

## SOLAR DECATHLON LATINO AMÉRICA Y CARIBE. CALI 2015 (COLOMBIA) PROYECTO AURA

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### ABSTRACT

Solar Decathlon Latin America and the Caribbean 2015 will take place in the city of Cali, Colombia. Coming from North America and after the European and Asian editions, now the competition for sustainable housing arrives Latin America.

'Solar Decathlon' is an international competition inviting students around the world from universities specialized in Engineering, Architecture, Urban Design, Renewable Energies and related careers to participate on creating, building and operating Self-sustaining social solutions, run by solar power.

In addition to the founding principles of the original Solar Decathlon, the SD LAC2015 Organization has decided to focus on the following four components, which will be fundamental to the proposals in order to adapt them to tropical climate and cultural conditions. The components are:

1. **Social Housing:** As social inequality is one of the most pressing issues in Latin America and the Caribbean, the Solar Decathlon should strive to prove that sustainable housing based on alternative energy sources can be accessible to the population at large, prioritizing dense urban areas where most of the population is living.
2. **Density:** Nowadays, most of the population lives in cities where building areas are increasingly scarce and expensive. Moreover, denser housing solutions can help minimize the environmental impact. Consequently, the SD LAC2015 will favour projects that optimize the architectural and urban footprint.
3. **Rational Use of Environmental Resources:** The vast majority of the Latin American population lives in the tropics, enjoying high solar radiation all year long and exceptional availability of water sources.
4. **Regional Relevance:** The SD LAC2015 embraces the goal of developing and promoting ideas, capacities and technologies that can be implemented for the benefit of the inhabitants of the LAC region.

The actual construction of prototypes will take place in the 'Universidad del Valle' campus. The competition combines both theoretical and practical knowledge considering projects must be built on real scale and be tested on 10 different contests.

The hisCali team, from the Sevilla University, will take part in competition together with the 'University of Santiago de Cali', and with the support of the IUACC and the official masters of Innovation and Sustainability, both from the Sevilla University.

Keywords: architecture, sustainability, society, competition, Latin America.

## **1.- Introduction**

When Fernand Braudel writes his memories on the Mediterranean (or Latin Mare Nostrum memories), guides the reader through the great “inland lake” with all its historical relevance, and throws him to the pleasure of traveling by traveling, and, incidentally, sharing his conviction that “(...) there is a continuity that is repeated without repeating, through the long and brilliant past of the Mediterranean”. [1]

Such recurrence -such continuity on the historical warp- seems almost implicit within the referred realm (Mediterranean habitat), meaning that much of the cultural heritage of the –wrongly called- Western comes from what happened for centuries in the Mediterranean civilizations.

For that reason the attendance at a call like this, which merges architecture, collective housing, sustainability, culture, of an interdisciplinary team from the two of borders the Latin area (Cali in Colombia and Seville in Spain) could be of great potential.

As far as the architectural and social facts are concerned -in the context of the tropical climate area- it might be considered that the Latin or the Mediterranean fact lies below the line, being its ends...the city that for centuries (through its India's Harbour) led the relationships with America and, the city that even being in the “peaceful” side of the American continent, illustrates like no other the evolution of the colonial city to current times.

It will be the cultural and contextual component of the “Mediterranean habitat” in Andalusia and Cali, that of sets the broad framework where the work will be performed.

Solar Decathlon has a long history of competition with American, Asian and European editions, to those the Caribbean-Latin edition is added this year, and which have given rise to a wide variety of documentation about sustainable architecture [2]. Besides, to tackle the goals of the Solar Decathlon in general, and especially in the SDLAC2015 of Cali, it is evident the demand of a trans-disciplinary approach which promotes the dialogue with the context, the environment and the society.

Due to that reason, the presence in the team of members from almost all the areas of the University of Seville, the academic framework in which the work is supported, is justified, taking into account the consideration of the suitability of the project in terms of sustainable sensitivity of the architectural fact. The valuable contribution of scholars, researchers and students from the Faculty of Engineering of the University of Santiago de Cali is also guaranteed. Further the Architecture School of the ‘Universidad Católica de Chile’ supports this project as consultants.

