Sustainable management of plastic waste and water in the production of houses of social interest in San Clemente, Manabí

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***Abstract*– Manabí is the second province in Ecuador with the largest housing deficit, with approximately 50% of this deficit in San Clemente alone. Around the beaches of this commune 800 kg of plastic waste are produced year after year and continually suffers from electrical blackouts due to poor design of the current electrical network. This scientific article addresses the problem through sustainable solutions that promote a sustainable housing design proposal based on the collection of plastic waste and obtaining hydraulic energy. The production of waste is analyzed for the production of 150 new houses based on this sustainable solution.**

***Keywords*-- Sustainable management, social housing, plastic waste, ecological materials, hydraulic energy**

I. INTRODUCTION

San Clemente, Manabí is currently a tourist spot with a medium-high affluence, which presents a problem that occurs year after year for the purposes of this activity, since its electrical and sanitary systems collapse due to the sudden increase in demand from users in the area city network consumption producing constant blackouts and accompanied by poor waste management that does not include routine collection, so the waste fills the beaches and estuaries. San Clemente is a hotel tourist destination, but not urban, since around it there are only rustic houses and they do not supply their own inhabitants, so there is currently a high housing deficit that reaches 50% and that does not generate development towards a consolidated housing plan. The thinking promoted by the 2030 [1] Agenda for sustainable development is taken in this document to propose sustainable solutions that combat these problems and improve the quality of life of the inhabitants and visitors of Playa San Clemente, Manabí.

The sustainable management of the territory has not been an urban planning instrument throughout the history of San Clemente Commune, Manabí, since being part of the Charapoto Canton, with 487 years of foundation, it has had problems due to the absence of instruments of sustainable development for which its services and infrastructure do not have sufficient coverage for a medium to high demand.

The hotel and housing demand is limited, as it only has a greater presence in the coastal profile, but towards the northwest and southwest it has a different face with abandoned homes, others not suitable for living and 60% homes with more than 7 members in confined spaces experiencing overcrowding [2]. The planning has been focused on the hotel sector, but depriving the residents of San Clemente of housing plans, who object that they do not have development paths due to the lack of economic means, having an average income index of $200 to $300 per month [3], which limits their access to decent housing. A social housing plan understands these needs, but proposing it so that it lasts is the challenge since housing plans have been proposed by cantonal and provincial planning entities, but they have not welcomed this sector of the population as they are still inaccessible financially for them.

It is estimated that the lack of services makes the outlook more unfavorable, among these is the electrical system, in which due to the sudden demand of the population that has grown by 70% in the last 20 years [4], blackouts are caused almost daily or at least once a week. As a favorable point, proposals for the use of energy for electricity generation have not been explored since the traditional system has not been a successful system.

As part of sustainable development, caring for the environment is paramount since it improves the quality of life of the inhabitants, among the factors that contribute to this development is the management and handling of waste or residues that year after year has been the problem at spend a season of high influx as they are between the months of January to March, leaving an approximate of 1000 Kg. of waste, being the plastic waste the one that has the greatest predominance with 800 Kg [5].

On the beach of San Clemente, collection campaigns are constantly carried out that contribute but do not eliminate the problem, since there are not enough containers for the deposit and processing of waste. This weakness in terms of services, but above all the lack of infrastructure for the correct disposal of waste, has resulted in a deterioration of the environment, thus generating significant effects on public health and compromising the well-being of the community, especially those segments with fewer opportunities and greater deficiencies [6].

In San Clemente there are no proposals on the management of solid waste for its conversion into ecological materials produced for the benefit of the community. Ecological materials

Digital Object Identifier (DOI):
http://dx.doi.org/10.18687/LACCEI2022.1.1.310
ISBN: 978-628-95207-0-5 **ISSN:** 2414-6390

for construction are presented in various ways depending on the needs, at present the assembly of traditional housing (reinforced concrete) entails both a high economic cost and a medium-high environmental impact [7], therefore The use of ecological materials leads to minimizing this affectation and it is proven that its serious production results at a minimum cost and is accessible to all population strata derived from their economic income [8]. Therefore, overcoming these problems as a first will turn San Clemente Beach into a focus of sustainable development.

OBJECTIVES

Overall Objective

Develop a sustainable housing design proposal that promotes the use of ecological materials and clean energy for the production of social housing for the San Clemente Commune, Manabí.

