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RURAL ELECTRIFICATION AT THE ECUADORIAN JUNGLE A NEW MANAGEMENT MODEL, PREPAID SYSTEM

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Abstract

A new management model for rural electrification with off grid photovoltaic systems is presented. This management model is based in a prepaid meter for each house that has a photovoltaic kit, where the electrical distribution company sells days of energy to the client. This model requires that the user visits an agency at least once every two months to recharge more days. The prepaid system allows to monitoring in a better way how the systems are working and how the clients interact with the new photovoltaic kits. The advantages of this management model are on the one hand that the electrical distribution company is closer to the client and achieves a better monitoring; on the other hand the system is implemented without additional communication equipment. This is made possible by the use of a prepaid key to recharge days of energy. The system is analyzed, data about clients is presented, and the future of the project is discussed

Keywords: *Rural electrification, prepaid meter, solar home system, solar energy, off grid system.*

1. Introduction

Ecuador has 4 regions: The Sierra, The Coast, Amazonia, where the jungle is, and the Galapagos Islands. The project is developed in two provinces of Amazonia: Sucumbíos and Orellana. These provinces are some of the ones with the least access to electrical energy. Indeed, according to the last census from 2010, 73,43% [1] of the people have access to electrical energy in Sucumbíos and Orellana. Consequently the object of the present program is to increment the access to electrical energy in order to reach the government plan of 96% of the population with access to electrical energy in the rural area.

To achieve this ambitious objective a new management model for rural electrification has been developed with individual isolated "Photovoltaic Systems" (PVS) including a prepaid meter. The main objective is to be able to monitor the PVS systems without additional communications equipment and without needing anybody to travel to the houses where the PVS have been installed. Trying to avoid old practices where the systems are installed, but no proper maintenances is given to the equipment. This causes some consequences like that the photovoltaic systems get broken and people lose trust in solar energy.

The aim is to reduce cost in maintenance and give a better service to the systems that are being installed in really remote communities, some accessible only by boat or small aircraft.

One additional objective is to encourage people to be responsible for the PVS. The prepaid meter system makes people think that the electric company is monitoring them and this will help to avoid the misuse of the equipments.

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2. System Overview

The new photovoltaic systems which are being installed in communities of the Ecuadorian jungle (Sucumbíos and Orellana) have two circuits, one for the DC lighting and the other for the AC part including the inverter. It is composed of the following elements:

- 3 Solar Panels (130 Wp)
- 1 Charge Controller + Prepaid System
- 1 Inverter (700W)
- 2 LED lamps (7W DC)
- 4 LED lamps (11W DC)
- 1 Portable lamp/ cell phone charger.
- 2 AGM Batteries (300Ah 6V)

The system is based in older systems to which some improvements have been added. One of them is the LED lighting, which permits illumination without depending on the inverter as well as being more efficient. The other significant improvement is the addition of a controller and a prepaid meter, which cut the energy in the house if there are no remaining days of energy. The meter helps to have a better control of the PVS, so people paid for consumption and also functions as a data logger. The following graph shows the schematic of the Photovoltaic systems.

