PROJECT
MANUAL

CASA FENIX

[DEPARTEMENT GÉNIE CIVIL - IUT UNIVERSITÉ DE LA ROCHELLE]
[UNIVERSIDAD TÉCNICA FEDERICO SANTA MARÍA]
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Faculty advisors Nina HORMAZABAL POBLETE, Universidad Técnica Federico Santa María and Gérard SCHELLENBAUM, IUT Université de La Rochelle, certify the Code Compliance Checklist document fulfill all the requirements given by the French building codes.

Nina HORMAZABAL POBLETE  
Faculty Advisor UTFSM

Gérard SCHELLENBAUM  
Faculty Advisor IUT La Rochelle
One of the most outstanding geographical features of Chile is the relatively constant threat of earthquakes, among other natural disasters, such as volcano eruptions, landslides and fires in urban areas. The regularity with which these events occur does not make them any less catastrophic for people. Many homes are lost and the people who are most affected are low-income families. The post-catastrophe situation throughout year has indeed been non-sustainable, therefore to develop and implement the concept of sustainable reconstruction is a big challenge for our country, where Casa FENIX ambition is to propose and offer a tangible solution.

**THE PROBLEM** While Chile is a political and geographical location where natural disasters are recurrent and affect a great part of the most socially vulnerable population, there are no official policies which outline a quality response to such events.

"When disaster strikes, the problems are resolved with quick, cheap, short-term solutions, such as the mediagua emergency houses" which end up causing more problems than they solve and lead to a great deal of waste in the long term.

**HYPOTHESIS** Casa FENIX is a design process that responds to a catastrophe, delivering energy efficient strategies to ensure quality of life as a key factor in a sustainable reconstruction; these strategies are not currently considered in post-catastrophe national policy. Sustainability factors include locally specific environmental, cultural and geographical issues, and also consider accessible and viable solutions for the most vulnerable sector of Chilean society.

Therefore, the original objective behind this proposal is:

"to create emergency dwellings that offer quick, good quality and sustainable homes for the families who are the victims of a disaster."

Thus the architectural and urban concepts that shape the proposal at both individual and collective levels are: **Modularity, progressivity, flexibility and affordability.**
Modularity
Casa FENIX evolves from a basic Survival Module to a complex Eco Village/Housing Complex. This process covers the stage of Emergency, Relief and Reconstruction.

Progressivity
Casa FENIX progression allows the Survival Module unit to become a final home. This incremental and evolving logistics is assumed by the urban design strategy.

Flexibility
Casa FENIX has the capability to adapt to different latitudes and climates, given the geographical characteristics and diversity of climates Chile possesses, from north to south.

Affordability
Casa FENIX is an affordable home. Each unit may be acquired through the progressive subsidy addressing the total cost of the home.

A R C H I T E C T U R A L PROGRAMME
For the SDE competition, the Casa FENIX Team proposes to bring a house that represents reconstruction as a growth progression and is configured to perform well in the Versailles climate. The basic structure and its components will subsequently be configured to meet the solar passive design strategy for the specific local climate where it is to be installed.

The programme represents the core concept of Casa FENIX, which takes a progressive approach to Emergency, Relief and Reconstruction, with sustainability in mind. It uses a passive solar design driven by a sunspace, which acts as the energy engine of the completed house and is a key spatial element which allows the articulation of the different modules.

Casa FENIX is a modular design in which each 11 m² module can be progressively attached and easily assembled during a post-disaster period, to form a dwelling measuring 60m².

The modules are as follows:
Survival Module
This is the quick initial response for the emergency period, immediately after a catastrophe strikes. Its main objective is to provide shelter, safety and a quality solution to the affected family.

Mechanical Module
This is the first module to be attached to the Survival Module as a progression during the relief period. It consists of the services and a technical core. It includes a bathroom and kitchen.

Living Module
This is the module that enables the house to expand and cover more than the basic needs during the reconstruction period, transforming the sum of modules into a definitive home.

Sunspace
The passive solar design strategy enables the regulation of the indoor climate by articulating the different modules with the exterior climate; this space grows with the addition of each module.

At a collective level, the group of emergency houses, which the FENIX team has called “Temporary Village FENIX, TVF” and the progression to a housing complex, which the FENIX team has called “Eco-Village FENIX, EVF” are conceived following the same logic. They have an open and flexible design that allows for the adaptation of modules and means that Casa FENIX can be adapted to different climatic, topographical, territorial and cultural realities.

THE GEOGRAPHICAL DIMENSION
Chile has 9 different climate types and the country stretches from latitude 18°S to 50°S. 90% of the population is located in areas where solar radiation is over 1000kWh/year. To address this climatic diversity and take advantage of the opportunity for solar radiation, the conceptual idea for

“Casa FENIX is similar to a skeleton or basic structure, an innovative structural design developed by students, where different components can be configured and assembled according to the users’ demands”
All the components to be attached to it respond to the demands for the different latitudes and to patterns of self-construction.

**SUSTAINABILITY FOR US**

It is important to mention that the understanding of sustainability in the case of developing nations differs much from the one used in developed nations, in the sense that the problems that needs to be addressed are much different, respect of priorities and urgencies. For the Chilean case the deterioration produced by natural disasters and the anthropic urban degradation produced by informal settlements and poverty are the immediate problems to solve in a sustainable way. To teach the general public about sustainability issues that go beyond recycling, energy efficiency and achieving a low carbon footprint, Casa FENIX proposes to focus mainly on local cultural aspects, quality of life and social relationships. In this case the sustainability aspects are focused on using technology and urban planning to enhance the intuitive know-how of a particular local population.

“The choice of site: Man’s physical freedom manifests itself no doubt in his ability to choose the place on earth where he wants to live”.

People act, build and adapt through self-construction to the different latitudes and geographical conditions over time using their intuitive and basic knowledge.

“Neither privations nor danger will deter man from selecting a spot [...]” to settle on (Rudofsky, 1964).

This recognition of the appropriateness of the way informal settlements and self-construction take place is basic and seen to be positive; however it is extremely precarious and unsustainable in many other
aspects and in extreme situations could produce complete devastation. This was the case in April 2014 when a wildfire ravaged Valparaíso for three days; 2,900 homes were destroyed and 14,000 people - 4% of the Valparaíso population (IMV, 2014) - were made homeless.

The reasons for the unsustainable settlements can be traced back to many issues related to post-disaster rehabilitation and poverty and a major factor is the lack of a sustainable urban code for areas of vulnerability. This sustainable urban code would need to respond in a general way to the emergency and in a particular way to the post-catastrophe situation that begins right after an emergency occurs.

Casa FENIX TEAM ORGANIZATION

Team Casa FENIX is a bi-national team composed of students and faculty members from the Universidad Técnica Federico Santa María [UTFSM], Valparaíso, Chile and from the Institute Universitaire de Technologie [IUT], Université de La Rochelle, France. In addition to all the opportunities that arise out of any international collaboration between academic institutions, team Casa FENIX seeks to respond coherently to SDE’s energy conservation objectives.

The proposal has been designed to address the circumstances and needs of Chile. However, transporting the house from Chile to France would entail a significant amount of CO2 emissions and the team has therefore set itself the goal of making a “PROTOTIPE” in Chile and a “REPLICA” in France, generating a dualism and a double challenge for our project. So, while the conceptual proposal is Chilean, the production of Casa FENIX is French.

TEAM Casa FENIX CHILE

The Chilean part of the team is in charge of all the theoretical, conceptual, architecture and urban design content of the project. One of the strengths of UTFSM is their research and work on bioclimatic architecture and earthquake resistant construction.

TEAM Casa FENIX FRANCE

The French part of the team is in charge of all the practical, construction, building and technology applications of the project. One of the strengths of IUT is their research into and work with wooden structures and construction. A complete version of a replica of Casa FENIX is being built in La Rochelle and this is the version that will compete in Versailles.
5.1.1 URBAN DESIGN STRATEGY

Casa FENIX evolves from a basic SM module [14m2] to the conjunction of SM, MM, LM, and SS modules [which add up to a total 64m2]. This progression allows an emergency unit to become a definitive home.

The incremental and evolving logic of the proposal at the individual scale is assumed by the urban design strategy and is comprised of two stages:

1. Foundation of an Emergency Housing Complex, “Temporary Village FENIX (TVF)” on previously identified neighbourhood football fields.

2. Transfer of the Emergency Housing Complex to its final site where the houses can evolve and consolidate, becoming definitive homes which constitute the permanent “Eco Village FENIX (EVF)”.

At first, this strategy is aimed at being an immediate, high quality, and sustainable solution addressing the need for homes after a disaster, which is defined as Stage 1 of survival or emergency 1 [the latter will be used mostly]. In the second instance, it should become a permanent and sustainable solution by means of an evolving proposal of consolidation of the home, defined as Stages 2 and 3 of relief and reconstruction.

Pursuant to this progression, the urban design strategy initially proposes the location and implementation of an Emergency Housing Complex on football fields located near the disaster site, as they possess utility networks and an appropriate urban connectivity.

Evolution from an Emergency Temporary Village FENIX to a Casa FENIX.

Emergency Housing Complexes are basically defined by their temporary character, i.e. they immediately solve the lack of shelter following a disaster. This characteristic will define their location and the duration of the first survival stage, which is estimated to last six months.

On the contrary, the Casa FENIX proposal is defined right from its origin as a versatile and incremental proposal that in the first stage will accommodate SM modules from the Emergency Village, so that they progressively come to form a Permanent Village. In order to do so, we have defined the intrinsic risks, as well as solutions and variables for each of them. The location of Casa FENIX will either be the site where the original home stood or another site defined by the Ministry of Housing and Urbanism [MINVU].

Why football fields? [“Canchas” in Spanish]

In Chile, a football field is a place where people meet, socialize and play, i.e. it is a public space par excellence. In the case of Valparaíso, the 27 football fields located in the hills are the only flat and empty places that exist. This condition makes them suitable as a site for the Emergency Housing Complex and for installing SM modules for the survival period.

This practice is in fact commonly used by local authorities following earthquakes, as flat areas are safer and freer of risk during seismic events.
The advantages of installing an Emergency Housing Complex on football fields:

- Football fields are the only flat places or esplanades available in the city of Valparaíso which also possess access to utilities [drinking water, electricity and sewage facilities].

- Football fields are easy to access, and are usually connected to main roads, which would ease the urban mobility of their inhabitants, as well as transportation of construction equipment and materials.

- Possible disasters and their effects

Considering the diversity of geographical and climatic environments that occur in Chile, we have defined the imminent risks that could be expected and controlled by means of the urban design strategy [Table 4].

In the case of Valparaíso, we have defined fire as an imminent disaster, as it is fires which have produced the most damage at an urban level.

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<tr>
<th>City</th>
<th>Climate</th>
<th>Köppen classification</th>
<th>Latitude</th>
<th>Imminent disaster</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alto Hospicio</td>
<td>North coast</td>
<td>Coastal desert, BWh</td>
<td>20° 13’S</td>
<td>earthquake</td>
</tr>
<tr>
<td>Valparaiso</td>
<td>Central coast</td>
<td>Mediterranean CSb</td>
<td>33°03’S</td>
<td>Wildfires</td>
</tr>
<tr>
<td>Los Andes</td>
<td>Center interior</td>
<td>Mediterranean, CSA</td>
<td>32°49’S</td>
<td>fire</td>
</tr>
<tr>
<td>Puerto Montt</td>
<td>South coast</td>
<td>Tempered oceanic Cfc</td>
<td>41° 28’S</td>
<td>earthquake and tsunami</td>
</tr>
<tr>
<td>Puerto Natales</td>
<td>Extreme south</td>
<td>Sub polar oceanic CFC</td>
<td>51°43’S</td>
<td>volcanic eruption</td>
</tr>
</tbody>
</table>

Table 4: Table of imminent disasters by climate zone

- Emergency Housing Complex for Chile

In each urban proposal, the criteria considering each type characteristics are as follows:

- Socio-cultural aspects

- Climate

- Geography and morphology of the terrain

- Local architecture

- Imminent disaster

- Urban mobility

As a sample of that, in the next pages is possible to see several proposals in which the “Temporarily Villa FENIX” is located in five major cities of Chile, subject to periodical natural disasters.
**CLIMATE** Coastal desert, influenced by the dry climate and the Humboldt Current. It is characterized by abundant cloudiness, low thermal amplitude oscillation between autumn and winter and early part of the spring, but changing in the summer when temperatures reach to the double and oscillation increases, being the most changeable highland town in Chile during summer season.

**NATURAL** It is a desert area, so it is characterized by dryness, but its proximity to the sea gives a high presence of moisture in the form of mist, which allows the existence of different types of cactus and shrubs. At the same time moisture generates a smaller temperature variation compared to similar inwards areas.

**VERNACULAR** An icon element of northern Chilean architecture are the "atrapanieblas", which allow the reuse of water for agricultural purposes. The atrapaniebla is an mesh element used in the desert to catch water droplets contained in the Camanchaca (coastal fog).

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<td>17</td>
<td>20</td>
<td>25</td>
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</tr>
</tbody>
</table>
ALTO HOSPICIO

EMERGENCY TEMPORARY VILLA

Located in a desert climate, the city of Alto Hospicio is constantly hit by high solar radiation and scarce precipitations, these conditions enable the possibility to create a villa capable of generating cool environment meeting spaces.

The project contemplates elements to catch fog, which allow water harvesting and at the same time create a humid space for maintaining urban orchards inside the villa.

In the sun protected spaces are located the common spaces as the dining rooms and interior patios. The distribution axes in the center of the villa are the place to locate water tanks and bicycle parkings.
**Climate** It is a transition between the warm steppe climate with very dry air and warm Mediterranean climate with long dry season of 6-7 months with an average annual rainfall of 398 mm. The annual average temperature for Los Andes is 15 °C with a peculiar temperature range, where the highest insolation months can easily reach 35 °C and the winter months can drop slightly below 0 °C.

**Natural** Rural area at the foot of the Andes mountains in the valley of the Aconcagua River. It has a great diversity of wildlife. It is a very fertile valley so the main production area is in the field of farming.

---

**Location**

Los Andes

---

**Perennnial** The local architecture is built of adobe with thick walls and small openings areas, which are protected by extensive eaves. The thermal inertia of the material and the presence of vegetation can generate a cool microclimate within homes.
LOS ANDES

EMERGENCY TEMPORARY VILLA

In response to a natural disaster, the local football field has been prepared to harbor temporary programs in optimized spaces, to satisfy basic needs as well as to some others related to dwelling and allowing the development of professional skills and talents. Considering the inhabitants, who come from different areas, it is necessary to generate spaces for human relationships, which link daily living activities. With this proposal the idea is to stimulate the relation between neighbors in the same block, therefore, it contemplates linked eating zones and common and wide leisure areas.
CLIMATE: Maritime warm temperature with the presence of heavy rainfall during winter, saline soil and atmosphere with high atmospheric moisture. Being a coastal city, is subjected to temperature variations, which leads to intense higher winds compared to the lower ones with uneven southwest and northern direction.

NATURAL: Flora espieses can be found like copihue, chamomile and olive, apple and lemon, in addition to trees like pines, eucalyptus and araucaria. Its fauna can be very varied having animals as diverse as warthogs, pumas and huemules up to starfish, jellyfish and various algae.

VERNACULAR: Wood is a predominant material in the architecture of this area. The weather is humid and cold so fire is the key element for habitability. [RAE-Fogon: Place where the fire is for cooking / gathering of friends by the fire.]

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<td>65</td>
<td>40</td>
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</table>
ARCHITECTURAL PROGRAM
- Housing
- Dining room
- Bathroom
- Fogón (stove)
- Nursery
- Neighborhood council
- Firewood storage
- Nursing
- Kitchen garden
- Workshops
- Shop area
- Vegetables fair
- Craft fair
- Guardhouse

DICHATO

EMERGENCY TEMPORARY VILLA

It is located in the coast village of Dichato, Región del Bio-Bio, and belongs to the thermal zone number 4 of the Chilean territory. The most important characteristics to be considered are the intense rains, high humidity and the predominant wind directions. The strategy to be used is the linear disposition, generating side streets to a central avenue. In this way the physical barrier protects inside spaces, in addition to the interior protected decks, along the streets, to protect pedestrians from rain. Also this allows de reception of common use programs as hotplates, trade fairs and workshops.
**CLIMATE** Oceanic, with abundant and constant rainfall, mild temperatures, low annual and daily fluctuations. The city lacks a dry season because even though between the months of October and April rainfall decreases, exceeds 60 mm. It is characterized by strong winds, with exceed 100 km/hr in gale season.

**NATURAL** Pumas, foxes, weasels and huemules can be found in mountain areas. While in the coastal zone, dolphins, sea lions and blue whales can be seen. The vegetation is abundant, highlighting the existence of ancient trees such as larch, araucaria and coigüe.

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<td>120</td>
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<td>120</td>
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</tr>
</tbody>
</table>

**VERNACULAR** Contemplates the use of intermediate spaces that protect from predominant rains and cold weather. Elevation protects floors from humidity so the construction of docks is very common. [Dock: Wood deck between houses building a raised floor.]

**LOCATION**

Puerto Montt

*Region de Los Lagos, Longitude 73°57'W, Latitude 41°27'S*
The lot is placed in a residential and commercial area, although it doesn’t exist any direct relation between them. For this reason, two axes are generated which ease the walking path inside the villa, and these at the same time, maximize both areas due to the increase of pedestrian flow. These axes have a public nature, whilst the secondary axes will be private, allowing the interaction inside the lot. FFENIX modules distribute grouping the largest ones (public services) to the extremes of the lot to protect the smallest ones (dwellings located inside) of the wind.

Wood is the main fuel used for heating, that is why to minimize expenses, the proposal contemplates building semi-detached houses to retain heat more efficiently.
CLIMATE Trans Andean steppe with degeneration. Rainfall decreases markedly, resulting in a steppe landscape type. Fall months can easily be identified (April and May) as the wettest. A second peak may occur between November and January. During winter precipitations are mainly in the form of snow.

NATURAL The town of Puerto Natales has coigües and beech forests and other wild species such as cauks, coiron, steppe and muddy kills. In its fauna condors “culpeos” foxes, guanacos, rheas, ommas and gray foxes can be found in the wild.

VERNACULAR The architecture is characterized by the construction of fire centered spaces. The wind protection is also essential characteristic giving an aerodynamic characteristic to buildings and placing entryways on protected sides of the houses.

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<th>Month</th>
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<td>Daily Minimum Temperature [°C]</td>
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</tr>
</tbody>
</table>
PUERTO NATALES

EMERGENCY TEMPORARY VILLA

It is placed in the city of Puerto Natales, located in the thermal zone number 7 of the Chilean territory, where possible flood areas are contemplated to get a sense of the amount of emergency housing that are needed. Due to the location, the wind speed must be specially considered and also the little light that is recorded annually. As urban strategy, the use of slopes was planned, as well as the reduced spacing between each FENIX module, to contain winds up to 120km/hr. Also takes care of roofs which enable common spaces for social interaction, implementing hotplates, neighborhood centers and places to accumulate dry wood among others.
Mobility of Emergency Housing Complex and Casas FENIX.

In the versatile and incremental design from an Emergency Village to Village FENIX, urban mobility is a strategic factor.

Mobility of Emergency Housing Complex

As was mentioned above, the Emergency Housing Complex will be located in football fields near the disaster zone. This strategic location has three main purposes:

- To ease the transfer of families from the disaster site to the emergency village, which we have defined as post-disaster residential mobility. [See section 5.1.4 “Mobility strategies”]

- To ease displacements from the emergency Village to the city, which we have defined as post-disaster urban mobility. [See section 5.1.4 “Mobility Strategies” ahead]

- To allow its inhabitants to maintain pre-existing social networks, i.e. avoid territorial uprooting, which could aggravate post-disaster trauma.

Mobility of Village FENIX

The Village FENIX will be located in the disaster zone or, failing that, in another area defined by the Ministry of Housing and Urban Development [MINVU].

This will depend on the impact of the disaster and the degree of deterioration of the site. This strategic location has three main purposes:

Figure 5: Ideas for the implantation of Eco-Permanent Villa FENIX in the city of Iquique
To ease the transfer of families from the emergency village to the final location where the Village FENIX will be built. This has been defined as post-survival period residential mobility. [See section 5.1.4 “Mobility Strategies”]

- To ease movements from the Village FENIX to the city. This has been defined as post-survival period urban mobility. [See section 5.1.4 “Mobility Strategies”]

- To allow its inhabitants to consolidate pre-existing social networks, thus reconstructing the social-spatial rooting.
Figure 7: Ideas for the implantation of Eco-Permanent Villa FENIX in the city of Chiloé
• Case study and urban design strategy: Emergency Housing Complex and Villages FENIX for Valparaiso City.

Aimed at defining and specifying the urban implementation strategy of the Casa FENIX, both in the “Emergency temporaly Villa FENIX” and in its progression into “Eco-Permanent Villa FENIX”, the city of Valparaiso has been chosen to develop the UDTA strategy, with the purpose of defining each and every aspect involved in it [Table 8].

Population

According to the 2012 Census, the city of Valparaiso has 292,510 inhabitants, 94% of who live in the hills of Valparaiso, with only 6% living in the flat part of the city bordering the coast, which is the urban, political, and social centre of the city. This segregated zoning generates vertical urban mobility from the hills to the coastal plain, where the inhabitants work, study, walk and buy their supplies.

<table>
<thead>
<tr>
<th>Geography / Demography of Valparaiso</th>
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<tbody>
<tr>
<td>Surface</td>
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<tr>
<td>Demography</td>
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<td>Climate</td>
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<td>Winds</td>
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<td>Relative Humidity</td>
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<td>Rainfall</td>
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Table 8: Geography and demography of Valparaiso

Climate

The average temperatures are moderate throughout the year and in summer they remain below the maximum comfort temperature. There is a low mean daily temperature oscillation: around 7°C in summer and only 5°C in winter. There is a high level of cloudiness all year round, and during the summer there is high probability of cloud cover in the mornings that dissipates by noon. Solar radiation is high in summer and moderate in winter: mean horizontal solar radiation ranges between 1.7 kWh/m2/day in July and 6.1 kWh/m2/day in January. There is high relative humidity all year round, with monthly averages of 68% in January and 84% in July. Precipitation is moderate, concentrated in winter. The winds are weak, with SW winds prevailing. When intense, they are combined with rain.

Imminent Disaster

In the case of Valparaiso, we have defined fire as an imminent disaster, for it has been the most recurrent disaster in the city over the last 10 years, even bearing in mind the earthquake [8.8 Richter Scale] that affected a large part of our national territory in 2010. The housing stock of the city of Valparaísó did not suffer the same large-scale damage as it does when ravaged by wildfires.

In the next pages is possible to see the main characteristics of Valparaiso, who Team FENIX was taking into account to developed the UDTA strategy.

---

1 2012 Census Executive Proceedings – Region of Valparaiso
Valparaíso football fields
Location for the 27 Emergency villas

- V.E 01
- V.E 02
- V.E 03
- V.E 04
- V.E 05
- V.E 06
- V.E 07
- V.E 08
- V.E 09
- V.E 10
- V.E 11
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- V.E 20
- V.E 21
- V.E 22
- V.E 23
- V.E 24
- V.E 25
- V.E 26
- V.E 27

Note: Some villas are not labeled with their full number due to the scale of the map.
Urban facilities in Valparaíso
Local Architecture

The vernacular-contemporary style in Valparaíso is evocative of the traditional and foreign styles of architecture that were erected in the city up to the beginning of the 20th century. There was significant immigration from Europe to Valparaíso, including people from Britain, Germany, Spain and Italy, who adapted American and European building technologies to the abrupt topography of the city. These styles of architectures have been imitated and reinterpreted for years by the inhabitants of Valparaíso, the majority of whom [app. 60%] have built their homes under these architectural and constructive reinterpretations [Figure 9]. The following types stand out:

- Houses with sunspaces and balconies [Figure 10]
- Houses built on retaining walls
- Dwellings erected on piles
- Houses with individual orchards [in planters formed by pallets]

Most old houses in Valparaíso have a wooden structure and “balloon frame” technology. These industrialised houses of European and American influence were transported to Valparaíso by sea in pieces to be mounted on the plain or in the hills of the city and, depending on the specific topography, were built on rock retaining walls or over pillars. Thus, the Village FENIX will take over this architectural and building tradition, adapting itself by means of piles, plinths, patios, terraces, and balconies.

Figure 9: Temporarily Villa FENIX Valparaíso, adopting the vernacular-contemporary Architecture.
Emergency Village in Valparaíso

In the design of the emergency village, we used a real case of a fire that occurred in 2008 on La Cruz hill. This disaster left 70 families homeless. They looked for a solution and resettled on the same site. In the first stage of a real emergency situation in Chile, as it is occurring right now in Valparaíso after de April 12th, 2014 fire, families installed tents and erected awnings of plastic netting to provide shade and shelter in order to safeguard and establish the boundaries of their properties [Figure 11].

Figure 10: Pictures showing self-construction in Valparaíso and the main architectural elements in the design

Figure 11: Improvised rooms, tents, and sunshades at the wreckage site. La Cruz hill, 12th April 2014
The next day they started clearing the site and rebuilding their homes.

The assigned football field is located on La Cruz hill at 225 metres above sea level. El Vergel is the main street with public transport and it is connected to Avenida Francia [See Figure on page 39]. For the families left homeless in this way, having access to an Emergency Village supplying shelter and their basic needs will allow them to cope far better with the disaster and this will decrease the posttraumatic impact.

The location of the Emergency Village near the wreckage site will allow the families to get to their properties quickly and this will ease the reconstruction work. It will also give them a safe and comfortable place to live in during the reconstruction process. At present, this Emergency Village model does not exist, so many families were installed in mediaguas at the same wreckage site, while other families were provided housing by the government by means of a rental subsidy, which is a waste of resources and also lengthens the reconstruction time.

**Eco Village FENIX Valparaíso**

In the case of Valparaíso, the urban proposal of the Eco Village FENIX focuses on how a housing complex Casa FENIX fits the abrupt topography of the city. It proposing an urban means of reusing and recovering the site that was socially and environmentally devastated, incorporating a system that could help prevent future fires.

The main objective of the Eco Village FENIX is to be the first sustainable neighbourhood for the Chilean population in a state of vulnerability. These sustainable Villages will adapt to the logic of self-construction, whereby the families are actively involved in the definition and design of the final product, as they are the ones who decide how to arrange and connect the different modules.

This participation in the final phases of the design of their own home gives it an added value greatly appreciated by these vulnerable families, as this social segment always complains that the solutions provided by the State are homogenizing and standardized and do not respond to the reality of each location.

This is also a positive factor that will allow Casa FENIX to be a product that is not only demanded by families in vulnerable circumstances, but also by members of the general public who need housing and want to build sustainably. [Further explanation of this point is in section 5.1.2 “Market viability of the product”]

**Urban structure and urban components**

The main objective of these components is to create a pedestrian circuit between homes, which will have a dual role; firstly, it will be the public space providing connectivity to Eco Village FENIX; and secondly, it will act as buffer spaces between the homes, like a firewall [Figure 12].

**Networks of public spaces**

- **Cornise Avenue:** public promenade crowning the hillside edge of El Vergel, allowing some space between the housing and the street, where fire hydrants and solar panels will be located to supply power for public lighting for the whole Eco Village FENIX [Figure 12].
- **Longitudinal terraces:** because of the natural slope of the land, three longitudinal terraces will be built to enable the staggered siting of each Casa FENIX unit. These terraces will be accesible from the transversal walkways and from the “ascensor” of Eco Village FENIX [Figure 12].

- **Transversal Platforms:** These are basically a network of public stairways that adapt to the natural slopes of the hill and divide platforms into several longitudinal sections, creating a transversal buffer space that acts as a firebreak in the event of fire. The platforms will stop or brake fire preventing material losses are reducing the incident by sectioning Eco Village FENIX in various zones [Figure 12].

- **Public Balconies:** Viewpoints [‘miradores’] that are positioned at the top of the platforms looking towards the creek [Figure 12].

- **Collection and recycling centre:** Provision of a site for collecting new and recycled building materials for use by the families; any unused materials will be recycled.

- **Collective PV panels:** These will supply electricity to all public areas and to the collection and recycling center of Eco Village FENIX [Figure 13].

- **Firebreak and rainwater harvesting systems**

- **Plinth:** Continuous plinth system along each longitudinal platform. This will have a dual function, retaining the natural terrain, as the function of a retaining wall, ready for Casa FENIX to be built and it will also function as a firewall in case of fire [Figure 12].
- **Rainwater Channelling and Harvesting**: Rainwater harvesting system takes water from the roofs of the Casa FENIX homes via prefabricated elements along plinths, enabling the irrigation of the individual gardens of the Eco Village FENIX.

- **Urban gardens**: Public garden system watered with the rainwater harvesting and collection system. These kitchen gardens enable the families to produce crops, produce, vegetables, herbs and compost in the green public and private spaces of the Eco Village FENIX [Figure 9].

  **Architectural elements enabling Casa FENIX to adapt to the steep topography**

- **Pillars**: These allow the adaptability of Casa FENIX to the rugged topography of Valparaiso.

- **Plinth**: These allow the adaptability of Casa FENIX to the abrupt topography of Valparaíso and retain longitudinal terraces that define the channelling of rainwater.

- **Patio-terraces**: Allow the creation of otherwise non-existent horizontal ground, used as outdoor extensions for Casa FENIX [Figure 12].

- **Patio-gardens**: Allows the creation of green and moist soil under Casa FENIX while supplying vegetables and crops to the families [Figure 9].

- **Patio-balconies**: Allows the connectivity of Casa FENIX with the surrounding environment, the neighbourhood and the city.

  **“How many people is Casa FENIX designed for?”**

Casa FENIX is designed for a family of four, so two or three SM modules should be assigned to larger families. Currently, when a natural disaster occurs, the solution is the emergency shelter “mediaguas” [Figure 14].

These are regarded by the state as a “temporary” solution due to their poor construction features. However, in reality these shelters eventually turn into the origin of a bad quality permanent home for the family that receives it or for other families that do not have a home. Because when permanent homes are allocated to families, the new owners sell their “mediagua” to others that need a home, increasing and extending the problem through out of time.

Eventually the solution becomes a problem, as the affected families find it very difficult to recover everything they have lost – often built up over their entire lifetime. Ultimately, this solution...
ends up being more expensive, as the quality of the precarious emergency solution means it must be enhanced to be more habitable, especially during the harsher weather in summer and winter.

Given this situation, the question that arises out of the current problem is:

“How can emergency housing become a permanent home?”

Developed nations may wonder why Chilean families cannot get new housing. This is very simple: in Chile around 60% of the housing stock is the result of a self-constructive incremental process, where during the course of their, people build and consolidate their homes. Therefore when a disaster strikes, clearly the process that has taken them many years to create and build cannot be recovered in just a few months. The emergency shelter therefore becomes the only housing they can afford for several years.

Another aspect to consider is that people cannot get insurance for self-built homes, so in the case of loss, the families are literally left on the street, becoming homeless. In other words, the vast majority of Chilean families have no economic security against a catastrophe. Given this market reality, a sustainable, modular and buildable housing design is offered under the concept “Do it yourself sustainably” [Explained further in section 5.1.2 “Market viability of the product”].

That is why Casa FENIX as a finished product is a very attractive project that could be easily subsidized by the state under the current policies for sustainable construction promoted by the Ministry of Housing and Urban Development.

5.1.2 MARKET VIABILITY OF THE PRODUCT

Positioned within the solar social housing industry, Casa FENIX subdivides its market into two main groups: buyers [wholesale market; important for distribution]; and end users.

The end users are the decision-makers, adapting the modular design of the homes to meet their primary or physiological needs, i.e. providing immediate shelter for families who have lost their homes as a result of natural and/or provoked disasters.

I. Market

In defining the market, the most common variables are associated with the buyers and their location.

i. Buyer

We believe that the buyer must be public and mixed institutions and private companies that act as intermediaries and distributors in order to reduce transportation costs.
Public Sector Buyer: The State of Chile through its institutions, MINVU\textsuperscript{2} [Ministry of Housing and Urban Development], GORE\textsuperscript{3} [Regional Governments] and Municipalities. In this case governmental institutions would act as intermediaries between the company which manufactures and/or distributes the prefabricated Casa FENIX and the families in vulnerable conditions who are the end users.

The state is therefore defined as a buyer and collective dealer. That is to say, the State will buy a number of Casa FENIX units for a community that has suffered a disaster and lost their homes.

Mixed Sector Buyer: NGOs, such as “Un Techo para Chile”, sports clubs, neighbourhood associations, community groups, among others. In this case the mixed sector would act as an intermediary between the company which manufactures and/or distributes the prefabricated Casa FENIX and the families in vulnerable conditions who are the end users.

The mixed sector is therefore defined as a buyer and collective dealer; without necessarily being from a particular community.

Private Sector Buyer: Companies engaged in the wholesale and retail of building materials, such as “Homecenter SODIMAC” [currently a Casa FENIX sponsor], “Easy”, “MTS”. In this case the private sector would act as an intermediary between the company which manufactures and/or distributes the prefabricated Casa FENIX and the families in vulnerable conditions and presumably private individuals who wish to buy a Casa FENIX too who are the end users.

The private sector is defined as a buyer and distributor which makes a profit.

1. End users

A. Socio-cultural aspects

Socio-cultural aspects influence and determine the purchasing decision for this group of buyers. End users are subdivided into two segments: the first subgroup corresponds to people who have lost their homes as a result of natural or provoked disasters i.e. fires; the second are the most vulnerable families living in illegal settlements [slums or campamentos]. In the event of an emergency, both of these subgroups of end users are assigned equally precarious emergency homes. These “mediagua” [Figure 14] emergency homes lack suitable insulation to withstand either summer or winter temperatures. Furthermore, they fail to meet the basic needs of families and this situation is aggravated by outbreaks of infection, disease and the accumulation of solid waste when families find themselves living in these emergency settlements for prolonged periods of time.

Faced with this reality, the team asked:

“Why would Casa FENIX be an attractive solution for the families who are the victims of a disaster in Valparaiso?”

Our market proposal is based on four key attributes.

For the “vulnerable” segment, i.e. socially vulnerable families who have lost their homes, Casa FENIX is an attractive and affordable solution because:

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\textsuperscript{2} MINVU, Ministerio de Vivienda y Urbanismo
\textsuperscript{3} GORE, Gobierno Regional
- It is a quick and versatile solution that is currently not available in the national housing market. The installation of a complete Casa FENIX [with at least one unit of each module] would take less than two weeks to assemble [to see the construction process of the structure follow the link http://vimeo.com/80013920], compared to the current social housing model for which families wait on average between two and four years.

- Users are involved in the final design of their home, i.e. the families themselves define the final aesthetic of their home by deciding on the number of modules and the configuration of the Casa FENIX, depending on the potential of the site where it will be installed and the family’s financial budget.

- Casa FENIX offers high standards of quality and design, accredited with the current energy certification that is being endorsed by the Chilean Ministry of Housing [MINVU].

- Public opinion of social housing is negative. Potential end users describe the mediaguas as “match boxes” due to their reduced size and like “prisons” because the areas where these homes are situated, predominantly on the outskirts of the cities, are isolated and have poor transport links.

For the “non-vulnerable” segment, those who have lost their home as a result of a disaster, the points mentioned above are equally valid. Casa FENIX presents an opportunity to create sustainable neighbourhoods built to high quality standards within a short period of time, while allowing the end users to participate in the final design of their homes.

According to the Social Research Centre of NGO “Un Techo Para Chile” [UTPCH 2012], which conducts characterisation studies into the use of emergency housing and living conditions after a disaster, 10.5% of families living in these precarious “mediaguas” have no access to drinking water and only 7.2% have access to mains water. For the remainder, water is supplied by water tankers 4.3% and wells 15%. For the disposal of waste water and sewage, 4.3% have no access to a drainage system and only 40.3% have access to a sewage system. The rest of the families use chemical toilets [3.9%], cesspits [12.8%] and septic tanks [38.7%].

In terms of electricity supply, 12.7% have no electricity, 9.8% access electricity illegally by “hooking up” and 77.5% have an authorized electricity supply. This study reveals the impoverished conditions in which the most vulnerable members of the population are living and the urgent need for improvements.

On 12 April 2014, a wildfire in the city of Valparaíso destroyed more than 3,000 homes in the hillside neighbourhoods where our target market is located, leaving more than 14,000 people without a home [figures not officially confirmed yet]. The Chilean Government is in the process of building 2,000 “mediagua” units and has begun the process for housing reconstruction count for the new subsidies for the victims of this fire. Nonetheless, the government has declared that the reconstruction will take over five years. This situation is a perfect example of Casa FENIX’s potential for the city of Valparaíso.
1.b. Socio-economic aspects

[whether it is affordable for the buyer]

It is important to point out that in economic terms; there are differences between the two segments, such as:

- **The “vulnerable” segment**
  lives in a precarious condition and belongs to the lowest socio-economic strata of Chilean society. They have a low and irregular household income and live in illegal settlements with no access to drinking water or electricity and no protection. Their homes are built from unsuitable, light materials and are predominantly self-builds.

  This degree of vulnerability is exacerbated to critical levels in the event of an emergency.

  This segment of the population has no financial savings which would enable them to opt for certain government housing subsidies and therefore the help provided by NGO’s or charities is indispensable in supporting this group.

- **The “non-vulnerable” segment**
  are those who own or rent their homes, which are built from more solid, suitable materials and provide better protection, meeting these families’ basic needs for shelter and safety. This segment has a regular household income and the ability to save money in order to apply for a government housing subsidy or a mortgage.

  For both market segments (vulnerable and non-vulnerable), in the event of a disaster and the total loss of home, their economic situation is directly affected. This is a critical situation as it is very difficult to start again and acquire a home in the short term to meet the immediate needs for shelter and safety. There are currently stakeholders and financing mechanisms within the housing industry to mitigate this situation.

  Two main groups of potential buyers for Casa FENIX have been identified: the public sector [Housing and Urban Development Ministry, Regional Governments and Municipalities] which provides finance in the form of housing subsidies [see Appendix 14.7 “UDTA Appendix” for different types of housing subsidies]; the Mixed sector [NGO’s and Community Associations] which make donations to the target segments; These groups of buyers make Casa FENIX viable in the market by providing housing solutions to the target market.

  A third, secondary group, is private individuals whom would like to by a Casa FENIX maybe as a second home or because they would like to have “an sustainable energy home”.

**Financing the 2010 Reconstruction**

In terms of financing the reconstruction program following the 2010 earthquake and tsunami, the Chilean Government budgeted a total of US$ 8.431 billion [€ 6,103,200,900] in 2010, which by the year 2013 had been partially spent. As of 2013, US$ 2.31 million [€1,672,209,000] of this total budget had been spent on housing reconstruction with 220,000 housing subsidies awarded.

**National Reconstruction Fund [“Fondo Nacional de Reconstrucción -FNR”]**

As a result of the recent disasters in Chile [the earthquake in the
south of Chile in February 2010, the recent earthquake in the Arica y Parinacota region and the Valparaíso wildfire], new regulations have been put in place to activate mechanisms such as the one established by law 20.444 which created the National Reconstruction Fund and established tax breaks for donations made in the event of a disaster. This Fund will receive contributions for two years from the date of the supreme decree indicating the affected zones, i.e. from 03/04/2014 when Supreme decree N° 918 was published.

Law 20.444 allows private and public entities to make financial or material contributions or donations to any public or private works or to finance specific projects. Contributions from private institutions [particularly large corporations] and civil society organizations are collected by the FNR which is administrated by the Treasury Ministry’s FNR Committee, thus complementing any funding assigned by the state.

Other foundations or institutions that collect finance from civil society, such as NGO’s and community associations like “Un Techo Para Chile” which donated US$27 million [€ 19,545,300], and other charities collaborate in disaster situations.

2. Location: Geographic situation [whether it adapts to the climate, topography, etc.]

As mentioned in the Urban Design Strategy, the geomorphological diversity of Chile gives rise to a range of potential adaptations for Casa FENIX in terms of climate and socio-cultural conditions, depending on where the home will be located.

In the case of Valparaíso, the city’s steep topography and the average socio-economic level of its inhabitants have historically defined it as a self-constructed city. Currently, 60% of the existing housing stock is a direct product of an on-going, evolving process of self-constructions in which each individual or family uses their own resources and an intuitive “know-how” that is part of Chile’s popular culture.

II. Target Markets

We have identified three target user groups

1. Socially vulnerable families, i.e. those families who have lost their homes following a disaster and who do not have the financial capacity to acquire or build a new home.

In regard to home size, during the emergency period these users will be allocated the SM module measuring 11m2, which will be completed in the second and third stages of consolidation and will eventually measure 60m2.

The construction quality will be of a high standard and have incremental and progressive features. It will be assessed and certified by the Chilean Building Code as well as Chilean Energy Efficiency standards. The aesthetics and distribution of the final product will depend on the requirements, user’s preferences, lot size and the local urban proposal. For the case of the City of Valparaíso, the location of Casa FENIX proposes a vertical growth in direct relation to the topography of the city.
2. Non-vulnerable families, i.e. those families who have lost their homes following a disaster and need a new one. Unlike the previous group, these families possess the savings, have the capacity to obtain a mortgage or had catastrophe insurance cover on the destroyed home, enabling them to buy a new home. In regard to home size, these users may have the economic means to allow them to buy all Casa FENIX modules [SM, MM, LM and SS] at the same time, even in duplicate or triplicate; i.e. more modules than the prototypical 60m² Casa FENIX. In this way they will obtain a unique and customizable design to suit their needs, acquiring a property assessed and certified by the Chilean Building Code as well as Chilean Energy Efficiency standards. The size, aesthetics and distribution of the final product will depend on the buying capacity, expectations and needs of the buyers and the size of the lot where the customized Casa FENIX will be built and installed.

Consequently, the size, aesthetics and the final distribution of the casa FENIX depend on the means of acquisition, whether this is granted through a governmental subsidy or the family obtains it through their own resources. However, the socio-spatial aspects, the geographical context and the urban fabric are the major determinants and modifying factors of the urban proposal. The possibility of opening the market of Casa FENIX to a general public with purchasing capacity is seen as a sales strategy that will allow home buyers to acquire in a short period a new, energy-efficient home.

3. Generic families, i.e. those families who are not the victims of a disaster but would like to acquire a Casa FENIX as their first or second single family home or are interested in acquiring a specific module. The factors that would influence this acquisition are the fast construction method and the quality and aesthetics of the home, as well as the participation of the buyers in the final design and arrangement of modules. The size, aesthetics and distribution of the final product will respond to the same parameters as for group 2; however these families may be choosing to buy the house as a second home to be installed in rural areas.

Casa FENIX provides a rapid, safe, housing solution thanks to its quick assembly and flexible design which can be adapted to suit the characteristics of the terrain and the family’s financial means. Casa FENIX homes have energy certification as endorsed by the Housing and Urban Development Ministry and offer the highest standards of quality, providing a dignified solution that improves the quality of life for families in terms of the design and size of their homes and their neighbourhood.

“vulnerable” and “non-vulnerable”. If we put to one side those families who are not the victims of a disaster but simply wish to buy a Casa FENIX, the common need shared by both segments in the event of natural disasters is the loss of their homes and the requirement for an immediate housing solution that provides them with shelter and basic services in the short term.
III. Attractive features

Demand

The end users are the approximately 400,000 families nationwide who require a housing solution. 27,378 of these families are living in squatter settlements [657 campamentos throughout Chile] and 370,000 families who lost their homes as a result of the 2010 earthquake and tsunami. Furthermore, 6% of the families affected by the 2010 disaster not only lost their homes, they also lost the land where their homes had been situated or in the case of families living in apartment blocks

Often in apartments that had been assigned to them as social housing - the entire building was declared uninhabitable. These 4,395 families are currently living in 107 emergency settlements.
In April 2014 a wildfire in the city of Valparaíso destroyed between 2,500 and 2,900 homes in the hillside neighbourhoods where our target market is located, leaving more than 12,000 people homeless [figures not officially confirmed yet]. The Chilean Government has already issued housing reconstruction subsidies for the victims of this fire. This situation is a perfect example of Casa FENIX’s potential for the city of Valparaíso.

In terms of the potential market, it is estimated that by 2015 there will be more than 2 million “non-homeless poor”, according to the 2009 CASEN Socio-economic Survey. This means people who are currently living on the verge of an emergency situation and are almost able to enter the market; in 2015 the growth rate will be 8%.

With Casa FENIX, the reconstruction time would be drastically reduced as the houses are designed to be progressive and permanent homes that evolve over time and families would not have to wait years to get their permanent home. Casa FENIX would be available on the regular market.

**Flexibility and spatial distribution**

At a national level, the standardisation of government social housing and private housing developments is often criticized. The only differences between the former and the latter are the quality of the constructions and the finishings. Faced with the limited options available in the national market, Casa FENIX offers an end product that is uniquely versatile with its progressive SM, MM, LM, SG modules and it is “sold separately” principle.

With Casa FENIX, the end user is directly involved in designing the home according to their needs and available budget, deciding on the configuration and connection of the various modules, as if building Lego.

This potential for flexible and variable construction is also one of the most attractive features of Casa FENIX. It creates a sense of identity in which each home is different and the standardisation and aesthetic monotony usually associated with prefabricated models is avoided.

Figure 16 shows the differences between Casa FENIX and the mediaguas and social housing units.

In the case of Valparaíso, this versatility will be enhanced by the diversity of the city’s landscape. Its abrupt topography and limited sun exposure will determine the way in which homes are positioned on the hillsides, with a vertical ascending growth to maximise the potential for solar energy. This will result in homes built on one, two or even three interlinking levels.

**Innovative components**

In addition to the four predesigned modules, Casa FENIX offers individual components, identical to those used in modules, which can be purchased independently to adapt the structure to different topographies or to create new complementary units.

In terms of the ecological and economic benefits of the project, this proposal is innovative because the concept of sustainable construction in Chile is becoming increasingly important. However, there is still no model for a prefabricated energy efficient
Social Housing / Mediagua / Casa FENIX

Social Housing “La Laguna” type, Valparaíso. Total: 40.74m²

Standard Mediagua Total: 18.3 m²

Casa FENIX Total: 64 m²
SM 14 m² + MM 21 m² + SS 15 m² + LM 14 m²

Figure 16: Comparison between mediagua, FENIX and typical social housing.
home. Casa FENIX homes would be the first homes with these features and could be used by the state to build new or post-disaster sustainable neighbourhoods.

These features are consistent with the “National Strategy for Sustainable Construction 2020” [MINVU, 2013], which sets the target of improving Chileans’ quality of life by building environments that facilitate social inclusion, respect and conservation of the environment.

IV. Economic benefits

Clearly Casa FENIX costs more than a “mediagua” [the typical flimsy home distributed in Chile following a disaster] and a social housing unit. However, in terms of durability, Casa FENIX is economically more convenient.

Casa FENIX’s durability is defined mainly by the material, construction and technological characteristics that it uses. Its envelope is designed to be energy efficient so that the used energy is minimal, reducing consumption and economic spending.

Casa FENIX proposes the use of solar panels to replace the use of gas to heat water; the use of highly efficient envelope insulation panels to avoid energy losses; and a sunspace, that allows the use of the natural radiation of the sun to warm the house thereby avoiding the need to burn fuel and other contaminants. Thus the high efficiency of the systems and the inclusion of renewable energy mean that although the initial investment is higher, in the long term, families will be able to recover the investment thanks to Casa FENIX’S energy self-sufficiency.

Finally the great advantage of Casa FENIX is that it is conceived and designed under the highest quality standards that make it worthy of sustainable building certification promoted by the state through the MINVU.

The exact price of Casa FENIX is expected to be determined in the final stages of this project, but it is likely to be more expensive than the ‘mediagua’ currently used for these situations. Hernán Bugueño, president of the Energy and Sustainability Committee and the Chilean Architects’ Association, explains that integrating sustainable strategies involves an average increase in construction costs of 10%, but that the savings derived from their operation, once the house is inhabited, can range from 30% to 60% in lower electricity, gas or oil, and water bills. We therefore anticipate that the product will be well received and have a clear impact on the increase in sales.
5.1.3 INDIVIDUAL OR COLLECTIVE HOUSING BUILDING CONCEPTS

In the case of the city of Valparaíso, the SM module, the Casa FENIX, the Temporary Village FENIX and the Eco Village FENIX must, as a primary requirement, adapt to the steep topography of the hills [Figure 17]. They must also respond to recurrent catastrophes, especially fires [Table 4].

Case study to be addressed by Casa FENIX: the wildfire in the La Cruz Hill, Sector El Vergel on 14, January 2008. 70 families were victims of the disaster. It was vital to make the area safe following the fire by wetting the whole area and then the whole neighbourhood had to be rebuilt.

The specific proposal for Valparaíso needs to address the following aspects for the different scales: module, home and village:

1. Individual home or single family home

The single-family proposal has two stages: The Survival Module [SM] and Casa FENIX. At this scale, adaptability to the topography is addressed through the implementation of foundations, retaining walls and columns to support each of the units.

The single family unit contemplates architectural and constructive progression from the SM module [initial product] to Casa FENIX [final product]; this

Figure 17: Casa FENIX is defined as the sum ans assembly of the SM, MM, LM and SS modules.
progression will define the size and density of Temporarily Villa FENIX and Eco-Permanet Villa FENIX.

a) The Survival Module (SM)

Generally the SM module is defined as a living unit that fulfils the basic needs for shelter.

- Site: Pedro Aguirre Cerda neighbourhood football field [Figure page 18].

- Size and potential growth: 11m2, without incremental opportunity.

- Occupation load: 3.5 m2 per person in the SM. Depending on the number of family members, more than one SM module could be allocated.

- Spatial strategies: modular construction. It provides 2 set of bunk beds, a kitchenette counter table (used from inside the Module through a window opening) and a small space for a clothesline dryer [Figure 18].

- Balanced ecosystem strategies: energy efficient module.

- Energy strategies: The features for thermal comfort include solar passive gains provided through a tall “Solar Window”. There are upper and lower windows for natural ventilation. The module has a highly efficient thermal envelope [with an affordable budget]. It also includes a small PV kit for lighting and a small radio. A 50-litre rainwater tank is located below the roof eaves for water harvesting.

- Short-term projection development: provision of a Casa FENIX within a maximum period of six months [Figure 18].

- Development and 30-year projection: a local community living in a sustainable neighbourhood [Figure 18].

b) Casa FENIX

It is defined as the sum and assembly of the SM, MM, LM, SS modules. Besides, the architectural concepts that define the formal expression of Casa FENIX are the double walls and the overlay of volumes [Figure 20].

- Site: the affected area if the residents are property owners or another place provided by the local housing authorities.

- Size and growth potential: from 16 to 69.5 m2, with an incremental opportunity in stages 2 and 3, namely the relief and reconstruction periods [Figure 20].

- Occupation load: 17.3 m2 per person of Casa FENIX

- Spatial strategies: incremental modular construction home, progression from SM to SM + MM + LM + SS [Figure 20].

- Energy strategies: The features for thermal comfort include solar passive gains provided through a tall “Solar Window”. There are upper and lower windows for natural ventilation. The module has a highly efficient thermal envelope [with an affordable budget]. It also includes a small PV kit for lighting and a small radio. A 50-litre rainwater tank is located below the roof eaves for water harvesting.

- Balanced ecosystem strategies: energy efficient module.

- Short-term projection development: provision of a Casa FENIX within a maximum period of six months.
- Development and 30-year projection: a local community living in a sustainable neighbourhood.

2. Collective housing

The proposal for collective housing has two stages: Temporary Village FENIX and the Eco Village FENIX. Besides, the architectural concepts that define the formal expression of Casa FENIX are the double walls and the overlay of volumes.

a) Emergency Temporary Village FENIX (TVF)

- Site: the TVF will be located on a nearby football field. In the case of Valparaiso, 27 football fields were identified, involving 27 possible Emergency Housing Complexes scattered across the hills of the city [Figure page 39].

- Size and growth potential: typical neighbourhood football field measuring 5000 m2; it has no possibility of growth.

- Density: 70 SM modules per 5000 m2 football field
- Occupation load: 17.3 m2 per person on emergency TVF

- Spatial strategies: definition of an orthogonal grid for optimization of the available surface, provision of shared areas between SM modules for buffering and extension [Figure 19].

- Energy Strategies: the energy demand is provided by solar PV panels and solar thermal panels installed on the community buildings. In southern Chilean cities, these installations are located on the buildings for storing firewood near to the SM for use in woodburning stoves.

- Balanced ecosystem strategies: the emergency Temporary Village FENIX will be energy efficient.

- Short-term projection development: No projection as a temporary solution. The development is designed to have a maximum duration of six months. [see GE-310].

b) Permanent Eco Village FENIX

At the urban level, the sale of Casa FENIX will be accompanied by a proposal for a specific urban structure where the houses will be installed. This will define the specific urban elements required for each proposal to ensure their proper implementation and achieve sustainability.

- Site: the affected area if the residents are property owners or another place provided by the local housing authorities.

- Size and growth potential: 26,000 m2, the site strategy can be increased by extending the longitudinal terraces [See section 5.1.1].

- Density: One Casa FENIX per lot, the neighbourhood will have 70 lots measuring 10m x 20m [Figure 19].

- Occupation load: 92 m2 per person

- Spatial strategies: The double walls will be reflected in both, at home in the sunspace and at urban level in the firewall and rainwater harvesting plinths [Figure 12]. While the overlay of volumes will be reflected, at home in the vertical growth, and at urban level, in the terracing of the damaged site. These concepts enable the house to be geographically and climatically adaptable. Therefore, despite being a pre-designed unit [SM, MM, LM, SS modules].
<table>
<thead>
<tr>
<th>Solution</th>
<th>Temporary</th>
<th>Permanent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Form / Site</td>
<td>Horizontal</td>
<td>Aleatory according to site characteristics, demands and/or family preferences.</td>
</tr>
<tr>
<td>Location</td>
<td>Football fields</td>
<td>Definite place, affected location reconstruction or new site defined by the MINVU.</td>
</tr>
<tr>
<td>Size</td>
<td>14m²</td>
<td>64m²</td>
</tr>
<tr>
<td>Public facilities and services</td>
<td>- Common courtyard - Health services - Common material storage - Orchard in portable vegetable back - Collective renewable energy systems</td>
<td>- Public spaces network - Public passage - Public platform - Observation deck - Urban orchard - Exchange square - Individual and collective renewable energy systems</td>
</tr>
</tbody>
</table>

Figure 18: Casa FENIX as a permanent solution
<table>
<thead>
<tr>
<th>Solution</th>
<th>Temporary</th>
<th>Permanent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Form / Site</td>
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</tr>
<tr>
<td>Location</td>
<td>Football field</td>
<td>Definite place, affected location reconstruction or new site defined by the MINVU.</td>
</tr>
<tr>
<td>N° of modules</td>
<td>70 SM Modules</td>
<td>70 Casa FENIX</td>
</tr>
<tr>
<td>Size</td>
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<td>26,000 m²</td>
</tr>
<tr>
<td>Public facilities and services</td>
<td>- Common courtyards</td>
<td>- Cornice avenue</td>
</tr>
<tr>
<td></td>
<td>- Health services</td>
<td>- Longitudinal terraces</td>
</tr>
<tr>
<td></td>
<td>- Common material storage</td>
<td>- Transversal platforms</td>
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<tr>
<td></td>
<td>- Orchards in portable vegetal back</td>
<td>- Public balconies</td>
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<tr>
<td></td>
<td>- Collective renewable energy systems</td>
<td>- Gathering and recycling center</td>
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<td></td>
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<td>- Collective wind turbine</td>
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<td></td>
<td></td>
<td>- Rainwater canalization</td>
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<td></td>
<td></td>
<td>- Urban orchard</td>
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Figure 19: Comparison between Temporary Villa FENIX and Eco-Permanent Villa FENIX
Easy assembly

Figure 20: Easy assembly in different lote shapes and sizes
5.1.4 MOBILITY STRATEGIES

The mobility strategy addresses two types of mobility: urban and residential for all the post-catastrophe stages.

The temporary Village FENIX addresses these types of mobility during the emergency phase, while the second and third phases [relief and reconstruction] are addressed with the permanent Village FENIX [Eco-Village FENIX, EVF].

Residential mobility basically focuses on users when moving home, while urban mobility refers to the daily journeys a person undertakes to go about their daily activities [work, school, shopping, entertainment, etc.].

As mentioned in section 5.1.1, Valparaíso has an urban setting that has historically been adapted to its steep topography. The city is basically composed of two geomorphological zones.

The first of these is a narrow coastal plain of limited size, known as the “Plan”, which was established as the urban, political and social centre of the city. Rising up from the plan are 42 hills, home to 94% of the city’s total population, numbering 292,510 inhabitants.

This segregated programmatic zoning defines how the locals relate and interact within the city; they need to move on a daily basis into the Plan area for goods and services.

It must be borne in mind that in Valparaíso, urban and forest fires are the most recurrent catastrophe, but they tend to not affect the networks of public and private transport. From this perspective, the cost of mobility will determine the urban mobility for the inhabitants of post-catastrophe villages.

Meanwhile, the need for urban mobility during the relief and reconstruction periods is defined primarily by the lack of appropriate sustainable transport networks that promote the sustainable and integrated development of the city.

It is for this reason that the urban strategy for siting post-catastrophe villages should focus on an existing field near to the disaster area. This will cushion the post catastrophe trauma and make it easier for families to reunite with their social networks, their daily routes and movement patterns.

1) Urban Mobility

In the case of the city of Valparaíso, where urban and forest fires are the most recurrent disaster, the networks of public and private transport are not affected.

Therefore the urban mobility proposal for Village FENIX is defined by two general concepts:

**Intra-neighbourhood mobility**: this is defined as mobility within the Village FENIX, which will be exclusively pedestrian, driven by the concept of “walkable communities” or “walkability”.

**Extra-neighbourhood mobility**: this is defined as the outward mobility of Village FENIX, i.e. towards the areas adjacent to the village, to the plan and to other cities. This mobility is pedestrian, mechanical and electrical, driven by the concept of a “sustainable electric transportation” network.
We must bear in mind that Chile generally lags a long way behind in urban mobility and sustainable public transport policies. What is more, in some remote communities in Chile, urban mobility is very limited and non-democratic.

Across Chile as a whole, only 2% of transport is public but in Valparaíso this percentage reaches 6%. However, the advantage for the city of Valparaíso is that it is the only city in Chile that possesses three means of electric transportation, the underground train, the trolley buses and the hillside elevators [known as ascensores]. This concentration of unusual means of transport is a major asset of Valparaíso’s urban culture and history and will facilitate community acceptance of a potential extension and increment of these means of transport.

The need for urban mobility according to age group

The mobility of the different age groups [Table 21] is directly related to the facilities and services that the inhabitants have access to.

As mentioned before there is a daily need to move to the “plan” or city centre.

Primary and pre-school children living in the hills of Valparaíso mostly attend daycare centres and primary schools close to their homes. In Valparaíso, there is a total of 69 daycare centres and primary schools, 80% of which are located in the hills of the city and most children walk to get to them.

Young people who live in the hills of Valparaíso and attend secondary school and higher education almost all have to travel into the centre, where 95% of the city’s 23 public and private secondary and higher education facilities are located. The journeys of these groups are on foot or private mass transport.

Most of the people, workers and adults who live in the hills of Valparaíso have to travel to the city centre and/or neighbouring towns or cities, such as Viña del Mar [8Km], Quilpué [20Km], Concón [21Km], San Antonio [88km] or Santiago [120km] [Table 22].

Senior citizens in Chile extend their work activity well beyond retirement age. In Valparaíso, one of the poorest cities in Chile,
there are many older people still working and therefore they also travel into the centre. Those senior citizens who have retired usually remain in their surroundings and participate in neighbourhood associations, women’s centro de madre clubs, dance or sports clubs, to which they mostly walk.

The sector of the population with disabilities also has to go into the centre, just like any other citizen. This process presents many difficulties, as there is no public transport designed to accommodate disabled people. This is a nationwide problem, which is accentuated in Valparaíso because of its topography.

The solution to this problem is still pending and will take a couple of decades to be implemented. Meanwhile, people with disabilities depend on the goodwill of their families and other people to enable them to move about in cities.

For these categories of users, urban mobility must address each of the needs of the predefined users and propose a democratic and comprehensive system of access to mobility for both the emergency period and the periods of relief and reconstruction.

a) Proposal for urban mobility during the post-disaster emergency period.

Stage 1: Emergency, Temporary Village FENIX [TVF].

The inhabitants of post-disaster Temporary Village FENIX’s urban mobility will be defined mainly by the cost of mobility for users. Therefore, the main strategy for this first stage of emergency should be given by the continuity of the mobility which was available prior to the disaster, the increment of paths and possibilities for user movement and the reduction of costs incurred.

Thus, the neighbourhood’s football fields become interconnected strategic locations, allowing affected families to remain within their neighbourhood, without the need to alter their regular paths and movements.

For this first stage, we propose a system of a “free pass for public transport”, a subsidy provided nationally for the inhabitants of “Temporarily Villa FENIX”, a “TVF pass”. This pass will allow residents to maintain their pre-disaster urban mobility and obtain a cost saving, which they can then redirect towards other expenses related to the reconstruction of their homes.

This pass will only be a temporary solution that will last until the families move to the permanent Eco Village FENIX. This stage of TVF is expected to last for a maximum period of 6 months.

Consequently, intra-neighbourhood mobility will be exclusively pedestrian and extra-neighbourhood mobility will be by means of a free pass, subsidised by the state for the inhabitants of the Temporarily Villa FENIX [Figure page 68].
b) Proposal for urban mobility after the post-disaster emergency period.

Stage 2 and 3: Relief and reconstruction, Permanent Eco Village FENIX [EVF].

The need for urban mobility during the period of relief and reconstruction is defined primarily by the lack of appropriate sustainable transport networks that promote the sustainable and integrated development of the city. That is why the proposal is based on an extension and consolidation of the electrical transport systems existing in the city of Valparaíso [Figure page 68], with an increase in the network of ascensores [hillside elevators], cable car bus lines [trolleys] and a cableway system.

This proposal is looking towards the long term and is subject to the development and success of sustainable construction and urban policies within the country. It is estimated that a proposal of this magnitude would take at least 10 to 20 years to implement.

Despite the above, we believe that the development of electric transportation is possible, as Valparaíso is the only city in South America that has three electric transport systems: the underground train, the cable car buses or trolleys, and the hillside elevators known as ascensores. However, these transport systems do not have the territorial impact.

The proposal is therefore to amend the current urban mobility in the city and transform it into a sustainable system. This why the proposal for urban mobility for Valparaíso in the long term considers two connectivity strategies:

1. Extension of vertical connectivity: by implementing new hillside elevator lines at an elevation of between 50 m and 100 m above sea level. The existing ascensores mostly go up to 40 m or 50 m above sea level, with the exception of one, which is currently not working, which gets up to a height of 100 metres above sea level [Figure page 68].

2. Extension of the longitudinal connectivity: by implementing new lines of cable car buses [trolleys].

A frontline route that runs the entire length of Avenida Alemania, the main artery road which connects almost all the hills of Valparaíso at an altitude of 100 metres above sea level, extending from Playa Ancha hill in the south to La Virgen hill in the north [Figure page 68].

A second route to rehabilitate the old tram route which used to operate in Valparaíso at the beginning of twentieth century, running from Avenida Argentina in the north to Cerro Playa Ancha in the south of the city [Figure page 68].

Both extensions will be part of an intermodal system of sustainable public transport for the city of Valparaíso.

Finally, it is important to mention that the bicycle as a means of transport is unlikely to Valparaíso because of the topographical conditions. But they are not excluded as a possibility. Thus the implementation of municipal bicycles should be included for longitudinal routes around Avenida Alemania at the 100 m contour level and in the Plan, the flat central area of the city, which is at sea level.
Existing electric urban mobility in Valparaíso
Proposed electric urban mobility in Valparaíso
2) Residential mobility

Residential mobility is determined mainly by the moving of the place of residence of a family or individual. However, we should mention that in Chile residential mobility is somewhat variable, since most homeowners, whether they buy or self-build, consider their abode to be their home for life. Therefore in Valparaíso, although their house was self-constructed and has been destroyed by a fire, few families choose to permanently change their place of residence.

a) Proposal for residential mobility during the post-disaster emergency period.

Stage 1: Emergency, Temporary Village FENIX (TVF).

Residential mobility for the emergency period implies moving from the affected zone to TVF [Figure 24].

From the operational point of view, this stage considers first the transport of survival modules [SM], chemical toilets and showers, tanks for potable water and other elements necessary for the installation of the TVF. These items will be transported either from the company that prefabricates Casa FENIX, or from the storage places of ONEMI [National Emergency Office]. The items will be transported by army trucks with a capacity of 50m³ and will be free of charge for the affected families. Additional collective transport will be needed to enable families to carry any goods and utensils that have been recovered from the disaster.

From a social perspective, this process has implications related to territorial uprooting and psychological post-disaster trauma and installing the TVF.

Figure 24: Schematic image of residential mobility and transport
in the football fields near to the disaster area will help overcome this, as families will be able to maintain their social and support networks, as well as their urban routines [Figure 25].

b) Proposal for residential mobility after the post-disaster emergency period. Stage 2 and 3: Relief and reconstruction, Permanent Eco Village FENIX (EVF).

Residential mobility for the relief and reconstruction periods involves the transfer from the Temporary Village FENIX to the permanent Eco Village FENIX [from TVF to EVF]. The transport arrangements for this installation is expected to be the same as that described for the first stage [Figure 24].

Thus the urban strategy of placing TVF on a football field near to the disaster area will help to reduce the post-disaster trauma and make it easier for families to find their everyday routes and movement patterns. It will facilitate both urban and residential mobility for the affected families. Valparaíso possesses 27 neighbourhood football fields, so there are 27 possible TVFs.

In both cases the public transport provided by the army trucks have a capacity of 50 m³, so one truck can move 2 emergency modules at a time.
5.1.4 AFFORDABILITY

Total cost of each module Casa FENIX in Chile.

- Cost and financing of whole house € 30,704 = 994 UF [Chile]
- Cost and financing of module SM 14m² € 4725
- Cost and financing of module MM 21m² € 15975
- Cost and financing of module LM 14m² € 4725
- Cost and financing of module SS 15m² € 5061

The total cost of Casa FENIX is of 994 UF [CL$ 23,618,225 equal to € 30,704], cost may be subsidized by the state subsidy “Buy property without credit to vulnerable groups” MINVU which subsidizes housing up to a value of 750 UF [17,820,592 million or € 23,167]. This grant is designed for vulnerable families that do not have a home, from urban or rural areas, that have Social Protection Record [FPS] and without savings’ capacity.

That is why the remaining cost [244 UF] can be financed with additional supplementary grants and subsidies from the MINVU, or in special cases with contributions coming from the NGO “Un Techo para Chile for example” [Figure 26].

Thus, the total cost of Casa FENIX is 75% subsidized by the State and 25% by the additional and/ or complementary grants from MINVU [Figure 26].

The Figure 26 compares the values between Casa FENIX, a typical social housing and a typical emergency home “mediagua”.

The estimated cost of Casa FENIX is 994 UF [CL$ 23,618,225 pesos], and the value of a social housing ranges from 500 [CL$ 11,880,395 pesos] to 1000 UF [CL$ 23,760,000 pesos], therefore Casa FENIX falls within the possible range eligible by government subsidies, in consequence Casa FENIX is an affordable housing solution for vulnerable families. In this way, if we take into consideration a typical social home, as the one portrayed in picture 15, Casa FENIX is not only an affordable alternative but has valuable features in its flexible and adaptive architectural design, with high quality standards in regard to spatial and material characteristics that make it superior to the current solutions of social housing promoted by MINVU.

As to the value of emergency housing or “mediagua” these cost 27,36 UF [$CL 650,000 pesos], well below the value that of the survival module SM has, which is 154 UF [$CL 3,661,702 million or € 4,725]. Obviously the cost of the SM is higher than the value of a “mediagua”, however, we must note that this increase in the value of the SM module is justifiable to the extent that the SM is a permanent and high quality solution. Although the SM module responds to the first stage of the emergency situation operating as an independent unit, this will be an integral part of the Casa FENIX, while the “mediagua” is not a permanent solution at last its value is higher to the costs mention before, since it always demands extra cost to respond

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5 The “Unidad de Fomento”, or UF CLF according to the ISO 4217 code is a financial unit indexed according to inflation [as measured by the Consumer Price Index or CPI]. It is used in the Republic of Chile and was created by Decree No. 40 of January 2nd, 1967 by the Chilen Ministry of Finance, with its original use in mortgage lending, as it is a way to redevelop according to variations inflation.

6 Ministry of Housing and Urban Development
to seasonal changes to offer comfort to user, as insulation for wintertime for example.

Then, the cost of the SM module is reasonably priced, considering that the “mediagua” presents constructive and poor design features. On one side, it is a wooden unit of 18m² that eventually becomes a precarious permanent solution requiring improvement, which demands extra post-emergency investment normally from the State and later from owners. On the other side, its design and construction materials deficiencies.

Finally, the “mediagua” cannot be compared to the SM module, the “mediagua” definitely lacks quality and comfort, it does not include thermal and acoustic insulation, sidings, and neither sanitary nor electrical installations. It is therefore an emergency solution that can not be considered as a long term solution, as the SM module and therefore Casa FENIX.

**Performance of the project on twenty years**

The Casa FENIX project has a long-term scope, since the proposed urban implementation provides regeneration and restructuring of the disaster area by fire or other catastrophe, a project of comprehensive territorial re-ordering, which initially within 5 years, proposes the housing implementation and basic infrastructure, services networks and public spaces will be built, transforming the disaster site in an eco-neighbourhood [Figure 27].
20 years

As a result, after a period of 20 years, when the proposal is implemented three major urban transformations are expected:

**At Urban level:** it is expected to achieve an eco-district fully integrated and connected to the surrounding urban environment and the city, providing the city with new public spaces. For the Eco-Village FENIX the expectations are to be recognized as an identifiable unit and as a model for action in similar sectors of the city.

**At social level:** Two major effects are expected, first, for the eco-neighborhood, the changes in the living conditions of the place should be able to generate a change in the economy of families, thanks to the energy savings involved in the medium-term use given the solar energy installations, this aspect will allow families to better consolidate and leave their vulnerability stage into a process of social mobility.

And second, it is expected that the eco-neighborhood social networks are consolidated by the provision of meeting places, such as neighborhood associations, community associations, workshops for children, spaces that will strengthen social networks and sense of neighbourhood belonging, which will have a positive effect on the pride, maintenance and care of this first eco-neighborhood.

**At the sustainability level:** It is mainly expected to be an energy efficient and autonomous neighborhood. For the neighbourhood public spaces and green areas are consolidated as an urban park that can serve the entire community. In which, the implementation

Figure 27: Progressive growth of Casa FENIX
of urban rainwater harvesting systems to water home and public’s gardens; wind micro generation system to supply electricity to the public spaces of the neighbourhood; public gardens to cultivate and harvest native plants that can be replanted in new neighbourhoods; recycling areas; among other sustainable facilities has to be considered.

The business model considers making Casa FENIX accessible to the wide spectrum of families defined in the target market, incorporating families in a vulnerable situation and non-vulnerable families who have been victims of a disaster, as well as members of the general public who wish to build sustainably and who require a Casa FENIX because of its exceptional features, such as quick assembly, energy efficiency and formal and constructive flexibility.

At this point we must remember that when a disaster implies the complete destruction of the basic networks and urban infrastructure, it is the Ministry of Public Works [Ministerio de Obras Públicas, MOP] who should restore their functioning and operation, leaving the damaged site ready to receive a permanent Eco Village FENIX.

There are therefore two general aspects to be looked at with regard to affordability: forms of finance in order to acquire a Casa FENIX and the cost of the assembly process.

We can define three forms of financing and three different assembly processes for Casa FENIX

**a) Forms of Financing**

1. Public sector financing, through government housing subsidies [Ministry of Housing and Urban Development, MINVU] and urban improvement [through the municipal government].

To finance Casa FENIX, the possibility of creating a progressive subsidy arises. We have defined a progressive subsidy programme, which aims to combine and complement various existing subsidies that enable vulnerable families to benefit from the acquisition of a Casa FENIX.

Under this programme, the State will during the first stage be able to buy all the SM modules that are necessary, and will define a second and third stage of reconstruction, in which the families must apply through a system of progressive subsidy.

The cost of construction of Casa FENIX per m2 is estimated to be between €350 and €750, making the total cost of the finished house €30,500.

Each Casa FENIX unit may be acquired through the progressive subsidy defined above or any other subsidy detailed in Figure 26, addressing the total cost of the house.

If the application process is done either individually or collectively, the housing authorities, along with the families, can decide which are the most appropriate government programmes for a housing subsidy to acquire a Casa FENIX.

2. Mixed sector financing through donations from NGOs, community associations and non-profit institutions, which buy Casa FENIX housing to donate to socially vulnerable families. This funding is made possible by donations made by these non-profit institutions and is focused only on socially vulnerable families.
3. Private sector financing through mortgage loans, catastrophe insurance [fire, earthquakes and others].

b) Casa FENIX assembly process
The assembly of the Casa FENIX can be approached in three different ways

1. Self-construction

This type of assembly will probably be the most utilized in the case of the city of Valparaíso, because of their tradition of self-building. All the families who get their Casa FENIX through a housing subsidy and are able and willing to build their homes themselves, fall into this category.

The process of self-construction for affected families will be accompanied by a social housing management entity [Entidad de Gestión Inmobiliaria y Social, EGIS] or a technical assistance service provider [Prestador de Servicios de Asistencia Técnica, PSAT], which must be listed on the National Registry of authorized technicians and backed by the Housing Ministry. In addition, each Casa FENIX kit or pack will include an assembly manual.

2. Technical assistance service and voluntary construction.

This service will be provided by FENIX technical assistance teams, the team will be trained at the same university that is developing this proposal, involving advanced students majoring in architecture and civil construction.

3. Technical assistance service and paid construction.

This service will be established with Casa FENIX construction teams, who will at short notice and according to customer demand build the house in the location defined by the buyers. It is estimated that a Casa FENIX can be built in two weeks and that the construction teams would consist of six people. It is proposed that the Casa FENIX pre-fabrication company should establish Casa FENIX construction teams. In this case the target audience would be people who have the need for housing, can buy all the modules at once and are also able to pay for the construction service. This service is not included within the cost of the house.

Assuming that the living conditions of the affected area have been restored, the assembly process of Casa FENIX would take two weeks. The first week would be destined to land preparation and construction of the foundations, leaving the second week for the assembly of the modules.

c) Maintenance cost

The Casa FENIX kit or pack will include a housing maintenance manual. The household users should perform this maintenance. Should anything unforeseen happen or any technological device fail, the family may apply for a home improvement subsidy, as a thermal conditioning subsidy for example, in order to purchase a new technological device. This aspect will be developed further with technical assistant from the Ministry of Housing.

d) Transport cost

The cost of transport in the event of a disaster would be zero for the affected families. This cost would be assumed directly by the state, through the use of public transport [trucks].
One of the most outstanding geographical features of Chile is the relatively constant threat of earthquakes, among other natural disasters, such as volcano eruptions, landslides and fires in urban areas. The regularity with which these events occur does not make them any less catastrophic for people. Many homes are lost and the people who are most affected are low-income families. The post-catastrophe situation throughout the year has indeed been non-sustainable, therefore to develop and implement the concept of sustainable reconstruction is a big challenge for our country, where Casa FENIX ambition is to propose and offer a tangible solution.

