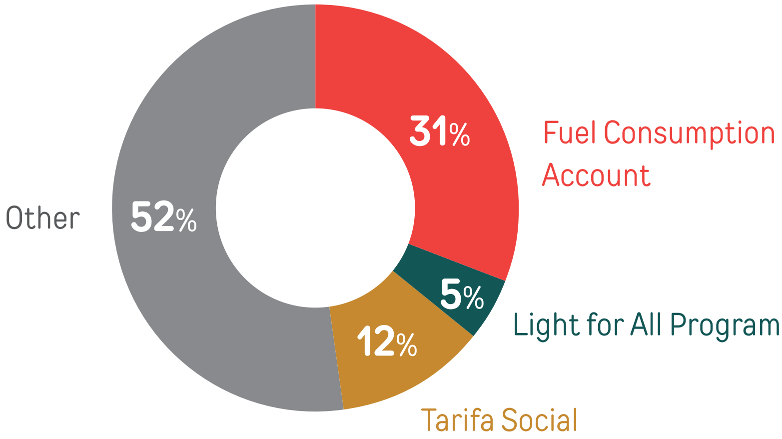
The cost of power (R$/kWh) generated in Isolated Systems and remote communities may be higher than the average cost in the SIN. This is because most of the systems outside the SIN rely on fossil fuel generators, like diesel, resulting in recurring costs related to fuel purchase and transportation, as it often needs to travel long distances to reach very hard to access areas.

In an attempt to make the cost to consumers in isolated and remote systems consistent with the amounts paid by consumers served by the SIN, the Fuel Consumption Account (*Conta de Combustíveis Fósseis* – CCC) was created under Brazilian Law no. 8,631/1993 (and more recently amended by Law no. 13,360/2016). Through this account, consumers in Isolated Systems get to pay less, as the resources from CCC are used to repay distributors for the difference between real cost of service and the amount paid by consumers. As a result, the tariff charged by distribution companies does not include the additional costs that would lead to higher tariffs.

On the other hand, CCC funds originate from the Energy Development Account (*Conta de Desenvolvimento Energético* – CDE), one of the sectoral taxes passed on to all power consumers in the SIN, created by Brazilian Law no. 10,438/2002 and more recently amended by Law no. 13,299/2016. CDE resources are also used to fund the Luz para Todos (LpT) program, as well as other subsidies such as *Tarifa Social* [Social Tariff], which applies discounts to the energy tariff paid by low-income families, indigenous communities and quilombolas.

The CDE budget is established by the Brazilian Electricity Regulatory Agency (ANEEL) at the beginning of every year. See (Image 3) the 2019 CDE budget, the highlight being the shares of CCC, LpT and Tarifa Social:

2019 CDE Budget



Total CDE budget for 2019 is R$20.2 billion, most of which (31%) corresponds to the CCC, while funding for Luz para Todos accounts for 5% and Tarifa Social for 12% of the total. Total budget and the respective shares of these subsidies had no significant variation from 2018 to 2019.

Fossil fuel generators entail recurring costs related to fuel purchase and transportation

The energy generated in Isolated Systems and remote systems can be more expensive than the average seen in the Interconnected System

ABOUT THE XINGU INDIGENOUS TERRITORY CLEAN ENERGY PROJECT

The local population was trained to install, operate and maintain the solar panels

In addition to these systems subject to the regulations of the Brazilian energy sector, other systems have been implemented through private initiatives of the communities (frequently using low-cost gasoline generators) as well as non-profit and public healthcare institutions. The systems installed by the Socio-environmental Institute (*Instituto Socioambiental* - ISA) in the Xingu Indigenous Territory (*Território Indígena do Xingu* – TIX), through the Xingu Indigenous Territory Clean Energy Project, are a good example.

In this case, the institute installed 70 photovoltaic systems – which generate energy from sunlight – in 65 communities up until March 2019. The Institute also offered training programs to teach the local population how to install, operate and maintain photovoltaic systems. The communities were actively participating in the installation procedures as part of the training process .

Photo Letícia Leite / ISA

Installation of solar panel during activity of the solar energy course in the Piyulaga community, from the Waurá people.

The Xingu Indigenous Territory Clean Energy Project project installed 70 photovoltaic systems in 65 communities up until 2019

This project is important because electricity supply in the TIX is very limited, and when available the energy used is supplied by systems fueled by diesel or gasoline, either acquired by residents or provided by the Special Department for Indigenous Health (*Secretaria Especial de Saúde Indígena* – SESAI) of the Brazilian Ministry of Health. Energy is important in making sure that the community's needs are met, in addition to other important uses such as cooling medication and vaccines, for example.