Specific objectives

- Analyze models of ecological materials to define a block design based on synthetic polymers.
- Conceptualize an electrical supply system based on hydraulic energy.
- Explain by means of a planimetry the design of the model of sustainable housing of social interest with the use of ecological materials and hydraulic energy.
- Design an urban location scheme of the sustainable housing plan of social interest.

II. THEORETICAL BASIS

Access to decent housing is a constitutional right in Ecuador, which means that it has quality, however, the economic reality does not allow them to access quality housing and designs are usually proposed that are not the most comfortable or with the climate, sunlight or external conditions of the specific place. Within the quality of housing, in particular, not much attention is paid to the internal thermal environment [9], nor to the importance of the environmental impact that it generates, causing as Consequently, the increase in energy consumption in ventilation and artificial air conditioning [10]. Social housing must be seen as housing that generates comfort, reduces production costs and is friendly to the environment [11], returning to the concept of the right to housing as a decent place to live and develop in a safe and secure environment. Quality [12]. In recent years, the construction industry has innovated in the production of new materials with an ecological trend [13] that provide energy savings and minimum cost in their production, generally these materials are produced with waste materials already made [14] that still have a very long useful life to reach the final degradation process. Plastic is one of the materials that takes the longest time to degrade, extending up to 500 years [15], which generates a long-term environmental problem. Decent housing must be friendly to the environment since it must reduce the gray footprint with ecological proposals [16]. Under this concept, it is obtained that seeking alternative ways to obtain energy would lead to a more pure and economical generation [17]. At present, there are various means for obtaining clean energy, but under the conditions of the environment, the most favorable one must be chosen so that its operation is adequate [18].

Hydraulic energy as an alternative is one of the most reliable and continuous production energies for electrical energization [19], as part of one of the renewable energies, it mentions the type of energy that can be obtained from natural sources, virtually the energy is a natural resource that can be exploited through the application of technology and various associated resources. The concept also allows us to say that it is the ability to set in motion or transform something that is inexhaustible, either because it contains an immense amount of energy or because it can regenerate naturally [20].

III. METHODOLOGY

A methodology with a mixed approach was used, with particular emphasis on the qualitative approach to analyze and conceptualize analogous models based on the collection of scientific articles and field analysis that expresses its results through tables and quantitative data. The types of research used for this document will be descriptive and field, applying the deductive method through participatory research using instruments such as field observation and interviews to prioritize the needs table and consolidate a sustainable housing scheme of social interest. . For its application, workshops were structured to discuss the design and special considerations for housing. In order to obtain valid and concrete data, an occasionally simple probabilistic demonstration was used, made up of 10 representatives of the San Clemente Commune previously chosen by traits of seniority, authority and representation in the activities and improvements for the community.

IV. RESULTS

The exposed results will respond to the general and specific objectives, starting from an analytical theoretical vision of models and conceptualizations of the dependent variables: ecological materials and renewable energies. As a second step, graphs, diagrams and explanatory tables of the data obtained will be elaborated to finalize in a planimetric, schematic proposal of the house and as a whole as a housing plan.

ECOLOGICAL MATERIALS

There are several methods for the production of a block based on plastic waste, below, some of the technologies for the production of block based on synthetic polymers will be exposed; which come from plastic bottles, covers, disposable containers, and all plastic elements altered by the hand of man [21].

- PET block or polyethylene-terephthalate are those produced based on PET plastic aggregates together with granite aggregates and low portions of sand and cement, according to this reference per ton (granite = 10% - sand = 4% - cement = 2%).
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• HDPE block made with the same base as PET, but which replaces granite with a high-density polymer (HDPE) in flakes, in proportions of 0; 25 and 50% coarse stone substitution.

• BYFusion block, this is a highly compressed brick that does not need aggregate or binders such as cement, and is produced by hot compression.

Once the three block models based on synthetic polymers have been obtained, their ability to choose according to the conditions of a decent and quality home is evaluated: comfort, reduced production costs and environmental impact, adding one more element: its resistance compared to the three types of block produced from plastic waste.