**THE PROBLEM** While Chile is a political and geographical location where natural disasters are recurrent and affect a great part of the most socially vulnerable population, there are no official policies which outline a quality response to such events.

“When disaster strikes, the problems are resolved with quick, cheap, short-term solutions, such as the mediagua emergency houses”

which end up causing more problems than they solve and lead to a great deal of waste in the long term.

**HYPOTHESIS** Casa FENIX is a design process that responds to a catastrophe, delivering energy efficient strategies to ensure quality of life as a key factor in a sustainable reconstruction; these strategies are not currently considered in post-catastrophe national policy. Sustainability factors include locally specific environmental, cultural and geographical issues, and also consider accessible and viable solutions for the most vulnerable sector of Chilean society. Therefore, the original objective behind this proposal is:

“to create emergency dwellings that offer quick, good quality and sustainable homes for the families who are the victims of a disaster.”

Thus the architectural and urban concepts that shape the proposal at both individual and collective levels are: **Modularity, progressivity, flexibility and affordability.**
Modularity
Casa FENIX evolves from a basic Survival Module to a complex Eco Village/Housing Complex. This process covers the stage of Emergency, Relief and Reconstruction.

Progressivity
Casa FENIX progression allows the Survival Module unit to become a final home. This incremental and evolving logic is assumed by the urban design strategy.

Flexibility
Casa FENIX has the capability to adapt to different latitudes and climates, given the geographical characteristics and diversity of climates Chile possesses, from north to south.

Affordability
Casa FENIX is an affordable home. Each unit may be acquired through the progressive subsidy addressing the total cost of the home.

ARCHITECTURAL PROGRAMME
For the SDE competition, the Casa FENIX Team proposes to bring a house that represents reconstruction as a growth progression and is configured to perform well in the Versailles climate. The basic structure and its components will subsequently be configured to meet the solar passive design strategy for the specific local climate where it is to be installed.

The programme represents the core concept of Casa FENIX, which takes a progressive approach to Emergency, Relief and Reconstruction, with sustainability in mind. It uses a passive solar design driven by a sunspace, which acts as the energy engine of the completed house and is a key spatial element which allows the articulation of the different modules.

Casa FENIX is a modular design in which each 11 m² module can be progressively attached and easily assembled during a post-disaster period, to form a dwelling measuring 60m².

The modules are as follows:
**Survival Module**
This is the quick initial response for the emergency period, immediately after a catastrophe strikes. Its main objective is to provide shelter, safety and a quality solution to the affected family.

**Mechanical Module**
This is the first module to be attached to the Survival Module as a progression during the relief period. It consists of the services and a technical core. It includes a bathroom and kitchen.

**Living Module**
This is the module that enables the house to expand and cover more than the basic needs during the reconstruction period, transforming the sum of modules into a definitive home.

**Sunspace**
The passive solar design strategy enables the regulation of the indoor climate by articulating the different modules with the exterior climate; this space grows with the addition of each module.

At a collective level, the group of emergency houses, which the FENIX team has called “Temporary Village FENIX, TVF” and the progression to a housing complex, which the FENIX team has called “Eco-Village FENIX, EVF” are conceived following the same logic. They have an open and flexible design that allows for the adaptation of modules and means that Casa FENIX can be adapted to different climatic, topographical, territorial and cultural realities.

**THE GEOGRAPHICAL DIMENSION**
Chile has 9 different climate types and the country stretches from latitude 18°S to 50°S. 90% of the population is located in areas where solar radiation is over 1000kWh/year. To address this climatic diversity and take advantage of the opportunity for solar radiation, the conceptual idea for

“**Casa FENIX is similar to a skeleton or basic structure, an innovative structural design developed by students, where different components can be configured and assembled according to the users’ demands**”
All the components to be attached to it respond to the demands for the different latitudes and to patterns of self-construction.

**SUSTAINABILITY FOR US** It is important to mention that the understanding of sustainability in the case of developing nations differs much from the one used in developed nations, in the sense that the problems that need to be addressed are much different, respect of priorities and urgencies. For the Chilean case the deterioration produced by natural disasters and the anthropic urban degradation produced by informal settlements and poverty are the immediate problems to solve in a sustainable way. To teach the general public about sustainability issues that go beyond recycling, energy efficiency and achieving a low carbon footprint, Casa FENIX proposes to focus mainly on local cultural aspects, quality of life and social relationships. In this case the sustainability aspects are focused on using technology and urban planning to enhance the intuitive know-how of a particular local population.

*“The choice of site: Man’s physical freedom manifests itself no doubt in his ability to choose the place on earth where he wants to live”.*

People act, build and adapt through self-construction to the different latitudes and geographical conditions over time using their intuitive and basic knowledge.

*“Neither privations nor danger will deter man from selecting a spot [...]” to settle on (Rudofsky, 1964).*

This recognition of the appropriateness of the way informal settlements and self-construction take place is basic and seen to be positive; however it is extremely precarious and unsustainable in many other
aspects and in extreme situations could produce complete devastation. This was the case in April 2014 when a wildfire ravaged Valparaíso for three days; 2,900 homes were destroyed and 14,000 people - 4% of the Valparaíso population (IMV, 2014) - were made homeless.

The reasons for the unsustainable settlements can be traced back to many issues related to post-disaster rehabilitation and poverty and a major factor is the lack of a sustainable urban code for areas of vulnerability. This sustainable urban code would need to respond in a general way to the emergency and in a particular way to the post-catastrophe situation that begins right after an emergency occurs.

Casa FENIX TEAM ORGANIZATION Team Casa FENIX is a bi-national team composed of students and faculty members from the Universidad Técnica Federico Santa María [UTFSM], Valparaíso, Chile and from the Institute Universitaire de Technologie [IUT], Université de La Rochelle, France. In addition to all the opportunities that arise out of any international collaboration between academic institutions, team Casa FENIX seeks to respond coherently to SDE’s energy conservation objectives.

The proposal has been designed to address the circumstances and needs of Chile. However, transporting the house from Chile to France would entail a significant amount of CO2 emissions and the team has therefore set itself the goal of making a “PROTOTIPE” in Chile and a “REPLICA” in France, generating a dualism and a double challenge for our project. So, while the conceptual proposal is Chilean, the production of Casa FENIX is French.

TEAM Casa FENIX CHILE
The Chilean part of the team is in charge of all the theoretical, conceptual, architecture and urban design content of the project. One of the strengths of UTFSM is their research and work on bioclimatic architecture and earthquake resistant construction.

TEAM Casa FENIX FRANCE
The French part of the team is in charge of all the practical, construction, building and technology applications of the project. One of the strengths of IUT is their research into and work with wooden structures and construction. A complete version of a replica of Casa FENIX is being built in La Rochelle and this is the version that will compete in Versailles.
5.2.1 ARCHITECTURAL CONCEPTS

The geographical dimension

One of the most outstanding geographical features of Chile is the relatively constant threat of earthquakes, among other natural disasters, such as volcano eruptions, landslides and fires in urban areas. The regularity with which these events occur does not make them any less catastrophic for people. Chile has been considered a developing country for some time, but the most immediate consequence of these natural or provoked disasters is the sudden increase in homelessness. Many homes are lost, and the people who are most affected are low-income families. Following natural disasters in Chile, there are campaigns to persuade people to volunteer to help and also to raise funds. These funds and volunteers build "media agua" [Figure 31], simple, poorly constructed wooden houses without much design. These temporary homes rapidly become obsolete, and ultimately are used as fuel for heating or as waste material.

In order to address the economic, social, psychological and energy issues arising out of this situation, the UTSFM – La Rochelle Team aims to design, develop, build and operate Casa FENIX [For Emergency Natural post-Impact eXtreme], a solar-powered home which proposes an incremental development from an emergency dwelling to a permanent home.

Due to Chile’s diverse climatic zones, the Casa FENIX solution will not only be adaptable to different latitudes and altitudes, but its design will also ensure that it is transportable, flexible and able to grow incrementally. Industrial pre-fabrication, transport to the disaster zone and easy in-situ assembly using simple tools are essential to the success of the proposal.

Architectural Concepts

The architectural and urban concepts that shape the proposal at both individual [unit] and collective [housing complex] levels are: Modularity, progressivity, flexibility and affordability.

The progression from the unit to the collective level: the group of emergency houses [several survival modules], which the FENIX team has called “Temporary Village FENIX, TVF” and the progression to a housing complex, which the FENIX team has called “Eco-Village FENIX, EVF” are conceived following the same logic. They have an open and flexible design that allows for the adaptation of modules and means that Casa FENIX can be adapted to different climatic, topographical, territorial and cultural realities.

In Chile the emergency protocol tend to have immediate responses to house people that have lost their home in a disaster with precarious solutions as the "mediagua" [Figure 30]. Mediagua could last from one to two years until the definite solution comes, in the mean time, people return to their places and begin self-construction in a very informal manner, the need for a clear after disaster protocol is much needed.
The time for reconstruction will depend much on the type of disaster. For the recent fire of Valparaíso, April 12th 2014, more than 3,000 homes, over 14,000 victims, the government has announced that the reconstruction will take more than five years.

The Casa FENIX team has defined the reconstruction periods as it is depicted in the Figure 32 at an early proposal level:

**A Sustainable Reconstruction model for Valparaíso:**

- **Emergency Period** – 1 to 6 months, to prevent psychological and social problems among victims.

- **Relief Period** – 6 months to 2 years, to return to normally progressively and victims can pursue their regular activities within a normal living.

- **Reconstruction Period** – 2 years to 5-10 years, permanent solutions that imply the full reconstruction of an urban or rural settlement/ neighbourhood, this time will vary much depending of the scale of the disaster.

![Figure 32: General Sustainable Reconstruction Timeline](image)

However, at the moment, the team is focused mainly on the competition, this aspect needs further studies and a profound understanding on the way the local culture and history acted and acts in such devastating events. Currently, the Casa FENIX team would develop a theoretical proposal for a “sustainable reconstruction” model to be presented to the Ministry of Housing during the month of May, given the recent disaster, however the complexity of the situation requires much development on this matter, to reach a real affordable and cultural solution, it
is a interdisciplinary proposal that requires many fields of expertise which our team do not have, such as social work, psychology, anthropology, human geography among others.

The concept

Casa FENIX addresses local issues from the reality of a developing nation subject to periodical natural disasters, in which many people, especially poor people, lose their homes.

Team Casa FENIX takes on the challenge of designing a sustainable and energy-independent home which can be deployed quickly following a disaster to respond to the emergency and which can be adapted to different climates. This is an opportunity to explore passive design strategies, given that energy and water supplies are often affected during and after a disaster and this also has a severe effect on people’s comfort. The main sustainability goal of Casa FENIX is focused on energy independence and the low to zero carbon design of a small solar Villagege, to supply the demand and meet the needs of a group of families following a disaster.

The American Institute of Architects [AIA] has proposed that after a natural disaster there are three clearly defined stages: Emergency, Relief and Reconstruction.

The conceptual idea for Casa FENIX contemplates three modules to be implemented progressively. [Figure 33]

The design is conceived as open and flexible, associative and an opportunity generator.

Chile has 9 different climate types [accordingly to the map shown in NCh 1079 Code], and the country stretches from latitude 18ºS to 50ºS. 90% of the population is located in areas where solar radiation is over 1000kWh/year. To address this climatic diversity and take advantage of the opportunity for solar radiation, the conceptual idea for Casa FENIX is similar to that of the electronic components of a computer, comprising a motherboard and components that can be configured according to the users’ demands. All the components are to be attached to it.

There are two scales in which this is done:

• The first scale, volumetric one, is related to the modular design of volumes attached to

1 Bustamante, 2009
the sunspace, which articulate and configure them as a spatial motherboard [Figure 34]. This sunspace is the base for the passive design strategy, where modules are configured in such a manner as to maximize the passive solar design. Then, the architectural programme is established sequentially through the Surviving Module [Sm], Mechanical Module [Mm] and Living Module [Lm].

The module sequence ranges from compact to extended design configuration and includes solar orientation and ventilation strategies, in which the sunspace is the engine and which drive the thermal comfort of Casa FENIX.

- The second scale, component one, is related to the building envelope as a component clipped to the structural skeleton, which in this case is a motherboard as well. It will be built of wood, which is key to providing an easy and fast response to the emergency stage. The teams of non-specialist volunteers who are commonly brought together in response to natural disasters will be able to assemble the Surviving module of these homes.

There will be a list of specific pre-fabricated components, which will be selected according to the location, family size and programme needs. These components must achieve the maximum flexibility in their design and specifications in regard to wall transmittance, thermal mass, type of windows, solar protection, roof slope, among other aspects. In this way, the sustainable home can be customized according to each family’s needs, and can support additions and upgrades at any time provided the skeleton (motherboard) can support the clipped-on components.

The Architectural Program

For the SDE competition, the Casa FENIX Team proposes to bring a house that represents reconstruction as a growth progression and is configured to perform well in the Versailles climate. The basic structure and its components will subsequently be configured to meet the solar passive design strategy for the specific local climate where it is to be installed.

The programme represents the core concept of Casa FENIX, which takes a progressive approach
to Emergency, Relief and Reconstruction, with sustainability in mind. It uses a passive solar design driven by a sunspace, which acts as the energy engine of the completed house and is a key spatial element, which allows the articulation of the different modules.

Casa FENIX is a modular design in which each 11 m² module can be progressively attached and easily assembled during a post-disaster period, to form a dwelling measuring 64 m².

The modules are as follows:

**Survival Module [SM]**

The Survival Module is the quick initial response, immediately after a disaster strikes. Its main objective is to meet the basic need for shelter, thus reinforcing the sense of safety of the affected family. Following the instructions in the User Manual, a team of volunteers can easily assemble this initial 11 m² module using simple tools [Figure 35].

This is a foundational module. It possesses anti-seismic features, which will establish the basic resistant structural language that will later be followed by the other modules.

This module has a passive design strategy in terms of the building envelope’s performance, natural ventilation, internal gains and thermal mass. The sunspace starts from this module and generates the space for passive solar gains.

A small FV system is installed simply to provide electricity for lighting

**Mechanical Module [MM]**

This is the second module to be built, and the first to be attached to the Surviving Module as a progression during the Relief period immediately following a natural disaster [emergency]. This module consists of the building services and the technical core. It includes a bathroom and a kitchen. Both these spaces support and manage solar energy, BIPV, DHW, and provide the climate active system [Figure 36].

This module is ready to connect to public services over time, after the initial emergency period has settled down.

The Mechanical Module is the heaviest and most complex module in the Casa FENIX engine. It not only holds the systems for the basic housing unit, but it also provides the connections that will link the house to others in a tied electrical system. This will later create an electrical network grid and a long-term district solar heating system.
The Living Module [LM]:

The Living Module is built during reconstruction following the disaster period, once the situation has normalized. It offers the users the possibility of expanding the lifespan of their new home. The Living Module is the last module to be added to Casa FENIX. It will also add more solar energy production to its envelope, and innovative ways of including BIPV. It will enable the house to expand and meet more than just basic needs, transforming the sum of modules from an emergency shelter into a definite home [Figure 37].

In this way, it makes the leap from the temporary condition created by emergency circumstances, to a stable house, which can even be a marketable housing solution [Figure 39].

Sunspace [SS]:

The Sunspace is a flexible space conceived of as a motherboard and to which the modules are attached [Figure 38].

The purpose is to generate and drive the passive energy and natural ventilation and to provide shade and solar protection.

The sunspace can be a porch gallery in Mediterranean Climates [such as the central valley of Santiago, Chile], shade and ventilated space in a sub-tropical climate [for instance the northern desert coastal climate of Iquique, Chile], or a sunspace for the Versailles climate.
5.2.2 SUMMARY OF RECONFIGURABLE FEATURES

**Interior reconfigurable features**

**Dinner table**

The kitchen inside to the Mechanical module [Mm], will have a dinner table that can be customized according to the inhabitants needs. This table can be deploy or fold according to the number of people that used in every moment. In the case of the competition, that special feature will allow the accessibility for people with special needs or disabilities in the kitchen area for the public tour. For more details please refer to drawing AR-042 and PT-101 [Figure 40].

**Living module [Lm] furnishing**

How parts of a Casa FENIX design strategy, we decide to do the furnishings as a part of the structure. In the Living module [Lm] we have four couches designed for our own students, this have the special feature that can be re-organized according to the moment. In the competition week, when the dinner party take place in our house, we will use this couches together with the dinner table. For more details please refer to drawing [Figure 41]

**Exterior reconfigurable features**

**Fabric Cover**

The exterior reconfigurable features, which change the measurable area is the fabric cover that can be over the access deck, this only will deploy in the public tour hours for shade the people who wait for come in to Casa FENIX. The design of this fabric cover was done according to rule 5.1, therefore comply with the solar envelope requirements. For more details please see drawing AR-103, AR-104 [Figure 42]

**Thermal curtains**

The use of curtains is considered in the exterior of the sunspace Windows to regulate thermic comfort inside the house. These curtains can be rolled up or down accordding to the need of the inhabitants. For further details please refer to Project Drawings AR-112 and AR-113 [Figure 43].
5.2.3 LIGHTING DESIGN NARRATIVE

Daylight analysis

The present study focuses on the analysis of the Daylight Factor [DF], aiming to ensure good levels of daylight in the indoor area.

DF is described as the ratio of internal light level to external light level and is defined as follows:

$$DF = \left( \frac{E_i}{E_o} \right) \times 100\%$$

Where,

- $E_i$ = illuminance due to daylight at a point on the indoors working plane, and
- $E_o$ = simultaneous outdoor illuminance on a horizontal plane from an unobstructed hemisphere of overcast sky.

Casa Fenix has originally been conceived in Valparaíso, Chile [33°S, 71°O]. According to the CIE Standard, the outdoor illuminance [$E_i$] is calculated under overcast Sky for 21 September at 12:00pm [Northern hemisphere].

As illumination levels vary depending on the location, lux levels in the outdoor environment

<table>
<thead>
<tr>
<th>$DFm$ [%]</th>
<th>$DF_{min}$ [%]</th>
<th>$DF_{max}$ [%]</th>
<th>$DF_{min} / DFm$</th>
<th>$DF_{min} / DF_{max}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>4,37</td>
<td>0,81</td>
<td>29</td>
<td>0,184</td>
<td>0,027</td>
</tr>
</tbody>
</table>

Table 5: Daylight Factor

Figure 44: Daylight analysis

Figure 46: Artificial light analysis

Figure 47: Artificial light analysis
for Valparaiso, Chile are considered as follows:

Ei Ground Ambient for studied location: 14564 lux

The house is designed as a rectangular shaped plan oriented to gain direct sun radiation from the south side.

The windows have been disposed in order to provide good levels of ventilation, sun gaining, as well as view to the outdoor environment. All the surfaces are painted in white, aiming to take advantage of the reflective properties of bright clear colors. The working plan for the whole area has been kept at 0.85mt.

As a calculation criteria, average DF should be no less than 4% for the living area. This criteria has been fixed by the Solar Decathlon competition.

**Calculation**

all the calculations were made with the software Dialux 4.11

The Table 45 show that Casa Fenix fulfills the requirements of indoor daylight levels under overcast sky, with an average Daylight Factor of 4.37% for the entire house.
Lighting analysis

As criteria, artificial light is designed to complement the performance of daylight, ensuring a sense of well-being and functionality throughout the day.

By analyzing the uses of each living area during the night together with the results of the daylight analysis, the design of artificial light combines the use of control systems and efficient light fixtures with lighting design quality aspects to create a comfortable and sustainable atmosphere for the inhabitants.

Casa Fenix has been conceived as an emergency shelter, therefore artificial light should be kept as simple as possible. High efficient fixtures producing diffusive light together with the proper use of vertical surfaces and its reflective properties are the fundamentals for the lighting design of Casa Fenix.

On the other hand, light has the ability to create atmospheres and emotions to the inhabitants. By proposing a lighting design narrative, it is possible to recreate the context of emergency where Casa Fenix was conceived.

Light has been divided into scenes, where different moments of the reconstruction are enhanced by the use of light and the changing of color temperature [2700K, 3000K, 4000K], creating a warm, cozy environment that will eventually settle, together with the house itself.

Concerning the technical aspects, lighting fixtures for the indoor area are described as follows:
- L1: LED 7W dimmable, 3000K, 12V, IP40, A2 Class incorporated transformer
- L2: LED 9W dimmable, 3000K, 220V, IP40, A2 Class incorporated transformer
- L4: LED 14W/Lm dimmable, 2700K, 12V, IP67.
- L5: LED 14W/Lm dimmable, 3000K, 12V, IP67
- L6: LED 14W/Lm dimmable, 4000K, 12V, IP67

Currently, the Norma Chilena Eléctrica Nch 4/2003 [Electric Chilean Standard] doesn’t provide illuminance criterias for residential areas. Therefore, standards used for the present analysis are taken from recommendations established by the US Illuminating Engineering Society [IES] at The Lighting Handbook [2013].

The Table 49 shows that the lighting plan assures a good amount of light in the indoor space.

Exterior Lighting design

Outdoor lighting aims to extend the use of public space throughout the night, providing a sense of security and integration to the community.

Accordingly with the indoor lighting criteria, exterior lighting combines the use of control systems and efficient light fixtures, while at the same time avoids lighting pollution by determining its position, lighting distribution and Luminous flux [lumen] [Figure 55].

In terms of the exhibition, the lighting design enhances the feeling of reconstruction by lighting up the building from below, in order to create a sense of lightness as the house emerges from the catastrophe. At the same time, the surroundings are enlightened dramatically, to represent the feeling of the community after the emergency.

Concerning the technical aspects, lighting fixtures for the outdoor area are described as follows:
- L3: LED 1W dimmable, RGB [Amber], 12V, IP68.
- L5: LED 14W/Lm dimmable, 3000K, 12V, IP67.

For the exterior lighting design project, it is important to take into consideration that Chile has one of the clearest skies in the world. This is why many of the greatest telescopes on Earth are located in the north of the country. Therefore, keeping the sky free from lighting pollution is the core objective in terms of sustainability. Currently, the Oficina de Protección de la Calidad del Cielo de Chile (Office for the Protection of Sky Quality Chile) has established some design criteria to keep control of lighting pollution:

- Keep lux levels under 50lux in outdoor spaces
- Keep luminaires height below 3-5 meters for pedestrian areas
- Avoid indirect lighting above 3 meters

The exterior lighting design of Casa FENIX takes into account these criteria, by the smart use of efficient fixtures, in order to lighten up the environment with the right amount of light [Table 56].

<table>
<thead>
<tr>
<th>Em [lx]</th>
<th>Emin [lx]</th>
<th>Emax [lx]</th>
<th>Emin / Em</th>
<th>Emin / Emax</th>
</tr>
</thead>
<tbody>
<tr>
<td>39</td>
<td>0.04</td>
<td>1267</td>
<td>0.0</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Table 56: Calculation of exterior lighting
5.2.4 ACOUSTIC DESIGN

Given that Casa FENIX will first insert an “Emergency Village” and later a “Reconstruction Village”, Team Casa FENIX is developing acoustic comfort firstly through an exterior design barrier, where the space between houses gives inhabitants a feeling of safety. This space will become in a private garden for each house. Therefore our team are developing two acoustic design strategies, one for each reconstruction stage.

After an emergency situation, when the Emergency Villages will be built, it is important that the inhabitants can feel safe in their own homes. This will be possible because they will be living in communities, where the neighbours can help one another. Therefore a main element of the acoustic design strategy for the Emergency Village is to provide outdoor space for the community within the village, where 4 or 5 families can share their day-to-day life. This exterior space will allow sounds from outside to come into the house. In an emergency situation the most important issue is that the people inside the houses have visual and acoustic control over what is happening outside. There are usually aftershocks for months following a big earthquake, so it is important for safety reasons that people can hear what is happening outside.

Another aspect for this emergency stage, during which families will live in the Survival Module, is to keep its price as low as possible; acoustic control would make it more expensive by adding an extra layer of material.

**After the emergency stage, the reconstruction** will get underway and the Emergency Villages will become Casa FENIX Villages in which each family is able to settle in a definitive home. During this process solidarity among neighbours is very important, therefore the community needs to be together, and the modular expansion of Casa FENIX will allow for acoustic control.

For the villages, an exterior noise and visual barrier can be designed, thus creating a private exterior space for each family.

The Chilean Acoustic code applies only to collective dwellings where a home shares a wall and/or a roof and floor with other dwelling.

<table>
<thead>
<tr>
<th>Frequency [HZ]</th>
<th>Noise reduction rate [dB(a)]</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>21.6</td>
</tr>
<tr>
<td>125</td>
<td>31.6</td>
</tr>
<tr>
<td>160</td>
<td>31.3</td>
</tr>
<tr>
<td>200</td>
<td>34.3</td>
</tr>
<tr>
<td>250</td>
<td>36.8</td>
</tr>
<tr>
<td>350</td>
<td>43.3</td>
</tr>
<tr>
<td>400</td>
<td>47.4</td>
</tr>
<tr>
<td>500</td>
<td>47.6</td>
</tr>
<tr>
<td>630</td>
<td>50.0</td>
</tr>
<tr>
<td>800</td>
<td>51.0</td>
</tr>
<tr>
<td>1000</td>
<td>51.2</td>
</tr>
<tr>
<td>1250</td>
<td>49.2</td>
</tr>
<tr>
<td>1600</td>
<td>49.1</td>
</tr>
<tr>
<td>2000</td>
<td>50.2</td>
</tr>
<tr>
<td>2500</td>
<td>53.3</td>
</tr>
<tr>
<td>3150</td>
<td>49.1</td>
</tr>
<tr>
<td>4000</td>
<td>-</td>
</tr>
<tr>
<td>5000</td>
<td>-</td>
</tr>
</tbody>
</table>

*Table 57: Acoustic design for interiors partitions*

In this case, the acoustic devices as a construction element must reduce at least 45dB[a] and show a maximum level of acoustic pressure of 75dB on floors.

In this case, the Casa FENIX units in a compact array of homes [i.e. a terraced or semi-detached array] will have the same construction design for walls and an extra layer of gypsum boards will be added to both sides to comply with the code for shared construction.

Exterior noise levels have not being studied as Team Casa FENIX does not have an acoustic specialist among its members.
5.3 ENGINEERING AND CONSTRUCTION DESIGN NARRATIVE

CASAFENIX

For Emergency post-Natural Impact eXtreme REMINDER

One of the most outstanding geographical features of Chile is the relatively constant threat of earthquakes, among other natural disasters, such as volcano eruptions, landslides and fires in urban areas. The regularity with which these events occur does not make them any less catastrophic for people. Many homes are lost and the people who are most affected are low-income families. The post-catastrophe situation throughout the year has indeed been non-sustainable, therefore to develop and implement the concept of sustainable reconstruction is a big challenge for our country, where Casa FENIX ambition is to propose and offer a tangible solution.

THE PROBLEM While Chile is a political and geographical location where natural disasters are recurrent and affect a great part of the most socially vulnerable population, there are no official policies which outline a quality response to such events.

“When disaster strikes, the problems are resolved with quick, cheap, short-term solutions, such as the mediagua emergency houses”

which end up causing more problems than they solve and lead to a great deal of waste in the long term.

HYPOTHESIS Casa FENIX is a design process that responds to a catastrophe, delivering energy efficient strategies to ensure quality of life as a key factor in sustainable reconstruction; these strategies are not currently considered in post-catastrophe national policy. Sustainability factors include locally specific environmental, cultural and geographical issues, and also consider accessible and viable solutions for the most vulnerable sector of Chilean society. Therefore, the original objective behind this proposal is:

“to create emergency dwellings that offer quick, good quality and sustainable homes for the families who are the victims of a disaster.”

Thus the architectural and urban concepts that shape the proposal at both individual and collective levels are: Modularity, progressivity, flexibility and affordability.
Modularity
Casa FENIX evolves from a basic Survival Module to a complex Eco Village/Housing Complex. This process covers the stage of Emergency, Relief and Reconstruction.

Progressivity
Casa FENIX progression allows the Survival Module unit to become a final home. This incremental and evolving logic is assumed by the urban design strategy.

Flexibility
Casa FENIX has the capability to adapt to different latitudes and climates, given the geographical characteristics and diversity of the climates Chile possesses, from north to south.

Affordability
Casa FENIX is an affordable home. Each unit may be acquired through the progressive subsidy addressing the total cost of the home.

Architectural Programme
For the SDE competition, the Casa FENIX Team proposes to bring a house that represents reconstruction as a growth progression and is configured to perform well in the Versailles climate. The basic structure and its components will subsequently be configured to meet the solar passive design strategy for the specific local climate where it is to be installed.

The programme represents the core concept of Casa FENIX, which takes a progressive approach to Emergency, Relief and Reconstruction, with sustainability in mind. It uses a passive solar design driven by a sunspace, which acts as the energy engine of the completed house and is a key spatial element which allows the articulation of the different modules.

Casa FENIX is a modular design in which each 11 m² module can be progressively attached and easily assembled during a post-disaster period, to form a dwelling measuring 60m².

The modules are as follows:
Survival Module
This is the quick initial response for the emergency period, immediately after a catastrophe strikes. Its main objective is to provide shelter, safety and a quality solution to the affected family.

Mechanical Module
This is the first module to be attached to the Survival Module as a progression during the relief period. It consists of the services and a technical core. It includes a bathroom and kitchen.

Living Module
This is the module that enables the house to expand and cover more than the basic needs during the reconstruction period, transforming the sum of modules into a definitive home.

Sunspace
The passive solar design strategy enables the regulation of the indoor climate by articulating the different modules with the exterior climate; this space grows with the addition of each module.

At a collective level, the group of emergency houses, which the FENIX team has called “Temporary Village FENIX, TVF” and the progression to a housing complex, which the FENIX team has called “Eco-Village FENIX, EVF” are conceived following the same logic. They have an open and flexible design that allows for the adaptation of modules and means that Casa FENIX can be adapted to different climatic, topographical, territorial and cultural realities.

THE GEOGRAPHICAL DIMENSION
Chile has 9 different climate types and the country stretches from latitude 18°S to 50°S. 90% of the population is located in areas where solar radiation is over 1000kWh/year. To address this climatic diversity and take advantage of the opportunity for solar radiation, the conceptual idea for “Casa FENIX is similar to a skeleton or basic structure, an innovative structural design developed by students, where different components can be configured and assembled according to the users’ demands”
All the components to be attached to it respond to the demands for the different latitudes and to patterns of self-construction.

**SUSTAINABILITY FOR US**

It is important to mention that the understanding of sustainability in the case of developing nations differs much from the one used in developed nations, in the sense that the problems that need to be addressed are much different, respect of priorities and urgencies. For the Chilean case the deterioration produced by natural disasters and the anthropic urban degradation produced by informal settlements and poverty are the immediate problems to solve in a sustainable way. To teach the general public about sustainability issues that go beyond recycling, energy efficiency and achieving a low carbon footprint, Casa FENIX proposes to focus mainly on local cultural aspects, quality of life and social relationships. In this case the sustainability aspects are focused on using technology and urban planning to enhance the intuitive know-how of a particular local population.

“The choice of site: Man’s physical freedom manifests itself no doubt in his ability to choose the place on earth where he wants to live”.

People act, build and adapt through self-construction to the different latitudes and geographical conditions over time using their intuitive and basic knowledge.

“Neither privations nor danger will deter man from selecting a spot [...]” to settle on (Rudofsky, 1964).

This recognition of the appropriateness of the way informal settlements and self-construction take place is basic and seen to be positive; however it is extremely precarious and unsustainable in many other
aspects and in extreme situations could produce complete devastation. This was the case in April 2014 when a wildfire ravaged Valparaíso for three days; 2,900 homes were destroyed and 14,000 people - 4% of the Valparaíso population (IMV, 2014) - were made homeless.

The reasons for the unsustainable settlements can be traced back to many issues related to post-disaster rehabilitation and poverty and a major factor is the lack of a sustainable urban code for areas of vulnerability. This sustainable urban code would need to respond in a general way to the emergency and in a particular way to the post-catastrophe situation that begins right after an emergency occurs.

Casa FENIX TEAM ORGANIZATION

Team Casa FENIX is a bi-national team composed of students and faculty members from the Universidad Técnica Federico Santa María [UTFSM], Valparaíso, Chile and from the Institute Universitaire de Technologie [IUT], Université de La Rochelle, France. In addition to all the opportunities that arise out of any international collaboration between academic institutions, team Casa FENIX seeks to respond coherently to SDE’s energy conservation objectives.

The proposal has been designed to address the circumstances and needs of Chile. However, transporting the house from Chile to France would entail a significant amount of CO2 emissions and the team has therefore set itself the goal of making a “PROTOTIPE” in Chile and a “REPLICA” in France, generating a dualism and a double challenge for our project. So, while the conceptual proposal is Chilean, the production of Casa FENIX is French.

TEAM Casa FENIX FRANCE

The French part of the team is in charge of all the practical, construction, building and technology applications of the project. One of the strengths of IUT is their research into and work with wooden structures and construction. A complete version of a replica of Casa FENIX is being built in La Rochelle and this is the version that will compete in Versailles.

Figure 60: Team FENIX in the Prototipe built in Chile

The design of Casa FENIX has been developed in Chile with the participation of the students from the French team during the process. Half of Casa FENIX will constitute the prototype built and tested in Valparaíso.
Introduction

Casa FENIX was born from necessity, to aid people who have suffered great material losses under unexpected circumstances. As such, the house is basic and responds to the emergency in every sense, from its structural system to its operation. It aims to quickly and simply supply a shelter and a minimum level of comfort in a disaster scenario.

In Chile, those who are most affected by natural disasters and house fires are typically lower income families, ranging from people living in typical social housing through to those living in extreme poverty in squatter settlements.

As target users, these families generally have very low expectations, and feel comfortable under a wide range of circumstances. Their homes will never include HVAC systems; just typically a small focal heating appliance. These users are extremely careful about expenses and will therefore actively work towards reducing all kinds of maintenance and energy costs.

The project will be successful so long as it is an affordable option for these target users and takes into account their local geographical and cultural circumstances, which vary considerably throughout the country.

Taking into account the needs of this group, its prime target market, Casa FENIX needs to be a basic, low-tech home, where passive strategies can be easily controlled by the occupants at no extra cost and the need for maintenance is reduced to a minimum.

Energy consumption should be eliminated as much as possible, enabling the occupiers to make savings or use their limited household budget for other purposes.

In this scenario, our aim is not technological innovation, but an innovative response to a disaster situation which is flexible enough to adjust to very different locations across Chile.

The first version of Casa FENIX has been designed specifically for the city of Valparaiso [a coastal city in central Chile, Lat 33 S – 71 West]. The consideration of both geographical and cultural factors therefore defines which strategies are the most viable for this particular location.

The concept

Casa FENIX has established a concept based on a progressive modular design, which can be flexible in terms of construction over time.

It was conceived as a primary structure and components on two different scales. The first is a spatial scale, in which the first part to be built is the Survival module, then the Mechanical module and finally the Living module are attached as components added to the Sunspace. The second scale is the “material scale”, where the different skins are attached for adapting the house environment to the diverse climate conditions. Flexibility is an important feature of the construction system, which can be assembled quickly in a post disaster scenario and later grow progressively into a definitive home during the subsequent reconstruction period.

This lightweight structure is capable of appending the envelope components completely from the exterior of the house. The skin can be homogeneous, thereby minimizing thermal bridges when assembled.
Wood is in plentiful supply in Chile, where there are sustainable forests, so it is a local sustainable material.

The skin or building envelope considers various passive design strategies, such as solar control devices, ventilation inlets and outlets, louvers, etc. Other attachable active components are also included, such as PV panels, thermal mass partition panels and solar thermal panels, among others.

5.3.1 STRUCTURAL DESIGN

Since deliverable #2, the structure of Casa FENIX has been subjected to several modifications. Currently, the team has developed two structures in parallel: the Casa FENIX Chilean Structure - PROTOTYPE original version and the Casa FENIX Versailles Structure - REPLICA.

The Prototype Casa FENIX Chilean Structure has conceived the structure as a wooden skeleton consisting of prefabricated parts which will be assembled on site by a team of volunteers after a catastrophe. The key constructive solution is the industrial production of wooden components that are pre-assembled and deployed as a Z shape on site. This version of the structure responds to the situation in Chile following a disaster, when resources are scarce and must be shared among all the people in need. The structural calculation of this version has been prepared to comply with the Chilean Regulations of seismic resistance

The Replica Casa FENIX Versailles Structure has been modified to comply with SDE 2014 rules and regulations. In addition, after the competition, the replica of Casa FENIX will remain in France, as it will be taken back to the University of La Rochelle, where it will remain. Therefore the FENIX Versailles Structure must comply also with French Regulations. The following list includes the most important aspects that have determined the evolution from the Casa FENIX Chilean Structure to the Casa FENIX Versailles Structure. The steps are chronologically organised:

- LEMCO Laboratory, UTFSM, Chile: Several tests of 1:4 scale models were made. Some of these coincided with the visit by the first French delegation from the U de La Rochelle and CILC S.A. in April 2013

- Design decision 1: all the envelope components will be attached from the exterior and the structure will be exposed in the interior of Casa FENIX.

- The design of Casa FENIX was modified to comply with

1 More details in Appendix 14.1 “Structural Appendix”
the French regulation on fire resistance.
• The structural calculation to comply with the French regulation was undertaken by ARCABIOS.

• **Design decision 2:** To transport Casa FENIX from La Rochelle to Versailles, it was necessary to change the modularity, ensuring a division for assembly by one crew working one 8-hour shift per day for 10 days. This new modularity considers the assembly of the structure, envelope and installations as a whole instead of as separate components [walls, floors, ceilings].

• **Design decision 3:** The maximum height allowed for transportation to Versailles is 4.20m

2 More details in Appendix 14.1 "Structural Appendix

A) Casa FENIX Chilean Structure - Basic element, the "Z" section

The "Z" section [Figure 62] was designed to be simple to
manufacture and produce with easily accessible materials which are commercialised widely. The name “Z” was given to the basic structural element which is used to build the complete module [Figure 62]. This structural component is made from widely available dimensioned timber which is attached at one point using bolts and nuts, providing the system with the flexibility required for assembly and disassembly.

This “Z” unit, once assembled, enables the construction of a braced panel, consisting of a COLUMN-FLOOR-DIAGONAL MEMBER AND ROOF BEAM [Figure 61].

This system works as one panel, which can be manufactured, built and installed quickly and transported easily, while also complying with the structural requirements for wooden dwellings in Chile. The emergency module is built of eight “Z” sections [Figure 63]. A variety of joints for attaching these sections in different angle positions was tested in order to find the best possible joint. The solution chosen provides the following advantages: easy manufacture and different angle position adoption, allowed by the dimensioned timber connected with pinned joints [Figure 63].

B) Casa FENIX Versailles Structure – competition version:

For the Casa FENIX Versailles Structure version the team modified the “Z” section logic by using a “panel and column” design to simplify the structure, while retaining the geometry and all the major design decisions of the original version of Casa FENIX structure. In other words, the “Z” section became part of the panel and it is not collapsible [Figure 64].

Simplicity of manufacture and production and accessibility to widely available building materials remained important aspects in order to facilitate the assembly and disassembly of the structure. Once the first structural set of “panel and columns” has been assembled, the other elements of the structure are attached with ease; the Casa FENIX Chilean
Structure is assembled in the same way [Figure 65].

The main purpose of the “panel and column” unit is to prevent distortion of most of the panels by fixing them diagonally to constitute a braced panel. The diagonals are only removed for door access, fenestrations and interior circulation openings.

After building the 1:1 scale prototype and carrying out many trial and error tests in Valparaíso and La Rochelle, we discovered that by using this assembly and disassembly process for the “panel and column” unit, it helped to maintain the shape of the panels, with the following advantages:

- The braced panels performed much better and were less inclined to distort, contributing positively to the whole structure.

- The assembly was faster.

The assembly depicted in Figure 66 is based on a previous tracing in situ of the exact position and levelling of the columns in relationship to its foundation points. It was detected that even minimal differences in levels of as little as 20mm could produce major distortions to the system as a whole. Also, if these distortions are not corrected in time, it affects the subsequent installation of the envelope components, resulting in many construction problems.

The Casa FENIX Versailles Structure is much heavier than the Casa FENIX Chilean Structure, given that the new sections needed to grow considerably in dimensions to comply with the French Regulations. Nevertheless, the weight of the new sections can still be managed by three people and it can be assembled in two days in an emergency situation.

The last prototype of the structure, which constitutes the structure for the 11m² Surviving module, was built [24.10.2013] in Valparaiso at UTFSM for the annual “open house” event, by ten students [five Chilean and five French] in 1.5 hours on a levelled surface to set the eight columns.

C) Anti-seismic design

The main focus of this structure is the anti-seismic design to meet the need for a strong and durable home. The chosen material is therefore wood, because of its flexibility and seismic resistance as a building material.

Structural calculations were carried out in order to reduce redundant components while maintaining the same strength. Each module has anti-seismic capabilities in itself. A quarter-scale model was tested on a seismic table at the equivalent of an earthquake measuring 8.5 on the Richter scale. The sample structure performed well and there was no damage [Figure 67 - Figure 68].

---

3 For the assembly process of the structure please visit the link http://vimeo.com/80013920

4 For the assembly process of the structure please visit the link http://vimeo.com/80013920
5.3.2 CONSTRUCTIVE DESIGN

The main challenge of this design is ensuring that the Survival Module can be built quickly and easily following a disaster.

The concept of a skeleton and skin establish the construction method for the subsequent Mechanical and Living Modules. In the event of a post-disaster rapid response situation, a team of volunteers will need to follow a construction manual for the Survival Module.

The components are designed to be lightweight, made of assembling parts and easy to build.

The materials were studied based on their sustainability, local availability and cost [using Chilean standards]. As a developing nation, we have to focus on cost, according to local economic conditions. However, one of the lessons learned from the reconstruction following the last earthquake in Chile was that the current wooden shelters do not last even one year because of their low cost and precarious design.

For this reason, the team discussed creative ideas for the choice of materials while working within a tight budget.

Wood was chosen for the structure, exterior cladding and the floor, because it is a local material sourced from sustainable forests [FSC wood would be used as much as possible].

The components are grouped on the structural skeleton and skin envelope.

- The skeleton components are:
  - Ground footings
  - Wooden footings
  - The “Z” sections are formed by columns and beams with a diagonal and they are the structure and wall at the same time
  - Floor beams.
  - Roof beams

- The Skin envelope components are:
  - Insulated floor panels
  - Wall panels with integrated windows
  - Roof-ceiling panels.
  - Roofing with a PVC membrane.
  - Ventilated skin cladding.

The construction follows a sequence, which is described in a construction manual: Assembly Sequence Manual.

a) Assembly sequence:

Casa FENIX Chilean Structure

Three non-qualified volunteers can effectively assemble the emergency module.

The sequence of assembly is as follows:

Each “Z” section is structured by its uppermost point being fixed with a bolt [3/16” x 3”]. When this has been done, a new column of the same section is appended at the far end and this must be joined to both the floor and roof beams [Figure 61].

For the Survival Module, the assembly of eight structural “Z” units is needed. Once these pieces have all been fixed, three crosses must be bolted at the stipulated points of each column. These joints, due to their light weight, can be manipulated easily by one person. Therefore to join one corner of the module, two volunteers are needed. Once the four separate corners have been
assembled, the module can be built by adjusting the joint points [Figure 63].

Once the cubicle corresponding to one basic module has been completed, the intermediate floor and roof beams need to be integrated. These have a major section and must be bolted to the intermediate columns on the same axis. For the roof structure, the upper beams must be placed and adjusted at the top of the columns. This part of the assembly requires the participation of three people and the use of a ladder.

The structural system has the advantage of not needing footings, due to its rigidity when all the pieces have been connected and assembled. To avoid the inconvenience caused by the need to wait for concrete to set, which hampers the emergency tasks in a disaster scenario, this module can be easily assembled and even incorporated to footings after completion. The structure needs nine footings points for one basic module.

In a later sequence, basic modules must be added to one another for the house extension. The diagonal wooden members can be removed as the house grows and to allow circulation areas between each space. The housing growth or expansion can be longitudinal or multidirectional, depending on the specific configuration required [Figure 69].

Casa FENIX Versailles Structure

As shown in Figure 66, the Casa FENIX Versailles structure requires eight foundation points, which must previously have been traced and levelled, over which the whole weight of the module will be distributed.

The rest of Casa FENIX will continue its growth following the same principles.

For Versailles, the team exceptionally opted to divide the house into two half modules to facilitate transportation and reduce the assembly and disassembly times, as shown in Figure 72.

The plan is for each module to be transported from the University of La Rochelle to Versailles with the floors and walls pre-installed. The roof and ceiling will be added at the end, after all the other components are in place.
B) The skin:

Casa FENIX Chilean Skin

The skin concept has been developed as “clip-on panels” which are hung from the structural skeleton in order to be easily assembled on site.

Pre-configured panel joints allow panels to be mounted on to one another and to be fixed to the structure by two people. The team therefore discussed how to keep their weight as low as possible.

The panels are defined as floor, wall and roof panels.

- The floor panels are made with one lower layer of 12mm Fibreboard + 120mm Mineral Wool [11kg/m3] + 12mm Fibre cement.

- The wall panels are made with one layer of 10mm Fibre cement + 100mm Mineral Wool [80kg/m3] + 15mm Plasterboard.

- The roof panels are made with 10mm Fibre cement + 160mm Glass Wool [11kg/m3] + 12.5mm Plasterboard.

Figure 70: Assembly sequence Casa FENIX France

Figure 71: Construction of prototype of the 11m2 Surviving module of Casa FENIX Versailles structure. UTFSM Open House

Figure 72: 11m2 Surviving module of Casa FENIX Versailles’ structure divided in two for transportation
The floor panels are installed first and fixed to the lower beam of the skeleton. The walls panels are assembled on top. Each wall panel is joined to the next and fixed to the floor with an L-shaped connector. The wall perimeter and partition are assembled in the same way.

Finally the roof panels are mounted over the roof beams.

**Casa FENIX Versailles Skin**

The skin concept of Casa FENIX Versailles [the Replica] is different to that of Casa FENIX Chile, because in the case of the Replica, the skin was built inside of the main structure, using a secondary structure as a support [Figure 73].

The French regulations are more demanding than the Chilean thermal code and so the thickness of the envelope is also different. Moreover the panels were not designed to change easily or adapt to different climatic conditions, but were measured and built with the Versailles climate in mind and to allow for the fact that the house will be transported from La Rochelle to Versailles, and should be assembled and disassembled in just a few days.

'C) Foundations

Blocks of glue-laminated timber [glulam] are placed below each structural stud. Depending on the topography of the site, pieces of plywood can be placed to level the house. 

5 More details in appendix 14.1

"Structural Appendix"
**5.3.3 PLUMBING SYSTEM DESIGN**

Casa FENIX has established a concept based on a progressive modular design, which can be flexible in terms of construction over time. Flexibility is an important feature of the construction system, which can be assembled quickly in a post disaster scenario and grow progressively into a definitive home during a reconstruction period.

It is to address the flexible design of Casa FENIX that the plumbing design has to be able to respond to the different post-disaster stages, since in each one of this stages, the resources available and the living conditions are different [Figure 74 - Figure 75 - Figure 76 - Figure 77].

First, during the emergency stages, when the emergency villages are being built, the design needs to include a quick response to people’s basic hygiene needs, so it is not a viable option to wait for the reconstruction of the entire public sewage network. For this stage, our design strategy is that all drinkable water systems, grey water and black water systems must be managed in a small community network, where all the inhabitants of the same village share this system.

As an example, we can see in Figure 78 the design of an emergency village for the city of Alto Hospicio, in the Tarapacá region of northern Chile [Latitude 20°S – 70°W]. In this proposal we decided to have two grouping levels for families: sharing community core, in which several sub-community centres are together and sub-community centres, in which four or five families share their daily life.

Each sharing community core has a tall drinking water tower. These are situated along the main village street to make them accessible for the emergency water trucks which will come to fill them with drinking water. As they are tall, they will project a long shadow throughout the day, creating a pleasant square-like atmosphere where people can get relief from the hot sun which prevails in this region.

In the case of community bathrooms the strategy was to site them at the edge of the Emergency Village, together with the system for washing, to
Figure 78: Emergency village for Alto Hospicio city, in Tarapacá region, Chile
avoid odours near the homes and to make them accessible for cleaning by specialized trucks. We also looked at the possibility of including a system of dry toilets, where the solid and liquid waste are separated. The high radiation of the Atacama Desert means that it would be possible to convert the solid waste into compost quickly, while the liquid waste and grey water from the washing could drain into the soil using a simple system to filter it through stones.

In the reconstruction stage when the Survival Module [SM] has been moved to its definitive location, construction gets underway for the Mechanical Modules [Mm] and the entire public sewage network. The main idea for the waste system design at this stage is to manage the waste as a community, where the preconfiguration of the Mechanical Module [Mm] will allow the grey water to be separated from black water. First the black water will go directly to the public network, while the grey water will be reused depending on the needs of each locality. It can go through a simple filtration system before being reused in the toilet, or filtered into the soil.

Casa FENIX plumbing system description

The plumbing system has been designed with a focus on functionality, simplicity and low cost.

The Mechanical Module has the bathroom and kitchen assembled in such a way that they share an installation wall, which includes the entire plumbing system and all the water fixtures. This wall has a cavity where the piping for inlets and outlets can run [Drawing AR-021 in PD].

The idea is to have a single point for cold-water inlet from the tank.

Hot water will be produced inside the home from the DHW solar system including a back-up [Gas boiler for the Valparaiso Prototype, and an electric resistance boiler for the Versailles Replica] using a branch off the cold water inlet.

The greywater and blackwater connections will be on the same wall.

At this stage a calculation for Valparaiso has being carried out using the “Water Consumption Assessment Tool”.

System description

- Water for the Valparaiso prototype

The water needs have been calculated for a family of four people in Valparaiso. The water budget was based on the following profile. [According the Water Consumption Assessment Tool]

- Hot water will be supplied for the shower and sink only.

- Hot water should be provided by a solar system [located on top of the Mechanical Module].

- A 200-litre thermal boiler will provide a back-up system for the hot water solar system.

The Table 79 show the results from the Water Consumption assessment tool.

This does not include a dishwasher since it is not a piece of equipment used widely by Chilean families.
### General Information

<table>
<thead>
<tr>
<th>Area</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area of green space wateres</td>
<td>35</td>
<td>m²</td>
</tr>
<tr>
<td>Area of vegetable garden</td>
<td>9</td>
<td>m²</td>
</tr>
<tr>
<td>Internal surface to be cleaned</td>
<td>54</td>
<td>m²</td>
</tr>
<tr>
<td>Number of users</td>
<td>4</td>
<td>user</td>
</tr>
<tr>
<td>Number of months of occupation</td>
<td>12</td>
<td>months / year</td>
</tr>
<tr>
<td>Number of cars</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Washing frequency</td>
<td>1 times/month</td>
<td></td>
</tr>
</tbody>
</table>

### Equipments

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Number of equipment</th>
<th>Equipment performance</th>
<th>Frequency of use (put 0 if no use)</th>
<th>Average time of use</th>
</tr>
</thead>
<tbody>
<tr>
<td>WC</td>
<td>1</td>
<td>6 L (common)</td>
<td>3 times / day / user</td>
<td></td>
</tr>
<tr>
<td>Bath</td>
<td>0</td>
<td>100 L (medium)</td>
<td>0 times / week / user</td>
<td></td>
</tr>
<tr>
<td>Shower</td>
<td>1</td>
<td>12 L / min (common)</td>
<td>7 times / week / user</td>
<td>5 minutes</td>
</tr>
<tr>
<td>Washbassin</td>
<td>1</td>
<td>10 L / min (common)</td>
<td>3 times / day / user</td>
<td>20 seconds</td>
</tr>
<tr>
<td>Sink</td>
<td>1</td>
<td>12 L / min (common)</td>
<td>3 times / day / user</td>
<td>30 seconds</td>
</tr>
<tr>
<td>Washing machines</td>
<td>1</td>
<td>70 L (common)</td>
<td>2 times / week / washing machine</td>
<td></td>
</tr>
<tr>
<td>Dishwashers</td>
<td>0</td>
<td>20 L (common)</td>
<td>0 times / week / dishwasher</td>
<td></td>
</tr>
</tbody>
</table>

### Distribution of water consumption

<table>
<thead>
<tr>
<th>Use</th>
<th>Result</th>
<th>Unit</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cleaning premises</td>
<td>0,6</td>
<td>m³ / year / building</td>
<td>0</td>
</tr>
<tr>
<td>Exterior consumption</td>
<td>3,4</td>
<td>m³ / year / building</td>
<td>2</td>
</tr>
<tr>
<td>Kitchen</td>
<td>26,3</td>
<td>m³ / year / building</td>
<td>16</td>
</tr>
<tr>
<td>Sanitary</td>
<td>128,5</td>
<td>m³ / year / building</td>
<td>77</td>
</tr>
<tr>
<td>Washing machines</td>
<td>7,3</td>
<td>m³ / year / building</td>
<td>4</td>
</tr>
<tr>
<td>Other equipments</td>
<td>0</td>
<td>m³ / year / building</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>166</td>
<td>m³ / year / building</td>
<td>100</td>
</tr>
</tbody>
</table>

### Domestic hot and cold water [DHC & DCW]

<table>
<thead>
<tr>
<th>Use</th>
<th>Result</th>
<th>Unit</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>DHW</td>
<td>62,1</td>
<td>m³ / year / building</td>
<td>37</td>
</tr>
<tr>
<td>DCW</td>
<td>103,9</td>
<td>m³ / year / building</td>
<td>63</td>
</tr>
</tbody>
</table>

Table 79: Distribution of water consumption in Casa FENIX Chile
• **Water for the Versailles Replica**

The water budget for the two-week contest has been calculated using the Competition Calendar. The contest water budget is summarised in Table 80. The total water needed for the two weeks of the contest is less than 2 m³.

The water cycle is described as follows:

1.- 2 x 750 litre water tanks are filled by the SDE, located in the exterior technical wall [Figure 84].

2.- A 12 V DC pump equipped with a pressure sensor draws water from the drinking water tank to the appliances when requested, so there is no need to maintain water storage under pressure [Figure 82].

3.- Cold water is delivered by a 23 mm inner diameter PEX tube to a general collector, which distributes it via 12 mm inner diameter PEX tubes to the kitchen and bathroom appliances. Connection from the toilet is not allowed.

4.- The DHW boiler tank has a cold water inlet at the bottom and a hot water outlet at the top, which delivers hot water to the appliances by the hot water mains.

5.- Used water is collected in each appliance and delivered to the grey water pipe [40 mm PVC tube].

6.- A 16 litre sewage chamber is placed underneath the structural floor on the north side of the replica. This chamber is equipped with a

<table>
<thead>
<tr>
<th>Activity</th>
<th>Consumption rate [Liters per use]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water meter test</td>
<td>50 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 50</td>
</tr>
<tr>
<td>Clothes Washer</td>
<td>41 0 0 1 1 1 1 0 0 1 1 1 1 1 0 0 410</td>
</tr>
<tr>
<td>Dishwasher</td>
<td>7 0 0 1 1 1 1 0 0 1 0 1 1 1 0 0 56</td>
</tr>
<tr>
<td>Cooking</td>
<td>3 0 0 1 1 1 1 0 0 1 1 1 1 1 0 0 24</td>
</tr>
<tr>
<td>Dinner</td>
<td>6 0 0 1 0 1 0 0 0 0 0 0 0 1 0 0 18</td>
</tr>
<tr>
<td>Hot Water Draws</td>
<td>50 0 0 3 2 3 2 3 0 0 0 2 3 2 0 1000</td>
</tr>
<tr>
<td>Water for plants</td>
<td>40 0 1 0 0 1 0 0 1 0 1 0 0 1 0 0 200</td>
</tr>
<tr>
<td>Total Daily</td>
<td>0 90 201 150 241 157 198 40 51 84 151 207 188 0 1758</td>
</tr>
</tbody>
</table>

Table 80: Contest week water budget
water level gauge and a 12 V DC pump draws the grey water to the dedicated tanks when necessary [Figure 81].

7.- 2x1000 litre grey water tanks are placed in the cabinet. The sizes of the openings are described in the technical specifications and reported in drawings PL-001 to PL-013 [Figure 83].

All the internal items of equipment are easily accessible for maintenance. The supplying water pump is placed under the washbasin and will be acoustically insulated.

Accessibility for all the tanks is from the door of each technical cabinet. The sizes of the openings are described in the technical specification located into Appendix 14.4 “DHW Appendix”.

Figure 81: Sewage chamber and grey water pump.
Figure 82: Supplying water pump.
Figure 83: Grey water tank
Figure 84: Drinkable water tank
5.3.4 ELECTRICAL SYSTEM DESIGN

General Description

Casa FENIX has three branches for electrical installation, one for lighting, one for the power circuit [AC circuits] and the third consists of the photovoltaic power generation equipment [DC circuit].

To configure these circuits, the estimated consumption and energy generation of Casa FENIX were considered, as discussed below.

As shown in Figure 85, the location of the grid connection box is on the north side of our lot. Our team will ensure that there is free space for the installation of all the necessary equipment in the indicated place.

3x16mm² wire will be used for the connection to the grid box.

- Design Specifications

In the design and selection of materials, it is important to note that the current capacity is able to support each element used in the electrical system, that the voltage capacity of the elements is not exceeded, and that suitable protection is provided for the safety of the users and installations.

It is also advisable to separate the different circuits to avoid overloading the conductors, and to use smaller current levels and, to avoid a blackout.

Hence the inner installation has been divided into three main families [Table 86].

The circuits described [Table 86] are adapted to the structural design of the Casa FENIX, by conduit from the photovoltaic panels, to the general board, then to the auxiliary distribution board and to the layout of the house.

---

*The exact number of lighting points and sockets are indicated in plan EL-501*
• Wiring

The current capacity of the conductor is the most important feature to consider and this consists of three factors:

- Coating insulation material
- Cross-section
- The working temperature

For these three reasons, the use of industrial rigid wires type cable U-1000 R2V characterized by a thermoplastic coating which is nylon reinforced, resistant to heat and moisture and can handle a maximum working temperature of 90°C [joule heat generated by current over-heating] and a voltage working range between 600V and 1000V was chosen.

The conductor size [cross sectional area] shown in Table 87 was calculated from the estimated power consumption by the individual appliances connected to the network of the home. Then with the tables of U-1000 R2V conductor manufacturer and temperature correction tables we chose the most appropriate conductor. We therefore selected 3G1.5, 3G2.5 and 3G6, mm2 wires, considering the temperature, grouping and harmonic factors.

### Table 86: Family of circuits

#### Family 1

<table>
<thead>
<tr>
<th>Power meter</th>
<th>Circuit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPT3</td>
<td>PC PI01</td>
<td>Home electronic sockets</td>
</tr>
</tbody>
</table>

#### Family 2

<table>
<thead>
<tr>
<th>Power meter</th>
<th>Circuit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPT2</td>
<td>ECL PI05</td>
<td>Entrance, bathroom and bedroom lighting</td>
</tr>
<tr>
<td></td>
<td>PC PI04</td>
<td>Kitchen sockets [6]</td>
</tr>
<tr>
<td></td>
<td>PLV</td>
<td>Dishwasher</td>
</tr>
<tr>
<td></td>
<td>PFR</td>
<td>Oven</td>
</tr>
<tr>
<td></td>
<td>ECL PI04</td>
<td>Living room, workspace and kitchen lighting</td>
</tr>
<tr>
<td></td>
<td>PECLEXT</td>
<td>Exterior lighting sockets [4]</td>
</tr>
<tr>
<td></td>
<td>PLL</td>
<td>Washing machine</td>
</tr>
<tr>
<td></td>
<td>PC PI05</td>
<td>Entry, bathroom and bedroom sockets (5)</td>
</tr>
<tr>
<td></td>
<td>P32A</td>
<td>Hob</td>
</tr>
</tbody>
</table>

#### Family 3

<table>
<thead>
<tr>
<th>Power meter</th>
<th>Circuit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPT1</td>
<td>PC Pompe 1</td>
<td>12V DC gey water pump</td>
</tr>
<tr>
<td></td>
<td>PC Pompe 2</td>
<td>12 V DC potable water</td>
</tr>
<tr>
<td></td>
<td>PCE</td>
<td>DHW electric backup</td>
</tr>
<tr>
<td></td>
<td>ATTREGUL</td>
<td>DHW regulation</td>
</tr>
<tr>
<td></td>
<td>ATTVMC</td>
<td>VMI Soléhom regulation</td>
</tr>
</tbody>
</table>

Table 86: Family of circuits
The norm NF C15100 establishes that the section of the conductor is chosen according to the nominal corrected current:

\[ I_b = I_{b´} / [K_1 K_2 K_3] \]

Where:
- \( I_b = \) nominal current \([A]\)
- \( I_{b´} = \)nominal current corrected \([A]\)
- \( K_1 = \)temperature factor
- \( K_2 = \)grouping factor
- \( K_3 = \)harmonic factor

**Electrical protections**

For this item we selected two types of protection [Table 87]:

- Thermomagnetic circuit breakers
- Differential protection.

Thermomagnetic protection relays were chosen for each appliance, with backup protection upstream of each item. The differential protection relays were selected for special cases and strategic support.

For direct contact, the sockets have IP6x with built-in child protection and the lighting has IP2x; all the protection [disjunction and differential] relays have a maximum current short circuit 6kA except the general differential protection of 63A@10kA.

---

7 that in addition these types of protection have two differentials each for the protection of photovoltaic panels (25A) and protection in addition to general board (63A), a differential of 40 amps - general for power circuit and a general differential protection for the complete system [EL-501]

<table>
<thead>
<tr>
<th>Circuit</th>
<th>Description</th>
<th>( I_b ) [A]</th>
<th>Method</th>
<th>mm2</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPT3</td>
<td>Dinner room sockets + Workstation sockets</td>
<td>16,0</td>
<td>A1</td>
<td>2,5</td>
</tr>
<tr>
<td></td>
<td>Counter CPT3 branch 1 not supplied</td>
<td>0,0</td>
<td>A1</td>
<td>2,5</td>
</tr>
<tr>
<td>CPT2</td>
<td>Dinner table lighting + Workstation lighting + Kitchen lighting</td>
<td>10,0</td>
<td>A1</td>
<td>1,5</td>
</tr>
<tr>
<td></td>
<td>Outside lighting sockets</td>
<td>10,0</td>
<td>A1</td>
<td>1,5</td>
</tr>
<tr>
<td></td>
<td>Clothwasher socket</td>
<td>16,0</td>
<td>A1</td>
<td>2,5</td>
</tr>
<tr>
<td></td>
<td>Sunspace sockets + bathroom sockets + bedroom sockets</td>
<td>20,0</td>
<td>A1</td>
<td>2,5</td>
</tr>
<tr>
<td></td>
<td>Induction cooker</td>
<td>32,0</td>
<td>A1</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Sunspace lighting + bathroom lighting + bedroom lighting</td>
<td>16,0</td>
<td>A1</td>
<td>1,5</td>
</tr>
<tr>
<td></td>
<td>Kitchen sockets</td>
<td>16,0</td>
<td>A1</td>
<td>2,5</td>
</tr>
<tr>
<td></td>
<td>Dishwasher socket</td>
<td>16,0</td>
<td>A1</td>
<td>2,5</td>
</tr>
<tr>
<td></td>
<td>Oven socket</td>
<td>16,0</td>
<td>A1</td>
<td>2,5</td>
</tr>
<tr>
<td>CPT1</td>
<td>Grey water 12v pump socket</td>
<td>6,0</td>
<td>A1</td>
<td>2,5</td>
</tr>
<tr>
<td></td>
<td>Drinkable water 12v pump socket</td>
<td>10,0</td>
<td>A1</td>
<td>2,5</td>
</tr>
<tr>
<td></td>
<td>DHW socket</td>
<td>16,0</td>
<td>A1</td>
<td>2,5</td>
</tr>
<tr>
<td></td>
<td>PV supply and regulation</td>
<td>6,0</td>
<td>A1</td>
<td>1,5</td>
</tr>
<tr>
<td></td>
<td>HVAC system</td>
<td>16,0</td>
<td>A1</td>
<td>2,5</td>
</tr>
</tbody>
</table>

Table 87: Expected consumption chart
For the indirect contact prevention, the system has a grounding connector for the power circuits, the plumbing system has a conductor to ground too, and the differential protection relays have a 30mA sensibility.

For the calculus of ground protection the norm NF C15100 establishes the following formula, for copper stakes type copper weld:

\[ R = \frac{2 \rho}{L} \]

Where:
- \( \rho \) = land resistivity [Ohm-meter]
- \( \rho \) = estimation for Versailles=50
- \( L \) = length of the stake copper weld (common case =3) [m]
- \( R \) = resistance to ground

Then:

\[ R = \frac{2 \times 50}{3} = 33.33[\Omega] \]

On the other side, all the connection boxes, the TGBT box and inverter have a class II protection from direct contact.

<table>
<thead>
<tr>
<th>Circuit</th>
<th>Description</th>
<th>Disjuntor</th>
<th>Differential</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPT3</td>
<td>Dinner room sockets + Workstation sockets</td>
<td>16,0</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Counter CPT3 branch 1 not supplied</td>
<td>0,0</td>
<td>-</td>
</tr>
<tr>
<td>CPT2</td>
<td>Dinner table lightig + Workstation lighting + Kitchen lighting</td>
<td>10,0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Outside lighting sockets</td>
<td>10,0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Clothwasher socket</td>
<td>16,0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sunspace sockets + bathroom sockets + bedroom sockets</td>
<td>20,0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Induction cooker</td>
<td>32,0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sunspace lighting + bathroom lighting + bedroom lighting</td>
<td>16,0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Kitchen sockets</td>
<td>16,0</td>
<td>ID type AC 2x40A 30mA</td>
</tr>
<tr>
<td></td>
<td>Dishwasher socket</td>
<td>16,0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Oven socket</td>
<td>16,0</td>
<td></td>
</tr>
<tr>
<td>CPT1</td>
<td>Grey water 12v pump socket</td>
<td>6,0</td>
<td>ID type AC 2x40A 30mA</td>
</tr>
<tr>
<td></td>
<td>Drinkable water 12v pump socket</td>
<td>10,0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>DHW socket</td>
<td>16,0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PV supply and regulation</td>
<td>6,0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>HVAC system</td>
<td>16,0</td>
<td></td>
</tr>
</tbody>
</table>

Table 88: Electrical protections
5.3.5 PHOTOVOLTAIC SYSTEM DESIGN

Introduction

With Casa FENIX, the goal is to develop an efficient system, which is able to maximize the production of energy, but considering the cost from the point of view of a developing country.

The system has therefore been reduced in size from 4.32kWp to 3.75kWp in order to be more affordable for the Valparaiso Prototype.

For the Versailles replica, the system consists of 15 panels of 260 kWp each, distributed in two strings of 7 and 8 panels respectively.

The panels will be installed on the roof of the sunspace with a slope of 17°. The 15 modules allow Casa FENIX replica to have 3.9kWp installed power [Figure 89].

General description of the photovoltaic system

The solar panels occupy almost the whole surface of the solar gallery roof, except at the eastern part of the roof, where a thermal solar collector is placed [Figure 89].

Considering the Versailles climate and an optimal shed field with a slope of 17°, this PV installation will provide 3632 kWh/yr [Figure 90].
Figure 90: Electrical PV production for Versailles site [From PVGIS v4 software]

<table>
<thead>
<tr>
<th>Monthly Production [kWh]</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
</tr>
<tr>
<td>February</td>
</tr>
<tr>
<td>March</td>
</tr>
<tr>
<td>April</td>
</tr>
<tr>
<td>May</td>
</tr>
<tr>
<td>June</td>
</tr>
<tr>
<td>July</td>
</tr>
<tr>
<td>August</td>
</tr>
<tr>
<td>September</td>
</tr>
<tr>
<td>October</td>
</tr>
<tr>
<td>November</td>
</tr>
<tr>
<td>December</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

January   110
February  176
March     299
April     394
May       443
June      455
July      497
August    443
September 341
October   242
November  145
December  87
Total     3632

---

Figure 91: Electrical PV production for La Rochelle site [from PVGIS v4 software]

<table>
<thead>
<tr>
<th>Monthly Production [kWh]</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
</tr>
<tr>
<td>February</td>
</tr>
<tr>
<td>March</td>
</tr>
<tr>
<td>April</td>
</tr>
<tr>
<td>May</td>
</tr>
<tr>
<td>June</td>
</tr>
<tr>
<td>July</td>
</tr>
<tr>
<td>August</td>
</tr>
<tr>
<td>September</td>
</tr>
<tr>
<td>October</td>
</tr>
<tr>
<td>November</td>
</tr>
<tr>
<td>December</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

January   157
February  210
March     357
April     445
May       489
June      513
July      551
August    500
September 420
October   287
November  193
December  136
Total     4258
From an environmental point of view, the PV production will prevent the emission of 0.323 yr tons of CO2 equivalent for the French production electricity profile [mean of 0.089 kg CO2/kWh].

The energy recovery time of the whole system is estimated to be 3.2 years [Table 92].

**Design and specifications**

The design of Casa FENIX has ensured that no shade is cast on the modules. This is very important for the energy production, because shade on any part of one string can reduce the production significantly due to the garden hose effect.

When a solar cell is shaded, it can no longer produce current. It then behaves like a blocking diode and current cannot flow in the other cells in the series either. Thus the shading of just one cell reduces the output of the modules, thereby reducing the output of the string, which in turn reduces the output of the entire array.

**Modules**

The Casa FENIX Versailles replica is equipped with 260 kWp VHM Énergies poly-crystalline modules. The dimensions of each module are 1648x991x40mm and each one consists of 60 x 6 inches cells, with a maximum peak power of 260 W and exhibits a nominal efficiency of nearly 16.6% [Figure 93].

The modules are distributed on two strings of 7 and 8 modules respectively. Each string is connected to the same inverter, which has two mppts.

---

**Table 92: Environmental balance for the PV installation**

<table>
<thead>
<tr>
<th>Bilan Environnemental</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Production d’électricité à Versalles (année 1)</td>
<td>=3,6321 MWh</td>
</tr>
<tr>
<td>Equivalent foyer moyen</td>
<td>=1,45 foyers</td>
</tr>
<tr>
<td>Emission de CO₂ évitée (Europe)</td>
<td>=1,729 t/an</td>
</tr>
<tr>
<td>Emission de CO₂ évitée (France)</td>
<td>=0,323 t/an</td>
</tr>
<tr>
<td>Matières hautement radioactives à</td>
<td>=12,349 g/an</td>
</tr>
<tr>
<td>longue vie évitées</td>
<td></td>
</tr>
<tr>
<td>Temps de retour énergétique</td>
<td>=3,2 ans</td>
</tr>
</tbody>
</table>

(simulation avec le logiciel PVGIS V4)

(2 500 kWh/ an sans chauffage ni eau chaude)

(moyenne Europe: 0,476 kg/kWh) [1]

(moyenne France: 0,089 kg/kWh) [1]

(0,0034 g/kWh)

(modules polycristallins: 3 kWh/Wc) [2]
Figure 93: PV modules characteristic curves

<table>
<thead>
<tr>
<th></th>
<th>String 1</th>
<th>String 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Peak [Pp]</td>
<td>2,08 kWp</td>
<td>1,82 kWp</td>
</tr>
<tr>
<td>Maximun Power Point Voltage [Vmpp]</td>
<td>230V</td>
<td>224,8V</td>
</tr>
<tr>
<td>Maximun Power Point Current [Impp]</td>
<td>8,0A</td>
<td>8,0A</td>
</tr>
<tr>
<td>Open Circuit Voltage [Voc]</td>
<td>38,28V</td>
<td>38,28V</td>
</tr>
<tr>
<td>Short Circuit Current [Isc]</td>
<td>8,67A</td>
<td>8,67A</td>
</tr>
</tbody>
</table>

Figure 94: PV instalation
Figure 95: PV Module

Figure 96: PV system electrical connections
• **Inverter**

Casa FENIX Versailles uses a SUNNY BOY 4000TL of SMA solar Technology. This inverter is designed to work with about 4 kWp installed. We have 3,9kWp, so the inverter can operate well with our array of modules in terms of power. The data sheet for the SMA inverter gives the following specifications:

- DC Nominal Power = 4 kW
- Minimum Peak Power Tracking Voltage = 180 V
- Maximum Peak Power Tracking Voltage = 500 V
- Maximum DC Input Voltage = 550 V
- DC Nominal Current = 12V

Considering the maximum powerpoint voltage of the strings [271,8 V], the temperature range in Versailles [1-25 ºC] and the voltage variation of the modules with the temperature [0,33%V/°C], the number of modules in each string must not be lower than 6 or higher than 15. Finally the voltage range of the modules will be between 224.8V and 230V, so the inverter satisfies the requirements.

• **Wiring**

The wiring is achieved with 6mm2 section cables, both in DC and AC parts.

According to standard NF C15100, the voltage drop of a channelled wire is given by the following:

\[ u = \left[ b \rho L / S \right] \left[ \cos(x) \right] \left[ \lambda L \sin(x) \right] \left[ I_{et} \right] \]

\[ \Delta u = 100u/U_0 \]

Where:
- \( u \): Voltage drop [V]
- \( \Delta u \): Relative voltage drop [%]
- \( b \): Coefficient = 2
- \( \rho \): Conductor resistivity in normal operation \( \rho = 0,0225 \Omega \text{mm}^2 / \text{m} \)
- \( L \): Channelization length [m]
- \( S \): Conductor section, [mm²]
- \( \cos \phi = 0.8 \) \( \sin \phi = 0.6 \)
- \( I \): Max operating current in amperes
- \( \lambda \): Reactance per unit length of the conductors, 0.00008 \( \Omega / \text{m} \)

Then:

Is important to note that a voltage drop is required of up to a maximum of 3% but 1% is recommended.

<table>
<thead>
<tr>
<th></th>
<th>AC Distribution</th>
<th>DC Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section</td>
<td>PDL- Armoire distribution</td>
<td>Armoire distribution - Inverter</td>
</tr>
<tr>
<td>current</td>
<td>22A</td>
<td>22A</td>
</tr>
<tr>
<td>voltage</td>
<td>230V</td>
<td>230V</td>
</tr>
<tr>
<td>Section</td>
<td>6mm²</td>
<td>6mm²</td>
</tr>
<tr>
<td>material</td>
<td>copper</td>
<td>copper</td>
</tr>
<tr>
<td>voltage drop</td>
<td>0,27%</td>
<td>0,07%</td>
</tr>
</tbody>
</table>

*Figure 97: Inverter specifications*
• **Solar Panel roof mounting**

The panels are installed on the roof with the simplified integration frame type K2 Systems [Figure 99].

This system allows natural ventilation under the panels, which enhances performance compared with fully integrated systems by limiting the increase in temperature of the panels.

The K2 method, whose components come with a 12 year guarantee, involves a rail fixing system that features “speedclips” screwed to the ceiling. These “speedclips” are made with resin and have a EPDM base. As the rails are not in direct contact with the roof membrane, there is no risk of thermal damage to the membrane [Figure 98].

