Ecomuseum and Environmental Awareness Oxapampa Peru - 2022

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Abstract

The objective of this research is to elaborate the architectural proposal of an Ecomuseum that allows environmental awareness in Oxapampa. This city is in a continuous state of contamination and depredation of its natural resources due to the lack of environmental culture on the part of the population. The methodology was based on the climatic analysis in which the Bioclimatic Chart (Olgyay, Givoni-Milne) and the Mahoney Table were used, likewise the bioclimatic criteria were applied seeking thermal, visual and light comfort in addition to the use of energy. clean materials (photovoltaic panels), sustainable, supported by thematic plans using digital tools (Revit, AutoCad, Ecotect Analysis). As a result, the Ecomuseum has an area of 1.1 hectares and has 20% thematic areas that promote environmental awareness, 30% green areas that allow a fresh environment and prevent the harmful formation of CO2, 50% of the energy used in the Ecomuseum is made through clean energy, which allows us to take advantage of the electromagnetic radiation of the sun, which allows us to have a clean energy source. As a conclusion, a proposal for an Ecomuseum was raised taking into account criteria such as sustainability, the climate of the area, the use of traditional construction systems and the use of affordable materials.

Keywords .- Ecomuseum, environmental awareness, biodiversity, environment, sustainability.

I. INTRODUCTION

Human intervention has greatly changed the environment in which humans live, so the balance between man and nature, and ecosystems have lost their original characteristics, resulting in the continuous and uncontrolled process of exploitation of natural resources [1].

That is why the preservation of wildlife is important for habitat conservation, and it is essential to provide realistic recommendations and coordination to build environmentally sustainable rural communities.[2] Ecomuseums around the world have been working on this issue for many years.

Ecomuseums around the world offer a myriad of different themes and models for protecting both cultural and natural heritage because of their flexible framework. Although there is no universal approach, ecomuseums ultimately have an enormous and profound impact on history, culture, environment, heritage, tourism and long-term community sustainability [3], these actions are promoted by the community where they are located and maintain both the identity and culture of the place.

Oxapampa is a territory where a heterogeneous population of different origins such as Yanesha, Asháninka, Austro-German and Andean migrant origin is settled,[4] it is a province where three regions are identified, called Ucayali Rainforests, Peruvian Yungas and Humid Puna of the Andes which define five ecosystems (Low Forest, High Forest, Cloud Forests, Puna and Perpetual Snow) [5]. On Wednesday, June 2, 2010, the United Nations Educational, Scientific and Cultural Organization (UNESCO) granted the Biosphere Reserve emblem to the Oxapampa - Ashaninka - Yanesha area, which covers a territory of 1,800,000 hectares and includes four natural protected areas: the Yanachaga Chemillén National Park, the Yánesha Communal Reserve, the San Matías San Carlos Protected Forest and the El Sira Communal Reserve [6]. According to SERNANP, this natural space is home to at least 127 mammal species, 321 bird species, 71 fish species, 75 amphibian species, 30 of which are considered endemic or native and restricted to this zone, and 306 butterfly species. In terms of flora, the biosphere reserve is home to more than 5,000 plant species, including more than 600 species of orchids and more than 50 endemic species. Because of these characteristics, it is considered a province with a wide variety of natural resources.[7] In the province of Oxapampa, there is a great variety of natural resources.

In addition, there are problems that threaten the conservation of the environment. The resulting ecological problems not only affect the sustainable development of the region but also seriously threaten the security of human beings themselves.[8] For this reason, it is very important to identify social and environmental relationships coordinated with key ecological functions and services to achieve regional sustainability.[9] Understanding the willingness of people to participate in habitat conservation is essential in order to provide realistic recommendations and coordination to build environmentally sustainable rural communities.[10] Therefore, this research is based on a thorough understanding of the environmental and social relationships that are essential to achieve regional sustainability.[11] The present research is based on a series of studies that have been carried out in the province of Oxapampa.[12] The present study is based on the results of this study.

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Therefore, the present research proposes the architectural development of an Ecomuseum that will function as an important site of interest in the town and attract the target community to become informed, researched and aware thus laying the foundation for greater environmental awareness and future sustainability in Oxapampa.

A. Literature Review

1) *Environmental Awareness*

Environmental awareness-raising is a strengthening tool based on training and environmental education in sectors of attention and focuses on institutional priority issues, generating a multiplier effect.[11] The identification of sectors of attention in which it is intended to generate reflection on the environmental deterioration was caused by human beings. For example, biodiversity, which includes all species of plants and microorganisms.[12] The identification of sectors of attention in which it is intended to generate reflection on the environmental deterioration caused by humans.

