The economic and social advantages

of a system of

bio-based building materials

for Senegal

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These notes aim to provide a basis of understanding for innovation of the construction systems presently used in many African countries, with particular reference to Senegal, the country where my research and development consortium is planning to implement our ideas. Our hypothesis is that if a complete system: composed of clay bricks and roof tiles, strengthened by fibers from agricultural waste, (millet/agave/hemp/waterhyacinth) and rendered waterproof and structurally sound via a green, plant based, bonding agent, fully integrated into an interlocking system of bamboo culms, is used to construct a house, it would offer many economic, as well as performance and social advantages to both the citizens and potential investors.

Senegal is a country of sixteen million inhabitants of which 41 % are under age fifteen. This means that within ten to fifteen years an additional six million citizens will need houses of their own. Assuming that most of them marry, that represents three million homes. This corresponds to the data gathered from the global property guide, (<https://www.globalpropertyguide.com/Africa/Senegal/Price-History>

Housing shortage despite construction boom:

Senegal has a shortage of affordable housing.

About 200,000 extra houses are needed in Senegal, and every year an increase of about 10% of the total housing stock is needed. Constraints to supply include the lack of formal market players, limited availability of serviced land, limited availability of relevant financial products, high construction costs, and weak government policy, according to the Centre for Affordable Housing Finance in Africa.

The data from the <http://housingfinanceafrica.org/countries/senegal/> indicates that:

According to the Secretary General of Ministry of Economy, Finances and Planning, demand for housing is estimated at 300 000 units per year while supply is about 50 000 which means a deficit of 250 000.

This means that there is a huge market for housing, and it is continually growing. In contrast, the supply of housing in many countries of Europe and in the United States is often well above the demand. Therefore there is a clear and unequivocal market for the product-

If one wants to design an improved construction system one first looks at what is being built at present. Again <http://housingfinanceafrica.org/countries/senegal/> provides relevant information:

Most Senegalese homes are self-built with cement, concrete and stone with corrugated iron for the ceiling, without an architect, and at a total cost of less than 30 million CFA Francs (US$50 589) or well above depending on the plan, the geographical situation and the quality of material used.

A good example of ongoing construction and the range of costs is described by the same source:

Bambilor is a new city about 10 minutes from Lac Rose and 30 minutes from downtown Dakar, and includes Cite CDC, consisting of two- to four-bedroom villas, built on 150 to 200m2 and costing about 10 to 47 million CFA francs (US$ 16,863 to US$ 79,257).

 The general situation seems to be positive and continually expanding:

Senegal is witnessing a dynamic growth in the real estate industry, particularly in Dakar and other urban areas. Factors driving the real estate boom include government programs establishing new urban zones and mass production of houses, population growth, and the reputation of Senegal as a stable democratic country which creates an enabling environment for investors.

Given this data, the important consideration is: What kind of house is built for the above listed cost? As evidenced by many photographs and descriptions of the real estate offerings on the web, the majority is in fact made using cement blocks and corrugated metal roofs. Therefore, there is clearly room for improvement. In analyzing the cost of a home built by a contractor through the data from <http://construireaujusteprixausenegal.unblog.fr/> it is apparent that the breakdown between materials and labor is nearly 75% percent to 25%. This means that the materials cost three times the labor. This is not so surprising, as the average mason in Senegal earns ten dollars a day, an order of magnitude less than an American or Italian doing the same task, but the cost of a fifty kilo bag of cement, about six dollars, is only twenty percent less than the cost in Europe or the States. The same ratio applies for all of the other construction materials.

This means that if the cost of materials were to be halved, the cost of a home would decrease by at least one third. This is about the difference needed to make a house affordable to the local population. An additional consideration is that the cement, the iron re-bars and the corrugated roofing needs to be transported from afar, or imported from South Africa, Russia or China or from companies owned by the above mentioned countries, though situated on the national territory. If the materials for a house were all available locally, this would represent an enormous economic advantage to Senegal’s future homeowners. Their savings would add to the national economy rather than flowing out of the country.

If local labor were to be used to prepare the raw materials for construction purposes, this would lead to much needed employment to the youth that is searching for work. There is nothing more stabilizing for a country than that of providing work for young adults.

The next important consideration is how the house would perform to fit the needs of the population at large. A principal desire of a homeowner in Senegal, and all hot countries, is to live in a cooler environment. For more than five decades air-conditioners have handled this task, in all of the parts of the world where the inhabitants can afford them. The following source <http://www.sciencemag.org/news/2018/03/countries-crank-ac-emissions-potent-greenhouse-gases-are-likely-skyrocket> indicates that the ‘side effects’ of air conditioners are not good:

"Growing populations and economic development are exponentially increasing the demand for refrigeration and air conditioning," says Helena Molin Valdés, head of the United Nations's (UN's) Climate & Clean Air Coalition Secretariat in Paris. "If we continue down this path," she says, "we will put great pressure on the climate system." But a slow start to ridding appliances of the most damaging compounds, hydrofluorocarbons (HFCs), suggests that the pressure will continue to build. HFCs are now "the fastest-growing [source of greenhouse gas] emissions in every country on Earth," Molin Valdés says.

As to the materials presently in use, it is well known that cement blocks are a very poor, practically the worst possible insulator against the heat or cold. The corrugated roofing in use throughout the world is a conductor of heat rather than an insulator. Therefore a house made of the standard building materials now in use is a severely inefficient way to stay cool, and an air-conditioner is an even more costly and damaging solution to the problem.

In addition to these considerations it has been calculated that bamboo culms,--to be used as a structural element for the homes,-- generates up to 35% more oxygen than equivalent stands of trees and that an hectare of bamboo sequesters 62 tons of carbon dioxide per year, while a young forest of the same size only sequesters 15 tons. As it does not require furnaces for processing, unlike iron for re-bars, its processing does not produce heat. All of this is a help to keep the planet cool. Bamboo also uses water very efficiently, and requires less than an equivalent stand of trees, in order to grow. As it grows without the need for fertilizer or pesticides that many other species require, it is one of the most natural solutions for the creation of a sturdy structure.

The materials that we propose and the architectural configuration to maximize shaded exterior walls, are aimed at solving these problems. The thermal inertia of clay and fibers is twice that of cement blocks, and at least three times that of corrugated roofing. Bamboo has been certified internationally as having greater strength per weight than iron. The design of the houses is aimed at maximizing airflow to create convection currents, to cool the structure as naturally as possible. We are hoping to build the first prototypes of our houses on a tract of land, that contains forty lots, and is situated half way between Bambilor and the Lac Rose, a very promising geographical address for future development. If such a home can be built for less than two thirds of the present construction costs, and can halve the use of air-conditioners, we believe it will have a large market, and an important return on investment for potential backers.