The following table compares the blocks according to their climatic comfort according to their composition:

TABLE I
CONFORT PARAMETERS

Materials	Application	Material composition %	Number offailed tests	Thermal conductivity (k)
PET plastics	Bricks or blocks	84%	0	0,15 W/mk
HDPE plastics	Bricks or blocks	95%	1	0,14 W/mk
ByFusion plastics	Bricks or blocks	99%-100%	0	0,16 W/mk
Pumice	Bricks or blocks	80%	2	0,12 W/mk

The minimal use of aggregates means that there is less waste in its production and that the assembly process is carried out in a simpler and cheaper way. According to this background, through a market study the following has been verified:

TABLE II
CONFORT PARAMETERS

Materials	Cost per unit	Provision in Ecuador
PET plastics	$0,08	Distributor exists
HDPE plastics	$0,21	Import
ByFusion plastics	$0,18	Does not exist
Pumice	$0,24	It is produced in Ecuador

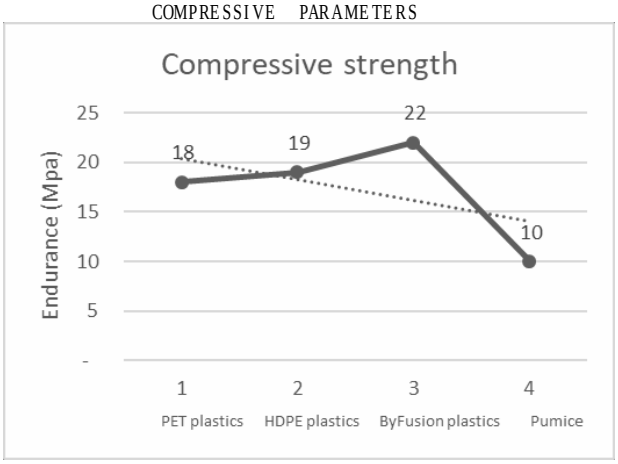
Being an ecological material, its production is more friendly to the environment since it is obtained based on a discarded product, but it still generates an impact on the environment, for which the following table will measure its impact among the 4 analyzed materials:

TABLE II
CONFORT PARAMETERS

Materials	Environmental impact		
	low	medium	high
PET plastics	1	0	0
HDPE plastics	1	0	0
ByFusion plastics	1	0	0
Pumice	0	1	0

The capacity of this material in its composition and compaction process for the production of various secondary materials means that its resistance becomes higher than that of a traditional cement block. Below is an explanatory table for a static compaction process:

TABLE IV
COMPRESSIVE PARAMETERS



Carrying out a standard measurement of the benefits, it can be obtained that the PET-type plastic block is cheaper with a cost of 66.67% less than the traditional block and less than the other two plastic blocks in comparison; its thermal conduction based on climatic comfort is average, being more comfortable than the traditional block and the PEAD, only below the BYFusion block; the environmental impact of the three plastic blocks is low while that of pumice stone is medium; the resistance of the PET type block is 22% more resistant, but lower in resistance than the HDPE and ByFusion block. For this reason, the PET block is chosen as ideal for the design proposal of sustainable housing of social interest.

RENEWABLE ENERGIES

The commune of San Clemente, being a coastal area with frequent waves, allows the introduction of a type of energy derived from hydraulics, which is the tidal wave, since it uses the energy obtained through the kinetic and potential energy that they produce the waves and tides. In observations made at the San Clemente breakwater, it was noted that the alternation between wave and wave is 9.5 seconds. Already with this first result, through the use of a level probe it was possible to obtain that its average depth from the coast to 100 meters into the sea presents a minimum depth of 2.40 meters and a maximum of 9.10 meters, therefore which we will apply the following formula for the apparent velocity.

Va=SQR(g/h); where g is the value of the gravity constant and h is the depth of the sea (SQR is the square root).

$Va=\sqrt{(9{,}807 m/s^2/5{,}75m)}$

Va =1,705 m/seg

The equation of the wavelength of the wave will be made prior to the following data, the average height of the waves in San Clemente is 2.40 meters on an annual average, so we will have the following:

$\lambda = A x Sen[2\pi(t/T \pm x/v)$; where A is the height of the wave, t is the time, T is the period, λ is the wave speed of the wave.

$\lambda = 2{,}40 x Sen[2(3{,}141592)(t/9{,}5\ seg \pm x/1{,}705)$

$\lambda = 2{,}40 x Sen[0{,}6613t \pm 0{,}0012.x)$

$\lambda = 2{,}40 x Sen[0{,}6613t \pm 0{,}0012.x)$

$\lambda = 14{,}76$ m.

