JOURNAL LA SOCIALE

VOL. 02, ISSUE 02 (001-005), 2021
DOI:10.37899/journal-la-sociale.v2i2.329

"El Triunfo" Photovoltaic Power Plant; Rural Development Study

José Emilio Camejo Cuán[1], Rubén Ramos Heredia[1], Roger Proenza Yero[1]

[1]*Electrification Department, Solar Energy Research Center, Cuba*

**Corresponding Author: José Emilio Camejo Cuán*

Article Info

Article history:
Received 18 January 2021
Received in revised form 9 February 2021
Accepted 24 February 2021

Keywords:
Rural Electrification
Centralized Photovoltaic Systems
Local Community Development

Abstract

The results of rural electrification in Cuba, from Photovoltaic Solar Energy, are presented as part of the technical-economic feasibility study of the use of medium-power Photovoltaic Plants in tropical climate conditions, based on the experiences obtained for more than 20 years of operation of the photovoltaic plant in the rural community "Santa María del Loreto" and its generalization in the photovoltaic plant in the rural community "El Triunfo". Both facilities are located in the mountainous area of the Songo - La Maya Municipality, Santiago de Cuba Province. The photovoltaic plant benefits the inhabitants of the rural community "El Triunfo", guaranteeing a high-quality, uninterrupted and stable electrical service, as well as a considerable change in the profiles of use of free night time with an increase in the activities of Entertainment , information with high-quality access to the mass media such as television and radio, all of this has influenced local community development, with special emphasis on the humanization of the work of women and housewives.

Introduction

In Cuba the electrification of social and economic objectives through Photovoltaic Solar Energy (ESP) has had an accelerated development, all based on a Rural Electrification Program, with photovoltaic systems of small and medium power. The technological variant of the centralized system seems to be the most advisable for the electrification of communities in our conditions, because "it provides a considerable reduction in the overall costs of installation, operation and maintenance" (Díaz et al., 1999; Yadoo & Cruickshank, 2012; Moner-Girona, et al., 2018; Sen & Bhattacharyya, 2014; Koirala et al., 2016).

Photovoltaic (PV) technology, like others, has focused its attention on technical factors to improve its efficiency, such as: ensuring the choice of good quality equipment and accessories, ability to withstand the rigors of the climate or those related to better adaptation to its use, among others.

The rural community of "El Triunfo" is located in the "Ti Arriba" area, with access to it, by the road axis of the influence on the design and operational parameters.

Santiago-Guantánamo highway, in the municipality of Songo-La Maya in the province of Santiago de Cuba constitutes one of the three settlements that occupy the plateau of "Santa María de Loreto", with an approximate altitude of 650 m above sea level and a tropical mountain climate. It has a population nucleus that groups 19 families, approximately 65 inhabitants, where the majority of adults live in 21 men and 17 women. The fundamental economic activity is agriculture, with a prevalence of small landowners.

The use of electric current begins when three houses in the community, with prior authorization and under study, access the electric service of the "Santa María de Loreto" Photovoltaic Power Plant (PPV), a neighbouring rural community (less than 1 km) with the possibility to connect luminaires and radios.

ISSN 2721-0960 (Print), ISSN 2721-0847 (online)

Development

The installation in 2004 of the PPV "El Triunfo" was carried out with the interest of promoting the social development of the community, which has a decisive This PPv was the second medium-scale experience in the climatic conditions of Cuba.

Based on the experiences and lessons learned at the PPV Santa (López et al., 2000), the Solar Energy Research Center (SERC) planned to develop the "El Triunfo" Photovoltaic Power Plant, after a socio-technological study, Starting from an own method that starts from knowing the particularities and most relevant characteristics of the community members, providing information on the technological variant to be used, their level of cooperativity in relation to the use of a resource in common use, and finally knowing the level of acceptance achieved in the population of the proposed technological variant; It is possible to provide information to the technical part about the inventory of household electrical appliances and its level of use, important aspects to consider for sizing the system and obtaining its consumption profile (Villalobos Montoya et al., 2002; Rodríguez et al., 1998; Wood & Newborough, 2003; Swan & Ugursal, 2009).

Among the actions carried out in the Sociodemographic diagnosis stage, the community map was prepared, which allowed us to know the location and order of the houses distance between them, which may indicate the level of grouping or dispersion of the settlement, as shown in Figure 1.