2) *Ecomuseum*

Ecomuseums are tools to protect the traces of rural societies,[13] as a long-term educational and sustainable means of local and social development.[14] They represent the opportunity to concretely involve communities in a virtuous process of definition, interpretation and regeneration of a territory, with all its characteristics and local vocations. [15].

3) *Bamboo*

Bamboo is an ideal material as it is green, fast growing and easy to process.[16] It is the plant with high tensile strength, bamboo offers an excellent alternative material to replace steel reinforcement in a concrete structure.[17] It is considered an interesting material with applications in various economic branches as a green material that has a positive influence on the environment.[18] Also, bamboo has a high tensile strength, it offers an excellent alternative material to replace steel reinforcement in a concrete structure.[19] Furthermore it is an interesting material with applications in various economic branches as a green material that has a positive influence on the environment.[20].

II. METHODOLOGY

A. Study phases

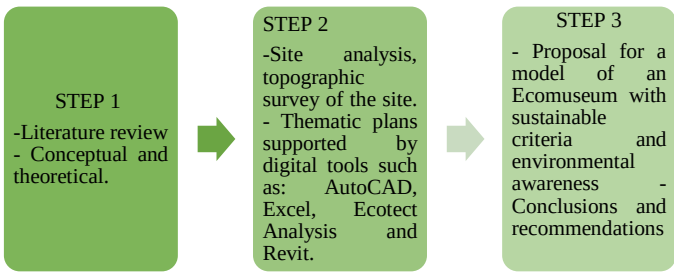

Figure 1. Diagram of study phases

Figure 1 shows the methodological process used to carry out this research.

B. Study site

The study site is in the department of Pasco, in the city of Oxapampa, located in the province of Oxapampa. It is located at coordinates 10° 5' south latitude and 75° 24' west longitude, with an altitude of 1814 m.a.s.l. [19].

Figure 2. Map of Oxapampa Province.

Figure 2 shows the intervention site, located on the western outskirts of the city, near the Chontabamba River and the San José Mountains.

C. Climatology

Oxapampa's climate is semi-warm, humid and rainy, due to the fact that it is geographically part of the central jungle of Peru with rainfall ranging from 1500 mm to 2000 mm. [20]

Table 1. Temperature in Oxapampa Province

Month	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Max. Temp.	25.5	25.4	24.7	25.4	25.9	25.3	25.2	25.4	25.8	26.2	25.1	25.5
Mean. Temp.	19.2	19.2	18.5.	18.6	18.1	17.2	17	17.3	18.3	19.2	19.1	18.9
Min. Temp.	12.9	13.1	12.4	11.9	10.4	9.2	8.9	9.3	10.8	12.2	12.1	12.3

Table 1 shows the temperature variation throughout the year, with the lowest temperature being 9.2°C in June and the highest temperature being 26.2°C in October. It can also be seen that the average temperature is 18.1°C and varies slightly with the passing months. [21]

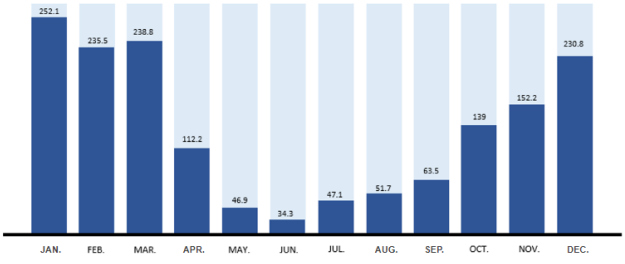

Figure 3. Precipitation in the province of Oxapampa

Figure 3 shows the total precipitation in Oxapampa throughout the year, which in the winter months is much lower with a minimum of 34.4 mm as opposed to the summer months when it reaches 252 mm.[21]

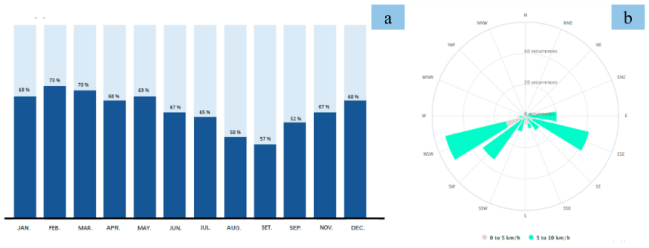

Figure 4 (a) Humidity percentage and (b) Wind rose in the province of Oxapampa.