According to this data, the final equation of the real speed of the wave can be obtained:

$Vf = \lambda/t$

$Vf = 14{,}76/9{,}50$

Vf = 1,55 m/seg

Therefore, the real correction speed of the wave is 1.55 m/sec, being an appropriate speed for the operation of a tidal turbine, but nevertheless the wind speed is sufficient only from June to December, so it remains between a standard of 13.2 km/h and 16.6 km/h and a maximum of up to 22 km/h, as can be seen in the graph:

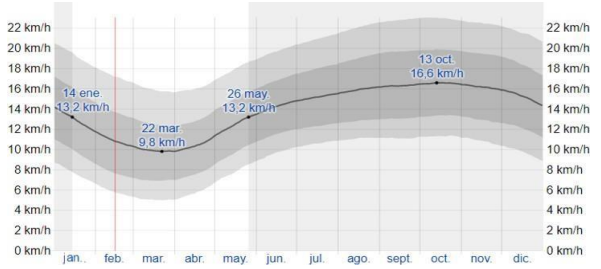


Fig. 1 Wind speed in San Clemente (Annual scale)

Therefore, supercapacitors and batteries for energy storage should be proposed for the months of January to May where the energy supply would be irregular. Below is an operating diagram of the tidal turbine at the San Clemente breakwater:

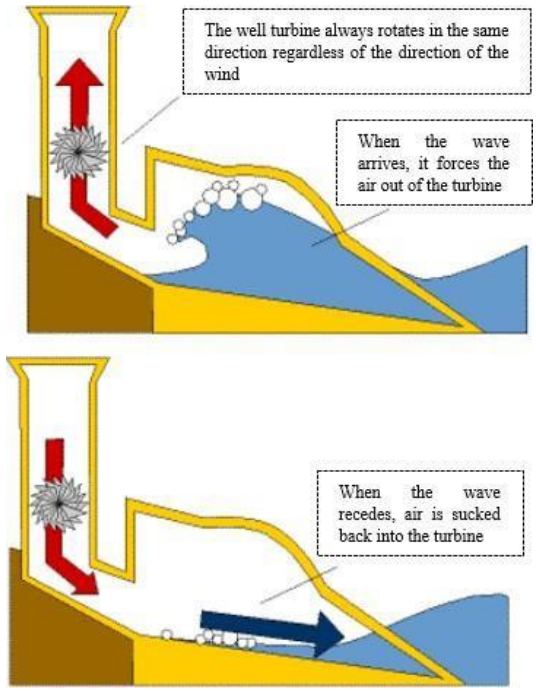


Fig. 2 Operation of a tidal turbine

According to the study of this scheme, it is proposed that it be a 600 kW turbine that works at medium capacity, giving a total supply for 150 homes. It is recommended to use 2 supercapacitors that work with a maximum storage capacity of 100 kW each and 2 batteries operating at 50kW each to obtain 30% energy in the months of low waves and wind speeds.

PARTICIPATORY DESIGN

The design of the house was carried out through active coordination with the 10 representative members of the San Clemente commune, forming a design that provides greater amplitude, climatic comfort and an economical design but that meets their needs to live in a decent place and quality.

Fig. 3 Meeting with the 10 representatives of the community

A first approach was obtained in two of the most critical cases of overcrowding inside the house, making a diagram of how they live today:

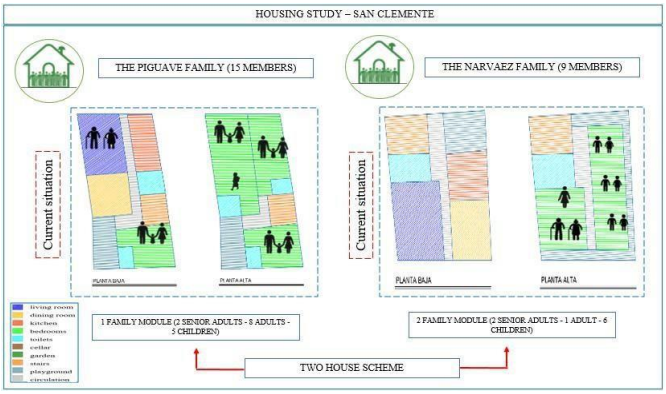


Fig. 4 San Clemente housing study

According to this scheme and the workshop carried out with the representatives, the housing needs plan was obtained, comprising 3 bedrooms, living room, dining room, kitchen, 2 full bathrooms, a half bathroom, a small patio or garden and that the design be raised on one floor, for which the following architectural distribution was obtained where all the walls and the lightened slab will be made entirely with PET blocks and the energization will be obtained through an electrical converter, which will provide tidal energy to the house.