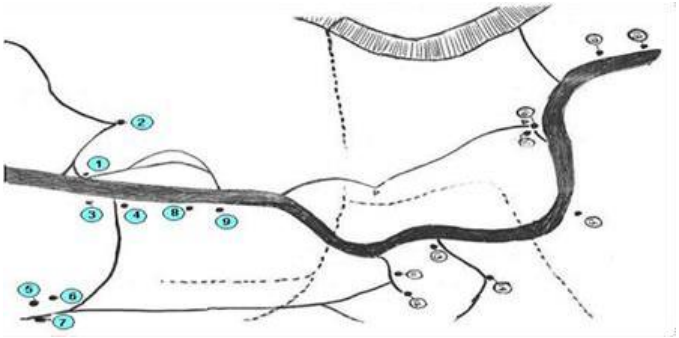

Figure 1. Location of the Houses in the Community "El Triunfo"

After having completed the informative and community awareness part, we proceeded to interview and apply surveys in all the houses (18), the 3 houses electrified with the electric service of the Santa María PV plant and the 15 houses without access to this service, to fundamentally know the degree of acceptance of its inhabitants regarding possible community electrification with a centralized photovoltaic system, from which the following information was obtained:

ISSN 2721-0960 (Print), ISSN 2721-0847 (online)

The processing of the questions referring to assessing the knowledge of the limitations of a photovoltaic system and the possibility of having a centralized system for the entire town, in this case yielded significant results in favor of the technological proposal with 89% of users that they see the system as little limited and not at all limited and with 96% that they accept having a system like this for all the people.

Through the inventory of equipment and the hourly use of household appliances that receive the service and the power to be installed in the other part that does not receive it, the consumption profile, could be obtained, which It is very useful in sizing the system.

With the determination of this basic profile of the community, it is possible to adjust the system to the real needs of the users, with a calculated or estimated growth margin depending on future aspirations for the acquisition of household appliances. Specifying the characteristics and type of profile from the very beginning of the project guarantees to be able to put into practice a group of measures aimed at reducing consumption peaks when necessary and feasible (Breukers et al., 2013; Jones & Voorhees, 2002).

It must also be borne in mind that when we think of electrifying communities with centralized photovoltaic systems, we must stop at the disposition of its inhabitants before the possible cooperative or selfish nature of the users in the use of energy.

That is why, through the processing of a question from the applied questionnaire, where the residents are asked about the way they use the resource, with the possible answers (1 sometimes), (2 never), (3 always), we are interested in knowing the disposition of the neighbors in relation to the cooperative or individualistic nature in energy consumption and as seen in the graph, Figure 2, most of them would like to maintain an energy consumption behavior that does not affect the needs of the other neighbors, which shows a positive level of cooperation regarding the use of a resource for collective use, in this case electric power.

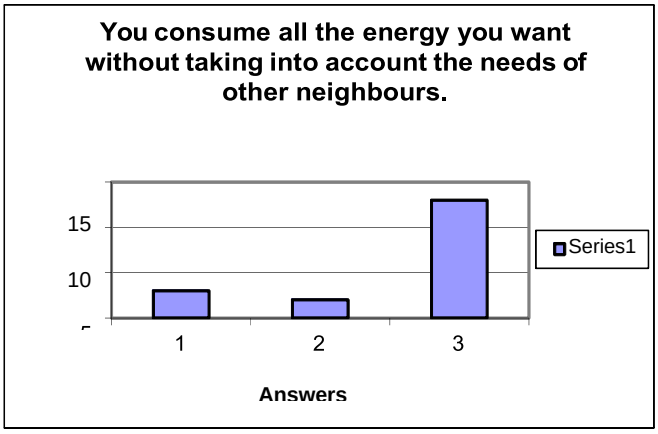

Figure 2. Result of the question

Based on the socio-demographic results obtained and based on community acceptance of this technology, the CFV "El Triunfo" was designed; it was designed for a total generation power of 4.8 kWp, a bank of 1101 Ah batteries and a 3 kW inverter.

The biggest obstacle recognized in Cuba for the sustainable generalization of PV technology for rural electrification is the micro-administration and the maintenance scheme that guarantee the long-term stable operation of the technology. The biggest recognized obstacle in Cuba for the sustainable generalization of PV technology for rural electrification is the micro-administration and the maintenance scheme that guarantee the long-term stable operation of the technology. To overcome this obstacle, the way to catalyze the social assimilation of

ISSN 2721-0960 (Print), ISSN 2721-0847 (online)

technology was used through training and participation in the project, from the beginning, by all members of the community.

To this end, in the execution of the project, the incorporation of residents into construction and assembly work was promoted, as well as the contribution to the attention of the team of technicians. Likewise, a neighbor was trained from the very beginning of the works for the operation and primary maintenance. Operational monitoring, as well as specialized repairs and maintenance are carried out by the SERC Electrification Department, with the support of the municipal and provincial governments, taking into account the demonstrative nature of the project.