Figure 4 (a) shows the percentage of humidity in Oxapampa during the year, showing levels above 50%, which means that it is a place with high humidity, and Figure 4 (b) shows the average wind speed and direction during the year. [21]

D. Psychometric Abacus

The Oxapampa abacus results show that it is not in the comfort zone and a passive solar collector system is needed to ensure the internal gains of the enclosures.

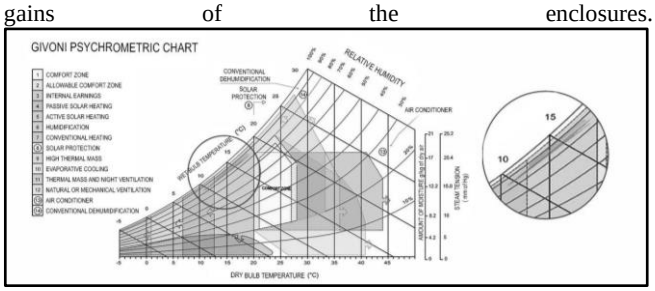

Figure 5. Psychometric Abacus of Oxapampa

E. Flora and Fauna

The 32% of the province's territory is made up of Natural Protected Areas of different categories (National Park, Communal Reserves, Protected Forests), and Municipal Conservation Areas, these areas are home to a great diversity of ecosystems and ecological complexes, as well as cultural and historical wealth. [22]

Table 2. Natural Protected Areas in the Province of Oxapampa.

Protected Area	Flora	Fauna
Yanesha Communal Reserve	Among 2800 types of plants and fungus	Mammals, birds and reptiles
Yanachaga Chemillen National Reserve	Among 2000 types of moss and orchids	Mammals, fishes and amphibians
Protection Forest San Matias San Carlos	Many types of orchids, moss and ferns	Many types of mammals
El Sira Communal Reserve	Endangered plants and fungus	Many types of mammals and reptiles

Table 2 below shows the Natural Protected Areas of the city of Oxapampa with their respective flora and fauna classification. [23]

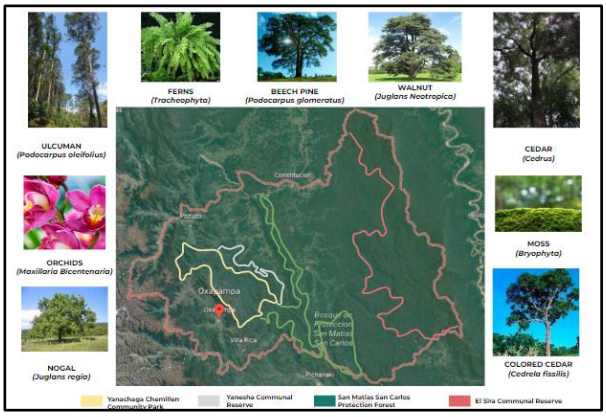

Figure 6. Flora of Oxapampa Province

Figure 7. Fauna of Oxapampa Province

In Figure 6 and 7 you can appreciate the diversity of flora and fauna found in the province of Oxapampa, you can find a great variety of birds, mammals and reptiles; most of which are vulnerable species or are in danger of extinction.[24] The diversity of flora and fauna found in the province of Oxapampa is shown in Figure 6.

Table 3. Endangered Species

Endangered species (by class)	Common name	Scientific nam
Mammal	Ateles belzebuth	Ateles paniscus
Mammal	Woolly monkey	Lagothrixlagotrichia
Mammal	Otter	Nutria longicaudi
Mammal	Ant bear	Myrmecophaga
Mammal	Spectacled Bear	Tremarctos ornatus
Mammal	Jaguar	Panthera onca
Bird	Royal Vulture	Sarcoramphus papa
Bird	Cock of the rock	Rupicola peruviana
Reptile	White alligator	Caiman crocodylus
Reptile	Dwarf lizard	Paleosuchus
Reptile	Boa	Boa constrictor

Table 3 represents some species of animals that are endangered of extinction. [15/25]

II. RESULTS

A. Location of the proposal

The Ecomuseum proposal is located to the west of the city of Oxapampa, in free plots of land. It seeks to prioritize the accessibility of low-emission vehicles, prioritizing the sustainability of the green areas of the ecomuseum. The objective of the ecomuseum is to focus on environmental sustainability, universal accessibility, comfort and landscaping.