The “speedclips” will be fixed with zamac Zacrovis screws on the inner wooden beams of the roof, as shown in Figure 100.

![Figure 98: Speedclips](image)

![Figure 99: K2 rails frame (horizontal) and PV panels arrangement (the last 1315 mm space is dedicated to the solar thermal collector, which is fixed on K2 rails also)](image)
Figure 100: Inner wooden beams of the roof

Figure 101: Connection between the AC/DC box, the PV panels and the general electric box
• Protection system

The system has an AC/DC connection box [Figure 102], which has systems lighting protection for both the DC and AC sides. Also as a side protection system, it has an AC circuit breaker of 25A-2P and 1000 R02V3G6mm2 wire and the DC side has a switch-600V DC and 25A Solar PV 6mm2 wire [Telkonet = 57A]. For the other side, all the conductors have canalization and the inverters have IP65 and a maximum current 22A [<25A of the protection].

For the grounding connection, the K2 method consists of individual connections to the modules, so when a module is removed, the equipotential bonding of the other modules is not interrupted.

Figure 102: Connection between the AC/DC box, the PV panels and the general electric box

Figure 103: Insulation of the rails
• **Maintenance plan**

**PV modules**

PV systems require little maintenance. It is recommended that the status of the modules be checked at least once every six months. However, if the system output drops at any time during the hours of sunshine, a check should be performed to remove any dust, tree leaves or other dirt from the modules. The amount of dirt that accumulates depends on the location of the house and the roof angle, and rain also helps to keep the modules cleaner.

To clean the modules, the person responsible for maintenance can simply use a ladder and climb up to the roof in a safe manner. Once on the roof, he/she can use water and a non-abrasive detergent to wash them.

**Inverter**

The inverter should be checked every three months for any visual signs of external damage. The status indicators can also be cleaned with a cloth. Corrosive substances should not be used for cleaning. In case of the inverter shutting down, the module branch belonging to the inverter should be checked and cleaned to remove any shade and the inverter should be reset.

**Wiring and protection**

An inspection should take place every six months with the following objectives:

- The terminals should be checked, to find out whether they are loose, overheated or burned out. If any wire is burned it should be replaced straight away.

- The wiring skin needs to be inspected, to detect any possible defects, to be fixed with self-adhesive tape.

- The inspection should check for oxidation in the welding and circuits of the PV modules [caused by the entrance of humidity across the enclosures].

- The connecting pin wiring of the PV modules should be checked for failures in pressure.

- The connection between the other equipment and the power values need to be checked.

- The sealing of the PV modules must be inspected and any affected elements replaced to avoid future malfunctions.

- The protection equipment needs to be checked, including all the relays, following the instructions of the manufacturer.

- In case of doubt, the manufacturer’s datasheet should be checked for further instructions concerning maintenance.

• **Step by step mounting**

The PV installation on the roof of the solar galery has been done in La Rochelle and the roof will be put as a one piece during the assembly phase. The only task that remains to do in Versailles is to connect the waiting electrical connectors between the house and the roof.
5.3.6 ELECTRICAL ENERGY BALANCE SIMULATION

• Introduction

A correct estimate of electrical needs is essential in order to ensure appropriate dimensioning of the components and housing comfort. Indeed a well insulated house with several effective technologies and control systems, can react easily to energy need variations. This is the reason why Casa FENIX’s system is extremely flexible and is able to adapt to several different scenarios.

The sources of energy consumption in the Casa FENIX project are the hot water backup system and the appliances. To achieve balance, solar facilities are installed to provide electricity, consisting of a 24.25 m² photovoltaic installation composed of 15 polycrystalline modules. Nevertheless, the efficiency of this installation depends on several parameters:

- Location
- Orientation and slope
- Site and neighborhood environment [Possible shadowing]
- Seasons

For this reason, we chose to design the solar installation to take account of the site and the seasons.

• List of the electrical loads

Heating and Cooling

The house’s heating and cooling needs are partly covered by an Air Solar Thermal System - the VMI-Solehom system, developed by Ventilairsec and Elva societies. The electrical consumption of the “VMI-Solehom” system depends on fan power. Thanks to the thermal dynamic simulations for the replica carried out using TRNSYS software, the heating and cooling needs are known hour by hour for the whole year.

The electrical energy consumption of the VMI-Soléhom system can then be accurately estimated, as well as the electrical consumption of the Archimedes screw, hot air fan and smoke fan extractor of the wood pellet stove which constitutes the heating backup system.

Electricity consumption varies throughout the year in accordance with the heating, ventilation and cooling demands.

Hot water back up consumption

Hot water needs at 50°C are estimated to 160 Litres/days, that is 10 Litres more than during the contest period. The electric backup need varies along the year, with of course higher needs in winter compared to summer. The backup consumption is estimated considering a 95% efficiency for the electric resistance [Table 104].

<table>
<thead>
<tr>
<th>Activity</th>
<th>Consumption [Lts]</th>
<th>Mon</th>
<th>Tue</th>
<th>Wed</th>
<th>Thur</th>
<th>Fri</th>
<th>Mon</th>
<th>Tue</th>
<th>Wed</th>
<th>Thur</th>
<th>Fri</th>
<th>Total Liters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot water draws</td>
<td>50</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>0</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>70</td>
<td>1000</td>
</tr>
<tr>
<td>Total Daily</td>
<td>150</td>
<td>100</td>
<td>150</td>
<td>100</td>
<td>150</td>
<td>0</td>
<td>100</td>
<td>150</td>
<td>100</td>
<td>1000</td>
<td>1000</td>
<td></td>
</tr>
</tbody>
</table>

Table 104: Hot water back up consumption
Appliances electrical consumption

This part of consumption is the addition of all electrical equipments [Table 107]. It does not depend on climate conditions. The electrical consumptions are evaluated from the technical data of the equipments provided by the manufacturers, either with the nominal power and the estimated hours of use [contest period or whole month] or with the conventional annual consumption provided by the manufacturer.

• Description of the tools used for the simulations

To estimate heating and cooling loads of Casa FENIX Versailles we use the software TRNSYS. This software is mainly used to assess the thermal performance of buildings and is based on an hour/hour simulation tool. The heating backup consumption of the pellet stove but also the VMI-Soléhom fan consumption are calculated with respect to the TRNSYS simulations.

To estimate the production of the photovoltaic installation, we used the European software PVGIS V4. This software is used for sizing and analyzing data of complete PV installations. It deals with grid-connected and stand-alone PV systems, and includes extensive meteo and PV systems components databases.

As only monthly results are available with this software, interpolation was done for the 12 days of the July contest period.

Hot water and electric backup needs are estimated from with SOLO 2000 method, developed by CSTB with a free n on-line versio tool available on the www.tecsol.fr site.

As only monthly results are available with this software, interpolation was done for the 12 days of the July contest period for the solar production and backup need.

The backup consumption is estimated by considering a 95% efficiency for the electric resistance.

• Photovoltaic system description

The correlation between input production and output consumption is a major issue in photovoltaic technology. The possibility of consuming locally what is produced at the time it is produced has very important consequences for the energy and urban organization policy of a country. The objective of the photovoltaic design of Casa FENIX Chile is to cover most of the house’s electricity needs with its own electricity production and to use a common space in the solar villages to install a communal solar PV system. This would allow the neighbourhood to earn some income through extra power generation, which could cover maintenance costs of the Eco Village FENIX solar system. Any over production will be sold. The Chilean government is currently working on the net-metering law. The price of power is currently going up making the payback time worthwhile.

The solar installation of Casa FENIX has a surface area of a 24.25 m² composed of 18 polycrystalline modules. Panels are installed as big shingles oriented towards the
south with a slope of 17°. This configuration is the most effective with regard to the available surface, the level of shade and the location of the site.

For the Versailles house

The PV modules are composed of Risen polycrystalline modules corresponding to 15 panels with an installed power of 3.9 kWp. The structure of the panels also ensures the roof functions: waterproofness, radiation protection, radiation reflection [Table 105].

The design of the structure provides a ventilated space which improves the efficiency of the panels.

The 15 panels are divided into two strings of 7 and 8 panels, each wired in a series. The strings are connected to a SUNNY BOY 4000TL of SMA inverter [Table 106].

Considering the Versailles climate and an optimal shed field with a slope of 17°, this PV installation will provide 3 632 kWh/yr [Figure 90].

From an environmental point of view, the PV production prevents the emission of 0.323/yr tons of CO2 for the French production electricity profile [mean of 0.089 kg CO2/kWh].

The energy recovery time of the whole system is estimated to 3.2 years [Table 92].

<table>
<thead>
<tr>
<th>Module Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>MPP-Voltage</td>
</tr>
<tr>
<td>MPP Current</td>
</tr>
<tr>
<td>Voltage Open Circuit</td>
</tr>
<tr>
<td>Current Short Circuit</td>
</tr>
<tr>
<td>Correction coefficient Voltage-Temperature</td>
</tr>
</tbody>
</table>

Table 105: Specification of the Modules

<table>
<thead>
<tr>
<th>Inverter specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Powe max</td>
</tr>
<tr>
<td>Mpp-max Voltage</td>
</tr>
<tr>
<td>Mpp-min Voltage</td>
</tr>
<tr>
<td>Voltage max</td>
</tr>
<tr>
<td>Current max</td>
</tr>
</tbody>
</table>

Table 106: Specification of the Inverter
• Contest scenario

The period or number of cycles of use of the different electrical equipments are estimated through the “Detailed Event Schedule” of the 12 days contest [Table 107] for the oven, dishwasher, washing machine, hob, and lightings and domestic electronics appliances.

The fridge and the VMI-Soléhom fan works 24h/day, and the potable and grey water pumps were supposed to work 2h/day each.

The VMI-Soléhom fan consumption is evaluated according the dynamical TRNSYS results [ventilation and night over-ventilation for cooling strategy].

• Results of the simulations

Simulations are done:

• For the 12 days contest period, by considering the day by day scenario, and estimating the periods of use of the different equipments or the consumption in proportion with the conventional annual consumption given by the manufacturers.

• For the whole year, considering reporting a month by month consumption. In that case, the contest scenario was repeated for most of the equipments, but new needs were also considered, as the heating backup consumption of the wood pellet stove as an example. The DHW backup consumption has been evaluated month by month following SOLO 2000 results and not by repeating the contest consumption. This of course give a higher consumption than considering only the contest consumption.

Similarly, the VMI-Soléhom fan consumption follows the TRNSYS monthly results and varies in time because night over-ventilation is only necessary during summer period.

The annual conventional consumptions for the fridge, washing machine and dishwasher are considered.
No vacation period has been considered.

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<th>Wend</th>
<th>Thur</th>
<th>Fri</th>
<th>Sat</th>
<th>Sun</th>
<th>Mon</th>
<th>Tue</th>
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Table 107: Contest week scenario
## Contest electrical energy balance

The electrical analysis consumption for the contest period is given in Table 108.

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<th>Use</th>
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<th>hrs or cycles/contest</th>
<th>Contest period consumption [kWh]</th>
<th>Contest period consumption [%]</th>
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Table 108: Electrical Energy Balance for the Contest Period
The detailed contribution of each equipment is reported in Table 109.

We observe that the more important part of the consumption comes from cooking activities [hob and oven], and represents 40% of the whole consumption. This means that a little change in the evaluation of the electrical consumption of these equipments, or changes in the cooking habits can greatly influence the electrical balance of the contest period.

Another major electrical consumption comes from the VMI-Soléhom fan, with 20% of the contest consumption. This is due to the night over-ventilation cooling strategy, with a high power of the fan compared to basic ventilation.

The electrical resistance for DHW only represents 10% of the consumption, due to the high solar cover of the needs at during this period.

On the other hand, the expected PV production for the period is 192,4 kWh and shows than Casa Fenix will produce 95 kWh more than the global 97,4 kWh consumption planned for the competition period. These 95 extra kWh will be injected into the grid network.
Annual electrical energy balance

The results are given month by month in Figure 110 and the detail by consumers families are reported in Table 112

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<td>Pellet stove</td>
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<tr>
<td><strong>TOTAL</strong></td>
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<tr>
<td><strong>TOTAL</strong></td>
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</tr>
</tbody>
</table>

Figure 110: Annual Electrical Energy Balance month by month
We can see that most of the consumption comes from DHW electrical resistance back up [37%]. The demand for DHW backup and washing machines represents nearly half of the annual needs, and the energy for cooking is 30% of the needs, with roughly 15% for the oven and for the hob.

The remaining consumption comes from the heating and ventilation auxiliaries [mainly from the VMI-Soléhom fan in summer period] and from the others appliances and devices [fridge and home electronics]. Finally, the lightings represents 5% of the annual consumption, with half of them from the exterior lighting.

The monthly analysis of the electrical system is also interesting to study.

Table 111 and Figure 113 shows that the PV production exceeds the electrical demand from April to October. The monthly consumption varies from 230kWh in summer to nearly 400kWh in winter, mainly due to the DHW backup needs.

### Annual Electrical Consumption

![Pie chart showing electrical consumption categories]

- **Appliances and devices**
- **Washing and DHW**
- **Cooking**
- **Lighting**
- **Heating and ventilation auxiliaries**

#### Table 112: Annual Electrical Consumption

<table>
<thead>
<tr>
<th>Month</th>
<th>PV production</th>
<th>Electrical demand</th>
<th>Balance</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>110</td>
<td>379,61</td>
<td>-269,61</td>
</tr>
<tr>
<td>February</td>
<td>176</td>
<td>333,30</td>
<td>-157,30</td>
</tr>
<tr>
<td>March</td>
<td>299</td>
<td>306,98</td>
<td>-7,98</td>
</tr>
<tr>
<td>April</td>
<td>394</td>
<td>263,49</td>
<td>130,51</td>
</tr>
<tr>
<td>May</td>
<td>443</td>
<td>239,54</td>
<td>203,46</td>
</tr>
<tr>
<td>June</td>
<td>455</td>
<td>233,59</td>
<td>221,41</td>
</tr>
<tr>
<td>July</td>
<td>497</td>
<td>229,78</td>
<td>267,22</td>
</tr>
<tr>
<td>August</td>
<td>443</td>
<td>239,25</td>
<td>203,75</td>
</tr>
<tr>
<td>September</td>
<td>341</td>
<td>274,64</td>
<td>66,36</td>
</tr>
<tr>
<td>October</td>
<td>242</td>
<td>312,17</td>
<td>-70,17</td>
</tr>
<tr>
<td>November</td>
<td>145</td>
<td>354,35</td>
<td>-209,35</td>
</tr>
<tr>
<td>December</td>
<td>87,1</td>
<td>384,88</td>
<td>-297,78</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>3632,1</strong></td>
<td><strong>3551,59</strong></td>
<td><strong>80,51</strong></td>
</tr>
</tbody>
</table>

#### Table 111: PV production and consumption [KWh]

Table 111: PV production and consumption [KWh]
Energy from the grid varies from 0 [the PV production exceeds the demand] to a maximum of 300 kWh in December.

If we see that the electrical energy consumption is 3.552 [kWh/year] and the generated energy from PV system is 3.632 [kWh/year], then Casa FENIX Versailles have a positive balance with 80[kWh/year] extra energy.

Positive electric energy balance is done using a smaller PV system than allowed for SD, with a maximum power of 5kWp. Our choice keeps investment cost on systems lower, making a more affordable home for mid and low income families.

Further improvements can be done replacing the back up system for DHW using other energy source different from electricity to increase the electric positive energy balance. But for SD restrictions it cannot be done. On the contrary increasing the solar thermal collector area will reduce the use for electric back up. This could be achieved as an example with two solar collectors of smaller size than the one we choose, or with an arrangement of vacuum tubes collectors, but in all the cases, the investment will be increased.

Lastly, we can note that small changes in the scenarios of use or in the nominal power of the equipments will have a noticeable influence on the annual energy balance.

Particularly, if the contest consumption is considered for the whole year, the DHW backup consumption dramatically reduces to 311 kWh instead of 1.345 kWh in the preceding simulation, and allows in that case a much more favorable positive balance of 1.115 kWh.

Finally, because of the numerous uncertainties associated with this evaluation, the result must be considered as only a rough estimation of the real annual balance.
5.3.7 SOLAR THERMAL DESIGN

Solar DHW strategy for replica

During the conception process, considering the general geometry of the house, the limited space available on the sunspace roof and also the limited inner space of the technical module, we chose to give priority to PV rather than thermal production. Because of the small amount of space available in the technical module, a 150-litre tank has been chosen, which fits well with the maximum daily hot water draws during the contest.

Therefore to ensure coherence between the storage and the solar collector surface, a single 2.6 m² thermal collector was chosen, consistent with a mean productivity ratio of 60 litres day/m² in France.

The solar system achieves at least 46% DHW solar fraction of the yearly needs, with a daily demand of 160L at 50ºC corresponding to occupation by 4 people [two adults and two children]. It is also expected to cover 80% of the house’s needs during the contest.

This solar DHW system for the Casa FENIX replica is clearly undersized for a real 4 person family in the context of the competition, but we must note that in the post-contest reuse phase of the house, it will be installed on the La Rochelle University campus, and will serve as a temporary residence for researchers or doctoral students. So, no more than two people will live in it at any one time and the yearly solar fraction in these conditions will be more than 69%.

Composition of the system

We chose a high performance 2.36 m² aperture area, single glazed Wagner Euro L20 AR solar collector. This choice, instead of a more sophisticated solar collector, such as vacuum tubes or double glazed collector, was made considering ease of installation, robustness and the durability of the collector and to achieve a better balance between performance and the financial cost of the system.

The thermal solar collector is mounted onto the solar gallery roof using a K2 system. The DHW storage is a 150 litre Termomeccanica Loddo accumulation boiler, with a single built inner heat exchanger.

A Viessmann DIVICON PS10 is provided to achieve the efficient heat transfer regulation of the solar circuit, including a very low consumption hydraulic pump, with a flow of 100 L/Hr.

Some important accessories are included, such as an automatic shutoff, a safety valve for each collector, a connection piece with an incorporated sheath to act as a temperature probe, a thermometer and a manometer and a 12 litre 10 bar expansion tank.

The fluid on the primary circuit is Tyfocor LS.

The system considers an auxiliary heating system to meet domestic hot water needs at the correct temperature when the solar energy is not enough. The auxiliary system is a 2kW electric resistance boiler which operates on a schedule managed by the DIVICON solar control unit.

The DHW storage is a 150 litre Termomeccanica Loddo accumulation boiler, with a single built inner heat exchanger.

A Viessmann DIVICON PS10 is provided to achieve the efficient heat transfer regulation of the solar circuit, including a very low consumption hydraulic pump, with a flow of 100 L/Hr.

Some important accessories are included, such as an automatic shutoff, a safety valve for each collector, a connection piece with an incorporated sheath to act as a temperature probe, a thermometer and a manometer and a 12 litre 10 bar expansion tank.

The fluid on the primary circuit is Tyfocor LS.

The system considers an auxiliary heating system to meet domestic hot water needs at the correct temperature when the solar energy is not enough. The auxiliary system is a 2kW electric resistance boiler which operates on a schedule managed by the DIVICON solar control unit.

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8 Estimations of the system are obtained from www.tecsol.fr site

9 The auxiliary system for Valparaiso is a gas boiler.
The connection between the solar collector and the DHW tank is achieved with Aeroline® flexible inox insulated tubes.

An energy meter will also be installed on the solar loop in order to obtain the solar productivity of the system. This meter will be monitored from the DIVICON PS10 unit.

**Summary of system components**

**Collector circuit**
- Collector: Wagner Euro L20 AR
- Collectors number: 1
- Total gross area: 2.61 m² but with
  - Total aperture area: 2.36 m²
- Slope: 17º
- Orientation: 0º
- Mounting system Rail K2
- “Aeroline® inox split 20” piping consisting of twin tubes with 17 mm thick thermal insulation \([\text{Lambda} = 0.037 \text{ W/m.K}]\) and a thermocouple routing.
- Working fluid: Tyfocor LS. The security sheet is provided in the Annexes.

**Solar Control and transfer Unit:**
- Viessmann Vitosolic 100 control and regulation unit
- Viessmann Divicon PS10 heat transfer module, with a very low consumption Wilo PARA 15/7.0 pump \([\text{PWM control from 3 to 45 W}]\)
- Energy meter Viessmann WMZ

**Domestic how water boiler:**
- Termomeccanica Loddo SFV00150R enamelled tank
- Volume: 150 L, 550 mm in diameter and 1030 mm height, including 50 mm peripheral polyurethane foam insulation.
- 0.85 m² inner heat exchanger.
- Magnesium anode protection
- Maximum operating conditions: 95°C, 8 Bar

**Auxiliary system:**
- Electric Resistance Askoma 2kW

**Domestic how water expansion tank**
- ZiILMET slar plus 10 Lt, 10 bar
- Security valve 10 bar
- COST FOR THE SYSTEM IN FRANCE €6019

**Maintenance operations and overheating protection**

**Maintenance operations**
- Regular washing of the solar collector, which can be reached easily with a ladder
- Regular checking of the physical integrity of the solar collector and temperature probes
- Checking that the different valves are working correctly
- Checking that the security valve is working correctly \([\text{every month}]\),
- Checking that the thermostatic temperature limiting valve is working correctly \([\text{every month}]\)
- Checking the anode integrity by carrying out intensity measurements between the anode and the ground line \([\text{must remain lower than 30 mA}]\). Visual checking if necessary \([\text{each year}]\),
- Checking of the primary loop fluid properties: PH and temperature protection level with a refractometer \([\text{each year}]\),
- Regular collecting of the accumulated functioning time of the solar pump, from PS100
Overheating protection:

The stagnation temperature for the L20 AR solar collector is nearly 230°C. Active overheating protection will be provided by the regulation and transfer modules, which can be configured for night cooling of the water tank by forced circulation, if too high a temperature level is observed in the tank.

In the event of a breakdown of the pump, the expansion tank is able to sustain the pressure drop in the solar circuit.

The whole installation is inside the house, and fully reachable, so a problem on the system can be quickly and easily detected.

Solar thermal simulation results

The solar thermal system in the Versailles Replica achieves a DHW solar Fraction of 46.9%, equivalent to 1.130kWh year [Figure 114].

The electrical backup resistance needed is 1279 kWh/yr. Considering 95% efficiency, this gives a yearly consumption of 1346 kWh/yr [Figure 114].

The avoided emissions are 100 kg of CO2/yr, compared to a full electric water boiler [mean of 0.089 kg CO2/kWh] [Figure 114].
**Données météo**

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<tr>
<th>Mois</th>
<th>Janv</th>
<th>Fev</th>
<th>Mars</th>
<th>Avr</th>
<th>Mai</th>
<th>Juin</th>
<th>Juil</th>
<th>Aout</th>
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<td>12,36</td>
<td>11,11</td>
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*T eau froide : Méthode ESM2 +3.0 C*

**Installation**

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<th>Type</th>
<th>Surface</th>
<th>Capteurs</th>
<th>Stockage</th>
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<tbody>
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<td>2,36m²</td>
<td>Situation</td>
<td>Interieur (18 °C)</td>
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<td>Inclinaison</td>
<td>17°/Horiz</td>
<td>Temperature ECS</td>
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<tr>
<td>Orientation</td>
<td>0°/Sud</td>
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<tr>
<td>(*) Coefficient B</td>
<td>0,855</td>
<td>Cste de refroidissement</td>
<td>0,2586 Wh/jour.l. C</td>
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<tr>
<td>(*) Coefficient K</td>
<td>4,38W/m².C</td>
<td>Type d’installation</td>
<td>Circulation forcee, echangeur noye</td>
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</table>

(*) Coefficient B et Coefficient K : données Tecsol validées par WAGNER and Co

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<tr>
<th>Mois</th>
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<th>Besoins (kWh/mois)</th>
<th>Apports (kWh/mois)</th>
<th>Apports (kWh/jour)</th>
<th>Taux (%)</th>
<th>Volume (litres)</th>
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<tr>
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<td>57,7</td>
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<td>0,9</td>
<td>13,0</td>
<td>160</td>
</tr>
</tbody>
</table>

Taux couverture solaire | 46,9 | % | Apport solaire annuel | 1130 | kWh/an |
Besoin annuel | 2409 | kWh/an | Productivité annuelle | 479 | kWh/m².an |

*Calcul réalisé sur www.tecsol.fr*

Figure 114: Results of the Thermal system simulation
Solar preheating system for HVAC

The French replica is equipped with an innovative system for ventilation and heating, the “VMI-Soléhom system”.

Brief description of the “VMI-Soléhom” system

A ventilation housing [PULS'R Prestige Maxi model from Ventilairsec] associated with a mixing box and an air flow distributor enables air to be dispatched within the house in a variety of ways, depending on the needs [Figure 115].

In winter time, air is drawn through air collectors, allowing it to be preheated before it is blown out into the living areas.

The air flow distributor allows the selection of the areas to be treated, depending on the time of day [priority is given to the living room and dining room during the day and to bedrooms at night, for example]. If the preheated air temperature is too high for room heating, the mixing box allows the temperature to be reduced by mixing preheated air with outdoor air.

Moreover, the system is able to store latent energy with Phase Change Materials [PCM], located between the air collector and the mixing box. This not only allows heat to be accumulated during the day and released at the beginning of the night, but also to level the temperature fluctuations of the air coming from the collectors and to improve the regulation of the system throughout the day.

Figure 115: Ventilairsec Diagram
In summer time, the air coming from the collectors is exhausted outside and the insufflated air comes from the “cold” air inlet, which should ideally be located on the north side. The system allows the implementation of a passive cooling strategy with night-time over-ventilation by increasing the air flow coming from the outside inlet.

The French replica for Casa FENIX is equipped with 2 double glazed air collectors with an overall surface area of 7m² and 2 PCM stocks of 45 litres each, with a melting point temperature of between 25°C and 28°C.

The collectors are mounted on the front of the Sunspace and on the southern facade of the Survival Module [Figure 116].

The ventilation, mixing and thermal storage housings are installed in the Sunspace’s false ceiling and are easily accessible for maintenance [filter replacement, for example].

The general floor plan layout diagram with the air inlet and outlet sections, as well as the positioning of air collectors are shown in the drawing ME-001, project drawings.

The airflow rate ranges from 70m³/h [0.5 ACH] in basic mode to 400m³/h [3 ACH] in night-time over-ventilation mode.

The absorbed fan power ranges from 11W for the basic mode to 145 W for night-time over-ventilation mode.

Air exhausts will be achieved using the “France Air” BSC air vent model for the basic mode.
[one in the bathroom and one in the kitchen]. In the night-time over-ventilation situation, the air exhaust will be operated by opening at least one window in partial opening mode.

**Heating backup system**

The VMI-Soléhom system is expected to cover nearly 25% of the heating energy needs of the Replica in the Versailles site conditions. So a backup system must be designed.

The ventilation housing can be equipped with supplementary electrical resistance, but for the Replica, supplementary heating will be provided by a low power/high yield electronically controlled wood pellet stove.

The technical documentation related to the VMI-Soléhom and the wood pellet stoves are in the Appendix 14.8 “HVAC Appendix”

### 5.3.8 BUILDING INTEGRATED SOLAR ACTIVE SYSTEM

Our team did not consider BIPV for the Casa FENIX design prototype.

For the Replica, the PV and thermal systems are not fully integrated and cannot pretend to be building integrated systems. Nevertheless, they constitute homogeneous equipment for the Sunspace roof. The PV, the thermal collector and the metallic box over the solar collector present the same RAL and form a harmonious whole.

The building integration of the system is achieved to a greater degree with the solar air collectors for preheating the air entering the VMI-Soléhom system. They are partly integrated into the front walls, and we designed them to have the same aspect [colour, width and height] as the neighbouring doors and windows [Figure 116].
One of the most outstanding geographical features of Chile is the relatively constant threat of earthquakes, among other natural disasters, such as volcano eruptions, landslides and fires in urban areas. The regularity with which these events occur does not make them any less catastrophic for people. Many homes are lost and the people who are most affected are low-income families. The post-catastrophe situation throughout the year has indeed been non-sustainable, therefore to develop and implement the concept of sustainable reconstruction is a big challenge for our country, where Casa FENIX ambition is to propose and offer a tangible solution.

**THE PROBLEM** While Chile is a political and geographical location where natural disasters are recurrent and affect a great part of the most socially vulnerable population, there are no official policies which outline a quality response to such events.

“When disaster strikes, the problems are resolved with quick, cheap, short-term solutions, such as the mediagua emergency houses” which end up causing more problems than they solve and lead to a great deal of waste in the long term.

**HYPOTHESIS** Casa FENIX is a design process that responds to a catastrophe, delivering energy efficient strategies to ensure quality of life as a key factor in a sustainable reconstruction; these strategies are not currently considered in post-catastrophe national policy. Sustainability factors include locally specific environmental, cultural and geographical issues, and also consider accessible and viable solutions for the most vulnerable sector of Chilean society. Therefore, the original objective behind this proposal is:

“to create emergency dwellings that offer quick, good quality and sustainable homes for the families who are the victims of a disaster.”

Thus the architectural and urban concepts that shape the proposal at both individual and collective levels are: **Modularity, progressivity, flexibility and affordability.**
**Modularity**
Casa FENIX evolves from a basic Survival Module to a complex Eco Village/Housing Complex. This process covers the stage of Emergency, Relief and Reconstruction.

**Progressivity**
Casa FENIX progression allows the Survival Module unit to become a final home. This incremental and evolving logic is assumed by the urban design strategy.

**Flexibility**
Casa FENIX has the capability to adapt to different latitudes and climates, given the geographical characteristics and diversity of climates Chile possesses, from north to south.

**Affordability**
Casa FENIX is an affordable home. Each unit may be acquired through the progressive subsidy addressing the total cost of the home.

**ARCHITECTURAL PROGRAMME**
For the SDE competition, the Casa FENIX Team proposes to bring a house that represents reconstruction as a growth progression and is configured to perform well in the Versailles climate. The basic structure and its components will subsequently be configured to meet the solar passive design strategy for the specific local climate where it is to be installed.

The programme represents the core concept of Casa FENIX, which takes a progressive approach to Emergency, Relief and Reconstruction, with sustainability in mind. It uses a passive solar design driven by a sunspace, which acts as the energy engine of the completed house and is a key spatial element which allows the articulation of the different modules.

Casa FENIX is a modular design in which each 11 m$^2$ module can be progressively attached and easily assembled during a post-disaster period, to form a dwelling measuring 60m$^2$.

The modules are as follows:
Survival Module
This is the quick initial response for the emergency period, immediately after a catastrophe strikes. Its main objective is to provide shelter, safety and a quality solution to the affected family.

Mechanical Module
This is the first module to be attached to the Survival Module as a progression during the relief period. It consists of the services and a technical core. It includes a bathroom and kitchen.

Living Module
This is the module that enables the house to expand and cover more than the basic needs during the reconstruction period, transforming the sum of modules into a definitive home.

Sunspace
The passive solar design strategy enables the regulation of the indoor climate by articulating the different modules with the exterior climate; this space grows with the addition of each module.

At a collective level, the group of emergency houses, which the FENIX team has called “Temporary Village FENIX, TVF” and the progression to a housing complex, which the FENIX team has called “Eco-Village FENIX, EVF” are conceived following the same logic. They have an open and flexible design that allows for the adaptation of modules and means that Casa FENIX can be adapted to different climatic, topographical, territorial and cultural realities.

THE GEOGRAPHICAL DIMENSION
Chile has 9 different climate types and the country stretches from latitude 18°S to 50°S. 90% of the population is located in areas where solar radiation is over 1000kWh/year. To address this climatic diversity and take advantage of the opportunity for solar radiation, the conceptual idea for

“Casa FENIX is similar to a skeleton or basic structure, an innovative structural design developed by students, where different components can be configured and assembled according to the users’ demands”
All the components to be attached to it respond to the demands for the different latitudes and to patterns of self-construction.

**SUSTAINABILITY FOR US**

It is important to mention that the understanding of sustainability in the case of developing nations differs much from the one used in developed nations, in the sense that the problems that needs to be addressed are much different, respect of priorities and urgencies. For the Chilean case the deterioration produced by natural disasters and the anthropic urban degradation produced by informal settlements and poverty are the immediate problems to solve in a sustainable way. To teach the general public about sustainability issues that go beyond recycling, energy efficiency and achieving a low carbon footprint, Casa FENIX proposes to focus mainly on local cultural aspects, quality of life and social relationships. In this case the sustainability aspects are focused on using technology and urban planning to enhance the intuitive know-how of a particular local population.

“*The choice of site: Man’s physical freedom manifests itself no doubt in his ability to choose the place on earth where he wants to live*”.

People act, build and adapt through self-construction to the different latitudes and geographical conditions over time using their intuitive and basic knowledge.

“*Neither privations nor danger will deter man from selecting a spot [...] to settle on* (Rudofsky, 1964).

This recognition of the appropriateness of the way informal settlements and self-construction take place is basic and seen to be positive; however it is extremely precarious and unsustainable in many other
aspects and in extreme situations could produce complete devastation. This was the case in April 2014 when a wildfire ravaged Valparaíso for three days; 2,900 homes were destroyed and 14,000 people - 4% of the Valparaíso population (IMV, 2014) - were made homeless.

The reasons for the unsustainable settlements can be traced back to many issues related to post-disaster rehabilitation and poverty and a major factor is the lack of a sustainable urban code for areas of vulnerability. This sustainable urban code would need to respond in a general way to the emergency and in a particular way to the post-catastrophe situation that begins right after an emergency occurs.

**Casa FENIX TEAM ORGANIZATION** Team Casa FENIX is a bi-national team composed of students and faculty members from the Universidad Técnica Federico Santa María [UTFSM], Valparaíso, Chile and from the Institute Universitaire de Technologie [IUT], Université de La Rochelle, France. In addition to all the opportunities that arise out of any international collaboration between academic institutions, team Casa FENIX seeks to respond coherently to SDE’s energy conservation objectives.

The proposal has been designed to address the circumstances and needs of Chile. However, transporting the house from Chile to France would entail a significant amount of CO2 emissions and the team has therefore set itself the goal of making a “PROTOTYPE” in Chile and a “REPLICA” in France, generating a dualism and a double challenge for our project. So, while the conceptual proposal is Chilean, the production of Casa FENIX is French.

**TEAM Casa FENIX FRANCE**

The French part of the team is in charge of all the practical, construction, building and technology applications of the project. One of the strengths of IUT is their research into and work with wooden structures and construction. A complete version of a replica of Casa FENIX is being built in La Rochelle and this is the version that will compete in Versailles.

**TEAM Casa FENIX CHILE**

The Chilean part of the team is in charge of all the theoretical, conceptual, architecture and urban design content of the project. One of the strengths of UTFSM is their research and work on bioclimatic architecture and earthquake resistant construction.

The design of Casa FENIX has been developed in Chile with the participation of the students from the French team during the process. Half of Casa FENIX will constitute the prototype built and tested in Valparaíso.
5.4.1 TECHNICAL PROJECT SUMMARY

Casa FENIX sustainability concept is based on the idea of an emergency home, which is energy efficient, and energy autonomous when grouped in solar villas.

As it has been pointed out, the emergency aspect comes from the locality in which the concept is born, where is scarce and costly. Chile is a developing country where one of the most common energy concerns is reducing risks of energy cuts, and maintaining a steady supply.

Energy consumption is still lower than first world countries and is also below the world average. However, more than 90% of fossil fuels are imported, and only 40% of electrical energy is generated from renewable sources. While this precarity persists and energy independence is not achieved, supply remains relatively uncertain, so there seems to be little space for discussion or concern about what comes after. Issues such as the use of green materials, life cycles, optimization of energy use, and CO2 emission, among others, are relatively unknown to the public at large, and only very recently have began to timidly appear on local government policies.

It is also relevant to emphasize that casa FENIX should enable shelter and comfort where fuels or energy grids are completely unavailable.

Therefore, the project is designed to operate without HVAC systems, and eventually establish an energy grid. However, we understand this is an approach which can change depending on the geographical and social context where the house is built. This would be one of the main reasons why in the local context of Valparaiso, for example, the use of HVAC is not considered [although for the purpose of the competition, heating and cooling loads have been simulated], while it exists in the context of Versailles.

Regarding the creation of energy grids, a cooperative energy approach has been studied on different scenarios where solar villa families share solar PV production. There is a home PV array and a community based PV array for the villa, where families can share the benefits of energy production, be it on a discount on energy bills, or as an income to aid in the maintenance of common areas.

Additionally, economic affordability, which is one of the main issues that Casa FENIX deals with, is usually a problem when sustainability is in mind. For this, a simple, passive design concept and the use of local materials such as wood, is the base line for successful energy efficiency.

As a main exploration point inherent to the competition, all technical features have been developed with the comfort of the inhabitants in mind, while adhering to the concept of Casa FENIX. In the course of the design process, issues such as materials transportation and site accessibility have also had a major impact on design exploration, which have benefited the project by ‘grounding’ it, and having the team face the challenge.
## 1. Project Dimension

<table>
<thead>
<tr>
<th>Data</th>
<th>Location of Detailed Information in PM/PD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area (m²)</td>
<td>63.7</td>
</tr>
<tr>
<td>Net Flor Area (m²)</td>
<td>54</td>
</tr>
<tr>
<td>Conditioned Volume (m³)</td>
<td>144.7</td>
</tr>
</tbody>
</table>

## 2. House Envelope

<table>
<thead>
<tr>
<th>Insulation Types and thickness (m)</th>
<th>Rock wool / Glass wool</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walls area (m²) and Thermal Transmittance (W/m²K)</td>
<td>73.09m²/0.36(W/m²K)</td>
</tr>
<tr>
<td>Floor area (m²) and Thermal Transmittance (W/m²K)</td>
<td>54m²/0.3(W/m²K)</td>
</tr>
<tr>
<td>Roof area (m²) and Thermal Transmittance (W/m²K)</td>
<td>55.9m²/0.24(W/m²K)</td>
</tr>
<tr>
<td>Glazing area (m²) and Thermal Transmittance (W/m²K)</td>
<td>27.74m²/1.5(W/m²K)</td>
</tr>
<tr>
<td>Glazing Solar Gains (SHGC)</td>
<td>0.7(W/m²K)</td>
</tr>
</tbody>
</table>

## 3. HVAC Systems

<table>
<thead>
<tr>
<th>Heating System</th>
<th>Radiant Gas stove</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Production Equipment</td>
<td>Gas stove</td>
</tr>
<tr>
<td>Type</td>
<td>Radiant Portable</td>
</tr>
<tr>
<td>Model</td>
<td>Estufa Vitra 40</td>
</tr>
<tr>
<td>Heating Capacity</td>
<td>4kW</td>
</tr>
<tr>
<td>Heating Efficiency</td>
<td>0.7</td>
</tr>
<tr>
<td>Cooling Capacity</td>
<td>N/A</td>
</tr>
<tr>
<td>Cooling Efficiency</td>
<td>N/A</td>
</tr>
<tr>
<td>Thermitial Unit</td>
<td>N/A</td>
</tr>
<tr>
<td>Type</td>
<td>N/A</td>
</tr>
<tr>
<td>Model</td>
<td>N/A</td>
</tr>
<tr>
<td>Refrigerant (Type)</td>
<td>N/A</td>
</tr>
<tr>
<td>Heat Recovery Ventilation or Energy Recovery Ventilation</td>
<td>N/A</td>
</tr>
<tr>
<td>Type</td>
<td>N/A</td>
</tr>
<tr>
<td>Model</td>
<td>N/A</td>
</tr>
<tr>
<td>Efficiency</td>
<td>N/A</td>
</tr>
</tbody>
</table>

## 4. Domestic Hot Water

<table>
<thead>
<tr>
<th>System (Type, Capacity)</th>
<th>Solar thermosyphon 130Lt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar thermal collectors</td>
<td>1</td>
</tr>
<tr>
<td>Type</td>
<td>Flat</td>
</tr>
<tr>
<td>Area (m²)</td>
<td>2.23m²</td>
</tr>
<tr>
<td>Estimated Thermal energy production (kWh/year)</td>
<td>1431 kWh/year</td>
</tr>
</tbody>
</table>

## 5. Electrical Energy Production

<table>
<thead>
<tr>
<th>PV Modules (Type)</th>
<th>Polycrystalline 250Wp</th>
</tr>
</thead>
<tbody>
<tr>
<td>PV Panels area (m²)</td>
<td>24.2m²</td>
</tr>
<tr>
<td>Installed PV Power (kWp)</td>
<td>3750kWp</td>
</tr>
<tr>
<td>Estimated energy production (kWh/year)</td>
<td>4592 kWh/year</td>
</tr>
</tbody>
</table>

## 6. Energy consumption

| Estimated energy consumption (kWh/year) | 4040 kWh/year |
| Estimated electrical consumption per conditioned (kWh/year per m²) | 13.3 kWh/year per m² |
| Energy use Characterization (%total energy consumption) | Heating (%) 12% (492 kWh Gas) |
| | Cooling (%) 0% |
| | Ventilation (%) 0% |
| | Domestic Hot Water (%) 23% (916 kWh Gas) |
| | Lighting (%) 7% (300.9 kWh elect) |
| | Appliances Devices (%) 58% (2329 kWh elect) |

## 7. Energy Balance

| Estimated energy balance (kWh/year) | 1983 kWh/year |
| Estimated CO2 emissions (Tn/year) | Include The calculation in the Project manual and indicate its location here |

## 8. List of Singular and Innovative materials and systems
**VERSAILLES REPLICA**

1. **Project Dimension**

<table>
<thead>
<tr>
<th>Area (m²)</th>
<th>Data</th>
<th>Location of Detailed Information in PM/PD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net Flor Area (m²)</td>
<td>54.2 m² global inner surface and 52.9 m² net area</td>
<td></td>
</tr>
<tr>
<td>Conditioned Volume (m³)</td>
<td>136.08</td>
<td></td>
</tr>
</tbody>
</table>

2. **House Envelope**

<table>
<thead>
<tr>
<th>Insulation Types and thickness (m)</th>
<th>Walls area (m²) and Thermal Transmittance (W/m²K)</th>
<th>Floor area (m²) and Thermal Transmittance (W/m²K)</th>
<th>Roof area (m²) and Thermal Transmittance (W/m²K)</th>
<th>Glazing area (m²) and Thermal Transmittance (W/m²K)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wooden wool insulation. Thickness varying from 160 to 240 mm</td>
<td>71.9 m² and 0.23 W/m².K</td>
<td>54.46 m² and 0.21 W/m².K</td>
<td>54.98 m² and 0.15 W/m².K</td>
<td>19 m² and 1.34</td>
</tr>
</tbody>
</table>

3. **HVAC Systems**

<table>
<thead>
<tr>
<th>Heating System</th>
<th>Energy Production Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>Model</td>
</tr>
<tr>
<td>Model</td>
<td>SUPRA Leios galet</td>
</tr>
<tr>
<td>Heating Capacity</td>
<td>0-5.5 kW</td>
</tr>
<tr>
<td>Heating Efficiency</td>
<td>90%</td>
</tr>
<tr>
<td>Cooling Capacity</td>
<td>NA</td>
</tr>
<tr>
<td>Cooling Efficiency</td>
<td>NA</td>
</tr>
<tr>
<td>Thermal Unit</td>
<td>NA</td>
</tr>
<tr>
<td>Model</td>
<td>NA</td>
</tr>
<tr>
<td>Refrigerant (Type)</td>
<td>NA</td>
</tr>
</tbody>
</table>

4. **Domestic Hot Water**

<table>
<thead>
<tr>
<th>System (Type, Capacity)</th>
<th>Area (m²)</th>
<th>Estimated Thermal energy production (kW/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar thermal collectors</td>
<td>flat, single glazed</td>
<td>1130</td>
</tr>
</tbody>
</table>

5. **Electrical Energy Production**

<table>
<thead>
<tr>
<th>PV Modules (Type)</th>
<th>PV Panels area (m²)</th>
<th>Installed PV Power (kWp)</th>
<th>Estimated energy production (kW/h/year) (include the inverter losses)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VMH Polycristallin 260-6-60-P</td>
<td>24.5</td>
<td>3.9</td>
<td>3632</td>
</tr>
</tbody>
</table>

6. **Energy consumption**

<table>
<thead>
<tr>
<th>Energy use Characterization (%total energy consumption)</th>
<th>Heating (%)</th>
<th>Cooling (%)</th>
<th>Ventilation (%)</th>
<th>Domestic Hot Water (%)</th>
<th>Solar circuit pump and water pumps</th>
<th>Lighting (%)</th>
<th>Appliances Devices (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ref. PM, Figure 110 Pp.134</td>
<td>31.2</td>
<td>3.7</td>
<td>3.7</td>
<td>26.9</td>
<td>3.7</td>
<td>3.7</td>
<td>32.3</td>
</tr>
</tbody>
</table>
### TEHNIC AL PROJEC T SUMMARY TABLE

<table>
<thead>
<tr>
<th><strong>VERSAILLES REPLICA</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Project Dimension Data</strong></td>
<td></td>
</tr>
<tr>
<td>Location of Detailed Information in PM/PD</td>
<td></td>
</tr>
<tr>
<td>Area (m²)</td>
<td>64.55</td>
</tr>
<tr>
<td>Net Floor Area (m²)</td>
<td>54.2 m² global inner surface and 52.9 m² net area</td>
</tr>
<tr>
<td>Conditioned Volume (m³)</td>
<td>136.08</td>
</tr>
<tr>
<td><strong>2. House Envelope</strong></td>
<td></td>
</tr>
<tr>
<td>Insulation Types and thickness (m)</td>
<td>w ooden w ool insulation. Thickness varying from 160 to 240 mm</td>
</tr>
<tr>
<td>Walls area (m²) and Thermal Transmittance (W/m².K)</td>
<td>71.9 m² and 0.23 W/m².K</td>
</tr>
<tr>
<td>Full regulatory report RT2012 replica, PM Appendix “14.5 Thermal Calculation”</td>
<td></td>
</tr>
<tr>
<td>Floor area (m²) and Thermal Transmittance (W/m².K)</td>
<td>54.46 m² and 0.21 W/m².K</td>
</tr>
<tr>
<td>Full regulatory report RT2012 replica</td>
<td></td>
</tr>
<tr>
<td>Roof area (m²) and Thermal Transmittance (W/m².K)</td>
<td>54.98 m² and 0.15 W/m².K</td>
</tr>
<tr>
<td>Full regulatory report RT2012 replica</td>
<td></td>
</tr>
<tr>
<td>Glazing area (m²) and Thermal Transmittance (W/m².K)</td>
<td>19 m² and 1.34</td>
</tr>
<tr>
<td>Full regulatory report RT2012 replica</td>
<td></td>
</tr>
<tr>
<td>Glazing Solar Gains (SHGC)</td>
<td>0.29 to 0.47</td>
</tr>
<tr>
<td>Full regulatory report RT2012 replica</td>
<td></td>
</tr>
<tr>
<td><strong>3. HVAC Systems</strong></td>
<td></td>
</tr>
<tr>
<td>Heating System</td>
<td>w ood pellet stove</td>
</tr>
<tr>
<td>Energy Production Equipment</td>
<td>w ood pellet stove</td>
</tr>
<tr>
<td>Type</td>
<td>SUPRA L eïos galet</td>
</tr>
<tr>
<td>Heating Capacity</td>
<td>0-5.5 kW</td>
</tr>
<tr>
<td>Heating Efficiency</td>
<td>90%</td>
</tr>
<tr>
<td>Cooling Capacity</td>
<td>N A</td>
</tr>
<tr>
<td>Cooling Efficiency</td>
<td>N A</td>
</tr>
<tr>
<td>Therminal Unit</td>
<td>N A</td>
</tr>
<tr>
<td>Type</td>
<td>N A</td>
</tr>
<tr>
<td>Model</td>
<td>N A</td>
</tr>
<tr>
<td>Refrigerant (Type)</td>
<td>N A</td>
</tr>
<tr>
<td>Heat Recovery Ventilation or Energy Recovery Ventilation</td>
<td>Air insufflation system with solar preheating of the outside air and PC M stock. Type VMI-Soléhom Model Soléhom by Ventilairsec and Elva. Efficiency 24% TRN SYS simulations results. PM Ch. 14.8</td>
</tr>
<tr>
<td><strong>4. Domestic Hot Water</strong></td>
<td></td>
</tr>
<tr>
<td>System (Type, Capacity)</td>
<td>Solar thermal collectors with a primary solar circuit and a 150 litres hot water stock, with electric backup resistance.</td>
</tr>
<tr>
<td>Solar thermal collectors</td>
<td>Wagner&amp;C oL 20 AR PM Ch. 14.4 “DHW Appendix”</td>
</tr>
<tr>
<td>Type flat, single glazed</td>
<td></td>
</tr>
<tr>
<td>Area (m²) net area</td>
<td>2,36 m²</td>
</tr>
<tr>
<td>Estimated Thermal energy production (kW h/year)</td>
<td>1130</td>
</tr>
<tr>
<td><strong>5. Electrical Energy Production</strong></td>
<td></td>
</tr>
<tr>
<td>PV Modules (Type)</td>
<td>VMH Polycristallin 260-6-60-P PM Ch. 14.3 “Photovoltaic Appendix”</td>
</tr>
<tr>
<td>PV Panels area (m²)</td>
<td>24.5</td>
</tr>
<tr>
<td>Installed PV Power (kW p)</td>
<td>3.9</td>
</tr>
<tr>
<td>Estimated energy production (kW h/year)</td>
<td>(include the info of all PV Types 3632)</td>
</tr>
<tr>
<td><strong>6. Energy consumption</strong></td>
<td></td>
</tr>
<tr>
<td>Estimated energy consumption (kW h/year)</td>
<td>5080,5</td>
</tr>
<tr>
<td>Estimated electrical consumption per conditioned (kW h/year per m²)</td>
<td>55,0</td>
</tr>
<tr>
<td>Energy use Characterization (%total energy consumption)</td>
<td></td>
</tr>
<tr>
<td>Heating (%)</td>
<td>31,2</td>
</tr>
<tr>
<td>Cooling (%)</td>
<td>N A</td>
</tr>
<tr>
<td>Ventilation (%)</td>
<td>4,4</td>
</tr>
<tr>
<td>Domestic Hot Water (%)</td>
<td>26,5</td>
</tr>
<tr>
<td>Lighting (%)</td>
<td>3,7</td>
</tr>
<tr>
<td>Appliances Devices (%)</td>
<td>32,3</td>
</tr>
<tr>
<td><strong>7. Energy Balance</strong></td>
<td></td>
</tr>
<tr>
<td>Estimated energy balance (kWh/year)</td>
<td>-1448,9</td>
</tr>
<tr>
<td>Electrical energy balance (kWh/year)</td>
<td>80,51</td>
</tr>
<tr>
<td>Estimated CO2 emissions (Tn/year) (Include The calculation in the Project manual and indicate its Hypothesis)</td>
<td>0,316 Hypothesis = 0,089 kgCO2/kWh for electricity and 0 kgCO2/kWh from Wood</td>
</tr>
<tr>
<td><strong>8. List of Singular and Innovative materials and systems</strong></td>
<td></td>
</tr>
<tr>
<td>VMI-Soléhom HVAC System</td>
<td>PM Ch. 5.5 Innovation report</td>
</tr>
<tr>
<td><strong>8. Energy consumption Details</strong></td>
<td></td>
</tr>
<tr>
<td>Estimated energy consumption (kWh/year)</td>
<td></td>
</tr>
<tr>
<td>Thermal energy consumption of the wood pellet stove</td>
<td>1528,9</td>
</tr>
<tr>
<td>Electrical consumption</td>
<td>3551,6</td>
</tr>
<tr>
<td>Total</td>
<td>5080,5</td>
</tr>
<tr>
<td>ref. thermal simulation table (case 2_bis). 1376 kWh/90% efficiency</td>
<td></td>
</tr>
<tr>
<td>ref. PM Figure 110 Pp.134</td>
<td></td>
</tr>
</tbody>
</table>

### Energy Balance Details

| Estimated energy balance (kWh/year) | -1448,9 |
| Electrical energy balance (kWh/year) | 80,51 |
| Estimated CO2 emissions (Tn/year) (Include The calculation in the Project manual and indicate its Hypothesis) | 0,316 Hypothesis = 0,089 kgCO2/kWh for electricity and 0 kgCO2/kWh from Wood |

### List of Singular and Innovative materials and systems

<table>
<thead>
<tr>
<th>Material/System</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>VMI-Soléhom HVAC System</td>
<td>PM Ch. 5.5 Innovation report</td>
</tr>
</tbody>
</table>

### Energy consumption Details

<table>
<thead>
<tr>
<th>Energy Type</th>
<th>Consumption (kWh/year)</th>
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</thead>
<tbody>
<tr>
<td>Thermal energy consumption of the wood pellet stove</td>
<td>1528,9</td>
</tr>
<tr>
<td>Electrical consumption</td>
<td>3551,6</td>
</tr>
<tr>
<td>Total</td>
<td>5080,5</td>
</tr>
</tbody>
</table>

---

[Solar Decathlon Europe] [Team FENIX]
5.4.2
COMPREHENSIVE ANALYSIS AND DISCUSSION REPORT

SECTION I – INFLUENCE OF ENERGY ANALYSIS ON HOUSE DESIGN AND COMPETITION STRATEGY

1) Introduction

A) Energy Analysis Objectives and Methodology

Objectives

For our team, the main objective of simulation and analysis is to verify that indoor conditions, more specifically temperatures and fresh air supply, remain within comfort ranges, with the use of low-tech passive strategies. The team aims to reach a constant comfort range of internal conditions, so that all PV energy production is used on appliances and not HVAC.

However, as the competition emphasizes the need for energy use reduction, national and international standards for energy consumption in dwellings have been considered as benchmarks for success.

The simulations have an impact on design and architecture, and affect variables such as: indoor heights and air volume, general layout, openings dimensions, building envelope configuration, windows schedules and operation, passive strategies operation, modelling technicalities, etc.

Methodology

Methodology consists of the creation of an initial design, which is then subjected to a series of tests and simulations that take on a trial and error approach. Each simulation provides results which are analysed and classified as successful or not, depending on energy consumption and other parameters. Conclusions for each simulation inform and evolution of the design and the models being tested. The process continues until the relevant goals are met.

The initial design was first established considering local conditions [in Valparaiso], such as geography, climate, urban context, social and economical circumstances. The study of the urban context and local architecture tells us about the architectural features that understand the local climate, and how to use it to create better indoor conditions, while using little energy. From this perspective, it is understood that the dwelling will already perform to deliver indoor comfort.

However, on a first stage of the studies, the simulations aim to provide feedback on optimization of design, based on energy consumption results, and not in indoor climatic conditions. National and international standards have been considered as benchmarks. Past this point, the analysis turns to indoor temperatures and effective fresh air supply, in order to fine tune strategies operation.
B) Climate Data and Weather Analysis

In general terms, weather analysis has considered the different climatic zones defined by the Chilean regulations, which also mention pre-designed generic solutions and strategies. The house main design concept uses these precedents, as well as examples of climatic architecture in the urban context.

The north facing bay can be seen in the satellite photo above [Figure 120]. It is generally well protected from stronger prevailing south west winds, [Figure 121] although this also implies that occasionally during winter, bad weather fronts will fall on the city from the north, causing very heavy rains and tidal swells.

However, wind presence is relatively constant all year round, which is beneficial in summer, when some cooling is needed.

Valparaiso has very mild climate -which can be considered Mediterranean [Koppencsb]- due to its coastal condition [which reduces the occurrence of extreme temperatures], and the amphitheatre shape of its hills, which protect it from the predominant south-west winds.

Temperatures range from 10°C to 28°C in summer, and between 5°C and 20°C in winter, with very little diurnal variations. Relative humidity is consistently above...
60%, and although the skies can sometimes be covered by fog, solar radiation is also very consistent and can be relied on for passive strategies all year round.

The psychrometric chart [Figure 123] describes a yearly weather with relatively good conditions, where thermal comfort can be experienced with no effort at all, or with internal gains strategies. Without the use of further strategies, heating might be needed for up to 25% of the time.

As it has been mentioned in the Urban Design Strategy section, the vernacular-contemporary style in Valparaíso evokes the ancient traditional and foreign architectures that were erected in the city until the beginning of the 20th century. Valparaiso received European immigrants, mainly British, Germans, Spaniards, and Italians, who adapted American and European building technologies to the abrupt topography of the city. Such architectures have been imitated and reinterpreted for years by the inhabitants of Valparaiso, a majority of whom [app. 60%] have built their homes under these architectural and constructive reinterpretations.

The following types stand out:

- Houses with sunspaces and balconies [Figure 124]
- Houses built on retaining walls [Figure 127]
- Pile-dwellings [Figure 125]
- Houses with orchards [Figure 126]

It is most common to find lightweight structures, sunspaces and open windows to deal with climatic conditions. Optimization of these elements would aid in reducing the need for heating in winter months. There is very little danger of overheating due to exterior conditions, although
In general terms, weather analysis has considered the different climatic zones defined by the Chilean regulations, which also mention pre-designed generic solutions and strategies. The house main design concept uses these precedents.

Valparaiso has very mild climate—which can be considered Mediterranean (Koppen csb)—due to its coastal condition (which reduces the occurrence of extreme temperatures), and the amphitheatre shape of its hills, which protect it from the predominant south-west winds. Temperatures range from 10ºC to 28ºC in summer, and between 5ºC and 20ºC in winter, with little diurnal variations. Relative humidity is consistently above 60%, and although the skies can sometimes be covered by fog, solar radiation is also very consistent and can be relied on for passive strategies all year round.

Valparaíso is very well protected by prevailing south west winds, although this also implies that occasionally during winter, bad weather fronts will fall on the city from the north, causing very heavy rains and tidal swells.

The psychrometric chart above describes a yearly weather with relatively good conditions, where thermal comfort can be experienced with no effort at all, or with internal gains strategies. Without the use of further strategies, heating might be needed for up to 25% of the time.
a good air tightness [which is a requirement in most energy efficient dwelling concepts] could be a potential concern, and some cooling might be required.

C) Team Energy Strategy

For our team, one of the main challenges consists on providing an immediate response to catastrophe under very harsh climatic, social and connectivity conditions that will in time turn into a permanent solution, to create a sustainable, energy productive urban environment. Most important issues to solve are enabling shelter and comfort, without the use of energy from a grid, or traditional fuels.

Therefore, it is understood that it is far more applicable to consider effective efficiency, rather than high performance. The team aims to make the most out of all ‘low-tech’ available possibilities. This view relies heavily on standard passive strategies. In effect, HVAC systems are not considered for Valparaíso, as the climate analysis shows it is entirely possible to disregard it, given appropriate measures. Humidity issues are dealt with by providing appropriate [well insulated] envelope and good ventilation. However, when HVAC is incorporated, as in the Casa FENIX version for Versailles, no HVAC central control systems are considered. While it is true that the competition tries to reach higher levels of efficiency, initial Casa FENIX concepts propose that it’s far more applicable to consider effective efficiency, rather than a very high performance. This is partly due to the very low available budget, and to the initial and maintenance costs associated to highly computerized technologies, and the emergency conditions under which the house is supposed to be built. In this kind of scenario, energy performance centres its focus on achievable, very low-budget, low-tech strategies.

As mentioned in the Urban Design Strategy section, the “Eco-Permanent Villa FENIX”, derived from the “Temporarily Villa FENIX”, needs to be a sustainable urban solution.

In terms of energy, this urban sustainability is partly achieved in a series of steps:

- Creation and construction of an energy efficient dwelling. This is, that uses very little energy to maintain inhabitants comfortable and healthy, with passive strategies at its core [mainly, solar gains management and natural ventilation], aided by the building envelope.

- Energy independence. To produce all energy required to maintain building systems.

- Energy production. To generate a surplus which will translate into monetary benefits to support the development and its occupants. Both energy independence and energy production are achieved by the reliance of active systems on solar thermal and PV systems, which provide energy for appliances and supplementary energy for the solar DHW and lighting.

The communitarian based PV array is proposed to increase the electrical energy production [besides each particular dwelling PV array], sharing the benefits among the families. This is based on the following scenarios:

- Each home with individual On Grid PV array, and the community
PV array On Grid producing extra income for the Eco Villa FENIX [Figure 128]

- Each home with individual On Grid PV array, connected to the community PV array Off Grid producing extra energy in winter or cloudy days [Figure 128].

- Smart network among FENIX Home PV arrays sharing the energy produced on an Off Grid system, and the community PV array On Grid producing extra income for the Eco Villa FENIX [Figure 128]

- Smart network among FENIX Home PV arrays sharing the energy produced on an On Grid system, and the community PV array On Grid producing extra income for the Eco Villa FENIX [Figure 128]

The energy analysis aims to optimize passive strategies, without use of sensors, centralized controls, etc.

2. Influence of Energy Analysis in the Project Design

**Thermal and energy simulations using Design Builder® software**

The energy simulation studies have aided in the shaping of the house, understanding how the different strategies such as type and shape of solar protections, layout, size of glazed area, exposure of sunspace, floor to ceiling height, envelope configuration, have affected interior climatic conditions. This is measured by the reduction of energy consumption on HVAC use. As benchmarks are met, the analysis moves on to indoor temperatures and achieved air changes per hour.

With regards to benchmarking for energy consumption, it was important to remain observant of local regulations as minimum standards. The Chilean Thermal Regulation\(^1\) [Table 129] is a very recent effort to start including measures of energy efficiency into new residential buildings. It has

\(^{1}\) RT2004 – Urbanism and Construction General Law [Ordenanza General de Urbanismo y Construccin]
undergone one renovation since its inclusion in 2004, although it is not yet official. Current regulation focuses on insulation levels according to geographical location. The country has been divided into 7 ‘thermal zones’ [Table 129].

As current regulation is very basic, we take it a starting point upon which to generate improvements. Valparaíso is classified as belonging to zone 2 of the Chilean Thermal Regulation [Table 129].

Research relating the state of the art with regards to a generic Chilean household and energy consumption is very recent. According to García Pérez de Arce and Croxford\(^2\), a standard home, as surveyed by the authors of this study, can be defined by:

- A relatively inefficient envelope, where little to no insulation is considered.
- Lack of centralized heating or cooling.
- If there are cooling mechanisms, it will usually consist as indoor electrical fans, to generate air movement.
- There will be heating appliances in use, mostly during the worst of the winter. Most used fuels are liquid gas, paraffin, wood, and electricity.

To use as a benchmark in our studies, we’ve compared our energy simulations to the results HVAC energy consumption obtained for a detached, 70m\(^2\) dwelling in the central zone of Chile.

a) Base case annual consumption: 200kWh/m\(^2\) [14.000kWh]

b) Local regulation case annual consumption: 110kWh/m\(^2\) [7.700kWh]

c) Improved case annual consumption: 75kWh/m\(^2\) [5.250kWh]

These values consider both cooling and heating energy consumption, where efficiency for cooling is a 100% [electricity], and a 60% for heating [liquid gas]. Another measure of efficiency with regards to Valparaíso is to consider indoor temperatures instead of energy consumption for HVAC. The latest cases have been evaluated with regard to indoor temperatures. Acceptable indoor temperature range is also defined by the HVAC temperature setpoints of the thermal models. In the case of Valparaíso, depending on room program, these temperatures can range between 15°C and 26°C.

A total of 35 cases have been modelled in Design Builder. Changes in design have evolved as shown in the next pages\(^3\):

---

\(^2\) Pilar García Pérez de Arce and Ben Croxford, “Policies to Reduce Residential Energy Consumption in Region Metropolitana of Chile, by Socio-Economic Status and Home Type,” REVISTA HABITAT SUSTENTABLE 2, no. 2 (February 1, 2013): 2–18

\(^3\) Case 31 will be discussed in later in this Deliverable.
| SET 01 | Lighteright structure. Walls with 60mm insulation | CASE 00A | No shading devices | 6132 | 5232 | 11364 | 15452 | Base HVAC loads and consumption | Solar shading devices required |
| CASE 00B | Fixed shading | 6734 | 2151 | 8885 | 13374 | Shading needed |
| SET 02 | Lightweight structure. Walls with 100mm insulation | CASE 01 | No shading devices | 5508 | 5252 | 10760 | 14432 | Little improvement | Better insulation is needed |
| CASE 02 | Fixed shading | 6524 | 1683 | 8207 | 12556 | Better improvement |
| SET 03 | Case 02 materials, with added ventilation strategies | CASE 03 | Case 02 + Night time ventilation | 6547 | 1668 | 8215 | 12580 | No effective reductions |
| CASE 04 | Case 02 + thermal mass partition | 6559 | 1516 | 8075 | 12448 | Some reductions |
| CASE 05 | Case 02 + night time ventilation & thermal mass partition | 6588 | 1492 | 8080 | 12472 | Previous case with less effort and similar results. |
| SET 04 | Schedule update | CASE 06 | Case 04 + schedule update | 4826 | 1423 | 6249 | 9466 | Energy consumption still too high | Consumption is still too high. Major architectural change required. |
| SET 05 | Architectural upgrade, to reduce internal air volume. | CASE 07 | Case 06 + new architecture | 3422 | 1067 | 4489 | 6770 | Good reduction from previous case |
| CASE 08 | Case 07 + added wall insulation (150mm) | 3211 | 1069 | 4280 | 6421 | Good reductions |
| CASE 09 | Case 07 + Low-E glazing | 3252 | 1083 | 4335 | 6503 | Some reductions |
| CASE 10 | Case 07 + added insulation & Low-E glazing | 3034 | 1089 | 4123 | 6146 | Less heating load, but preferable |
### MAIN FEATURE
**CASE VARIATION**

| CASE 11 | Weather file adjustment | 2488 | 975 | 3463 | 5122 | Continuity |
| CASE 12 | Case 11 + independent sunspace | 2555 | 973 | 3528 | 5231 | No benefit, disregard |
| CASE 13 | Case 11 + Pavatex (walls) | 2402 | 914 | 3316 | 4917 | Better |
| CASE 14 | Case 13 + DVH AGC U=1.1 | 2085 | 1014 | 3099 | 4489 | Better |
| CASE 15 | Case 14 + winter gains (no shading in winter) | 1649 | 1099 | 2748 | 3847 | Good shading operation |
| CASE 16 | Case 15 + independent sunspace | 2072 | 1032 | 3104 | 4485 | No benefit, disregard |
| CASE 17 | Case 15 + full Pavatex envelope | 2025 | 1061 | 3086 | 4436 | Too much insulation? |
| CASE 18 | Case 17 + Free running Sunspace | 1199 | 1083 | 2282 | 3081 | Little reduction suggest sunspace doesn’t require HVAC. |
| CASE 19 | Case 18 + Independent sunspace | 1270 | 1359 | 2629 | 3476 | No benefit, analyse software capability |
| CASE 20 | Case 18 + basic night time ventilation | 1232 | 957 | 2189 | 3010 | Better |
| CASE 21 | Case 20 + Daytime ventilation | 1239 | 898 | 2137 | 2963 | Better |
| CASE 22A | Case 21 + 200mm roof insulation | 1187 | 880 | 2067 | 2858 | No relevant reduction |
| CASE 22B | Case 21 + 250mm roof insulation | 1142 | 866 | 2008 | 2769 | Better |
| CASE 22C | Case 21 + 300mm roof insulation | 1111 | 861 | 1972 | 2713 | Too much effort for little reduction. Disregard. |
| CASE 23 | Case 22B + 0.75 ach infiltration rate | 897 | 978 | 1875 | 2473 | Good reductions |
| CASE 24 | Case 22B + 0.5 ach infiltration rate | 594 | 1261 | 1855 | 2251 | Good reductions, particularly in heating. Prefer this situation. Lower infiltration rates not realistic |
| CASE 25 | Case 24 + sunspace partition controlled ventilation modelling strategies | 155 | 2933 | 3088 | 3191 | Partition operation too complicated and ineffective. Keep materials for energy use reductions |

**Operation of partition between sunspace and living spaces needs to be carefully considered, as software technicality creates more extreme indoor conditions. Permanent summer ventilation strategies needed due to high envelope performance. Sunspace should be free running.**
<table>
<thead>
<tr>
<th>MAIN FEATURE</th>
<th>CASE</th>
<th>VARIATION</th>
<th>HEATING LOAD kWh</th>
<th>COOLING LOAD kWh</th>
<th>TOTAL LOAD kWh</th>
<th>TOTAL SUMPTION kWh</th>
<th>CASE CONCLUSION</th>
<th>SET CONCLUSIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>SET 09 Partition wall modelling strategies to fit Valparaiso climate. Evolution of sunspace partition design</td>
<td>CASE 26</td>
<td>Case 25 + lightweight partition</td>
<td>192</td>
<td>357</td>
<td>549</td>
<td>677</td>
<td>Better</td>
<td>Sunspace modelling considered appropriate. Thermal mass to be used. Effective reductions at a limit. Further analysis to involve effective air changes and indoor temperatures.</td>
</tr>
<tr>
<td></td>
<td>CASE 27</td>
<td>Case 25 + mass partition</td>
<td>205</td>
<td>293</td>
<td>498</td>
<td>635</td>
<td>Better</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CASE 28</td>
<td>Case 27 + mass management</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>SET 10 Calculated Ventilation modelling. Focus on partition and indoor temperatures</td>
<td>CASE 29</td>
<td>Case 26 + calculated ventilation</td>
<td>280</td>
<td>172</td>
<td>452</td>
<td>639</td>
<td>Better</td>
<td>Good indoor conditions, and reduced energy use.</td>
</tr>
<tr>
<td></td>
<td>CASE 30</td>
<td>Case 27 + calculated ventilation</td>
<td>344</td>
<td>108</td>
<td>452</td>
<td>681</td>
<td>Better</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CASE 31</td>
<td>Case 30 with temperature analysis</td>
<td>344</td>
<td>108</td>
<td>452</td>
<td>681</td>
<td>Same</td>
<td></td>
</tr>
</tbody>
</table>
3) Influence of Energy Analysis in the HVAC systems

It has been mentioned that the house in Valparaiso will ideally not rely on HVAC systems. This decision was based on local reality, where only small, inefficient heating appliances are considered, and for a short period during winter only [Valparaiso inhabitants tend to prefer radiant portable gas heaters].

Energy simulation results have helped the team sustain this position. The use of required heating has been reduced to the minimum expression, occurring mostly during part of the winter months, and to be supplied with a small portable heater, at least in the Valparaiso area. It is safe to assume the system should be incorporated in harsher, colder climates, in locations towards the southern part of the country.

SECTION II: PROJECTED PERFORMANCE OF FINAL HOUSING UNIT DESIGN

1) Housing Unit and System Description

A) Overall Description of the Project.

To address the flexible design that Casa FENIX proposes for different climates and conditions, the team have studied different ways to achieve under the concept of modular design and skeleton and skin [Figure 130].

Chilean diverse climatic condition has been faced on the design of set of interchangeable components that allows Casa FENIX different configurations in a progressively expansion [Figure 130].

Modular configuration varies from compact on cold climates to extended on hot desert climates. The use of courtyard on central valley towns, and space in between such corridors, verandas etc according to the vernacular architecture legacy and local social tradition.

Figure 130: Variation of modular configuration according to climate condition
For Valparaiso climatic condition configuration for Casa FENIX components are:

- SUNSPACE MODULE as a main piece of volumetric component
- One SURVIVAL MODULE
- One MECHANICAL MODULE
- One LIVING MODULE

Sunspace as a sunspace North oriented is the thermal engine for the whole house.

Modules are attached to this Sunspace module and share the passive solar thermal and natural ventilation strategies among them.

In the envelope components strategy are mainly focused on a high insulation, air tightness exclusion on thermal bridges with the budget restriction in mind. Envelope panel are then clipped on the structure to conform the volumetric living space. At this stage discussion on the clipped system is under research.

Proposed Eco Villa FENIX is adapted to the slope of Valparaiso hills, giving diverse module and Sunspace configurations as a connector for allocating the stair [Figure 131].

Figure 131: Variation of modular configuration according to geographical location
b) Passive design strategies and energy efficiency measures

The whole concept of Casa FENIX, which involves an entire design and construction process dedicated to supply a quality, affordable dwelling solution [in our local Chilean context] to people who have lost everything, cannot define its efficiency exclusively in terms of energy consumption for cooling and heating, or how advanced its technologies are. While the Solar Decathlon competition is highly focused on innovation, the creative use of new technologies and new uses for more traditional ones, our team understands that our Casa FENIX can only be realised if it considers more traditional, relatively inefficient, entirely passive systems [this is explained in detail in section 5.6. Sustainability Report].

With regards to passive strategies, controlled passive solar gains are the key strategy for thermal comfort in Valparaiso, as well as natural ventilation.

Sunspace faces the north in order to achieve greenhouse effect and transfer the heat to the modules attached to them.

A partition containing high mass material acts as storage and buffer between both, Modules and Sunspace. Heat can be “directed” in a desired direction by the operation of thermal roll curtains.

Natural Ventilation is being addressed as a controllable mechanism for heat transfer and coolness generator, using different openings in the sunspace and the living spaces, as well as the already mentioned insulation of the thermal mass partition.

A movable exterior shading device [in the shape roller curtains] in front the sunspace windows allows controlling the solar radiation when gains are not desirable. Thermal models consider an external, highly reflective shading which blocks excessive radiation during summer months, but is absent at all other times. Further optimization, such as night time use in winter to avoid heat losses is also being studied.

There is an insulated building envelope to maintain thermal conditions within the living spaces. The envelope has evolved to consider local materials and distributors.

Slightly different strategies have been considered, both for summer and winter, depending on whether the space is adjoined to the sunspace or not.

2) House HVAC Simulations (annual)

a) Brief Simulations description. Tools used.

Several kinds of testing have been run in parallel to inform the design:

i. Thermal and energy simulations using Design Builder© software:

ii. Natural Ventilation studies, on scale models

iii. Buoyancy effect studies

These simulations and results are detailed below:

4 To see a detailed description of the Passive design strategies, please refer to Drawing BA-015, BA-016, BA-017 y BA-018 located in the Project Drawings
i. Thermal and energy simulations using Design Builder© software:

Simulations are being carried out using Design Builder software for thermal and energy analysis. Design Builder uses EnergyPlus as its engine, as well as requiring an hourly weather data. Where this information cannot be obtained on site [taking up the use of a meteorological station for over a year of data collection], software like Meteonorm can produce the simulation weather hourly data. While on site collected data is preferable, Meteonorm has been proven to produce fairly accurate weather data. An hourly weather data has been produced for Valparaiso.

The dynamic thermal simulations allow planning and designing passive strategies and their effect on the final energy consumption for an entire year, and allowing results of up to hourly intervals. However, some strategies such as natural ventilation and air exchange between the main living space and the sunspace can be less accurate to model in Design Builder. Both thermal and previous ventilation analysis complement each other.

In this deliverable, the results obtained for the latest model will be discussed.

ii. Natural Ventilation studies, on scale models

Two different types of study were carried out to analyse the natural ventilation strategy and options. In the first instance, a section of the house was built on a 1:4 scale [Figure 135], exposed to climatic conditions and measured. The second study was simple simulation to determine the effectiveness of opening sizes and areas, in order to validate results from the previous study. Using scale models and sensors, these studies aims to identify effective wind speeds with relation to available openings.

Scale Model Experiment

The indoor air renewal is done by air extraction or injection. The purpose of this is to ensure the cleanliness of the air and contribute to the thermal conditioning of the building. In the case of casa FENIX, ventilation occurs by the difference of density that is generated by the temperature difference [temperature gradient] between two air masses, this is called Stack Effect. This is produced when the Sunspace is heated, and thanks to openings designed in both, a lower level for air inlet and in a higher level for air outlet, will generate air flows that will help the expulsion of hot air fresh air intake from outside.

