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Sustainable Housing with Endogenous Resources

Diego Simisterra-Guagua [a], Renán Tóala-Sánchez [b], Antonio Vázquez Pérez [c], Andy Ariel Guerrero-Velez [d]

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Corresponding Author [a]

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Abstract

In Ecuador, typical homes in rural areas are built with indigenous resources such as guadua cane (Bamboo). Currently, alternatives are being sought that improve the quality of life of the people who live in these houses. The objective of the research is to propose energy alternatives that do not affect the environment and that enhance the sustainability of the territories. Bamboo constructions have increased in the country as have isolated photovoltaic systems for electrification, the combination of them improves living conditions, benefiting many families who are employed in the production and construction of these homes. The result was guadua cane homes that use photovoltaic systems as a source of energy, combining endogenous resources efficiently.

Contents

[a] Sustainable Construction Workshop School with Bamboo, Manabí, Ecuador
[b] Sustainable Construction Workshop School with Bamboo, Manabí, Ecuador
[c] Universidad de Alicante, Alicante, España
[d] Notori S.A. Guayas, Guayaquil, Ecuador

1 Introduction

Endogenous development refers to a form of economic improvement that arises from the internal activity of a region, instead of depending on investments outside the territory. This type of development is based on the growth of local capabilities and activities and aims to achieve economic growth that is sustainable in the long term, which has a positive impact on the quality of life of the local population (Camarillo Cuenca et al., 2020).

Some of the factors to achieve endogenous development include education, innovation, investment in infrastructure, legal security, and political stability (Vidal et al., 2022). The guadua cane or bamboo is a plant that is abundant in the Manabita territory (Hidalgo Zambrano et al., 2021), it is one of the materials used since ancient times by man to increase their comfort and well-being. In today's world of plastic and steel, bamboo continues to make its centuries-old contribution and is still growing in importance (NEC–SE–GUADÚA, 2016).

The province of Manabí has great solar power (Vázquez et al., 2018), this means that it can be used for electrification in any part of the territory, taking into account that photovoltaic systems are increasing on a scale global and local and bamboo for construction means that these combinations present in almost all of the Manabi territory provide social benefits where migration to the city is reduced and improvement of life in the countryside.

The activities related to bamboo in Ecuador correspond to a solid and constantly growing productive chain, which clearly identifies the actors in each link, who, articulated with each other, form multiple effective and equitable value chains, to generate competitive products and services.

2 Materials and Methods

Qualitative, quantitative, and mixed research was carried out. Qualitative research is based on the understanding of social reality, the methods of interviews, observation, and document analysis were used. It focuses on describing the solution to a specific problem; it is a structured method, complemented with mathematical tools to quantify the problem under study. The endogenous resource of the Manabi territory was studied to propose an efficient and sustainable system that can be implemented throughout the province.

3 Results and Discussions

Sustainable development with bamboo refers to the use of these plantations to promote economic and social development in the Manabita territory, in this area there are bamboo plantations in some cantons, in addition, the map of the solar potential in the province is shown, these are shown in Figure 1.