B. Accessibility

The proposal is to connect two roads from the Chontabamba highway to the ecomuseum. Both automobiles and bicycles will be able to access these roads. Interior circulation is planned and there is a bike path that runs around the perimeter of the site. Priority will be given to the use of bicycles inside and outside the ecomuseum. In addition, large squares with green areas are planned.

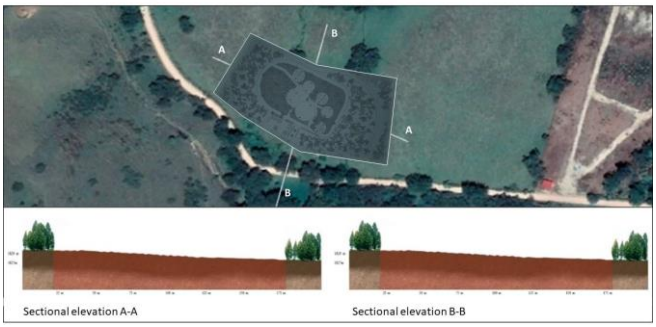

Figure 8. Terrain elevation profile of the proposed Oxapampa site.

C. Planimetry

Within a 1.1-hectare plot of land, green areas are planned to integrate the community, outdoor enclosures and a pedestrian path with a bicycle lane. In addition to areas for cultural exchange and services.

Figure 9. Distribution of the Ecomuseum Proposal

Figure 10. Volumetric proposal

D. Construction system

Shingles, teak wood and wood fiber are used for construction.

- The walnut and bamboo tree provides ventilation due to its height and branching crown.
- The use of teak wood is based on its resistance to moisture.

The ideal material to use would be wood, as it is not a heat bridge, it keeps the house in a state of comfort. It is an accessible and more economical material to use, employing the area's own species for the raw material.The roof would be composed of wood fiber, which is a natural thermal insulator to minimize the heat in the rooms.

Figure 11. (a) Detail of materials, (b) Roofs, (c) Cut of the proposal.

Figure 11(a) shows the traditional materials used for the proposal, in image (b) shows the details of the roof in which the crown wood is used as termination and an inclination of 30° due to the abundant rains in Oxapampa and in (c) the cut of the building can be observed.

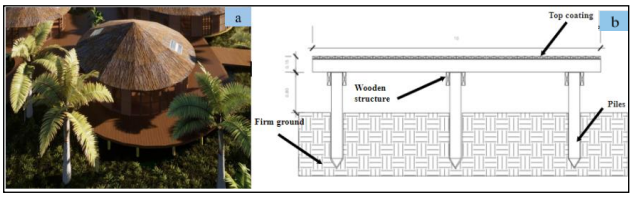

Figure 12. (a) timber piles, (b) detail of piles.

In Figure 12 (a) timber piles, (b) details of piles used in complex foundation conditions, due to the existence of very soft soil and the presence of water in the soil [26].

Figure 13. (a) Proposed lighting, (b) Solar pavers

Figure 13 (a) shows the lighting proposal, in which solar pavers are placed to illuminate, this photovoltaic system absorbs sunlight during the day and thus makes the pavers shine throughout the night. This light can be seen at distances of more than 800 m. using solar energy, and in the image (b) details a solar paver.

E. Sun path

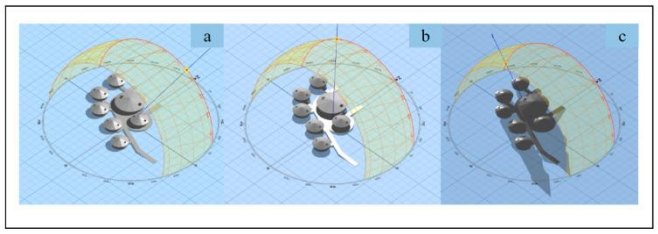

Figure 14 (a), (b) and (c). Solar path on architectural proposal

Figure 14 shows the sun hours: (a) Month of June at 10:30 am, (b) Month of June at 14:05 pm, (c) Month of June at 17:15 pm.

