Analysis of the Off-Grid Solar Energy Implementation in the Aracari Community in Novo Airão - Amazonas

Andreza Pinto de Oliveira
andrezaoliveiratt@gmail.com
FAMETRO University Center – Brazil

Fabiana Rocha Pinto
fabiana.floresta@gmail.com
Engineering Coordination at FAMETRO University Center – Brazil

David Barbosa de Alencar
david002870@hotmail.com
Galileo Institute of Technology and Education of the Amazon – ITEGAM

Gisele de Freitas Lopes
gikalps@gmail.com
Galileo Institute of Technology and Education of the Amazon – ITEGAM

Abstract

The challenges of bringing electricity to isolated communities in the Amazon are extremely complex, especially due to their large territorial extension. However, photovoltaic solar energy technology becomes a viable alternative for electrification of isolated regions. In view of this possibility, the concessionaire responsible for the distribution of electricity in the state of Amazonas, Amazonas Energia, prepared a project and implemented photovoltaic generation and distribution systems in twelve communities, located in six municipalities in the Amazon. Therefore, this research aimed to present the analysis of the off-grid photovoltaic system project, which aims at serving the Aracari community in Novo Airão - AM, as well as its positive and negative impacts after the project implementation, considering the tripod variables. of sustainability. The analysis of the results showed that the installed system presents major problems in relation to maintenance, a situation attributed to the lack of resources forecasting and disarticulation of this initiative with public policies aimed at social, economic and environmental sustainability. Consequently, the installed system cannot meet the potential demand of the community, since due to the lack of maintenance and operation services, it caused the system to be interrupted, in which there was a power outage in the mini plant, rendering it inoperative.

Keywords: Photovoltaic system; Isolated communities; Sustainability Tripod.

1. Introduction

Given that Brazil is one of the richest countries in natural resources in the world, there are still countless families living on the margins of social inclusion, even without using basic resources, especially electricity. The state of Amazonas, in the northern region of the country, has a large number of communities in this situation, characterized by small groups of people, with low commercial activity, in areas difficult to reach due to the geographical peculiarity, making conventional energy interconnection impracticable.

For the improvement of citizens' quality of life, the availability of electricity through public services and equipment is of utmost importance. In rural communities, electric power facilitates access to public social, educational and health programs, thus providing opportunities for human development, health and family income.

Considering this need, Amazonas Energia, an energy concessionaire in Amazonas, in conjunction with the Ministry of Mines and Energy - MME, elaborated a project that aims at serving households located in remote regions of the interior of the State, using energy generated in photovoltaic systems as an inducing component of economic, social and environmental development.

The deployment of solar power generation systems has numerous advantages compared to other energy sources, making it a viable alternative for energy viability in communities without access to energy, aiming to respond to the tripod of sustainability. Solar energy has the facility of being installed anywhere, being able to generate electricity at the point of consumption. In addition, unlike other energy sources, it can be installed throughout the national territory, being rural and urban areas.

Many Brazilian homes have been serviced by the Luz para Todos (Light for All) Program, established by the Federal Government in 2004, through the creation of MME Ordinance No. 60/2009, which enabled the development of electrification projects using renewable energy and new technologies. , mainly targeting isolated Amazon communities.

Isolated communities, according to [1], are on the margins of Brazilian economic life and socially excluded. Most of them suffer from a lack of essential services and other basic conditions for citizenship and its members, such as access to energy and its benefits.

These communities live in isolated places in the Amazon region, which makes it impossible to receive resources, such as electricity, not enjoying the various services offered by this condition [2]. It is estimated that more than two million people in the Amazon live without access to electricity [3], where most of the places where there is electricity only exist through social and environmental alternatives that do not come from the conventional means provided by large distributors. power.

An important alternative that has been considered to guarantee electricity to isolated communities and to provide better quality of life, allowing the valorization of life in the rural environment and economic development, is the implementation of electricity systems from local resources, having as example the harnessing solar resources [1].

The first applications of space and satellite technology occurred between the 1950s and 1960s. Subsequently, applications in the telecommunications sector emerged in the 1970s, and finally in the 1980s solar energy began to become interesting given the decline price, to provide electricity to users far from conventional electricity infrastructure.