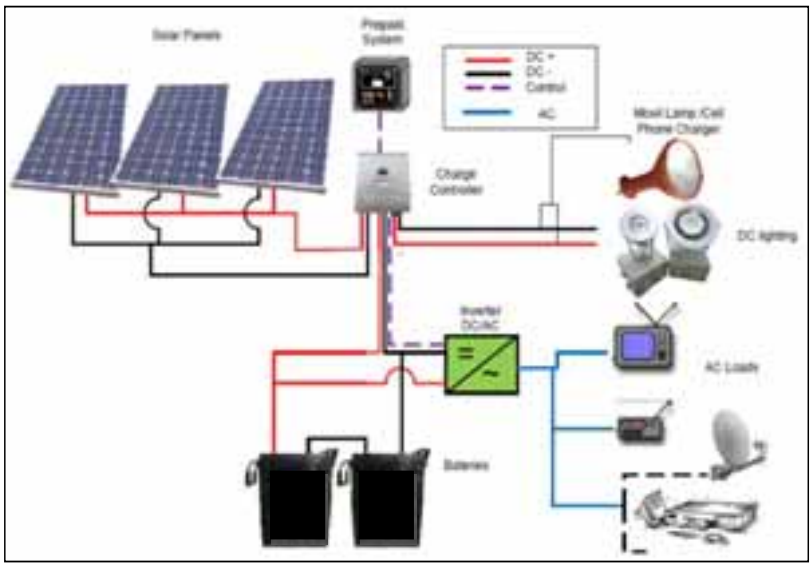

Figure 1: Photovoltaic system with prepaid meter scheme

3. Prepaid System

The prepaid system allows users to have energy for a given number of days, depending on the credit acquired. All the information of the PVS as the operation of the solar systems, how much credit is available, is saved in the prepaid system and a prepaid key. This small key permit to buy days of energy and to download the information of the PVS when it is connected to a recharge center, then new data is downloaded and additional energy days are sold to the client.

One special feature is if the user, for any reason, has no credit in the system. He could request a maximum of

10 more days until he could go to a recharge center with only pressing a button on the prepaid equipment. The credit can be acquired in any authorized recharge center. In case the prepaid key is remove from the prepaid systems, all the equipment continues to work.

The prepaid system methodology forces the people to bring the key to an authorized recharge center in order to get more days of energy. In case the prepaid system does not have days, the controller shuts down the DC lights and the inverter. A maximum of 60 days of energy can be charged in this management model. This allows the energy company to get data on the PVS at least every 2 months for better monitoring. The recharge centers are usually in the main town where people from the communities go at least one time per month for trade, medical assistance and other activities.

The main requirement for the recharge centers is to have access to internet. Indeed, it enables to save data of the different prepaid keys and send it to a main database, where it could be used for further analysis.

Among the advantages that the prepaid system presents are:

- To be able to know the production of the solar panels
- State of the batteries, voltage of battery.
- Alarms in the system, low battery, over charge, days without energy.
- How many days of energy the client has left and when was his last recharge.

3.1. Prepaid system implementation.

This new management model is already implemented in some areas around Quito and it has been installed in the Ecuadorian jungle. After the installation of some photovoltaic systems, the distribution company observes that the users come to the recharge centers at least once per month to acquire credit for their PVS. The data obtained permits us to know how the system is working and monitor the systems, consequently the customer feels more responsible with the solar equipment and the electrical distribution company has a bigger income for future maintenance and most importantly, the change of batteries after 5 years.

One of the major challenges that the project is facing is the interconnectivity of the recharge centers with the database. This is due to the fact that some of the recharge centers are in remote cities and consequently the internet connections are poor, which can prohibit getting the data from PVS. Recharge centers must have a secure internet connection for these kinds of projects to be successful.

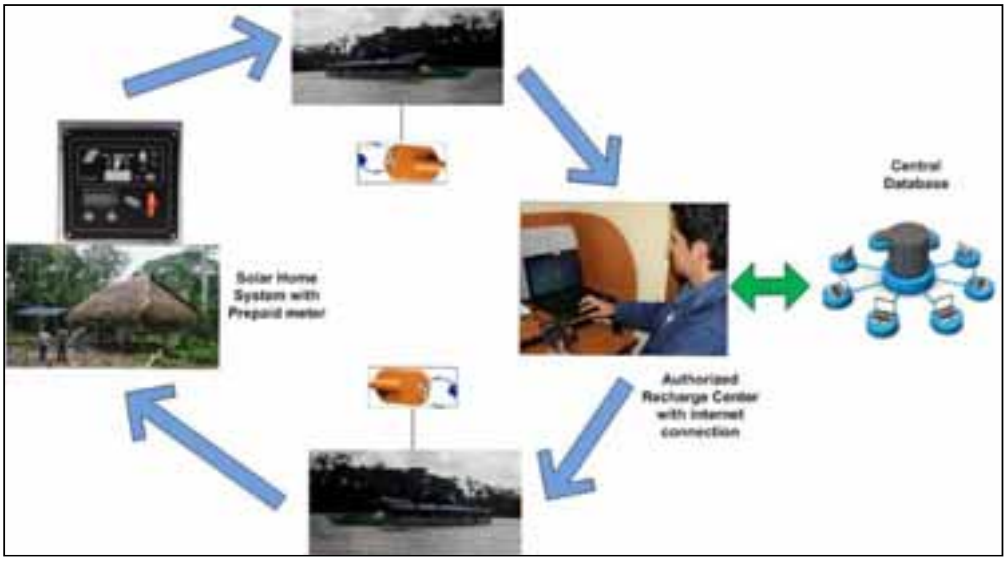

Figure 2: Prepaid system management model schematic

Figure 3: Typical installation of prepaid system and inverter.