In winter, the ventilation strategy is aiming to generate air changes and during summer, to allow the entry of fresh air into the house.

Objectives of the experiment

- Firstly, to determine whether current geometry allows reliable use of a stack ventilation strategy. Two different gradients have been proposed for this study: a 5°C and a 10°C difference in temperature.
- To define the relationship between both air inlet and outlet, with regards to sizes, distance and heights, and define outlet size for more effective ventilation. The openings in study are four, two located in the top of the Sunspace and two lower openings, one in

5 A summary of all models run to date, including their main features and general results can be found in section 2) Influence of Energy Analysis in the Project Design, earlier in this report

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the Sunspace side and the other inside the living space, in the north side [Figure 133][shaded side].

- To determine what sort of slope for the roof, or type of roofing for the gallery is the most effective for ventilating. The idea is to compare three proposals and to determine which of them has a better performance.

CASE 1: Flat roof
CASE 2: 20° Sloped roof
CASE 3: Roof with chamber

- To compare the various vents proposals and to find out the importance or the impact of them on total ventilation.

Description of the model under study

A 1:4 scale model has been made to study the variables in a controlled environment. It represents the minimum structural section of the house [Figure 132].

The envelope of the model was made from 30mm expanded polystyrene, which simulates the real insulation. The Sunspace has a 5mm thick glass. This model does not consider the thermal mass partition to only take one component of study at a time [Figure 132].

Figure 132: Section of the house made in a model scale, for test the natural ventilation
Experiments and results

CASE 1: Flat Roof

The experiment consists in measuring the speed of the air stream generated by the temperature difference and the opening of the slots at different positions in a flat roof of the Sunspace. The aim of this experiment is to determine the air change per hour [ACH] by varying the opening area in the upper air outlets.
Results

The Figure 136 shows in the left side the different relations between the areas of aperture and the vent flow they generate in m3/h; the rectangles filled with yellow are the area of openings of the outlet area [100% = 0,05 m2] and the rectangles filled with red are the area of openings of the inlet area [constant = 0,004 m2]. In the right side, the green polygons are the times the air gets renewed in one hour.

Figure 136: Result of the experiment CASE 1
CASE 2: Sloped Roof

The experiment consists in measuring the speed of the air stream generated by the temperature difference and the opening of the slots at different positions, the same idea of the previous experiment, but this time in a 20° slope roof. The aim of this experiment is to determine the air change per hour [ACH] by varying the opening area in the upper air outlets [Figure 137].

Results

The Figure 138 shows in the left side the different relations between the areas of aperture and the vent flow they generate in m3/h; the rectangles filled with yellow are the area of openings of the outlet area [100% = 0.05m2] and the rectangles filled with red are the area of openings of the inlet area [constant = 0.004m2]. In the right side, the green polygons are the times the air gets renewed in one hour.

Figure 137: Model under study, scale 1:4, Case 2
**General conclusions**

Not all proposed cases were studied to time constrictions.

However, the first two proposed cases were studied. - First, stack ventilation is possible with current geometry, while the airflow can be regulated with the outlet area: greater outlet area means a superior airflow than a smaller one, therefore, more air changes per hour. At the same time, comparatively speaking, a greater temperature gradient also implies an increase in the air flow, because having a higher temperature; the air will tend to rise faster as the density becomes lower.

- Secondly, smaller distance between the entry and exit of air also causes an increase in the...
speed at which the indoor air is renewed. However, when two openings are at the same level, as in the case E of ventilation, air shows no significant movement, as there is no pressure difference between the openings.

- Finally, between the two experiments, the one that shows a better performance is the one with the sloped roof, as it has a greater height, allows a better circulation. The best case obtained for the model so far is with an inlet area of 0.004 m², an outlet area of 0.036 m², giving as a result a vent flow of 10.44 m³/h.

### iii. Buoyancy effect studies

Steady state analysis which evaluates effective air changes per hours considering temperature differences and available stack height. It uses the Optivent® tool.

Buoyancy studies aim to verify that the air change rates established in the thermal modeling, which are very high, can actually be achieved.

![Figure 139: Results of the Buoyancy effect studies using Optivent tool](image)

An initial requirement is to achieve sufficient air changes to maintain a minimum fresh air supply. Achieved results are much higher than requirements, so this particular issue is not a concern.

The situation is different when looking at results in reference to minimum requirements for cooling. It is appropriate to mention that this exercise responds to an analysis of a worst case scenario, where no wind pressure is available. As will be shown in the thermal modelling assumptions, ventilation strategies rely on a rate of 10ach as a maximum, to ensure comfort, which are already achieved by the current assumptions, while capacity for cooling could improve. However, perfectly still air conditions are unusual for Valparaiso, so achieved results are regarded as appropriate. The remaining air required would be supplied by wind pressure.

This last assumption was tested in the latest set of energy simulations, which included hourly wind data [Figure 139].

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Camilo Diaz and Brian Ford & Associates
B) Housing Modelling

Assumptions, including internal gains, occupancy behavioural patterns, ventilation and losses by the building envelope

A standard Chilean family has defined the dwelling’s occupancy pattern. According to the INE [Chilean National Institute of Statistics] during the last decade, up to 40% percent of constituted homes were formed by two parents, and two or less children, where one parent acts as the main provider for the family.

For the energy model and internal gains, this translates as two adults and two children. One adult remains at home permanently, staying in both Kitchen and Living Room, while the other adult and the two children leave for work and schooling on a daily basis, from Monday to Friday. Some models have considered a different scenario, where a “Workspace” as been included to be used by one of the adults, while the other adult stays in the Kitchen and Living Room area.

Vacations and holidays have not been included, and the occupancy pattern for the week is unchanged during the year.

Most of the activity occurs in the Living room and Kitchen area, while the Bedroom is strictly used during night hours.

The daily patterns for occupancy, lighting, equipment use, and heating and cooling use have been defined for each room, where applicable. Most comfort patterns have been derived from CIBSE* guidelines and benchmarking.

Aside from architectural changes, as well as operation strategies, other input data such as occupancy schedules [number of occupants, density, room occupation, lighting, HVAC use, luminance targets, and internal gains from appliances] remain unchanged from the previous cases.

Most relevant changes for latest cases is the building envelope, and ventilation rates for different rooms are in the chart.

While natural ventilation rates are a fixed input in the models, there operations is controlled depending on the season. Natural ventilation fixed rates have been assigned as follow:

- Bedroom: 4.5 [ACH]
- Living Room and Kitchen: 3 [ACH]
- Workspace: 3 [ACH]
- Sunspace: 10 [ACH]

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8 CIBSE (2006), Environmental Design: Guide A.
**c) Housing Unit Energy Loads**

Internal gains from appliances and lighting have been considered as two separate, homogeneous bulks [W/m²], as shown in the occupancy patterns in previous Deliverables. Most relevant gains are those related to the use of the Kitchen, at four different meal times [breakfast, lunch, ‘onces’ and dinner].

---

**3) Results and Discussion**

**A) Housing Unit energy performance as a whole and system by system.**

Case 30 and 31 are the latest energy models. While Case 30 greatly reduces energy use, ventilation rates are fixed. Case 31 is exactly the same model, but ventilation rates are a result of the modeling ‘calculated ventilation’ setting. In this setting, wind hourly data is used, to complement effective ventilation results provided by Optivent in previous sections.

The first point of comparison from previous models is the general thermal balance [Figure 141].

Only occupancy gains have remained constant [as input data for modelling remained unchanged], while all other losses and gains have been reduced due to a better performing envelope. Energy studies at this point have since considered envelope performance to exceed local regulation standards [less strict than European standards], while considering locally available materials, thus reducing resistance of some building elements. Infiltration has been kept at 0.5 ACH, which seems high enough to be realistic under the expected construction conditions. While lower infiltration generally renders models warmer, appropriate ventilation rates have been established to reduce cooling loads to a maximum.

While the passive ventilation strategies consider heavily ventilating all living spaces throughout summer for appropriate cooling [with the exception of the bedroom where ventilation is controlled], as well as sunspace, the HVAC demands dynamic present an almost non-existent need for cooling. This has been achieved by, reducing solar gains to a maximum, and enhancing natural ventilation strategies.

Occupancy remains the higher internal gains factor, as it is considered that appliances will be less efficient. Due to assumed budget limitations, appliances will be of lesser quality and/or very old, reducing efficiency in terms of both higher energy consumption and higher heat release to the environment.

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9 Please see Appendix 14.9 “Energy efficiency Appendix” for more details.
b) Predicted Indoor Temperatures

Free running models have been considered to analyze indoor temperatures. While current results show curves with similar behavior to those shown in the previous deliverables, the ranges of temperatures achieved have varied, particularly for colder climatic conditions.

**Coldest Week**

In general terms, we can see in the Figure 143 that the house envelope performs to keep indoor temperature roughly 10°C above exterior temperatures. The sunspace reaches very comfortable temperatures.

More specifically, the bedroom remain above 15°C within most occupied hours, while the rest of the day temperatures raise an lower to match exterior temperature, although maintaining a difference of 10°C or higher.

For the Living Room, we can see that for the beginning of the occupied period, temperatures fall below comfort range. During the day, temperatures peak at the same time as the use of kitchen appliances, for the four meals of the day. While temperatures don’t raise above 18°C, they remain well above 15°C for most of the occupied period.

As a more isolated area, even while it’s within the living room, the workspace temperatures remain low throughout most of the day. While we understand that these results expressing a software limitation, [workspace and Living room are not separate spaces, although a partition needs to be added in the software to create separate analysis or programmatic areas] ventilation on this space should be considered carefully.

---

**Figure 141: Casa FENIX General Thermal Balance**

<table>
<thead>
<tr>
<th>Component</th>
<th>Power (kW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lighting</td>
<td>419</td>
</tr>
<tr>
<td>Occupancy</td>
<td>383</td>
</tr>
<tr>
<td>Solar Gain Exterior Windows</td>
<td>399</td>
</tr>
<tr>
<td>Zone Sensible Heating</td>
<td>643</td>
</tr>
<tr>
<td>Zone Sensible Cooling</td>
<td>695</td>
</tr>
<tr>
<td>Total Latent Load</td>
<td>431</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Component</th>
<th>Power (kW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooling</td>
<td>143</td>
</tr>
<tr>
<td>Mechanical Ventilation</td>
<td>463</td>
</tr>
<tr>
<td>Internal Combustion</td>
<td>434</td>
</tr>
<tr>
<td>Internal Convection</td>
<td>695</td>
</tr>
<tr>
<td>External Convective</td>
<td>421</td>
</tr>
<tr>
<td>External Interception</td>
<td>387</td>
</tr>
<tr>
<td>Solar Gain Interception</td>
<td>434</td>
</tr>
<tr>
<td>HVAC</td>
<td>695</td>
</tr>
<tr>
<td>Mechanical Ventilation</td>
<td>463</td>
</tr>
<tr>
<td>Occupancy</td>
<td>383</td>
</tr>
<tr>
<td>Zone Sensible Heating</td>
<td>643</td>
</tr>
<tr>
<td>Zone Sensible Cooling</td>
<td>695</td>
</tr>
<tr>
<td>Total Latent Load</td>
<td>431</td>
</tr>
</tbody>
</table>
Figure 142: Casa FENIX Coldest Day

Figure 143: Casa FENIX Coldest Week
The sunspace makes use of solar gains, and temperature rises above 20°C. This air can certainly be used to heat up more of the Living Room.

Behaviour for coolest day [Figure 142] is maintained throughout the week, while there is sufficient solar radiation. In case of days with less radiation, the envelope helps maintain internal gains. During the coldest week, indoor temperatures range from 10°C to 20°C [Figure 143]

**Hottest Week**

The well-protected, well-ventilated Sunspace shows in the Figure 145 that the temperatures barely above 25°C. Higher temperatures can be seen for both bedroom and workspace.

This is less relevant for the bedroom as it comes into use roughly around 22:00hrs, when outside temperatures drop and ventilation becomes more effective for cooling.

In the case of the workspace, the software models it as an enclosed, small space, although it is very much linked to the living room. This limitation tends to raise its temperature. Higher ventilation rates could help in solving this problem.

The hottest day behaviour [Figure 144] is sustained during the hottest week, with a sunspace with cooler loads due to ventilation strategies, and shading devices use. This air could be still used to make internal Living Room conditions better. However, as it has been pointed out before, providing different analysis zones creates an obligatory discontinuity in the spaces, even those such as the sunspace and living room, where there is literally no limit between them, but a hanging partition which works a bit a screen in spatial terms. The software enforces a ‘virtual partition’, which acts as a glazed area with no thickness. However insignificant, this glazed area tends to affect general results.

The solution to this problem has been to model with a ‘calculated ventilation’ approach, where the software uses the wind hourly data, with a constant 4pa atmospheric pressure, and considers available openings, infiltration cracks, etc, instead of the assigned air change rates for natural ventilation that the models have been using thus far.

Under this approach, internal virtual partitions can be enabled as windows, which are, opened to the full extent of their area a 100% of the time, solving the problem of spatial continuity and airflow. This analysis evaluated effective air changes and maximum available ventilation rates.

We have focused on the differences for both models during the hottest week. The ventilation schedules for hottest week are on a fulltime 24/7 basis, so windows are completely open in ‘calculated ventilation’ mode.
Figure 144: Casa FENIX Hottest Day [°C]

Figure 145: Casa FENIX Hottest Week [°C]
The use of calculated ventilation for the bedroom produces more desirable results during the hottest week. Peak temperatures are reduced, while night time temperatures fall several degrees lower, sometimes below 20°C.

While in case 30 we saw that external temperatures were lower than indoor temperatures in spite of the forced ventilation, we can see that case 31 has better results, as indoors are cooled to match exterior temperatures and even below.

Temperatures for the sunspace remain within excellent ranges, always below 25°C, even on the hottest day. The difference in ventilation calculation allows for lower temperatures, and a more evident lag due to the mass partition.

In general terms, the house deals with most extreme temperatures in an appropriate manner even during the hottest and coldest week of the year.

Additionally, the change in the way ventilation is simulated has shown that our previous results with fixed ventilation assumptions are valid as well. There is a continuity to the results, with the added plus of the house performing better than in all previous models, in terms of internal temperatures.

Figure 146: Bedroom Temperatures - Standard v/s Calculated - Cases 30 v/s 31 - Hottest Week
Figure 147: Living room and Kitchen Temperatures - Standard v/s Calculated

Figure 148: Sunspace Temperatures - Standard v/s Calculated
c) HVAC System Selection Criteria.

It has been initially discussed that heating and cooling should be provided depending on local availability of fuels and possibly technology. In the particular case of a house in Valparaiso, cooling systems are not considered. This is due to a cultural fact, where cooling systems are only very rarely present in dwellings. On the other hand, small, localized heating appliances can be used. It is for this reason that both building envelope design and ventilation strategies have so far aimed to reduce cooling loads in the thermal models as much as possible, disregarding [within reason] an increase in heating loads.

However, as the competition emphasize the evaluation of efficiency in terms of energy consumption, the models for Valparaiso have been configured to measure HVAC loads, which will be presented in the following section.
**d) Predicted heating and cooling loads, and HVAC energy demands.**

Ventilation strategies and envelope have worked towards reducing cooling loads. There still seems to be room left to reduce heating loads, with the fine-tuning of solar passive gains strategies.

As it stands, the energy models of our latest case has produced an HVAC energy consumption of 11.9 kWh/m².\(^4\)

The heating loads curve Figure 151 tells us the house is cool. It also shows the points where both natural ventilation and solar gain strategies come into use. Ventilation regime is very heavy between October and April, as is the use of shading devices to block as much direct gains as possible, inducing heating loads. Ventilation is reduced between May and September, and the shading devices are removed, to increase solar gains, with aims to reduce the need for heating.

![HVAC Monthly Loads (kWh/month)](image.png)

Figure 151: HVAC monthly loads

**4) Conclusions**

- **The overall energy performance** suggest the house could still be improved by dealing with weak points, particularly during the warmer season
  - **Building envelope:** external walls are at their limit with the regards to transmittance reduction, considering budget, local availability and regulations.
  - **Infiltration rates:** more controlled infiltration has been used, although it still remains high by certain standards such as PassiveHaus, in order to account for difficult construction conditions [emergency situations], which might impact on the air tightness of the envelope
  - **Shading devices:** the external roller curtains located outside the sunspace and used as shading have been modelled to consider optimal use of solar energy [blocking it in summer and allowing direct radiation into the sunspace in winter]. This has proven to be a very effective tool in managing resulting internal gains.

- **In general terms,** current design and passive strategies have proven successful. The HVAC mixed loads have been reduced to 11.9 kWh/m², which is almost a 10% of those shown in similar studies, for well above regulation refurbished homes, around 75 kWh/m². Further improvement could be extracted from models by fine-tuning the solar gain strategies, as well as management of thermal mass partition, which so far has proven to be a difficult scenario to simulate with reliable results.
SECTION III - ADAPTATION MADE BY THE TEAM IN THE HOUSE FOR THE PROTOTYPE IN VERSAILLES

FENIX Team has decided on the construction of two Casa FENIX, one Prototype in Chile and one Replica for Versailles. They both adapt their design and development to fit local circumstance, such as available materials, local regulations and standards, and other requirements.

General Summary

Structure

The modular concept remains the same, and the structure assembled folded “Z” has been reformulated in a fixed “Z diagonal” element as panel and column. [Figure 152]

Modules

For transportation requirements, the Versailles prototype has been divided in several modules, and the Sunspace height was reduced in 60cm in related to Casa FENIX Chile, reducing the total volume [Figure 153].

Envelope

As regards air tightness, we expect performances of approximately 0.15 m³/m²h in the Casa FENIX Chile, which is far below French regulations.

Windows

The replica’s joineries are made of wood and aluminium [wooden frame and aluminium exterior finishes]. The windows are triple glazed on the North front and double glazed on other fronts.

These windows provide high performances as concerns surface loss and airtightness. One of the main differences between the prototype and the replica is the opening of windows and fanlights. Chilean joineries are equipped with English-style opening [push] whereas joineries made in France.
are outfitted with French-style openings [pull].

Thus, the replica’s joineries are equipped with tilt and turn windows, and with a simple tilt mechanism [fanlight located at the bottom of Sun Space’s joineries]. This allows to implement passive ventilation strategies as for the prototype, but limits the possibilities of opening the joineries of the Sunspace. Because of the stiffeners, we managed to equip only one of the three joineries with an opening fanlight.

The shading devices initially planned on the front of the Sun Space were also replaced with solar membrane outdoor blinds, Soltis 86 model from Serge Ferrari\textsuperscript{11}. Every joineries of the West façade were equipped the same way.

**Energy efficiency design**

For the French replica of Casa Fenix, we met various challenges, with requirements, if not contradictory, at least difficult to reconcile. The initial aim of the Chilean prototype is to provide a cost effective simple accommodation, making best use of local materials and of the Chilean climate, to use passive ventilation and cooling, whilst using simple systems [gas stove for heating, solar domestic hot water production system by thermosyphon].

On the French side, the requirements for the contest lead us to design and to perform a highly-efficient system as concerns energy consumption, solar energy, and comfort.

We had to deal with a really schizophrenic situation. Indeed, we had to preserve the “soul” of the original project [that is a project with low requirements in terms of user-friendliness and equipment], while maintaining a high performance level to meet the criteria of the contest [with household appliances and operative tests, requiring to use electrical appliances only, and hence advanced technology equipment].

In a nutshell, we had to reconcile simplicity, sometimes even basic comfort [for the original project], with performances which exceed standards [for the replica]. We had to meet all these requirements within a low volume and surface accommodation, with constraints as concerns interior fittings due to the earthquake-resistant structure.

Additional challenge: the expected performance is assessed under local conditions, i.e. under the Chilean climate. The replica is assessed only during the time of the contest in Versailles. It is not assessed in annual operating conditions on the site where it will be moved after the contest, i.e. La Rochelle, where weather conditions are more favourable than in Versailles. The whole project must as well comply with the French regulation RT2012, in particular as concerns the final energy/primary energy equivalence. This equivalence precludes the use of “all electric” solutions.

\textquoteleft\textquoteleft So we developed a project which preserves the existing structure, but differs from the prototype on various points concerning energy management and equipment, with a strong adaptation to the French situation\textquoteright\textquoteright.
In summary, the general design of the replica relies on some bioclimatic principles associated with a really good performance level of the envelope:

- An excellent airtightness. Regulatory calculations are held with a default value of 0.6m³/m²h, but the expected performance, thanks to the construction system and the care taken in terms of airtightness, is 0.15m³/m²h.

- Optimal solar energy supply with joineries on the Southern façade, and especially those located on the Sunspace.

- Solar energy supply is controlled to avoid overheat, using awning blinds on the joineries fitted on Southern and Western façades.

- Passive cooling using natural ventilation through the structure, via the management of joinery opening.

- Solar air collectors to preheat outdoor air, ensuring a hygienic air renewal, associated with PCM stocks.

- A thermal wall which can accumulate the solar energy forwarded through the joineries of Sunspace during winter and dephase those supplies at the beginning of the night. We decided to use a thermal wall made from wood compartments between the stiffeners and a stack of bottles filled with water. This provides a cost effective, modular and easy to mount/maintain in case of leakage on a bottle. This also allows to keep a decent lighting level for the rooms located behind the wall [Figure 154].

Solar supply management is allowed by masking the joineries of Sunspace. This blocks solar supply to the accommodation, eliminating the energy build-up in the thermal wall or the other walls. This approach also avoids piercing the envelope and thus preserves its airtightness.

HVAC and solar thermal systems

In terms of equipment, the replica is characterized by:

- The use of an innovative air blowing system, associated with air collectors [which allow to preheat the air during winter], with a PCM storage to dephase energy supplies, and with an optional mechanical over-

12 Operating scenarios are described in the PD

![Figure 154: Thermal mass made with water bottle](image)
ventilation if natural ventilation is not sufficient [VMI-Soléhom system].

- A supplementary heating provided by a modular low power/high performance wood pellet stove.

- The priority given to solar energy production making the best use of the available surface on the Sunspace roofing.

- High performance equipment, whether for the solar thermic system [ultra-low consumption pump for the solar circuit, for example], or for photovoltaic panels [high yield per square meter]. The decision to not integrate the photovoltaic panels within the roofing provides a real benefit here, as it ensures a better natural ventilation of the soffit panels, and improves their productivity and lifetime.

Simulation of the replica’s thermal behaviour and performance assessment

Beyond the regulatory aspect that the replica must respect in order to be reused after the contest, we ran Dynamic Thermal Simulations [DTS]. The aim of these simulations is to assess the thermal behaviour of the accommodation, particularly how temperatures evolve within the different areas, as well as to anticipate the needs and estimate annual energy consumption.

As the accommodation is equipped with the VMI-Soléhom system, which is being marketed and not yet referenced in business tools, we could not run these DTS with the COMFIE-PLEIADES tool that we used for the regulatory aspect. So we ran those simulations using the TRNSYS simulation environment, feeding it with the type developed for the system in the context of the development consortium of VMI-Soléhom.

Four cases were considered for the simulations:

CASE N°1, with a single flow controlled mechanical ventilation system, associated with a wood pellet stove.

CASE N°2, with the complete VMI-Soléhom system [air collectors and a 2x50 litres PCM stock], associated with a wood pellet stove.

The last cases [1_bis and 2_bis] are variants of cases 1 and 2, for which we considered the presence of a thermal wall between the Sunspace, the kitchen and the living room, made up of a 20cm thickness water reserve, containing 1m3 of water.

This wall was inserted to verify the relevance and influence of a stronger structural thermal inertia of the accommodation. For the contest, the wall will be made of a stack of water bottles between the stiffeners.

The energy specifications of the equipment are as follows:

- Fan power: ranging from 11W in basic ventilation [70m3/h] to 145W in night over-ventilation [400m3/h], estimated according to manufacturer data.

- Power of the electrical auxiliary components of the wood pellet stove: 50W [hot air fan, Archimedes screw and smoke extractor], estimated according to manufacturer data. Thermal efficiency of the stove: 90%.
The ventilation scenario is as follows:

- **In the heating season**: basic ventilation, with air flowing through the air collectors.

- **During summer**: air flowing through the collectors is bypassed [air is blown outside], ventilation comes from the “cold” outside air intake, with:
  
  a) Night over-ventilation as soon as the difference between inside and outside temperatures exceeds 3°C
  
  b) Basic ventilation otherwise

Outdoor blinds management is the same in every case:

- **In the heating season**, full closing of the blinds during the night
- **During summer**, blinds closed at 70% if the luminous flux received on the floor of Sunspace exceeds 140W/m², full opening otherwise.

The wooden pellet stove’s thermal efficiency retained was 90% [manufacturer data], whereas the value retained for electrical auxiliary components [VMI’s fan and pellet stove] is 95%.

Occupancy and internal supplies taken into account for the 4 occupants are based on conventional scenarios defined in the French RT2012.

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Single flow mechanical ventilation</th>
<th>VMI-Solehom system</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 (without thermal wall)</td>
<td>1_bis (with thermal wall)</td>
</tr>
<tr>
<td>Annual heating thermal demand (kWh)</td>
<td>1 864</td>
<td>1 833</td>
</tr>
<tr>
<td>Annual electricity consumption for the VMI-Soléhom fan (kWh)</td>
<td>225.4</td>
<td>225.4</td>
</tr>
<tr>
<td>Annual electricity consumption for the wood pellet stove (kWh)</td>
<td>75.6</td>
<td>75.6</td>
</tr>
<tr>
<td>Total annual electricity consumption (kWh)</td>
<td>301</td>
<td>301</td>
</tr>
<tr>
<td>Total annual primary energy consumption (kWh)</td>
<td>2 847.7</td>
<td>2 813.3</td>
</tr>
</tbody>
</table>

Table 155: Energy demand and consumption for heating
1. Energy demand and consumption for heating

The results obtained for the 4 cases are reported in the Table 155 - Table 156

Global energy demand and primary energy consumption

First, we can notice that the combination of air collectors and latent energy storage within the PCM is very interesting, as it allows a significant reduction of heating needs, approximately 24% compared to a single flow ventilation system. We note as well that the thermal wall reduces heating needs, but it is out of proportion with the whole VMI-Soléhom benefits [3% gain compared to the case without thermal wall].

2. Summer thermal behaviour and comfort evaluation

In summer conditions, the air circuit of solar collectors is bypassed, and the system works in basic ventilation or in over-ventilation from the “cold” air outdoor intake. The scenario is the same in every case.

The cases with/without thermal wall are compared. The maximum temperatures and the amount of discomfort hours are given in the Table 156. The amount of discomfort hours is related to the amount of hours where T > 27°C.

In the light of these results, we can conclude that the thermal wall dramatically reduces summer overheating, on the one hand by reducing the maximum of recorded temperatures, on the other hand by transferring overheating from the bedroom to the Sunspace, but above all by significantly reducing the amount of discomfort hours.

Indeed, we can point out 102 discomfort hours without the thermal wall, but only 39 hours with the wall.

However, we can note that the maximum number of discomfort hours is always observed in the bedroom, not in the Sunspace. However, the discomfort periods in the bedroom are observed at midday and at the end of the day, but rarely at night, preserving in this way the occupants’ comfort.

The following curves display temperature changes in the rooms, and provide a comparison between scenarios with and without thermal wall.

<table>
<thead>
<tr>
<th>Configuration</th>
<th>without thermal wall</th>
<th>with thermal wall</th>
</tr>
</thead>
<tbody>
<tr>
<td>T max, living room (°C)</td>
<td>27.6</td>
<td>25.6</td>
</tr>
<tr>
<td>T max, all rooms (°C)</td>
<td>31.7</td>
<td>30.1</td>
</tr>
<tr>
<td>Localisation of T max</td>
<td>bedroom</td>
<td>Sunspace</td>
</tr>
<tr>
<td>Max amount of discomfort hours, all rooms (h)</td>
<td>102</td>
<td>39</td>
</tr>
<tr>
<td>Amount of discomfort hours, bedroom (h)</td>
<td>102</td>
<td>39</td>
</tr>
</tbody>
</table>

Table 156: Amount of discomfort hours
Figure 157: Temperature evolution without thermal wall

Figure 158: Temperature evolution with thermal wall
Figure 159: Global vertical radiation South facade [W/m²]

Figure 160: Temperature evolution in the sunspace
These figures highlight the thermal wall’s influence on overheat levelling in the bedroom and the living room, with a maximum decrease of temperatures reaching 3°C in the bedroom during the hottest days.

By contrast, the evolution of temperatures within the Sunspace is not or almost not influenced by the thermal wall during the day. This is probably because the Sunspace is directly subject to incident solar radiation through its façade and doesn’t benefit from the thermal buffer effect provided by the wall.

In the end, these simulations lead us to think that the strategy implemented to associate the initial bioclimatic design of the Casa FENIX and the active equipment of the replica is efficient and relevant.

This strategy aims at:
- Fostering solar supplies in heating season and controlling them during summer with outdoor blinds management.
- Limiting temperature variations by increasing the accommodation’s structural inertia with a thermal wall.
- Allowing the recovery of solar supplies via air collectors and the ability to cool down at night using an over-ventilation strategy thanks to the VMI-Soléhom system.

Compliance of the replica with the RT2012 French regulation
The project’s regulatory compliance was verified with the COMFIE-PLEAIDES software suite, marketed by Izuba [version 3.4.4.0], certified by the CSTB [French Scientific and Technical Centre for Building].
The VMI-Soléhom is neither marketed nor certified by an ATEX [experimentation technical assessment]. The system is not referenced in the software’s equipment library. Moreover, as there is no possibility to take into account air collectors in COMFIE, we couldn’t design a heating system which would replicate the Soléhom system’s behaviour.

However, in order to assess how the replica could comply with the RT2012 regulation, we studied the case of a single flow ventilation with a 70m3/h constant flow, equivalent to the VMI-Soléhom’s basic flow. The fan power is set to 11W.

This case is unfavourable compared to the VMI-Soléhom, as it doesn’t take into account the energy recovery via air collectors.

Other equipment [solar DHW, PV panels, wood pellet stove] were considered with their actual characteristics. The default value of air permeability was 0.6m3/m².h.

As the replica will be relocated in La Rochelle after the contest, calculations were performed for the relevant climate zone.

The results for the envelope’s bioclimatic quality are as follows:

- **Bbio complies with Bbio,max:**
  - Bbio = 60.9
  - Bbio, max = 73.7

A 17.4% gain compared to the regulatory value.

- **The conventional indoor temperature is also met:**
  - Tic = 33.5°C,
  - Tic,ref = 36.9 °C

The results as regards primary energy consumption also match required values:

- Cep = 87.1 kWhep/m²SHONRT
- Cep max + 12 = 90.7 kWhep/m²SHONRT

As a conclusion, we can notice that even in this unfavourable case, the replica complies with RT2012. Therefore, we can assume that the replica’s performance will be even higher with the VMI-Soléhom system, as the thermal simulations we ran show a 24% lowering of heating needs\(^\text{13}\).

\(^{13}\) For more details please refer to the full regulatory report RT2012 in Appendix 14.5 “Thermal Calculation.”
CASA FENIX
For Emergency post-Natural Impact eXtreme REMINDER

One of the most outstanding geographical features of Chile is the relatively constant threat of earthquakes, among other natural disasters, such as volcano eruptions, landslides and fires in urban areas. The regularity with which these events occur does not make them any less catastrophic for people. Many homes are lost and the people who are most affected are low-income families. The post-catastrophe situation throughout year has indeed been non-sustainable, therefore to develop and implement the concept of sustainable reconstruction is a big challenge for our country, where Casa FENIX ambition is to propose and offer a tangible solution.

THE PROBLEM While Chile is a political and geographical location where natural disasters are recurrent and affect a great part of the most socially vulnerable population, there are no official policies which outline a quality response to such events.

“When disaster strikes, the problems are resolved with quick, cheap, short-term solutions, such as the mediagua emergency houses” which end up causing more problems than they solve and lead to a great deal of waste in the long term.

HYPOTHESIS Casa FENIX is a design process that responds to a catastrophe, delivering energy efficient strategies to ensure quality of life as a key factor in a sustainable reconstruction; these strategies are not currently considered in post-catastrophe national policy. Sustainability factors include locally specific environmental, cultural and geographical issues, and also consider accessible and viable solutions for the most vulnerable sector of Chilean society. Therefore, the original objective behind this proposal is:

“to create emergency dwellings that offer quick, good quality and sustainable homes for the families who are the victims of a disaster.”

Thus the architectural and urban concepts that shape the proposal at both individual and collective levels are: Modularity, progressivity, flexibility and affordability.
Modularity
Casa FENIX evolves from a basic Survival Module to a complex Eco Village/Housing Complex. This process covers the stage of Emergency, Relief and Reconstruction.

Progressivity
Casa FENIX progression allows the Survival Module unit to become a final home. This incremental and evolving logic is assumed by the urban design strategy.

Flexibility
Casa FENIX has the capability to adapt to different latitudes and climates, given the geographical characteristics and diversity of climates Chile possesses, from north to south.

Affordability
Casa FENIX is an affordable home. Each unit may be acquired through the progressive subsidy addressing the total cost of the home.

ARCHITECTURAL PROGRAMME
For the SDE competition, the Casa FENIX Team proposes to bring a house that represents reconstruction as a growth progression and is configured to perform well in the Versailles climate. The basic structure and its components will subsequently be configured to meet the solar passive design strategy for the specific local climate where it is to be installed.

The programme represents the core concept of Casa FENIX, which takes a progressive approach to Emergency, Relief and Reconstruction, with sustainability in mind. It uses a passive solar design driven by a sunspace, which acts as the energy engine of the completed house and is a key spatial element which allows the articulation of the different modules.

Casa FENIX is a modular design in which each 11 m² module can be progressively attached and easily assembled during a post-disaster period, to form a dwelling measuring 60m².

The modules are as follows:
**Survival Module**
This is the quick initial response for the emergency period, immediately after a catastrophe strikes. Its main objective is to provide shelter, safety and a quality solution to the affected family.

**Mechanical Module**
This is the first module to be attached to the Survival Module as a progression during the relief period. It consists of the services and a technical core. It includes a bathroom and kitchen.

**Living Module**
This is the module that enables the house to expand and cover more than the basic needs during the reconstruction period, transforming the sum of modules into a definitive home.

**Sunspace**
The passive solar design strategy enables the regulation of the indoor climate by articulating the different modules with the exterior climate; this space grows with the addition of each module.

At a collective level, the group of emergency houses, which the FENIX team has called “Temporary Village FENIX, TVF” and the progression to a housing complex, which the FENIX team has called “Eco-Village FENIX, EVF” are conceived following the same logic. They have an open and flexible design that allows for the adaptation of modules and means that Casa FENIX can be adapted to different climatic, topographical, territorial and cultural realities.

**THE GEOGRAPHICAL DIMENSION**
Chile has 9 different climate types and the country stretches from latitude 18°S to 50°S. 90% of the population is located in areas where solar radiation is over 1000kWh/year. To address this climatic diversity and take advantage of the opportunity for solar radiation, the conceptual idea for

“Casa FENIX is similar to a skeleton or basic structure, an innovative structural design developed by students, where different components can be configured and assembled according to the users’ demands”
All the components to be attached to it respond to the demands for the different latitudes and to patterns of self-construction.

**SUSTAINABILITY FOR US** It is important to mention that the understanding of sustainability in the case of developing nations differs much from the one used in developed nations, in the sense that the problems that need to be addressed are much different, respect of priorities and urgencies. For the Chilean case the deterioration produced by natural disasters and the anthropic urban degradation produced by informal settlements and poverty are the immediate problems to solve in a sustainable way. To teach the general public about sustainability issues that go beyond recycling, energy efficiency and achieving a low carbon footprint, Casa FENIX proposes to focus mainly on local cultural aspects, quality of life and social relationships. In this case the sustainability aspects are focused on using technology and urban planning to enhance the intuitive know-how of a particular local population.

“**The choice of site: Man’s physical freedom manifests itself no doubt in his ability to choose the place on earth where he wants to live**”. People act, build and adapt through self-construction to the different latitudes and geographical conditions over time using their intuitive and basic knowledge.

“**Neither privations nor danger will deter man from selecting a spot [...]” to settle on (Rudofsky, 1964).**

This recognition of the appropriateness of the way informal settlements and self-construction take place is basic and seen to be positive; however it is extremely precarious and unsustainable in many other
aspects and in extreme situations could produce complete devastation. This was the case in April 2014 when a wildfire ravaged Valparaíso for three days; 2,900 homes were destroyed and 14,000 people - 4% of the Valparaíso population (IMV, 2014) - were made homeless.

The reasons for the unsustainable settlements can be traced back to many issues related to post-disaster rehabilitation and poverty and a major factor is the lack of a sustainable urban code for areas of vulnerability. This sustainable urban code would need to respond in a general way to the emergency and in a particular way to the post-catastrophe situation that begins right after an emergency occurs.

Casa FENIX TEAM ORGANIZATION Team Casa FENIX is a bi-national team composed of students and faculty members from the Universidad Técnica Federico Santa María [UTFSM], Valparaíso, Chile and from the Institute Universitaire de Technologie [IUT], Université de La Rochelle, France. In addition to all the opportunities that arise out of any international collaboration between academic institutions, team Casa FENIX seeks to respond coherently to SDE’s energy conservation objectives.

The proposal has been designed to address the circumstances and needs of Chile. However, transporting the house from Chile to France would entail a significant amount of CO2 emissions and the team has therefore set itself the goal of making a “PROTOTYPE” in Chile and a “REPLICA” in France, generating a dualism and a double challenge for our project. So, while the conceptual proposal is Chilean, the production of Casa FENIX is French.

TEAM Casa FENIX FRANCE
The French part of the team is in charge of all the practical, construction, building and technology applications of the project. One of the strengths of IUT is their research into and work with wooden structures and construction. A complete version of a replica of Casa FENIX is being built in La Rochelle and this is the version that will compete in Versailles.

TEAM Casa FENIX CHILE
The Chilean part of the team is in charge of all the theoretical, conceptual, architecture and urban design content of the project. One of the strengths of UTFSM is their research and work on bioclimatic architecture and earthquake resistant construction.

The design of Casa FENIX has been developed in Chile with the participation of the students from the French team during the process. Half of Casa FENIX will constitute the prototype built and tested in Valparaiso.
5.5.1 INNOVATION IN ARCHITECTURE

Team Casa FENIX takes on the challenge of designing a sustainable and energy-independent home which can be deployed quickly to respond to the emergency following a disaster and which can be adapted to different climates.

The current solution for addressing disaster situations in Chile is to provide a mediagua, a shelter of short duration, which does not respond to local climatic, geographic and social issues. The mediagua has a very short life and its design does not consider the local built environment in a sustainable way.

The architectural innovation of Casa FENIX is a modular and progressive house capable of adapting to adversity, diverse climates, topography and social circumstances, thanks to its flexible and progressive design. Moreover casa FENIX is capable to become a permanent home, as from an emergency shelter.

The conceptual idea for Casa FENIX contemplates three modules to be implemented progressively. The design is conceived as the open and flexible use of components that need to respond to the demands of the users, the available technology and the budget.

Modular and component design operates on different scales and to different architectural shapes of modular design and structural specifications, allowing the addition of different technologies based on local materials, where a constant dialogue takes place between the design requirements and available resources.

In our geographical diverse country, Casa FENIX is capable of adapting to every landscape and climate, ranging from the desert region in the north, through the central valley and coastal landscapes down to the flat grasslands of Patagonia flat in the far south. This is made possible by us transforming the array of modular construction and adapting the skin of the building envelope to the climatic condition.

5.5.2 INNOVATION IN ENGINEERING AND CONSTRUCTION

Pre-fabricated components

The design involves specific pre-fabricated components, which will be selected according to the location, family size and programme needs. These components, including the structure and the building envelope must achieve the maximum flexibility.

Team Casa FENIX has conceived the structure as a wooden skeletal frame in prefabricated parts which is assembled on site by a team of volunteers.

In designing the structural system, it was borne in mind that owners may opt for self-construction. The key constructive solution is the industrialization of wood components which are pre-assembled in a “Z” shape and deployed on site.

Structural basic elements “Z”

We propose to manufacture and produce the “Z” in a simple manner with easily accessible materials. We gave the name “Z”
to the basic structural element with which the complete module is built.
This element allows makes Casa FENIX Easy to Assemble

The structural system is designed to be easy to assemble, and built from wood components [FSC certified wood as a sustainable material], because wood performs well in natural disasters [especially earthquakes and aftershocks].
The system can easily grow from the Survival Module to include the Mechanical and Living Modules.

8 FENIX team members assembled the competition replica measuring 64m2 in just 24 hours.

Prototype and Replica

For the competition, the main idea is to build and test a Prototype in Chile and afterwards build a Replica to take to Versailles. This demonstrates Team Casa FENIX’s commitment to sustainability, as well as its concept of being easy to replicate.

The reason for using the prototype-replica concept is to save on time, transportation and costs. We aim to minimize the CO2 emissions of grey energy involved in transporting the whole house.
If the house were to be shipped from Chile to Versailles for the 2014 SD competition, the carbon footprint would be an estimated 39 tons of CO2 equivalent [Based on two 40’ containers travelling the 16960 km route [one way]]

When the house reaches the industrial stage, Casa FENIX is expected to be a “do it yourself” [DIY] or self-build design and people will be able to find the plans and assembly instructions online, enabling them to build the house with cheap and easy-to-use tools.

5.5.3 INNOVATION IN ENERGY EFFICIENCY

The sustainability concept of Casa FENIX is based on the idea of an emergency home, which is energy autonomous when grouped into an emergency solar village and can be developed during the later reconstruction stage into an eco solar village.

Our design is simple and low tech, but certainly not disposable; it goes beyond an emergency shelter to provide an energy efficient and sustainable home.

Bottled Thermal Mass

A thermal wall is made with bottles of water, which can accumulate the solar energy which comes into the Sunspace during winter and diphase those supplies at the beginning of the night. We decided to use a thermal wall made from wood compartments between the stiffeners and a stack of bottles filled with water. This provides a cost effective, modular and it is easy to mount and also to maintain, for instance in the event of a bottle leaking. This also enables adequate lighting levels for the rooms located behind the wall [Figure 165].
The Replica, which is adapted to Versailles

The French replica is equipped with an innovative system that combines a hygienic air renewal feature with the passive preheating of this air. It also offers the potential to cool down with night over-ventilation.

This system, called VMI Soléhom, is being marketed and is a joint development between Ventilairsec, a company which specializes in air blowing Elva, a joinery maker, and the CEA-INES Research Centre, which modelled the system and estimated its performance.

We can consider the general system as a single flow mechanically assisted ventilation system. But this system blows filtered and preheated air, instead of using traditional extraction. Thus, the treated premises are in an overpressurised state and the used airflows escape via specialized outlets located in the technical rooms [kitchen, bathroom, toilets]. This system relies on a single fan. The blow-out chamber is equipped with a F7 class filter in accordance with the standard EN 779-2012.

This enables many outdoor pollutants, particularly pollens, to be suppressed and therefore guarantees a much better indoor air quality than with single flow systems, but without the disadvantages of double flow systems [2 ductworks and 2 fans].

How it works

A ventilation housing [PULS’R Prestige Maxi model from Ventilairsec] associated with a mixing box and an air flow distributor allows air to be dispatched within the house in a variety of ways, depending on the needs.

- In wintertime, [Figure 166] air is drawn through air collectors (1), which enable it to be preheated before it is blown out into the living areas (2). The airflow distributor allows selection of the areas should be treated (3), this can vary depending on the time of day [priority can be given to the living and dining rooms during the day and to bedrooms at night, for example]. If the preheated air temperature is too high for room heating, the mixing box allows the temperature to be reduced by mixing preheated air with outdoor air.
Moreover, the system is able to store latent energy with Phase Change Materials [PCM], located between the air collectors and the mixing box. This not only allows heat to accumulate during the day and be released at the beginning of the night but also the levelling out of temperature fluctuations in the air coming from the collectors and improvements in the regulation of the system during the course of the day.

- **In summer time**, the air coming from the collectors is exhausted outside and the insufflated air comes from the “cold” air inlet, which should ideally be located on the north side. The system allows the implementation of a passive cooling strategy with night-time over-ventilation by increasing the airflow coming from the outside inlet.

A user-friendly HMI is being finalised for an industrial development, and will be showcased during the contest.

It will be located on a wall in the living room, like any traditional room thermostat and allows to automate the different operating modes according to predefined
scenarios and the ambient temperature measured in the living areas.

This user-friendly HMI comprises a control board and a wireless communication protocol with the various components of the VMI- Soléhom. The GUI consists in a touch screen of the size of a smartphone.

The welcome screen [Figure 168] displays current date/time, inside temperature and current operating mode.

A second screen [Figure 169] gives access to system data [outlet temperature of the collector, outside air temperature, temperature and hygrometry of the air blown into the accommodation, and quality of inside air]

Menus [Figure 170] allows to define the temperature set point and to modify the operating mode [collectors’ bypass, VMI operating mode] and to display the state of the particle trap.

**Description of the VMI-Soléhom system for the replica**

The French replica for Casa FENIX is equipped with 2 double glazed air collectors. The overall surface measures 7 m² and there are 2 PCM stocks of 50 litres each, with a melting point temperature of between 25°C and 28°C.

The collectors are mounted on the front of the Sunspace and on the southern facade of the Survival Module [Figure 171].

**Heating backup system**

Supplementary heating will be provided by a low power/high yield electronically controlled wood pellet stove [model Leïos, “Galet” pattern, from SUPRA. Adjustable power from 0 to 5.5kW, η=90%].

[Figure 168: Welcome screen]  
[Figure 169: System data screen]  
[Figure 170: Menu’s screen]  
[Figure 171: Placement of the Ventilairsec system]
5.5.4 INNOVATION IN COMMUNICATION AND SOCIAL AWARENESS

The Communication Plan section of our proposal described few manner of innovating in communication and social awareness that has been very successful during the different presentations. The team would like to develop them further and making them as part of our character. The main objective for us, given we are working with disasters that affect many human lives and therefore they required much humanitarian attention, is to try to reach and sensitise a big audience of catastrophes and how we could help to think of sustainable way to deal with them.

These catastrophes affect much social-economic vulnerable people, therefore, for us it seem incoherent to have a enormous display of resources to create awareness of such terrible situations.

Then we have work on activities that relies on more close to audience approach media, instead of relying on the typical highly technological and expensive way of creating social awareness, in other worse we have use many techniques from the drama and acting field, where the members of the team show Casa FENIX utilising their histrionic aspects; voice, faces, body. In fact for the SDE second workshop in Paris, our team was the only team that did not use a power point presentation, it was the team itself that tried to personalised Casa FENIX ideas and objectives, this help the SDE organisation to define next SPR requirements and gave other team fresh ideas for communicating their project in more effective, creative and non-typical manner.

**SECOND SDE 2014’S WORKSHOP IN PARIS [20-11-2013]**

Our team presented the project in an unconventional way, including a performance of all team members, for what it captured the attention of the peer attendants being very well acclaimed. For the second SPR by streaming our team wanted to make a statement in regard to rely on low-tech, simple and creative presentation, again the team did not want to rely in a power point presentation that will be so dependent on technology. Our challenge too was how to present Casa FENIX progress in a short period of time, to be able to be precise and concise, yet having a clear message that was able to show the most essential aspect of Casa FENIX.

**SECOND SPEED PEER REVIEW BOOTCAMP [03-04-2014]**

This was an event hosted by the SDE organizers as an innovative way to present and review what all the teams were doing. The Casa FENIX presentation took the same unconventional form as in workshop #2: a low-tech approach using signs, puppets and an unexpected ending. The message behind the presentation was as proposed in the Communication Plan, to show the consequences of a disaster and Casa FENIX solution.

Team Casa FENIX would like to humanised the project as much as possible, would like to bring a reality that sometimes is very far to others, and yet very common to certain parts of the world, where housing is a common problem to all societies as well as the energy issues that affect our planet.
5.5.5 INNOVATION IN URBAN DESIGN, TRANSPORTATION AND AFFORDABILITY

In the time since the last deliverable was made, an earthquake measuring 8.2 on the Richter Scale hit northern Chile, leaving 850 families homeless and damaging a further 3,000 homes. Then, in April 2014, a major wildfire broke out in the city of Valparaíso completely destroying almost 3,000 homes.

Following the earthquake, Chile’s urban design strategy has led to football fields in Iquique and Alto Hospicio in northern Chile being converted into emergency relief centres. In Valparaíso, schools are also being used as refuges.

In anticipation of the next catastrophe, Chilean cities are pushing for the design of new emergency urban layouts and relief centres. Transport and key infrastructure in the areas around emergency centres provide much resilience to victims, helping the negative psychological process individual suffer after these catastrophes.

The main objective of the FENIX Eco Village is to be the first sustainable neighbourhood designed for those sectors of the Chilean population who live in vulnerable circumstances.

We see the opportunity for innovation in making a step change from the current concept of post disaster aid, in which short-term, poorly made wooden shelters, called mediaguas, are provided to those made homeless.

Our Survival module costs twice as much as a mediaguas, but it provides excellent thermal comfort and, most important of all, it is not disposable, but actually the first piece of a definitive modular home. Its energy performance is a vast improvement on that of a mediaguas, as Casa FENIX’s heating demand is 6kWh/m²/year, compared to the 80kWh/m²/year of the solution currently deployed in Valparaiso and elsewhere following a disaster.

Government subsidies mean that people would only need to pay 20% of the cost, so a large proportion of the low-income population would be able to access the Casa FENIX.

In Valparaíso’s weather conditions, the occupants would rarely need to use the heating, therefore leading to significant savings with regard to heating. Solar energy will provide 80% of the houses hot water [DHW] needs and the PV system is expected to generate a positive electric energy balance, so the payback for the PV system is 9 years without government subsides, which has not been spread in Chile yet, therefore for this region it is very innovative, despite these application have many year in developed nations.

The concept of a sustainable Village is to adapt to the logic of self-construction, in other words, where families are actively involved in the definition and design of the final product, as they are the ones who decide how to arrange and connect the different modules and there are few technical constraints.

This participation in the final phases of the design of their own home gives it an added value which will be greatly appreciated by the families in vulnerable circumstances.
One of the most outstanding geographical features of Chile is the relatively constant threat of earthquakes, among other natural disasters, such as volcano eruptions, landslides and fires in urban areas. The regularity with which these events occur does not make them any less catastrophic for people. Many homes are lost and the people who are most affected are low-income families. The post-catastrophe situation throughout the year has indeed been non-sustainable, therefore to develop and implement the concept of sustainable reconstruction is a big challenge for our country, where Casa FENIX ambition is to propose and offer a tangible solution.

**THE PROBLEM** While Chile is a political and geographical location where natural disasters are recurrent and affect a great part of the most socially vulnerable population, there are no official policies which outline a quality response to such events.

“When disaster strikes, the problems are resolved with quick, cheap, short-term solutions, such as the mediagua emergency houses”

which end up causing more problems than they solve and lead to a great deal of waste in the long term.

**HYPOTHESIS** Casa FENIX is a design process that responds to a catastrophe, delivering energy efficient strategies to ensure quality of life as a key factor in a sustainable reconstruction; these strategies are not currently considered in post-catastrophe national policy. Sustainability factors include locally specific environmental, cultural and geographical issues, and also consider accessible and viable solutions for the most vulnerable sector of Chilean society. Therefore, the original objective behind this proposal is:

“to create emergency dwellings that offer quick, good quality and sustainable homes for the families who are the victims of a disaster.”

Thus the architectural and urban concepts that shape the proposal at both individual and collective levels are: Modularity, progressivity, flexibility and affordability.
Modularity
Casa FENIX evolves from a basic Survival Module to a complex Eco Village/Housing Complex. This process covers the stage of Emergency, Relief and Reconstruction.

Progressivity
Casa FENIX progression allows the Survival Module unit to become a final home. This incremental and evolving logis is assumed by the urban design strategy.

Flexibility
Casa FENIX has the capability to adapt to different latitudes and climates, given the geographical characteristics and diversity of climates Chile possesses, from north to south.

Affordability
Casa FENIX is an affordable home. Each unit may be acquired through the progressive subsidy addressing the total cost of the home.

ARCHITECTURAL PROGRAMME
For the SDE competition, the Casa FENIX Team proposes to bring a house that represents reconstruction as a growth progression and is configured to perform well in the Versailles climate. The basic structure and its components will subsequently be configured to meet the solar passive design strategy for the specific local climate where it is to be installed.

The programme represents the core concept of Casa FENIX, which takes a progressive approach to Emergency, Relief and Reconstruction, with sustainability in mind. It uses a passive solar design driven by a sunspace, which acts as the energy engine of the completed house and is a key spatial element which allows the articulation of the different modules.

Casa FENIX is a modular design in which each 11 m$^2$ module can be progressively attached and easily assembled during a post-disaster period, to form a dwelling measuring 60m$^2$.

The modules are as follows:
**Survival Module**
This is the quick initial response for the emergency period, immediately after a catastrophe strikes. Its main objective is to provide shelter, safety and a quality solution to the affected family.

**Mechanical Module**
This is the first module to be attached to the Survival Module as a progression during the relief period. It consists of the services and a technical core. It includes a bathroom and kitchen.

**Living Module**
This is the module that enables the house to expand and cover more than the basic needs during the reconstruction period, transforming the sum of modules into a definitive home.

**Sunspace**
The passive solar design strategy enables the regulation of the indoor climate by articulating the different modules with the exterior climate; this space grows with the addition of each module.

At a collective level, the group of emergency houses, which the FENIX team has called “Temporary Village FENIX, TVF” and the progression to a housing complex, which the FENIX team has called “Eco-Village FENIX, EVF” are conceived following the same logic. They have an open and flexible design that allows for the adaptation of modules and means that Casa FENIX can be adapted to different climatic, topographical, territorial and cultural realities.

**THE GEOGRAPHICAL DIMENSION**
Chile has 9 different climate types and the country stretches from latitude 18°S to 50°S. 90% of the population is located in areas where solar radiation is over 1000kWh/year. To address this climatic diversity and take advantage of the opportunity for solar radiation, the conceptual idea for

“Casa FENIX is similar to a skeleton or basic structure, an innovative structural design developed by students, where different components can be configured and assembled according to the users’ demands”
All the components to be attached to it respond to the demands for the different latitudes and to patterns of self-construction.

**SUSTAINABILITY FOR US** It is important to mention that the understanding of sustainability in the case of developing nations differs much from the one used in developed nations, in the sense that the problems that needs to be addressed are much different, respect of priorities and urgencies. For the Chilean case the deterioration produced by natural disasters and the anthropic urban degradation produced by informal settlements and poverty are the immediate problems to solve in a sustainable way. To teach the general public about sustainability issues that go beyond recycling, energy efficiency and achieving a low carbon footprint, Casa FENIX proposes to focus mainly on local cultural aspects, quality of life and social relationships. In this case the sustainability aspects are focused on using technology and urban planning to enhance the intuitive know-how of a particular local population.

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5.6.1 GENERAL CONCEPTS OF THE PROJECT AND SUSTAINABILITY

The challenge of the project is to build a dwelling with design and construction strategies that significantly reduce or eliminate the negative impact of the buildings on the environment and that protect people’s health and wellbeing. The team understands that the term sustainability deals with the ability to maintain environmental, economical, and social systems over time.

Casa FENIX is committed to developing a Sustainable Re-Built Environment after a catastrophe, addressing these three aspects throughout the development process. The Casa FENIX environmental benefits derive from the reduced impact of the building’s construction on the air, water, landfill, and non-renewable energy resources, as well as the reduction of CO2 emissions related to transportation and raw material extraction.

The economic benefits come from reduced operating costs [energy efficiency], affordability [low-cost housing] and accessibility [reduced transportation costs], minimizing the strain on local infrastructure. The social benefits come to improve health and comfort in buildings, promote local culture and enhance wellbeing.

Casa FENIX is born from necessity, to aid people who have suffered great material losses under unexpected circumstances. As such, the house is basic and responsive to the emergency in every sense, from its structural system to its operation. It aims to quickly and simply supply a shelter and minimum comfort.

In Chile, it is typically lower income families, living in circumstances ranging from typical social housing to extreme poverty in squatter settlements, who are most affected by natural disasters and wildfires. There are two main aspects to this:

1. First, these dwellings are basic, without luxuries, but in most extreme cases self-construction and improvisation apply, with savings made in the costs of construction materials wherever possible, which means that inappropriate materials are used. This can compromise the integrity of the structure, making such homes even more vulnerable to the harsh climatic conditions, fires, earthquakes and other disasters.

2. Secondly, these dwellings are often located in areas where the per-square-metre cost of land is lower, and this may be due to unfavourable geographical circumstances, for instance because the land is susceptible to floods or the rapid spread of wild or provoked fires and/or has poor accessibility, etc. Other characteristics are the higher density of occupation [where more than one family live under the same roof], and the lower level of urbanization [sometimes affecting the regular supply of drinking water and electricity].

As a target user, these families generally have very low expectations, and feel comfortable under a very wide range of circumstances. Their homes will never include HVAC systems, except for some small local heating appliance. These users are extremely careful about expense; so they will actively work towards reducing all kinds of maintenance and energy costs.
The project is successful as long as it is an affordable option for this target user, and takes into account the local geographical and cultural circumstances, which vary considerably across Chile.

In recent decades, the Chilean State has implemented several funds allocated to providing different levels of basic housing, depending on families’ income. The profile of the applicants for these programs is clear and includes families who have some capacity for savings but are not eligible for financial loans from standard banking institutions. These funds have slowly helped improve living conditions for this sector of the Chilean population. However, there has been a lack of real development with regard to the actual dwellings being built or purchased, so there is ample room for improvement and better use of resources. The government has only very recently launched a new multi-ministry program called “Construcción Sustentable”, which includes sustainability, health, and educational issues for social housing.

Thus, the superior goals related to climate change, such as energy conservation and decarbonisation are to be addresses by the whole world, but probably our immediate and urgent local problems comes before than those, acknowledging the differences in CO2 emission production and energy consumption by the different nations of the world.

5.6.2 URBAN DESIGN, TRANSPORTATION AND AFFORDABILITY

The urban design strategy is progressive and evolutionary. This means that the development of the Village has different stages. First, and in order to respond quickly to natural disasters, the Survival Module [SM] will be installed on football fields, setting up the Temporary Village FENIX [TVF]. Then, after the survival period, families will be relocated to definitive sites to start the reconstruction process. The SM will be relocated to the site and the other two modules of the dwelling will be assembled on site [Mechanical and Living Modules – MM, LM], developing the Eco-Village FENIX [EVF].

In Chile, football fields are socially significant places, and are scattered all over the country and in different neighbourhoods. For instance, following the earthquake in northern Chile in April, football fields in Iquique have been set up as a temporary health care facility and to house families in tents. Following the fire in Valparaiso, people were given refuge in schools, because of the dust and ash in the atmosphere,

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1 MINVU, 2013, Chilean Ministry of Housing
affecting nearby football fields. Therefore the urban strategy of siting post-catastrophe villages on an existing field near to the disaster area remains possible in some cases. This has the advantage of cushioning the post-catastrophe trauma and makes it easier for families to reunite with their social networks, their daily routes and movement patterns. In the hills of Valparaíso, these fields are the only flat areas available and have direct access to the urban services [drinking water, electricity and sewerage]. They are also well connected to the urban transport system, facilitating people’s mobility as well as the transportation of construction equipment and materials. The advantages of building the TVF in the football fields are: easy urban mobility for families between the catastrophe area and the village; easy urban mobility between the village and the city [connectivity]; maintenance of the urban and social networks of the affected families. Thus, the neighbourhood’s football fields become interconnected strategic locations, allowing affected families to remain within their neighbourhood realm and not alter their regular paths and movements.

As explained in Rule 39, the mobility strategy addresses two types of mobility: urban and residential for all the post-catastrophe stages: the emergency phase with the Temporary Village FENIX, as well as the second and third phases, relief and reconstruction with the Permanent Village FENIX [Eco-Villa FENIX, EVF].

During the post-disaster stage, free public transport is mandatory. Residential mobility basically focuses on users when they move house, while urban mobility refers to the journeys a person undertakes to go about their daily activities [work, school, shopping, entertainment, etc.].

5.6.3 BIOCLIMATIC STRATEGIES: PASIVE DESIGN STRATEGY

Considering the needs of the prime target for Casa FENIX, which have been mentioned above, Casa FENIX needs to be a basic, low-tech home, where passive strategies can be easily controlled by the occupants, at no extra cost, reducing the need for maintenance to a minimum. If heating were needed, the house would need to optimize the use of whichever system is applicable depending on the local climatic and cultural circumstances. Even better, in order to improve the quality of life of the occupants, energy consumption should be reduced as much as possible, enabling savings, freeing up the limited household budget for other expenses.

In this scenario, our aim is not necessarily technological innovation, but an innovative response to catastrophe, which is able to adapt to very different locations.

The first version of Casa FENIX has been designed specifically for the city of Valparaiso. Therefore the geographical and cultural factors...
have defined which strategies are most viable for this particular location.

Valparaiso is a coastal city in central Chile, with very unique features, summarized as follows:

**The Bay of Valparaíso faces north**

[Figure 175]

Valparaiso is a favoured and protected bay; it faces the Pacific Ocean and is oriented towards the north, which means the city is protected from excessive and predominant wind exposure. More than 50 hills rise up from the flat central area in a steep amphitheatre shape and this means that the city’s residential areas are mostly located on steep slopes. This gives them the advantages of great ocean views and good sun exposure to the north, which naturally favours solar gain strategies.

**Climate**

Valparaiso has a very mild climate—which can be considered Mediterranean [Koppen csb]-due to its coastal condition [which reduces the occurrence of extreme temperatures], and the amphitheatre shape of its hills, which protect it from the predominant south-west winds. Temperatures range from 10°C to 28°C in summer, and between 5°C and 20°C in winter, with very little diurnal variation. Relative humidity is consistently above 60% and although it can sometimes be foggy, solar radiation is also very consistent and can be relied on for passive strategies all year round. Occasionally during the winter, bad weather fronts will fall on the city from the north, causing very heavy rains and tidal swells.

**Vernacular and Immigrant Architecture**

The city’s architecture is a mixture of the vernacular, planned and imported architecture. A very strong European influence can be appreciated, as the city hosted many immigrant colonies due to its major importance as an international port during the 1800s. Regardless of the architectural style or level of spontaneity, a constant feature is the use of solar spaces.

These sunspaces are intermediate spaces, which can be linked to the interior spaces or not, and are used on a seasonal basis. The sunspace can work as extensions of the living spaces in the dwelling. They can also have more utilitarian uses, and be used to hang laundry to dry, etc.

Unfortunately, a great part of current planned architecture,
residential developments in particular, disregards the richness and subtlety of the way in which the city has grown, replacing it instead with very standard, apathetic volumes.

All of the above are important issues that make up the cultural and everyday aspects of life in Valparaiso, which was given the status of a “world heritage site” by UNESCO in 2003.

While it may not be particularly innovative in technological terms, the use of a sunspace reveals an important social aspect of the city, given the profile of smaller streets conformed by sunspaces as glassed balconies, a repeated feature of the city layout on hills. The sunspace then, is an intermediate area between the public and private space. The sunspaces give depth to the façades in areas where open spaces, such as yards or gardens are scarce because of the topography, so residents take their social interactions to the façade level. Moreover, the thick façade works as an environmental engine, providing heat or ventilation when needed.

**Casa FENIX Local Structure**

*The skin as a measure of adaptability in different contexts.*

While the affordable wooden structure and building process remain relatively stable [please refer to sections Structural Design, and Constructive Design], the skin and general formation of the house adapt to the local circumstances at an affordable price. The geometry of the different parts of the house changes subtly depending on the available feasible passive strategies, while the skin remains as “clip on panels”, which are hung from the structural skeleton in order to be easily assembled on site [Figure 176].

Pre-configured panel joints allow cladding panels to be mounted on to each other and to be fixed to the structure by two people. With this in mind, the team has worked on making the panels as light as possible, for ease of handling.

The floor panels are installed first and fixed to the lower beam of the skeleton. The walls panels are assembled on top. Each wall panel is joined to the next and fixed to the floor with an L-shaped connector. The wall perimeter and partition are assembled in the same way.

Finally the roof panels are mounted over the roof beams.
The building envelope is configured by panels, which are defined as floor, wall [including glazing] and roof panels, and the Table 178 shows the composition for Valparaiso

• Glazing

The glazing specification is a double panel which is air filled and has a thermal transmittance of 1.5W/m²C. for all windows. North facing sunspace windows are protected with exterior shading using roller blinds with high reflectivity [Table 178].

In winter solar gains are allowed to warm the house using the greenhouse effect, through a classic solar passive strategy.

The window frames are of PVC to keep the cost down.

• Daylight

Casa FENIX was originally conceived in the context of Valparaiso, Chile [33°S, 71°O]. According to the CIE Standard, the outdoor illuminance [Ei] is calculated under an overcast Sky for 21 September at 12:00pm [Northern hemisphere]. As illumination levels vary depending on the location, lux levels in the outdoor environment for Valparaiso, Chile are considered as follows.

Ei Ground Ambient for studied location: 14564 lux

The house is designed as a rectangular shaped volume oriented to gain direct sun radiation from north to the Chilean prototype and south for the French replica. The location of the windows has been designed to provide good levels of ventilation, solar gain, as well as a view of the surrounding area. All the surfaces are painted in white, so as to take advantage of the reflective properties of light and bright colours. The window’s sill working surface work as a table or kitchen counter in the Surviving Module has been kept at at a height of 0.85mt. offering the possibility for the other windows as well in case users would like to adapt sills for this.

As calculation criteria, the average DF should be no less than 4% for the living area. This criterion has been fixed by the Solar Decathlon competition.

Table 178: U-Value of each part of the envelope

<table>
<thead>
<tr>
<th>Element</th>
<th>Detail [From exterior to interior]</th>
<th>U-Value [W/m²K]</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXTERNAL WALLS</td>
<td>10mm Fibrecemnt + 90mm Mineral wool 120kg/m³ + 15mm OSB</td>
<td>0.36</td>
</tr>
<tr>
<td>PARTITIONS</td>
<td>25mm Plasterboard + 100mm Glass Fibre Quilt + 25mm Plasterboard</td>
<td>0.32</td>
</tr>
<tr>
<td>MASS PARTITION</td>
<td>100mm Limestone Estra Hard 2600kg/m³ [c= 2.3W/m²K]</td>
<td>3.29</td>
</tr>
<tr>
<td>ROOF</td>
<td>10mm Fibrecemnt + 160mm Glass Wool 12Kg/m³ + 12.5mm Plasterboard</td>
<td>0.24</td>
</tr>
<tr>
<td>FLOOR</td>
<td>10mm Fibrecemnt + 120mm Glass Wool 12Kg/m³ + 12.5mm Plasterboard</td>
<td>0.3</td>
</tr>
<tr>
<td>OPPENINGS</td>
<td>AGC Planibel Low-e Top NT on Clear 4mm</td>
<td>1.5</td>
</tr>
</tbody>
</table>

Figure 177: Daylight factor model
Also glare control is provided by the exterior blinds in summer time [Figure 177].

**Space planning**

In terms of design flexibility and adaptation, the Sunspace is a flexible space conceived of as a motherboard, to which the modules are attached. The purpose is to generate and drive the passive energy and natural ventilation and to provide shade and solar protection.

For example, the sunspace can be a porch gallery in Mediterranean Climates [such as the central valley of Santiago] or a shaded and ventilated space in a subtropical climate [for instance the northern coastal desert climate of Iquique], or a sunspace of greater height for the Valparaiso climate.

The geometry of Casa FENIX should adapt to the topography by stacking and overlapping volumes, it also requires to secure the air movement through volumes [Figure 180].

The skin will also change according to the climatic conditions. Northernmost locations will demand thicker, ventilated roofs. Central Chile will need better walls, while southern locations need an envelope which has all-round lower transmittance.

The modular design makes this a flexible space where a growth strategy can be planned over time.

The bedroom and living space are attached to a half module, which becomes a hallway and/or a sunspace.

The thermal strategy for Valparaiso is for the house to be attached to a north-facing glazed space in order to share the benefits of passive solar gains and cross ventilation strategies.

Modular spaces also allow the house to adapt to the topography, which favours solar-oriented spaces for solar gain, as well as ventilation and natural light access and control.

**Passive heating strategies and passive cooling strategies**

The physical and geometrical configuration of the house are defined according to the geographical location, and aim to serve the feasible passive strategies available, which will change depending on the geography. As discussed before, the Casa FENIX for Valparaiso will be better served by solar passive and natural ventilation strategies, served mainly by the sunspace.

In the case of Valparaiso, the sunspace’s main features perform with regards to:

- Solar control,
- Solar gain optimization,
- Heat source for living spaces,
- Reduction of radiation losses during winter nights,
- Buoyancy driven stack as a ventilation engine.
Sunspace as a thermal engine

In order to work as a thermal engine, the sunspace supposes a different configuration for different climatic instances in the same location.

For solar control, high reflectance, low transmittance blinds are to be rolled down on the exterior of the sunspace glazing, whenever radiation becomes too intense, [more than 120W/m²], particularly during the summer months from October to April.

The specifications of the blinds are:

- Conductivity 0.1
- Solar Transmittance 0.1
- Solar Reflection 0.8

In terms of solar gain optimization, controlled passive solar gains are the key strategy for thermal comfort. The sunspace faces north in order to achieve a greenhouse effect and transfer the heat to the modules attached to it. The exterior blinds would have to be rolled up to allow solar gains during the daytime in the colder seasons. To reduce heat losses during winter nights, the blinds should be rolled down so that the heat collected during the day will be radiated into the house.

The building envelope is insulated to maintain thermal conditions within the living spaces. The envelope uses local materials and distributors. Additionally, a partition containing high water thermal mass material acts as storage and a buffer between modules and the sunspace at the solar gallery [Figure 181].

Thermal Mass Applicability [low cost energy storage]

It has been mentioned that our target users are used to having few comforts but they will occasionally resort to small local heating appliances, such as electric heaters, gas heaters, wooden stoves, etc. On the contrary, cooling devices will hardly be used. It is therefore appropriate to cool down the house as much as possible. The air tightness and solar gain strategies mean that overheating might still occur, particularly in summer and mid-season. While local context studies do not particularly recommend the use of thermal mass in locations where there are no marked daily temperature variations, its controlled application might help reduce overheating peaks which cannot be managed by solar control. Coolness can then be ensured.

The thermal mass wall is being studied to analyse its influence to reduce overheating of the sunspace, the experimental results have shown that the...
overheating is reduced in 75% using night cooling ventilation strategies.

The current design for the thermal mass wall is to use bottled water stored on shelves [Figure 181]. This means that used PET bottles can be recycled. It also allows natural light to penetrate through the wall.

**Natural Ventilation**

Natural Ventilation is being addressed as a controllable mechanism for transferring heat transfer and generating coolness, using different openings in the sunspace and the living spaces, as well as the previously mentioned insulation provided by the thermal mass partition.

In terms of the engine for ventilation, the sunspace draws fresh air from the living spaces, via appropriately positions openings at low levels [see the chapter 5.4.2, section Natural Ventilation Study] and ejecting it at the top.

As shown in the Natural Ventilation Study, this stack effect occurs because of the difference in density that is generated by the temperature difference [temperature gradient] between two air masses. This is produced when the Sunspace is heated and, thanks to openings designed in both, a lower level for the air inlet and a higher level for the air outlet, will generate air flows that will help the expulsion of hot air and the entry of an intake of fresh air from outside.

This air flow is also aided by wind pressure. The prevailing winds from the south-west are reduced by the protection offered by the Bay of Valparaiso and at worse provide a constant breeze. In winter, the ventilation strategy is aimed at generating air changes and during summer, it seeks to allow the entry of fresh air into the house.

The stack height and the opening sizes for Valparaiso have been defined to ensure the desired rate of air changes per hour. These rates have been established with the development of thermal simulations, discussed in the Energy Efficiency Narrative

**Hybrid or semi-passive systems**

For the local context there is not semi-passive system at the moment.

**Exterior design**

The main objective of these components is to create a pedestrian circuit between the homes. This has a dual role; first it is the public space providing connectivity to the Eco Village FENIX, and second, it acts as buffer spaces between the homes, with a firewall like effect [Figure 182].

**Networks of public spaces**

- **Cornise Avenue:** Public promenade crowning the hillside edge of El Vergel, leaving some space between the housing and the street, where fire hydrants and solar panels will be located to supply power for public lighting for the whole Eco Village FENIX [Figure 182].

- **Adjacent Terraces:** taking advantage of the natural slope, three longitudinal terraces allow the staggered location of each Casa FENIX unit. These terraces are accessible from the transversal platforms. They are built close to the hillside elevator of Eco Village FENIX [Figure 182].

- **Transversal Platforms:** This is basically a network of public stairways that adapt to the natural
hill slopes and divide platforms into several longitudinal sections, creating a transversal buffer space that will act as a firebreak in the event of fire. The platforms are sectioned Eco Village FENIX into various zones to enable fires to be slowed or brake and material losses to be reduced [Figure 182].

- **Public Balconies:** Viewpoints or ‘miradores’ that are positioned on the top of the platforms facing towards the creek [Figure 183].

**Firebreak and rainwater harvesting systems**

- **Plinth:** Continuous plinth system along each longitudinal platforms. These have a dual function, provide the required retaining wall to position Casa FENIX and function as firewalls in case of fire [Figure 182].

- **Rainwater Channelling and Harvesting:** The rainwater harvesting system from the roofs of the Casa FENIX homes uses prefabricated elements along plinths to allow the irrigation of the kitchen gardens of the Eco Village FENIX.
Architectural elements enabling Casa FENIX to adapt to the steep topography

- **Pillars:** These allow Casa FENIX to adapt to the rugged topography of Valparaiso [Figure 184].

- **Plinth:** These allow Casa FENIX to adapt to the abrupt topography of Valparaiso and retain the longitudinal terraces that define the channelling of rainwater [Figure 182].

- **Patio-terraces:** These allow the creation of otherwise non-existent flat ground, used as outdoor extensions for Casa FENIX [Figure 184].

- **Patio-gardens:** These allows the creation of a green and moist soil under Casa FENIX while supplying vegetables and crops to the families [Figure 184].

- **Patio-balconies:** These allows Casa FENIX to connect with the surrounding environment, neighbourhood and the city [Figure 184].
5.6.4 CONSTRUCTION SYSTEM

Casa FENIX has established a concept based on a progressive modular design, which can be flexible in terms of construction over time. During the emergency stage, it is very important that the homes can be built quickly by volunteers following a simple design and a written manual. It is also important that the homes can be easily transported to the disaster region in a package.

Casa FENIX was conceived as a primary structure with components and the design was conceived in two different scales.

The first is a spatial scale, where the first part to be built is the Survival module. Then the Mechanical and finally the Living modules are attached as components added to the Sunspace [Figure 186].

The second scale is the “material scale”, where the different skins are attached enabling the house to adapt to diverse climatic conditions [Figure 187].

The house has been designed with industrialization in mind to keep costs low at first, but at the same time, it presents an opportunity to control energy use in the construction of components. Therefore construction is more than a mere on-site assembly process. The benefits of industrialisation with regard to these issues have not yet been calculated.