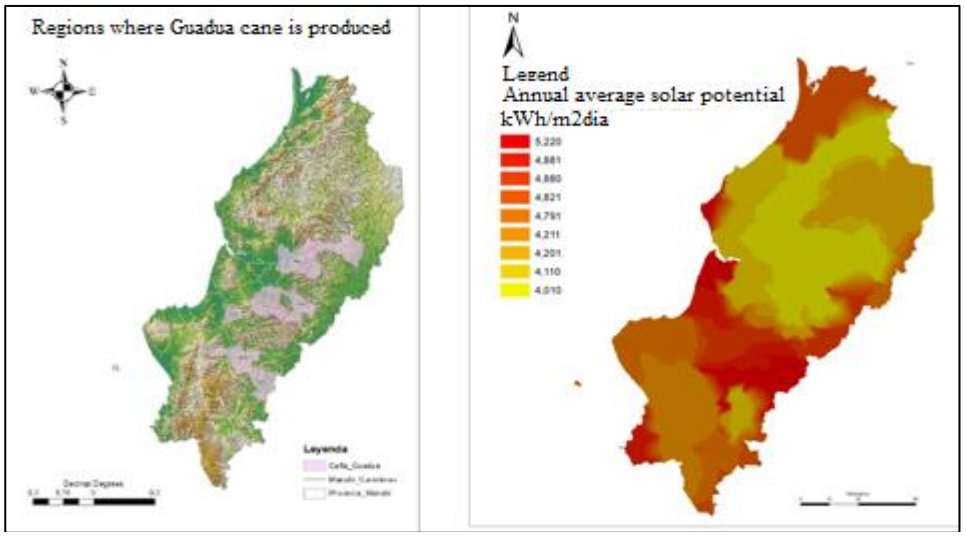

Figure 1. Manabita territory with bamboo and solar potential

As can be seen, they are indigenous resources that can be used to design sustainable systems in their construction and in the way they are supplied with energy. These types of technology have been implemented in rural territories of the province of Manabí and Esmeraldas. A small tourist center, a rural home, and a bamboo collection center were electrified. In these facilities, the lights and electrical cables are embedded inside the guadua cane that was previously treated with materials that give it resistance to heat, reducing the possibility of fire hazards (Dong & Hui, 2022; Amsler et al., 2017; Wémeau et al., 2018; Xia et al., 2023; Thyagaraju, 2016).

The Tablada del Tigre site is a small tourism center that has an electrical supply network that sometimes presents disturbances in voltage levels, in addition the Mirador Barquito tourist cabin is an eco-tourism project aimed at promoting the use of the natural resources of the sector in the construction of environmentally sustainable projects, in this sense it was supplied with electrical energy by taking advantage of the existing solar potential, using existing resources and maintaining environmental sustainability, as shown in figure 2.

Figure 2. Mirador Barquito tourist cabin

As can be seen, the luminaires are embedded inside the guadua cane, the photovoltaic system was designed to satisfy the existing demand in the center, 12 lamps were placed with a power of 4 Watts each, designed for 4 hours of operation that required energy of 192 W/day, as the cabin was isolated from the electrical system, an autonomous system was installed with its accumulation system. The system was designed using PvSyst (PVsyst, 2022), where solar radiation data and different environmental variables were obtained, as seen in the table in Figure 3.

	Global Irradiation kWh/m²/día	Horizontal diffuse irradiation kWh/m²/día	Temperature °C	wind speed m/s	Linke Turbidity [-]	Humidity - %
January	4.34	2.59	24.4	2.69	3.782	76.7
February	4.57	2.63	24.4	2.10	3.936	81.6
March	4.99	2.57	24.7	2.09	3.911	80.4
April	5.33	2.36	24.2	2.39	4.201	80.9
May	4.77	2.40	24.2	2.90	4.478	77.2
June	3.70	2.29	22.8	3.29	4.397	79.6
July	3.81	2.35	22.5	3.60	4.344	78.6
August	4.17	2.73	22.1	3.79	4.835	78.5
September	4.02	2.63	21.8	3.90	5.404	79.0
October	3.12	2.11	22.2	4.01	4.694	78.1
November	3.68	2.09	22.3	3.90	4.749	77.7
December	4.35	2.43	23.7	3.59	4.412	74.1
Year	**4.24**	**2.43**	**23.3**	**3.2**	**4.429**	**78.5**

Figure 3. Solar radiation and climatic variables

As can be seen, the highest solar potential is reached in the month of April with an irradiance value of 5.33 kW/m2/day, in the same way the month with the lowest solar potential corresponds to October with an irradiance value of 3.12 kW/m²/day, both with very good conditions to design photovoltaic systems connected to the grid, isolated and pumping (Pinargote & Gámez, 2021), the latter necessary in summer times where many communities do not have water for irrigating the plants (Perez-Leira et al., 2018).

The monthly and annual energy values generated by the photovoltaic system consider the radiation in Figure 2, the average monthly value of the ion on the plane of the generator, thereby determining the energy performance of the installation shown in daily irradiate Figure 4.