Thus, in the 1990s photovoltaic systems were consolidated as an economically viable technology to supply energy in isolated systems [4]. It is noted that the alternative to supply electricity using photovoltaic systems in isolated systems is interesting due to the high costs incurred in the construction of electrical infrastructure to distant places and, in most cases, places with low charge density [5].

The direct conversion of solar energy into electrical energy occurs by the effects of radiation on certain materials, particularly semiconductors. These include thermoelectric and photovoltaic effects. The first is characterized by the emergence of a potential difference caused by the joining of two metals under specific conditions. In the second, the photons are converted into electricity through the use of solar cells [6].

Among the various processes of harnessing solar energy, the most widely used today are water heating and photovoltaic power generation. In Brazil, the first is found most in the South and Southeast Regions due to climatic characteristics and the second, in the North and Northeast Regions, in communities isolated from the power grid [6].

The use of the solar source in the generation of electric power provides benefits, cited by [7]. From an electrical point of view, the author cites the contribution to matrix diversification, increased security of supply, reduction of losses and relief of transformers and feeders. From an environmental point of view, there is a reduction in greenhouse gas emissions, the emission of particulate materials and the use of water to generate electricity. Regarding the socioeconomic benefits, photovoltaic solar energy generation contributes to the generation of local jobs, increased revenues and increased investments [8].

The photovoltaic power system, also known as solar energy (off-grid), is a model in which its components work to capture the sun's energy, converting it into energy to be used in places where conventional electricity is used. not enough or in back-up systems, the main applications are: water pumping system, rural electrification, fence electrification, lampposts, telecommunication systems, radars, health clinics, vaccination refrigerators, among others [9].

Therefore, the objective of this study is to analyze the deployment of off-grid photovoltaic solar energy in the Aracari community in Novo Airão - AM. Considering also the description of the experience of Amazonas Energia - AmE and Guascor / Kyocera Consortium in the implementation of mini plants and mini grids through solar panels in isolated communities, in order to evaluate the positive and negative impacts on social, economic and environmental aspects. after project implementation.

2. Material and Method

The analysis was performed in an isolated rural locality, called Aracari community, about 125 km away from Manaus, located on the left bank of Rio Negro, municipality of Novo Airão - AM, with coordinates (S) 02 ° 22 '. '7.8' 'and (W) 61 ° 05' 08.3 " (Figure 01).