Flexibility is an important feature of the construction system, which can be assembled quickly in a post-disaster scenario and later, grow progressively into a definitive home during a reconstruction period.

The panels that conformed envelope components of Casa FENIX are capable of being installed and fixed completely from the exterior of the house to the lightweight wooden structure, obtaining a homogeneous skin, thereby minimizing thermal bridges.

Wood is in plentiful supply in Chile, where there are sustainable forests, so it is therefore a local sustainable material.
5.6.5 MATERIALS

• Green materials

The Casa FENIX prototype manufactured in Chile proposes local materials, mainly wood, to keep its carbon footprint low, ensure low embodied energy, low grey energy for transport, and lastly because Chile has a substantial timber industry. However no data for embodied energy is available for the timber industry in Chile.

Industrialization for the production of the modules is an important issue, allowing efficiency of construction, reducing waste, enhancing the quality and management of energy during the process.

The waste and water used during the assembly of the module onsite are very low when a modular system and lightweight material such as wood is used.

Recyclable materials are used in the building envelope, where layers of insulation are made from mineral wool, which contains 80% recycled slag from the Chilean copper industry [data from the producer and FENIX Sponsor VOLCAN Industry]. Layers of fiber cement boards contain Chilean cellulose fibre from the timber industry and locally produced cement. Gypsum board is also a locally produced material.

The envelope panelling will also be made using an industrialized system, providing the same benefits as previously mentioned. It is mainly the wood structure, which is expected to be recyclable after the end of lifecycle of the house, recyclable materials are not yet a concern in the Chilean construction industry, therefore this could establish a trend in for the industry.

The finishing material for interior walls and surface proposed for Casa FENIX is wood, and a new material called Vestoparticle boards that include copper nanoparticles because of their antimicrobial features.

Moreover, the interior thermal mass wall can be built mainly using recyclable materials, who a natural disaster left behind as a waste. This mass materials could be stones, broken bricks, sand, remains of adobe, or even use recyclable bottles fills out with water.

• Incorporated energy

This is a difficult task, since in Chile no research has yet been carried out into the embodied energy of construction materials.

• Incorporated CO2

In Chile no research has yet been carried out into the CO2 emissions of any construction material.

• Maintenance plan

The maintenance plan shall include:

- Painting for the outer wall surface once every 4 years.
- Wooden structure with bolts and nuts which need to be periodically checked for possible losses.
- Control of damp inside the living space in winter
5.6.6 ACTIVE SYSTEMS AND EQUIPMENT

In the local context, the target user families rely on few appliances and do not have a central HVAC system. However, the good weather conditions mean that people are comfortable even with low energy use. Usually local appliances use electricity and gas as the main sources of energy.

Casa FENIX has been designed to meet the basic needs and support systems of low-income families through a government program by using Solar Thermal and PV Systems.

The electrical appliances are a washing machine, microwave, iron, radio, TV set, DVD and fridge-freezer. The only appliance to have been received Chilean government energy efficiency labelling is the fridge-freezer.

The usual lighting fixtures are incandescent light bulbs and CLF light bulbs.

The Casa FENIX prototype includes energy efficient lighting fixtures using LEDs because of their low energy demand, low power and the long lifetime of the lighting appliances.

The gas appliances include a stove with an integrated oven, 4kW portable gas heater and a 10 litre instant gas boiler. All these appliances use LP gas balloon containers, which are delivered locally.

Gas appliance efficiency is not yet regulated in Chile, therefore they are not sustainable at all. Finally, the main goal for the team is to reduce as much as possible this low efficiency equipment, relying on a home designed to have a low energy demand.

5.6.7 SOLAR SYSTEM

Solar systems are highly recommended for the local context given that Chile imports 90% of its fossil fuels and 60% of the electricity matrix depends on these fossil fuels.

Renewable primary energy is a big issue because of the environmental impact of CO2 emissions and also because adverse public opinion has let some large-scale hydro-electric power plants and long transmission lines being banned, because of the environmental impact on virgin forest locations.

Locally produced renewable energy has now made it onto the political agenda and financial aid for solar thermal systems has been a success. In a few months’ time, the new Net Metering law will allow people with solar PV systems to sell energy to the grid. Making the ECO Village energy efficient and energy independent is at the core of Team Casa FENIX’s concept regarding sustainability.

The solar thermal system can cover almost 60% of of a single home’s DHW production, thanks to the high solar radiation on site [1.416kWh/year].
Our proposal is for a PV solar System based on both individual and collective systems for the Eco Village FENIX [EVF], allowing families to pay for the investment through other complementary subsidies or financial aid [Figure 188].

- **Energy recovery time**

  **Solar thermal investment recovery time**

  The Domestic Hot Water [DHW] solar fraction is 60.9%.

  The cost of the system € 883. [Thermosyphon]. A total of €168 will be saved per year in LP gas.

  The payback period is 7 years. The saving in terms of CO2 emissions is 0.47 ton per year.

  The size of the installed power of the PV system is 3.75kWp. Annual energy production is 4592kWh.

  The annual positive electricity balance is 3872kWh, equivalent to €603.

  The system cost amounts to €6185, with a payback period of 8 years. Each year, 3.6 tons of CO2 emissions are avoided.

- **CO2 emissions**

  The fact that this type of equipment needs to be imported from the northern Hemisphere, especially Asia means that the carbon footprint for transport is very high, something which no serious research association has calculated.

  Some data regarding embodied energy can be found for just a few manufacturers but this is not the case of our sponsored equipment.

- **Accessibility**

  The Solar panels occupy almost the whole surface of the sunspace roof, except at the west end of the roof, where a thermal solar collector is placed.

  Easy access to the roof is allowed from the north façade for the Valparaiso Prototype [south for the Versailles replica].

- **Solar Thermal maintenance operations:**

  - Regular washing of the solar collector, which is easy to reach with a ladder,
  - Regular checking of the physical integrity of the solar collector and temperature probes,
  - Checking that the different valves are working properly,
  - Checking that the security valve is working properly [every month],
  - Checking that the thermostatic temperature limiting valve is working properly [every month],
  - Checking the anode integrity by taking intensity measurements between the anode and the

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2 Data from TSol Expert Software package

3 Data from PVsol Expert Software package
ground line [must remain lower than 30 mA]. Visual checking if necessary [each year],
- Checking the primary loop fluid properties: the PH and temperature protection level with a refractometer [each year],
- Regular collecting the accumulated functioning time of the solar pump, from PS100.

- Solar PV maintenance operations.

PV modules

PV systems require little maintenance. It is recommended that the status of the modules be checked at least once every six months. However, if the system output drops at any time during sunlight hours, a check should be performed to remove any dust, leaves or other dirt from the modules. The amount of dirt accumulated periodically depends on the location of the house and the roof angle. Rain also helps to keep the modules cleaner.

To clean the modules, the person performing the maintenance can simply use a ladder and climb safely up onto the roof. Once there, can use water and a non-abrasive detergent to wash them.

Inverter

The inverter should be checked every three months for any visual signs of external damage. The status indicators can also be cleaned with a cloth. Corrosive substances should not be used for cleaning. In case of the inverter shutdown, the module branch belonging to the inverter should be checked and cleaned to remove shadowing and the inverter should be reset.

Wiring and protection

An inspection should be made every six months. The inspection will check:

- The terminals, to find out whether they are loose, overheated or burned out. If any wire is burned, it should be replaced straight away.
- The wiring skin, to detect any possible defects, to be fixed with self-adhesive tape.
- Oxidation in the welding or circuits of the PV modules [caused by the entrance of humidity across the enclosures].
- The connecting pin wiring of the PV modules to check for failures in pressure.
- The connection between the other equipment, checking power values.
- The sealing of the PV modules, to replace any affected elements, avoiding future malfunctions.
- The protection equipment, including all the relays, following the instructions of the manufacturer.
- In case of any problems or concerns, the manufacturer’s datasheet should be checked for further instructions concerning the maintenance.
5.6.8 WATER

Project’s general water use, management and conservation concept

In a post catastrophe scenario, water pipes and reservoirs usually collapse during earthquakes measuring more than 7 on the Richter Scale. Following an earthquake, Chilean cities can be without water for several weeks and some for up to a month or more. For this reason, Casa FENIX water strategy is mainly focused on water saving, but also on rainwater harvesting, which is only feasible in the southern part of Chile.

Therefore, in the post catastrophe scenario, emergency villages on football field consider temporary community water reservoirs for people to use. Also, the Survival Module includes a 50-litre rainwater tank to be located below the roof eaves for water harvesting in villages in southern Chile.

In both the reconstruction and Eco Village FENIX, the urban proposal includes a Rainwater Channelling and Harvesting system based on the street profile design and roof harvesting systems.

<table>
<thead>
<tr>
<th>Source of water use</th>
<th>Result</th>
<th>Unit</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consumption of drinkable water</td>
<td>118.2</td>
<td>m3/year/building</td>
<td>88</td>
</tr>
<tr>
<td>Consumption of rainwater</td>
<td>17.8</td>
<td>m3/year/building</td>
<td>11</td>
</tr>
<tr>
<td>Consumption of grey water</td>
<td>0.0</td>
<td>m3/year/building</td>
<td>0</td>
</tr>
<tr>
<td>TOTAL</td>
<td>166.0</td>
<td>m3/year/building</td>
<td>100</td>
</tr>
</tbody>
</table>

For water reuse, it is possible to include grey water treatment filters.

**Strategies for reducing consumption**

Water saving is possible in each home through the use of water efficient taps and water saving washing machines and sanitary appliances.

**Treatment of waste water**

Waste water must go to the city’s waste water system to a large domestic water treatment plant, since the domestic treatment of waste water for reuse is not allowed for sanitary reasons. However a study will be made of an Eco Village treatment plant and this will be presented in the next deliverable.

**Grey water system**

Not allowed by sanitary law.

**Recycling, reuse**

Not allowed by sanitary law.

**Rain water use**

This consists of a rainwater harvesting system from the roofs of the Casa FENIX homes, using prefabricated elements along plinths to allow the irrigation of the kitchen gardens of the Eco Village FENIX.

**Expected final water consumption**

Average water consumption in Chile is 137 litres/person per day [Sanitary Services statistics 2010]. This means a family of four consumes 200m3 year. The expected water consumption of Casa FENIX Valparaiso is 148m3 year [based on the calculation given for SD Assessment tool Water Consumption], where rainwater only represents 11% of the yearly total [Figure 189].
**5.6.9 SOLID WASTE**

Solid domestic waste is usually separated into organic and recyclable matter in many places in Chile.

Cardboard collectors are organized to collect cardboard from every district in the cities and contribute to recycling paper in the bigger cities in Chile [Figure 190].

Casa FENIX will include a strategy for managing household solid waste.

**Construction phase assessment**

Collection and recycling centre: Provision of a site for the collection of new and recycled building materials, that could be used by families. Those materials that are not used can be recycled.

**Project use and maintenance**

Solid domestic waste will usually be separated into organic and recyclable matter in the Eco Village FENIX [Figure 191].

Recycling bins for cardboard, metal, plastic and glass will be set up in the Eco Village FENIX.

In Chilean cities, where low-income families can get by with a small income, many people earn their living from recycling materials.

The organic waste from homes will provide organic material for worm humus production and domestic compost production. These materials will be used in the village kitchen garden.
End of Life Assessment

Recent events in Chile have shown that homes often only last until the next natural disaster occurs.

The end-of-life discussion loses relevance when people’s homes are destroyed with such regularity and they have to start over again and again.

In the case of Valparaiso, fires occur almost every summer season and some families have suffered loss more than once.

Furthermore, as has been mentioned, in just two weeks, 11,000 tonnes of debris and rubble were removed from the hills of Valparaiso following the fire [Figure 192].

5.6.10 Life Cycle Analysis

This analysis is not applicable to our reality, as the software is not appropriated to the local situation. It does not offer a library of materials related to the available building materials in Chile. There is no local data yet available for LCA in Chile, currently these analysis are based on estimates that are not reliable.

When we try to use the software the results were not reliable and completely not applicable to our reality, therefore we discard them and stop forcing a bad analysis.

It is important to mention that this type of software need major adaption to be applicable beyond the developed nation boundaries.
5.7 COMMUNICATIONS PLAN

CASA FENIX
For Emergency post-Natural Impact eXtreme REMINDER

One of the most outstanding geographical features of Chile is the relatively constant threat of earthquakes, among other natural disasters, such as volcano eruptions, landslides and fires in urban areas. The regularity with which these events occur does not make them any less catastrophic for people. Many homes are lost and the people who are most affected are low-income families. The post-catastrophe situation throughout the year has indeed been non-sustainable, therefore to develop and implement the concept of sustainable reconstruction is a big challenge for our country, where Casa FENIX ambition is to propose and offer a tangible solution.

THE PROBLEM While Chile is a political and geographical location where natural disasters are recurrent and affect a great part of the most socially vulnerable population, there are no official policies which outline a quality response to such events.

“When disaster strikes, the problems are resolved with quick, cheap, short-term solutions, such as the mediagua emergency houses“

which end up causing more problems than they solve and lead to a great deal of waste in the long term.

HYPOTHESIS Casa FENIX is a design process that responds to a catastrophe, delivering energy efficient strategies to ensure quality of life as a key factor in a sustainable reconstruction; these strategies are not currently considered in post-catastrophe national policy. Sustainability factors include locally specific environmental, cultural and geographical issues, and also consider accessible and viable solutions for the most vulnerable sector of Chilean society.

Therefore, the original objective behind this proposal is:

“to create emergency dwellings that offer quick, good quality and sustainable homes for the families who are the victims of a disaster.”

Thus the architectural and urban concepts that shape the proposal at both individual and collective levels are: Modularity, progressivity, flexibility and affordability.
Modularity
Casa FENIX evolves from a basic Survival Module to a complex Eco Village/Housing Complex. This process covers the stages of Emergency, Relief and Reconstruction.

Progressivity
Casa FENIX progression allows the Survival Module unit to become a final home. This incremental and evolving logic is assumed by the urban design strategy.

Flexibility
Casa FENIX has the capability to adapt to different latitudes and climates, given the geographical characteristics and diversity of climates Chile possesses, from north to south.

Affordability
Casa FENIX is an affordable home. Each unit may be acquired through the progressive subsidy addressing the total cost of the home.

ARCHITECTURAL PROGRAMME
For the SDE competition, the Casa FENIX Team proposes to bring a house that represents reconstruction as a growth progression and is configured to perform well in the Versailles climate. The basic structure and its components will subsequently be configured to meet the solar passive design strategy for the specific local climate where it is to be installed.

The programme represents the core concept of Casa FENIX, which takes a progressive approach to Emergency, Relief and Reconstruction, with sustainability in mind. It uses a passive solar design driven by a sunspace, which acts as the energy engine of the completed house and is a key spatial element which allows the articulation of the different modules.

Casa FENIX is a modular design in which each 11 m² module can be progressively attached and easily assembled during a post-disaster period, to form a dwelling measuring 60m².

The modules are as follows:
Survival Module
This is the quick initial response for the emergency period, immediately after a catastrophe strikes. Its main objective is to provide shelter, safety and a quality solution to the affected family.

Mechanical Module
This is the first module to be attached to the Survival Module as a progression during the relief period. It consists of the services and a technical core. It includes a bathroom and kitchen.

Living Module
This is the module that enables the house to expand and cover more than the basic needs during the reconstruction period, transforming the sum of modules into a definitive home.

Sunspace
The passive solar design strategy enables the regulation of the indoor climate by articulating the different modules with the exterior climate; this space grows with the addition of each module.

At a collective level, the group of emergency houses, which the FENIX team has called “Temporary Village FENIX, TVF” and the progression to a housing complex, which the FENIX team has called “Eco-Village FENIX, EVF” are conceived following the same logic. They have an open and flexible design that allows for the adaptation of modules and means that Casa FENIX can be adapted to different climatic, topographical, territorial and cultural realities.

THE GEOGRAPHICAL DIMENSION
Chile has 9 different climate types and the country stretches from latitude 18°S to 50°S. 90% of the population is located in areas where solar radiation is over 1000kWh/year. To address this climatic diversity and take advantage of the opportunity for solar radiation, the conceptual idea for

“Casa FENIX is similar to a skeleton or basic structure, an innovative structural design developed by students, where different components can be configured and assembled according to the users’ demands”
All the components to be attached to it respond to the demands for the different latitudes and to patterns of self-construction.

**SUSTAINABILITY FOR US** It is important to mention that the understanding of sustainability in the case of developing nations differs much from the one used in developed nations, in the sense that the problems that needs to be addressed are much different, respect of priorities and urgencies. For the Chilean case the deterioration produced by natural disasters and the anthropic urban degradation produced by informal settlements and poverty are the immediate problems to solve in a sustainable way. To teach the general public about sustainability issues that go beyond recycling, energy efficiency and achieving a low carbon footprint, Casa FENIX proposes to focus mainly on local cultural aspects, quality of life and social relationships. In this case the sustainability aspects are focused on using technology and urban planning to enhance the intuitive know-how of a particular local population.

“The choice of site: Man’s physical freedom manifests itself no doubt in his ability to choose the place on earth where he wants to live”.

People act, build and adapt through self-construction to the different latitudes and geographical conditions over time using their intuitive and basic knowledge.

“Neither privations nor danger will deter man from selecting a spot [...]” to settle on (Rudofsky, 1964).

This recognition of the appropriateness of the way informal settlements and self-construction take place is basic and seen to be positive; however it is extremely precarious and unsustainable in many other
aspects and in extreme situations could produce complete devastation. This was the case in April 2014 when a wildfire ravaged Valparaíso for three days; 2,900 homes were destroyed and 14,000 people - 4% of the Valparaíso population (IMV, 2014) - were made homeless.

The reasons for the unsustainable settlements can be traced back to many issues related to post-disaster rehabilitation and poverty and a major factor is the lack of a sustainable urban code for areas of vulnerability. This sustainable urban code would need to respond in a general way to the emergency and in a particular way to the post-catastrophe situation that begins right after an emergency occurs.

Casa FENIX TEAM ORGANIZATION

Team Casa FENIX is a bi-national team composed of students and faculty members from the Universidad Técnica Federico Santa María [UTFSM], Valparaíso, Chile and from the Institute Universitaire de Technologie [IUT], Université de La Rochelle, France. In addition to all the opportunities that arise out of any international collaboration between academic institutions, team Casa FENIX seeks to respond coherently to SDE’s energy conservation objectives.

The proposal has been designed to address the circumstances and needs of Chile. However, transporting the house from Chile to France would entail a significant amount of CO2 emissions and the team has therefore set itself the goal of making a “PROTOTIPE” in Chile and a “REPLICA” in France, generating a dualism and a double challenge for our project. So, while the conceptual proposal is Chilean, the production of Casa FENIX is French.

TEAM Casa FENIX FRANCE

The French part of the team is in charge of all the practical, construction, building and technology applications of the project. One of the strengths of IUT is their research into and work with wooden structures and construction. A complete version of a replica of Casa FENIX is being built in La Rochelle and this is the version that will compete in Versailles.

The design of Casa FENIX has been developed in Chile with the participation of the students from the French team during the process. Half of Casa FENIX will constitute the prototype built and tested in Valparaíso.

TEAM Casa FENIX CHILE

The Chilean part of the team is in charge of all the theoretical, conceptual, architecture and urban design content of the project. One of the strengths of UTFSM is their research and work on bioclimatic architecture and earthquake resistant construction.
5.7.1 INTRODUCTION

In Chile, the issue of natural disasters is highly relevant, as they affect thousands of people each year. The fact that there is no immediate quality housing response for those poor families who are made homeless means that they end up living in precarious conditions for years.

The Casa FENIX proposal means that when a disaster destroys entire neighbourhoods, it presents the opportunity to regenerate new sustainable urban fabric, enables the creation of spaces for debate in Chile and it achieves the most important objective: that of ensuring that the issue falls into the hands of the people who make decisions in the area, who will study with real objectivity the best and most economically viable option, selecting that which represents a true social solution, improving the quality of life of local people.

Figure 196: Valparaíso, Chile. Abril 2014, Fire destroyed 2500 houses, leaving 11000 homeless people
5.7.2 COMUNICATIONS PROJECT

The Communication Plan seeks to maximise the visibility of the Casa FENIX For Emergency post-Natural Impact eXtreme project and the Solar Decathlon Europe 2014 competition. Its objective is to sensitize and inform the community in a creative way about the serious consequences to humans and the material damage caused by natural disasters and emergencies, as well as raise awareness of the advantages of a modular home, which is assembled in stages and provides long-term, sustainable housing for the families affected by the disaster. The goal is to reach several different segments of the public, such as children and teenagers, the general public and professionals in the areas of the built environment and sustainable technology.

Having consolidated the objectives and target audience which the project wants to reach, it is important to define a strategy to accomplish them. The main strategy of Casa FENIX is to use disasters and their consequences as a hook to sensitize people, appealing to their human side, showing the worst aspects of an emergency situation in order to reveal the best in people. When a person is confronted with a situation that their compassion comes to the fore, most of the time they either want to get involved actively or passively for changing it. Once people’s awareness has been raised, they will contribute towards the dissemination of the project and the problem it addresses.

The Plan includes a range of media products, supports and initiatives which will be deployed throughout the project development up to and beyond the exhibition. It is, in parallel, a documentary record of how the Casa FENIX is gradually transformed from concept to reality thanks to the passion, intelligence and hard work of a team of students and professors from Universidad Técnica Federico Santa María and Université de La Rochelle.

ANALYSIS OF THE SITUATION

There are two important areas to be studied in regard to the context of the competition and to the context of Chile.

The first is an internal analysis as a team and involves looking at Casa FENIX as a product to be commercialized.

The second is an external analysis, which comprises two sections: an analysis of the competition from the perspective of the Solar Decathlon and of the Chilean context; and an analysis of the general public to assess their interest in the subject. It is very important to identify the characteristics of the project and the team, in order to maximize the presence of Casa FENIX in the different media channels. The disadvantages that could weaken the dissemination of the project must also be identified. A SWOT analysis will be used to identify these issues.

Internal Analysis

Casa FENIX, the opportunity to aid the catastrophes
1. Strengths

- The fact that we are an international partnership means that we have different points of view on a wide variety of topics; this enriches the final outcome of the project and also the collaborating experience.

- By building a Prototype in Valparaíso, Chile and a Replica in France for Versailles, the carbon footprint of the project is reduced, as only the replica build in France will go to the competition avoiding the transportation over 15,000 Km.

- To have a Prototype and a Replica enables constant monitoring and feedback on performance in two different latitudes and realities.

- One of the Faculty Advisors has experience from a previous Solar Decathlon.

- The team is bringing to the table a topic, with an innovative construction system that is not normally used by Solar Decathlon teams, where natural disasters are much less frequent.

- Casa FENIX is the only South American Team in this version of the Solar Decathlon, which might attract more public attention.

2. Weaknesses

- We are a team with a relatively small number of members and this makes it more difficult to fully develop all areas.

- The language difference between the two collaborating universities can often lead to misunderstandings or difficulties in communication.

- As Chile is a developing country, many energy technologies are not widely neither applied, nor produced in Chile yet; these technologies are normally imported. This makes it more challenging to develop and study a project involving renewable energy technologies’ application.

- There is a lack of Chilean sponsors, given the characteristic

- The use of an innovative construction system for our project means that a lot of issues and details, which take a long time to resolve, and this entails delays in the planning and construction phase.

External Analysis

1. Opportunities

- There is nobody else currently developing emergency housing projects in Chile.

- The frequency with which these disasters occur in Chile.

- New policies in the government regarding sustainability issues.

- Growing interest in the project and its concept by government ministries, enterprises, professionals and general public.

- Use of a construction material that is produced nationally: wood.

2. Threats

- There are 3 other teams which are addressing natural catastrophe issues.

- The Chilean mindset is to opt for low quality, cheap solutions instead of high quality but expensive; a reluctance to think about long term benefits.

- Sustainability is not a real issue in daily life among the Chilean population.
- The wide variation in climate in Chile, which means that various types of Casa FENIX need to be developed to suit the different Climate Zones.

- The project is a double challenge, two projects in one, with sometimes extreme difference, especially in regard to budget.

In conclusion, there are really good inputs to make this project attractive to the public. The fact that Chile is a developing country might seem to be a disadvantage for the development of the project, but it is also an advantage for making people aware and creating discussion about the current situation in Chile. There are still many informal settlements or squatters in Chile, which become badly destroyed after a disaster [as the recent disaster occurred during the fire of Valparaíso on April the 12th, 2014 where 2,900 home were destroyed and 14,000 victims were left behind, 4% of the Valparaíso population'].

Besides the devastation, it also provides an opportunity for people and professionals to get involved; in this way Casa FENIX acts as a stimulus for those who are interested in the topics of sustainability and addressing disasters, and motivates them to do something about those issues, to help and contribute towards the development of Chile.

DEFINITION OF THE COMMUNICATION OBJECTIVES

As mentioned in the Abstract, the main goal of the Communication Plan is to generate awareness and discussion about the housing problem created in the wake of a destructive natural disaster. Thus realistic and better solutions can be proposed to those who make decisions about these subjects. Secondary objectives that support the principal objective are:

- To show people the advantages of the Casa FENIX project compared with the existing solutions. These include its modular construction, assembly in phases, seismic resistant design and sustainability.
- To teach people about sustainability issues over and above recycling, energy efficiency and achieving a low carbon footprint, taking account of local cultural aspects, quality of life and human relationships.
- To publicise the Solar Decathlon competition as an initiative which creates the opportunity to propose innovative ways of using passive systems in the operation of a home, to promote international cooperation and to raise awareness about current local urban problems.

IDENTIFICATION OF THE TARGET GROUPS

Focus on the general public and on some specific segments of the public. The mass media will be used to reach the general public with the most important project milestones and with the most generic and crosscutting topics. The main objective will be the general public in Chile as a whole, especially the population from areas that has been affected by disaster during the last years, currently our main target are Arica and Valparaíso regions, given the recent catastrophes.

Specific audiences [architects, engineers, students, the inhabitants of areas at risk] will be reached through publications and other niche support means. Information about the system of construction, materials, seismic resistant qualities,
use of renewable energy, the progressive modular system etc. will be provided. Detailed information about the Solar Decathlon competition will also be disseminated in this way.

The following are the principal groups that the Casa FENIX Communication Plan intends to target:

1. **Professionals and governmental authorities of the housing industry.**

   This is the main target the Communication Plan would like to reach, as this is this group that can make us achieve our most important objective; that of generating discussion and proposing better, more concrete solutions for emergency and permanent housing in Chile. So the main message for this group would be to get involved, to knock on doors and to make it happen. This group will be targeted through specialist media channels, such as Architecture and engineering publications and magazines, websites, TV programmes and trade fairs and exhibitions. [Figure 197]

2. **Children and teenagers**

   This group is the future of Chile; it is these young people who will make the decisions in the next 20-50 years, so it is really important to teach them about sustainability issues and local problems, to motivate them to get involved and to show them how they can save energy and generate less contamination in their daily life now and in the future. So the message for them is mainly more illustrative, giving examples of how they can start being sustainable, the use of wood as a sustainable construction material and showing them how disasters occur.

   The way to reach them will be mainly through exhibitions and fairs or visits to the project. There are also some TV shows that are targeted to this audience [Figure 198].

3. **University Students**

   This is most probably the group with the greatest interest in the project, as the teams in the Solar Decathlon competition are mainly students.

   This is also a really important as they will get involved in these
issues in the near future. At first it was necessary to promote the project to try to get them involved, but now the focus is more on raising awareness and motivating them to make some noise, as they are often the voice of the people. Therefore the message for them will be to show them the problem and compare the current solution to our solution. The strategy will also be to teach them how sustainability concepts are employed in the project.

The media used to reach this group is mainly the social media networks, such as Facebook, Twitter, Instagram, etc. Other media used are press appearances in the university newspapers, specialist publications and magazines and websites. [Figure 199]

4. General Public

The main objective of reaching this segment is so that they can also generate discussion, as some of them are affected by these disasters, so they are the ones we going to help if this project is realised. The message to them will concentrate on the features of Casa FENIX that make it a more attractive solution than the solution which is currently available [i.e. the mediagua houses]. The focus will therefore be on the concepts that shape the proposal; modularity, progressivity, flexibility and affordability.

To reach this group, press appearances in local and national newspapers, TV appearances and exhibitions and fairs will be used. [Figure 200]

MESSAGE

We already have a slogan that comes from the acronym of FENIX, For Emergency post-Natural Impact eXtreme, but it is also important to have a real message to transmit to the audience, a message that it is easy to relate to and easy to remember.

The main message or establishment Casa FENIX wants to transmit is the following:

“Casa FENIX is a home for emergencies”

This message is itemized by the message for each of the target group, according to the main objectives and strategy.

1. Professionals and housing authorities

As we want this segment to get involved and generate discussion about the subject. The message will be:

“Casa FENIX: Use of technology to improve the future of our community”

2. Children and teenagers

The idea is to teach them how they can be sustainable now and in the future. The message is the following:

“Casa FENIX: Do it yourself sustainably (DIY•S)”

3. University Students

This message is intended to motivate them to take action in the social networks, helping us to promote this initiative. The message is:

“Casa FENIX: Post-disaster solution for people who lost their homes”
4. General Public

As Casa FENIX is a product designed for this audience, the idea is to enlighten them about its features and how by they themselves can improve their situation. The message is:

“Casa FENIX: Customized and affordable solar emergency house”

STRATEGY

Content Strategy

The main objective of the Communication Plan is to raise awareness among the general population. To achieve this goal, the first part of the strategy is to capture people’s attention by showing them images of the consequences of natural disasters, such as earthquakes, tsunamis, fires, volcanic activity and floods. Then, once their attention has been engaged, the problem is revealed: the lack of a quality housing response to such events. We then go on to show that our solution, Casa FENIX, is a sustainable shelter that can become permanent, with its modular construction system and seismic resistant design.

Dissemination Strategy

Appearances in the local and national media are being handled by the Communication Departments of the two universities, as they have direct links with local and national press. This is the most important way of disseminate the project. The project has already been featured in prominent newspapers, such as La Tercera, El Mercurio and Las Ultimas Noticias in Chile and Le Moniteur in France, as well as on national and regional television channels in both countries, such as, Canal 13, TV Chile and CélàTV. Thanks to these features, the team has been contacted by a number of national and international magazines and websites, such as Plataforma Arquitectura and Le Bois International.

To enhance further dissemination it is advisable to start the mass dissemination through a national printed media and cascade information from that starting point. This is the most effective route for this type of information.

The team might try to partner with a relevant news medium, providing it with additional information, but without granting exclusivity. Examples in Chile could include El Mercurio or La Tercera newspapers.

Tools

1) Press releases through notes and/or reports prepared and published by national and regional news media, in written format, on television, radio or online.

2) Press releases through notes and/or reports prepared by journalists from the Universidad Técnica Federico Santa María and Université de La Rochelle communication offices in order to be distributed to media outlets that are not likely to cover the story themselves.

3) Project website

4) Social networks have a great impact, thus we are communicating most through this media.

5) Exhibitions and fairs to reach specific target groups.

6) Presentation of the project at different events.
7) Presentation of the prototype and replica houses to specific segments.

8) Use of the audiovisuals generated for the competition in different media.

9) Generation and distribution of illustrative resources, such as a project model, leaflets, posters and stickers.

Definitions by topic, technique, format or style:

1) The audiovisual materials, unless there is some clear incompatibility, include real cases of people who have suffered as a result of some disaster, briefly describing the disaster. The audiovisual materials will not be over-dramatic.

2) The printed materials will include images of disasters, with a few exceptions.

3) The website will include information about natural disasters or other events caused by irresponsible human behaviour in the Valparaíso region and in Chile.

4) The scripts and stories will show sympathy for the situation of those affected but also express hope.

5) The project’s sponsors will be included in the support materials where possible.

Coordination:

It is important to have trained spokespeople with fluent English who are able to respond promptly to the needs of the media.

They will need to have available a standard description of the project, containing key information and which is structured specifically for communicative actions.

Chile:
Carolina Sepúlveda
[Communication Coordinator]

France:
Simon Ribreau
[Communication Coordinator]

ACTION’S DESCRIPTION

Past Actions

1. Ongoing dissemination resources

A. Internet

Websites

Casa FENIX official website
www.casafenix.cl

Old Website
This medium is mainly for people who are aware of the project and want to know more about it. This website is in English and has information about the project, press, news, pictures, videos, sponsors and contact information.

Target: All audiences
Budget:
- Design: Free
- Domain: € 50 monthly
- Maintenance: € 160 monthly

New website
A new website was developed in order to improve the identity of the team. This website will be more user-friendly, with a renewed image and adaptable to other formats [Figure 201].

Target: All audiences
Budget:
- Design: € 1500
- Domain: € 50 monthly
- Maintenance: Free

*Casa FENIX unofficial website*
*solardecathlon.iut-larochelle.fr*

This website was developed mainly to seek sponsors in Poitou Charentes, France, as well as to disseminate the project to the university community and it is therefore in French. [Figure 202]

Target: Sponsors and students
Budget: Free

*Casa FENIX unofficial website (Arquitectura UTFSM)*
*www.arq.utfsm.cl/casafenix/*

This webpage shows a limited amount of information about the project, with the objective of motivating new students to join the faculty. [Figure 203]

Target: Chilean Students
Budget: Free

**Facebook**

This instrument is one of the most used and updated, as it is easy to use and enables us to directly reach one of our target groups.

Facebook#1 (Chile)
*www.facebook.com/CasaFenixSde2014*
Number of followers: 436

Facebook#2 (France)
*www.facebook.com/sdeiutcasafenix*
Number of followers: 414

B. Videos
These are the videos requested by the organization, for deliverable #2, Workshop#2 and Deliverable #6.

**Audiovisual #1**

The video concept was used to describe the problem posed by disasters and the current solution and it also showed the main design concept of the project and the structure. [Figure 204]

Target: All audiences  
Budget: € 900

**Audiovisual #2**

The main idea of the video was to explain the urban concept and the international cooperation of the two universities. [Figure 205]

Target: All audiences  
Budget: € 1700

**Audiovisual #3**

The idea of this video was to show the devastation after an urban wildfire, and how Casa FENIX is desing as an answer this [Figure 207].

Target: All audiences  
Budget: € 2200
C. Survival Module Structure

During the months of August and September 2013, the first 1:1 scale module was built by the Chilean team members. This module was used in several presentations, to attract the attention of the general audience, and to show how the modular progression of the project works. [Figure 206]

Target: All audiences
Budget: € 800

D. Illustrative Resources:

**Leaflets**

The leaflets include basic information about the competition and the project. They are handed out at each of the events hosted or attended by Casa FENIX. They are also used for seeking sponsors in both countries. There are two designs of leaflets- one for Chile, which is in Spanish, and one for France in French.

**Leaflet # 1 [Chile]**

This leaflet contains an explanation of what the Solar Decathlon is and the contests and tasks that will take place in the competition. Secondly, it explains the concept of Casa FENIX and the qualities that differentiate it from other projects [Figure 208 - Figure 209].

Target: All Audiences
Units printed: 500
Budget: € 330
Suivez le projet Casa FENIX sur solardecathlon.iut-larochelle.fr
Solar Decathlon Europe 2014 - CASAFENIX

& tous nos partenaires sur solardecathlon.iut-larochelle.fr

Figure 210: Leaflet #2 France [Larger size in Appendix 14.11]

La Casa FENIX
Casa For Emergency post-Natural Impact eXtreme est une maison modulaire et évolutive capable de répondre rapidement aux situations d’urgence pour reconstituer un habitat durable et autonome en énergie.

Figure 211: Leaflet #2 France [Larger size in Appendix 14.11]
Leaflet # 2 [France]

This leaflet first explains the Solar Decathlon competition and then talks about the French-Chilean collaboration on this project. It then explains the project and the stages from the initial concept right up to the competition. Finally it includes space for the collaborating institutions and sponsors [Figure 210- Figure 211]

Target: All Audiences
Print: 2700 leaflets
Budget: € 350

Posters

These are used locally at indoor locations inside the IUT facilities. They contain basic information and an image of the project.
Target: Students and IUT professors and personnel
Print: 2 posters [A0 size] and 30 posters [A3 size]
Budget: €40

Models

The team made 2 models of the projects to a scale of 1:25.

One of them was sent to France to be shown in Workshop #2 and

Figure 213: Casa FENIX model

Figure 212: Posters

Figure 214: Stickers

Figure 215: Stickers

Figure 216: Team FENIX Bags
the other was kept in Chile to be presented at different exhibitions [Figure 213].

Target: All Audiences
Units: 2
Budget: € 100

**Stickers**

The stickers are mainly used for building a brand presence. They are given to people at exhibitions and the team members and friends have put them on all sorts of items, including cars, helmets, laptops, books, etc [Figure 214 - Figure 215].

Target: All Audiences
Print: 1000 stickers
Budget: €150

**Bags**

These are used by Casa FENIX team members to promote the brand inside IUT facilities.
Target: Casa FENIX team members, students and IUT professors and personnel [Figure 216].
Units: 20
Budget: €175

2. Events

**A. Meetings and several presentation of Casa FENIX**

project to sponsors from industry and governmental authorities in France and in Chile to obtain financial supports [2013-2014]

Resources used: Power Point Presentation and physical models when necessary.
Place: they vary depending on the location of the office
Target: Industry and Government
Reach: Specific target
Budget: €6000 [Travels]

**B. Launch of the Casa FENIX project to the UTFSM**

Departments [08-01-2013]. At the launch event, the project and the Solar Decathlon competition were presented to UTFSM academics. The objective of this event was to get the other departments of the university involved in the project.

Resources used: Power Point Presentation.
Place: Auditorio Principal, UTFSM facilities, Valparaíso
Target: Academics of Universidad Técnica Federico Santa María
Reach: 80 people
Budget: Free

**C. Workshop #1 [20-03-2013]**

The Workshop was attended by Nina Hormazábal [Faculty Advisor UTFSM], Sebastián Rojas, [Student Team Leader, UTFSM], Gérard Schellenbaum [Faculty Advisor, La Rochelle], Nicolas Blanchard [Team member, La Rochelle], Jean Noël Simonneau [CILC]

2-day workshop held by SDE Organization, during which the teams met, there was a visit to Versailles and presentation of Cité du Solei. A general presentation of each team’s project was held in La Cité de la Architecture. The FENIX team presented the
composition of the team, the problem and the current solution and finally the characteristics of the project i.e. that this is an emergency sustainable home that becomes long-term because of its modular and progressive features that allow it to grow [Figure 217].

Resources used: Speech
Place: La Cité de la Architecture, Paris
Target: SDE team members and professionals
Reach: 150 people
Budget: € 3,469 [Travel + extras]

D. Presentation to the university community of the progress of Casa FENIX [09-07-2013]

The objective of this presentation was to show the students and professors of architecture and engineering, the scope of the project in order to recruit new participants to join the team.

Resources used: PowerPoint presentation and the first model of the project
Place: Main Auditorium, UTFSM, Valparaíso
Target: Students and professors of UTFSM
Reach: 80 people

E. Exhibition of the Project at Puertas Abiertas USM [24-10-2013]

Puertas Abiertas is an “open house” instance where the different departments of the university show their projects and activities to motivate prospective students to enrol at the university. The Casa FENIX team participated in this activity using the Survival Module Structure as a stand for the architecture department, seizing this opportunity to show the region of Valparaíso the relevance of the project. This event lasted two days [Figure 218].

Resources used: Survival Module Structure, Posters, Project Model, Leaflets.
Place: Central Patio, UTFSM, Valparaíso.
Target: Students and teenagers of the Valparaíso Region.
Reach: 5000 people
Budget: Resources used, budget specified in Ongoing Dissemination Actions section.

F. Workshop #2 [20-11-2013]

The Speed Peer Review was the first activity of the team in the second workshop of the competition, which took place in la Cité de l’Architecture de Paris. Each team
explained its project in a 5-minute presentation. This presentation was delivered to an audience comprising approximately 300 peers - other team members and SDE organizers.

The team presented the project in an unconventional way, with a performance which involved all the team members, thereby attracting the attention of the audience and it was, in fact, the most acclaimed presentation of the session.

Later in the day, four of the twenty teams made a short presentation of their projects to the French Minister of Housing, Cécile Duflot. They were introduced by the director of the event, Pascal Roullet, with a brief introduction of each project and model [Figure 219].

Resources used: Printed signs.
Place: La Cité de la Architecture, Paris
Target: SDE team members and professionals
Reach: 300 people
Budget: € 12,140 [Travel + extras]

G. Ségalène Royal Visits the IUT de La Université de La Rochelle [14-11-2013]

In this activity, the project presentation from Workshop#2 was performed once more for the visit of Ségalène Royal [President of the region of Poitou-Charentes]. The structure of the Replica was already assembled, so it was a great opportunity to show the progress of the construction phase. Casa FENIX team, students, faculties and university authorities from both universities were able to attend to this occasion, as the French SDE Faculty Advisor, Gérard Shellenbaum [UIT Département Génie Civil – Université de La Rochelle] was in charge of this event.

On this occasion the regional council contributed €110,000 to this project which will finance the assembly phase and the transportation of Casa FENIX to Versailles.

It is worth mentioning that sponsors such as CILC are all from the Poitou-Charentes region and committed to this bi-national project. This event was really important to disseminate the project in the Poitou Charentes...
region, as relevant media were present [Figure 220].

Resources used: Printed signs.
Place: Space Bois, IUT, La Rochelle.
Target: Collaborating institutions and sponsors
Reach: 100 people
Budget: Free

**H. Degree in Architecture** earned thanks to the Casa FENIX Project [10-01-2014]

Four members of the team obtained their degree in Architecture after presenting the Casa FENIX project to an evaluation committee; they awarded the highest score to the project.

The exhibition of the project was open to the public for 2 weeks at the Ex-Cárcel Cultural Centre in Valparaíso [Figure 221].

Resources used: Posters, models, leaflets, projected images and Survival Module Structure.
Place: Ex-Cárcel Cultural Centre, Valparaiso.
Target: Students of Architecture, Architects and General Public
Reach: 500 people
Budget: € 260

**I. Presentation of Casa FENIX project** to the community of University of La Rochelle [23/01/2014]

As the open house activity realised in UTFSM, Valparaiso. ULR, La Rochelle also does an equivalent activity were Casa FENIX project was shown to the university community. In this event people could learn about our environmental project, which gave them ideas for further studies. As a result of this exhibition, Casa FENIX inspired members from the faculty of sciences and they started to work with their students on the different possibilities for the foundations of Casa FENIX. The foundations were not developed at the time of the exhibition, moreover for the case of Valparaiso and its abrupt topography the foundations is one of the most challenging aspect of the project [Figure 222].

Resources used: PowerPoint presentation, structure of the replica, stickers and leaflets
Place: IUT, La Rochelle
Target: Students and professionals of the built environment
Reach: 60
Budget: Free
J. Presentation of Casa FENIX to Civil Engineering students of the IUT [30/01/2014]

It was very important to show and disseminate the project and the SDE competition to Civil Engineering students from ULR, because all of the five French students participating in Casa FENIX - SDE 2014 are from Civil Engineering department.

As a result of this presentation, a group of Civil Engineering students decided to work on issues related to Casa FENIX for their final project.

Several students were interested in forming new teams to apply for future Solar Decathlon competition [Figure 223].

Resources used: PowerPoint presentation, stickers and leaflets
Place: IUT, La Rochelle
Target: University students
Reach: 200
Budget: Free

k. Invitation and presentation of Casa FENIX to French sponsors [05/02/2014]

This event was very important because the French industry was a crucial target for us, for Casa FENIX would not be possible without them.

All the sponsors were invited to a detailed presentation of Casa FENIX. For this presentation the team described technical aspects about the structure and its performance [thermal, structural, environmental, etc.]

The sponsors and the Casa FENIX team members had the opportunity to talk to each other while refreshments were served [Figure 224].

Figure 224: Presentation of the Project Casa FENIX to the French Sponsors

Figure 225: Presentation of the Project Casa FENIX to the ULR administration Council
Resources used: PowerPoint presentation, exhibition of the construction, stickers and leaflets
Place: IUT, La Rochelle
Target: Sponsors
Reach: 30
Budget: €700

I. Presentation of Casa FENIX to the ULR Administration Council [18/03/2014]

The presentation to the ULR Administration Council is to keep them informed of the progress of Casa FENIX project, to get them involved, interested and invite them to the various activities of this nature [Figure 225].

Resources used: Construction of Casa FENIX in progress
Place: IUT, La Rochelle
Target: Members of URL authorities
Reach: 10
Budget: 100

M. School groups visit [20/03/2014]

This visit of schoolchildren to see Casa FENIX project is within environmental education and dissemination among youngsters. Our goal is to develop their awareness on sustainable living

Figure 226: School group visit

Questionnaire d'avant-visite - Ecole de Lacourbe

« La Casa Fenix est une maison en bois conçue et fabriquée par une équipe d’étudiants franco-chilienne pour répondre aux situations d’urgence »

1. Les catastrophes naturelles
   - Dans quel pays y a-t-il le plus de séismes ? Pour quelles raisons ?

   - Quelles sont les conséquences de ces catastrophes naturelles ?

2. La construction en bois
   - Quels sont les modes de construction écologiques ?

Figure 227: Information and questionnaire
Visite Casa Fénix (Maël, Vincent, Giovanna, Marie et Lola)

Jeudi 20 Mars nous sommes allés à l'IUT de la Rochelle pour visiter la Casa Fenix.

Dans notre groupe il y avait un chef de chantier : Vincent, un menuisier : Marie, un conducteur de travaux : Giovanna, un dessinateur : Maël et un architecte : Lola. Nous avons appris que les sélismes et les tremblements de terre sont les plus nombreux au Chili. La Casa Fenix est construite par les étudiants de l'IUT pour un concours mondial. La maison est complètement écologique, elle est construite en bois. Les étudiants travaillent avec des professionnels du bâtiment Chili. La maison n’est pas encore finie, elle doit être finie avant Juin. Notre groupe a tout aimé car c’était intéressant et que les étudiants ont bien expliqué. A la fin le vrai menuisier nous a montré tous les outils par exemple : la scie, il a fait une démonstration pour faire des copeaux.
and energy conservation issues [Figure 226].

The team produced a pre-visit information and questionnaire for the schoolteachers to inform them about Casa FENIX [Figure 227].

The team Casa FENIX presented to two school groups: 4th and 5th year of primary school [CM1 and CM2]. The team gave them a tour of the house in small groups and presented Casa FENIX in five themes [Figure 228].

The tour ended with a quiz on the different design strategies and technologies applied to Casa FENIX [Figure 233].

A week later an article with a really nice feedback was posted in the local news [Figure 234].

Resources used: Posters, construction of Casa FENIX in progress and leaflets.

Place: IUT, La Rochelle
Target: Children
Reach: 60
Budget: Free

Figure 235: Exhibition of Casa FENIX project in Lollapalooza festival

N. Lollapalooza, Aldea Verde Fair
[29 and 30/03/2014]

Lollapalooza is a music festival that takes place every year in Santiago, Chile. Lots of famous and international musicians perform at the event, which is attended by thousands of young people.

“Aldea Verde” [Green Village] is a thematic fair that takes place inside the festival, oriented to sustainability and healthy lifestyles. The team was invited to exhibit the project by one of the organizations selected by this fair: La Ruta Solar.

La Ruta Solar is an NGO in Chile that promotes the use of solar energy and it is most famous for the La Ruta Solar solar cars competition. La Ruta Solar became interested in our project following the appearance of Casa FENIX on a TV programme called Tecnociencia on Canal 13 [National TV Channel]. They have declared their intention to develop a South American version of Solar Decathlon.

The event lasted two days, during which the project was exhibited at the La Ruta Solar stand [Figure 235].
Resources used: Posters, Project Model and leaflets.
Place: O’Higgins Park, Santiago
Target: Students, Teenagers and the general public.
Reach: 160,000 people
Budget: Free

**o. Presentation and visit of the general public** as part of the “Semaine du développement durable” [03/04/2014]

Nationwide invitation to the general public to show Casa FENIX project, it included a presentation in an auditorium and a guided tour of the house [Figure 236].

Resources used: PowerPoint presentation, construction of Casa FENIX in progress and leaflets.
Place: IUT, La Rochelle
Target: General public
Reach: 30
Budget: Free

Figure 236: Presentation of the Project Casa FENIX to the General public

Figure 237: Presentation of the Project Casa FENIX to “Université du Temps Libre”
P. Presentation and visit by the “Université du Temps Libre” of La Rochelle [03/04/3014]

Presentation and visit of Casa FENIX project to “l’Université du Temps Libre”, a local and cultural association whose members are seniors, recently retired people, among others, whom have spear time and want to spend time in learning about new topics, share knowledge, participate in workshops and meet other people from other fields. The UTL plays an important social role: to ensure that culture and new knowledge is accessible and understandable to all in an open and friendly atmosphere [Figure 237].

Resources used: PowerPoint presentation, construction of Casa FENIX in progress and leaflets.
Place: IUT, La Rochelle
Target: General public
Reach: 30
Budget: Free

Figure 238: The evolution of Casa FENIX exhibition

Q. Exhibition of “The evolution of Casa FENIX” [03-04-2014]

Casa FENIX was shown through poster size pictures depicting the development of the project, from the beginning until the present, including a brief description on each picture. The public that visit Casa FENIX could see the different stages of the project [Figure 238].

Resources used: Pictures in poster size and construction of Casa FENIX in progress
Place: IUT, La Rochelle
Target: General public
Reach: 50 people
Budget: €50

R. Speed Peer Review Bootcamp [03-04-2014]

This was an event hosted by the SDE organizers as an innovative way to present and review what all the teams are doing. The Casa FENIX presentation took the same unconventional form as in workshop #2: a low-tech approach using signs, puppets and an unexpected ending. The message behind the presentation was as proposed in the Communication Plan, to show the consequences of a disaster and Casa FENIX solution. This presentation was different in that it focused on the urban design and the evolution
from the Emergency Temporary Village into the Eco Permanent Village [Figure 239].

Resources used: Signs and puppets  
Place: Space Bois, IUT, La Rochelle, in connection with all the participating countries.  
Target: Students and Professionals participating in the SDE  
Reach: 800 people  
Budget: € 60

S. **Guided visit for technical personnel** from La Rochelle University [09-04-2014]

Casa FENIX was shown to three delegates from La Rochelle city:  
Patrice GIRET: Director of physical plant and technical services  
Eric VILEAE: Health and Safety  
Annick PARATTE: Energy Engineer

Resources used: Construction of Casa FENIX in progress  
Place: IUT, La Rochelle.  
Target: Built environment and related professionals  
Reach: Local authorities  
Budget: Free

T. **Casa FENIX team helped as volunteers** after the recent devastating wildfire in Valparaíso [13 to 16-04-2014]

On Saturday 12 April, the city of Valparaíso suffered its worst fire ever. Almost 3,000 homes were completely destroyed, leaving more than 14,000 victims. During the development of Casa FENIX project, Team FENIX has been working on catastrophe issues, in order to develop our urban design proposal, the team has taken the case study of a past fire in Cerro La Cruz [2008], one of the 9 hills that burned, again, in this recent fire.

The whole team has a fair knowledge of this devastating situation, therefore it seemed so natural and obvious to volunteer in clearing the burnt sites, and help on any required task as the very first stage after the catastrophe [Figure 240].

U. **Casa FENIX Model Exhibition** in EXPOMIN [21 to 25-04-2014]

The model of Casa FENIX was exhibited at Expomin 2014 [one of the biggest mining fairs²], in the

http://www.expomin.cl/
stand of “Construye Solar”, the new solar home competition for Latin America organised by La Ruta Solar, MINVU\(^3\) and the Chile Green Building Council.

**V. Prototype Inauguration** [25-04-2014]

The inauguration included a presentation, display of information and a guided tour of the finished prototype of half Casa FENIX [32 sqm] in Valparaiso at the UTFSM.

This event was to show Casa FENIX to the university community, local representatives, industry sponsors and other collaborating institutions.

This event was a milestone within the development of our project in Chile. For this event, given the devastating situation the city of Valparaíso is going through, the team decided to do a very austere event and take the opportunity to offer our solution to the authorities [Figure 241 - Figure 242].

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\(^3\) Chilean Ministry of Housing
**Place:** Centro de Innovación Tecnológica, UTFSM, Valparaíso  
**Target:** UTFSM community, SDE  
**Faculty Advisor and professor from LRU, local authorities, sponsors and built environment professionals.**

**Reach:** 100 people  
**Budget:** € 150

### Several Important Visits to Casa FENIX Prototype in Valparaíso

After the inauguration of the Prototype in Valparaíso, the project has received several important visits from local and national organisms and possible donators of Casa FENIX for homeless people, given the importance the project has achieved on a possible solution to the reconstruction of Valparaíso after the Great Fire of April 12th and the Earthquake in Iquique. These events give the team great satisfaction, as the main objective of the development of the project was to reach governmental institutions and to make them rethink how reconstruction is made in Chile, and our goal is progressively being achieved. These are the visits and meeting the Team has hosted:

**Monday, April 28th:** Visit of the President of the Superior Council of the Universidad Técnica Federico Santa María, Sergio Solís and Mr. Pedro Durán, Commercial Attache in France, Fabien Gendron, Dean of the Faculty of Civil Engineering of the ULR Gérard Schellenbaum, Faculty Advisor SDE-House FENIX France and Nina Hormazábal, Project director and Faculty Advisor SDE-House FENIX Chile.

**Tuesday, May 6th:** Visit of the Presidential Delegate for the catastrophe of Valparaíso, Mr. Andres Silva. The visit, led by Nina Hormazábal, Faculty Advisor of the Team FENIX, contemplated the exposure of the Casa FENIX prototype. The purpose of the visit to Casa FENIX of the Presidential delegate was to get local experiences within the reconstruction work. Casa FENIX is a prototype for an emergency shelter that can become into a permanent house. The project based on the topography and context of the ravines of the city of Valparaíso, includes the phases of the emergency, reconstruction and urbanization.

« It is important to meet local initiatives in the universities, because there’s a serious work being done towards the reality of Valparaíso, which is a city unique in the country. Our universities must focus on the issue of prevention, because we are an area highly exposed to this kind of risk. Having FENIX project as is very important in order to have alternatives to address future emergencies » said Andrés Silva, Presidential Delegate for the Reconstruction of Valparaíso [Figure 243].

**Wednesday, May 7th:** Visit of representatives of the Ministry of Housing and Urban Development and Regional Secretary of Housing and Urban Development in the Region of Valparaíso.

**Thursday 8 May:** Visit of foreign scientific teachers settled in Chile.

**Tuesday, May 13th:** Visit of Senator Antonio Horvath and a Senate delegation. With the presence of the Directors of the General Direction of Investigation and Postgraduate Studies, Patricio Vargas and Tomás Santibañez, Director of Civil Works, Rodrigo Delgadillo of the UTFM, Team FENIX, students and professors.

**Wednesday, May 14th:** Meeting with Venergia, enterprise interested in donating all solar systems for one of the houses that
will be built for the reconstruction in Valparaiso. Invitation to the Team FENIX to exhibit the project in the committee for the reconstruction of the Senate chaired by Senator Antonio Horvath, and the presence of the senators of this committee and representatives of the UTFSM Tomas Santibañez, Rodrigo Delgadillo, Andrea Pino and Alejandra Brusco.

**Friday, May 15th:** Meeting with our one of sponsors company, VOLCAN, which is interested in donating Casa FENIX houses for the reconstruction in Valparaiso.

**Visit of IUT University Staff and members of the French Building Federation to the Replica in IUT** [13-05-2014]

The presentation was to show the evolution of the house hosted by 5 French team members and 4 Chilean team members, a buffet dinner was offered at the end.

**Visit of the French Sponsors and the President of Poitou-Charentes** [14-05-2014]

Team FENIX Replica hosted the visit of the French sponsors and the President of Poitou-Charentes Region, Jean-François Macaire.

This is the last important visit Casa FENIX will receive in La Rochelle, before the departure of the modules to Solar Decathlon competition in Versailles. The evening was closed with a dinner prepared [Figure 244].

**Upcoming Actions**

1. **Future dissemination resources**

   **A. Leaflets**
   The team has design 2 different types of leaflets for the Public Tour, which will respond to different targets. The first is aimed for the general public and it contains basic information about the project in an innovative and playful way. The second leaflet is aimed for professionals in the area and it contains a more detailed description of the project [Check Appendix 14.11 for the design].

   **Target:** By specific target groups
   **Units:** To be determined
   **Budget:** To be determined

   **B. Song**
   A song is being composed and a video clip will be added of our experience of the Casa FENIX project. This video-song will explain the project.

   Music brings out people’s emotions and feelings, so the team has decided to use it to stimulate people to think about the importance of our project. The song is in Em (RE minor) and we decided to use a happy rhythm to give a sense of hope and joy. The idea is that the song will be played during the SDE competition period and will tell the tale of the international cooperation involved in developing this project and the humanitarian work the team is developing.

   **Budget:** Free

2. **Public Tour**

   During the exhibition of Casa FENIX in Versailles will contain several activities organised where some of them will be done by decathletes and other will be display through different media within the Casa FENIX, some of the activities and media are:

   **C. Informative Wall**

   This is the first and self-guided station of the Public Tour; it consists of a section of the structure of the house which will have informative description about Chile and its features regarding the natural catastrophes [See Appendix 14.11 for the design].
D. Signs
The signs will be placed in different parts of the site of the house, mainly in the exterior area, with the objective of explaining different features and areas. This is not part of the Public Tour itself, but is an invitation for people walking by [See Appendix 14.11 for the design].

E. UDTA Models
The team will elaborate two models in different scales of the Urban Design, with the aim of showing the public the way the team proposes the reconstruction of one of the hills of Valparaíso, after the Great Fire of Valparaíso in April. This is a great opportunity to show in an interactive way how reconstruction can build a sustainable and better neighborhood.

F. Self Gardening for Children
This is an opportunity to teach children about sustainability. The Team will provide an area for children which will include learning how to make a vertical garden with recycled bottles.

G. Exhibition of all videos produced during the development process of the competition.

H. Handicap information
Information of the house available for handicap people in Braille in the entrance of the house.

In addition to the Public Tour content it is planned to:
1. Record videos and take photos with the goal of developing a documentary and a short audiovisual production, with the whole Casa FENIX project.
2. Collect background and experiences of the decathletes, with the aim of producing a testimonial book with the expectation of it to become a historical record, with the whole history of Casa FENIX; for archive collection since the beginning.
3. Direct actions to publicize Casa FENIX, following the competition in France:
   - Presentation of Casa FENIX to national governmental authorities, especially ONEMI (Emergency Office), MINVU (Ministry of Housing) and MINENERGIA (Ministry of Energy)
   - Exhibition of Casa FENIX to local community leaders and other local people.
   - Exhibition of Casa FENIX to professionals and specialists.

2. Future Events

A. Exhibition in the Committee for the Reconstruction [June 2014]
Exhibition of the project in the committee for the reconstruction of the Senate chaired by Senator Antonio Horvath, and the presence of the senators of this committee and representatives of the UTFSM.

B. Meeting and visit with ONEMI [June 2014]
Meeting and visit of the Assistant Director of the ONEMI [Emergency National Office], Victor Orellana and other delegates for the topic of the catastrophe and reconstruction.

C. SDE 2014 [June, July 2014]
Most of the communication media will be used during the Public Tour, where leaflets aimed for specific target groups will be handed out, also the model will be displayed and specially designed posters will be placed inside the house. It is planned to produce and use special media for people with disabilities, such as a 3D modelled board with the
architectural plan of the house and a description in Braille. The tour itself is part of the communication strategy; this is described in the Public Tour section. Other activities include the playing of the song which is being composed especially by team members and a surprise event for the country day. Place: Cité du Soleil, Versailles

D. “Expo Eficiencia Energética” Energy Efficiency trade fair [October 2014]

This Fair is a national fair, where exhibitors from different sectors showcase their initiatives to improve energy efficiency. Casa FENIX will have a stand to show the project. As with the “Edifica” Fair, it is also a great opportunity to reach built environment professionals as one of our target group. Place: Santiago

E. Expo Hall BU [September 2014]

Exhibition of photos to be displayed on a half structure module of Casa FENIX at the university library in La Rochelle, in collaboration with the URL communication office. This will exhibit through visual media the collection of pictures through the whole process of Casa FENIX development for the SDE competition. Place: La Rochelle

Press Coverage Plan for 2013-2014

1 July 2013/2 Press appearances

Topics:
1) The project, its characteristics and scope. Emphasis on the technical characteristics and the types of disaster or emergency in which the house provides a solution for the affected families.

2) Renewable energy and sustainable technologies and components in architecture. Show the sustainable energy materials and technologies applied to the construction of Casa FENIX.

1 November 2013/3 press appearances

Topics:
1) How Casa FENIX will perform in the various regions of the country. Information will be given about the versatility of Casa FENIX to operate in different geographical and climatic conditions.

2) Architecture students will participate in the construction of the Solar Home which will compete in an international competition in France. Emphasis will be given to the solidarity aspect, helping people affected by a disaster and as a formative experience for students.

3) Capsule (Arranged by the UTFSM Communication Office and Canal13C emission on Internet TV and the institutional website) Micro documentary with technical-academic information about the project and how it responds to different disasters.
3 March 2014 / 4 press appearances

Topics:

1) Modular, seismic-resistant home. Highlighting its functionality in earthquakes, one of the most common natural disasters in Chile.

2) Architects opt for an ecological home for dealing with emergency situations. Draws out the importance of its condition as a sustainable house.

3) History of the Solar Decathlon. Describes the history of the fair taking place in France.

01 May 2014 / 5 press appearances

Topics:

1) Preparations for the trip. Focus on the building excitement as there is little time left to get ready for the fair. A project which will be realised and which could be a large-scale solution for dealing with the home lost drama of the victims of a disaster. A closer look.

2) Chileans to take part in the Solar Decathlon.

A more global view of the team taking part in the Casa FENIX project.

3) Characteristics of and preparations for the Solar Decathlon, including statements from the SDE organizer. Material recorded in France in the lead-up to the SDE’s inauguration.

4) History of the Casa FENIX project. A retrospective look leading up to the departure for France.

02 June 2014 / 6 press appearances

Topics:

1) The trip and the replica in France. The focus is on the copy of the Casa FENIX, the reasons for its construction, how it compares to the prototype in Chile.

2) While the competition is underway [Webcam interviews with the spokespeople] Includes presentation material of the USM team at the fair in France.

03 November 2014 / 7 press appearances

Topics:

1) Competition results. The coverage will depend on how well Casa FENIX does. This will show the development of the fair with the main focus on the Chilean project.

2) Coming home (Webcam interviews with the spokespeople) Emotional piece centred either on the sense of triumph or the satisfaction of having presented a project to help those who are affected by disasters.

3) The experience of competing at international level (Photos and videos of the competition and the presentation of Casa FENIX in France to be provided) Reflective piece on being part of an unusual formula linked to learning, material realization and social sense.
Featuring of Casa FENIX in the Press


22/08/2014 Electricidad, la revista energética de Chile (Web-Magazine) Schneider presento al equipo creador de Casa FENIX http://www.revistaei.cl/2014/08/22/schneider-presento-al-equipo-creador-de-la-casa-fenix/


22/07/2014 Acuerdos (Web-Magazine) Casa FENIX: La vivienda de emergencia que amenaza con sepultar a la mediagua http://www.acuerdos.cl/noticia/casa-fenix-la-vivienda-de-emergencia-que-podria-reemplazar-a-la-mediagua/

30/06/2014 Electro Industria (Chile-Magazine), Casa FENIX llega a Francia http://www.embeddinga.com/20140630w28

08/06/2014 Tecnociencia C13 (Chile-TV Show) Casa FENIX: Una vivienda para la Emergencia https://www.youtube.com/watch?v=5Cz8jD0-bFg&list=UU17 NbXdPM_0LEapf7hk4Y5Q&index=21&spfreload=10

21/05/2014 El Mercurio (Chile Newspaper) Innovaciones simples y de bajo costo ayudan a enfrentar de mejor forma una catástrofe http://impresa.elmercurio.com/Pages/NewsDetail.aspx?dt=2014-05-21&Paginald=13&BodyId=1
16/05/2014 Region Poitou-Charentes News
(Chile_Virtual News)
Casa Fenix: l’IUT de La Rochelle construit la maison solaire de demain

09/05/2014 Las Últimas Noticias
(Chile Newspaper, Page 20)
Casa FENIX amenaza con sepultar el largo reinado de la mediagua

09/05/2014 Estrella de Valparaiso
(Chile Newspaper)
FENIX: La versión 2.0 de la vivienda de emergencia
http://www.estrellavalpo.cl/impresa/2014/05/08/full/8/

05/05/2014 Revista EMB Construcción
(Chile-Virtual Magazine)
Vivienda para la emergencia que puede transformarse en permanente
http://www.emb.cl/construccion/noticia.mvc?nid=20140505w25

04/05/2014 La Voz de Valparaiso
(Chile-Virtual News)
Casa FENIX: La vivienda para la emergencia que puede transformarse en permanente

01/05/2014 UCV Radio
(Chile-Virtual News)
Casa FENIX: La vivienda para la emergencia que puede transformarse en permanente
http://www.ucvradio.cl/website/2014/05/01/casa-fenix-la-vivienda-para-la-emergencia-que-puede-transformarse-en-permanente/

30/04/2014 UniverMind
(Chile-Virtual News)
Casa FENIX: Vivienda de emergencia que puede ser permanente
http://www.univermind.es/noticia_3624_Casa-FENIX:-Vivienda-de-emergencia-que-puede-ser-permanente.html

30/04/2014 Infocyt
(Chile-Virtual News)
USM desarrolla vivienda de emergencia que puede transformarse en permanente
http://www.infocyt.cl/articulo.php?id=493

07/04/2014 - France3 – Edition Atlantique
(Chile-TV Show)

04/04/2014 - Sud-Ouest La Rochelle
(Chile-Virtual Newspaper)
La Casa FENIX est prête pour aller à Versailles

02/04/2014 - CélàTV: Le JT
(Chile-TV Show)
http://www.cela.tv/fr/?videoactive=x1lgf20&page=

02/04/2014 - lumo-france.com
(Chile-Web Page)
http://www.lumo-france.com/blog/2014/04/02/casa-fenix-una-maison-a-l-epreuve-de-la-nature
21/03/2014 - ACTUALITÉS
RÉGION POITOU-CHARENTES
(France_Web Page)
http://www.poitou-charentes.fr/
environnement/solar-decathlon/
introduction.html

10/03/2014 - SUD OUEST – Les suppléments du quotidien : le bois en compétition
(France_Virtual Newspaper)
http://solardecathlon.iut-
larochelle.fr/wp-content/
uploads/2014/03/Sud-Ouest-Les-suppl%C3%A9ments.pdf

02/2014 - Conseil de développement de Loire-Atlantique
(France_Web Page)
http://conseil-developpement.
loire-atlantique.fr/solar-decathlon-europe-2014/

18/02/2014 - L’agenda du Développement Durable – Communauté d’Agglomération de La Rochelle
(France_Web Page)
http://solardecathlon.iut-
larochelle.fr/wp-content/
uploads/2014/02/Agenda-DD-
CDA.pdf
– à lire en page 3

02/2014 - Evénements sur developpement-durable.gouv.fr
(France_Web Page)
http://evenements.
developpement-durable.gouv.fr/
campagnes/evenement/198

01/02/2014 - Le Bois International
(France_Virtual Magazine)
Casa Fenix, un prototype riche en collaborations
http://www.leboisinternational.
com/fr/actu/construction-casa-
fenix-un-prototype-riche-en-
collaborations

27/01/2014 - Plage17
(France_Radio programme)
https://soundcloud.com/
plage17/27-01-2014-mission-9

24/01/2014 - CélàTV : Le JT
(France_TV Show)
http://www.dailymotion.com/
video/x1adyh2_cela-tv-le-jt-une-
maison-d-urgence-construite-
par-des-etudiants-rochelais_tv

23/01/2014 - France 3 – Edition Atlantique
(France_TV Show)
http://vimeo.com/85079823

21/01/2014 - Plataforma Arquitectura
(Chile/International_Web Page)
Equipo de la UTFSM representará a Chile en el próximo Decatlón Solar
www.plataformaarquitectura.cl/2014/01/21/equipo-de-la-
utfsm-representara-a-chile-
en-el-proximo-decatlon-solar-
europa-2014/

04/01/2014 - Vivienda y Decoración El Mercurio
(Chile_Newspaper Magazine)
Proyecto Casa FENIX, page 12
http://impresa.elmercurio.com/
Pages/NewsDetail.aspx?dt=2014-
01-04&dtB=04-01-2014%20
0:00:00&Paginald=12&SupplementId=4&bodyId=0

01/2014 - EspriIUT n°15
(France_Magazine)
EspriIUT page 54
http://solardecathlon.iut-
larochelle.fr/wp-content/
uploads/2014/01/EspriIUT.pdf

19/12/2013 - Les Brèves Futurobois
(Chile_Magazine)
Brèves Futurobois n°42
http://solardecathlon.
iut-larochelle.fr/wp-
content/uploads/2014/01/
Br%C3%A8ves-42.pdf
10/12/2013 - Revista EMB Construcción
(Chile_Virtual Magazine)
Vivienda de emergencia diseñada por sansanos entre favoritas del Solar Decathlon Europe 2014
http://www.emb.cl/construccion/noticia.mvc?nid=20131210w32

10/12/2013 - Noticias y Negocios
(Chile_Virtual Newspaper)
Vivienda de emergencia diseñada por sansanos entre favoritas del Solar Decathlon Europe 2014
http://www.noticiasynegocios.com/educacion/vivienda_de_emergencia_diseñada_por_sansanos_es_una_de_las_favoritas_del_solar_decathlon_europe_2014_20131210_9810.html

10/12/2013 - Revista Electricidad
(Chile_Virtual Magazine)
Estudiantes chilenos y franceses sorprenden en la Solar Decathlon Europe con su vivienda ‘post catástrofe’

10/12/2013 - Pergamino Virtual
(Argentina_Virtual Newspaper)
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http://www.emb.cl/construccion/flipbook/201311/#/61

10/12/2013 - Portal Minero
(Chile_Virtual Newspaper)
Vivienda de emergencia diseñada por sansanos entre favoritas del Solar Decathlon Europe 2014
http://www.emb.cl/construccion/flipbook/201311/#/61

10/12/2013 - Dirección General de Comunicaciones UTFSM
(Chile_Virtual Newspaper)
Vivienda de emergencia diseñada por sansanos entre favoritas del Solar Decathlon Europe 2014
http://www.comunicaciones.usm.cl/2013/12/10/vivienda-de-emergencia-diseñada-por-sansanos-es-una-de-las-favoritas-del-solar-decathlon-europe-2014/

12/2013 - Twitpic
(Chile_Virtual Newspaper)
Vivienda de emergencia diseñada por sansanos entre favoritas del Solar Decathlon Europe 2014
http://twitpic.com/do9if2

11/2013 - Bestiario del Futbol
(Chile_Virtual Newspaper)
Vivienda de emergencia diseñada por sansanos entre favoritas del Solar Decathlon Europe 2014

12/2013 - Twitpic
(Chile_Virtual Newspaper)
Vivienda de emergencia diseñada por sansanos entre favoritas del Solar Decathlon Europe 2014
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11/2013 - Revista EMB Construcción
(Chile_Magazine)
Estudiantes franceses participan en la construcción del proyecto Casa FENIX-UTFSM, page 61
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25/11/2013 - Actualités IUT La Rochelle
(France_Virtual Newspaper)
Salon de la Croissance verte à Angoulême
http://www.iut-larochelle.fr/actualites/participation-de-liut-au-salon-croissance-verte-angouleme

21/11/2013 - Actualités IUT La Rochelle
(France_Virtual Newspaper)
Rencontre entre Ségolène Royal et les étudiants participant au Solar Decathlon Europe 2014
14/11/2013 - **Actualités Région Poitou-Charentes**
(France_Virtual Newspaper)
La conception d’une maison solaire avec le Projet Solar Decathlon
http://www.poitou-charentes.fr/actus-region/a-la-une/-/alaune/ae5c986c-4d46-11e3-a792-950b4888e6bf

13/11/2013 - **Solar Decathlon Les projets en compétition**

07/11/2013 - **Le Moniteur**
(France_Virtual Newspaper)
Versailles se prépare à accueillir le Solar Decathlon 2014

24/10/2013 - **La Estrella de Valparaíso**
(Chile_Newspaper)
Estudiantes levantan una « supercasa » : antisísmica y con energía solar
http://www.estrellavalpo.cl/impresa/2013/10/24/full/7/

11/10/2013 - **Un minuto de Innovación, USM en TV & Canal 13**
(Chile_TV Show)
http://vimeo.com/76695769

10/2013 - **Actualités IUT La Rochelle**
(Chile_Virtual Newspaper)
L’Espace Bois de l’IUT sélectionné pour le SOLAR DECATHLON 2014

01/10/2013 - **Sud Ouest**
(Chile_Virtual Newspaper)
La maison écologique qui défiera les séismes

31/08/2013 - **Innova TV Chile**
(Chile_TV Show)
http://www.tecno-ciencia.cl/videos.php?id=4068

06/2013 - **La Rochelle le journal**
(Chile_Virtual Newspaper)
Objectif Solar Decathlon 2014, page 4
http://lun.com/lunmobile/pages/

28/05/2013 - **Dirección General de Comunicaciones UTFSM**
(Chile_Virtual Newspaper)
Innovadoras muestras de robótica, software y arquitectura presentará la USM en Imagina Chile
http://www.dgc.usm.cl/2013/05/28/innovadoras-muestras-de-robotica-software-y-arquitectura-presentara-la-usm-en-imagina-chile/

08/01/2013 - **Pergamino Virtual**
(Argentina_Virtual Newspaper)
USM presenta modelo de vivienda de emergencia para situaciones extremas

01/2013 – **Las Ultima Noticias**
(Chile_Newspaper)
Científicos chilenos trabajan en la Casa FENIX antiterremotos
http://www.lun.com/lunmobile/pages/
08/01/2013 - Dirección General de Comunicaciones UTFSM

USM presenta modelo de vivienda solar de emergencia para situaciones extremas
http://www.dgc.usm.cl/2013/01/08/usm-presenta-modelo-de-vivienda-de-emergencia-para-situaciones-extremas/
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<td>Presentation of the project to France sponsors of Casa FENIX</td>
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<td>Presentation of Casa FENIX to the ULR Administration Council</td>
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<td>Presentation and visit of the general public as part of the “Semaine du développement durable”</td>
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<td>Speed Peer Review Bootcamp</td>
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<td>Casa FENIX team helped as volunteers after the recent devastating wildfire in Valparaíso</td>
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<td>Prototype Inauguration</td>
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<td>Visit of the President of the Superior Council of the Universidad Tecnica Federico Santa Maria</td>
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<td>Visit the Presidential Delegate for the catastrophe of Valparaiso</td>
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<td>Visit of representatives of the Ministry of Housing and Urban Development and Regional Secretary of Housing and Urban</td>
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<td>Visit of foreign scientific teachers settled in Chile</td>
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<td>Visit of IUT University Staff and members of the French Building Federation to the Replica in IUT</td>
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<td>Visit of French Sponsors and the President of Pouitou-Charentes</td>
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<td>Meeting with VOLCAN, donation of Casa FENIX houses for the reconstruction of Valparaiso</td>
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### Activity

#### TV coverage

- "Tecnociencia" in Canal 13 Cable
  - Media: TV
  - Date: 30-06-2013
  - Relevance: National (Chile)
- "Innova" in TV Chile
  - Media: TV
  - Date: 31-08-2013
  - Relevance: National (Chile)
- "Un minuto de Innovación" in USM en TV and Canal 13
  - Media: TV
  - Date: 11-10-2013
  - Relevance: National (Chile)
- France 3 – Edition Atlantique
  - Media: TV
  - Date: 23-01-2014
  - Relevance: Regional (Poitou-Charentes)
- CélàTV : Le JT
  - Media: TV
  - Date: 24-01-2014
  - Relevance: Regional (Poitou-Charentes)
- CélàTV : Le JT
  - Media: TV
  - Date: 02-04-2014
  - Relevance: Regional (Poitou-Charentes)
- France3
  - Media: TV
  - Date: 07-04-2014
  - Relevance: Regional (Poitou-Charentes)

#### Meetings Between Chilean and French members of the Team

- Visit of the Chilean Faculty Advisor to the French Faculty Advisor of Casa FENIX at La Rochelle
  - Meeting
  - Date: 23-07-2013
  - Relevance: Internal
- Visit of the French students and Faculty Advisor of the Team to UTFSM
  - Working together
  - Date: 09-10-2013
  - Relevance: Internal
- Visit of four Chilean students and a professor to IUT in La Rochelle
  - Working together
  - Date: 12-11-2013
  - Relevance: Internal
- Three Chilean students at IUT in La Rochelle
  - Working together
  - Date: 28-01-2014
  - Relevance: Internal
- French Faculty Advisor in Valparaiso
  - Meeting
  - Date: 22-04-2014
  - Relevance: Internal
- Two Chilean students travel to La Rochelle
  - Working together
  - Date: April-May 2014
  - Relevance: Internal
5.7.3 PUBLIC TOUR DESCRIPTION

General Description

The concept of the tour will be to guide the general public and special visitors through Casa FENIX following the progressive growing of a post-disaster sustainable reconstruction process, which gives the geometrical form to Casa FENIX replica [Figure 245].