The operation of the PPV of "El Triunfo" has been stable and the technical breakdowns caused have not allowed it to go out of operation during all these years of operation. The breakdowns occurred in the PPV have been resolved collectively among the residents and the direct action of the operator, which demonstrates an adequate appropriation of the technology for the self-management of the energy demanded. Both reasons demonstrate the technical feasibility of this type of installation in the specific conditions of our country.

The interviews carried out with the residents show that the change in the quality of life of the community is identified, all of which is also based on the following aspects; (1) An uninterrupted electrical service that guarantees domestic lighting and means of communication and food preservation; (2) The population has increased their level of knowledge by having greater possibilities of information through radio and television and children have also developed greater skills, due to the possibilities they have to study and perform recreational activities appropriate to their age at night.

Conclusion

Based on the experiences and lessons learned in the Santa María del Loreto photovoltaic plant and as a result of its generalization in isolated rural communities in Cuba, the photovoltaic plant was designed and installed in the rural community "El Triunfo", it has more 15 years of uninterrupted operation, guaranteeing a stable and quality electrical service that allows them to have domestic lighting, televisions, radios and food preservation means, evidencing social and economic development in the community. The success factors for the generalization of photovoltaic systems for rural electrification are based on the collectivist sentiment of the inhabitants, the existence of the local technician and his high level of training, as well as the level of appropriation of technology by users, All this allows the community to achieve local administration of the resource, a crucial aspect when it comes to centralized photovoltaic solar systems.

References

Breukers, S., Mourik, R., & DuneWorks, B. V. (2013). The end-users as starting point for designing dynamic pricing approaches to change household energy consumption behaviours. *Report for Netbeheer Nederland, Project group Smart Grids (Pg SG). Arnhem: March*.

Díaz, J. R., R. Ramos, I., Batista. J. E., & Camejo. (1999). *Lecciones del programa de Electrificación Rural Fotovoltaica en Cuba*. I Symposio Nacional de Fuentes Renovables de Energía. Santiago de Cuba.

Jones, E. A., & Voorhees, R. A. (2002). Defining and Assessing Learning: Exploring Competency-Based Initiatives. Report of the National Postsecondary Education Cooperative Working Group on Competency-Based Initiatives in Postsecondary Education. Brochure [and] Report.

ISSN 2721-0960 (Print), ISSN 2721-0847 (online)

Koirala, B. P., Koliou, E., Friege, J., Hakvoort, R. A., & Herder, P. M. (2016). Energetic communities for community energy: A review of key issues and trends shaping integrated community energy systems. *Renewable and Sustainable Energy Reviews*, *56*, 722-744.

López, J. R. D., Cuán, J. E. C., Cruz, I. B., Heredia, R. R., Pérez, R. H., Cisnero, I., & Borges, A. (2000). Two year experience in the operation of the first community photovoltaic system in Cuba. *Renewable and Sustainable Energy Reviews*, *4*(1), 105-110.

Moner-Girona, M., Solano-Peralta, M., Lazopoulou, M., Ackom, E. K., Vallve, X., & Szabó, S. (2018). Electrification of Sub-Saharan Africa through PV/hybrid mini-grids: Reducing the gap between current business models and on-site experience. *Renewable and Sustainable Energy Reviews*, *91*, 1148-1161.

Rodríguez M. Ramos G., R. Hernández H., R. Moreira P., J. Márquez A.,S. Camejo M., JE Borges C., A. Cisneros G., I., Ferro V. ., Núñez A. Alonso R., M. G.(1998) "*Experiencias en el programa de electrificación rural photovoltaica en Cuba*. " Congreso Mundial de fotovoltaica. Viena, Austria. 1998.

Sen, R., & Bhattacharyya, S. C. (2014). Off-grid electricity generation with renewable energy technologies in India: An application of HOMER. *Renewable Energy*, *62*, 388-398.

Swan, L. G., & Ugursal, V. I. (2009). Modeling of end-use energy consumption in the residential sector: A review of modeling techniques. *Renewable and sustainable energy reviews*, *13*(8), 1819-1835.

Villalobos Montoya, C., Schweizer-Ries, P., & Ramírez, E. (2002). Apoderamiento y estrategias para la intensificación de la participación de las comunidades de usuarios en el proceso de la electrificación rural–parte 1 & 2. *Energía y Desarrollo*, (21).

Wood, G., & Newborough, M. (2003). Dynamic energy-consumption indicators for domestic appliances: environment, behaviour and design. *Energy and buildings*, *35*(8), 821-841.

Yadoo, A., & Cruickshank, H. (2012). The role for low carbon electrification technologies in poverty reduction and climate change strategies: A focus on renewable energy mini-grids with case studies in Nepal, Peru and Kenya. *Energy Policy*, *42*, 591-602.

ISSN 2721-0960 (Print), ISSN 2721-0847 (online)