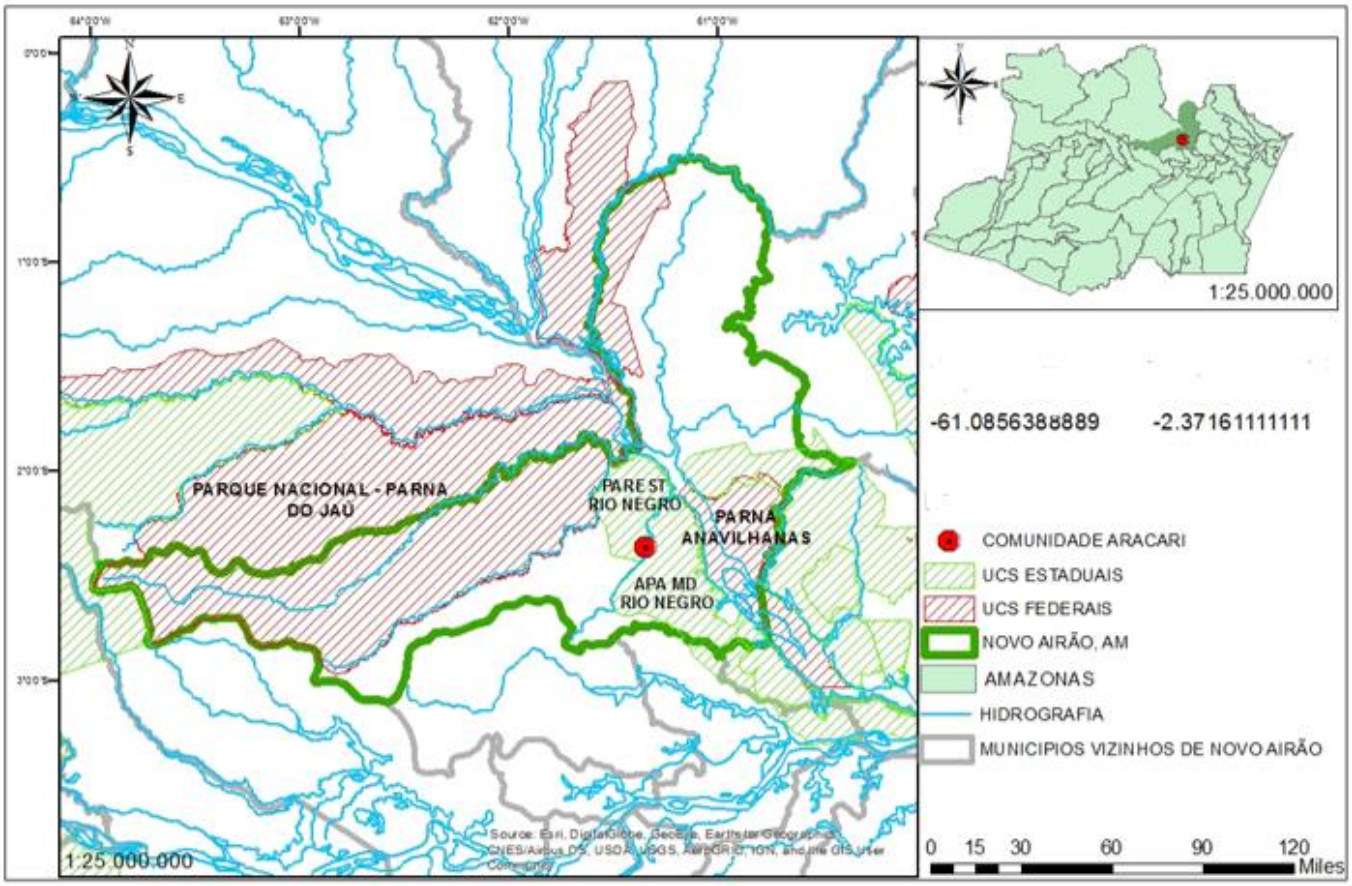

Figure 1 - Aracari community location map
Source: Own authorship, 2019.

The descriptive methodology was used, using the elaboration of an analysis, considering the variables of the sustainability tripod. According to [10], descriptive research seeks the cause-effect relationship between phenomena, facilitating the power to describe the complexity of a given hypothesis or problem, as well as analyzing the interaction of variables, understanding and classifying dynamic processes, presenting contributions in the price of the problem. changing the system, creating or forming opinions of a particular group and allowing the interpretation of the particulars of the behaviors or attitudes of individuals.
The analysis aimed at the relation between the project conception, using the photovoltaic energy in the referred community and the monitoring of the system functionality. The "Luz para Todos" program, instituted by the Federal Government in 2004, has been seeking alternatives to bring electricity to families living in isolated regions, providing minimum living conditions for the population.

3. Results and Discussion

The creation of Ordinance MME (Ministry of Mines and Energy) No. 60/2009 - Manual of Special Projects of the Luz para Todos Program, led to the elaboration of electrification projects using renewable sources and the use of new technologies. From the creation of the referred Ordinance, the Ministry of Mines and Energy - MME, having the survey of some rural communities without electrification selected 30 communities, to verify the possibility of implantation of the project that consisted of the implantation of

mini solar panels networks, being verified at the end observed the impossibility of implantation due to technical characteristics.

Amazonas Energia, which had participated with the MME in the 15th visit of the 30 communities, suggested a new listing to the MME to verify the implementation of special projects, defined in 13 communities at the end. These communities were distributed in six Amazonian municipalities. After the selection were sent to the MME necessary information for the development of the special projects, authorized by the MME the project development.