All of them are ready to face the challenge of conceiving a piece of Latin American city in a tropical and socially dense environment.

## **2.- Conceptual Urban and y Architectural Design**

### **2.1.- Manifiesto**

Solar Decathlon ETSA-US + FI-USC team (for now on hisCali team) develops this proposal as an intentions one, looking for an alternative and sustainable management of housing and its spaces.

#### **2.1.1.-Fundamental principles**

- In the absence of other participation procedures, the proposal is enclosed within the Cultural Developments of the place and the Scheduling of strategies of knowledge, production and dissemination on housing.
- As a starting point, the metropolitan housing is considered as unique territory, being necessary its environmental characterization as well as the

improvement of its quality in terms of social cohesion, habitability and urban landscape.

- Social housing acts as an efficient cultural facility, giving significance from participation and long-term planning, with institutional and economic support. Thus, a fragmented and shared residential substrate is proposed, which establishes as a reference community and environmental values.

### **2.1.2.- First goals**

Settings-charts around the dwelling as social housing

- About its Management: looking for social, urban and territorial cohesion within the Colombian regional development policies, legal and administrative endorsement will be provided. Following the proposal of the “Manifiesto por los Humedales de Colombia” [3] it is intended that, ‘beyond the economic situation in which (humedales) social housing is arranged, a comprehensive program aimed at promoting and developing research to support their integrated management in long-term horizons, forming the basis for designing a policy where conservation and development are merged.
- About the Production: The housing, located in urban areas of high incidence, is proposed as urban and differential nexus of a set of homogeneous segments which are characterized by having social needs, aspirations and comparable claims. From a space-time net (as support of the schedule), their household appliances (gadgets) and a specific economics (as a system of relationships between individuals and communities) that enables efficiency and involvement of patronage (networks, institutions or companies) both local (as a priority) and external.
- About the training: As technical support for the increase of civic skills, at different steps of its construction (complex materiality easy to use for self-assembly) and its start of application (both productive and reproductive emerging modes of living).
- About the broadcast: The facilities comprise Information and Communications Technologies (network of actors, producers, locations, increased reality) and a general procedure that is particularized and applied to other situations in terms of the actual ‘housing service’. (Image captures devices located in the selected communal housing, allowing real-time presentation).

### **2.1.3.-Considerations on the prototyping**

The prototype guarantees, with its construction in the Villa SD, its applicability and reliability. It verifies the improvement and optimization of results in its potential urban concretions, as it activates social indexes (cohesion), urban indexes (employment), economic indexes (materialization) and environmental indexes (efficiency), respecting the existing resources.

Its exhibition, from the three aforementioned steps, will develop a handbook to inspire and guide citizens. This will address the following elements: neighbourhood relationships (contacts) and environment (extensions) for the cell housing; management and spatial aggregation (community and occupation gradients) and environment (identity and image) for the building; and social and territorial cohesion for the urban community.

### **2.2.- Goals**

Our aim is to search for an implementation process within the city that makes its extrapolation possible to the entire Latin American and Caribbean region. That is why we are seeking to exemplify the process in Santiago de Cali, looking out for a specific

solution and solving real problems in the city; in order to achieve a sustainable model, not only on an environmental level but on an economically and socially equitable level. Ultimately the aim is to establish an adaptable city and put it through checks (try it/ put it to the test/ test it) in the case of Cali, not create a city for Cali.

### **2.3.- Urban model**

Our methodology is based on three scales related homothetically, to the most viable degree of self-sufficiency.

#### **2.3.1.-Unit housing**

At the household level the aim is to create a flexible, progressive and productive housing unit with the highest possible degree of self-sufficiency, seeking to be energy efficient and managing waste production at source.

#### **2.3.2.-The building**

At a constructional level the goal is to generate a diverse housing territory where productive housing units blend in with shops and community facilities. This system also seeks to achieve greater self-sufficiency in managing resources, waste and energy.