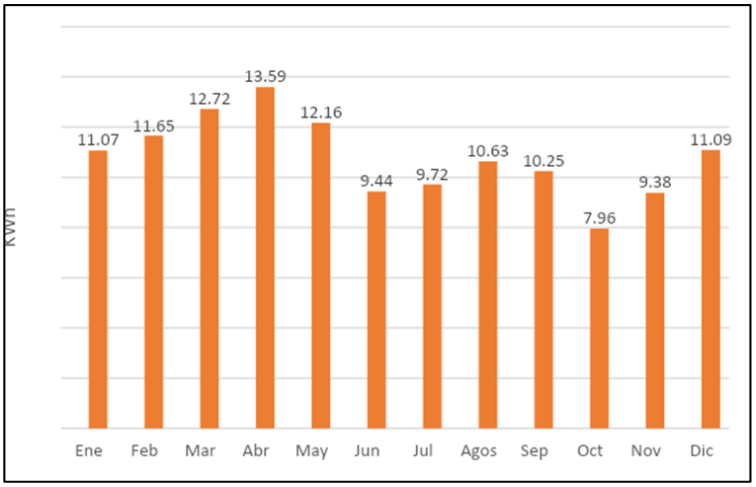

Figure 4. Energy performance of the installation

It is noted that the months of greatest performance coincide with the months of greatest solar radiation, this corroborates that technology can be implemented to solve problems in different sites in the province, all linked to the construction technology of Guadúa cane, the system makes sustainable (Angrill et al., 2017; Roufechaei et al., 2014; Seyfang, 2010; Arcentales et al., 2017). Previous experience allowed the system to be replicated in larger cane constructions, providing it with energy produced with a photovoltaic system and where the cables are embedded inside the cane, as shown in Figure 5.

Figure 5. Recessed luminaires inside the reed

In this sense, recessed luminaires have better aesthetics and are not at risk of any type of accident because the bamboo is chemically treated before installation, and the possible existence of short circuits can be verified through tests when using the appropriate concentric conductor. for installations of that type. These types of ecological facilities help promote tourism; In addition, the environmental benefit was evident by avoiding carbon dioxide emissions during the life of the system, which demonstrates the viability of the installation. These types of ecological facilities help promote tourism; In addition, the environmental benefit was evident by avoiding carbon dioxide emissions during the life of the system, which demonstrates the viability of the installation (Dalton et al., 2005; Szymańska & Chodkowska-Miszczuk, 2011; Suphaphiphat et al., 2015).

4 Conclusion

Environmental, economic, and social benefits were obtained as a result, being able to take advantage of the existing endogenous resource in some territories of the province of Manabí by developing sustainable tourism; Furthermore, the experience can be replicated in isolated rural homes that today do not have energy service and whose constructions are typical where they use bamboo or guadúa cane, managing to improve people's quality of life.

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Biography of Authors

Diego Simisterra-Guagua
He is an Electrical engineer, and a specialist in sustainable bamboo constructions and photovoltaic systems, he currently works at Sustainable Construction Workshop School with Bamboo, Manabí, Ecuador.
Email: dsimisterra96@gmail.com
Orcid: https://orcid.org/0009-0005-6623-4509

Renán Tóala-Sánchez
He is an Electrical engineer, and a specialist in sustainable bamboo constructions and photovoltaic systems, he currently works at Sustainable Construction Workshop School with Bamboo, Manabí, Ecuador.
Email: retosa22@hotmail.com
Orcid: https://orcid.org/0009-0005-6623-4509

Antonio Vázquez Pérez
He has a Ph.D. in Philosophy and Letters, a Master's in Environmental Education, a Degree in Law, and a specialist in the energetic regulatory framework, currently working on supporting PhDs in line with their subject at the University of Alicante.
Email: avp56@alu.ua.es
Orcid: https://orcid.org/0000-0002-2994-8626

Andy Ariel Guerrero-Velez
He is an Electrical Engineer, and a specialist in electrical installations and photovoltaic systems, he currently works in the company Notori S.A. en Guayaquil.
Email: andyguerrero399@gmail.com
https://orcid.org/0009-0009-6411-211X