This is for visitors to get an idea of loosing everything, and have to begin a new life from scratch, the meaning of this process where people have to keep on, get on their feet and keep going with their lives. To carry out the tour of the house, the following personnel will be needed:

- Three decathletes who will give the tour, English and French speakers.
- One decathlete in charge at the entrance to receive people in groups of eight persons.
- One decathlete will hand out leaflets in the row of entrance to the house while people wait to visit Casa FENIX.

The tour will comprise of four stations, where three of them will be guided. The stations are as follow:

1. **Catastrophe**: Chile and its natural disasters. [Self guided]
2. **Response**: Casa FENIX as an emergency shelter. [Guided]
3. **Relief**: Casa FENIX as a permanent solution. [Guided]
4. **Awareness**: Consciousness about resilience and the opportunity of creating new safer and sustainable neighborhoods through sustainable reconstruction process. [Guided]
DETAILED DESCRIPTION OF EACH STAGE

Entrance [A]

The main entrance will be at the Southern street, where the waiting line will be managed by two persons; one will be in charge of letting in groups of eight people to the beginning of the tour; the other one will be in charge of handing out leaflets to people waiting in line [Figure 246].

Leaflets will have two versions:

*Casa FENIX: Do it yourself sustainably!*

This is the leaflet for general public; it will contain the summarized version of the concepts of the project, the construction of the replica and how the team is comprised. [See Appendix 14.11 “Communication Plan Appendix”]

*Casa FENIX: Use of technology to improve the future of a community*

This is a more extend leaflet with deeper explanations of every section and some technical details. This will be hand out to built environment professionals and visitors who show specific interest in the project and its features. [See Appendix 14.11 “Communication Plan Appendix”]

By having this two types of leaflets the team addresses more specifically the different target groups in the public visits la Cité du Soleil ®.

The waiting line zone that is nearer to the entrance of the house will be a shadowed area, by a structure constructed with

Figure 246: Entrance diagram

Figure 247: Entrance Timing
the same principle of Casa FENIX. This area will be considered as part of the tour and it is called “Catastrophe Station”.

**Catastrophe Station [B]**

This station is self-guided and will be part of the waiting line, as an introduction to the tour of Casa FENIX. The Station consist of a structure made with the same design principle of the house, but without an envelope, this way, visitors will have a better insight of the structure of the house, which is a very important feature, as the structure was designed by the students to achieve address modularity [Figure 248].

The objective of having this structure is to build an informative wall. This informative wall will have basic information about Chile, its natural disasters, and the current solution for people who lose their homes. The structure has two parallel walls which will have two flat surfaces to display parallel information.

See Figure 250 - Figure 251 - Figure 252 - Figure 253 for the informative wall, and for a larger size, please check appendix 14.11.
Figure 250: Posters in the Informative Wall
Figure 251: Posters in the Informative Wall
Figure 252: Posters in the Informative Wall
Figure 253: Posters in the Informative Wall
Response Station [C]

This station will take place at the entrance deck of the house. One decathlete will give a short brief about the information in the “Catastrophe Station” and will show the “Catastrophe Ground”. After this, he/she will explain Casa FENIX as a sustainable response to a catastrophe, and will explain the modules according to the stages of reconstruction of a natural disaster. To finish this station, he/she will describe the features of the Surviving Module, and will invite the visitors to enter the house, and to take a look to the SM to the right side of the entrance. At this point visitors will have the possibility to look at the catastrophe scene that will be set on one of the sides of the site. This wrecked looking landscape is shown to resemble the view after a tsunami has hit the city. On this zone visitors will see the part of the house that corresponds to de Survival Module [Figure 254].
Relief Station [D]

Inside the house, visitors will be guided to the Mechanical and Living Module. Here, the decathlete will explain the Sunspace where visitors walked through, as a solar passive strategy to manage the indoor climate of Casa FENIX, through cooling and heating passive strategies. The decathlete will explain the features of both MM and LM modules. And also, the decathlete will explain the active solar system of the house.

Inside the Mechanical Module and Living Module the visitors will see the kitchen, workspace and living space of the house, also the decathlete will explain some facts about the city of Valparaíso [Figure 256].

At last, the decathlete will lead them into the exit of Casa FENIX and they will be walked to the next decathlete waiting in the backyard.

The backyard deck will be an optional station, where the visitors will have the opportunity to see information about recycling and self-gardening.
**Awareness [E]**

In this last station, the decathlete will talk about the opportunity of creating new, safe and sustainable neighborhoods within sustainable reconstruction for cities, given that many of the wrecked communities not always had a good quality of life before the catastrophe, therefore, the disaster is taken as a chance to build more resilient neighbourhood [Figure 258]. This explanation will be supported by two models of the Urban Design for the reconstruction of a hill of Valparaíso, after the Great Fire occurred in April. Finally the decathlete will thanks the visitors for their interest on Casa FENIX and will say goodbye.

![Figure 258: Awareness Station Diagram](image)

![Figure 259: Awareness Station Timing](image)
Support graphic elements

In addition to the guided tour Casa FENIX will include some graphic elements to support and give extra information to the visitors [Figure 260]. These will be located in strategic points and will consist of signs with written, precise and clear information, to capture and learn about Casa FENIX proposal.

Within Casa FENIX site we consider signs [Figure 261] looking in and looking out, for the guided tour visitors and general visitors to la Cité du Soleil ® that are just passing by [See appendix 14.11 “Comunication Plan Appendix”].

Figure 260: Location and information of the signs.
Figure 261: Signs on the casa FENIX Site
Self-gardening for children

For children we propose a space where they can stay and learn how to plant on vertical gardens with plastic bottles. The objective is to entertain and take care of the children while their parents visit the house in addition to teach them a way of recycling [Figure 262].

This area will be located in the backyard zone of the house, because this is north oriented and will be more protected from the sun.

Braille Information Sign

In the entrance deck, a sign in Braille will be placed for visual handicap people. This sign will include a tactile plan and section of the house and written in Braille; the most outstanding features of the house [Figure 263].

Use of Audiovisuals

Display the 3 Audiovisuals made for the Deliverables in the computer and television inside the house, as it was done in the inauguration of the prototype in Valparaíso [Figure 264].
Script for Guided Tours

The scripts for decathletes that will be doing the guided tours will be prepared and written down to avoid confusing explanations and they will be organized the same way Casa FENIX Speed Peer Reviews have been done. Where the decathletes in charge of doing the talking, rehearse several time previously to presentations, learning by heart the scripts, and practicing the pitch and clarity to voice them the best way possible. To do that the team has worked with a drama player who gives them basic techniques to get the best out of an oral presentation. The scripts will be added to the next deliverable # 6.

Models of the Urban Design

The team will elaborate two models of the Urban Design to display as part of the Public Tour, as an interactive way to show how the team has planned reconstruction with Casa FENIX after a Catastrophe. The city chosen for the representation will be Valparaíso, where a great fire destroyed nearly 3000 dwellings last April. These model will show the reconstruction at two different scales; the first at a larger scale to display how the design integrates to the urban fabric of the city and the second to explain how the concept adapts the abrupt topography of the hills of Valparaíso.
The «character» of the team Casa FENIX as a brand is a strong one, on one hand the name already play that role, because everybody, knows the bird Fenix, on the other the image of it should evoke on one hand the disaster (represented by the flame’s colour and image) and, on the other hope, the fly of the bird pointing up. Thus, the brand focussed on a nation whose people suffer losses following a disaster but are nevertheless able to pick themselves up, overcome adversity and move forward with their lives. But the team’s character is also warm and empathetic; as social beings we cannot be oblivious to the events that shake our country frequently. This project is our way of showing solidarity as a team towards our compatriots. It is also designed to sensitize the population about this subject functioning as part of the search for better solutions for the future. These characteristics are reflected in all the different components that form part of our corporate image.

Name of the house, team name and slogan

The team discussed a number of different names for the house that would explain in a simple way the concept that originated the design of the house: i.e. a house that addresses the need for shelter following a major disaster that has destroyed the home of thousands of people. It was agreed to use the Phoenix as a representative icon for the house, as this mythological bird has the ability to be reborn in all its glory from its own ashes, just as Casa (Spanish for “house”) FENIX (Spanish for “Phoenix”) does after a tragedy.

Given the need to create a slogan that would help to improve the understanding of the first image that comes to mind with Casa FENIX, the team came up with the idea of creating an acronym with the letters of the word FENIX. For Emergency post-Natural Impact eXtreme therefore briefly explains the uses of the house, an emergency house that is built after a natural disaster.

In order to be consistent with the concept and the idea we want to transmit and avoid causing any confusion by using a different name, the name of the team is the same of the house.

Logotype

After a name was chosen for the house, the concept for the logotype was straightforward: clearly it would be an image of a Phoenix. The idea is to show the bird in its best shape, when it has just been reborn from its ashes; this is the reason why it is looking upwards and has outstretched wings, representing optimism about a new future. The main logotype is encircled because the circle transmits one part of the personality of the team, which is warm and empathetic, showing solidarity.

Main Logotype: This logotype was designed to be mainly shown alone, as it includes a lot of information. There are two versions of this logo, one which is set against a red background and one that can be used against any background colour [Figure 265- Figure 266].
Isotype

This is an abstract graphical symbol of the logotype, which effectively communicates the project connotations. The isotype helps us to reduce the information delivered in the main logotype, while still transmitting the same image. The isotype is used in conjunction with other logotypes and information [Figure 267].

Colours

The main corporate colour is red, representing us as a team which is energetic, dynamic. Red also evokes emotion and power.

The secondary colours that are used are yellow, which represents innovation and action, white which in this case represents unity and positivism, dark grey which represents a transition, in this case from the disaster to the reconstruction and orange that represents energy and warmth [Figure 268].

Typography

The main typography used in all the documents and communication tools is “Calibri”. The main characteristic of this typography is

Figure 265: Team FENIX main logotype

Figure 266: Team FENIX main logotype
Figure 267: Team FENIX Isotypes

Figure 268: Colours
its rounded shape which, like the circle in the logotype, transmits warmth and emotion [Figure 269 - Figure 270]. Secondary typography used are “Impact” which, as its name implies, generates impact and strength [Figure 271] and Meyrio IU which is also rounded and soft.

**Logotype in conjunction with other logotypes**

As a rule, the FENIX logo should always be on the left hand side and have a higher hierarchy. Here are presented the official way of how the conjunction of the logos should appear, with the SDE logo and the main supporting institutions. [Figure 273 - Figure 274- Figure 275]

In conjunction with the supporters, the hierarchy should be; the supporting institutions, sponsors and SDE supporters [Figure 276]
Figure 273: FENIX logo with the old SDE logo

Figure 274: FENIX logo with the new SDE logo

Figure 275: Team logo in conjunction with those of the partner universities and main departments.
Figure 276: Team logo in conjunction with the supporters logos
Examples of the use of the Identity Manual

Figure 277: Invitation to the inauguration of the Prototype

Figure 278: Presentation Cards

Figure 280: Web Page

Figure 281: Web Page

Figure 279: Presentation Cards
Team Uniforms

The concept

The concept of the team uniform is simple but straightforward. It uses red as the official colour of the team [CYMK code: C0/M96/Y81/K0] in addition to white [CYMK code: C0/M0/Y0/K0] and blue [CYMK code subjected to availability], representing the two countries, as both the Chilean and French flags have the same combination of colours.

Main clothing item: a t-shirt

Team FENIX will have two variations of the uniform, one for the contest week and another for the assembly and disassembly period.

Uniform #1 Assembly and disassembly

The main element will be the t-shirt, bearing the official team colour [CYMK code: C0/M96/Y81/K0]. The team’s logotype appears on the front, on the lower right side. It is large to ensure that it is easy to identify the team members.

The back features the acronym of “CASA FENIX For Emergency post-Natural Impact eXtreme” and the official logos of SDE and both the Chilean and French flags.

The sleeves bear the logos of the leading entities involved in the project from each country from each country.

At this stage, the team is planning to have two t-shirts for each team member.

For Chile: Universidad Técnica Federico Santa María; Departamento de Arquitectura; UTFSM

Figure 282: Uniform #1 Assembly and disassembly
For France: Poitou Charentes Region; Université de La Rochelle IUT La Rochelle

The specific working clothes are blue trousers and safety shoes [details to be determined, depending on availability] [Figure 282].

Uniform #2 Competition week and activities

To be used during contest week, at workshops and special events specified by the organizers. This version of the uniform has the same official t-shirt, combined with standard jeans/denim trousers. The main objective is to for the clothing to be comfortable and easy to acquire. It can include denim trousers or shorts, because of the high temperatures in Versailles during the competition period [Figure 283].

Figure 283: Uniform #2 Competition week and activities
Figure 284: Details of the t-shirt logos
5.7.5 SPONSORSHIP MANUAL

As our team is building and assembling two houses; one for Chile, called the Prototype, and the one that is going to participate in Versailles, called the Replica, we needed to get sponsors and patrons in both countries.

The person in charge of seeking sponsors in Chile is Pablo Sills, a professor at UTFSM and team FENIX member.

Contact details:
E-mail: psills@diav.cl
Mobile phone: +56 9 96707764

In France, the sponsorship manager is Pierre Maudet, a student at Université de la Rochelle and team FENIX member.

Contact details:
E-mail: p.maudet944@laposte.net
Mobile phone: 033 6 86 77 61 78

Collaborating institutions in Chile

Chilean Ministry of Energy - Ministerio de Energía, Gobierno de Chile: This ministry’s main objectives are planning policies and establishing norms in coherence with national strategy for the energy sector.
http://www.minenergia.cl/

Chilean Ministry of Housing and Urban Development - Ministerio de Vivienda y Urbanismo, Gobierno de Chile: This ministry’s main objective is to reduce the housing deficit for the vulnerable sector of the population.
http://www.minvu.cl/

Chilean Agency for Energy Efficiency - Agencia Chilena de Eficiencia Energética: The objectives of this agency are to promote, strengthen and consolidate energy efficiency in all national sectors.
http://www.acee.cl/

Universidad Técnica Federico Santa María: “Vision: To be a leader, both nationally and internationally, in the fields of science and technology, to foster a university community of excellence, to encourage the dissemination of knowledge, to create value in all areas of work, and to be recognized as a leading UNIVERSITY IN ENGINEERING, SCIENCE AND TECHNOLOGY.”
www.utfsm.cl

Pie> A, Programa de Iniciativas Estudiantiles Académica - Student Academic Program Initiatives (UTFSM): Extracurricular activities program for technological innovation, social responsibility and non-traditional learning experiences.
http://www.piea.usm.cl

3IE (UTFSM): International Institute for business innovation.
http://www.3ie.cl/

CETAM Centro de Tecnologías Ambientales - Environmental Technology Centre (UTFSM): Seeks to develop and strengthen research capacity in the areas of environment and environmental technologies inside the university community.
http://www.utfsm.cl/investigacion/centros/tecnologias-ambientales/

CIE. Centro de Innovación Energética, UTFSM - Energy Innovation Center (UTFSM): Seeks to build human capital with
a high specialization in energy, able to create and manage knowledge that results in ensuring and satisfying national energy demand and sustainable social and economic development.
http://www.utfsm.cl/investigacion/centros/innovacion-energetica/

**Departamento de Arquitectura – Architecture Department (UTFSM):** To contribute through teaching, research and training architects with great human, scientific and technological qualities, thus contributing to improve the environment in which these professional would operate.
http://www.arq.utfsm.cl/

**Departamento de Electrónica – Electronic Department (UTFSM):** To contribute through teaching, research and outreach to national development in the areas of electronics, telematics, and applications.
http://www.elo.utfsm.cl

**Departamento de Mecánica – Mechanics Department (UTFSM):** To contribute to the advancement of mechanical engineering and the industrial and technological developments that Chile needs
http://www.mec.utfsm.cl/

**Departamento de Ingeniería Eléctrica – Electrical Engineering Department:**
http://www.eli.utfsm.cl

**Departamento de Obras Civiles – Civil Works Department:** To contribute to the generation of knowledge and to create a learning environment that enables, through teaching, research and outreach, the training of professionals of excellence, who are able to contribute to the development of society in the field of civil works.
http://www.ociv.usm.cl/

**Collaborating institutions in France**

**Region Poitou Charentes**

**Fédération Française du Bâtiment:** This entity represents the built environment professionals in front of public administration and authorities, economic policy makers and stakeholders when any issue comes during the construction process.
http://www.ffbatiment.fr/

**Sponsors in Chile**

**CIA INDUSTRIAL EL VOLCAN S.A.:** A business which makes construction materials. Its sponsorship took the form of donations of materials, such as mineral wool and glass wool insulation, plasterboard and fiber cement.
http://www.volcan.cl/

**REHAU S.A.:** A company which provides polymer solutions. Its sponsorship took the form of donations of materials to elaborate PVC windows in collaboration with RENOVA TEK.
http://www.rehau.com/CL_es/

**RENOVATEK LTDA.:** This company produces PVC doors and windows. It helped the project by assembling the PVC windows in collaboration with REHAU.
http://www.renovatek.cl/

**SCHNEIDER ELECTRIC:** This is a global supplier of electric solutions. It supplied all the electric components for Casa FENIX’s electricity requirements in Chile and France.
http://www.schneider-electric.cl

**SERGE FERRARI S.A.S.:**
This producer of composite
Membranes donated membranes for the roof.
http://es.sergeferrari.com/

**IENERGÍA:** Energy solutions supplier, whose sponsorship took the form of a discount on the purchase of PV panels.
http://www.ienergia.cl/

**SODIMAC:** This company is a distributor and retailer of building materials. Sodimac provided a discount on all the materials bought there (Safety implements, tools, etc).
http://www.sodimac.cl/

**Webgo:** This company specialises in web design, corporate image, publicity and market investment consultancy. It provided a discount on the webpage design.
http://www.sodimac.cl/

**Sponsors in France**

**CILC:** This is a company focused on the production and distribution of structural products and wooden structures. Its sponsorship was in the elaboration of the entire wooden structure of the house and the exterior deck, ramps and handrails.
http://www.cilc.fr/

**RULLIER BOIS:** This company produces wood and derivative products. Its sponsorship took the form of supplying all the wood needed for the construction of the replica in France.
http://www.rullier.fr/

**MILLET:** These specialists in tailor-made doors and windows made all the windows and doors for the house.
http://www.groupe-millet.com/

**PAVATEX:** Specialists in insulation materials. They provided all the insulation needed for the house.
http://www.pavatex.fr/

**ARCABOIS:** This is a construction engineering firm specialising in wood and building envelopes. They calculated the entire house structure.
http://www.arcabois.fr/

**SOLÉHOME:** Provider of ventilation by insufflation systems. They provided the Ventilairsec System for the house.
http://www.ventilairsec.com/air-sain-habitation.html

**ELVA:** Custom made doors and windows

**SIGA:** Is a company focused on the development, production and distribution of products free from residential toxins for the air and windtight building envelopes. It provided all the sealings, vapour barrier and humidity barrier for the house.
http://www.siga.ch/fr/

**Pivetau:** Timber solutions for outdoor area, coatings and construction.
http://www.piveteaubois.com/e-Sales/esa/default.jsp

**JIT SOLAIRE:** Specialists in photovoltaic projects. It provided all the PV panels for the requirements of the house.
http://www.jit-solaire.com/fr/

**INTIS:** A company specialising in sustainable energy systems, Intis provided the thermal solar collector.
http://www.intis.fr/

**KRONO:** This company specialises in wood-based products
http://www.kronofrance.fr/

**SFS INTEC:** This is a global supply partner specialized in mechanical fastening systems. They provided the screws for the construction of
the house.
http://www.sfsintec.biz/en/

M2B: This supplier of bolts provided all the bolts for the construction of the house.

TREMCO: This is a manufacturer and service provider of high-performance sealing, bonding, flooring, waterproofing, and passive fire protection for the construction and manufacturing industries. They provided the window’s sealing.
http://www.tremco-illbruck.com/fr_FR

CCC: This is a company that provides plumbing elements and sanitation components. It donated all the plumbing elements and sanitation components.
http://www.ccchabitat.fr/

LYCEES VIELJEUX: This technical and professional institute installed all the plumbing components.
http://www.lycee-vieljeux.fr/

SOFLUX: This company offers multi-skilled services in engineering, electrical, climate and renewable energy engineering. They donated electrical components.
http://www.soflux.fr/

PREFATEC: This company manufactures electrical components. They provided an electrical octopus for the house.
http://www.prefatecfrance.fr/

SCHNEIDER ELECTRIC CHILE: This global supplier of electrical solutions supplied electric components to meet Casa FENIX’s electricity requirements in Chile and in France.
http://www.schneider-electric.cl

SERGE FERRARI: A company specialising in composite membranes, which donated membranes for the exterior.
http://es.sergeferrari.com/

EC2I: Company that provides ceiling cover and insulation. They donated the roof membrane.

Sika: Sealing, bonding, soundproofing, strengthening and protection supplier
http://fra.sika.com

CADWORK: Software for the construction of wooden structures. They provided the license of the software for the project.
http://www.cadwork.com/

LOCIELS ACORD: Software for calculating wooden structures. They donated a license of the software for the project.
http://www.itech-soft.com/

VICAT: A company with a substantial expertise in cement, concrete and aggregates. They will make the concrete foundation for the permanent place it will be given to Casa FENIX replica in La Rochellepaint.
http://www.vicat.fr/

SOLS REVE: Floor coverings firm which provided flooring for the replica.
http://www.sols-reve.com/

E.R.C. HARRANGER: They provided the safety helmets for the team.
http://www.harranger.fr/

SARRION: truck: Transport and logistics company, which granted a discount in the cost of truck transport for taking the replica modules from La Rochelle to Versailles and back.
http://www.sarrion-transports.fr/

COUTEAUX FAROL: Producer of knives. They provided a discount price for knives to be given to sponsors as gifts.
http://www.farol.fr/
Chile

Financial sponsorship from the public sector

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<th>Contribution</th>
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Financial sponsorship from industrial partners in the private sector

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Material donations from industrial partners in the private sector

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France

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Financial sponsorship from industrial partners in the private sector

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Technical sponsorship from industrial partners in the private sector

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Material donations by industrial partners in the private sector

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<td>Sols Reve</td>
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</table>

Figure 286: Value of Donations
Engagement Strategy

In Chile

It proved very difficult to engage sponsors, as Europe, where the competition is taking place, is not a major market for the companies targeted, so they could not perceive any real benefits to be gained from supporting our project. So the strategy was to start by sensitizing potential sponsors to collaborate in this project for humanitarian and social responsibility reasons. We also suggested that sponsoring our project would paint their company with the colours of sustainability, as sustainability is currently in vogue, and that this would make their company more attractive for the buyers of their products. We also appealed to their patriotism, asking them to help Chile and Team FENIX make this challenge possible. As a developing country, we are not always on the first pages of newspapers for developing innovative ideas, only for the disasters that constantly hit us, so this is a chance to position Chile on the world map of innovation. The presentation attached first shows the relevance of Solar Decathlon worldwide, then the reality in Chile with the natural disasters and the current solution. Afterwards comes the presentation of the project and its features. Finally it ends with the potential benefits for the sponsors and collaborators; which are as follows:

- RDI Products [Research, Development and Innovation]
- Opening foreign markets for domestic products
- Round of negotiations on housing presented at Versailles
- Patents and academic publications as co-researchers or co-developers
- International validation of the prototypes
- Relationship with government entities
- New applications for products in emerging markets

To check the Chilean Power Point presentation for engaging potential supporters please see Appendix 14.11

In France

Most of our sponsors are from France and it proved easier to attract them than in Chile. The majority of them belong to the Poitou Charentes region where Université de La Rochelle is located. As many of our current sponsors already work in conjunction with the IUT and some of the personnel of these companies also work as professors at the university, getting them to sponsor Casa FENIX was very feasible. The strategies to engage potential collaborators was to first obtain recognition and publicity by being featured in such an important event, then secondly to help position the region as a strong producer of construction materials in France and Europe, and third, to also represent the collaborator with the colours of sustainability and corporate social responsibility.

To check the French Power Point presentation for engaging potential supporters please see Appendix 14.11
C A S A F E N I X
For Emergency post-Natural Impact eXtreme
R E M I N D E R

One of the most outstanding geographical features of Chile is the relatively constant threat of earthquakes, among other natural disasters, such as volcano eruptions, landslides and fires in urban areas. The regularity with which these events occur does not make them any less catastrophic for people. Many homes are lost and the people who are most affected are low-income families. The post-catastrophe situation throughout year has indeed been non-sustainable, therefore to develop and implement the concept of sustainable reconstruction is a big challenge for our country, where Casa FENIX ambition is to propose and offer a tangible solution.

THE PROBLEM While Chile is a political and geographical location where natural disasters are recurrent and affect a great part of the most socially vulnerable population, there are no official policies which outline a quality response to such events.

“When disaster strikes, the problems are resolved with quick, cheap, short-term solutions, such as the mediagua emergency houses”

which end up causing more problems than they solve and lead to a great deal of waste in the long term.

HYPOTHESIS Casa FENIX is a design process that responds to a catastrophe, delivering energy efficient strategies to ensure quality of life as a key factor in a sustainable reconstruction; these strategies are not currently considered in post-catastrophe national policy. Sustainability factors include locally specific environmental, cultural and geographical issues, and also consider accessible and viable solutions for the most vulnerable sector of Chilean society. Therefore, the original objective behind this proposal is:

“to create emergency dwellings that offer quick, good quality and sustainable homes for the families who are the victims of a disaster.”

Thus the architectural and urban concepts that shape the proposal at both individual and collective levels are: Modularity, progressivity, flexibility and affordability.
Modularity
Casa FENIX evolves from a basic Survival Module to a complex Eco Village/Housing Complex. This process covers the stage of Emergency, Relief and Reconstruction.

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Casa FENIX progression allows the Survival Module unit to become a final home. This incremental and evolving logic is assumed by the urban design strategy.

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Casa FENIX is an affordable home. Each unit may be acquired through the progressive subsidy addressing the total cost of the home.

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For the SDE competition, the Casa FENIX Team proposes to bring a house that represents reconstruction as a growth progression and is configured to perform well in the Versailles climate. The basic structure and its components will subsequently be configured to meet the solar passive design strategy for the specific local climate where it is to be installed.

The programme represents the core concept of Casa FENIX, which takes a progressive approach to Emergency, Relief and Reconstruction, with sustainability in mind. It uses a passive solar design driven by a sunspace, which acts as the energy engine of the completed house and is a key spatial element which allows the articulation of the different modules.

Casa FENIX is a modular design in which each 11 m² module can be progressively attached and easily assembled during a post-disaster period, to form a dwelling measuring 60m².

The modules are as follows:
Survival Module
This is the quick initial response for the emergency period, immediately after a catastrophe strikes. Its main objective is to provide shelter, safety and a quality solution to the affected family.

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THE GEOGRAPHICAL DIMENSION
Chile has 9 different climate types and the country stretches from latitude 18°S to 50°S. 90% of the population is located in areas where solar radiation is over 1000kWh/year. To address this climatic diversity and take advantage of the opportunity for solar radiation, the conceptual idea for

“Casa FENIX is similar to a skeleton or basic structure, an innovative structural design developed by students, where different components can be configured and assembled according to the users’ demands”
All the components to be attached to it respond to the demands for the different latitudes and to patterns of self-construction.

**SUSTAINABILITY FOR US** It is important to mention that the understanding of sustainability in the case of developing nations differs much from the one used in developed nations, in the sense that the problems that needs to be addressed are much different, respect of priorities and urgencies. For the Chilean case the deterioration produced by natural disasters and the anthropic urban degradation produced by informal settlements and poverty are the immediate problems to solve in a sustainable way. To teach the general public about sustainability issues that go beyond recycling, energy efficiency and achieving a low carbon footprint, Casa FENIX proposes to focus mainly on local cultural aspects, quality of life and social relationships. In this case the sustainability aspects are focused on using technology and urban planning to enhance the intuitive know-how of a particular local population.

“*The choice of site: Man’s physical freedom manifests itself no doubt in his ability to choose the place on earth where he wants to live.*”

People act, build and adapt through self-construction to the different latitudes and geographical conditions over time using their intuitive and basic knowledge.

“*Neither privations nor danger will deter man from selecting a spot [...]” to settle on* (Rudofsky, 1964).

This recognition of the appropriateness of the way informal settlements and self-construction take place is basic and seen to be positive; however it is extremely precarious and unsustainable in many other
aspects and in extreme situations could produce complete devastation. This was the case in April 2014 when a wildfire ravaged Valparaíso for three days; 2,900 homes were destroyed and 14,000 people - 4% of the Valparaíso population (IMV, 2014) - were made homeless.

The reasons for the unsustainable settlements can be traced back to many issues related to post-disaster rehabilitation and poverty and a major factor is the lack of a sustainable urban code for areas of vulnerability. This sustainable urban code would need to respond in a general way to the emergency and in a particular way to the post-catastrophe situation that begins right after an emergency occurs.

Casa FENIX TEAM ORGANIZATION Team Casa FENIX is a bi-national team composed of students and faculty members from the Universidad Técnica Federico Santa María [UTFSM], Valparaíso, Chile and from the Institute Universitaire de Technologie [IUT], Université de La Rochelle, France. In addition to all the opportunities that arise out of any international collaboration between academic institutions, team Casa FENIX seeks to respond coherently to SDE’s energy conservation objectives.

The proposal has been designed to address the circumstances and needs of Chile. However, transporting the house from Chile to France would entail a significant amount of CO2 emissions and the team has therefore set itself the goal of making a “PROTOTIPE” in Chile and a “REPLICA” in France, generating a dualism and a double challenge for our project. So, while the conceptual proposal is Chilean, the production of Casa FENIX is French.

TEAM Casa FENIX CHILE The Chilean part of the team is in charge of all the theoretical, conceptual, architecture and urban design content of the project. One of the strengths of UTFSM is their research and work on bioclimatic architecture and earthquake resistant construction.

The design of Casa FENIX has been developed in Chile with the participation of the students from the French team during the process. Half of Casa FENIX will constitute the prototype built and tested in Valparaíso.

TEAM Casa FENIX FRANCE The French part of the team is in charge of all the practical, construction, building and technology applications of the project. One of the strengths of IUT is their research into and work with wooden structures and construction. A complete version of a replica of Casa FENIX is being built in La Rochelle and this is the version that will compete in Versailles.
6.1.1 INTRODUCTION

The dinner party menu content objective is to highlight the Chilean food driven by a diversity of soil types and climates for producing a vast variety of fruits and vegetables; grains, nuts and cereals; meats and seafood and dairy products. Blessed with long, hot summers and cool coastal breezes, natural irrigation from melting snow and a virtually pest and disease free environment, Chile has some of the finest terrain in the World.

Almost all the regions are rich in seafood that come from the Pacific Ocean and varies greatly from north to south being influenced by the cold Humbolt current. Also the islands, archipelagos, Magellan’s Strait and Patagonia contribute with many rare species to the Chilean kitchen since historical times.

The great variety of fruits and vegetables harvested seasonally are produced mostly in the Central Valley. Although, the berries and dairy products come from the south lake district, the colourful potatoes comes from the Island of Chiloe, the very distinct “Limachino” tomato is harvested in Limache, the great variety of delicious avocados come from La Cruz, the chilli to prepare the smoked hot powder “merken” from Temuco. The northern regions are known for the cereals, where our natives cultivated the ancestral Quinoa and maize, to name a few!

Chile is the paradise for winemakers with 14 wine regions from the Elqui valley in the north to the Bío Bío valley in the south, where the world recognised Cabernet Sauvignons, Carmenere, Merlot, Pinot Noir, Shiraz, Malbec, Chardonnay and Sauvignon Blanc wines are produced and imported to all the world.

6.1.2 APPETIZER

The appetizer will be the same for all the dinner options

**DRINKS**
- Natural Juice
- Pineau de Charentes
- Pisco Sour

**STARTERS**
- Goat cheese with olive’s mix
country day
6.1.3 FIRST COURSE

Option 1 “La Rochelle à la Chilien”

Preparation

Set aside La Rochelle oysters open and iced preserved.

Limonnette dressing: mix lemon juice, chili diaguita, olive oil, salt and set aside. Chop brunoise cut and remove seeds of limachino type tomatoes and sauté in olive oil and salt.

Option 2 “Quinotto de Los Andes”

Ingredients

- 300 gr quinoa
- 1 onion cut in brunoise
- 1 carrot cut in brunoise
- 1 zucchini cut in brunoise
- 200 gr mushrooms in emance cut
- 200 cc cream
- 1 cup of white wine
- 1 clove garlic cut in brunoise
- 50 ml olive oil
- 1 bay leaf
- Pinch of salt, pepper, merkén

Preparation

Wash quinoa until the water runs clear, then cook the quinoa three cups of water until tender and reserve.

Saute onion, carrots and zucchini with mushrooms. Add white wine, cream, salt and pepper and assorted seafood (for vegetarians, do not include seafood). Add the cooked quinoa and parmesan cheese. Mix everything well and distribute in Chilean ceramic bowls.

Option 3 “La mer et la terre pimenté”

1.5 kg of mussels in shell
200 g of potatoes
1 onion cut in julianne
1 small carrot cut in brunoise
100 ml white wine
1 clove garlic cut in brunoise
50 ml olive oil
1 bay leaf
Pinch of salt, pepper, merkén

Preparation

Wash the mussels and keep them cold aside. Cut the onions, carrot and garlic. Fry the vegetables in oil for 5 minutes, add the mussels, season with merkén, salt and pepper, add white wine and add water or broth. Cover pot or pan until the mussels open and set aside.

6.1.4 MAIN COURSE

Option 1 “La Rochelle à la Chilien”

535.2 Kcal per serving

1 kg of sea bass fillet
200g roasted and ground dried meat (“Charqui” Chilean beef jerky)

For sauce:
1 bunch basil
1 bunch parsley
100 ml cream
1 clove garlic
50 ml white wine

For cocho:
300 gr of toasted flour (Chilean harina tostada)
1 onion cut in brunoise
2 diced tomatoes
Pinch of salt, pepper

Preparation

Cut fish into 6 portions and set aside. Roast and grind the charqui in a toaster. Bread the sea bass fillets in ground charqui and cook the fillets in oiled skillet, set aside. For cocho, saute onion and tomatoes, add salt, pepper, water and toasted flour, cook to form a puree. For sauce, grind the basil and garlic, mix with cream, heat and cook in a frying pan, season

1 Vegetarian and non-vegetarian
with salt and pepper, garnish with chopped parsley and serve.

Option 2 “Quinotto de Los Andes”

1 kg of sea bass fillet
200 ml cream
100 gr of sea urchin tongues
100 ml white wine
50 g butter
300 gr Chuchoca (Chilian polenta)
200 gr peeled potatoes cut in brunoise
100 gr butternut squash cut in brunoise
1 red bell pepper cut in brunoise
1 small onion in whole
Olive oil, salt and pepper

Cut fish in fillets, cook in a skillet and set aside. For chuchoca: saute onion and pepper in a pot, add the potatoes and squash, add water and cook, then add the chuchoca and cook for 5 minutes. For sea urchin sauce: cook the cream with butter and sea urchin tongues in a pan, season with salt and pepper and add a touch of white wine. To smoke onion oil, placed the whole small onion on the fire until it burns then wash down it in oil.

Option 3 “La mer et la terre pimenté” (vegetarian and non-vegetarian)

1k potatoes chilotas
Celery leaves
600 gr lamb loin for vegetarian alternative
1 cochayuyo (Durvillaea Antarctica seaweed)
100 g butter
2 onions cut in julienne
50 g sugar
1 garlic clove chilote
4 eggs
Olive oil, salt and pepper

Preparation

Cook the potatoes in plenty of water, once cooked and cut into wedges, oven baked with butter, salt, garlic and celery leaves. Cut the lamb loin into cubes or cut the cochayuyo previously soaked in water for two hours, season and saute in a pan. Add sugar in a skillet to caramelised the onions, cook for about 10 minutes and set aside.

6.1.5 DESSERT

OPTION 1 “Semola con leche”

300 gr semolina
500 cc of milk
1 orange
1 cinnamon stick
500 g sugar
4 apples
1 bottle of grape arrope syrup

Preparation

Heat milk with cinnamon, orange peel and sugar, once boiled add the semolina stir until thickened, divide into individual portion in dessert bowls and let cool. For the applesauce, cook apples in sugar water until soft, remove water and grind to form a puree.

OPCION 2 “Southern fruit compote”

Two bottles of 1k of myrtle or quince fruit in syrup ()
One jar og 50 g of calafate jam
Cinnamon

Preparation

Distribute the fruit in individual portion in dessert bowls, garnish with calafate jam and with a cinnamon stick.
OPTION 3 “La Rochelle à la Chilien Celestines”

400 Kcal (100 gr)

4 eggs
200 ml of milk
100 gr of flour
100 ml of oil
500 gr of manjar (caramel milk)
200 gr of delicacy lucuma puree
100 cc of cream
200 gr of icing sugar

Preparation

For crepes: In a bowl mix eggs and flour, add milk and beat slowly to form a homogeneous batter, prepare the celestinos (crepes) in a previously warmed teflon pan. Prepare individual celestinos filled with manjar. For lucuma cream: beat the cold cream with icing sugar and stir in lucuma puree.

6.1.6 MENU

Our team has developed several “Menu cards” with the idea of bringing to the Solar Decathlon the best of Chilean gastronomy, which is skilfully mixed with the best French food, reaching thus the best of both cultures.

The main idea of this “Menu cards” is to show in a right way the best of both cultures joined in one dinner.

Please find in the next pages all of the graphic material that we will use for introducing the best of both food cultures.
Introduction

The dinner party menu content objective is to highlight the Chilean food driven by a diversity of soil types and climates for producing a vast variety of fruits and vegetables, grains, nuts and cereals, meats and seafood and dairy products. Blessed with long, hot summers and cool coastal breezes, natural irrigation from melting snow and a virtually pest and disease-free environment, Chile has some of the finest terroirs in the world.

Almost all the regions are rich in seafood that come from the Pacific Ocean and varies greatly from north to south being influenced by the cold Humbolt current. Also the islands, archipelagos Magellan’s Strait and Patagonia contribute with many rare species to the Chilean kitchen since historical times.

The great variety of fruits and vegetables harvested seasonally are produced mostly in the Central Valley. Although, the berries and dairy products come from the south lake district, the colourful potatoes comes from the Island of Chiloé, the very distinct “Limachino” tomato is harvested in Limache, the great variety of delicious avocados come from La Cruz, the chilli to prepare the smoked hot powder “merken” from Temuco. The northern regions are known for the cereals, where our natives cultivated the ancestral Quinoa and maize, to name a few!

Chile is the paradise for winemakers with 14 wine regions from the Alto valley in the north to the Bío Bío valley in the south, where the world recognised Cabernet Sauvignon, Carmenere, Merlot, Pinot Noir, Shiraz, Malbec, Chardonnay and Sauvignon Blanc wines are produced and imported to all the world.
Appetizer

Goat Cheese with Olives's Mix in Country Bread

Fresh Fruit Juice

Pisco Sour

Pineau des Charentes
**INGREDIENTS**

- 24 oysters
  - 16 Kcal (1 und)
- 30 ml lemon juice
  - 12 Kcal (1 und)
- 5 drops of de chili diaguita
  - 1 Kcal
- 50 ml Olivas’s oil
  - 884 Kcal (100 cc)
- 5 gr. of salt
  - 0 Kcal
- 3 tomatoes
  - 18 Kcal (1 und)
- Frappe’ ice

**CALCULATION**

184.8 kcal per serving

**PREPARATION**

Wash quinoa until the water runs clear, then cook the quinoa three cups of water until tender and reserve. Sauté onion, carrots and zucchini in brunoise cut with mushrooms in emance cut. Add white wine, cream, salt and pepper and assorted seafood (for vegetarians, do not include seafood). Add the cooked quinoa and parmesan cheese. Mix everything well and distribute in Chilean ceramic bowls.

- 300 gr of quinoa
  - 368 Kcal (100 gr)
- 1 onion
  - 40 Kcal (1 und)
- 1 carrot
- 1 zucchini
  - 19 Kcal (1 und)
- 200 gr mushrooms
  - 22 Kcal (100 gr)
- 200 ml liquid cream
  - 122 Kcal (100 gr)
- 1 cup of white wine
  - 82 kcal (100 gr)

143.8 kcal per serving

- 1.5 kg of mussels in shell
  - 7 Kcal (1 und)
- 200 gr of potatoes
  - 77 Kcal (100 gr)
- 1 onion
  - 40 Kcal (1 und)
- 1 small carrot
  - 41 Kcal (1 und)
- 100 ml white wine
  - 82 Kcal
- 1 of mussels in shell
  - 149 Kcal (100 gr)
- 50 ml oliva’s oil
  - 450 Kcal
- 1 bay leaf
  - 313 Kcal (100 gr)
- 1 pinch of merken
  - 33 Kcal (10 gr)
- salt
  - Pimienta
  - 255 Kcal (100 gr)

Wash the mussels and keep them cold aside. Cut the onions in julienne, carrot and garlic in brunoise. Fry the vegetables in oil for 5 minutes, add the mussels, season with merken, salt and pepper, add white wine and add water or broth. Cover pot or pan until the mussels open and set aside.
INGREDIENTS

1 kg of sea bass fillet  
97 Kcal (100 gr)
200 ml cream  
122 Kcal (100 gr)
100 gr of sea urchin  
tongues  
13 Kcal (100 gr)
100 ml white wine  
41 Kcal (100 cc)
50 gr butter  
750 Kcal (100 gr)
300 gr de Chuchoca (Chilian  
polenta)  
361 Kcal (100 gr)
200 gr peeled potatoes cut  
in brunoise  
77 Kcal (100 gr)
100 gr butternut squash cut  
in brunoise  
15 Kcal (100 gr)
1 red bell pepper cut in  
brunoise  
27 Kcal (100 gr)
1 small onion in whole  
60 Kcal (1 und)
olive oil  
884 Kcal (100 cc)
Salt  
255 Kcal (100 gr)
Pimenta  
654.9 kcal per serving

PREPARATION

Cut fish into 6 portions and  
set aside. Roast and grind  
the charqui in a toaster.  
Bread the sea bass fillets in  
ground charqui and cook  
the fillets in oiled skillet, set  
aside. For cocho, saute  
onion and tomatoes, add  
salt, pepper, water and  
toasted flour, cook to form  
a puree. For sauce, grind  
the basil and garlic, mix  
with cream, heat and cook  
in a frying pan, season with  
salt and pepper, garnish  
with chopped parsley and  
serve.

Cut fish in fillets, cook in a  
skillet and set aside. For  
chuchoca: saute onion  
and pepper in a pot, add  
the potatoes and squash,  
add water and cook, then  
add the chuchoca and  
cook for 5 minutes. For sea  
urchin sauce: cook the  
cream with butter and sea  
urchin tongues in a pan,  
season with salt and  
pepper and add a touch  
of white wine. To smoke  
onion oil, place the  
whole small onion on the  
fire until it burns then wash  
down it in oil.

1 kg potatoes chilotas  
66 Kcal (100 gr)
Celery leaves  
16 Kcal (100 gr)
600 gr lamb loin for vegeta- 
rian alternative: 1 cochayuyo  
(Durvillaea Antartica)  
122 Kcal (100 gr)
100 g butter  
750 Kcal (100 gr)
2 onions cut in julienne  
40 Kcal (1 und)
50 g sugar  
398 Kcal (100 gr)
1 garlic clove chilote  
49 Kcal (100 gr)
4 eggs  
62 Kcal (100 gr)
oil  
884 Kcal (100 cc)
Salt  
255 Kcal (100 gr)
Pepper  
448.6 kcal per serving

Cook the potatoes in  
plenty of water, once  
cooked and cut into  
wedges, oven baked with  
butter, salt, garlic and  
celery leaves. Cut the  
lamb loin into cubes or cut  
the cochayuyo previously  
soaked in water for two  
hours, season and saute  
in a pan. Add sugar in a skil- 
let to caramelize the  
onions, cook for about 10  
minutes and set aside.
Dessert

Celestinos
White Caramel Milk and Lucuma

Semolina Pudding
White Apple Sauce and Arrope Syrup
**INGREDIENTS**

- 300 gr semolina
  - 360 Kcal (100 gr)
- 500 ml of milk
  - 42 Kcal (100 gr)
- 1 orange
  - 47 Kcal (100 gr)
- 1 cinnamon stick
  - 247 Kcal (100 gr)
- 500 gr of sugar
  - 387 Kcal (100 gr)
- 4 apples
  - 52 Kcal (100 gr)
- 1 bottle of grape arrope syrup

**584.3 kcal per serving**

**PREPARATION**

Calentar la leche con canela, cascara de naranja y 300 gr de azúcar, una vez hervida agregar la sémola revolverse hasta esezar, disponer en una fuente y dejar enfriar.

Para el pure de manzana, cocer manzanas en agua con azúcar hasta que estén blandas, retirar el agua y moler hasta formar un pure.

**4 eggs**
- 52 Kcal (100 gr)

**200 ml of milk**
- 42 Kcal (100 gr)

**100 gr of flour**
- 366 Kcal (100 gr)

**100 ml of oil**
- 884 Kcal (100 cc)

**½ kg of manjar (caramel milk)**
- 315 Kcal (100 cc)

**200 gr of delicacy lucuma puree**
- 12 Kcal (100 cc)

**100 ml of cream**
- 122 Kcal (100 gr)

**200 gr of icing sugar**
- 400 Kcal (100 gr)

**6.79 kcal per serving**

En un bowl agregar los huevos y la harina, batir y agregar la leche lentamente hasta formar una masa homogénea, calentar en un sarten de teflón y preparar los celestinos, reservar. Para la crema de lúcuma, batir la crema helada con lúcuma y azúcar fior, reservar.
Chilean Carménère Reserve

TABALI wine limari valley

CASAS DEL BOSQUE wine casa blanca valley

OVEJA NEGRA wine maipo valley
CONTEST WEEK TASK’S PLANNING

CASA FENIX

[Solar Decathlon Europe] [Team FENIX]
One of the most outstanding geographical features of Chile is the relatively constant threat of earthquakes, among other natural disasters, such as volcano eruptions, landslides and fires in urban areas. The regularity with which these events occur does not make them any less catastrophic for people. Many homes are lost and the people who are most affected are low-income families. The post-catastrophe situation throughout the year has indeed been non-sustainable, therefore to develop and implement the concept of sustainable reconstruction is a big challenge for our country, where Casa FENIX ambition is to propose and offer a tangible solution.

**THE PROBLEM** While Chile is a political and geographical location where natural disasters are recurrent and affect a great part of the most socially vulnerable population, there are no official policies which outline a quality response to such events.

*“When disaster strikes, the problems are resolved with quick, cheap, short-term solutions, such as the mediagua emergency houses”*

which end up causing more problems than they solve and lead to a great deal of waste in the long term.

**HYPOTHESIS** Casa FENIX is a design process that responds to a catastrophe, delivering energy efficient strategies to ensure quality of life as a key factor in a sustainable reconstruction; these strategies are not currently considered in post-catastrophe national policy. Sustainability factors include locally specific environmental, cultural and geographical issues, and also consider accessible and viable solutions for the most vulnerable sector of Chilean society. Therefore, the original objective behind this proposal is:

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People act, build and adapt through self-construction to the different latitudes and geographical conditions over time using their intuitive and basic knowledge.

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# 7.1.1 Daily Schedules

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<th>Monday 27 June</th>
<th>Tuesday 28 June</th>
<th>Wednesday 29 June</th>
<th>Thursday 30 June</th>
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- **Schedules:**
  - Task start time
  - Task end time

- **Activities:**
  - Task description
  - Task status

- **Notes:**
  - Additional information

**Sunday 25 June**
- **Task:**
  - Task description
  - Task status

**Saturday 26 June**
- **Task:**
  - Task description
  - Task status

**Thursday 22 June**
- **Task:**
  - Task description
  - Task status

**Wednesday 21 June**
- **Task:**
  - Task description
  - Task status

**Tuesday 20 June**
- **Task:**
  - Task description
  - Task status

**Monday 19 June**
- **Task:**
  - Task description
  - Task status
## Solar Decathlon Europe [Team FENIX]

### Monday 30 June

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[Solar Decathlon Europe] [Team FENIX]
COST ESTIMATE AND PROJECT FINANCIAL SUMMARY

CASA FENIX

[Solar Decathlon Europe] [Team FENIX]
Casa FENIX
For Emergency post-Natural Impact eXtreme REMINDER

One of the most outstanding geographical features of Chile is the relatively constant threat of earthquakes, among other natural disasters, such as volcano eruptions, landslides and fires in urban areas. The regularity with which these events occur does not make them any less catastrophic for people. Many homes are lost and the people who are most affected are low-income families. The post-catastrophe situation throughout the year has indeed been non-sustainable, therefore to develop and implement the concept of sustainable reconstruction is a big challenge for our country, where Casa FENIX ambition is to propose and offer a tangible solution.

THE PROBLEM While Chile is a political and geographical location where natural disasters are recurrent and affect a great part of the most socially vulnerable population, there are no official policies which outline a quality response to such events.

“When disaster strikes, the problems are resolved with quick, cheap, short-term solutions, such as the mediagua emergency houses”
which end up causing more problems than they solve and lead to a great deal of waste in the long term.

HYPOTHESIS Casa FENIX is a design process that responds to a catastrophe, delivering energy efficient strategies to ensure quality of life as a key factor in a sustainable reconstruction; these strategies are not currently considered in post-catastrophe national policy. Sustainability factors include locally specific environmental, cultural and geographical issues, and also consider accessible and viable solutions for the most vulnerable sector of Chilean society. Therefore, the original objective behind this proposal is:

“to create emergency dwellings that offer quick, good quality and sustainable homes for the families who are the victims of a disaster.”

Thus the architectural and urban concepts that shape the proposal at both individual and collective levels are: Modularity, progressivity, flexibility and affordability.
Modularity
Casa FENIX evolves from a basic Survival Module to a complex Eco Village/Housing Complex. This process covers the stage of Emergency, Relief and Reconstruction.

Progressivity
Casa FENIX progression allows the Survival Module unit to become a final home. This incremental and evolving logic is assumed by the urban design strategy.

Flexibility
Casa FENIX has the capability to adapt to different latitudes and climates, given the geographical characteristics and diversity of climates Chile possesses, from north to south.

Affordability
Casa FENIX is an affordable home. Each unit may be acquired through the progressive subsidy addressing the total cost of the home.

ARCHITECTURAL PROGRAMME
For the SDE competition, the Casa FENIX Team proposes to bring a house that represents reconstruction as a growth progression and is configured to perform well in the Versailles climate. The basic structure and its components will subsequently be configured to meet the solar passive design strategy for the specific local climate where it is to be installed.

The programme represents the core concept of Casa FENIX, which takes a progressive approach to Emergency, Relief and Reconstruction, with sustainability in mind. It uses a passive solar design driven by a sunspace, which acts as the energy engine of the completed house and is a key spatial element which allows the articulation of the different modules.

Casa FENIX is a modular design in which each 11 m² module can be progressively attached and easily assembled during a post-disaster period, to form a dwelling measuring 60m².

The modules are as follows:
Survival Module
This is the quick initial response for the emergency period, immediately after a catastrophe strikes. Its main objective is to provide shelter, safety and a quality solution to the affected family.

Mechanical Module
This is the first module to be attached to the Survival Module as a progression during the relief period. It consists of the services and a technical core. It includes a bathroom and kitchen.

Living Module
This is the module that enables the house to expand and cover more than the basic needs during the reconstruction period, transforming the sum of modules into a definitive home.

Sunspace
The passive solar design strategy enables the regulation of the indoor climate by articulating the different modules with the exterior climate; this space grows with the addition of each module.

At a collective level, the group of emergency houses, which the FENIX team has called “Temporary Village FENIX, TVF” and the progression to a housing complex, which the FENIX team has called “Eco-Village FENIX, EVF” are conceived following the same logic. They have an open and flexible design that allows for the adaptation of modules and means that Casa FENIX can be adapted to different climatic, topographical, territorial and cultural realities.

THE GEOGRAPHICAL DIMENSION
Chile has 9 different climate types and the country stretches from latitude 18°S to 50°S. 90% of the population is located in areas where solar radiation is over 1000kWh/year. To address this climatic diversity and take advantage of the opportunity for solar radiation, the conceptual idea for “Casa FENIX is similar to a skeleton or basic structure, an innovative structural design developed by students, where different components can be configured and assembled according to the users’ demands”
All the components to be attached to it respond to the demands for the different latitudes and to patterns of self-construction.

**SUSTAINABILITY FOR US** It is important to mention that the understanding of sustainability in the case of developing nations differs much from the one used in developed nations, in the sense that the problems that needs to be addressed are much different, respect of priorities and urgencies. For the Chilean case the deterioration produced by natural disasters and the anthropic urban degradation produced by informal settlements and poverty are the immediate problems to solve in a sustainable way. To teach the general public about sustainability issues that go beyond recycling, energy efficiency and achieving a low carbon footprint, Casa FENIX proposes to focus mainly on local cultural aspects, quality of life and social relationships. In this case the sustainability aspects are focused on using technology and urban planning to enhance the intuitive know-how of a particular local population.

“Our choice of site: Man’s physical freedom manifests itself no doubt in his ability to choose the place on earth where he wants to live”.

People act, build and adapt through self-construction to the different latitudes and geographical conditions over time using their intuitive and basic knowledge.

“Neither privations nor danger will deter man from selecting a spot [...]” to settle on (Rudofsky, 1964).

This recognition of the appropriateness of the way informal settlements and self-construction take place is basic and seen to be positive; however it is extremely precarious and unsustainable in many other
aspects and in extreme situations could produce complete devastation. This was the case in April 2014 when a wildfire ravaged Valparaíso for three days; 2,900 homes were destroyed and 14,000 people - 4% of the Valparaíso population (IMV, 2014) - were made homeless.

The reasons for the unsustainable settlements can be traced back to many issues related to post-disaster rehabilitation and poverty and a major factor is the lack of a sustainable urban code for areas of vulnerability. This sustainable urban code would need to respond in a general way to the emergency and in a particular way to the post-catastrophe situation that begins right after an emergency occurs.

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## COST ELEMENTS

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<td>Expenses Allowance</td>
<td></td>
<td>100.00</td>
<td>-</td>
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<tr>
<td></td>
<td>Sub-Total First Workshop</td>
<td></td>
<td>3,469.00</td>
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<td>-----------------</td>
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<td>A.4</td>
<td>Second Workshop - Team FENIX</td>
<td></td>
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<tr>
<td></td>
<td>Travel &amp; Transport</td>
<td>5 Chileans + 5 French</td>
<td>8,400,00 €</td>
<td>-</td>
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<td></td>
<td>Lodging</td>
<td>5 Chileans + 5 French</td>
<td>3,440,00 €</td>
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<td></td>
<td>Expenses Allowance</td>
<td>Team Members + Unit Cost</td>
<td>300,00 €</td>
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<td></td>
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<td><strong>Sub-Total Second Workshop</strong></td>
<td><strong>12,140,00 €</strong></td>
<td>0.00 €</td>
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<td>A.5</td>
<td>Administrative and miscellaneous</td>
<td></td>
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<tr>
<td>A.5.1</td>
<td>Administrative and miscellaneous - Team FENIX Chile</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Administrative expenses</td>
<td></td>
<td>5,024,33 €</td>
<td>-</td>
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<td></td>
<td></td>
<td><strong>Sub-Total Administrative and miscellaneous - Team FENIX Chile</strong></td>
<td><strong>5,024,33 €</strong></td>
<td>0.00 €</td>
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<td>A.5.2</td>
<td>Administrative and miscellaneous - Team FENIX France</td>
<td></td>
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<tr>
<td></td>
<td>Consumables and office supplies</td>
<td></td>
<td>1,950,00 €</td>
<td>-</td>
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<tr>
<td></td>
<td>Administrative expenses</td>
<td></td>
<td>2,500,00 €</td>
<td>-</td>
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<td></td>
<td></td>
<td><strong>Sub-Total Administrative and miscellaneous - Team FENIX France</strong></td>
<td><strong>4,450,00 €</strong></td>
<td>0.00 €</td>
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<tr>
<td></td>
<td></td>
<td><strong>Sub-Total Administrative and miscellaneous</strong></td>
<td><strong>9,474,33 €</strong></td>
<td>0.00 €</td>
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<td>A.6</td>
<td>International Exchange</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>A.6.1</td>
<td>First International Exchange - French students - Construction in Chile</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Travel &amp; Transport</td>
<td>5 Students</td>
<td>7,000,00 €</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Lodging</td>
<td>5 Students</td>
<td>1,125,00 €</td>
<td>-</td>
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<tr>
<td></td>
<td>Expenses Allowance</td>
<td>5 Students</td>
<td>1,375,00 €</td>
<td>-</td>
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<tr>
<td></td>
<td>Miscellaneous Expenses</td>
<td>Casa FENIX team activities during visit</td>
<td>300,00 €</td>
<td>-</td>
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<td></td>
<td></td>
<td><strong>Sub-Total First International Exchange</strong></td>
<td><strong>10,000,00 €</strong></td>
<td>0.00 €</td>
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<td>A.6.2</td>
<td>Second International Exchange - Chilean students - Construction Phase of CASA FENIX 2014 in La Rochelle</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Travel &amp; Transport</td>
<td>5 Chileans depart a La Rochelle</td>
<td>7,655,00 €</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Lodging</td>
<td>Total of all members (24,5 months)</td>
<td>5,635,00 €</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Expenses Allowance</td>
<td>Total of all members (24,5 months)</td>
<td>28,677,00 €</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Miscellaneous Expenses</td>
<td>Visa and Travel Insurances</td>
<td>3,420,00 €</td>
<td>-</td>
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<tr>
<td></td>
<td></td>
<td><strong>Sub-Total Second International Exchange</strong></td>
<td><strong>44,787,00 €</strong></td>
<td>0.00 €</td>
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<td>A.6.3</td>
<td>International Exchange - French Professors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>First Mission in April 2013</td>
<td>2 Professors and 1 industrial manager (1 week)</td>
<td>6,635,01 €</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Second Mission in October 2013</td>
<td>1 Professor and 1 engineer (1 week)</td>
<td>4,480,01 €</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Third Mission in April 2014</td>
<td>2 Professors (1 week)</td>
<td>4,480,01 €</td>
<td>-</td>
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<tr>
<td></td>
<td></td>
<td><strong>Sub-Total International Exchange - French Professors</strong></td>
<td><strong>14,995,01 €</strong></td>
<td>0.00 €</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Sub-Total International Exchange</strong></td>
<td><strong>69,782,01 €</strong></td>
<td>0.00 €</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Sub-Total Development Phase Cost Estimate</strong></td>
<td><strong>175,398,70 €</strong></td>
<td><strong>940,76 €</strong></td>
</tr>
</tbody>
</table>
## SDE 2014 COMPETITION EN FRANCE

**Team's Abbreviations:** FNX

**School's Name:** UNIVERSIDAD TECNICA FEDERICO SANTA MARÍA - UNIVERSITE DE LA ROCHELLE

**Team's Name:** CASA FENIX

### COST ELEMENTS

<table>
<thead>
<tr>
<th>No</th>
<th>Name</th>
<th>Description</th>
<th>Budget ex VAT</th>
<th>% Total</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>ex VAT</td>
<td>VAT</td>
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</tbody>
</table>

#### B.1 Direct Materials

**B.1.1 Direct Materials - Team FENIX Chile - Prototype**

<table>
<thead>
<tr>
<th>Description</th>
<th>Budget</th>
<th>% Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purchased Materials &amp; Parts</td>
<td>26,653,30</td>
<td>4.5%</td>
</tr>
<tr>
<td>Purchased Services</td>
<td>9,286,00</td>
<td>1.6%</td>
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<tr>
<td>Purchased Equipment</td>
<td>28,644,00</td>
<td>4.8%</td>
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</tbody>
</table>

**Total Direct Materials Team FENIX Chile - Proto:** 64,583,30

#### B.1.2 Direct Materials - Team FENIX France - Replica

<table>
<thead>
<tr>
<th>Description</th>
<th>Budget</th>
<th>% Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw Materials</td>
<td>56,982,65</td>
<td>9.0%</td>
</tr>
<tr>
<td>Purchased Materials &amp; Parts</td>
<td>70,263,00</td>
<td>11.9%</td>
</tr>
<tr>
<td>Purchased Services</td>
<td>7,200,00</td>
<td>1.2%</td>
</tr>
<tr>
<td>Purchased Equipment</td>
<td>15,908,00</td>
<td>2.6%</td>
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</tbody>
</table>

**Total Direct Materials Team FENIX France - Rep:** 149,553,72

**Total Direct Material:** 214,537,02

#### B.2 Direct Labor

**B.2.1 Direct Labor - Team FENIX Chile - Prototype**

<table>
<thead>
<tr>
<th>Description</th>
<th>Budget</th>
<th>% Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Professors &amp; Researchers</td>
<td>7,287,91</td>
<td>1.2%</td>
</tr>
<tr>
<td>Granted Students</td>
<td>4,478,10</td>
<td>0.8%</td>
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<tr>
<td>Labores and Technicians</td>
<td>173,40</td>
<td>0.0%</td>
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</tbody>
</table>

**Sub-Total Labor Materials - Team FENIX Chile - Proto:** 11,939,41

#### B.2.2 Direct Labor - Team FENIX France - Replica

<table>
<thead>
<tr>
<th>Description</th>
<th>Budget</th>
<th>% Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Professors &amp; Researchers</td>
<td>10,000,00</td>
<td>1.7%</td>
</tr>
<tr>
<td>Granted Students</td>
<td>23,160,00</td>
<td>3.9%</td>
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<tr>
<td>Labores and Technicians</td>
<td>15,000,00</td>
<td>2.5%</td>
</tr>
<tr>
<td>Others students</td>
<td>1,365,00</td>
<td>0.2%</td>
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</tbody>
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**Sub-Total Labor Materials - Team FENIX France - Rep:** 49,465,00

**Total Direct Labor:** 61,404,41

#### B.3 Lower - Tier Subcontractors

**B.3.1 Lower - Tier Subcontractors - Team FENIX Chile - Prototype**

<table>
<thead>
<tr>
<th>Description</th>
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<tbody>
<tr>
<td>Total Lower - Tier Subcontractors - Team FENIX Chile - Prot</td>
<td>0,00</td>
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</table>

**B.3.2 Lower - Tier Subcontractors - Team FENIX France - Replica**

<table>
<thead>
<tr>
<th>Description</th>
<th>Budget</th>
<th>% Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plumbing and Sanitary</td>
<td>800,00</td>
<td>0.1%</td>
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<tr>
<td>Electrical</td>
<td>1,750,00</td>
<td>0.3%</td>
</tr>
</tbody>
</table>

**Total Lower - Tier Subcontractors - Team FENIX France - Rep:** 2,550,00

**Sub-Total Lower - Tier Subcontractors:** 2,550,00
### SDE 2014 COMPETITION EN FRANCE

**Team’s Abbreviations**  
FNX

**School’s Name**  
UNIVERSIDAD TECNICA FEDERICO SANTA MARIA - UNIVERSITE DE LA ROCHELLE

**Team’s Name**  
CASA FENIX

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**COST ELEMENTS**

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<th>Description</th>
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<th>% Total</th>
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<tr>
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<td>ex VAT</td>
<td>VAT</td>
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<tr>
<td>B.4</td>
<td>Consultants</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>B.4.1 Consultants - Team FENIX Chile - Prototype</td>
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<td>0,00 €</td>
<td>0,00 €</td>
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<td></td>
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<tr>
<td></td>
<td></td>
<td>Structure Engineering CILC</td>
<td>4,000,00 €</td>
<td>- €</td>
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<tr>
<td></td>
<td></td>
<td>Structure Engineering ARCABOIS</td>
<td>1,000,00 €</td>
<td>- €</td>
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<tr>
<td></td>
<td></td>
<td>Solar Engineering JIT SOLAIRE</td>
<td>2,500,00 €</td>
<td>- €</td>
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<tr>
<td></td>
<td></td>
<td>Electrical Engineering SNÉE</td>
<td>800,00 €</td>
<td>- €</td>
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<td></td>
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<td>Sub-Total Consultants - Team FENIX France - Rep</td>
<td>8,300,00 €</td>
<td>0,00 €</td>
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<tr>
<td></td>
<td></td>
<td>Sub-Total Consultant</td>
<td>8,300,00 €</td>
<td>0,00 €</td>
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<td>B.5</td>
<td>Other Direct Costs</td>
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<td>B.4.1</td>
<td>Other Direct Costs - Team FENIX Chile - Prototype</td>
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<td>Sub-Total Other Direct Costs - Team FENIX Chile - Prot</td>
<td>0,00 €</td>
<td>0,00 €</td>
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<td>B.4.2</td>
<td>Other Direct Costs - Team FENIX France - Replica</td>
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<td></td>
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<td>General &amp; Administrative Expenses</td>
<td>1,500,00 €</td>
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<td>Security</td>
<td>1,548,62 €</td>
<td>- €</td>
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<td>Sub-Total Other Direct Costs - Team FENIX France - Rep</td>
<td>3,048,62 €</td>
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<td></td>
<td>Sub-Total Other Direct Cost</td>
<td>3,048,62 €</td>
<td>0,00 €</td>
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<td>Sub-Total House Construction Cost Estimate</td>
<td>289,840,05 €</td>
<td>10,979,16 €</td>
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**C. HOUSE DISASSEMBLY IN ORIGIN AND TRANSPORTATION** To be estimated in France when Fenix Replica

| C.1 | Disassembly in origin                                    |                                 |         |         |           |
|-----|----------------------------------------------------------|---------------------------------|---------|---------|           |
|     | Personnel                                                | Team Members + Unit Cost        | 60,000 €  | - €        | 6,1%       |
|     | Material and equipment                                   | Lifting tackle, crane           | 3,264,00 €  | - €        | 0,6%       |
|     | Other Expenses                                           |                                 | - €      | - €        | 0,0%       |
|     |                                                           | Sub-Total Disassembly in orig | 3,864,00 €  | 0,00 €  | 0,7%      |

| C.2 | House Transportation                                     |                                 |         |         |           |
|-----|----------------------------------------------------------|---------------------------------|---------|---------|           |
|     | Transport                                                |                                 | 17,640,00 €  | - €        | 3,0%       |
|     | Transport Insurance                                      | Included in Transport           | - €      | - €        | 0,0%       |
|     |                                                           | Sub-Total House Transportation | 17,640,00 €  | 0,00 €  | 3,0%      |

|     |                                                           | Sub-Total House Disassembly in Origin Cost Estimate | 21,504,00 €  | 0,00 €  | 3,6%      |
## COST ELEMENTS

<table>
<thead>
<tr>
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<th>Budget</th>
<th>% Total</th>
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<tr>
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<td>ex VAT</td>
<td>VAT</td>
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<td>D.1</td>
<td>Travels &amp; Costs for Final Phase in Versailles - Team FENIX Chile</td>
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<tr>
<td>D.1.1</td>
<td>Travel &amp; Transport</td>
<td>Team Members * Unit Cost</td>
<td>12,053,00 €</td>
<td>- €</td>
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<td></td>
<td>Lodging</td>
<td>Team Members * Unit Cost</td>
<td>32,263,05 €</td>
<td>- €</td>
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<tr>
<td></td>
<td>Expenses Allowance</td>
<td>Team Members * Unit Cost</td>
<td>10,314,00 €</td>
<td>- €</td>
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<td>Miscellaneous Expenses</td>
<td></td>
<td>314,00 €</td>
<td>- €</td>
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<td>Sub Total Travels &amp; Costs for Final Phase in Versailles - Team FENIX Chile</td>
<td></td>
<td>54,944,05 €</td>
<td>0,09 €</td>
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<td>D.1.2</td>
<td>Travel &amp; Transport</td>
<td>Team Members * Unit Cost</td>
<td>2,409,38 €</td>
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<td>Lodging</td>
<td>Team Members * Unit Cost</td>
<td>7,463,80 €</td>
<td>- €</td>
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<td>Expenses Allowance</td>
<td>Team Members * Unit Cost</td>
<td>8,490,00 €</td>
<td>- €</td>
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<td>Miscellaneous Expenses</td>
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<td>3,750,00 €</td>
<td>- €</td>
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<td>Sub Total Travels &amp; Costs for Final Phase in Versailles - Team FENIX France</td>
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<td>22,113,18 €</td>
<td>0,09 €</td>
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<td>Sub-Total Travels &amp; Costs for Final Phase in Versailles</td>
<td></td>
<td>77,057,23 €</td>
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### SDE 2014 COMPETITION EN FRANCE

#### Team's Abbreviations
FNX

#### School's Name
UNIVERSIDAD TECNICA FEDERICO SANTA MARIA - UNIVERSITE DE LA ROCHELLE

#### Team's Name
CASA FENIX

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<tr>
<td>D.2</td>
<td>Assembly and Disassembly Processes</td>
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<td></td>
<td></td>
</tr>
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<td></td>
<td>Cranes</td>
<td>mobile crane (74h)</td>
<td>8,340.00 €</td>
<td>1.4%</td>
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<td>Equipment and machinery</td>
<td>stepladder, barriers, scaffold</td>
<td>1,980.00 €</td>
<td>0.3%</td>
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<td></td>
<td>Assembly direct labor in Le Cité du Soleil</td>
<td>Team Members' Unit Cost</td>
<td>4,200.00 €</td>
<td>0.7%</td>
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<tr>
<td></td>
<td>Disassembly direct labor in Le Cité du Soleil</td>
<td>Team Members' Unit Cost</td>
<td>2,100.00 €</td>
<td>0.4%</td>
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<tr>
<td></td>
<td>Sub-Total Assembly, Transport, Disassembly Processes</td>
<td></td>
<td>16,620.00 €</td>
<td>2.8%</td>
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</tbody>
</table>

| D.3 | Insurance Policies                           |                                          |                 |         |
|     | Liability Insurance                          | included with students inscriptions     | - €             | 0%      |
|     | Transport Insurance                          | included with students inscriptions     | - €             | 0%      |
|     | Accident Insurance                           | included with students inscriptions     | - €             | 0%      |
|     | Medical Insurance                            | included with students inscriptions     | - €             | 0%      |
|     | Sub-Total Insurance Policies                 |                                          | 0,00 €          | 0%      |

Sub-Total Final Phase in La Cité du Soleil Cost Estimate: 93,677.23 €

### E. POST EVENT COST ESTIMATE

| E.1  | House Permanent Assembly                     |                                          |                 |         |
|      | Direct Labor                                 |                                          | 2,000.00 €      | 0.3%    |
|      | Materials                                    | Crane                                    | 4,800.00 €      | 0.8%    |
|      | Electric and Water connections               |                                          | 2,000.00 €      | 0.3%    |
|      | Lower - Tier Subcontractors                  | Excavation - Foundation                 | 2,000.00 €      | 0.3%    |
|      | Sub-Total House permanent Assembly           |                                          | 10,800.00 €     | 1.8%    |

| E.2  | As built                                     |                                          |                 |         |
|      | Professors & Researchers                     | not estimated                            | - €             | 0%      |
|      | Granted Students                             | not estimated                            | - €             | 0%      |
|      | Consumables and office supplies              | not estimated                            | - €             | 0%      |
|      | Administrative expenses                      | not estimated                            | - €             | 0%      |
|      | Sub-Total As Built                           |                                          | 0,00 €          | 0%      |

Sub-Total Post Event Cost Estimate: 10,800.00 €

### Total Price / Cost Estimated

- 591,219.97 € (100%)
- 11,919.94 €

Please CHECK (X) your status: 
- If you benefit VAT Recovering: -11,919.94 €
- If you don't: 11,919.94 €

Total Price / Cost Estimated included VAT: 591,219.97 € (100%)
### SDE 2014 COMPETITION

**Team's Abbreviations**: FNX  
**School's Name**: UNIVERSIDAD TECNICA FEDERICO SANTA MARIA - UNIVERSITE DE LA ROCHELLE  
**Team's Name**: CASA FENIX

### INCOMES

<table>
<thead>
<tr>
<th>Company Name</th>
<th>Collaboration Details</th>
<th>Amount of support</th>
<th>% Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Institutional Support</strong></td>
<td></td>
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<tr>
<td><strong>Institutional Support in Chile</strong></td>
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<td>UTFSM</td>
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### Industrial Partners & Sponsors

**Industrial Partners & Sponsors * Actual fund raised in Chile**

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<tr>
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<th>Amount of support</th>
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</thead>
<tbody>
<tr>
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**Industrial Partners & Sponsors * Actual fund raised in France**

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<td>Fédération départementale du Bâtiment</td>
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<td>Wood Company</td>
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<td>Plumbing</td>
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<td>Millet</td>
<td>Windows</td>
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<td>Soléhorn</td>
<td>Ventilair sec</td>
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<td>Serge Ferrari</td>
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<tr>
<td>SIGA</td>
<td>Achesives</td>
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</table>
### SDE 2014 Competition

**Team's Abbreviations**: FNX  
**School's Name**: UNIVERSIDAD TECNICA FEDERICO SANTA MARIA - UNIVERSITE DE LA ROCHELLE  
**Team's Name**: CASA FENIX

## INCOMES

<table>
<thead>
<tr>
<th>Company Name</th>
<th>Collaboration Details</th>
<th>Amount of support</th>
<th>% Total</th>
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<td>M2B</td>
<td>Bolt</td>
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<td>SFS intec</td>
<td>Saw</td>
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<tr>
<td>TREMCO Illbruck</td>
<td>Waterproofness</td>
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<td>Sub-Total Industrial Partners &amp; Sponsor</td>
<td>176,107,00 €</td>
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</table>

**Other Income Details**

| SDE                | First income                     | 30,000,00 €        | 5.2%    |
| SDE                | Future income                    | 20,000,00 €        | 3.5%    |

**Sub-Total Other Income Detail**: 50,000,00 €  
**Total Income**: 579,300,04 €  
**100%**
### COST

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<th>Budget</th>
<th>% Total of ex VAT</th>
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<td>(VAT)</td>
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<tr>
<td></td>
<td></td>
<td>on ex VAT</td>
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<td>A</td>
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<tr>
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<td>Personnel</td>
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<td>A.2</td>
<td>Communication</td>
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<td>A.3</td>
<td>First Workshop - Team FENIX</td>
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<td>Second Workshop - Team FENIX</td>
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<td>A.5</td>
<td>Administrative and miscellaneous</td>
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<td>A.6</td>
<td>International Exchange</td>
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<td>B.1</td>
<td>Direct Materials</td>
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<td>B.2</td>
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<td>B.5</td>
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<td>C</td>
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<td>C.1</td>
<td>Disassembly in origin</td>
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<td>C.2</td>
<td>House Transportation</td>
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<td>D</td>
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<td>D.1</td>
<td>Travels &amp; Costs for Final Phase in Versailles</td>
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### COST

<table>
<thead>
<tr>
<th>No.</th>
<th>Name</th>
<th>Budget ex VAT</th>
<th>VAT</th>
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<td>Insurance Policies</td>
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<td>E.1</td>
<td>House Permanent Assembly</td>
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<td><strong>Total Price / Cost Estimated</strong></td>
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<td><strong>11,919,94 €</strong></td>
<td><strong>100 %</strong></td>
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### INCOMES

<table>
<thead>
<tr>
<th>Company Name</th>
<th>Amount of support</th>
<th>% Total</th>
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<tbody>
<tr>
<td><strong>Institutional Support</strong></td>
<td>353,193,04 €</td>
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<tr>
<td>Institutional Support in Chile</td>
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<td>176,107,00 €</td>
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<td>26,644,00 €</td>
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<td>147,463,00 €</td>
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<td><strong>Other Income Details</strong></td>
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<td>9%</td>
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<tr>
<td><strong>Total Incomes</strong></td>
<td><strong>579,300,04 €</strong></td>
<td><strong>100 %</strong></td>
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### BALANCE

-11,919,94 €
C A S A F E N I X

For Emergency post-Natural Impact eXtreme R E M I N D E R

One of the most outstanding geographical features of Chile is the relatively constant threat of earthquakes, among other natural disasters, such as volcano eruptions, landslides and fires in urban areas. The regularity with which these events occur does not make them any less catastrophic for people. Many homes are lost and the people who are most affected are low-income families. The post-catastrophe situation throughout year has indeed been non-sustainable, therefore to develop and implement the concept of sustainable reconstruction is a big challenge for our country, where Casa FENIX ambition is to propose and offer a tangible solution.