F. Design Strategies

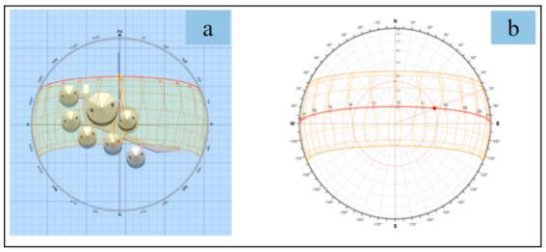

Figure 15 (a) and (b). Solar projection on architectural proposal

According to the graph, we determined that the north façade has greater solar gain during the year. It is recommended to use eaves and ventilation to achieve comfort, also the east and north facades would be the most exposed to the winds of the area.

●Roof: 30° slope allows for ragged roofing from rainfall. The structure with triangular trusses would be the structural solution, it allows to save large spans, also has ease and quick confection, they can be prefabricated or assembled on site.

●Flooring: It is necessary to use piles or platforms due to the high humidity rate.

●Trees: Trees stop the sun's rays, generating shade to prevent the loss of humidity in the environment.

●Gutters: They are important to avoid water puddling from rainfall and wear and tear on roofs.

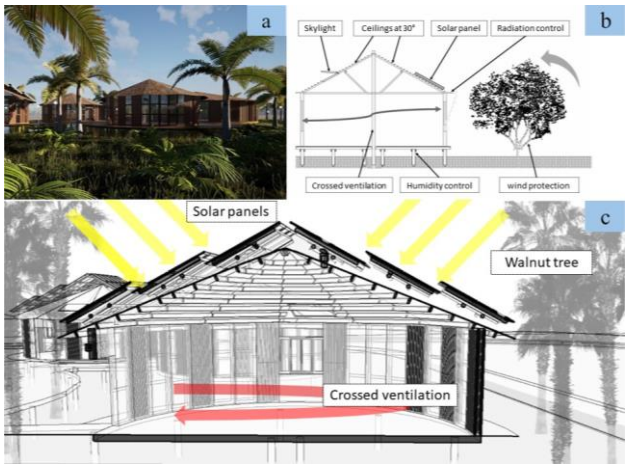

Figure 16. (a) Volumetric section view (b) Detail of bioclimatic strategies (c) Cut of proposal

In Figure 16 (a) Volumetric section view of the proposal (b) Detail of bioclimatic strategies used to achieve thermal comfort using clean technologies and in the image (c) the cut of the proposal can be seen.

●Skylights: They contribute to heating the rooms by capturing and distributing solar energy, and also improve natural lighting. The thermal energy captured, as it cannot escape, manages to remain inside the rooms. Located on the roofs in the east and west direction, this way thermal comfort is achieved.

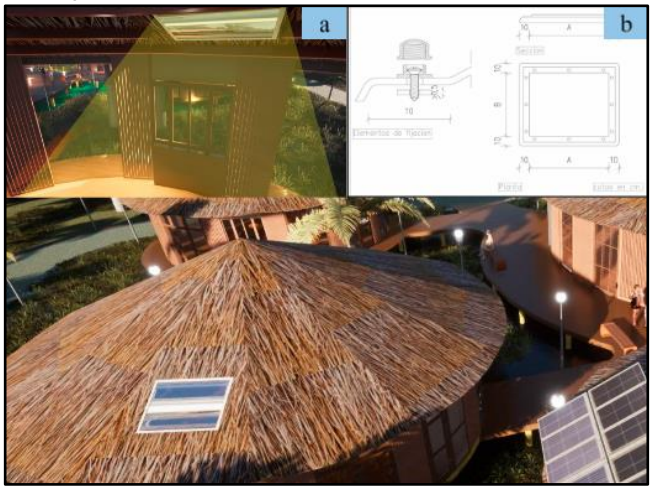

Figure 17. (a) Skylight in roofs, (b) Detail of skylight

Figure 17 (a) shows the skylight being a roof element as part of the bioclimatic strategy used for this sustainable Ecomuseum proposal, and (b) shows the detail of the skylight.

●Photovoltaic panels for electrification: Panels are devices that are made up of photovoltaic cells, these allow the generation of electricity by transforming solar energy. Also commonly known as

"solar panels". Their useful life varies according to cost and quality. Through their installation, they are generally composed of charge controllers, batteries and current converters. These charge controllers manage the energy to and from the batteries, thus avoiding excessive overloads and discharges that can damage the useful life of these devices. Batteries also allow storing the electrical charge generated during the day and then distributing it. Current converters on the other hand are used to transfer the energy stored in the batteries to 220 volts, which is the voltage used in the national distribution network.[27] The batteries can also be used to transfer the energy stored in the batteries to 220 volts.

