Photovoltaic energy access on riverine isolated communities in the Amazonas State

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Introduction

Electric energy is one of the biggest challenges to the development of the Amazonas’ riverine communities due to the difficulties of the interconnection logistics from these localities to the existent energy net. In addition, the expansion of the transmission lines results in the opening and maintenance of trail openings in the forest, which fragment the natural ecosystems. According to the data of the State Climate Change Center (CECLIMA/SDS), approximately 10 thousand communities and localities still don’t have access to Luz para Todos program¹ in the State of Amazonas. The energy generation situation in the 562 communities attended by Amazonas Sustainable Foundation (FAS), indicates that over 91% (514) only have four hours per day of energy from diesel generators. This data corresponds to 60 days per year for each community, with over 1.8 million of diesel liters consumed. This consumption costs over R$ 5.7 million to the institutions that acts with this public and the communitarians themselves. The Ambiental impact of this situation is the generation of over 4.5 thousand tons of CO₂ (equivalent carbon) along one year, or, average of 8.7 tons per community.

The isolated communities interconnection the electric net involves a high economic cost and significant impacts for the environment. The VillaSmart project uses the clean energy concept, which befitting to the sustainability concept related to the management of the Conservation Unities (CUs). The VillaSmart project seeks the development of a solution linked between the photovoltaic hybrid generation and thermoelectric generation (diesel) for being consumed in the isolated riverine communities of Amazonas. FAS’ initiative in partnership with Schneider Eletric, implanted two pilot unities of the VillaSmart Project in two communities of the Sustainable Development Reserve of Rio Negro: Tumbira e Santa Helena do Inglês, on June, 2012. The Centro Estadual de Mudanças Climáticas (Ceclima), the Associates of the Sustainable Communities of the Rio Negro Reserve (Rio Negro ACS), Cummins Brasil and Conin, the Serviço Nacional

¹ Luz para Todos program is set of public measures of Brazil, coordinated by Ministry of Mines and Energy, that aims to take electrification to remote areas, charging a subsidized price through Federal Government, State Government and distributors.
de Aprendizagem Industrial (Senai) were important partners of this initiative. The investments of the VillaSmart implementation in two communities were of R$ 475,000.00 (Sale’s price²).

**Objective**

The aim of this project was to test application of photovoltaic solutions at two riverine communities of Amazonas State, at Rio Negro Reserve.

**VillaSmart at Tumbira community**

At Tumbira community (http://fas-amazonas.org/street-view-na-amazonia), it was installed a set of 50 photovoltaic plates, fueled by a 32 batteries of 100 amperes, with 12kva capacity. The implanted system fulfills 17 residences, five community collective usage spaces (municipal school, communitarian center, church, public illumination), as well as the structure of the Center for Conservation and Sustainability (NCS). The NCS fulfills 180 enrolled students from the Reserve’s communities. Its facilities include bulbs, computers, printers, internet, televisions, DVDs, fridges, water bombs, among others. In this community, the generator adopted as backup of the VillaSmart system has 52HP and 30kva. Its operation occurs only when the battery boats aren’t enough charged to deliver energy to the consumption unities. These are situations expected in periods of a lot of nebulosity and consumption peaks.

The pattern of consumption at the Tumbira community was influenced especially for the 40% raise in the number of resident families. These families return from Manaus and Novo Airão due to the improvements in education, health, energy and income generation opportunities. There wasn’t, however, a raise in the number of the system’s plates and batteries. As consequence of the raise in the energetic consumption during the analyzed period from the system to Manaus (from São Paulo), bulbs, individual meters, generator house and earthing.

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² Including shipping from the system to Manaus (from São Paulo), bulbs, individual meters, generator house and earthing.
period, also affected by the seasonality (bigger nebulosity periods\(^3\)), the community consumed the monthly average of 872 diesel liters, from the daily average function of 5.8 hours of backup (generator). The VillaSmart made available 76% of the consumed energy in 24h of this community.

In case the backup worked for 24 hours, the monthly consumption would be quadruplicate. Equivalent for at least 9,300.00 per month and over R$ 112,100.00 per year (Considering the price of diesel’s price of R$ 2,59). Considering that, the payback of the investment is estimated in 5 years and the cost of acquisition of a system with those configurations is R$ 265,000.00, in less than 2 years and a half the acquisition of the system would be justified. The indicated result is promising, with economic, social and ambiental advantages for the energy generation. The services’ scope of the VillaSmart in the Tumbira community was reduced and nowadays attends the Agnello Bittencourt NCS, since the community opted for the exclusive integration of the distribution net of the Luz Para Todos Program for reasons detailed next. However, in the residents and FAS’ technicians evaluation, the VillaSmart project reached its objectives of presenting an sustainable energy generation model that can be replicated in other communities.