#### **2.3.3.-The urban community**

At an urban level the goal is to escape urban zoning and create a diverse and productive city structured through a mesh of local centres, generating a network of communities able to meet the needs of the citizens. These communities are self-sufficient city cores at all levels, not only in introducing resources but also in managing and recycling waste. The intention is to consider ecosystems that have to meet their needs on site, with a heterogeneous and diverse network ranging from production spaces to recycling spaces.

### **2.4.- Open system on three scales**

The three scales mentioned above rests on three conceptual axes that articulate the urban model in its entirety.

#### **2.4.1.-Three scales as Open System**

Our focus is not on establishing a mechanism of repetition, but an abstract system of rhythms and sequences open to vary and specific system solutions. A latent form conceived more as a result of a system than as of a layout: open systems versus closed layouts.

The system addresses the typological diversification of housing from the reciprocating motion of core servers, in a predefined fixed unit area, a grid. The proposal is based on the variable location of three equipped walls, conceived as hard elements (cell clots) forming a fluid space conforming to its surroundings, favouring the removal of interior walls and substituting them with sliding panels. Different combinations appear this way ranging from more conventional distributions to other more open distributions.

We propose housing as the sum of three factors: cell + membrane + free space. The first consists of the individual functions (living room-bedroom -study), the service spaces (kitchen-bathroom) and ambiguous spaces (circulations). The second will vary according to the orientation and environment (single layer, multilayer, top layer, blind layer, transparent layer...) and the last will form the outer space of each dwelling unit, whether patio, garden or orchard. (Fig.1)

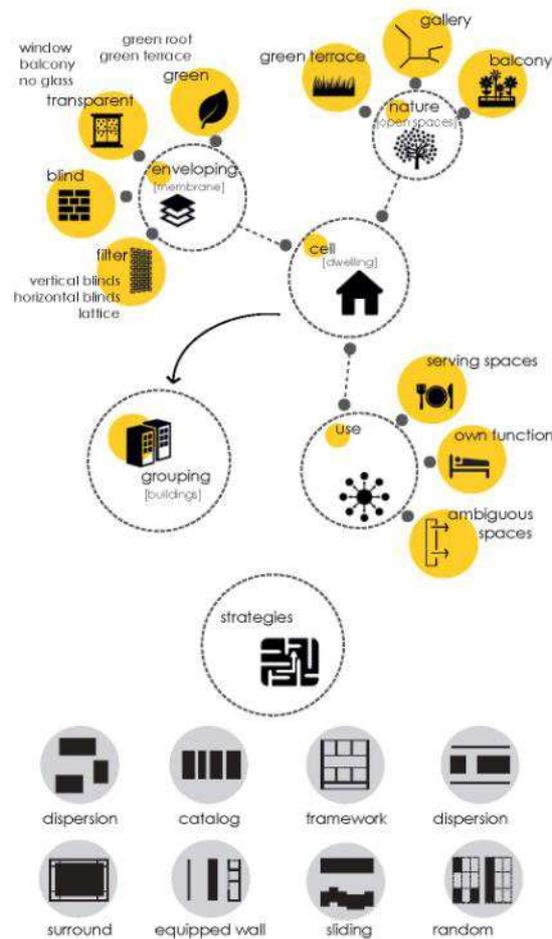


Fig. 1 “Housing strategies”. Source: authors

### 2.4.2.- Three scales as frames/plots, traces and grids

We propose the use of frames as those defined through reference meshes of recognizable geometries and / or deformed but with ability to overcome the rigid lattice order and promote flexible frameworks.

### 2.4.3.- Three flexible scales

Today the concept of flexibility should be associated with increased degree of multi-tasking and versatility of space. In this sense, both tactical actions of a structural nature (progressive use of large light and minimization of the structure) as well as relations with the design of equipment such as those related to distribution systems and division, about evolutionary require equal importance.

Housing derives from the idea to adapt, to the greatest extent possible, to any family situation and circumstances at a time. The combination of types with different modalities allows for a variety of spaces that seek to adapt to the multiple social identities, all possible and necessary in Latin American society.