THE PROBLEM While Chile is a political and geographical location where natural disasters are recurrent and affect a great part of the most socially vulnerable population, there are no official policies which outline a quality response to such events.

“When disaster strikes, the problems are resolved with quick, cheap, short-term solutions, such as the mediagua emergency houses”

which end up causing more problems than they solve and lead to a great deal of waste in the long term.

HYPOTHESIS Casa FENIX is a design process that responds to a catastrophe, delivering energy efficient strategies to ensure quality of life as a key factor in a sustainable reconstruction; these strategies are not currently considered in post-catastrophe national policy. Sustainability factors include locally specific environmental, cultural and geographical issues, and also consider accessible and viable solutions for the most vulnerable sector of Chilean society. Therefore, the original objective behind this proposal is:

“to create emergency dwellings that offer quick, good quality and sustainable homes for the families who are the victims of a disaster.”

Thus the architectural and urban concepts that shape the proposal at both individual and collective levels are: Modularity, progressivity, flexibility and affordability.
**Modularity**

Casa FENIX evolves from a basic Survival Module to a complex Eco Village/Housing Complex. This process covers the stage of Emergency, Relief and Reconstruction.

**Progressivity**

Casa FENIX progression allows the Survival Module unit to become a final home. This incremental and evolving logic is assumed by the urban design strategy.

**Flexibility**

Casa FENIX has the capability to adapt to different latitudes and climates, given the geographical characteristics and diversity of climates Chile possesses, from north to south.

**Affordability**

Casa FENIX is an affordable home. Each unit may be acquired through the progressive subsidy addressing the total cost of the home.

**ARCHITECTURAL PROGRAMME**

For the SDE competition, the Casa FENIX Team proposes to bring a house that represents reconstruction as a growth progression and is configured to perform well in the Versailles climate. The basic structure and its components will subsequently be configured to meet the solar passive design strategy for the specific local climate where it is to be installed.

The programme represents the core concept of Casa FENIX, which takes a progressive approach to Emergency, Relief and Reconstruction, with sustainability in mind. It uses a passive solar design driven by a sunspace, which acts as the energy engine of the completed house and is a key spatial element which allows the articulation of the different modules.

Casa FENIX is a modular design in which each 11 m² module can be progressively attached and easily assembled during a post-disaster period, to form a dwelling measuring 60m².

The modules are as follows:
**Survival Module**
This is the quick initial response for the emergency period, immediately after a catastrophe strikes. Its main objective is to provide shelter, safety and a quality solution to the affected family.

**Mechanical Module**
This is the first module to be attached to the Survival Module as a progression during the relief period. It consists of the services and a technical core. It includes a bathroom and kitchen.

**Living Module**
This is the module that enables the house to expand and cover more than the basic needs during the reconstruction period, transforming the sum of modules into a definitive home.

**Sunspace**
The passive solar design strategy enables the regulation of the indoor climate by articulating the different modules with the exterior climate; this space grows with the addition of each module.

At a collective level, the group of emergency houses, which the FENIX team has called “Temporary Village FENIX, TVF” and the progression to a housing complex, which the FENIX team has called “Eco-Village FENIX, EVF” are conceived following the same logic. They have an open and flexible design that allows for the adaptation of modules and means that Casa FENIX can be adapted to different climatic, topographical, territorial and cultural realities.

**THE GEOGRAPHICAL DIMENSION**
Chile has 9 different climate types and the country stretches from latitude 18°S to 50°S. 90% of the population is located in areas where solar radiation is over 1000kWh/year. To address this climatic diversity and take advantage of the opportunity for solar radiation, the conceptual idea for

> “Casa FENIX is similar to a skeleton or basic structure, an innovative structural design developed by students, where different components can be configured and assembled according to the users’ demands”
All the components to be attached to it respond to the demands for the different latitudes and to patterns of self-construction.

**SUSTAINABILITY FOR US** It is important to mention that the understanding of sustainability in the case of developing nations differs much from the one used in developed nations, in the sense that the problems that needs to be addressed are much different, respect of priorities and urgencies. For the Chilean case the deterioration produced by natural disasters and the anthropic urban degradation produced by informal settlements and poverty are the immediate problems to solve in a sustainable way. To teach the general public about sustainability issues that go beyond recycling, energy efficiency and achieving a low carbon footprint, Casa FENIX proposes to focus mainly on local cultural aspects, quality of life and social relationships. In this case the sustainability aspects are focused on using technology and urban planning to enhance the intuitive know-how of a particular local population.

“The choice of site: Man’s physical freedom manifests itself no doubt in his ability to choose the place on earth where he wants to live”. People act, build and adapt through self-construction to the different latitudes and geographical conditions over time using their intuitive and basic knowledge.

“Neither privations nor danger will deter man from selecting a spot […]” to settle on (Rudofsky, 1964).

This recognition of the appropriateness of the way informal settlements and self-construction take place is basic and seen to be positive; however it is extremely precarious and unsustainable in many other
aspects and in extreme situations could produce complete devastation. This was the case in April 2014 when a wildfire ravaged Valparaíso for three days; 2,900 homes were destroyed and 14,000 people - 4% of the Valparaíso population (IMV, 2014) - were made homeless.

The reasons for the unsustainable settlements can be traced back to many issues related to post-disaster rehabilitation and poverty and a major factor is the lack of a sustainable urban code for areas of vulnerability. This sustainable urban code would need to respond in a general way to the emergency and in a particular way to the post-catastrophe situation that begins right after an emergency occurs.

Casa FENIX TEAM ORGANIZATION Team Casa FENIX is a bi-national team composed of students and faculty members from the Universidad Técnica Federico Santa María [UTFSM], Valparaíso, Chile and from the Institute Universitaire de Technologie [IUT], Université de La Rochelle, France. In addition to all the opportunities that arise out of any international collaboration between academic institutions, team Casa FENIX seeks to respond coherently to SDE’s energy conservation objectives.

The proposal has been designed to address the circumstances and needs of Chile. However, transporting the house from Chile to France would entail a significant amount of CO2 emissions and the team has therefore set itself the goal of making a “PROTOTIPE” in Chile and a “REPLICA” in France, generating a dualism and a double challenge for our project.

So, while the conceptual proposal is Chilean, the production of Casa FENIX is French.

TEAM Casa FENIX CHILE
The Chilean part of the team is in charge of all the theoretical, conceptual, architecture and urban design content of the project. One of the strengths of UTFSM is their research and work on bioclimatic architecture and earthquake resistant construction.

The design of Casa FENIX has been developed in Chile with the participation of the students from the French team during the process. Half of Casa FENIX will constitute the prototype built and tested in Valparaiso.

TEAM Casa FENIX FRANCE
The French part of the team is in charge of all the practical, construction, building and technology applications of the project. One of the strengths of IUT is their research into and work with wooden structures and construction. A complete version of a replica of Casa FENIX is being built in La Rochelle and this is the version that will compete in Versailles.
9.1.1 AIM

A Site Operations Plan is required for the competition of the Solar Decathlon Europe. Its purpose is mainly to define the organization of the construction site to set up the house in ten days in Versailles, then to disassemble it in due course at the end of the competition. At the level of safety this plan also allows us to anticipate and to prevent risks of accidents.

9.1.2 PROJECT DESCRIPTION

One of the features of Casa FENIX is that this home can be assembled quickly by anyone without construction skills in a group of at least four persons. The architectural design was thought to allow a simple and fast assemblage.

Casa FENIX is made up of three basic modules and two half modules as connectors. All the modules are divided in half-modules, previously assembled and implemented with all the components, ready to be transported by truck to Versailles. Every half-module also includes its roof and it is connected to the corresponding deck portion of the Sunspace [Table 299].

For the sunspace roof, including solar and PV panels, which will be transported as a single block by truck. Then, all these sections will arrive ready to be assembled in Versailles.

All the other components, furniture, white line appliances, deck, among other parts will be independently transported by truck. In other words, the major size sections of modules, including structure plus envelope are going to be prefabricated in La Rochelle and will be brought to Versailles ready for assemblage and finishings.

Given the size and weight of many components of Casa FENIX a crane for the assembly and dismantling of the prototype will be necessary.

<table>
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<th>Module</th>
<th>Size</th>
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<td>Half Module n°2</td>
<td>5.07x1.7x3.30 m</td>
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<tr>
<td>Half Module n°3</td>
<td>6.8x2.02x3.39 m</td>
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<td>Half Module n°4</td>
<td>5.7x1.7x3,39 m</td>
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<td>Half Module n°5</td>
<td>5.7x1.7x3,39 m</td>
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<tr>
<td>Half Module n°6</td>
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<tr>
<td>Half Module n°7</td>
<td>5.7x1.9x3,39 m</td>
</tr>
<tr>
<td>Half Module n°8</td>
<td>3.72x1.9x3,39 m</td>
</tr>
<tr>
<td>Sunspace's Roof</td>
<td>9.7x3.2x0.33 m</td>
</tr>
<tr>
<td>Structure of presentation</td>
<td>6.8x2x3 m</td>
</tr>
<tr>
<td>Technical Elements</td>
<td>6.18x1,00x1,45 m</td>
</tr>
<tr>
<td>Container</td>
<td>6.00x2.44x2.59 m</td>
</tr>
</tbody>
</table>

Table 299: Size of each module, house components and site components
9.2 SITE OPERATION COORDINATORS

Team Casa FENIX will be divided into four sub-teams to work on site. As we need one site operation coordinator for each sub-team, we have four decathletes as site operations coordinators [Table 300].

But it will be the Leader Site Operation Coordinators, Pierre MAUDET, all the time on the construction site, to check if the progress of the works is according to the planning. But he will work only if the Team 1 is working.

<table>
<thead>
<tr>
<th>Name</th>
<th>Mail</th>
<th>Phone</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Pierre MAUDET</td>
<td><a href="mailto:p.maudet944@laposte.net">p.maudet944@laposte.net</a></td>
<td>+ 33 (0)6 86 77 61 78</td>
</tr>
<tr>
<td>2 Thomas MABY</td>
<td><a href="mailto:maby.thomas21@gmail.com">maby.thomas21@gmail.com</a></td>
<td>+ 33 (0)6 69 36 29 49</td>
</tr>
<tr>
<td>3 Sebastian ROJAS</td>
<td><a href="mailto:sebastian.rojasve@alumnos.usm.cl">sebastian.rojasve@alumnos.usm.cl</a></td>
<td>+ 56 9 84 36 90 45</td>
</tr>
<tr>
<td>4 Maxime DORY</td>
<td><a href="mailto:dorymaxime@hotmail.fr">dorymaxime@hotmail.fr</a></td>
<td>+ 33 (0)6 87 48 98 65</td>
</tr>
</tbody>
</table>

Table 300: Site operation coordinators
9.3 LOGISTIC OUTSIDE OF LA CITÉ DU SOLEIL

9.3.1 TRUCKS ROUTE

The truck convoy will leave the University Institute of Technology, ULR rue de Roux in La Rochelle to arrive at allée des Tilleuls in Versailles. The total distance is 461 km and the road includes 106 km of freeway or highway type of route [Figure 301].

NOTE: One truck [the truck n°7] will leave from the CILC Company at Jaunay-Clan [86] and will take the Highway A10 to Versailles.
9.3.2 TRUCKS SPECIFICATIONS AND SHIPMENTS

To transport the different modules of the Casa FENIX to Versailles for the competition, it will be needed two types of truck.

NOTE: For the first day of the assembly phase, a personal car will go to the construction site to bring the necessary tools and a little part of the foundations at 8h.

**Truck specification**

**TRUCK # 1: Articulated**

- Total Length : 18,75m
- Trailer Length : 7 + 8m
- Width : 2,55m
- Pure Weight : 18 t
- Number of axles : 4
- Permissible load : 38t
- Trailer Height : 0,80m
- Permissible Height : 4,20m

**TRUCK # 2: Classic**

- Total Length : 16,50m
- Trailer Length : 12m
- Width : 2,55m
- Pure Weight : 18 t
- Number of axles : 4
- Permissible load : 38t
- Trailer Height : 1,00m
- Permissible Height : 4,20m

According to the weather conditions during the transportation period, loads might require coverage.

For the full transportation of Casa FENIX to Versailles, 7 trucks will be required.

The trucks 1 to 5 are articulated and the trucks 6 and 7 are classics.
• Truck shipment

• Truck n°1

Type: Articulated

Assembly Phase
Arrival to Versailles: 16/06 14h
Departure from Versailles: 18h

Disassembly Phase
Arrival to Versailles: 17/07 14h
Departure from Versailles: 17/07 18h

Figure 304: Detailed load of truck n°1

<table>
<thead>
<tr>
<th>Trucks</th>
<th>Designation of the elements</th>
<th>Quantity</th>
<th>Dimensions</th>
<th>Weight (Kg)</th>
<th>Total Load</th>
<th>Machinery For Unloading</th>
</tr>
</thead>
<tbody>
<tr>
<td>Truck 1</td>
<td>Container</td>
<td>1</td>
<td>6,01 2,44 2,59</td>
<td>1900</td>
<td></td>
<td>Mobile Crane</td>
</tr>
<tr>
<td></td>
<td>FURNITURES, TOOLS AND MISCELLANEOUS INSIDE THE CONTAINER</td>
<td>Not Determined</td>
<td></td>
<td>Not Determined</td>
<td>4220</td>
<td>Unloaded by the hands</td>
</tr>
<tr>
<td></td>
<td>Half Module n°3</td>
<td>1</td>
<td>6,8 2,02 3,39</td>
<td>1900</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Wall's junction 3-4</td>
<td>1</td>
<td>2,75 0,265 0,134</td>
<td>20</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Wall's junction 3-4</td>
<td>1</td>
<td>2,75 0,265 0,134</td>
<td>20</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Floor's junction 3-4</td>
<td>1</td>
<td>3,35 0,135 0,094</td>
<td>30</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Roof's junction 3-4</td>
<td>1</td>
<td>3,8 0,396 0,255</td>
<td>50</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Foundations</td>
<td>30</td>
<td>0,5 0,35 0,1</td>
<td>10</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
• Truck n°2

**Type:** Articulated

**Assembly Phase**

Arrival to Versailles: 17/06 8h  
Departure from Versailles: 12h

**Disassembly Phase**

Arrival to Versailles: 17/07 10h  
Departure from Versailles: 17/07 12h

---

**Figure 305: Detailed load of truck n°2**

<table>
<thead>
<tr>
<th>Trucks</th>
<th>Designation of the elements</th>
<th>Quantity</th>
<th>Dimensions</th>
<th>Weight (Kg)</th>
<th>Total Load</th>
<th>Machinery For Unloading</th>
</tr>
</thead>
<tbody>
<tr>
<td>Truck 2</td>
<td>Half Module n°4</td>
<td>1</td>
<td>5,7</td>
<td>1,7</td>
<td>3,39</td>
<td>1500</td>
</tr>
<tr>
<td></td>
<td>Half Module n°2</td>
<td>1</td>
<td>5,07</td>
<td>1,7</td>
<td>3,3</td>
<td>1200</td>
</tr>
<tr>
<td></td>
<td>Roof’s junction 1-2</td>
<td>1</td>
<td>4,45</td>
<td>0,396</td>
<td>0,24</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>Floor’s junction 1-2</td>
<td>1</td>
<td>3,35</td>
<td>0,135</td>
<td>0,094</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>Wall’s junction 1-2-1</td>
<td>1</td>
<td>2,95</td>
<td>0,265</td>
<td>0,134</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Wall’s junction 1-2-2</td>
<td>1</td>
<td>2,75</td>
<td>0,265</td>
<td>0,134</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Wall’s junction 2-3-1</td>
<td>1</td>
<td>2,95</td>
<td>0,265</td>
<td>0,134</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>Floor’s junction 2-3</td>
<td>1</td>
<td>3,35</td>
<td>0,135</td>
<td>0,094</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>Roof’s junction 2-3</td>
<td>1</td>
<td>3,8</td>
<td>0,396</td>
<td>0,25</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>Roof Overhang 2</td>
<td>1</td>
<td>2,14</td>
<td>0,97</td>
<td>0,238</td>
<td>62</td>
</tr>
<tr>
<td></td>
<td>Roof’s junction 4-5</td>
<td>1</td>
<td>3,7</td>
<td>0,396</td>
<td>0,255</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>Wall’s junction 4-5-1</td>
<td>1</td>
<td>2,75</td>
<td>0,265</td>
<td>0,134</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Wall’s junction 4-5-2</td>
<td>1</td>
<td>2,75</td>
<td>0,265</td>
<td>0,134</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Floor’s junction 4-5</td>
<td>1</td>
<td>4,94</td>
<td>0,135</td>
<td>0,094</td>
<td>30</td>
</tr>
</tbody>
</table>

3117  

Mobile Crane  

Unloaded by the hands
• Truck n°3

Type Articulated

**Assembly Phase**
Arrival to Versailles: 17/06 14h
Departure from Versailles: 18h

**Disassembly Phase**
Arrival to Versailles: 17/07 8h
Departure from Versailles: 10h

---

Figure 306: Detailed load of truck n°3

<table>
<thead>
<tr>
<th>Trucks</th>
<th>Designation of the elements</th>
<th>Quantity</th>
<th>Dimensions</th>
<th>Weight (Kg)</th>
<th>Total Load</th>
<th>Machinery For Unloading</th>
</tr>
</thead>
<tbody>
<tr>
<td>Truck 3</td>
<td>Half Module n°5</td>
<td>1</td>
<td>5,7</td>
<td>1,7</td>
<td>3,39</td>
<td>1600</td>
</tr>
<tr>
<td></td>
<td>Half Module n°1</td>
<td>1</td>
<td>5,07</td>
<td>1,79</td>
<td>3,3</td>
<td>1900</td>
</tr>
<tr>
<td></td>
<td>Roof Overhang 1</td>
<td>1</td>
<td>4,49</td>
<td>0,74</td>
<td>0,238</td>
<td>148</td>
</tr>
<tr>
<td></td>
<td>Wall's junction 5-6 1</td>
<td>1</td>
<td>2,75</td>
<td>0,265</td>
<td>0,134</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Wall's junction 5-6 2</td>
<td>1</td>
<td>2,75</td>
<td>0,265</td>
<td>0,134</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Roof's junction 5-6</td>
<td>1</td>
<td>3,7</td>
<td>0,396</td>
<td>0,255</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>Floor's junction 5-6</td>
<td>1</td>
<td>4,94</td>
<td>0,135</td>
<td>0,094</td>
<td>30</td>
</tr>
</tbody>
</table>

3768

- Mobile Crane
- Unloaded by the hands
Truck n°4

Type Articulated

**Assembly Phase**
Arrival to Versailles: 18/06 8h
Departure from Versailles: 12h

**Disassembly Phase**
Arrival to Versailles: 16/07 16h
Departure from Versailles: 18h

<table>
<thead>
<tr>
<th>Trucks</th>
<th>Designation of the elements</th>
<th>Quantity</th>
<th>Dimensions</th>
<th>Weight (Kg)</th>
<th>Total Load</th>
</tr>
</thead>
<tbody>
<tr>
<td>Truck 4</td>
<td>Half Module n°6</td>
<td>1</td>
<td>5,7</td>
<td>1,7</td>
<td>3,39</td>
</tr>
<tr>
<td></td>
<td>Technical Elements</td>
<td>1</td>
<td>6,44</td>
<td>1,83</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Water Tank 750L</td>
<td>2</td>
<td>1,66</td>
<td>0,78</td>
<td>0,78</td>
</tr>
<tr>
<td></td>
<td>Water Tank 1000L</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Floor's junction 6-7</td>
<td>1</td>
<td>4,94</td>
<td>0,135</td>
<td>0,094</td>
</tr>
<tr>
<td></td>
<td>Roof's junction 6-7</td>
<td>1</td>
<td>3,7</td>
<td>0,396</td>
<td>0,255</td>
</tr>
<tr>
<td></td>
<td>Wall's junction 6-7 1</td>
<td>1</td>
<td>2,75</td>
<td>0,265</td>
<td>0,134</td>
</tr>
<tr>
<td></td>
<td>Wall's junction 6-7 2</td>
<td>1</td>
<td>2,75</td>
<td>0,265</td>
<td>0,134</td>
</tr>
</tbody>
</table>

Figure 307: Detailed load of truck n°4

- **Machinery For Unloading**
  - Mobile Crane
  - Unloaded by the hands
• **Truck n° 5**

Type Articulated

**Assembly Phase**

Arrival to Versailles: 18/06 14h  
Departure from Versailles: 18h

**Disassembly Phase**

Arrival to Versailles: 16/07 10h  
Departure from Versailles: 16h

---

<table>
<thead>
<tr>
<th>Trucks</th>
<th>Designation of the elements</th>
<th>Quantity</th>
<th>Dimensions</th>
<th>Weight (Kg)</th>
<th>Total Load</th>
<th>Machinery For Unloading</th>
</tr>
</thead>
<tbody>
<tr>
<td>Truck 5</td>
<td>Half Module n°7</td>
<td>1</td>
<td>5.7</td>
<td>1.9</td>
<td>3.39</td>
<td>1600</td>
</tr>
<tr>
<td></td>
<td>Half Module n°8</td>
<td>1</td>
<td>3.72</td>
<td>1.9</td>
<td>3.35</td>
<td>1700</td>
</tr>
<tr>
<td></td>
<td>Roof Overhang 3</td>
<td>1</td>
<td>4.49</td>
<td>0.739</td>
<td>0.238</td>
<td>148</td>
</tr>
<tr>
<td></td>
<td>Wall’s junction 7-8 2</td>
<td>1</td>
<td>2.75</td>
<td>0.265</td>
<td>0.134</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Floor’s junction 7-8</td>
<td>1</td>
<td>3.35</td>
<td>0.135</td>
<td>0.094</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>Roof’s junction 7-8</td>
<td>1</td>
<td>3.7</td>
<td>0.396</td>
<td>0.255</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>Wall’s junction 7-8 1</td>
<td>1</td>
<td>2.75</td>
<td>0.265</td>
<td>0.134</td>
<td>20</td>
</tr>
</tbody>
</table>

Figure 308: Detailed load of truck n°5
**Truck n°6**

Type: Classic

**Assembly Phase**
Arrival to Versailles: 23/06 14h
Departure from Versailles: 18h

**Disassembly Phase**
Arrival to Versailles: 16/07 8h
Departure from Versailles: 16 10h

---

<table>
<thead>
<tr>
<th>Trucks</th>
<th>Designation of the elements</th>
<th>Quantity</th>
<th>Dimensions</th>
<th>Weight (Kg)</th>
<th>Total Load</th>
<th>Machinery For Unloading</th>
</tr>
</thead>
<tbody>
<tr>
<td>Truck 6</td>
<td>Sunspace's Roof</td>
<td>1</td>
<td>9,7</td>
<td>3,1</td>
<td>0,3</td>
<td>1200</td>
</tr>
</tbody>
</table>
• Truck n°7

Type : Classic

Assembly Phase
Arrival to Versailles: 20/06 8h
Departure from Versailles: 18h

Disassembly Phase
This truck will not be present for the Disassembly Phase; the loading will be load on the truck 6

<table>
<thead>
<tr>
<th>Trucks</th>
<th>Designation of the elements</th>
<th>Quantity</th>
<th>Dimensions</th>
<th>Weight (Kg)</th>
<th>Total Load</th>
<th>Machinery For Unloading</th>
</tr>
</thead>
<tbody>
<tr>
<td>Truck 7</td>
<td>Decks and Access ramps</td>
<td>34</td>
<td>1,6</td>
<td>0,268</td>
<td>77</td>
<td>3298</td>
</tr>
<tr>
<td></td>
<td>Presentation Module</td>
<td>1</td>
<td>6,8</td>
<td>2</td>
<td>3</td>
<td>Mobile Crane</td>
</tr>
</tbody>
</table>

Figure 310: Detailed load of truck n°7
9.4 LOGISTIC IN LA CÎTÉ DU SOLEIL

9.4.1 INFRASTRUCTURE

We will install a Container of 20 feet [6.06mx2.44mx2.59m] on site during the Assembly and Disassembly phases to stock all the necessary tools and materials.

This container will have to be stocked by the organization during the competition phase.

9.4.2 CONSTRUCTION WORKING TEAMS

• Teams in the assembly phase

The Table 311 shows the teams who will work in the assembly process.

In the Table 312 the detailed schedule for this team.

<table>
<thead>
<tr>
<th>Team 1</th>
<th>Team 2</th>
<th>Team 3</th>
<th>Team 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pierre MAUDET</td>
<td>Thomas MABY</td>
<td>Sebastián ROJAS</td>
<td>Maxime DORY</td>
</tr>
<tr>
<td>Alejandra CARRASCO</td>
<td>Constanza CAMPOS JOFRE</td>
<td>Nathan FASSIER</td>
<td>Soizic DENEUX</td>
</tr>
<tr>
<td>Aurélien VINCENT</td>
<td>Baptiste JARLET</td>
<td>Guillaume DESIRAT</td>
<td>Joris SCALMANA</td>
</tr>
<tr>
<td>Léa LERY-LACHAUME</td>
<td>Quentin DUEZ</td>
<td>Laure ANGENARD</td>
<td>Victor BIGOT</td>
</tr>
<tr>
<td>Adrien CAT BLONDEAU</td>
<td>Axel DENECHAUD</td>
<td>Maxime GUIBERT</td>
<td>Simon RIBREAU</td>
</tr>
<tr>
<td>Damien BRUNET</td>
<td>Carolina SEPULVEDA</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 311: Teams in the assembly phase

<table>
<thead>
<tr>
<th>Team</th>
<th>Day 1</th>
<th>Day 2</th>
<th>Day 3</th>
<th>Day 4</th>
<th>Day 5</th>
<th>Day 6</th>
<th>Day 7</th>
<th>Day 8</th>
<th>Day 9</th>
<th>Day 10</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>8h-18h</td>
<td>8h-18h</td>
<td>8h-18h</td>
<td>No work the Sunday</td>
<td>8h-12h</td>
<td>10h-16h</td>
<td></td>
<td>32h</td>
</tr>
<tr>
<td>2</td>
<td>10h-18h</td>
<td>8h-18h</td>
<td>8h-18h</td>
<td></td>
<td></td>
<td></td>
<td>14h-18h</td>
<td>14h-18h</td>
<td>30h</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>8h-12h</td>
<td></td>
<td>8h-18h</td>
<td>8h-11h</td>
<td></td>
<td></td>
<td>8h-10h</td>
<td>8h-18h</td>
<td>25h</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>8h-16h</td>
<td></td>
<td></td>
<td></td>
<td>9h-18h</td>
<td>8h-12h</td>
<td>16h-18h</td>
<td>8h-18h</td>
<td>27h</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 312: Teams schedule in the assembly phase

• Teams in the disassembly phase

The Table 313 show the team who will work in the disassembly phase and the detailed schedule for each one is in the Table 314.
<table>
<thead>
<tr>
<th>Team 1</th>
<th>Team 2</th>
<th>Team 3</th>
<th>Team 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pierre MAUDET</td>
<td>Thomas MABY</td>
<td>Sebastián ROJAS</td>
<td>Simon RIBREAU</td>
</tr>
<tr>
<td>Alejandra CARRASCO</td>
<td>Constanza CAMPOS</td>
<td>Nathan FASSIER</td>
<td>Laure ANGENARD</td>
</tr>
<tr>
<td>Carolina SEPULVEDA</td>
<td>Daniela GIL</td>
<td>Lucia SIMONS</td>
<td>Diego POBLETE</td>
</tr>
<tr>
<td>Pilar AGUILAR</td>
<td>Diego GONZALES</td>
<td>Felipe VERGARA</td>
<td>Katherine CABEZAS</td>
</tr>
<tr>
<td>Pedro ASCENCIO</td>
<td>Christian LOPEZ</td>
<td>Carolina REYES</td>
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Table 313: Teams in the disassembly phase

<table>
<thead>
<tr>
<th>Team</th>
<th>Day 1</th>
<th>Day 2</th>
<th>Day 3</th>
<th>Day 4</th>
<th>Day 5</th>
<th>Total</th>
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<tbody>
<tr>
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<td>8h-18h</td>
<td>8h-18h</td>
<td>8h-17h</td>
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<td>31h</td>
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<tr>
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<td>8h-18h</td>
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<td>8h-18h</td>
<td>8h-17h</td>
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<tr>
<td>4</td>
<td>8h-18h</td>
<td>8h-18h</td>
<td>8h-18h</td>
<td>8h-17h</td>
<td></td>
<td>31h</td>
</tr>
</tbody>
</table>

Table 314: Teams schedule in the disassembly phase
9.4.3 PHASES DESCRIPTION

- **Phase 1**: Team 4 - Necessary timing: 4H

  **“Site installation”**
  Positioning of the Storage and Waste area, the first aid box and the fences. Assembly of the scaffolding

- **Phase 1bis**: Team 3 - Necessary timing: 4H

  **“Implantation”**
  First, it will be required the marking on our construction site with a theodolite and a CORDEX to place all the main components of Casa FENIX.

- **Phase 2**: Team 2 - Necessary timing: 4H

  **“Foundations”**
  The positioning of the decided foundation to comply with SDE rules and regulations will be placed on the site

- **Phase 2bis**: Team 4 - Necessary timing: 2H

  Installation of the container.

- **Phase 3**: Team 2 - Necessary timing: 16H

  Positioning and Setting of the entire half module

- **Phase 4**: Team 3 - Necessary timing: 8H

  Electric and Water connections between each module

- **Phase 5**: Team 1 - Necessary timing: 28H

  Roof’s, Floor’s and Wall’s junction between the module

- **Phase 5 bis**: Team 3 and 4 - Necessary timing: 12h

  Fixtures and Fittings

- **Phase 6**: Team 2 - Necessary timing: 4H

  Positioning and Setting of the Sunspace’s roof

- **Phase 7**: Team 3 - Necessary timing: 2H

  Electric and PV connections with the Sunspace’s roof

- **Phase 8**: Team 1 - Necessary timing: 4H

  Junctions with the sunspace’s roof

- **Phase 9**: Team 3 and 4 - Necessary timing: 6H

  House fitting and electric connections of the household appliances

- **Phase 10**: Team 2 and 3 - Necessary timing: 3H

  Connecting Power grid and water system to the Solar Village

- **Phase 11**: Team 2 and 4 - Necessary timing: 4H

  House and Outside Cleaning

**NOTE1**: All the teams on site are in the limit authorized by rules [Health and Safety Plan]

**NOTE2**: The disassembly process will be the same, but in reverse order, and faster because we have only 5 days
9.4.4 WASTE MANAGEMENT

Thanks to the prefabrication, Casa FENIX will be transported and brought by completed half modules to Versailles, and it will be only the connections between the different modules the main work to complete on site. This will allow us to minimize waste on site.

It is projected to produce 1m3 of waste during the assembly and disassembly phases, hoping that the real volume will be significantly less than this projection. For the sorting of waste, we will have four types of waste:

- The wooden waste which can be recycled
- Recyclable cardboard
- Recyclable plastics, scrap [bolts, nails, broken pieces, empty containers, etc].
- Hazardous waste [glue, paint, etc].

We will classify the waste into these four groups, where some of the non-hazardous waste will be used to create our “post-catastrophe area”, an area to remind the conditions after a natural disaster.
### 9.5 ASSEMBLY AND DISASSEMBLY SCHEDULE

#### 9.5.1 ASSEMBLY SCHEDULE

<table>
<thead>
<tr>
<th>Actions</th>
<th>Dates</th>
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<tr>
<td>Planned deadline for wind and water tight</td>
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<tr>
<td>Planned deadline for electrical connection to the village grid</td>
<td>25/06/2014</td>
</tr>
<tr>
<td>Planned deadline for house delivery</td>
<td>25/06/2014</td>
</tr>
</tbody>
</table>

Figure 315: Planned deadline for key deliveries  

Figure 316: General assembly schedule [For more details please refer to APPENDIX 14.10 “Site operation Appendix”]  

Figure 317: Schedule of preparation phase [For more details please refer to APPENDIX 14.10 “Site operation Appendix”]
Figure 318: Schedule of the “Positioning of Casa FENIX” [For more details please refer to APPENDIX 14.10 “Site operation Appendix”]

Figure 319: Schedule of the “Junctions and connections” [For more details please refer to APPENDIX 14.10 “Site operation Appendix”]

Figure 320: Schedule of the “Secondary equipments” [For more details please refer to APPENDIX 14.10 “Site operation Appendix”]
9.5.2 DISASSEMBLY SCHEDULE

Figure 321: Disassembly schedule [For more details please refer to APPENDIX 14.10 “Site operation Appendix”]

CATEGORIE 1 : MOBILE CRANE

PLEASE COMPLETE THE ASSEMBLY & DISASSEMBLY CHARTS

CATEGORIE 2 : CONSTRUCTION EQUIPMENT

<table>
<thead>
<tr>
<th>EQUIPMENT</th>
<th>DESIGNATION</th>
<th>REFERENCE</th>
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<th>QUANTITY NEEDED</th>
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<td>Forklift</td>
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CATEGORIE 3 : OTHER EQUIPMENT

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<td>Fences HERAS (including plots)</td>
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Figure 322: Equipment Rental Chart
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**INSPECTION DAY**
### ASSEMBLY/DISASSEMBLY CHART

**TEAM FNX**

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#### DAY 2 - 16.07.2014

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#### DAY 3 - 17.07.2014

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<td></td>
</tr>
<tr>
<td>Trucks in Matelots</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Cranes for storage area</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

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**Trucks which are waiting in Allée des Matelots along la Cité du Soleil®**

### USAGE OF THE CRANE during ASSEMBLY

<table>
<thead>
<tr>
<th>Crane capacity</th>
<th>Usage time</th>
</tr>
</thead>
<tbody>
<tr>
<td>35 tn / 30m</td>
<td>46H</td>
</tr>
</tbody>
</table>

### USAGE OF THE CRANE during DISASSEMBLY

<table>
<thead>
<tr>
<th>Crane capacity</th>
<th>Usage time</th>
</tr>
</thead>
<tbody>
<tr>
<td>35 tn / 30m</td>
<td>18H</td>
</tr>
</tbody>
</table>

### USAGE OF THE CRANE for storage area

<table>
<thead>
<tr>
<th>Crane capacity</th>
<th>Usage time</th>
</tr>
</thead>
<tbody>
<tr>
<td>35 tn</td>
<td>4 hours</td>
</tr>
<tr>
<td>No.</td>
<td>Function</td>
</tr>
<tr>
<td>-----</td>
<td>----------------------------------</td>
</tr>
<tr>
<td>1</td>
<td>Site Operations Coordinator</td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>No.</th>
<th>Name</th>
<th>Dimensions [m]</th>
<th>Weight [kg]</th>
<th>Machinery Used for Unloading/Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Containers for storage</td>
<td>6.01x2.44x2.59</td>
<td>3900</td>
<td>Crane</td>
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<td>Technical Elements</td>
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</tr>
<tr>
<td>3</td>
<td>Rail Module n°1</td>
<td>5.61x1.70x3.30</td>
<td>1900</td>
<td>Crane</td>
</tr>
<tr>
<td>4</td>
<td>Rail Module n°2</td>
<td>5.07x1.70x3.30</td>
<td>1200</td>
<td>Crane</td>
</tr>
<tr>
<td>5</td>
<td>Rail Module n°3</td>
<td>6.82x0.62x3.39</td>
<td>1900</td>
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</tr>
<tr>
<td>6</td>
<td>Rail Module n°4</td>
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<td>7</td>
<td>Rail Module n°5</td>
<td>5.71x1.70x3.29</td>
<td>1600</td>
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<td>8</td>
<td>Rail Module n°6</td>
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<td>1500</td>
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<tr>
<td>9</td>
<td>Rail Module n°7</td>
<td>5.71x1.90x3.39</td>
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<td>10</td>
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<td>1700</td>
<td>Crane</td>
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<tr>
<td>11</td>
<td>Sunspace’s Roof</td>
<td>9.70x3.10x0.3</td>
<td>1200</td>
<td>Crane</td>
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<tr>
<td>12</td>
<td>Decks and Access ramps</td>
<td>1.5x1.6x0.25</td>
<td>77</td>
<td>Crane</td>
</tr>
<tr>
<td>13</td>
<td>Presentation Module</td>
<td>6.8x2x1</td>
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<table>
<thead>
<tr>
<th>No.</th>
<th>Type</th>
<th>Dimensions [m] (Tractor unit + Trailer)</th>
<th>Weight [kg] (Truck + Loading)</th>
</tr>
</thead>
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<tr>
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<td>Articulated Truck</td>
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<td>21117</td>
</tr>
<tr>
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<td>Articulated Truck</td>
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<tr>
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<td>6</td>
<td>Classic Truck</td>
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<td>15200</td>
</tr>
<tr>
<td>7</td>
<td>Classic Truck</td>
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<table>
<thead>
<tr>
<th>No.</th>
<th>Name</th>
<th>Capacity</th>
<th>Usage Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mobile Crane PSEUV 30m/35t</td>
<td>35t</td>
<td>46 h</td>
</tr>
<tr>
<td>PHASE</td>
<td>MATERIAL AND EQUIPMENT RESOURCES</td>
<td>HUMAN RESOURCES</td>
<td>DURATION</td>
</tr>
<tr>
<td>-------</td>
<td>---------------------------------</td>
<td>-----------------</td>
<td>----------</td>
</tr>
<tr>
<td>1</td>
<td>Site installation</td>
<td>5</td>
<td>4h</td>
</tr>
<tr>
<td>2</td>
<td>Installation</td>
<td>5</td>
<td>4h</td>
</tr>
<tr>
<td>2b</td>
<td>Installation of the container</td>
<td>Mobile crane</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>Positioning and setting of the entire half module</td>
<td>Mobile crane, individual platform, scaffolding</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td>Electric and water connections between each half module</td>
<td>Individual platform</td>
<td>5</td>
</tr>
<tr>
<td>5</td>
<td>Roof’s, Floor’s and Wall’s junction between the module</td>
<td>Individual platform, scaffolding, lifeline</td>
<td>6</td>
</tr>
<tr>
<td>9b</td>
<td>Fixtures and Fittings</td>
<td>10</td>
<td>12h</td>
</tr>
<tr>
<td>6</td>
<td>Positioning and setting of the sunspace’s roof</td>
<td>Mobile crane, individual platform, scaffolding</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td>Electric and PV connections with the sunspace’s roof</td>
<td>Individual platform</td>
<td>5</td>
</tr>
<tr>
<td>8</td>
<td>Junctions with the sunspace’s roof</td>
<td>Individual platform, scaffolding, lifeline</td>
<td>6</td>
</tr>
<tr>
<td>10</td>
<td>House fitting and electric connections of the household appliances</td>
<td></td>
<td>10</td>
</tr>
<tr>
<td>11</td>
<td>Connecting Power grid and water system to the Solar village</td>
<td></td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>House and Outside cleaning</td>
<td>11</td>
<td>4h</td>
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<table>
<thead>
<tr>
<th>DISASSEMBLY</th>
<th>PHASE</th>
<th>MATERIAL AND EQUIPMENT RESOURCES</th>
<th>HUMAN RESOURCES</th>
<th>DURATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Electrical and Plumbing disconnecting</td>
<td>9</td>
<td>3h</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Disassembly of the decks, access ramps, exhibition structure and loading on the truck</td>
<td>10</td>
<td>6h</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Loading of furnishings and household appliances in the container</td>
<td>9</td>
<td>3h</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Disassembly and loading of the sunspace roof on the truck</td>
<td>Mobile crane, individual platform, scaffolding</td>
<td>10</td>
<td>4h</td>
</tr>
<tr>
<td>5</td>
<td>Disassembly of the entire half module and loading on the trucks</td>
<td>Mobile crane, individual platform, scaffolding</td>
<td>19</td>
<td>35h</td>
</tr>
<tr>
<td>9</td>
<td>Disassembly of the technical elements and loading on the truck</td>
<td>Mobile crane</td>
<td>9</td>
<td>2hr</td>
</tr>
<tr>
<td>7</td>
<td>Loading of the rest equipments in the container</td>
<td>Mobile crane</td>
<td>9</td>
<td>3h</td>
</tr>
<tr>
<td>8</td>
<td>Loading of the container on the truck</td>
<td>Mobile crane</td>
<td>9</td>
<td>2hr</td>
</tr>
<tr>
<td>9</td>
<td>Cleaning of the construction site</td>
<td>Mobile crane</td>
<td>19</td>
<td>8h</td>
</tr>
<tr>
<td>TYPE</td>
<td>VOLUME (m³)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>---------------------</td>
<td>-------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Wooden Waste</td>
<td>0.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Cardboard &amp; Plastic</td>
<td>0.3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Scrap</td>
<td>0.02</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 Hazardous Waste</td>
<td>0.18</td>
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</table>

<table>
<thead>
<tr>
<th>TYPE</th>
<th>VOLUME (m³)</th>
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<tbody>
<tr>
<td>1 Wooden Waste</td>
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<tr>
<td>3 Scrap</td>
<td>0.02</td>
</tr>
<tr>
<td>4 Hazardous Waste</td>
<td>0.18</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DESIGNATION</th>
<th>DIMENSIONS [m³]</th>
<th>WEIGHT (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Container</td>
<td>9,01x2,44x2,59</td>
<td>1900</td>
</tr>
</tbody>
</table>
CASAFENIX

For Emergency post-Natural Impact eXtreme R E M I N D E R

One of the most outstanding geographical features of Chile is the relatively constant threat of earthquakes, among other natural disasters, such as volcano eruptions, landslides and fires in urban areas. The regularity with which these events occur does not make them any less catastrophic for people. Many homes are lost and the people who are most affected are low-income families. The post-catastrophe situation throughout the year has indeed been non-sustainable, therefore to develop and implement the concept of sustainable reconstruction is a big challenge for our country, where Casa FENIX ambition is to propose and offer a tangible solution.

THE PROBLEM While Chile is a political and geographical location where natural disasters are recurrent and affect a great part of the most socially vulnerable population, there are no official policies which outline a quality response to such events.

“When disaster strikes, the problems are resolved with quick, cheap, short-term solutions, such as the mediagua emergency houses”

which end up causing more problems than they solve and lead to a great deal of waste in the long term.

HYPOTHESIS Casa FENIX is a design process that responds to a catastrophe, delivering energy efficient strategies to ensure quality of life as a key factor in a sustainable reconstruction; these strategies are not currently considered in post-catastrophe national policy. Sustainability factors include locally specific environmental, cultural and geographical issues, and also consider accessible and viable solutions for the most vulnerable sector of Chilean society. Therefore, the original objective behind this proposal is:

“to create emergency dwellings that offer quick, good quality and sustainable homes for the families who are the victims of a disaster.”

Thus the architectural and urban concepts that shape the proposal at both individual and collective levels are: Modularity, progressivity, flexibility and affordability.
Modularity
Casa FENIX evolves from a basic Survival Module to a complex Eco Village/Housing Complex. This process covers the stage of Emergency, Relief and Reconstruction.

Progressivity
Casa FENIX progression allows the Survival Module unit to become a final home. This incremental and evolving logics is assumed by the urban design strategy.

Flexibility
Casa FENIX has the capability to adapt to different latitudes and climates, given the geographical characteristics and diversity of climates Chile possesses, from north to south.

Affordability
Casa FENIX is an affordable home. Each unit may be acquired through the progressive subsidy addressing the total cost of the home.

ARCHITECTURAL PROGRAMME
For the SDE competition, the Casa FENIX Team proposes to bring a house that represents reconstruction as a growth progression and is configured to perform well in the Versailles climate. The basic structure and its components will subsequently be configured to meet the solar passive design strategy for the specific local climate where it is to be installed.

The programme represents the core concept of Casa FENIX, which takes a progressive approach to Emergency, Relief and Reconstruction, with sustainability in mind. It uses a passive solar design driven by a sunspace, which acts as the energy engine of the completed house and is a key spatial element which allows the articulation of the different modules.

Casa FENIX is a modular design in which each 11 m² module can be progressively attached and easily assembled during a post-disaster period, to form a dwelling measuring 60m².

The modules are as follows:
Survival Module
This is the quick initial response for the emergency period, immediately after a catastrophe strikes. Its main objective is to provide shelter, safety and a quality solution to the affected family.

Mechanical Module
This is the first module to be attached to the Survival Module as a progression during the relief period. It consists of the services and a technical core. It includes a bathroom and kitchen.

Living Module
This is the module that enables the house to expand and cover more than the basic needs during the reconstruction period, transforming the sum of modules into a definitive home.

Sunspace
The passive solar design strategy enables the regulation of the indoor climate by articulating the different modules with the exterior climate; this space grows with the addition of each module.

At a collective level, the group of emergency houses, which the FENIX team has called “Temporary Village FENIX, TVF” and the progression to a housing complex, which the FENIX team has called “Eco-Village FENIX, EVF” are conceived following the same logic. They have an open and flexible design that allows for the adaptation of modules and means that Casa FENIX can be adapted to different climatic, topographical, territorial and cultural realities.

THE GEOGRAPHICAL DIMENSION
Chile has 9 different climate types and the country stretches from latitude 18°S to 50°S. 90% of the population is located in areas where solar radiation is over 1000kWh/year. To address this climatic diversity and take advantage of the opportunity for solar radiation, the conceptual idea for “Casa FENIX is similar to a skeleton or basic structure, an innovative structural design developed by students, where different components can be configured and assembled according to the users’ demands”
All the components to be attached to it respond to the demands for the different latitudes and to patterns of self-construction.

**SUSTAINABILITY FOR US**

It is important to mention that the understanding of sustainability in the case of developing nations differs much from the one used in developed nations, in the sense that the problems that needs to be addressed are much different, respect of priorities and urgencies. For the Chilean case the deterioration produced by natural disasters and the anthropic urban degradation produced by informal settlements and poverty are the immediate problems to solve in a sustainable way. To teach the general public about sustainability issues that go beyond recycling, energy efficiency and achieving a low carbon footprint, Casa FENIX proposes to focus mainly on local cultural aspects, quality of life and social relationships. In this case the sustainability aspects are focused on using technology and urban planning to enhance the intuitive know-how of a particular local population.

“**The choice of site: Man’s physical freedom manifests itself no doubt in his ability to choose the place on earth where he wants to live**”.

People act, build and adapt through self-construction to the different latitudes and geographical conditions over time using their intuitive and basic knowledge.

“**Neither privations nor danger will deter man from selecting a spot [...]** to settle on (Rudofsky, 1964).”

This recognition of the appropriateness of the way informal settlements and self-construction take place is basic and seen to be positive; however it is extremely precarious and unsustainable in many other
aspects and in extreme situations could produce complete devastation. This was the case in April 2014 when a wildfire ravaged Valparaíso for three days; 2,900 homes were destroyed and 14,000 people - 4% of the Valparaíso population (IMV, 2014) - were made homeless.

The reasons for the unsustainable settlements can be traced back to many issues related to post-disaster rehabilitation and poverty and a major factor is the lack of a sustainable urban code for areas of vulnerability. This sustainable urban code would need to respond in a general way to the emergency and in a particular way to the post-catastrophe situation that begins right after an emergency occurs.

Casa FENIX TEAM ORGANIZATION

Team Casa FENIX is a bi-national team composed of students and faculty members from the Universidad Técnica Federico Santa María [UTFSM], Valparaíso, Chile and from the Institute Universitaire de Technologie [IUT], Université de La Rochelle, France. In addition to all the opportunities that arise out of any international collaboration between academic institutions, team Casa FENIX seeks to respond coherently to SDE’s energy conservation objectives.

The proposal has been designed to address the circumstances and needs of Chile. However, transporting the house from Chile to France would entail a significant amount of CO2 emissions and the team has therefore set itself the goal of making a “PROTOTIPE” in Chile and a “REPLICA” in France, generating a dualism and a double challenge for our project. So, while the conceptual proposal is Chilean, the production of Casa FENIX is French.

TEAM Casa FENIX FRANCE

The French part of the team is in charge of all the practical, construction, building and technology applications of the project. One of the strengths of IUT is their research into and work with wooden structures and construction. A complete version of a replica of Casa FENIX is being built in La Rochelle and this is the version that will compete in Versailles.

TEAM Casa FENIX CHILE

The Chilean part of the team is in charge of all the theoretical, conceptual, architecture and urban design content of the project. One of the strengths of UTFSM is their research and work on bioclimatic architecture and earthquake resistant construction.

The design of Casa FENIX has been developed in Chile with the participation of the students from the French team during the process. Half of Casa FENIX will constitute the prototype built and tested in Valparaíso.

Figure 325: Team FENIX in the Prototype built in Chile
10.2 GENERAL DATA OF THE PROJECT

Solar Decathlon Europe 2014 is an event organized by the SDE organisation. Our response to this event is to build the CASA FENIX.

**Team FENIX: «For Emergency post Natural Impact eXtreme»**

The team FENIX is an interdisciplinary group which comprises two different universities: Universidad Técnica Federico Santa María from Valparaiso, Chile and l’Université de La Rochelle, Institut Universitaire de Technologie [IUT] - Génie Civil from France.

We have created an international partnership to respond to the SDE competition.

**Project**

During the competition, we need to assemble, maintain and subsequently disassemble the replica of CASA FENIX, an emergency house measuring approximately 55 m². Casa FENIX is divided into three modules to be implemented progressively in three spatial modules that respond to the three different post disaster stages: namely the Survival, Mechanical and Living modules. All the modules are articulated by the sunspace, which works as the energy engine for the whole home.

The construction can be divided into phases:

- Arrival of the construction modules
- Installation
- Assembly of the modules

<table>
<thead>
<tr>
<th>Legal contents</th>
<th>Location in the report or in drawings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name and address of SDE 2014, HS Coordinator, Prevention authorities, Team</td>
<td>General data of the project</td>
</tr>
<tr>
<td>Number of workers</td>
<td>Number of workers taking part in the construction</td>
</tr>
<tr>
<td>Contact information of the Site Operation Coordinator</td>
<td>General data of the project</td>
</tr>
<tr>
<td>Description of works</td>
<td>Planned activities</td>
</tr>
<tr>
<td>First aid procedure</td>
<td>Accident victims evacuation HS 430 – 431</td>
</tr>
<tr>
<td>Name and number of first aid certificated worker</td>
<td>Planned measures in case of accident: first aid</td>
</tr>
<tr>
<td>Description of the team’s first aid kit</td>
<td>First aid bag</td>
</tr>
<tr>
<td>Description of hygiene conditions (toilet, changing room, restroom...)</td>
<td>Construction site installation</td>
</tr>
<tr>
<td>Detailed description of operating modes</td>
<td>Planned activities</td>
</tr>
<tr>
<td>Risk assessment – Risks generated by other</td>
<td></td>
</tr>
<tr>
<td>Risk assessment – Risks generated by environment</td>
<td></td>
</tr>
<tr>
<td>Risk assessment – Risks generated on other</td>
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</tr>
<tr>
<td>Risk assessment – self generated risks</td>
<td></td>
</tr>
<tr>
<td>Procedures to adapt collective protection</td>
<td>Collective protection</td>
</tr>
</tbody>
</table>

Table 326: Health and Safety Plan index
- Installation of the solar gallery roof with the solar panels
- Connections [water and electricity]
- Construction of the deck and the exostructure.

During the competition, the maintenance of the Sunspace will be essential. The disassembly will consist of the inverse of the construction phases.

**Description of the FENIX project**

Architectural footprint: 55 m²
Max height: 3.80 metres
Max length: 13.4 metres
Width: 6 metres

These dimensions are for just the three modules together with the Sunspace of Casa FENIX. During the construction phase the team decided to cut the Casa FENIX in two halves, where the assembly of modules is located, to facilitate the transport and on site assembly. This will also enable the team to gain more installation time.

<table>
<thead>
<tr>
<th>H&amp;S Team Coordinator</th>
<th>H&amp;S Team Assistant</th>
</tr>
</thead>
<tbody>
<tr>
<td>MABY Thomas</td>
<td>FASSIER Nathan</td>
</tr>
<tr>
<td>Tel.: (+33) 6 69 36 29 49</td>
<td>Tel.: (+33) 6 63 36 99 30</td>
</tr>
<tr>
<td><a href="mailto:maby.thomas21@gmail.com">maby.thomas21@gmail.com</a></td>
<td><a href="mailto:fassier.nathan@gmail.com">fassier.nathan@gmail.com</a></td>
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<table>
<thead>
<tr>
<th>SO Coordinator</th>
<th>SDE H&amp;S Organisation</th>
</tr>
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<tbody>
<tr>
<td>MAUDET Pierre</td>
<td>Bureau Veritas</td>
</tr>
<tr>
<td>Tel.: (+33)6 86 77 61 78</td>
<td>Tel.: (+33) 4 96 17 13 50</td>
</tr>
<tr>
<td><a href="mailto:p.maudet944@laposte.net">p.maudet944@laposte.net</a></td>
<td></td>
</tr>
</tbody>
</table>

**Table 327: Health and safety officers**

**Construction site in La Rochelle**

Hall Béton, IUT Génie Civil La Rochelle, Address: 15 Rue Francois De Vaux de Foletier, 17000 La Rochelle
Tel.:05 46 51 39 00

**Emergency telephone numbers in France**

Hospital-based Ambulance [SAMU]: 15
Service-based Ambulance: 18
Fire Department: 18
Police: 17

**Address of the nearest hospital**

Centre Hospitalier La Rochelle
Address: Rue du Docteur Schweitzer 17000 La Rochelle
Tel: 05 46 45 50 50

**Construction site on Versailles**

Site of the Solar Decathlon
Address: Allée des Matelots, 78000 Versailles

**On-site installation of Team Casa Fénix**

**Emergency telephone numbers in France**

Hospital-based Ambulance [SAMU]: 15
Service-based Ambulance: 18
Fire Department: 18
Police: 17

**Address of the nearest hospital**

Hôpital André Mignot
Address: 177 Rue de Versailles 78157 Le Chesnay
Tel.: 01 39 63 91 33
10.3 HEALTH AND SAFETY PLAN OBJECTIVES

As stated in Rule 3.3, “each team is responsible for the safety of its operations and each team member and team crew member shall work in a safe manner at all times during the project.”

Ensuring safety is an area of major importance for the organizers of the competition; great emphasis is going to be made on checking that the teams are complying in this area:

Planning and executing a safe production process: Teams must comply with the health and safety requirements right throughout the project, incorporating them into the planning and development of every single phase of the competition.

The European Union and/or French law on the Prevention of Occupational Risks [Health and Safety at Work]. This is completely mandatory, because the event is located in Versailles in France.

First of all, the Health and Safety Plan is a reference document with which all the decathletes in every SDE team must comply.

The Health and Safety Plan objectives must be simply and clearly stated so that the Casa FENIX Team can work following a safer process and their participation is normal and smooth at all times before, during and after the competition while assembling and disassembling Casa FENIX in Chile and/or France.

Risk prevention must be integrated during the preparation, assembly, execution, maintenance and dismantling of Casa FENIX at all times and on all sites, in Chile and/or France. This will involve training and awareness raising activities for all the decathletes of the Casa FENIX Team.

10.3.1. MAIN OBJECTIVE

This document aims to identify and prevent every risk before starting any construction work on Casa FENIX; in order to avoid risks during construction, it is necessary to minimize improvisation and avoid taking unplanned actions.

This document is meant to guide the actions of all team members during the different stages of construction; ensuring that they know how to develop the construction process in a safe manner at all times.
10.3.2. GENERAL OBJECTIVES

- Know the French regulations regarding health and safety on construction sites.

- Analyze and know the different work processes, the working environment and the place where the different stages will be developed in order to identify and prevent possible risks.

- Avoid dangerous situations and replace them with non-dangerous or less dangerous situations, even if they involve extra time.

- Develop a comprehensive prevention plan by integrating technology, work planning, social relationships and the influence of environmental factors.

- Implement collective protection measures as a priority over individual protective measures.

- Identify and evaluate potential risks in order to design a risk prevention plan, so as to avoid or adequately resolve risk situations, especially for those tasks that entail very high risks. The risks are those related to the construction process, including assembly, maintenance and disassembly, for the team members and everyone who participates in the whole process of this competition.

- In the event of an accident, follow the instructions produced and posted on the construction site.
10.4 CONDITIONS OF THE SITE DURING THE CONSTRUCTION PHASE

10.4.1 CONSTRUCTIVE PROCESS

This part details the whole phase during the construction on the site in Versailles. Some phases can be summed up in the main steps.

The risks for all of these phases will be assessed. A study of every phase will be made in detail for every phase of loading and unloading.

The Table 328 shows the location of every drawing detailed according to every phase.

<table>
<thead>
<tr>
<th>Construction process</th>
<th>Description of phase</th>
<th>HS Drawings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work area preparation</td>
<td>Installation of the work area</td>
<td>HS 001, HS 101, HS 201, HS 301, HS 403, HS 404, HS 420</td>
</tr>
<tr>
<td>Foundation system</td>
<td>Installation on the site of the foundations</td>
<td>HS 404</td>
</tr>
<tr>
<td>Assembly of the prefabricated modules</td>
<td>Assembly of the two halves is drawn and described in the site operation project</td>
<td>HS 302, HS 405 – 413, HS 423 – 427</td>
</tr>
<tr>
<td>Installation of the solar roof on the solar gallery</td>
<td>Implantation of the roof</td>
<td>HS 417, HS 421</td>
</tr>
<tr>
<td>Connections</td>
<td>Connecting the electricity and water systems</td>
<td>HS 414, HS 418, HS 420, HS 422</td>
</tr>
<tr>
<td>Construction of the deck and the external structure</td>
<td>Construction of the external arrangements</td>
<td>HS 415 – 416, HS 420 – 421</td>
</tr>
<tr>
<td>Cleaning of the construction site</td>
<td>Arrangement of the site</td>
<td>HS 419, HS 428</td>
</tr>
</tbody>
</table>

Table 328: Location of every phase detailed into PD
10.4.2 Type and Characteristics of the Materials and Elements

For the construction we are just using 5 types of materials [Table 329].

During the assembly and disassembly phases, the hazardous products that will be use:

- ADHESIVE SEALANT:
  Contains: Hardener Li [Isophrone-dialdimine], Bis [1,2,2,6,6-pentamethyl-4-piperidyl] sebacate.
  Contains some isocyanates.
  This kind of adhesive can activate an allergic reaction. The use of gloves is mandatory.
  Emissions into the internal air A+.

<table>
<thead>
<tr>
<th>N°</th>
<th>Materials and equipments</th>
<th>COMPONENTS OF THE RISK</th>
<th>PREVENTION MEASURES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Wood</td>
<td>Splinters / Concussion</td>
<td>Incorrect handling / People nearby could be injured</td>
</tr>
<tr>
<td>2</td>
<td>Glass / Windows</td>
<td>Cut / Concussion</td>
<td>Incorrect handling / Incorrect fixation</td>
</tr>
<tr>
<td>3</td>
<td>Electric systems</td>
<td>Electric Electric shock</td>
<td>Incorrect handling</td>
</tr>
<tr>
<td>4</td>
<td>PVC water connection</td>
<td>Exposure to hazardous substances</td>
<td>Incorrect handling</td>
</tr>
<tr>
<td>5</td>
<td>Steel</td>
<td>Cut / Concussion</td>
<td>Incorrect handling</td>
</tr>
</tbody>
</table>

Table 329: Prevention measures against risks of the materials.
10.4.3 SITE DESCRIPTION

Location

To the west of central Paris, on the site of the Château de Versailles, behind the ornamental lake known as “Pièce d’eau des suisses”

Address: Allée des matelots 78000 Versailles [Figure 330].

Description of the site

The competition site has a principal entrance: “Avenue de la Division Leclerc [D10]”, through which access is gained to the site of the Solar Decathlon Europe 2014.

“Allée des Matelots” is perpendicular to the principal entrance and provides access to the site which will be occupied by team FENIX.

Lot number: Casa FENIX will be located at the centre of the site next to the principal street [Figure 332].

Elements around the lot: Team Casa FENIX is located next to team PLT [Plateau, Spain] and near the main path entrance [Figure 332].
Lot size: 20 m x 20 m [400 m²] during the assembly phase.

There are a number of hazards in the area around the Team Casa FENIX lot [Figure 333].

Trees, trucks passing by, the work of other teams could present a hazard. It is necessary to be very attentive to all of these hazards. Respect safety instructions. Safety is everyone’s concern.

The health and safety signs enables the risks to be identified and safety measures to be established. The risks need to be assessed according to their likelihood and the maximum possible damage and level of seriousness involved [Figure 334].
<table>
<thead>
<tr>
<th>N°</th>
<th>OPERATION Identification</th>
<th>COMPONENTS OF THE RISK</th>
<th>PREVENTION MEASURES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Trees</td>
<td>Concussion with the trees/ discomfort during the manoeuvre</td>
<td>Electric shock</td>
</tr>
<tr>
<td>2</td>
<td>Too many people on site</td>
<td>Injury resulting from Concussion or fall</td>
<td>Electric shock/ Fall</td>
</tr>
<tr>
<td>3</td>
<td>Small site</td>
<td>Concussion with other people/ Concussion with stored parts / discomfort during manoeuvres</td>
<td>Electric shock</td>
</tr>
<tr>
<td>4</td>
<td>An assailant getting on site</td>
<td>A member of the team could be attacked</td>
<td>Attacker</td>
</tr>
</tbody>
</table>

Table 335: Prevention measures against risks of the environment
10.4.4 CLIMATE DESCRIPTION

Generalization

Climate: Oceanic Climate

The Ile-de-France is in a basin, affected by oceanic influences to the west and continental influences to the east. There are therefore two types of weather, which alternate, but the oceanic influence tends to prevail.

There are low levels of sunlight, not exceeding 1.664 hours per year and on average there are only fifty days per year when the sky is totally clear.

Precipitation is distributed throughout the year, but is heavier in the spring and autumn.

The bowl is between 100 and 150 metres in depth.

For the competition:

In summer the maximum temperatures in Versailles are between 21.8°C and 24.5°C.

Average summer rainfall is between 52 and 52.2 millimetres during June and July.

The average relative humidity in summer is about 70%.

There is an estimated 30 days of sunny days in summer.

The wind is always above 61 km/h in this area.

This climatic description is important for us to optimize the construction and work well. We need take into account the rain, wind and sun during the onsite construction. We have therefore evaluated the risks relating to climate.

During the construction, it is possible that weather could stop work. This decision has to be made by the SDE organization and the Team Safety Officer. The workers can request permission to stop work after discussions with the project manager and the team safety officer.
<table>
<thead>
<tr>
<th>N°</th>
<th>Identification</th>
<th>Dangerous phenomenon or danger</th>
<th>Dangerous situation</th>
<th>Dangerous event</th>
<th>Action/protection</th>
<th>Means</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Rain</td>
<td>Risk of slipping on wet surfaces / potential damage to the construction / Electric Electric shock</td>
<td>Incorrect handling / Construction without protection</td>
<td>Risk of slipping and falling over / damage to the construction / Electric Electric shock</td>
<td>Anti slip measures / drainage of water/ Electric plugs/ Personal Protective Equipment (PPE)</td>
<td>Anti slip mats on slippery surfaces / drainage of water/ waterproof plugs / Personal Protective Equipment (PPE)</td>
</tr>
<tr>
<td>2</td>
<td>Wind</td>
<td>Electric shock / damage to the construction / risk of falls</td>
<td>Placing the Casa FENIX halves / risk when working at heights / Incorrectly fixed elements might fall</td>
<td>Electric shock / damage to the construction / fall</td>
<td>Collective and Personal Protective Equipment (PPE)</td>
<td>Personal Protective Equipment (PPE)</td>
</tr>
<tr>
<td>3</td>
<td>Sun</td>
<td>Extreme heat</td>
<td>Carrying out building work without using solar protection</td>
<td>Sunstroke / sunburn / dehydration</td>
<td>Personal Protective Equipment (PPE) / access to drinking water / sunscreen / sun glasses</td>
<td>Personal Protective Equipment (PPE) / access to drinking water / sunscreen / sun glasses</td>
</tr>
</tbody>
</table>

Table 337: Prevention measures against risks of the weather
10.4.5 ACCESES AND PATHS FOR VEHICLES

Road from La Rochelle to Versailles:

The truck convoy will leave the University Institute of Technology, ULR Rue de Roux in La Rochelle to arrive at Allée des Tilleuls in Versailles [Figure 338]

The total distance is 461 kilometres and the road includes 106 kilometres of freeway or highway types of route.

Specification: One truck [truck n°7] will leave from the CILC company at January-Clan [86] and take Highway A10 to Versailles [Figure 339]

For the type of trucks at the site operation work the team will use the ones provided by SDE organization which complies with the SDE rules.

During the journey, the trucks and the cargo are exposed to different risks, the safety measures that will take, are describe in the Table 326

The team must respect the rules regarding access by the trucks to the CITE DU SOLEIL. There are
only two main entrances through which access can be gained to the site and all traffic must follow the established route.

During the competition, the circulation of the trucks and the crane present some potential risks to workers. Those risks and the security measures are explained in the Table 340.

### Vehicles

Regardless of the additional measures adopted, in order to avoid risks, when trucks or any other vehicles are moving in LA CITE DU SOLEIL:

- Their speed must adapt to walking pace and the specification of each truck/crane.
- One person must walk in front of the truck, on the driver’s side.
- Another person must walk behind the truck on the other side and must be visible in the rear-view mirror.

These two people will:

- Establish the maximum speed of the vehicles.
- Direct the movement of the truck.
- Avoid the truck being involved in an accident involving people, other vehicles and/or with the different elements of LA CITE DU SOLEIL.

### Load operation

French Regulations establish specific limitations on the loads to be carried by people. In accordance with French law on the Prevention of Occupational Risks, the maximum load to be carried by any one person is 25 kg.

Workers could be harmed by any type of accidents. This can be mainly the following:

- The sling break letting the load fall over the crew.
- Crane accident due to overloading, overbalancing and collapse of the support.
- Breaking of the stabilizing beams.

For these reasons, it is essential to inform all workers the conditions of the machine operated at each moment.

- The weight of the load [axis of the elements in the crane and axis of the load to be raised]
- The height of installation or removal of the load
- The characteristics of the load

<table>
<thead>
<tr>
<th>Risks</th>
<th>Measures</th>
</tr>
</thead>
</table>
| Organisation | - Prepare the route beforehand to organize the time it will take [itinerary with the time, state of the road, the rest areas and timings of breaks]  
- Organize the times of breaks and resume work normally  
- Organize the mission by taking into account predictable hazards  
- Arrangement of the working time of the employees |
| Technique | - Use vehicles adapted at both to the journey and the task to be realized.  
- Verify the maintenance of utilised vehicles according to the type of vehicle.  
- Inform the drivers of the basic checks to be made before departure and the procedure for describing anomalies.  
- Set up safety elements signs on vehicles, first-aid kit, high visibility vest for the driver.  
- Be attentive to any obstacle which crops up along the way. |
| Human | - Inform the driver about the nature of his/her load.  
- Make the driver aware of risks such as talking on his/her mobile phone while driving, failing to comply with break times and taking certain substances or medications.  
- Check the driver document are within norms. |

Table 340: Risks during the trucks journey
The wind also presents a risk. In the event of high winds, construction work can be stopped in order to safeguard both the load and the workers.

In respect to the site operation the crane can be located at the top of the road or on the nearest site.

For the loading and unloading phase, a minimum of 5 people. Four of them are there to secure the load with slings. The four slings are fastened at the four corners of the load. This will stop the load from moving around and will help the installation. The fifth person is there to communicate information to the driver of the crane if he/she otherwise has no visibility. The fifth person must wear a high visibility vest BANKSMAN.

For the mobile crane, the radio link is required in case there is no direct visibility with the timekeeper; otherwise communication will be the use of conventional movements by the worker [Table 341].

<table>
<thead>
<tr>
<th>Sign</th>
<th>Movement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up</td>
<td>One fist on the hip, the other arm bended upward, over shoulders, to turn the front arm.</td>
</tr>
<tr>
<td>Down</td>
<td>One fist on the hip, the other tense arm facing downward at the level of the hip, the hand is turned towards the ground and is moved in circles or falls energetically till the middle path of the vertical line.</td>
</tr>
<tr>
<td>Movement Horizontal</td>
<td>One fist on the hip, the other arm half tightened upward cleaves through the air in a vertical plane up to the line of breast, in the direction where the load must be carried.</td>
</tr>
<tr>
<td>Stop</td>
<td>One fist on the hip, the other arm opens energetically breast-high. The crane driver has to stop the device gradually. The same movement with the two arms making a stop expression.</td>
</tr>
<tr>
<td>At the end of the command</td>
<td>In front of crane driver. Both arms framing the face develop energetically up to the line of breast. This gesture means: “it is not any more me who give you orders”.</td>
</tr>
</tbody>
</table>

Table 341: Different kind of movements, for the communication with the mobile crane
5.4.6 THE FACTORS TO DETERMINE THE LOCATION OF THE HOUSE

The CASA FENIX measures some 64 m² and it is to be built in the centre of the site. The house is orientated with the solar gallery facing south to achieve the maximum solar gain. The Survival Module is situated nearest to the road access to ensure it is high visible to the public.

This orientation will enable the house to be installed step by step without needing to carry load on passing through the top of the house, in accordance with the safety plan. Team Casa FENIX is next to PLATEAU team, while the other teams are separated from our plot by the main entrance and another access.

5.4.7 OVERLAPS WITH THE Affected SERVICES AND OTHER CIRCUMSTANCES OR Activities OF THE LOCAL ENVIRONMENT

The construction site is narrow, neighbour to the PLATEAU team site, therefore we have to pay attention to the other teams and to the traffic on site.

The risks associated to the local environment are described in the Table 342

During the loading, the crane must not pass onto the site of PLATEAU. In case the PLATEAU team needs to pass on our site, we will need to stop construction by agreement among the two team’s site operation coordinator.

<table>
<thead>
<tr>
<th>Risks</th>
<th>Description</th>
<th>Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concussion</td>
<td>- Concussion during loading</td>
<td>- A load must not pass above another load or through the top of the site</td>
</tr>
<tr>
<td></td>
<td>- Concussion of the workers</td>
<td>- Control the movements of the load (HS 302). See the details of the load operation in the HS Plan</td>
</tr>
<tr>
<td></td>
<td>- Concussion with trucks</td>
<td>- Use the Personal Protective Equipment (PPE)</td>
</tr>
<tr>
<td></td>
<td>- Concussion with the crane</td>
<td>- Respect the rules for vehicles in LA CITE DU SOLEIL</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- A load must not pass above another load or to the top of the site</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Control the movements of the load (HS 302). See the details of the load operation in the HS Plan</td>
</tr>
</tbody>
</table>

Table 342: Different risks, and safety measures for the workers

It is possible that the SDE organisation or other teams’ members will come to our construction site. They must respect our HS Plan, use Personal Protective Equipment [PPE] or abide by collective protection measures and must be accompanied by a person from our team to ensure their safety. Access to the construction site for other people is not authorised.
5.4.8 PLANNED ACTIVITIES

The Table 343 described all the planned activities for each phase in the construction period.

Nevertheless after to the assembly phase, a lot of works will be developed, one of them are the maintenance works.

Maintenance Plan

For this step, we need to clean the solar and thermal panels. We also need to resolve any other problems that arise, such as an electrical problems during the installation.

To clean the solar panels, we can access the outside of the house with the ladder, this task does not involve working on the roof.

And for the electrical problems, all the installations are accessible from the inside of the house.

Maintenance of the solar panels

- Inverters
  - Internal visual control inverter - Check state and test of ventilators
  - Check any existing internal fuses and the tightness of the AC connections
  - Check the connectors.