However, oil-derived energy sources involve issues such as loud noise during operation, greenhouse gas (GHG) emissions and logistics and financial challenges in acquiring fuel, which may result in lack of supply and limited operation time. In an attempt to find a solution for the community's energy needs and, at the same time, reduce their dependence on fuels, the Xingu Indigenous Territory Clean Energy Project has four main goals:

1. **Become a benchmark project for the implementation of renewable energy sources as a means to increase access to electricity;**
2. **Provide technical training to local representatives, increasing the autonomy of communities and reducing the risk of accidents linked to electricity use;**
3. **Develop community strategies for the use and management of energy supply;**
4. **Identify gaps in public policies to support and demand their revision, coming up with versions that are more compatible to each local reality.**

It is important to point out that the project's initial goal was not to meet all current energy needs. The photovoltaic systems installed are small in size (mainly 280 Wp), therefore the use of diesel or gas generators is still present. Still, the installation of photovoltaic systems made it possible to increase energy availability without noise, fuels or greenhouse gas emissions.

In addition, even though the government is responsible for guaranteeing universal access to electric power, it is important to highlight the value of pilot projects such as Xingu Indigenous Territory Clean Energy Project. The project explores the possibilities for ensuring appropriate service that is integrated to the local reality and uses sustainable solutions that are compatible with the region.

SOCIAL, CULTURAL AND BEHAVIORAL IMPACTS OF SOLAR ENERGY IN THE XINGU REGION[3]

The Institute for Energy and Environment (*Instituto de Energia e Meio Ambiente* – IEMA) performed a qualitative and quantitative study of the results of the Xingu Indigenous Territory Clean Energy Project to evaluate how local social, environmental and behavioral aspects were affected by the increased access to electricity. Agents involved in the project were interviewed for the study: participants of the training programs, indigenous leaders, and ISA partners and team. The goal was to perform an initial evaluation. Note that the analysis presented herein must be carefully considered, since the solar energy systems had only been installed for a year at the time, and interaction between the communities and the use of electricity is constantly evolving.

To carry out the analysis, IEMA went on two field trips to TIX, in July and September 2018, with visits to 15 villages, eight of which had photovoltaic systems installed and seven of which had not. The institute also interviewed 117 community representatives through pre-structured questionnaires. The villages were selected to allow for comparison between the results of groups with and without solar panels. The paired data methodology for variable analysis was applied. Few studies have been performed on indigenous land using this approach, therefore it is expected that this first experience be improved and used in future work, with even more comprehensive samples.

3. The results laid out in this report are more thoroughly discussed in the reports "Analysis of the social and environmental impact of introducing renewable energy sources in the TIX" [Avaliação de impacto socioambiental da introdução de sistemas fotovoltaicos no TIX] and "Lessons and challenges from the implementation of solar photovoltaic technology at TIX" [Aprendizados e desafios da inserção de tecnologia solar fotovoltaica no Território Indígena do Xingu]. Available at: www.energiaeambiente.org.br

Interviews revealed that the increased supply of electric power enabled an expansion in the use of small devices, such as mobile phones and flashlights. It also made certain activities easier, such as nighttime classes. The advantages of the photovoltaic system compared to diesel were reported as lack of noise, easier maintenance for not having mobile parts like the diesel generators[4], and the fact that it does not require fuel. The training programs for system operation and local participation in the installation process were also mentioned as positive aspects of the project.

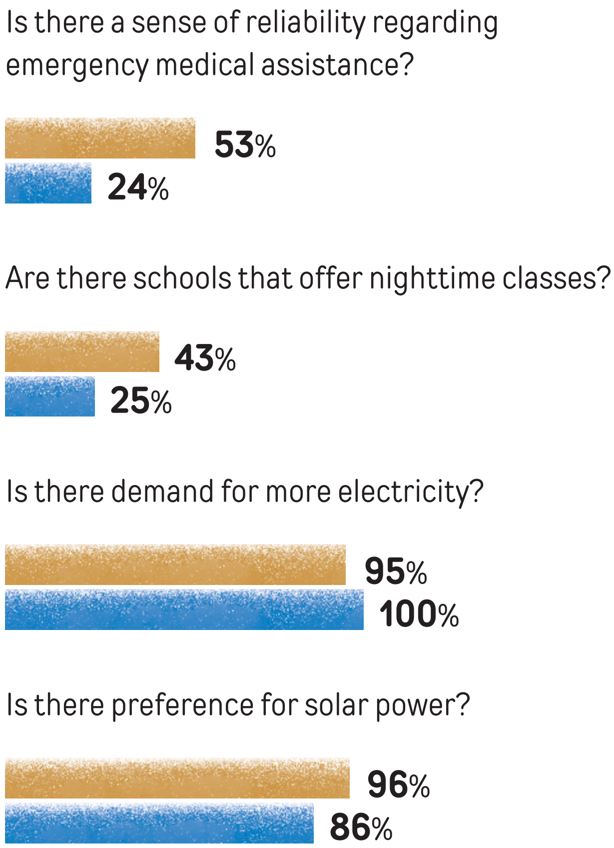
Interviewees of each group either disagreed or were aligned with regard to a few topics. See the comparison between the interview results:

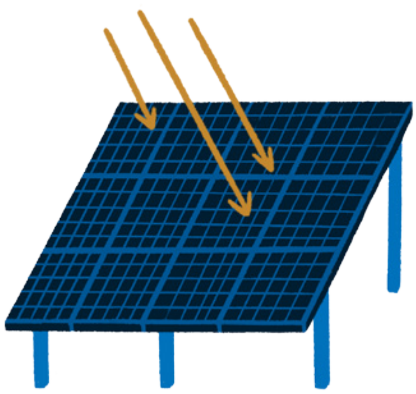
4. The diesel generators used there are also very worn out.

Percentage of interviewed locals who anwered "yes" to the questions

Communities with solar power

Communities without solar power





As previously mentioned, most of the communities without solar power rely on public or private fossil fuel generators. This explains, for instance, the existence of nighttime classes in communities without solar power. A comparison between the community groups reveals an increased perception of safety in emergency medical assistance in the communities with solar power. The availability of nighttime classes is also higher in that group. In both cases, the interviews reveal that there is still a significant amount of repressed demand, as well as a preference for solar power over other sources.

PROJECT FIGURES

2
field trips to TIX by IEMA

15
villages visited in 2018

8
had photovoltaic systems installed

7
only had diesel generators or not even those

117
community representatives were interviewed

Few studies have been carried out on indigenous land using the methodology applied in this work

Solar energy is preferred over other sources

THE COST OF EACH ENERGY SOURCE[5]

Photo Felipe Barcellos / IEMA

Sunset at the Suyá-Missu river, located at TIX.

In addition to the qualitative analysis, electricity demand and supply scenarios in all of the Xingu Indigenous Territory (TIX) were identified for an evaluation of the costs involved in investing in solar energy and subsidizing the operation if the service were provided through public policies in the energy sector. Energy in the TIX is not currently generated inside the framework provided by these policies or subsidies established by regulation. The solar panels were installed by ISA and the Ministry of Health, or the community itself, are responsible for maintaining the diesel generators.

As this is one of the first studies ever made on Xingu Indigenous Territory Clean Energy Project, cost estimates regarding the implementation and operation of solar panels are somewhat limited. The limitations include: not considering seasonality in energy consumption; definition of standard consumption for different consumer units; and using simplified formulations, stages and values. This means that the purpose of this analysis was to provide initial data on the amounts involved in providing this service to the communities, based on the information available from the Xingu Indigenous Territory Clean Energy Project.

5. The results laid out in this report are more thoroughly discussed in the report "Lessons and challenges from the implementation of solar photovoltaic technology at TIX" [Aprendizados e desafios da inserção de tecnologia solar fotovoltaica no Território Indígena do Xingu]. Available at: www.energiaeambiente.org.br

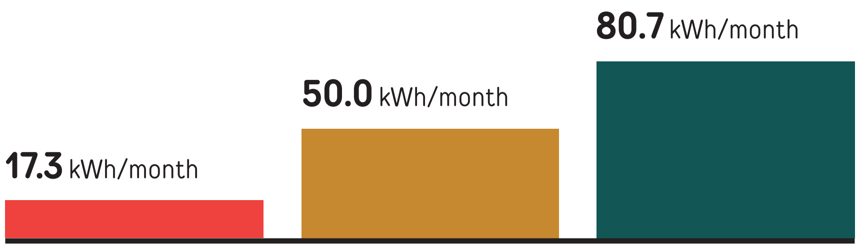
The project analyzed the costs of three options: diesel system, solar power and both technologies combined

The solar system showed an economic advantage in the long run. It was followed by the hybrid system, which also provided energy safety

Three electricity consumption scenarios were defined. Each includes monthly consumption amounts for family units and for each type of "building" in the TIX – settlements, associations, water pumping, production equipment, schools, community areas and Basic Health Units.