### 2.4.4. Bioclimatic Operation

In the project presented by the hisCali4 team, adaptation to local climatic conditions is subject of special attention. As with equatorial wet tropical climates, Cali has warm temperatures and no significant seasonal changes (averaging temperatures ranging from 25 ° C to a minimum temperature of 17 ° C), abundant rainfall concentrated in two annual periods (March-April and October-November) and records of relative humidity whose values range between 70% and 80% throughout the year, plus variable winds in both intensity and direction. This climatic environment requires

careful evaluation of different ambient parameters to achieve the desired objective of internal comfort with minimal energy consumption.

Therefore it is a priority to implement actions designed to optimize energy consumption by suitable adaptation to solar radiation, both direct and diffuse kind, the use of cross ventilation to achieve an adequate level of hygrothermal comfort, etc. [4].

There will be measures to reduce water consumption, such as studying the water cycle within the housing and exploiting the abundance of rain water.

The building has superior spaces to housing, community use, is flexible, able to accommodate production or energy use: the building's topography reaches the highest possible level of self-sufficiency, complementing housing and out sources into the city system, the minimum load of waste and energy supply.

The result of this system is a diverse city structure that generates a range of situations ranging from resource production to recycling waste and water: a collage, a territory, a topography in which the pedestrian has priority and local processes are encouraged. In short, neighbourhoods act as the district headquarters of the activity of the city equipped with a core of collective identity.

## **2.5.- Lines of Action**

After the theoretical study of a series of physical parameters that have allowed us to assess the status and functioning of the city, three lines of action have been established. (Fig.2)

[ENV] In the first line one of the main objectives is to relate set architecture with nature so that it functions as an ecosystem that can absorb the waste produced, this calls for the proposal of two intervention strategies: the creation of free open spaces and green areas, and the establishment of a new water cycle which will allow recycling for the most part. Other major environmental and economic objectives would be to reduce energy consumption through passive design techniques, looking for good environmental conditioning using natural means, and more effective means of waste management, strengthening local governance and increasing the proportion of recycled waste. This way, one can count on a modularization, which is standardized by systems and patents. One that, from the outset of its installation in the work to its disassembling, can permit the reuse of most of the components.

[SEC] In the socioeconomic context, the objective is to create a social infrastructure that enables the development of a community without segmented sectors and an equitable distribution of resources, to facilitate social integration. Infrastructure that drives concepts such as self-management or citizen participation, from self-constructional work in home creation to creating jobs and training workshops that can produce and establish a micro-economic network that stimulates economic flows.

[URB] On the other hand at the urban level, efforts will be made to implement an improved system of sustainable urban mobility that promotes personal relationships and improves accessibility to services and the city's public spaces, with a new network of infrastructure to facilitate this. Given the density and diversity of existing uses of equipment, we will establish three scales: local proximity, intermediate or city level.