4. The Overall Cost

The investment for each individual photovoltaic system with the prepaid meter is around $ 2400.00 which includes all the components of figure 1 and installation.

At the provinces of Sucumbíos and Orellana 500 new prepaid photovoltaic systems and 500 prepaid meters for repowering old systems, will be installed. The investment for the first phase of the project is $1,575,152.80 for the installation and purchase of the 500 new PVS and 500 prepaid systems for repowering.

The project has social interests, such as an understanding of the social costs of not having electrical energy as well as the benefits that the project will produce like:

- Savings in the cost of transportation to bring diesel for gen sets.

- Prevent migration to big cities

-Access to information and communication

-Improve the service of utilities, education, health and drinking water.

The PVS systems have an expected life time of 20 years and the batteries will be changed 3 times in the life time of the system.

5. Results

The project developed in the surroundings of Quito permit us to evaluate how the system will work in the Ecuadorian jungle. The data is obtained when the client goes to charge days on the prepaid key, the data from the PVS is downloaded to the database and we obtained the basic information to evaluate the system as shown below:

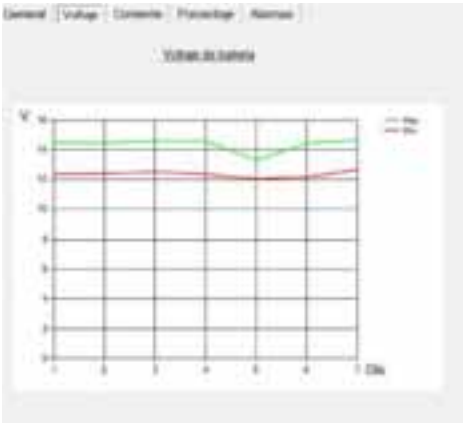

Figure 4: Battery voltage of a PVS, actual data download from a prepaid key. [2]

Figure 5: General Data of the PVS, downloaded from the prepaid key. [2]

This information allows to know if the system is operating properly, giving us an idea of the consumption and the production of solar panels. Some important information is how many times the user acquires credit for the prepaid system, which could show if the system was manipulated by the user. For example if the user does not recharge the prepaid key in more than two months, perhaps they are taking energy directly from the batteries.

The expected result in the jungle is to have a power of 195kW installed with solar power and a daily production of 780kWh. The new individual solar systems will provide electricity to around 500 families and repower 500 more systems in the Ecuadorian jungle, which are going to be monitored by the prepaid meter.

6. Conclusions and Outlook

This article presents the implementation of the prepaid system in individual photovoltaic systems for rural electrification and the expectations for monitoring in the Ecuadorian jungle.

By the end of the project 500 new PVS will be installed in the provinces of Sucumbios and Orellana, and 500 more will be repowered.

One of the advantages of the present project is that it is being carried out without additional communication lines or communication devices for monitoring. The prepaid meter and its key permit to obtain data of the PVS, when the users acquire more days of energy.

A recommendation for this type of projects is that the recharge centers should have a secure internet

connection in order to send data to the servers and the database. Additionally one person should be in charge of the database to monitor the data and observe for inconsistencies of the system.

These new photovoltaic systems allow access to electrical energy to people who live in communities at the middle of the jungle, the access to communication, a better education and an improvement in their economy.

As complement of the project new hybrid (solar-genset) microgrids will be developed in some communities, installation of solar water pumpers and solar public lighting as part of a big plan to provide electrical energy service to communities in the Ecuadorian jungle.

7. References

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[2] PHOCOS, 2014. Program PREPCOM.

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