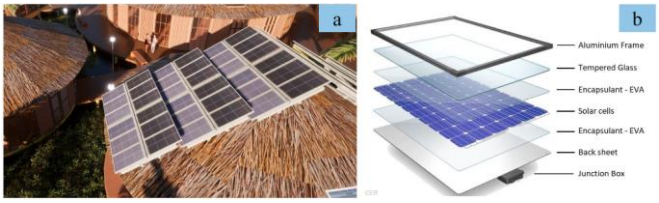

Figura 18. (a) Photovoltaic panels, (b) Photovoltaic panel detailed

Figure 18 (a) shows the photovoltaic panels located on the roofs of the proposed Ecomuseum and (b) shows the detail of a solar panel, the sun's rays hit against plates composed of semiconductor materials that transform the energy received into electricity.

The ones in charge of this transformation are called solar cells. They form the solar panels and are small cells made of crystalline silicon or gallium arsenide. [28]

The sun projects the equivalent of 1 kilowatt (kW) or 1000 watts onto the solar panel. This converts that energy into 200 watts of electricity that can be used to power the Ecomuseum. Based on this, we would say that this solar panel would have an efficiency of 20%.[29] This is a high efficiency solar panel.

High efficiency panels. Their efficiency can range from 19% to 23%.[30]

Considering a common panel of about 300W, and calculating with the hours of sunshine in the city of Oxapampa we obtained a result 300W x 11 hours of sunshine per day = 3300W or what is the same, 3.3 kWh per day.

In the Ecomuseo proposal, it is calculated that the daily energy consumption would be approximately 54.53kW. This would require approximately 17 solar panels.

Table 5. Solar energy consumption at the Ecomuseum

	Use Time	Approximated area	Kwh per day
Approximate consumption by interior areas	10h	722.55m2	46.53Kwh
Approximate consumption by exterior areas	6h	139.76m2	9.00Kwh
		Total consumption per day:	54.53Kwh
		Total energy generated per day:	3.3Kwh
		Approximated quantity of solar panels required: 17	

Table 5 shows the calculation to obtain the approximate electricity consumption, and with this the amount of solar panels that will be necessary for the Ecomuseum is determined.

III. DISCUSSION

According to authors Meng Li and Gehan Selim, ecomuseums in China must find the balance and relationship between economic development and heritage conservation and create a huge and profound impact on history, culture, environment, heritage, tourism and long-term community sustainability[14],on the other hand, according to author Ho Soon Choi, natural energy sources, solar panels have been developed and can be applied to building facades in this way solar energy can be harnessed in this way renewable energy generation can be maximized,in response to increasingly severe global pollution, environmental protection solutions have been sought worldwide, furthermore The United Nations announced the Sustainable Development Goals (SDGs) policy and set the goal of "lasting access to affordable, reliable, sustainable and modern energy for all" by 2030[31].

Therefore, the design of the Ecomuseum in Oxapampa was based on the objective of achieving a positive impact on the community, focused on the care of the environment, thus creating spaces where they are in constant connection with the natural environment and sensitizing the community about its flora and fauna, also with the purpose of informing them that their individual actions for the care of these environments will bring positive consequences in their quality of life. An architectural design of an Ecomuseum with solar panels was applied for the collection of energy in the city of Oxapampa, considering that a common panel of about 300W, and calculating with the hours of sunshine in the city of Oxapampa we obtained a result 300W x 11 hours of sunshine per day = 3300W or what is the same, 3.3 kWh per day, this calculation is for each photovoltaic panel of the Ecomuseum. [32].

IV. CONCLUSIONS

The design of the Ecomuseum with the use of clean energy, photovoltaic panels, maximizes the efficiency of energy generation, achieving that 50% of the energy used comes from the photovoltaic panels. On the other hand, environmental awareness in the citizens of Oxapampa is important, so that they have a greater care and protection of their natural resources, and help to become aware of the unsustainable and predatory problems, environmental degradation and imbalances, since as could be evidenced there is a large number of species of flora and fauna in danger of extinction. For this reason, a design is proposed that promotes contact with the environment and spaces for the community to have access to information in order to promote citizen action, in addition to contributing to local education. It is also concluded that the use of bioclimatic strategies are essential in this area of the country to achieve adequate thermal, lighting and visual comfort for the users of the Ecomuseum, and finally, local materials were used to encourage construction with non-conventional materials.

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