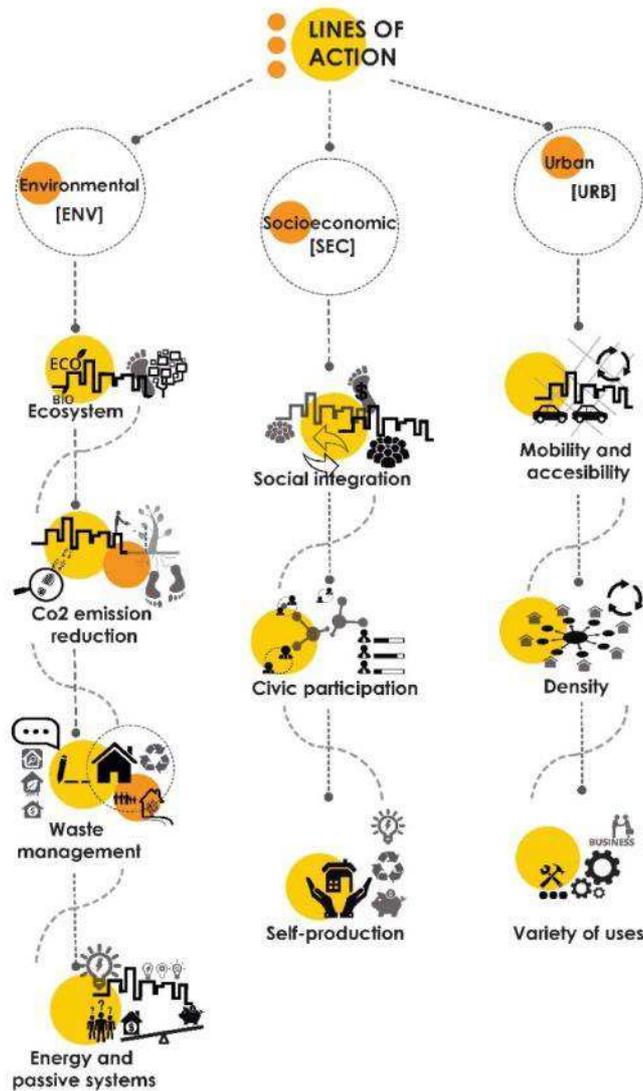


Fig. 2 "Lines of action". Source: authors

### 2.5.1- [ENV] Ecosystems

One goal of the project is to link nature and architecture. To achieve this we intend to examine the possible relationship between the proposed urban system and nature's capacity to absorb produced waste, so that it works as an ecosystem. (fig.3).

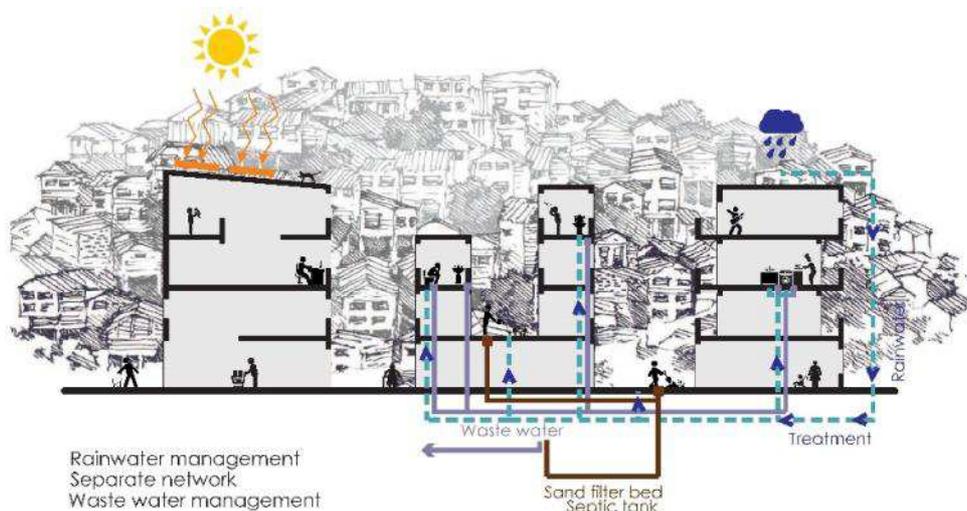


Fig. 3 "Waste management". Source: authors

### **2.5.2- [ENV] CO2 Reduction**

In order to remove CO<sub>2</sub> from the atmosphere, it is necessary to carry out a process that naturalizes the public space. To do this, we propose incorporating carbon sinks by planting native plant masses, typical of tropical species, and as these are the best adapted to this climate, they of course, require less care and maintenance.

### **2.5.3- [URB] Mobility and accessibility**

We therefore propose on a first level, within each unit, the existence of the existence of facilities, the necessary basic free zones and places that satisfy the first need of mobility favouring pedestrian traffic. In this way there will be less need to use motorised transport because there will be enhanced travelling proximity.

On a second and third level, to achieve movement of average proximity and at the city level, we propose a network of optimal public transport that allows access to all amenities and public spaces of the city. This network will be efficient and will be available to all residents, regardless of the social strata to which they belong. Thereby favouring the horizontal city structure that we propose as against a hierarchically ordered society.

To support the public transport network we propose attaching a network of bike lanes that run throughout the entire city, as the weather is conducive to this type of mobility. This will reduce the emission of gaseous pollutants and motivate a rational use of private vehicles and foster the protection of the environment. (fig.4).