Amazonas Energia made formal requests to the financing agent of the "Light for All" Program, ELETROBRÁS, and forwarded the necessary documents, obtaining in November 2009 the financing approval. In that same period, ELETROBRÁS obtained from ANEEL through Resolution No. 2,150 / 2009, authorization to implement, in a pilot service character, the 13 isolated communities with the adoption of billing in the prepayment system of solar energy mineders.

The technicians of the National Light for All Program and AmE, reached this number of 13 communities that would be served, given the budget amount, which was available at the time. Visits were carried out and one was finally excluded, located in the municipality of Barcelos, called Democracy, once the community dispersed.

In order to serve these communities in remote regions, where the supply of energy through conventional distribution through transmission lines is not feasible, the proposition was due to the innovation in the system of generation and commercialization of energy, with environmental commitment, besides digital inclusion with the availability of internet access in the schools of each community.

The 12 communities were distributed in 6 (six) municipalities of the state of Amazonas: Barcelos - Terra Nova; Autazes - São Sebastião do Rio Preto; Beruri - Our Lady of Carmel; Eirunepé - Mourão and Santo Antonio; Maués - Our Lady of Nazareth, Saint Luzia, Saint Mary and Saint Joseph; Novo Airão - Aracarí, Bom Jesus do Puduari and Sobrado.

With the authorization of the regulatory agent ANEEL and the financing, ELETROBRÁS / Amazonas Energia, started the elaboration of the projects for the implantation of the 12 photovoltaic generation systems with minired distribution, where in July / 2010 it was hired the executing company, winner of the bidding process, the Guascor / Kyocera Consortium.

After data collected by AmE, a public power system was implemented with the following components: a) photovoltaic mini-plant for generation and storage; b) distribution network; c) remote monitoring system; d) prepaid energy sales system.

The base survey was conducted in the municipality of Novo Airão - Aracari community, sizing the generation system to serve the 14 Consumer Units - UC's, of this location.

The criteria used to create the project was based on: Communities with difficult physical access; high cost of O&M - Operation and Maintenance, in these communities, distance to be covered by the sector responsible for system maintenance; few consumer units within the system's range; lower long-term cost given the nature of the system; non-significant environmental impacts compared to fossil fuel power generation; and no need for an operator, given its control by the utility company remotely.

The project consists of: a rustic wooden building to be built by the community themselves, with project resources and guidance from the concessionaire's technicians, in which this building will be sheltered from

batteries, busbars, control panels and inverters; area for the installation of photovoltaic modules; low voltage distribution mini-network.

For the planned system configuration, composed of photovoltaic generator blocks, having all electrical parameters available in a power house through a control, storage and inversion system. All this information of the electrical parameters of generation, demand (mini grid), power flow, temperature, humidity, solar radiation and presence sensor are in a Remote Terminal Unit - RTU, which transmits this data via satellite to the operating center of the minis photovoltaic plants located in Manaus (Figure 2).