See the definition of each scenario and the respective average monthly consumption of a family unit:

Family Unit Consumption



CURRENT SCENARIO
Based on equipment currently available at the average village.

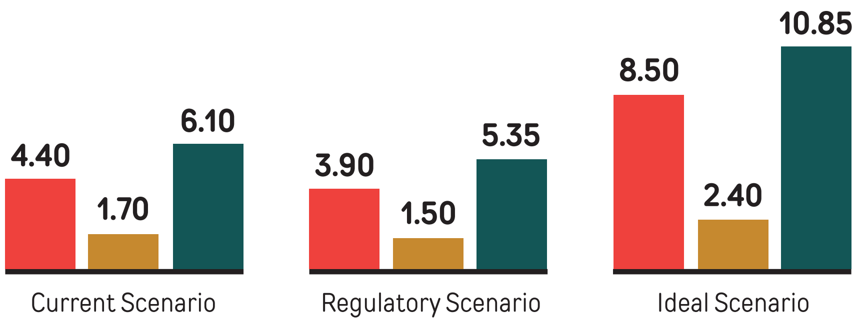
REGULATORY SCENARIO
Defined in accordance with the payment exemption limit in indigenous communities, based on Tarifa Social.

IDEAL SCENARIO
Developed in accordance with the forecast of use and purchase of new equipment obtained in the field, with samples of households with the highest consumption today.

Cost of service using solar, diesel and hybrid generation was compared in all three scenarios. The latter considered an investment in both systems to guarantee full supply, even in rainy months. After all, solar panels need sunlight to generate energy.

The analysis was based on the value of equipment according to the systems installed in the TIX, external references showing the average cost of electric energy generation equipment, current fuel prices and the regulations in force in the energy sector. See the initial investment required in each scenario to supply the entire TIX (R$):

Initial investment required in each scenario to supply the entire TIX (millions of R$)



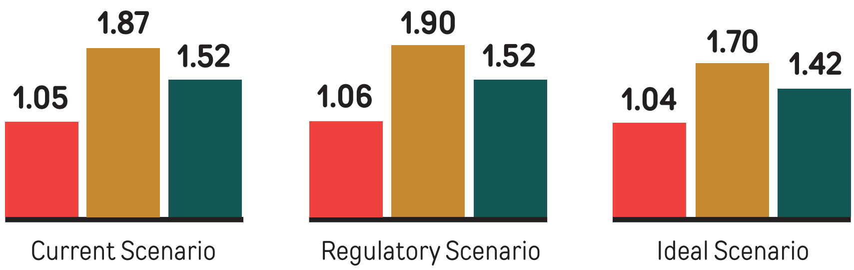
Solar
Diesel
Hybrid

At first glance, data points to an advantage in using diesel technology compared to the solar source. This is due to a lower acquisition cost. The hybrid option has even higher costs, as it includes both types of system. However, for an appropriate economic comparison between the technologies, it is paramount to consider the operating expenses incurred over the course of the system's life cycle.

As such, the analysis considered an estimated cost of generation for each unit and each technology. This included all expenditures incurred in the operation and all generation over the course of the 25-year life cycle of the systems.

Energy cost estimate (R$/kWh)

Solar
Diesel
Hybrid



For a single technology, price variation in each scenario is due to the dissolution of fixed costs, regardless of the scenario, into different amounts of energy generated. As a result, scenarios with higher energy availability tend to be more cost-efficient and therefore entail lower energy costs.