### **2.5.4- [URB] Density / Compactness**

Our proposal is the design of the city based on an increased housing density raising building heights in order to liberate spaces to be used for parks and facilities. The aim of the consolidated city is also to regenerate these urban spaces to progressively change its configuration.

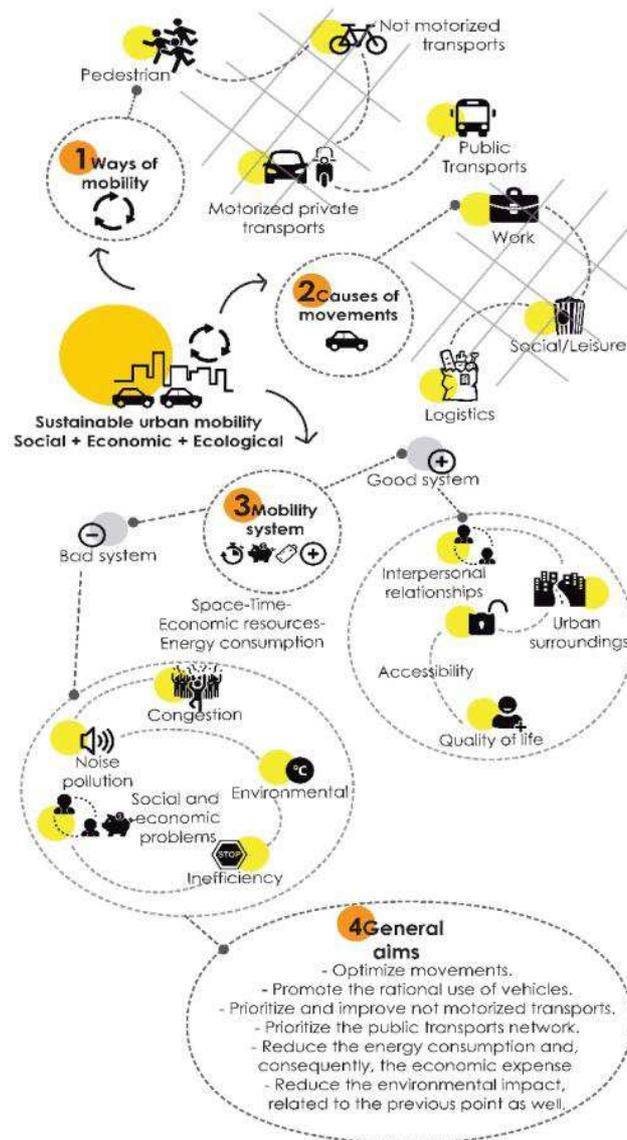


Fig. 4 “Mobility and Accessibility”. Source: authors

### 2.5.5- [URB] Diversity of Uses / Urban complexity

We propose a structure of facilities at three scales:

- **Local facilities in close proximity:** these complements the housing system, constituting the heart of the public space and a self-reference and identity area, meeting and management spot. Such as business-related areas (bazaar, small shops) and socio-cultural facilities (cultural centres of the neighbourhood).
- **Intermediate facilities:** these facilities generate an intermediate system that completes local facilities without actually having a city level identity. Educational equipment (kindergarten, school, college), health (health centres, external health clinics), socio-cultural (civic centre, worship centre), sports (multipurpose rooms), health care, municipal services (police station) and business-related areas (market).
- **City level Equipment:** this equipment is integrated into the city in order to be shared by the different districts or communities. Educational facilities (university, undergraduate and artistic), health (hospital), socio-cultural (library, theatre, showroom), sports (sports stadium), welfare (social services centre), urban services (public administration, firehouse, security, justice, cemetery) and business-related areas (shopping centre).

### 2.5.6- [SEC] Social Integration

The aim is to create a social infrastructure that generates community sense without differentiating social strata. It is essential to achieve an adequate and equitable distribution of city resources. Housing plays a key role in guaranteeing the dignity, but we also foresee the creation of additional spaces aiming the development of social life of the neighbourhood.