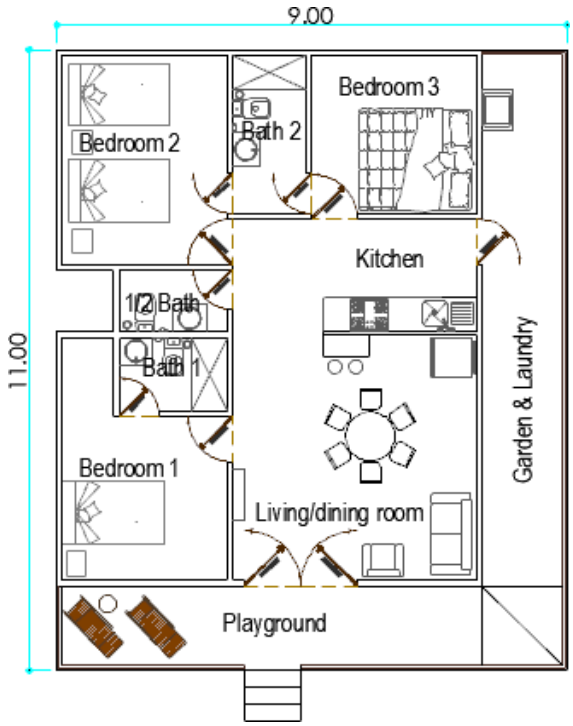


Fig. 5 Housing design

This house is equipped to supply a total of 6 people, it uses an ecological design using wooden decks for the floor, a cane structure and reinforced concrete plinths for foundations, a roof made of clay tile material and a wooden structure for closing the doors. deck and playground.

Fig. 6 3D Housing design

HOUSING PLAN

The housing plan is proposed under the guidelines of sustainability and will be located in the northwest area of San Clemente with a total of 150 homes operating as an urban complex that will supply 750 people, promoting the urban development of San Clemente. With savings of up to 40% compared to a traditional home. The location of the project was chosen because of its proximity to the San Clemente breakwater, which is close to Playa Punta Bikini, and because it is an area where the vast majority of human settlements are located.

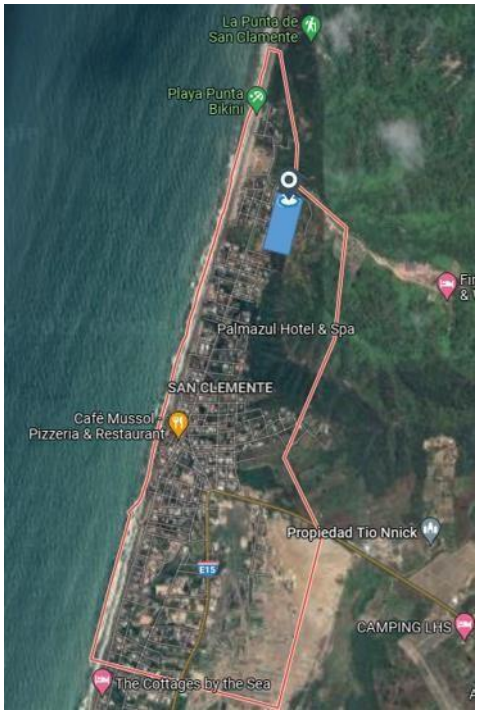


Fig. 7 Urban location scheme

V. CONCLUSIONS

As conclusions, the project will generate an urban housing development, an energy use will be obtained through renewable sources with a supply for 150 homes through the use of a 600 kW tidal turbine and the reduction in the construction of

traditional housing up to 40% with the use of the PET block, which will be convenient to obtain a decent and quality home under concepts of sustainability. The homologation of the type of block used suggested the use of a block with conditions of thermal conductivity, resistance, cost and environmental impact so that it is a material that is easy to introduce into the environment under study.

ACKNOWLEDGMENT

Thanks to the support of the University of Guayaquil for promoting science through the exhibition of scientific articles.

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