**VillaSmart at Santa Helena do Inglês community**

At this community, the system fulfills 16 residences and three community collective usage spaces (municipal school, communitarian center and church), beyond water pump. It was installed a set of 22 photovoltaic plates, fueled by a 24 batteries of 100 amperes, with 06kva capacity. Since the beginning of 2013, with the connection of the community with Luz para Todos Program, the VillaSmart runs with backup to this system. The mainly result was the reduction of diesel, almost zero.

The communitarians opted themselves to keep both systems running jointly, allowing new observation on consumption and energetic efficiency patters. When Luz para Todos cannot provide energy for the community, the VillaSmart system features with 8-hour

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\(^3\) In periods of bigger nebulosity, the solar plates significantly reduce the solar rays catchment and the retrieved energy in the batteries bank is used to fulfill the community. However, when the level of available energy is reduced, the diesel energy generator is actuated more times in order to balance the energetic availability, causing bigger energy consumption.
Community Management
Both Tumbira and Santa Helena do Inglês community differ especially on community infrastructure and amount of residents, 24 and 16 families respectively. Besides, Tumbira hosts a Center for Conservation and Sustainability. The outcomes are distinct regarding governance and use strategy established by any community.

Tumbira had nine community workshops to set up the internal regiment of using and management of the energy system. Santa Helena do Inglês had four workshops. The regiments propitiated better organization and management around social goods, once the goals were taken by participative way through communitarians, for example, the consumption rates, social tariff, penalties and responsibilities. All the record of the process documentation was accomplished by the communitarians.

The aim of the community management was also to sensitize and “empower” the local population regarding the energy consumption, security and installation. It provides a sense of “empowerment” through the use of the VillaSmart system.

Training for electrician agent
During the Project was conducted a training for communitarian electrician agents, an open initiative to juveniles and adults from communities of Rio Negro Reserve. The acquired knowledge allows the agents to provide installation and maintenance of low and medium complexity in equipment and networking of energy distribution. The training was a partnership of SENAI, Scheinder Eletric, Cummins and Conin.
The Energy Supply Arrangement
Before the implantation of VillaSmart, the energy used to be fulfilled from a diesel generator. The engine before the project implantation had the potency of 18HP and 12KVA, despite representing a relatively low consumption (300 liters per month), it resulted in constantly maintenance and the energy fulfill had constantly intermittent oscillation, causing damages to electric equipment. The supply used to have 5.8-hour per day of energy, mostly in the night period (figure 1).

Previously the project, the costs to generate one-hour energy at the communities was around R$ 2.87, considering expenses with maintenance and operation (15%). However, the daily availability of energy did not exceeded 5-hour, with intermittent oscillation and damages to equipment of communities.

Figure 3: Before VillaSmart project

After the VillaSmart project, the availability of energy increased in 4.5 times (the daily average is superior to 18-hour in both communities).

- At Santa Helena do Inglês community, where the system didn’t run 24 hour, the cost with diesel was almost zero;
- At Tumbira community, during the project, the VillaSmart released more than 18 from 24 hours of provided energy. The remaining supply was accomplished by diesel generator.

Both communities were integrated into the Luz para Todos program network in 2013. Santa Helena do Inglês opted for the joint system (Figure 3). At Tumbira, more populous and structured, the integration implied in the selection of only one system (Luz para Todos) to supply residences, and VillaSmart only attends the Center for Conservation and Sustainability (Figure 4).
Conclusion

- The VillaSmart solution features economic, social and environmental advantage in relation to supplied energy through diesel generation to communities isolated.
- One of the determining factors to accomplish the success in the project of alternative generation of energy in the communities is the complete involvement of residents in the full process of taking decision, formation, rebuilding the distribution network and equipment installation, with highlight to the elaboration of communitarian internal regiment to the management and use of the energy system.
- The training of 23 communitarian electrician agents contributed to a bigger involvement of young in communitarians issues and allowed improvement in the distribution network in other communities, beyond VillaSmart, in addition to a new occupation and income generation.