### 2.5.7- [SEC] Citizen participation and self-management

The goal is to get a city where people can recognize themselves and can participate in management. This requires spaces of collective identity and public management. Management occurs through an organized network (neighbourhood associations and organizations) that can manage the community: resources, activities and use of community spaces, its representation must be recognisable in the neighbourhood and the urban discourse through public buildings and spaces.

### 2.5.8- [SEC] Financing

Housing is proposed as a growing organism, that cans reassemble the way in which people and their circumstances live and develop. Our strategy generates an unfinished housing, based on minimum margins, which is not an end but a manipulable object territory that allows progressive investment and can host a micro-productive activity, with the consequent benefit of the resident population and the neighbourhood in order to accommodate a micro-economic production.

### 2.5.9- [SEC] Self-construction and prefabrication

We propose training workshops teaching construction techniques, to encourage self-construction limiting the additional cost of labour. These workshops will constitute not only training centres, but also spaces for interaction and co-working that can to enable the provision of services and the production of goods able to meet the minimum needs. They will also support the creation of a market-cell which can be extrapolated to the agency / district / commune system / city. (Fig.5)

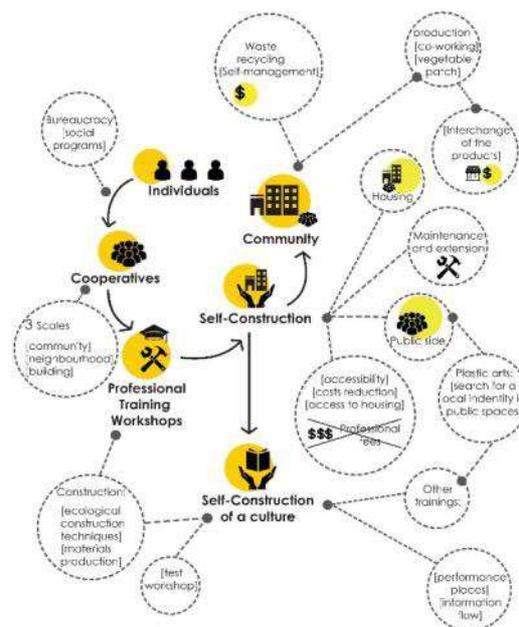


Fig.5 “Self-construction and prefabrication”. Source: authors

### **3.- Technical Innovation**

The Solar Decathlon Team ETSAS UNIVERSITY OF SEVILLE+ + FI-USC (hisCali team) proposes to build series of housings using modular and energy self-sufficient elements including a set of qualified domestic spaces and related community prefabricated modular systems.

This Project includes ecological footprint indicators measuring both the resources and the waste generated in order to maintain the production and consumption standards of the community where these housings will be located.

The construction of these houses are based on a environmental model which uses low energy construction elements obtained from previous recycled materials which can be later reused due to the fact that their dry construction allows an uncomplicated disassembly system. The Project also takes into account that the cultural and geographical area where this Project is going to be implemented; Latin America and the Caribbean.

Our work is thus based on the following concepts:

#### **3.1.- Industrialization**

Industrialization is a rational and automated production process, which involves advanced designs of production, manufacturing and management technologies, using materials, transportation and mechanized techniques in series aiming the highest possible productivity.

##### **3.1.1.- Open prefabrication**

Prefabrication applied to the construction system is based on the design and production of components and subsystems produced in series implemented at a location remote of its final destination. These components and subsystems are designed to make up all or part of a building or construction through a simple, accurate and not laborious assembly process. The “open prefabrication” system is based on compatible, interchangeable and renewable elements or systems, that excludes any closed or processes.

##### **3.1.2.-Proportion and modulation**

The project applies modular coordination in different scales between systems, modules, and other elements, and takes account of manufacturing tolerances and assembly.

##### **3.1.3.- Flexibility**

The use of an open prefabrication system combined with compatible components will provide flexibility in spatial organization, and allow the adaptation of the model to different ways of housing occupancy and the transformation of the housing spaces in many different ways adjusted over time to meet the families' needs.