Photo Natália Branco

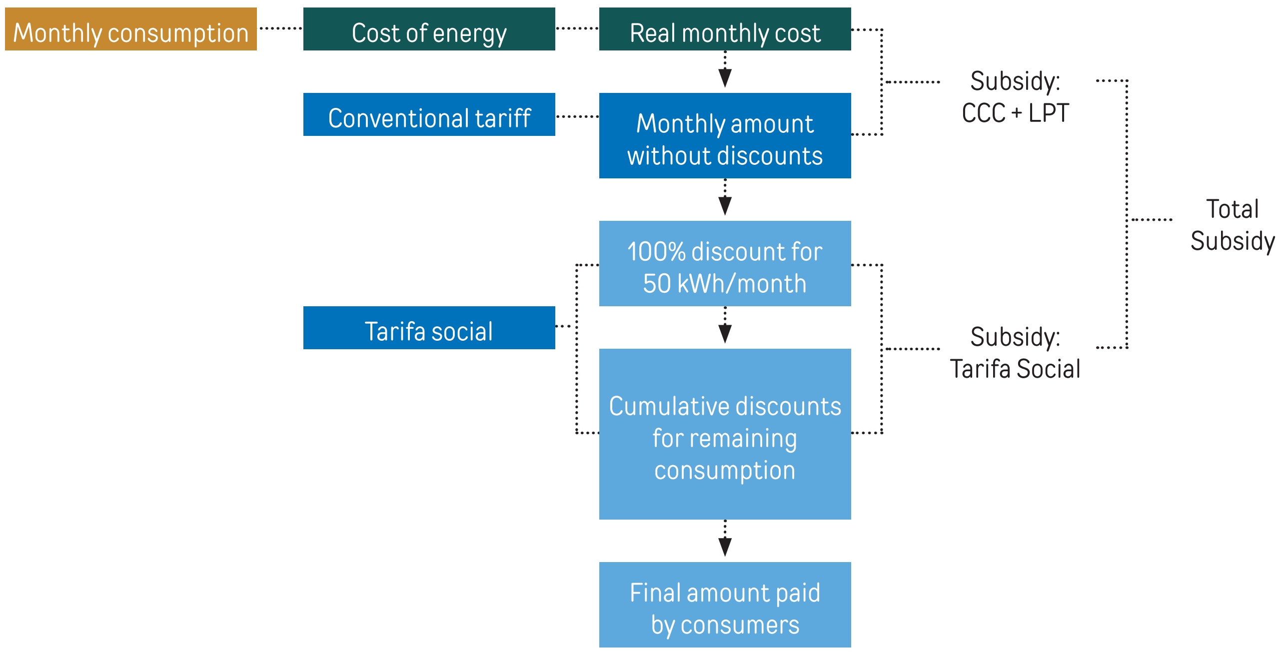
Indigenous household in the Moygu community, from the Ikpeng people. At the Xingu region, one residence is shared by ten people on average, but this number can go up to forty people in the same household.

It is estimated that up to two million people still have no access to electric power in Brazil

In addition, since the analysis considers both the cost of investment and operations, results show that solar generation offers the best value for money of all three options in the long term, and that the hybrid alternative would also be less costly compared to diesel, despite the higher initial investments required in both cases.

The subsidies (via LpT, CCC and Tarifa Social) that would be paid for by all other Brazilian consumers were also analyzed. For that analysis, the real cost estimated to service the whole TIX was compared to the amount that would be effectively paid by the consumer units. The diagram shows the incidence of subsidies in a remote community between the real cost of service and the final amount paid by consumers:

Incidence of subsidies in energy tariffs in indigenous communities:

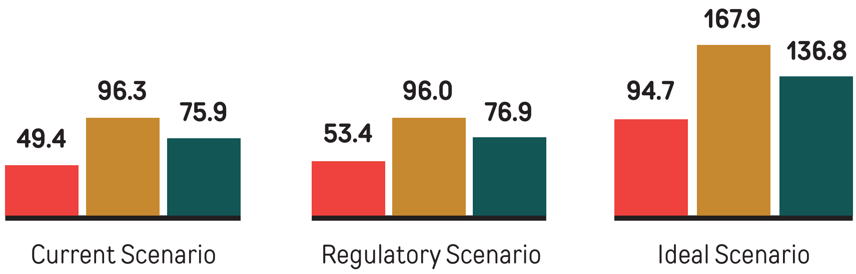


Real monthly cost in each scenario can be calculated based on the aforementioned energy value and respective monthly consumption. The difference between this amount and the one valued by the conventional tariff is covered by funds from the LpT program, which supports the initial investment, and by CCC funds, which cover some of the operating expenses. Moreover, in indigenous communities, payment is exempt for consumption of up to 50 kWh/month, due to Tarifa Social, with successive discounts for consumption above this level. Total monthly subsidy can be calculated by adding these portions together.

See bellow the scenario comparisons, i.e. the monthly subsidy amount required for the entire TIX in each scenario and technology combination(R$/month):

Monthly subsidy amount required for the entire TIX (thousand R$/month)

Solar
Diesel
Hybrid



The use of solar energy instead of diesel generators in the TIX could save more than R$73,000 per month in subsidies. Potential savings in subsidies from the use of solar energy in remote communities nationwide are even more significant considering that the TIX population is only 7,000 people and it is estimated that up to two million people still have no access to electric power in Brazil.