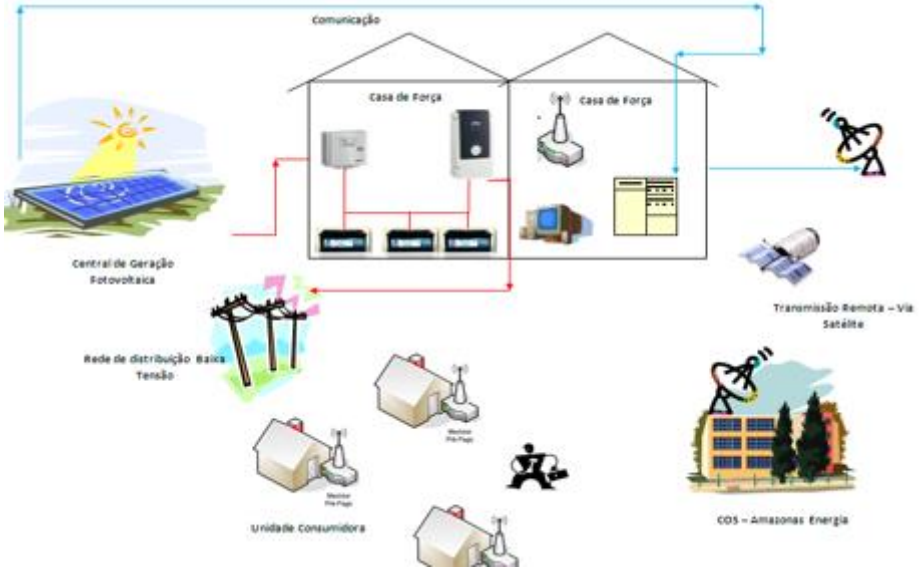

Figure 2 - System Configuration Illustration
Source: Amazonas Energia, 2011

The electricity generated is distributed to the consumer units through a 127 V single-phase distribution network with bare aluminum cables, supported by wooden poles (Figure 3).

Figure 03 - Mini network distribution network
Source: Amazonas Energia (2011)

3.1 Description of the Social, Economic and Energy Profile of the Community

The local economy is focused on fishing. There is also a small plantation of sugar cane, banana, pineapple

and a cassava plantation where families make flour for their support. There are 06 private flour houses. Electricity has existed for 07 years (1 generator of 07 kVA - artesian well - piped water and 1 generator of 13 kVA - for households - works from 19:00 to 21:00 hours - working poorly). The City Hall donates 100 l of diesel per month to the school and the community, which participates with $ 10.00 / domicile / month to buy diesel - to supplement the insufficient amount of diesel donated by the City.

The implementation of the mini photovoltaic power plant in the Aracari community had significant social, economic and environmental impacts on the community. The installed system temporarily provided access to information and the possibility of continuing education for young people and adults, because at night time increased access of residents to education and also facilitated distance education, as well as digital inclusion with the use of internet in school.

However, with the system interruption, the indefinite energy consumption became unviable. According to [11], for the project to achieve the proposed objectives, it is necessary to maintain and periodically monitor the operation. Even if the operation is unattended, there is a cost reduction, periodic preventive maintenance must be performed, because the equipment is expensive and this could render them unusable or expensive to maintain, which could make the project unfeasible and frustrate the people who had access. electricity and then back into the dark, as has happened with other projects in other communities. As the mini-plants are in hard to reach places, this is perhaps the biggest challenge for Amazonas Energia, the local energy concessionaire responsible for the project.

Regarding environmental sustainability, the generation of electricity via photovoltaic system does not cause pollution [12], but due to the complex logistics to the isolated community, it caused damage to some equipment, specifically the OPz battery, which resulted in the leakage of electricity. electrolyte, being a threat when disposed on the ground. According to [13], the manufacture of automotive batteries relies on the generation of liquid effluents. Thus, according to CONAMA Resolution No. 430/2011, effluent is the term used to characterize liquid discharges from various activities or processes.

Liquid effluents generated in the battery production process can cause serious damage to the environment if not handled correctly, causing contamination of soil and surface and groundwater, as well as damage to fauna and flora, because relevant effluents contaminated with acid are generated. sulfuric acid with low lead concentrations. It is also considered the need for proper disposal of batteries, since it is a device that causes environmental impact, if not disposed of correctly.

With regard to economic development, the system implemented was found to be economically sustainable - temporarily - and the prepayment system made it possible to make payment without the need to move from the community during its operation period [14] .

The joint and articulated work of the various municipal, state and federal government agencies is fundamental for access to energy and other public policies to be of high quality to ensure access to citizenship and to break with inequality of development in the Amazon. Interventions in communities should take place in order to increase the process of social organization, that is, to favor the process of solidarity organization among families, to favor sharing, the economy of reciprocity, the collective use of services and equipment available within the community.

4. Conclusion

For the development of a region, the fundamental requirement is to guarantee access to energy through public services and equipment. It enables access to other rights and services, adding value to products.

Access to electricity is a right of the citizen and alternative sources of energy, which have allowed more families to enter electricity, but it is necessary to continue to improve photovoltaic technology associated with the expansion of its use. offer, in the short term, even better social, economic and environmentally sound solutions for power generation in isolated rural communities.

A policy of expanding the distribution of energy must be associated and articulated with other public policies in order to universalize the social benefits and improve the quality of life of citizens living in remote regions of this country.

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