##### **3.1.4.- Materials**

The project will use preferably local sustainable materials considering their energy balance and lifecycle. Sustainability will be addressed through the extensive use of renewable, low environmental impact materials that require minimum maintenance, and recyclable and recoverable elements.

#### **3.2.- Sustainability / Energy Efficiency**

The rational and efficient use of energy is a priority. To achieve this goal, we must encourage energy savings through passive and active measures and promote the use of renewable energy. Costly, sophisticated and fragile equipment can be

replaced by ingenious and pragmatic bioclimatic strategies, that take into account the needs and possibilities of the environment, the climate and the geographical peculiarities of the location.

### **3.2.1.-Integration to the environment**

The choice of materials has an impact both on the external and the internal environment of buildings, and on the users' health. In order to assess the environmental impact of the construction materials we must consider each of the phases of the materials life cycle and its related risks: manufacturing, assembling, use and maintenance, demolition and disposal of waste.

### **3.2.2.-Life cycle analysis**

This project will implement life cycle analysis (LCA) as the study methodology of: product life cycle and its production process; raw materials; the material integrated energy and possible emissions. The project will also consider the supply of raw materials necessary to produce the prototype, its transportation and manufacturing and, finally, the product itself, including packaging, product use and the waste generated by its use.

### **3.2.3.-Reuse**

A key objective will be the minimization of waste production through reuse and recycling. With these intentions get not only environmental benefits, but also obtain economic benefits. The construction components valued based on the weight of the waste arising have little value. But if suffering minor processing, or, if it could be, without them, can be regenerated or reused directly, their economic value is very high. Here, the re is a way to minimize the waste caused, less complex and costly manner than recycling.

## **3.3.- Energy – renewable energy**

Thus, we set the objective of promoting energy independence, not only in housing but also seek this intention transcends the limits of it, so that these units by forming gayolas / buildings / structures, which in once form communities, generate interrelated systems that are, as mentioned, energy self-sufficient [5].

### **3.3.1.-Consumption levels**

Regardless, therefore, of what the specific evidence of consumption in the place in which we are speaking, we must encourage the development of sustainable management of urban energy that tends towards more rational energy consumption by promoting saving energy and more intense use of renewable energy sources. The combination of these measures related to energy has a direct impact on reducing emissions of greenhouse gases, and thus on climate change.

### **3.3.2.-Renewables and self-sufficiency**

The proposal for the Solar Decathlon in Cali seeks to address these challenges through a change of energy metabolism, also applicable to other locations. Reduce the energy demand of the users of housing is the main objective to pursue. It is therefore important impact on energy-efficient design, ranging from urban planning to architectural design itself.

#### 4.- Conclusions

The Solar Decathlon LAC2015 pursues proposals that benefit the whole society, considering the circumstances of social and economic inequality in the countries of Latin America and Caribbean area. For this, the proposal is based on four items:

- **Social housing:** sustainable and self-sufficient housing for a minimum of five inhabitants will be designed. Those dwellings are grouped in communities that are self-managed by their inhabitants. Self-assembly of these homes, prefab in high percentage, is proposed to save additional costs to the users.
- **Density:** density between 160 and 180 dwellings per hectare, with buildings of at least PB + 4, is considered. Accessibility strategies are required to interconnect buildings of different heights (PB + 4 is the predominant height) by means of the minimum number of lifts and decreasing costs.
- **Rational use of resources:** the natural resources of the region will be taken in order to guarantee an environmental balance that ensures the on-going use of resources. The use of solar, wind and hydric resources is proposed. In addition, the increase of nature qualities of the public areas to reduce CO2 emissions will be promoted.
- **Regional significance:** an open system that adapts to the cultural, economic and climatic conditions of different countries of the Tropics is established.

Socioeconomic action lines [SEC], environmental [ENV] and urban [URB] will be developed, creating networks that form the city and the inhabitant relationship.

A main goal is to develop ideas and technologies that benefit the people of the region.



Fig. 6 “Proposal Solar Decathlon LAC2015: Fundamentals Scheme”.  
Source: authors

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