However, it is important to consider that the analysis presented here is based on aspects pertaining to the reality of TIX. Parameters of cost and solar resource should vary from one location to the other. Still, the savings potential demonstrated in this analysis justifies more comprehensive studies on the use of renewable sources in the process of guaranteeing universal access to electric energy.

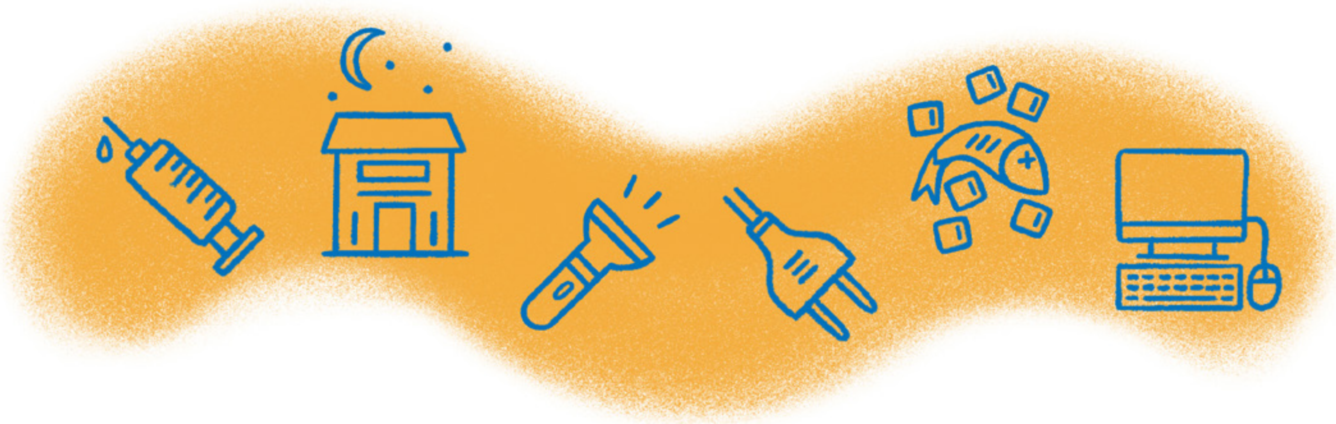
UNDERSTANDING TARIFA SOCIAL

Tarifa Social is a discount in electricity bills for families registered in the Unified Registry [Cadastro Único] and people who receive the Continued Social Assistance Benefit (BPC). It is granted progressively based on energy consumption range. Indigenous and quilombola families with a per capita income of up to half the minimum wage are entitled to a 100% discount in electricity bills, up to a consumption limit of 50 kWh/month.

Source Ministry of Citizenship

MAIN CONCLUSIONS

Access to electric power can provide a series of benefits to communities, such as guaranteeing the cooling of vaccines, venom antiserum or food, pumping and storage of drinking water, as well as enabling the expansion of productive, cultural and educational activities in indigenous and traditional communities. To achieve universal access in the best way, leveraging all of these benefits, it is important to develop implementation models that promote community inclusion and public policies in the electricity sector must adjust to local realities.



This is why projects like Xingu Indigenous Territory Clean Energy Project are important. They are laboratories to collect data and try out possibilities for service provision in remote regions. The ongoing evaluation of projects, given the evolution of the relationship between communities and electric energy, is another important tool for improving public policies targeting service expansion. Connecting with government representatives through the experiences seen mainly in the Luz para Todos program can also play a significant role in securing advances in service quality, adjustment to local realities and monitoring of social and cultural impacts.

Photo Felipe Barcellos / IEMA

Community health center served by the Xingu Indigenous Territory Clean Energy Project at the Capivara community, from the Kawaiweté people

Another option for residents of remote areas to have access to electricity and become independent for system operation and maintenance is to consider different paths, such as establishing a local legal entity to be in charge of the service. This option would allow for greater local autonomy. On the other hand, the bureaucracy of it would take its toll. An interesting option would be to gradually increase the level of engagement in these communities while clarifying the feasibility and details of this format, in order to develop an optimal service model.

Results also show that there is an opportunity to make access universal through renewable energy sources. This would have a lower social and environmental impact and reduce costs for the communities and society. In this regard, it is imperative that we consider the possibility of having different solutions for each location, always examining supply alternatives using technology that is appropriate to each location, people and culture.

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