- Junction box
  - Check the general state of the DC connectors
  - Check the state of the threads and G-strings
  - Check the DC lightning conductor

- Electric cupboard AC
  - Check the general state
  - Check the presence of documents
  - Check the tightness of terminals
  - Check the AC lightning conductors

- Photovoltaic field
  - Check the general state of cables in contrast with the plans and the position of them on the modules
  - Check the diagram of the system of integration

Progress of cables

- Control of the progress of the roof until the inverter is set up
<table>
<thead>
<tr>
<th>N°</th>
<th>PHASE</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Site preparation / Installation</td>
<td>- We will install the foundation system and implant them; delimitate the work and construction areas. The installation of the different half modules. We need to pay attention to the delimitation area and prepare all the security systems. - Ensure that the electrical installation for work is secure.</td>
</tr>
<tr>
<td>2</td>
<td>Foundations / Installation of the technical elements and general installation / Storing decks</td>
<td>- We will use the theodolite and the level to put in the foundation systems - This is the installation on site. The area is delimited in the first phase and we need to unload the first trucks with all the materials.</td>
</tr>
<tr>
<td>3</td>
<td>Installation of the ½ module / Installation of the 2/2 Survival Module / Other modules</td>
<td>- The half modules are prefabricated in La Rochelle, we need to install and join them. After the installation of the first half module, we need to prepare it to receive the second half module. [Take off the systems for protecting it during transport and prepare the cross for the junction] - Precisely install the second half module in front of the first. And do a little operation with the crane so the crosses slide in while waiting for the posts for this half module. - For all the half modules, the operation is the same for phases 3 and 4.</td>
</tr>
<tr>
<td>4</td>
<td>Electric and Water connection between each module</td>
<td>- The electrical junction will be simplified with plugging systems; this phase is being handled by a professional electrician. For the water connection we only need to connect the systems with the water tank and all the installations are included in the half module of the bathroom.</td>
</tr>
<tr>
<td>5</td>
<td>The junctions for Roofs, Floors and Walls between each module</td>
<td>- We need to make the insulation junction between the half module in the roof, in the floor and in the wall. This operation is to minimise the thermal deck.</td>
</tr>
<tr>
<td>5 bis</td>
<td>Exhibition Structure, Storing of the decks and installation in the devastated area / Installation and Assembly of the decks and Access Ramps</td>
<td>- This phase represents the onsite installation. - We will install the access ramps for the public and connect them to the structure.</td>
</tr>
<tr>
<td>6</td>
<td>Positioning and Setting of the roof of the sunspace</td>
<td>- We need to be very attentive to this operation, because the roof is composed of the solar and thermal panels. We need to include the roof in the structure of the solar gallery.</td>
</tr>
<tr>
<td>7</td>
<td>Electric and PV connections for the sunspace roof</td>
<td>- For connecting this, the same system of phase 6 will be used</td>
</tr>
<tr>
<td>8</td>
<td>Junctions with the Sunspace roof</td>
<td>-</td>
</tr>
<tr>
<td>9</td>
<td>House fitting and electric connections of the household appliances</td>
<td>- To be undertaken by a professional electrician.</td>
</tr>
<tr>
<td>10</td>
<td>Connecting the Power grid and Water System to the Solar Village</td>
<td>-</td>
</tr>
<tr>
<td>11</td>
<td>House and clearing up</td>
<td>- We need to load the container, the safety accessories and other elements onto a truck in order to clear the site for the safety of the public during the competition.</td>
</tr>
</tbody>
</table>

Table 343: Description of each planned activities/phases
5.4.9 AUXILIARY RESOURCES PLANNED FOR THE CONSTRUCTION

During the construction, we will need to use different resources such as:

- Trucks
- Crane
- Container
- Storage zone
- Lights
- Electrical systems

For a description of the installation of these different resources, please refer to the site operation plan.

These resources can include some risks [Table 344]:

The wind can create dangerous conditions for the mobile crane. It is therefore important to keep informed about the weather forecast so as to be warned as soon as possible and at least 2 hours in advance of any wind in excess of the authorized maximum speed (72 km/h). All the movements of the crane with a load must be controlled to minimize the risk of falls and other hazards.

<table>
<thead>
<tr>
<th>Resources</th>
<th>Risks</th>
<th>Prevention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crane</td>
<td>- Concussion with the load</td>
<td>- See the rules for cranes</td>
</tr>
<tr>
<td></td>
<td>- Concussion with the lot surrounding</td>
<td>- See drawing HS-302</td>
</tr>
<tr>
<td>Trucks</td>
<td>-Workers may be struck/run over</td>
<td>- See the rules for trucks</td>
</tr>
<tr>
<td></td>
<td>- The load may fall</td>
<td>- See drawing HS-301</td>
</tr>
<tr>
<td>Container</td>
<td></td>
<td>- Control access to the container</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Make a list of using</td>
</tr>
<tr>
<td>Storage zone</td>
<td>- Objects stored may fall</td>
<td>- Delimit the area</td>
</tr>
<tr>
<td>Lights</td>
<td>- Electrocution</td>
<td>- Use protective for the lights</td>
</tr>
<tr>
<td>Electric systems</td>
<td>- Electrocution</td>
<td>- Protect systems from the rain</td>
</tr>
</tbody>
</table>

Table 344: Risks associated to the auxiliary resources
5.4.10 MACHINERY PLANNED FOR THE CONSTRUCTION

The construction is designed in such a way that no building will be necessary on the site; there will merely be the need for joins. But in the event of problems with the loading, machinery will be used [Table 345]

<table>
<thead>
<tr>
<th>Machinery</th>
<th>Risks</th>
<th>Prevention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jigsaw</td>
<td>- Cutting</td>
<td>- Use Personal Protective Equipment [PPE] and organize the work area</td>
</tr>
<tr>
<td></td>
<td>- Incorrect handling</td>
<td></td>
</tr>
<tr>
<td>Circular saw</td>
<td>- Cutting</td>
<td>- Use Personal Protective Equipment [PPE] and organize the work area</td>
</tr>
<tr>
<td></td>
<td>- Incorrect handling</td>
<td></td>
</tr>
<tr>
<td>Screwing machine</td>
<td>- People’s hands will be vulnerable to injury</td>
<td>- Work safely</td>
</tr>
<tr>
<td></td>
<td>- Incorrect handling</td>
<td>- Use Personal Protective Equipment [PPE] and take collective protection measures</td>
</tr>
<tr>
<td>Cutter</td>
<td>- Cutting</td>
<td>- Use Personal Protective Equipment [PPE]</td>
</tr>
</tbody>
</table>

Table 345: Risks associated to the auxiliary resources
5.4.11 CONSTRUCTION SITE INSTALLATION

During the assembly of the construction, we will use electrical systems for the machinery. This involved risks, [electric Electric shocks]. The installation needs for protection and risk prevention has to be continuously controlled by authorised personnel. However, all the installation work will be done in La Rochelle. The electrical work in Versailles will merely involve joining all the plugs, so there will be no risks involved. Access to drinking water will be necessary for the safety and refreshment of the workers.

Installation of WC

Chemical toilets have been arranged by the organization.

Drinking water and industrial water

The organization takes care of the installation of drinking water and water distribution systems on the construction site.

The delivery of industrial water for the construction site phase will also be necessary.

The organization is also taking care of the installation of the phone and electricity networks.

Waste

A maximum of 1m³ of waste is expected to be generated during the assembly and disassembly phases; however we hope that the actual volume will be significantly less than this projection.

Waste will be classified and sorted into four different types [Table 346]:

- Wooden waste to be recycled
- Recyclable cardboard and plastics
- Scrap [bolts, nails, broken pieces, empty containers, etc]
- Hazardous waste [glue, paint]

Some of the non-hazardous waste will be used to create our “post-catastrophe simulated area”, an area to remind people about the conditions following a natural disaster.

<table>
<thead>
<tr>
<th>TYPE</th>
<th>VOLUME [m³]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wooden Waste</td>
<td>0.5</td>
</tr>
<tr>
<td>Cardboard &amp; Plastic</td>
<td>0.3</td>
</tr>
<tr>
<td>Scrap</td>
<td>0.02</td>
</tr>
<tr>
<td>Hazardous waste</td>
<td>0.18</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TYPE</th>
<th>VOLUME [m³]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wooden Waste</td>
<td>0.5</td>
</tr>
<tr>
<td>Cardboard &amp; Plastic</td>
<td>0.3</td>
</tr>
<tr>
<td>Scrap</td>
<td>0.02</td>
</tr>
<tr>
<td>Hazardous waste</td>
<td>0.18</td>
</tr>
</tbody>
</table>

Table 346: Different kind of waste and the quantity

<table>
<thead>
<tr>
<th>Module</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Half Module n°1</td>
<td>5.07x1.79x3.30 m</td>
</tr>
<tr>
<td>Half Module n°2</td>
<td>5.07x1.71x3.30 m</td>
</tr>
<tr>
<td>Half Module n°3</td>
<td>6.8x2.02x3.39 m</td>
</tr>
<tr>
<td>Half Module n°4</td>
<td>5.7x1.7x3.39 m</td>
</tr>
<tr>
<td>Half Module n°5</td>
<td>5.7x1.7x3.39 m</td>
</tr>
<tr>
<td>Half Module n°6</td>
<td>5.7x1.7x3.39 m</td>
</tr>
<tr>
<td>Half Module n°7</td>
<td>5.7x1.9x3.39 m</td>
</tr>
<tr>
<td>Half Module n°8</td>
<td>3.72x1.9x3.39 m</td>
</tr>
<tr>
<td>Sunspace Roof</td>
<td>9.7x3.2x0.33 m</td>
</tr>
<tr>
<td>Outside structure</td>
<td>6.8x2x3 m</td>
</tr>
<tr>
<td>Technical Elements</td>
<td>6.18x1.00x1.45 m</td>
</tr>
<tr>
<td>Container</td>
<td>6.00x2.44x2.59 m</td>
</tr>
</tbody>
</table>

Table 347: Approximate size of the trucks Load

[Solar Decathlon Europe] [Team FENIX]
10.5 RISK PREVENTION ACTIVITIES

To prevent risks, all the team members will read the health and safety plan, to ensure that they know the plan and the rules [More details about Health and Safety Plan Brochure in the Appendix 14.6 “Health and Safety Appendix”].

Some of the members will receive especial training in regard to risk prevention activities.

For ease of construction, only construction joins will be realized on the construction site [waterproof, insulation and cladding joins]; thus no construction will be carried out on the construction site.

The whole team will be trained in how to join two half modules, so they are familiar with the systems of setting-up and the tasks which must be realized on the site. This will allow us to optimize the construction during the 10 days of competition and to reduce the risks.

10.5.1 CONSTRUCTION PLAN: DETERMINATION OF WORK EFFECTIVE TIMING

During the construction phase, we will work in four teams [Table 348].

Each team will assume a specific task. Each team is composed of 6 students, and one of six, has to know the entire site operation, to manage the team. The team will work 8 hours per day with a break for lunch between 12 noon and 2 p.m. There will be a 15-minute break every two hours.

There will also be four teams for the disassembly stage [Table 349], but the teams will be different. For the timing of each team, please refer to the site operation plan that depicts the details of all the work.

<table>
<thead>
<tr>
<th>Team 1</th>
<th>Team 2</th>
<th>Team 3</th>
<th>Team 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pierre MAUDET</td>
<td>Thomas MABY</td>
<td>Sebastián ROJAS</td>
<td>Maxime DORY</td>
</tr>
<tr>
<td>Alejandra CARRASCO</td>
<td>Constanza CAMPOS</td>
<td>Nathan FASSIER</td>
<td>Soizic DENEUX</td>
</tr>
<tr>
<td>Aurélien VINCENT</td>
<td>Baptiste JARLET</td>
<td>Maxime GIBERT</td>
<td>Simon RIBREAU</td>
</tr>
<tr>
<td>Léa LERY-LACHAUME</td>
<td>Quentin DUEZ</td>
<td>Laure ANGENARD</td>
<td>Victor BIGOT</td>
</tr>
<tr>
<td>Adrien CAT BLONDEAU</td>
<td>Axel DENECHAUD</td>
<td>Guillaume DESIRAT</td>
<td>Joris SCALMA-NA</td>
</tr>
<tr>
<td>Damien BRUNET</td>
<td>Carolina SEPULVEDA</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 348: Teams in the assembly phase

<table>
<thead>
<tr>
<th>Team 1</th>
<th>Team 2</th>
<th>Team 3</th>
<th>Team 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pierre MAUDET</td>
<td>Thomas MABY</td>
<td>Sebastián ROJAS</td>
<td>Simon RIBREAU</td>
</tr>
<tr>
<td>Alejandra CARRASCO</td>
<td>Constanza CAMPOS</td>
<td>Nathan FASSIER</td>
<td>Laure ANGENARD</td>
</tr>
<tr>
<td>Carolina SEPULVEDA</td>
<td>Daniela Gil</td>
<td>Lucia SIMONS</td>
<td>Diego POBLETE</td>
</tr>
<tr>
<td>Pilar AGUILAR</td>
<td>Diego GONZALES</td>
<td>Felipe VERGARA</td>
<td>Katherine CABEZAS</td>
</tr>
<tr>
<td>Pedro ASCENCIO</td>
<td>Christian LOPEZ</td>
<td>Carolina REYES</td>
<td></td>
</tr>
</tbody>
</table>

Table 349: Teams in the disassembly phase
10.5.2 NUMBER OF WORKERS TAKING PART IN THE CONSTRUCTION

This is an interdisciplinary group, and on the construction site we will have students from the two different universities [Table 350].

<table>
<thead>
<tr>
<th>UFTSM</th>
<th>ULR LPBBC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sebastián ROJAS VERA</td>
<td>Damien BRUNET</td>
</tr>
<tr>
<td>Constanza CAMPOS JOFRÉ</td>
<td>Aurélien VINCENT</td>
</tr>
<tr>
<td>Carolina SEPULVEDA LAVANCY</td>
<td>Soizic DENEUX</td>
</tr>
<tr>
<td>Alejandra CARRASCO SERRANO</td>
<td>Guillaume DESIRAT</td>
</tr>
<tr>
<td>Pilar AGUILAR</td>
<td>Laüre ANGENARD</td>
</tr>
<tr>
<td>Pedro ASCENCIO</td>
<td>Axel DENECHAUD</td>
</tr>
<tr>
<td>Dianela GIL</td>
<td>Joris SCALMANA</td>
</tr>
<tr>
<td>Diego GONZALES</td>
<td>Thomas MABY</td>
</tr>
<tr>
<td>Christian LOPEZ</td>
<td>Nathan FASSIER</td>
</tr>
<tr>
<td>Lucia SIMONS</td>
<td>Victor BIGOT</td>
</tr>
<tr>
<td>Felipe VERGARA</td>
<td>Quentin Duez</td>
</tr>
<tr>
<td>Carolina REYES</td>
<td>Maxime GUIBERT</td>
</tr>
<tr>
<td>Diego POBLETE</td>
<td>Pierre MAUDET</td>
</tr>
<tr>
<td>Katherine CABEZAS</td>
<td>Simon RIBREAU</td>
</tr>
<tr>
<td></td>
<td>Maxime DORY</td>
</tr>
<tr>
<td></td>
<td>Léa LERY-LACHAUME</td>
</tr>
<tr>
<td></td>
<td>Adrien CAT BLONDEAU</td>
</tr>
<tr>
<td></td>
<td>Baptiste JARLET</td>
</tr>
</tbody>
</table>

Table 350: Workers in the assembly and disassembly phase
10.5.3 CONTRACTING PLANNED

In order to ensure compliance with the French maximum work periods, teams are asked to arrange the schedule of work of each team member and team crew.

The French legal work period are show in Table 351:

<table>
<thead>
<tr>
<th></th>
<th>Daily [from 0:00 to 24:00]</th>
<th>Weekly [from Mon 0:00 to Sun 24:00]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day work</td>
<td>10 hrs Max</td>
<td>48 hrs Max</td>
</tr>
<tr>
<td>Night work</td>
<td>8 hrs Max</td>
<td>48 hrs Max</td>
</tr>
<tr>
<td>Rest</td>
<td>11 consecutive hrs Min</td>
<td>24 hrs consecutive hrs Min</td>
</tr>
</tbody>
</table>

For each person:
- Weekly work can be increased to a maximum of 60 hrs
- Daily daytime work can be increased to a maximum of 12 hrs
- Daily nighttime work can be increased to a maximum of 10 hrs

All the team members will work for the maximum of 8 hours in the daytime. There are two people who are going to work every day [8hrs]; they are the site operation coordinator and the health and safety coordinator.

But they will work a maximum of 48 hrs per week and have a 24-hour rest on Sunday, in accordance with French regulations.

<table>
<thead>
<tr>
<th>Team</th>
<th>Day 1</th>
<th>Day 2</th>
<th>Day 3</th>
<th>Day 4</th>
<th>Day 5</th>
<th>Day 6</th>
<th>Day 7</th>
<th>Day 8</th>
<th>Day 9</th>
<th>Day 10</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td>8h-18h</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>8h-12h</td>
<td>10h-16h</td>
<td></td>
<td>32h</td>
</tr>
<tr>
<td>2</td>
<td>10h-18h</td>
<td>8h-18h</td>
<td>8h-18h</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>30h</td>
</tr>
<tr>
<td>3</td>
<td>8h-12h</td>
<td></td>
<td></td>
<td>8h-18h</td>
<td>8h-11h</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>25h</td>
</tr>
<tr>
<td>4</td>
<td>8h-16h</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>9h-18h</td>
<td>8h-12h</td>
<td></td>
<td></td>
<td></td>
<td>27h</td>
</tr>
</tbody>
</table>

Table 351: Legal work period

Table 352: Teams schedule in the assembly phase
10.6 CRITICAL WORK PHASES FOR RISK PREVENTION:

All the construction is prefabricated in La Rochelle, and we are going to disassemble all the half modules for transportation. On site we will only unload the half modules and join the insulation, make the electric and water connections.

For the electrical installation, the power must be disconnected for safety reasons and the connection will be done with plugs.

The regulations require an electrician, but this will not be necessary, because all the electrical connections will be doing with some plugs.

However, for safety reasons, there is a student who has the ability to do electrical work.

Maxime DORY

dorymaxime@hotmail.fr
+ 33 [0] 6 87 48 98 65

---

1 Her electrical skills are detailed in the appendix 14.6 “Health and safety Appendix”
10.7 RISK IDENTIFICATION AND ASSESSMENT OF THE EFFICACY OF THE PROTECTIVE MEASURES ADOPTED

10.7.1 LOCATION AND IDENTIFICATION OF THE AREAS WHERE THE WORKS INVOLVING SPECIAL RISKS WILL TAKE PLACE

<table>
<thead>
<tr>
<th>Type of work</th>
<th>Location</th>
<th>Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Movement of the crane</td>
<td>- Movements are only authorised on the FENIX construction site</td>
<td>- See the rules regarding access and paths for vehicles.</td>
</tr>
<tr>
<td>Loading and unloading</td>
<td>- There is a location for the trucks, which they must respect.</td>
<td>- Control the operation of loading and unloading, as in HS 302</td>
</tr>
<tr>
<td></td>
<td>- See the installation in the site operation for details of the location of the half module.</td>
<td></td>
</tr>
<tr>
<td>Work on the roof</td>
<td>- Only on the roof of the survival, mechanical and living modules</td>
<td>- Protection elements will be installed on the roof during the maintenance and the junction of the roof.</td>
</tr>
<tr>
<td>Transport of the load</td>
<td>- On the construction site</td>
<td>- The load not pass over an already installed half module</td>
</tr>
</tbody>
</table>

Table 353: Location and identification of the areas where the works involving special risks will take place
10.7.2 RISK IDENTIFICATION AND ASSESSMENT OF THE EFFICACY OF THE PROTECTIVE MEASURES ADOPTED

Every phase has been detailed and the risks have been estimated in each case. Depending on the evaluation of the risk, protection is to be set up or alternatives sought to avoid the risk. Another assessment will be made following the implementation of the measures.

Please refer to the appendix 14.6 “Health and Safety Appendix” for details of the identification of risks and the assessment of the efficacy of the protective measures adopted.
10.8 COLLECTIVE PROTECTION RESOURCES TO BE USED

Collective security measures comprise

- **Cones and ribbons**: they will be used to mark critical areas like storage areas or to indicate a hazard.

- **Drinking water**

- **First aid bag**: this is described later.

- **Site fence**: these fences will prevent unauthorized persons from accessing the construction site.

- **Waterproof plugs for connections out of doors**

- **Railing**: this will be included in the upper element to protect people connecting the power grids, airflow and hydraulics.

- **Rolling safety ladder**

- **Interior scaffolds**

- **Extinguisher**: there will be an « AB » fire extinguisher in the container.

The specifications and manufacturer’s user manual for all equipment will be available on site.

**Cones and ribbons**: These will be used to create the different work areas and to make a delimitation between the truck area and the construction site.

**First aid bag**: The construction site has several first-aid kits. Team members must refer to the planned measures in the event of an accident.

**Site fence**: These barriers will be used to deter every type of intrusion when the construction site is not occupied. We can also secure the construction site with these barriers.

**Waterproof plugs**: These will be used for making electrical connections and will help avoid the risk of electrocution.

**Working at heights**: The access equipment [Ladder] and working platforms [scaffold] must be used whatever the height of crossing or work. There will only ever be two people on the roof of the house. They will be there to install the elements of the junction of the current roof and to install the roof of the solar gallery. These two people will also take care of the joins to ensure the waterproof membrane. These two people will be the same for both the assembly and the disassembly. They will first have received training on the risks of work at heights.

The workers will be secured against falls by the use of a “mobile Lifeline 20 m”. [MILLER by Honeywell] [Figure 254]

This “line of life” is installed between the sunspace. The safety of the workers is further assured.

![Figure 354: Protective measures in the roof](image)
by two other lines [Coulisseau Titan 20m]. This system helps prevent the risk of falling.

To install the line, team members can be inside the house with the ladder or outside the house with scaffolding. This is the same for the disassembly of the lifeline.

**Training on working at heights**

The enterprise LORTEK training made us a course on 12 May 2014.

The people who received this training:

RIBREAU Simon
FASSIER Nathan
ANGENARD Laure
MAUDET Pierre
MABY Thomas

Moreover, the helmet of the worker in height will be adapted with a system which doesn’t permit the fall of the helmet.

**Scaffolding**

We need to use scaffolding for working at height. To install the scaffolding elements, the team has a member who is trained in this type of work.

Maxime DORY
Date of end: 11/06/2016
N°: 130472/04

Ladder: The use of the fixed ladder will be permitted following a risk assessment and the authorization of the works foreman. The use of the safety harness is compulsory. Never make works in height without the harness.

We are going to use two different ladders, in accordance with the rules [Table 355].

**Positioning of the ladder:**

The base of the ladder is spread from a distance D. Its support at height is equal in 4XD. The scale has to exceed by a metre. This rule ensures the scale retains good stability.

| Telescopic individual platform 4/6 steps with fixed lifeline Sherpascopic TUBESCA |
|------------------------------------------|------------------------------------------|
| **Anti-fall system** | The lifeline has tools at the front, banisters at the sides and a tubular gate at the back to create a real “seat belt” |
| **Exceptional stability** | - Balance device ensure that even if the user bends he/she will not fall.  
- The latter are retractable for use in narrow spaces. |
| **Safe** | - Platform 600x420mm surrounded with a baseboard, a height of 100mm.  
- Anti-skid board  
- The wheels have a diameter of 160mm and the precision of the regulation will be made thanks to stabilizers according to the quality of grounds. |

<table>
<thead>
<tr>
<th>Individual platform F3 TANDEM PRO</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Anti-fall system:</strong></td>
</tr>
<tr>
<td><strong>Stability</strong></td>
</tr>
</tbody>
</table>

2 More information about the installation of the « lifeline » is available in the appendix 14.6 “Health and Safety Appendix”

3 The certificates are located into Appendix 14.6 “Health and safety Appendix”

Table 355: Ledder that our Team will use
**Manual handling:** Use correct movements when lifting weights.

Use the right equipment to handle the weight. Two people can lift a weight together, reducing the effort involved. Wear gloves when lifting goods. The use of the crane for lifting and moving loads is compulsory for weights of 25 kilos and over.

**Raise a load manually:** Lift the load at the balance point in the centre of it. Keep the back straight. Bend legs. Unbend legs to raise the load.

**The Extinguisher:** there will be an « AB » fire extinguisher.

This contains water and can be used to combat fires fuelled by paper, wood, fabrics, oil, fats and hydrocarbons.

For safety reasons, we are going to have three extinguishers. Two will have a capacity of 9 litres and 21A-233B efficiency.

They will be kept in the container during the construction period and then in the interior of the house.

There will also be a CO2 fire extinguisher for electrical installations inside the house, kept near the electrical box.

**Commercial SICLI 17**

MR DECHAMPS
0608276200
Stephan.deschamps@sicli.com

Please refer to the appendix 14.6 “Health and Safety Appendix” for information about the different extinguishers.
10.9. PERSONAL PROTECTIVE EQUIPMENT

General instructions for the prevention of risks.

Wear the following personal protective equipment:

- A helmet [white color]
- Working clothes
- Safety shoes or boots
- A reflective jacket [yellow colour] typical for construction sites
- A safety harness for working at heights

You can also wear in certain situations:

- Gloves, for any work presenting risks to hands [handling, use of dangerous products, soldering]
- Hearing protection [headphones], for all tasks exposed to sound levels superior to 85dBA [driven by machine, cutting, grinding]
- Safety glasses, for all tasks presenting a risk of items getting into eyes [grinding, injection, cutting]
- Masks, for all tasks which take place in polluted areas [dust, toxic gases]

Particular rules of prevention related to the activity:

The site operations coordinators, the Health and Safety team coordinator and the safety officers must be easily identified by the organisation with a special hard hat [yellow hat].

We have to clearly identify the crane signal person with a special reflective jacket with the word « BANKSMAN », written on the back in black capital letters.

Figure 356: Personal and collective protections
### Figure 357: Personal and collective protections

<table>
<thead>
<tr>
<th>Risks</th>
<th>Prevention</th>
<th>What to do in the event of an accident</th>
</tr>
</thead>
<tbody>
<tr>
<td>Products which are harmful to skin</td>
<td>Use of work clothes / Gloves / Glasses</td>
<td>- The person should wash the affected area immediately and abundantly with soap and water</td>
</tr>
<tr>
<td>Product getting into the eyes</td>
<td>Use of glasses</td>
<td>- Rinse the affected eye with abundant amounts of water or a sterile ophthalmic solution</td>
</tr>
<tr>
<td>Inhalation of vapour</td>
<td>Use of a mask</td>
<td>- The person should rest, breathe fresh air and get medical help</td>
</tr>
<tr>
<td>Ingestion of dust</td>
<td>Workers should wash their hands before eating / Do not eat in the place of work / Do not eat while wearing work clothes</td>
<td>- Rinse the mouth immediately and drink abundant amounts of water - Seek medical help</td>
</tr>
<tr>
<td>Cuts</td>
<td>Use of protective gloves</td>
<td>- First-aid kit - Seek medical help</td>
</tr>
<tr>
<td>Burns</td>
<td>Use of protective gloves</td>
<td>- First-aid kit - Seek medical help</td>
</tr>
<tr>
<td>Fire</td>
<td>Fire extinguisher</td>
<td>- First-aid kit - Seek medical help</td>
</tr>
</tbody>
</table>
10.9.1 SIGNPOSTING OF THE RISKS

The road marking of construction site aims at informing the user, at influencing its behavior, even at imposing him certain limitations. It has to report most exactly possible of the situation, to evolve in the time and in the space and to disappear since disappeared the motives having led to implant it.

**Permanent signposting at the lot’s entrance**

**Construction site forbidden to the public**: this prevents and dissuades people from intruding onto the site during the construction or during other phases of no activities.

**Compulsory helmet use**: like the use of the entire individual

No parking during the day or night: This informs people circulating in front of the lot that here there is an entrance or an exit which must be never blocked.

No smoking or flammable substances: During the construction or maintenance work.
10.10 SAFE WORKING PROCEDURES OF EVERY TEAM MEMBER

Presentation of the Health and Safety Plan:

All the team members will be shown a presentation of the HS Plan. This presentation is a summary of the rules. This will at least have details of the circulation on site, the presentation of the construction, on-site health and safety and the emergency plan procedure.

All workers must receive this presentation and know all the rules. If they do not, they can be refused access to the work site. Workers can be asked questions to check that they know about all the procedures and rules.

Generalities:

This part is a summary of information about the site operation coordinator and health and safety coordinator, as well as the SDE organization in charge of Health and Safety.

Organization:

All the names of the team members are given in this part. In Versailles, the interdisciplinary group will be composed of 32 workers from the two universities. 22 will work during the assembly period and 19 during the disassembly period.

Environment:

The project concerns the construction of CASA FENIX in the CITE DU SOLEIL where the competition is being held this year. This part contains a description of the site in Versailles and the description of the lot and its surroundings.

Accessibility:

To work at La Cité du Soleil, any foreign employee needs a temporary work permit. The employer is in charge of making the necessary arrangements for its employees to get a temporary work permit. This does not apply to students.

Only students are going to be on site, because no professional help is needed and all the work will be prepared in La Rochelle. For safety reasons, the team includes a student who is able to make electrical connections.

Team Casa FENIX will be working next to the PLATEAU team. The Casa FENIX lot will be delimited by barriers, enabling access to the lot to be controlled and reducing the risks of incidents with other team members or anyone else.

To maintain control and work site safety, only people who know the Health and Safety Plan can access the site. Personal Protective Equipment is required to work on or visit the construction site.

It is possible that the SDE organization or the members of other teams will come to our construction site. They must respect our Health and Safety Plan, use the personal protective equipment and abide by collective protection measures and must be accompanied by a person from our team to ensure their safety. Others people are not authorized to access the construction site.

Vehicular access is controlled:

The rules for this are contained in the report. The safety rules for the circulation of trucks inside the lot are also included.
Load operations:

French Regulations establish specific limitations on the loads to be carried by people. In accordance with the French law for the Prevention of Occupational Risks, the maximum load to be carried out by one person is 25 kg.

Hours of work by team members:

Team Casa FENIX will work 8 hours per day, with a break between 12 noon and 2 p.m.

Not all teams will work at the same time, so that there can be a relay for all the tasks during the construction, and the teams can take the necessary breaks. Teams will take a 15 minute break every 2 hours.

Accident prevention at work:

• Objective: to execute the assembly construction work in 10 days and the disassembly in 5 days, while protecting the physical and mental integrity of the Team Casa FENIX members.
• Fundamental rules:
  - No work shift can start without a preliminary formalized risk analysis [Health and Safety Plan].
  - The implementation procedures will be explained to the teams by the works supervisor.
  - No workers can take their post without having received the Health and Safety presentation of the project and an identification badge.
  - The use of a helmet and high visibility work clothes is compulsory.

Personal protective equipment:

• Basic equipment:
  - Work clothes in the colours of the team
  - High visibility vest
  - White and yellow safety helmet for the coordinators. Members of the organization can be distinguished by their orange-coloured helmets.
  - Safety shoes
• For more specific work:
  - Hear plugs.
  - Safety glasses.

Work clothing:

All team members will receive before the start of the competition: work clothing, a safety helmet, high visibility vest, all the appropriate personal protective equipment. The work clothing will enable the team members to be easily identified. This will also enable control of access to the site.

Alcohol and drugs:

“ It is formally forbidden to introduce, distribute alcoholic drinks or to let people who are under the influence of drink to enter or stay in the workplace” [Art R 4228-20 and 21 of the labour code]

“ General ban on the consumption of classified stupefying products [cannabis, heroin, cocaine]” [Art L 3421-1 of the public code of health]

Quarter-hour security:

A quarter-hour security will be held to review the rules on site and the different procedures. Another meeting can be held if there are any problems on site or to improve safety.
**Fire evacuation:**

The evacuation for fire or other problems must be organized before the start of construction. The team will be trained for this evacuation, which comprises 4 steps.

- First there is a sound signal: A “Foghorn” is used to give three signals of 5 seconds with a break of 5 seconds.

- Secondly, everything must be stop after this signal. Electrical systems must be switched off. All workers are responsible for ensuring this rule is complied with, but the foreman of each teams must check that it has been done.

- Thirdly, all workers must evacuate the lot and head to the emergency muster point. The evacuation must take place calmly.

- Finally, a roll call of all workers is taken to make sure that nobody has been left behind on the lot. The foreman is responsible for his/her team.

If all is good, when the problem is resolved, a check must be made by the site operation coordinator and the health and safety coordinator to determine if the work can be resumed.

**Accident reporting:**

The Health and Safety Plan can enable the risks of an accident on site to be reduced, but if there is an accident, a report procedure must be prepared to explain the incident.

**Hygiene at work:**

Hygiene at work is based on adapted premises, on the provision of specific installations [toilets, changing rooms, premises for breaks and relaxing] and the use of appropriate equipment [protective clothing or personal protective equipment]. The maintenance and cleaning of these premises, installations or equipment are the responsibility of the organization.

Hygiene at work also depends on individual behaviour [use of adapted protection equipment, washing of hands, good nutrition, hydration and sleep adapted to the constraints of the work, the physical activity].

Some hygiene regulations for whilst at work for the workers:

- Wash your hands before eating, drinking or smoking, after all contact with potential contaminants, as well as before and after going to the toilet
- Do not put your hands or an object [pen for example] in your mouth
- In the event of a sting, bite or cut, immediately wash the wound with drinking water and soap
- Protect any wound with a waterproof bandage
- Take a shower at the end of work if your work has exposed you to dust, liquid or projectiles
- If possible, change your clothes before leaving work
- Regularly change your work clothes [to avoiding putting back on clothes which are covered with dust or with chemical or biological products]
- Do not take soiled clothes back to your place of residence [they can contribute to transferring pollution within the family circle]

**Presentation of the work:**

Prior to the start of construction, the site operation coordinator and the health and safety coordinator...
will prepare a book which explains all of the phases. Every day, each team will receive a description of the day’s work. This is to minimize questions on site, and to respond to the entire construction plan.

This Health and Safety book only gives brief details of the phases with the time; this is to quickly inform all the team workers about the work that we need to do.

**Emergency evacuation:**

The emergency evacuation plan is located at the end of the book to enable ease of access in the event of an accident. The location of the nearest hospital is written and the paper is case of emergency with the “alert relief”.

The members of all the teams must complete the personal data sheet so that this information is available in the event of an accident. The most important is the first aid information; it is important to know if a person has any heart problems, allergies or needs any special medical treatment.

All these documents are including in the appendix 14.6 “Health and Safety Appendix” and a copy will be located on site with the health and safety coordinator.

Information about the team members is included in the appendix 14.6 “Health and Safety Appendix”.
10.11 PLANNED MEASURES IN CASE OF ACCIDENT

This Health and Safety Plan enables us to plan and avoid hazards during the construction. However, it is still necessary to look at different situations that might arise and plan the measures which need to be taken in the event of an accident.

10.11.1 FIRST AID

It is essential to have certified first aiders on the construction site. Two people on each team need to hold the Level 1 first aid certificate. Copies of the certificates will be accessible on site, with the health and safety coordinator.

In our Team there are three certified first aiders:

**Name: MABY Thomas**  
**Date:** 22 June 2011

**Name: DORY Maxime**  
**Date:** 21/06/2013

**Name: Diego Gonzáles**  
**Date:** 10/05/2014

---

5 The certificates are located in appendix 14.6 “Health and Safety Appendix”

10.11.2 FIRST AID BAG

The first aid bag must include a small bandage which can be placed on a wound prior to the arrival of medical aid. French standards stipulate that first aid kits will have all the items in the Table 358

Team Casa FENIX will have two first-aid kits, which will be situated inside the construction and be available outside at any moment.

They will be kept at two definitive points and signposted so that one can find them as quickly as possible.

The list of elements in the kit will be posted in quoted by the point of road marking. Every time, when any item from the kit is used, it will be necessary to highlight this and replace it so that the kit is always complete.

An index card of care given will be prepared to ensure that follow up action is taken.

More details in HS-430, into Project Drawings

<table>
<thead>
<tr>
<th>Material</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bandages: large / medium / small</td>
<td>20</td>
</tr>
<tr>
<td>Disinfecting wipes</td>
<td>3</td>
</tr>
<tr>
<td>Cream for irritations / drying the skin</td>
<td>2</td>
</tr>
<tr>
<td>Anti-mosquito wipes</td>
<td>2</td>
</tr>
<tr>
<td>Soothing wipes / knocks</td>
<td>2</td>
</tr>
<tr>
<td>Antiseptic frost(gel)</td>
<td>1</td>
</tr>
<tr>
<td>Compresses</td>
<td>5</td>
</tr>
<tr>
<td>Compressif plug</td>
<td>1</td>
</tr>
<tr>
<td>Stretchable band(strip)</td>
<td>1</td>
</tr>
<tr>
<td>Stretchable band(strip)</td>
<td>1</td>
</tr>
<tr>
<td>Adhesive roll</td>
<td>1</td>
</tr>
<tr>
<td>Pair of gloves</td>
<td>1</td>
</tr>
<tr>
<td>Refreedol</td>
<td>1</td>
</tr>
<tr>
<td>Mask for mouth-to-mouth resuscitation</td>
<td>1</td>
</tr>
<tr>
<td>Safety pins</td>
<td>1</td>
</tr>
<tr>
<td>Foil blanket</td>
<td>1</td>
</tr>
<tr>
<td>Pair of scissors</td>
<td>1</td>
</tr>
<tr>
<td>Tweezers?? for splinters</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 358: First aid bag
10.11.3 PREVENTIVE MEDICINE

All the workers need to pass a medical examination before they can gain access to the construction site. This examination will reveal if the worker is fit for working on the construction.

All of these certificates are located in the appendix 14.6 “Health and Safety Appendix”

10.11.4 EVACUATION OF THE VICTIM OF AN ACCIDENT

Terms to use

If a harmful product gets onto the skin:
The person must wash him/herself immediately with abundant soap and water.

If a product gets into the eyes:
Wash the affected eye immediately with abundant water or a sterile ophthalmic solution.

Inhalation of vapour:
Get some rest, breathe in fresh air. Seek medical help

Ingestion of dust:
Rinse the mouth immediately and drink abundant water. Seek medical help.

Cuts:
Get the first-aid kit. Clean and disinfect the cut with an antiseptic solution.

Seek medical help. Get protection against tetanus from a doctor within 12 hours, except immunization days.

Burns:
Get the first-aid kit. Immediately cool the affected area with water. Or apply a dressing. Seek medical help. Refer to the doctor for further treatment and monitoring.

Nosebleed:
Put a haemostatic pad on the nose, head forward.

Contusion or no breach wound:
Apply arnica and immobilize the limb. Refer to a doctor if serious.

Evacuation of the victim of an accident:
The procedure for evacuation to be followed in the event of an accident is as follows:

1) Move yourself and others to a place of safety to avoid new accidents.

2) Call for additional help from nearby and call the emergency services. Certified first aiders can intervene until the emergency service or medical care arrives.

3) Maintain control of the environment and prevent further injuries until professional help arrives.
4) Notify the SD Organizers, including the public safety organizers.

Take the person to the hospital closest to our two points of construction for speed.

For the evacuation, we found the fastest route to the hospital selected in our plan. The journey time is 16 minutes and the distance is 11 kilometres [Table 359].

**Fire evacuation:**
The procedure for evacuation in the event of a fire or another problem must be organized before the start of the construction. The team will undergo training for this evacuation, which comprises 4 steps.

- First there is a sound signal: A “Foghorn” is used to give three signals of 5 seconds with a break of 5 seconds.

- Secondly, everything must be stop after this signal. Electrical systems must be switched off. All workers are responsible for ensuring this rule is complied with, but the foreman of each teams must check that it has been done.

- Thirdly, all workers must evacuate the lot and head to the emergency muster point. The evacuation must take place calmly.

- Finally, a roll call of all workers is taken to make sure that nobody has been left behind on the lot. The foreman is responsible for his/her team.

<table>
<thead>
<tr>
<th>Start</th>
<th>Allée des Matelots, 78000 Versailles</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Take &quot;Allée des Matelots&quot; and continue during 285 m</td>
</tr>
<tr>
<td>2</td>
<td>Turn right onto &quot;Avenue de la Division Leclerc (D10)&quot; and continue for 2.6 km</td>
</tr>
<tr>
<td>3</td>
<td>Turn right on “Rue du Docteur Vaillant” and continue for 662m</td>
</tr>
<tr>
<td>4</td>
<td>At the roundabout turn right onto “Rue du Docteur Vaillant” and continue for 2.9 km</td>
</tr>
<tr>
<td>5</td>
<td>At the roundabout, continue onto the “Route de Saint-Cyr” and continue for 703m</td>
</tr>
<tr>
<td>6</td>
<td>Turn right onto D307 and continue for 3.1 km</td>
</tr>
<tr>
<td>7</td>
<td>Turn right onto “Rue de Versailles” and continue for 684m</td>
</tr>
<tr>
<td>Finish</td>
<td>177 Rue de Versailles, 78150 Le Chesnay</td>
</tr>
</tbody>
</table>

Table 359: Evacuation route to the nearby hospital

<table>
<thead>
<tr>
<th>Evacuation Report</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date :</td>
</tr>
<tr>
<td>Hours :</td>
</tr>
<tr>
<td>Numbers of workers :</td>
</tr>
<tr>
<td>Progress:</td>
</tr>
<tr>
<td>Evaluation / type of accident :</td>
</tr>
</tbody>
</table>

Table 360: Evacuation Report
11.11.5 ACCIDENT REPORT

This will be used to report incidents and accidents that occur while transporting, assembling, maintaining, operating or disassembling the Casa FENIX [Table 361].

<table>
<thead>
<tr>
<th>Accident Report</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date:</td>
</tr>
<tr>
<td>Time:</td>
</tr>
<tr>
<td>Location:</td>
</tr>
<tr>
<td>Incident/Accident description:</td>
</tr>
<tr>
<td>Causal Factors:</td>
</tr>
<tr>
<td>Corrective Actions to prevent Recurrence:</td>
</tr>
<tr>
<td>Lessons Learned:</td>
</tr>
</tbody>
</table>

Table 361: Accident Report
10.12 ADOPTED SYSTEM FOR CONTROLLING HEALTH AND SAFETY DURING THE WORKS

The worker signs this paper to indicate that he/she agrees with the Health and Safety Plan and can say that he/she knows the safety rules.

Before the construction we will do some training on health and safety on site during the assembly and the disassembly. All the personal protective equipment will be distributed for all the workers.

The workers will be trained in the use of the collective protection elements.

The phase of assembly and disassembly will be explained at all the workers, so that they are aware of the stages and anticipate danger. The entire team Casa FENIX will know the tasks which must be carried out in order to be better organized and to know what the others make has side of them to prevent the risks.

The team workers who have agreed with the Health and Safety Plan are detailed in the appendix 14.6 "Health and Safety Appendix."
DETAILED WATER BUDGET

CASA FENIX
CASA FENIX

For Emergency post-Natural Impact eXtreme REMINDER

One of the most outstanding geographical features of Chile is the relatively constant threat of earthquakes, among other natural disasters, such as volcano eruptions, landslides and fires in urban areas. The regularity with which these events occur does not make them any less catastrophic for people. Many homes are lost and the people who are most affected are low-income families. The post-catastrophe situation throughout the year has indeed been non-sustainable, therefore to develop and implement the concept of sustainable reconstruction is a big challenge for our country, where Casa FENIX ambition is to propose and offer a tangible solution.

THE PROBLEM While Chile is a political and geographical location where natural disasters are recurrent and affect a great part of the most socially vulnerable population, there are no official policies which outline a quality response to such events.

“When disaster strikes, the problems are resolved with quick, cheap, short-term solutions, such as the mediagua emergency houses”

which end up causing more problems than they solve and lead to a great deal of waste in the long term.

HYPOTHESIS Casa FENIX is a design process that responds to a catastrophe, delivering energy efficient strategies to ensure quality of life as a key factor in a sustainable reconstruction; these strategies are not currently considered in post-catastrophe national policy. Sustainability factors include locally specific environmental, cultural and geographical issues, and also consider accessible and viable solutions for the most vulnerable sector of Chilean society. Therefore, the original objective behind this proposal is:

“to create emergency dwellings that offer quick, good quality and sustainable homes for the families who are the victims of a disaster.”

Thus the architectural and urban concepts that shape the proposal at both individual and collective levels are: Modularity, progressivity, flexibility and affordability.
Modularity
Casa FENIX evolves from a basic Survival Module to a complex Eco Village/Housing Complex. This process cover the stage of Emergency, Relief and Reconstruction.

Progressivity
Casa FENIX progression allows the Survival Module unit to become a final home. This incremental and evolving logis is assume by the urban design strategy.

Flexibility
Casa FENIX has the capability to adapt to different latitudes and climates, give the geographical characteristics and diversity of climates Chile possesses, from north to south.

Affordability
Casa FENIX is an affordable home. Each unit may be acquired through the progressive subsidy adressing the total cost of the home.

ARCHITECTURAL PROGRAMME
For the SDE competition, the Casa FENIX Team proposes to bring a house that represents reconstruction as a growth progression and is configured to perform well in the Versailles climate. The basic structure and its components will subsequently be configured to meet the solar passive design strategy for the specific local climate where it is to be installed.

The programme represents the core concept of Casa FENIX, which takes a progressive approach to Emergency, Relief and Reconstruction, with sustainability in mind. It uses a passive solar design driven by a sunspace, which acts as the energy engine of the completed house and is a key spatial element which allows the articulation of the different modules.

Casa FENIX is a modular design in which each 11 m² module can be progressively attached and easily assembled during a post-disaster period, to form a dwelling measuring 60m².

The modules are as follows:
Survival Module
This is the quick initial response for the emergency period, immediately after a catastrophe strikes. Its main objective is to provide shelter, safety and a quality solution to the affected family.

Mechanical Module
This is the first module to be attached to the Survival Module as a progression during the relief period. It consists of the services and a technical core. It includes a bathroom and kitchen.

Living Module
This is the module that enables the house to expand and cover more than the basic needs during the reconstruction period, transforming the sum of modules into a definitive home.

Sunspace
The passive solar design strategy enables the regulation of the indoor climate by articulating the different modules with the exterior climate; this space grows with the addition of each module.

At a collective level, the group of emergency houses, which the FENIX team has called “Temporary Village FENIX, TVF” and the progression to a housing complex, which the FENIX team has called “Eco-Village FENIX, EVF” are conceived following the same logic. They have an open and flexible design that allows for the adaptation of modules and means that Casa FENIX can be adapted to different climatic, topographical, territorial and cultural realities.

THE GEOGRAPHICAL DIMENSION
Chile has 9 different climate types and the country stretches from latitude 18°S to 50°S. 90% of the population is located in areas where solar radiation is over 1000kWh/year. To address this climatic diversity and take advantage of the opportunity for solar radiation, the conceptual idea for “Casa FENIX is similar to a skeleton or basic structure, an innovative structural design developed by students, where different components can be configured and assembled according to the users’ demands.”
All the components to be attached to it respond to the demands for the different latitudes and to patterns of self-construction.

**SUSTAINABILITY FOR US** It is important to mention that the understanding of sustainability in the case of developing nations differs much from the one used in developed nations, in the sense that the problems that need to be addressed are much different, respect of priorities and urgencies. For the Chilean case the deterioration produced by natural disasters and the anthropic urban degradation produced by informal settlements and poverty are the immediate problems to solve in a sustainable way. To teach the general public about sustainability issues that go beyond recycling, energy efficiency and achieving a low carbon footprint, Casa FENIX proposes to focus mainly on local cultural aspects, quality of life and social relationships. In this case the sustainability aspects are focused on using technology and urban planning to enhance the intuitive know-how of a particular local population.

“The choice of site: Man’s physical freedom manifests itself no doubt in his ability to choose the place on earth where he wants to live”.

People act, build and adapt through self-construction to the different latitudes and geographical conditions over time using their intuitive and basic knowledge.

“Neither privations nor danger will deter man from selecting a spot [...]” to settle on (Rudofsky, 1964).

This recognition of the appropriateness of the way informal settlements and self-construction take place is basic and seen to be positive; however it is extremely precarious and unsustainable in many other
aspects and in extreme situations could produce complete devastation. This was the case in April 2014 when a wildfire ravaged Valparaiso for three days; 2,900 homes were destroyed and 14,000 people - 4% of the Valparaiso population (IMV, 2014) - were made homeless.

The reasons for the unsustainable settlements can be traced back to many issues related to post-disaster rehabilitation and poverty and a major factor is the lack of a sustainable urban code for areas of vulnerability. This sustainable urban code would need to respond in a general way to the emergency and in a particular way to the post-catastrophe situation that begins right after an emergency occurs.

Casa FENIX TEAM ORGANIZATION

Team Casa FENIX is a bi-national team composed of students and faculty members from the Universidad Técnica Federico Santa Maria [UTFSM], Valparaíso, Chile and from the Institute Universitaire de Technologie [IUT], Université de La Rochelle, France. In addition to all the opportunities that arise out of any international collaboration between academic institutions, team Casa FENIX seeks to respond coherently to SDE’s energy conservation objectives.

The proposal has been designed to address the circumstances and needs of Chile. However, transporting the house from Chile to France would entail a significant amount of CO2 emissions and the team has therefore set itself the goal of making a “PROTOTIPE” in Chile and a “REPLICA” in France, generating a dualism and a double challenge for our project. So, while the conceptual proposal is Chilean, the production of Casa FENIX is French.

TEAM Casa FENIX CHILE

The Chilean part of the team is in charge of all the theoretical, conceptual, architecture and urban design content of the project. One of the strengths of UTFSM is their research and work on bioclimatic architecture and earthquake resistant construction.

The design of Casa FENIX has been developed in Chile with the participation of the students from the French team during the process. Half of Casa FENIX will constitute the prototype built and tested in Valparaiso.

TEAM Casa FENIX FRANCE

The French part of the team is in charge of all the practical, construction, building and technology applications of the project. One of the strengths of IUT is their research into and work with wooden structures and construction. A complete version of a replica of Casa FENIX is being built in La Rochelle and this is the version that will compete in Versailles.
<table>
<thead>
<tr>
<th>Activity</th>
<th>Consumption rate (litres per use)</th>
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<th>25</th>
<th>30</th>
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<th>3</th>
<th>4</th>
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<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>15</th>
<th>Total Litres</th>
</tr>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Mon</td>
<td>Wed</td>
<td>Mon</td>
<td>Tue</td>
<td>Wedn</td>
<td>Thur</td>
<td>Fri</td>
<td>Sat</td>
<td>Sun</td>
<td>Mon</td>
<td>Tue</td>
<td>Wedn</td>
<td>Thur</td>
<td>Fri</td>
<td>Tue</td>
<td></td>
</tr>
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<td>3</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>1000</td>
</tr>
<tr>
<td>Water for Plants</td>
<td>40</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>200</td>
</tr>
<tr>
<td>Total Daily</td>
<td></td>
<td>0</td>
<td>90</td>
<td>201</td>
<td>150</td>
<td>241</td>
<td>157</td>
<td>198</td>
<td>40</td>
<td>0</td>
<td>51</td>
<td>84</td>
<td>151</td>
<td>207</td>
<td>188</td>
<td>0</td>
<td>1758</td>
</tr>
<tr>
<td>Drinkable water in tank</td>
<td></td>
<td>1500</td>
<td>1410</td>
<td>1209</td>
<td>1059</td>
<td>818</td>
<td>661</td>
<td>463</td>
<td>423</td>
<td>423</td>
<td>722</td>
<td>638</td>
<td>487</td>
<td>280</td>
<td>92</td>
<td>92</td>
<td></td>
</tr>
<tr>
<td>Grey water in tank</td>
<td></td>
<td>0</td>
<td>90</td>
<td>291</td>
<td>441</td>
<td>682</td>
<td>839</td>
<td>1037</td>
<td>1077</td>
<td>1128</td>
<td>1212</td>
<td>1363</td>
<td>1570</td>
<td>1758</td>
<td>-92</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water Delivery</td>
<td></td>
<td>1500</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>350</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1850</td>
</tr>
<tr>
<td>Water Removal</td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1850</td>
</tr>
</tbody>
</table>
C A S A  F E N I X

For Emergency post-Natural Impact eXtreme R E M I N D E R

One of the most outstanding geographical features of Chile is the relatively constant threat of earthquakes, among other natural disasters, such as volcano eruptions, landslides and fires in urban areas. The regularity with which these events occur does not make them any less catastrophic for people. Many homes are lost and the people who are most affected are low-income families. The post-catastrophe situation throughout a year has indeed been non-sustainable, therefore to develop and implement the concept of sustainable reconstruction is a big challenge for our country, where Casa FENIX ambition is to propose and offer a tangible solution.

THE PROBLEM

While Chile is a political and geographical location where natural disasters are recurrent and affect a great part of the most socially vulnerable population, there are no official policies which outline a quality response to such events.

“When disaster strikes, the problems are resolved with quick, cheap, short-term solutions, such as the mediagua emergency houses”

which end up causing more problems than they solve and lead to a great deal of waste in the long term.

HYPOTHESIS Casa FENIX is a design process that responds to a catastrophe, delivering energy efficient strategies to ensure quality of life as a key factor in a sustainable reconstruction; these strategies are not currently considered in post-catastrophe national policy. Sustainability factors include locally specific environmental, cultural and geographical issues, and also consider accessible and viable solutions for the most vulnerable sector of Chilean society. Therefore, the original objective behind this proposal is:

“to create emergency dwellings that offer quick, good quality and sustainable homes for the families who are the victims of a disaster.”

Thus the architectural and urban concepts that shape the proposal at both individual and collective levels are: Modularity, progressivity, flexibility and affordability.
Modularity
Casa FENIX evolves from a basic Survival Module to a complex Eco Village/Housing Complex. This process covers the stage of Emergency, Relief and Reconstruction.

Progressivity
Casa FENIX progression allows the Survival Module unit to become a final home. This incremental and evolving logic is assumed by the urban design strategy.

Flexibility
Casa FENIX has the capability to adapt to different latitudes and climates, given the geographical characteristics and diversity of climates Chile possesses, from north to south.

Affordability
Casa FENIX is an affordable home. Each unit may be acquired through the progressive subsidy addressing the total cost of the home.

ARCHITECTURAL PROGRAMME
For the SDE competition, the Casa FENIX Team proposes to bring a house that represents reconstruction as a growth progression and is configured to perform well in the Versailles climate. The basic structure and its components will subsequently be configured to meet the solar passive design strategy for the specific local climate where it is to be installed.

The programme represents the core concept of Casa FENIX, which takes a progressive approach to Emergency, Relief and Reconstruction, with sustainability in mind. It uses a passive solar design driven by a sunspace, which acts as the energy engine of the completed house and is a key spatial element which allows the articulation of the different modules.

Casa FENIX is a modular design in which each 11 m² module can be progressively attached and easily assembled during a post-disaster period, to form a dwelling measuring 60 m².

The modules are as follows:
Survival Module
This is the quick initial response for the emergency period, immediately after a catastrophe strikes. Its main objective is to provide shelter, safety and a quality solution to the affected family.

Mechanical Module
This is the first module to be attached to the Survival Module as a progression during the relief period. It consists of the services and a technical core. It includes a bathroom and kitchen.

Living Module
This is the module that enables the house to expand and cover more than the basic needs during the reconstruction period, transforming the sum of modules into a definitive home.

Sunspace
The passive solar design strategy enables the regulation of the indoor climate by articulating the different modules with the exterior climate; this space grows with the addition of each module.

At a collective level, the group of emergency houses, which the FENIX team has called “Temporary Village FENIX, TVF” and the progression to a housing complex, which the FENIX team has called “Eco-Village FENIX, EVF” are conceived following the same logic. They have an open and flexible design that allows for the adaptation of modules and means that Casa FENIX can be adapted to different climatic, topographical, territorial and cultural realities.

THE GEOGRAPHICAL DIMENSION
Chile has 9 different climate types and the country stretches from latitude 18°S to 50°S. 90% of the population is located in areas where solar radiation is over 1000kWh/year. To address this climatic diversity and take advantage of the opportunity for solar radiation, the conceptual idea for

“Casa FENIX is similar to a skeleton or basic structure, an innovative structural design developed by students, where different components can be configured and assembled according to the users’ demands”
All the components to be attached to it respond to the demands for the different latitudes and to patterns of self-construction.

**SUSTAINABILITY FOR US** It is important to mention that the understanding of sustainability in the case of developing nations differs much from the one used in developed nations, in the sense that the problems that needs to be addressed are much different, respect of priorities and urgencies. For the Chilean case the deterioration produced by natural disasters and the anthropic urban degradation produced by informal settlements and poverty are the immediate problems to solve in a sustainable way. To teach the general public about sustainability issues that go beyond recycling, energy efficiency and achieving a low carbon footprint, Casa FENIX proposes to focus mainly on local cultural aspects, quality of life and social relationships. In this case the sustainability aspects are focused on using technology and urban planning to enhance the intuitive know-how of a particular local population.

“The choice of site: Man’s physical freedom manifests itself no doubt in his ability to choose the place on earth where he wants to live”.

People act, build and adapt through self-construction to the different latitudes and geographical conditions over time using their intuitive and basic knowledge.

“Neither privations nor danger will deter man from selecting a spot [...]” to settle on (Rudofsky, 1964).

This recognition of the appropriateness of the way informal settlements and self-construction take place is basic and seen to be positive; however it is extremely precarious and unsustainable in many other
aspects and in extreme situations could produce complete devastation. This was the case in April 2014 when a wildfire ravaged Valparaiso for three days; 2,900 homes were destroyed and 14,000 people - 4% of the Valparaiso population (IMV, 2014) - were made homeless.

The reasons for the unsustainable settlements can be traced back to many issues related to post-disaster rehabilitation and poverty and a major factor is the lack of a sustainable urban code for areas of vulnerability. This sustainable urban code would need to respond in a general way to the emergency and in a particular way to the post-catastrophe situation that begins right after an emergency occurs.

Casa FENIX TEAM ORGANIZATION Team Casa FENIX is a bi-national team composed of students and faculty members from the Universidad Técnica Federico Santa María [UTFSM], Valparaíso, Chile and from the Institute Universitaire de Technologie [IUT], Université de La Rochelle, France. In addition to all the opportunities that arise out of any international collaboration between academic institutions, team Casa FENIX seeks to respond coherently to SDE’s energy conservation objectives.

The proposal has been designed to address the circumstances and needs of Chile. However, transporting the house from Chile to France would entail a significant amount of CO2 emissions and the team has therefore set itself the goal of making a “PROTOTIPE” in Chile and a “REPLICA” in France, generating a dualism and a double challenge for our project. So, while the conceptual proposal is Chilean, the production of Casa FENIX is French.

TEAM Casa FENIX FRANCE
The French part of the team is in charge of all the practical, construction, building and technology applications of the project. One of the strengths of IUT is their research into and work with wooden structures and construction. A complete version of a replica of Casa FENIX is being built in La Rochelle and this is the version that will compete in Versailles.

TEAM Casa FENIX CHILE
The Chilean part of the team is in charge of all the theoretical, conceptual, architecture and urban design content of the project. One of the strengths of UTFSM is their research and work on bioclimatic architecture and earthquake resistant construction.

The design of Casa FENIX has been developed in Chile with the participation of the students from the French team during the process. Half of Casa FENIX will constitute the prototype built and tested in Valparaiso.
12.1 STRUCTURE

12.1.1 FOUNDATION

For foundation, blocks of glue-laminated timber [glulam] are placed below each structural stud. Depending on the topography of the site, pieces of plywood can be placed to level the house. [For more details, refer to Drawing ST-001 into PD, and Appendix 14.1 into PM]

12.1.2 STRUCTURAL FLOOR AND SECTIONS

In the width dimension of the plan, the structural floor is made by joists, assembled on studs by bolts. Lengthwise, joists are fixed by chair bearings and distributed according to the position of studs.

All the joists are 45x145 mm in section. 9 mm thickness Oriented Strand Board (OSB) panels are laid on bottom as a casing for a first insulation layer, sustained by pieces of wood of 45x45 mm in section in the two long sides.

A second, structural 18 mm thick OSB is laid and fixed on joists by 90 mm nails every 15 cm. Finally, a Pavaboard wood fibre high density insulation board is put behind the upper layer, a 16 mm thick OSB.

As the structure is divided in half module, a double joist is placed for the junction. Consequently, when the modules are disassembled, each floor is sustained by the corresponding joist. During reconstruction, a piece of steel is used to assemble and truss the entire floor. [For more details, refer to Drawing ST-011 into PD]
12.2 ARCHITECTURE

12.2.1 ENCLOSURE

Floor

From bottom to top, layer of OSB 9 mm thick, as a casing for insulation. Flexible wood fibre Pavaflex board 100 mm thick, of 55 kg/m3 density and 0.038 W/m.K thermal transmittance. Layer of OSB 18 mm thick. High density Pavaboard wood fibre board 60 mm thick, of 210 kg/m3 density and 0.046 W/m.K thermal transmittance. Upper layer of OSB, 16 mm thick. Water resistant strips between all panels. Finishing layer of linoleum. [For more details, refer to Drawing ST-001 into PD]

Ceiling / Roofing

From bottom to top: White painted wood siding 13.5 mm thick for ceiling. Air space of 45 mm wide. Vapor barrier paper, sd-value 0.1 m. Rigid wood fibre Pavatherm board, 80 mm thick, of 140 kg/m3 density and 0.042 W/m.K thermal transmittance. Wood fibre Pavaflex board, 160 mm thick, of 55 kg/m3 density and 0.038 W/m.K thermal transmittance. Ventilated air space 60 mm thick. Layer of 18 mm thick OSB panels and plastic membrane coating.

Walls

From inside to outside: White painted wood siding 13.5 mm thick. Air space 45 mm wide for wiring. Vapor barrier paper, sd-value 0.1 m. Wood fibre Pavaflex board 100 mm thick, of 55 kg/m3 density and 0.038 W/m.K thermal transmittance. Rigid wood fibre Pavatherm board 60 mm thick, of 140 kg/m3 density and 0.042 W/m.K thermal transmittance, with felt paper waterproofing coating, sd-value 0.05 m. Ventilated air space 22 plus 30 mm wide and vertical wood cladding.

12.2.2 OPENINGS

Windows facing north, triple glazing with argon and aluminum coated wood frame. Windows facing south, double glazing with argon, aluminum coated wood frame and solar protection by means of wood shade screen.
12.2.3 PARTITIONS

White painted wood siding on studs. Vapor barrier paper to stop insulation dust. Flexible wood fibre board 100 mm thick of 55 kg/m³ density. Vapor barrier paper, air space and white painted wood siding.

12.2.4 FINISHES

Ceramics and gypsum board in the bathroom. White painted wood in room partitions and ceilings. Linoleum on the entire floor.

12.2.5 FURNISHINGS

All furnishing are made in wood. The top of the dining table is composed of two parts slightly different in height, so as to hide one under the other and easily make room when necessary. The oven, the sink and the dishwasher are integrated in the kitchen furnishing. In the living room, 4 wood seats with storages are installed. [For more details, refer to Drawing IN-201; IN-401; IN-411 into PD]
12.3 SYSTEM INSTALLATION

12.3.1 FIRE SUPPRESSION

Two smoke detectors have been placed, one in the middle of the main room and the other in the bedroom of the survival module. Two portable fire extinguishers are necessary; they are placed at each side of the solar gallery, one near the electrical system and the other beside the entry. During the construction, an additional extinguisher will be provisionally placed outside the house, on the site.

12.3.2 PLUMBING SYSTEMS

PVC pipes for cold and hot water supply and drainage and waste water systems.

12.3.3 HVAC

With a mechanical ventilation system air is continuously supplied to the building. It creates a positive pressure inside the premises, which forces stale air out through leakages of the envelope. Fresh air is filtered and heated or cooled prior to be supplied.
12.3.4 ELECTRICAL
Wiring: 3 phase copper wire with PVC insulation cable protected by PVC conduits. Panel including main breaker, differential breaker and thermal-magnetic circuit breakers. Outlets for appliances and LED lamps in lighting fixtures.

12.3.5 SOLAR SYSTEMS – PHOTOVOLTAIC AND THERMAL
The solar gallery includes a solar thermal collector and 15 solar PV panels with 260 Wp each. [For more details, refer to Drawing PV-001 into PD]

12.3.6 TELECOMUNICATION AND BUILDING AUTOMATION
Casa FENIX doesn’t include any automation system other than the mechanical ventilation system which controls whether the air needs heating or cooling.
12.4 SAFETY INFORMATION

12.4.1 FIRE SAFETY TABLE

Fire protection

As EURIMA [European Insulation Manufacturers Association] states:

“Every second counts once a fire has started. Choosing the right building materials can delay the spread of fire and provide the vital extra minutes needed to save the occupants and limit the damage. The materials used in building our homes, schools or offices are increasingly being chosen because of their environmental performance. But we also need to prepare for when things go wrong. Security needs to be paramount as Europe develops its sustainable construction sector.

It is not simply household contents which allow the fire to spread.

Once flame takes hold, the building itself can make the situation even more dangerous. A flashover is when simultaneous ignition of all combustible material in the room takes place. It is provoked by hot smoke which results from fire. If the room’s surface temperatures reach 500°C, flashover can occur.

Flashover takes less than fifteen minutes in a typical apartment fire and thereafter temperatures will quickly jump to over 1,000°C. Materials are either combustible or not. But the protection provided by non-combustible materials varies considerably. The best materials do not burn. Nor do they shrink, become brittle or lose load capacity when temperatures rise dramatically.

Another key safety factor is whether the material creates smoke or toxic gases at high temperatures - as smoke can kill before fire. Low conductivity is likewise essential; non-combustible materials having high thermal conductivity will end up channelling heat, allowing fire to ignite in adjoining rooms.

EU standards set the benchmark when evaluating fire resistance capacity. The human, financial and environmental consequences of fire are devastating. By choosing sensible building materials, we optimise fire resistance and risk can be reduced. Simply put, there will be a little more time to leave the building”.

The recent fire of April 12th, 2014, occurred in the City of Valparaiso has been the worst tragedy for the last century for the city, destroying more than 3,000 homes, 16 deaths and over 12,000 victims because none of the fire protection and application of regulations were taken into consideration. Any building should be designed and constructed in a way that, in the event of fire, its stability will be maintained for a reasonable period, the past fire of Valparaiso, took minutes to consume hundreds and hundreds of houses, and neighborhood facility buildings.

Resistance to Fire

The published law in the “Journal Officiel” on March 22nd 2004 set up into place the European classification of products concerning resistance to fire. The tests are now made in accordance with the new European standards.

Fire resistance is usually expressed in terms of compliance with a test regime defined by national standards. It is a measure of the time taken before a component of construction exceeds specified limits for structural capacity, insulation and integrity. These
limits are clearly defined in the standard. There are three performance criteria for the most test method. These are related to low bearing capacity, insulation, and integrity [Table 368]

1. **Low bearing capacity**: For the building structure, the test specimen shall not collapse in such a way that it no longer performs the structural function for which it was constructed.

2. **Integrity**: For building components such as walls, floors, and roofs, the formation of openings through which flames or hot gases can pass shall not occur. Loss of integrity is deemed to have occurred when a specified cotton wool pad applied to the unexposed face is ignited.

3. **Insulation**: For building components such as floors-ceilings and walls that have the function of separating two parts of a building,

   a) The average temperature rise at the unexposed face of the specimen shall not exceed 139 °C, and
   b) The maximum temperature rise at the unexposed face of the specimen shall not exceed 181 °C.

### Fire Regulation in France

The main purpose of the French fire regulations is to ensure the protection of people inside any kind of building and these are the same premises Team FENIX shall apply for Casa FENIX.

- To limit the risks of the ignition and spreading of a fire [reaction to fire]
- To give time people in case of danger
- To make easier the work of the emergency services

The requirements of this regulation will depend on the nature of the building. For residential buildings the requirements are described in the modified law of the 31st of January 1986 [Protection contre l’incendie des bâtiments d’habitation]

### Reaction to fire

In order to control the spreading of the fire inside the building and to let the time to people to evacuate, the furniture and the construction materials have to be classified for their reaction to fire. The French classification of reaction to the fire ranks from the incombustible to the easily flammable.

- M0 = non-combustible
- M1 = not ignite [Ceiling]
- M2 = not highly ignite [Wall]
- M3 = moderately ignite [Evacuation ways]
- M4 = highly ignited [Flooring]

The published law in the “Journal Officiel” on November 21st 2002 set up the European classification of products concerning reaction to fire. The tables below [Table 370] define the correspondence between European classification and national requirement.

<table>
<thead>
<tr>
<th>Allowed European Classification</th>
<th>French Regulation Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>R [load bearing or structural capacity]</td>
<td>SF – Stable au feu = stable fire</td>
</tr>
<tr>
<td>E or REI [Integrity or load bearing + integrity]</td>
<td>PF – Pare-Flammes = retards fire</td>
</tr>
<tr>
<td>EI [Insulation + Integrity]</td>
<td>CF – Coupe-Feu = firewall</td>
</tr>
<tr>
<td>With the same level of performance either expressed in hours or in minutes</td>
<td></td>
</tr>
</tbody>
</table>

Table 368: Fire resistace classification
It leads for the interior of the building, furniture, and decoration, particularly for the products with harmonised standard, we can apply:

- **Ceiling:** M1 or B-s3, d1 or better = not ignite.
- **Wall:** M2 or C-s3 d1 or better =
- **Evacuation ways:** M3 or Cfl = moderately ignite.
- **Flooring:** M4 or Dfl or better = highly ignited.

### European Regulation Classification of the building components according to NF EN 13501-1

<table>
<thead>
<tr>
<th>Fire behaviour</th>
<th>Smoke production</th>
<th>Drops</th>
<th>French Regulation Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>-</td>
<td>-</td>
<td>Non-combustible</td>
</tr>
<tr>
<td>A2</td>
<td>s1 (no smoke)</td>
<td>d0 (no drop)</td>
<td>M0</td>
</tr>
<tr>
<td>A2</td>
<td>s1</td>
<td>d1 (drop)</td>
<td>M1</td>
</tr>
<tr>
<td>B</td>
<td>s1, s2, s3</td>
<td>d0, d1</td>
<td>M2</td>
</tr>
<tr>
<td>C</td>
<td>s1, s2, s3</td>
<td>d0, d1</td>
<td>M3, M4 [No drop]</td>
</tr>
<tr>
<td>D</td>
<td>s1, s2, s3</td>
<td>d0, d1</td>
<td>M4</td>
</tr>
</tbody>
</table>

All classes expected E-d2 and F

### Table 369: Building components excluding floors, source: FireRetard.com

<table>
<thead>
<tr>
<th>Fire behaviour</th>
<th>Smoke production</th>
<th>Drops</th>
<th>French Regulation Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1fl</td>
<td>-</td>
<td>-</td>
<td>Non-combustible</td>
</tr>
<tr>
<td>A2fl</td>
<td>s1</td>
<td>-</td>
<td>M0</td>
</tr>
<tr>
<td>Bfl</td>
<td>s1</td>
<td>-</td>
<td>M3</td>
</tr>
<tr>
<td>Cfl</td>
<td>s1, s2</td>
<td>-</td>
<td>M4</td>
</tr>
<tr>
<td>Dfl</td>
<td>s1, s2, s3</td>
<td>-</td>
<td>M4</td>
</tr>
</tbody>
</table>

### Table 370: Flooring component products, source: FireRetard.com

**French technical building codes, includes:**
- DTU bois-feu 88
- Professional rules
- Calculation rules by CSTB
## Casa FENIX Fire Safety

### 1. Interior propagation:

<table>
<thead>
<tr>
<th>Type of material</th>
<th>Class</th>
<th>Location in Specifications in PD and PM</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Covering [See Rule 51.3 Note 1]</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Wood structure (C24 class 1)</td>
<td>D, s1, d0</td>
<td>AR 331</td>
</tr>
<tr>
<td>- Wood insulation (Pavaflex 160)</td>
<td>Class E</td>
<td></td>
</tr>
<tr>
<td>- OSB 18 (OSB 3)</td>
<td>D, s2, d0</td>
<td></td>
</tr>
<tr>
<td>- PVC membrane</td>
<td>M1 (A2, s1, d1)</td>
<td></td>
</tr>
<tr>
<td><strong>Ceiling [See Rule 51.3 Note 2]</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OSB interior</td>
<td>D, s2, d0</td>
<td>AR 331</td>
</tr>
<tr>
<td>Insulation</td>
<td>Class E</td>
<td></td>
</tr>
<tr>
<td>Wood structure</td>
<td>D, s1, d0</td>
<td></td>
</tr>
<tr>
<td><strong>Walls [See Rule 51.3 Note 2]</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wood structure</td>
<td>D, s1, d0</td>
<td>AR 341</td>
</tr>
<tr>
<td>Insulation</td>
<td>Class E</td>
<td></td>
</tr>
<tr>
<td>Cladding</td>
<td>D, s2, d0</td>
<td></td>
</tr>
<tr>
<td><strong>Flooring</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wood structure</td>
<td>D, S1, d0</td>
<td>AR 321</td>
</tr>
<tr>
<td>Insulation</td>
<td>Class E</td>
<td></td>
</tr>
<tr>
<td>OSB</td>
<td>D, s2, d0</td>
<td></td>
</tr>
<tr>
<td>Lino PVC</td>
<td>M1 (A2, s1, d1)</td>
<td></td>
</tr>
<tr>
<td><strong>Pipes and ducts [running through flooring, walls &amp; ceilings]</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tube PVC</td>
<td>A2, s1, d0</td>
<td>PL 001</td>
</tr>
<tr>
<td><strong>Textile cover elements integrated into building</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lino PVC</td>
<td>M1 (A2, s1, d1)</td>
<td></td>
</tr>
<tr>
<td><strong>Thermal screen of thermal and acoustic insulation products</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pavaflex</td>
<td>Class E</td>
<td>AR 351</td>
</tr>
<tr>
<td>Pavaboard</td>
<td>Class E</td>
<td></td>
</tr>
<tr>
<td>Pavatherm</td>
<td>Class E</td>
<td></td>
</tr>
</tbody>
</table>
2. Evacuation of occupants:

In case of fire, the evacuation of both decathletes, during construction and competition periods and visitors of Casa FENIX, during public tours, will be done in compliance with SDE Rules and according to the French norms for emergency situations. The evacuation “Exit” and “Sortie” signage will be installed in visible places and easy to read for the visiting public. It will follow the way the Public Tour is organised, in order to help the mobility of people opposed to the running all over, and the Team FENIX tour guides will be trained exactly on what to do and where to go in case of fire.

The evacuation areas, free of risks are clearly established and they are:

- The main corridor inside of the Sunspace

The evacuation route and exits are:

- Main entrance door, located in the north facade.

The public tours are organised to comply with the number of visitors Casa FENIX can have at a given period of time preventing a safe evacuation in case of any emergency, and keeping track through the training of Team FENIX public tour guides to move groups of visitors within established schedules. For it all the scripts of Public Tours are rehearse, timed and prepared ahead of time by the selected Team FENIX decathletes that will be in charge of dealing with the general public

Evacuation ways and component’s dimensions

- Doors and doorways W i d t h : 0.90m [<100 persons]
- Hallways and ramps W i d t h : 1.40m

The Table 371 shows the dimention of each component, and the location into PD

3. Fire protection systems:

For the fire protection systems Team FENIX has considered three fire extinguishers: Two of 9 litres capacity, classified as 21A-233B efficiency, during the construction period one will be located in the interior of the house and the second one in the container. The third C02 fire extinguisher will also be located in the interior of the house but specifically for electrical installations, therefore it will always near to the electrical box.

Approved smoke detectors [Figure 383] will be installed in the two main rooms of the house, they are the 4th category type, and could be used on situation involving less than 300 people. The features of the smoke detector and the picture of it are as it follows:

<table>
<thead>
<tr>
<th>Evacuation components</th>
<th>Width (m)</th>
<th>Specifications in PD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Doorways</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exit Sunspace door</td>
<td>965/2100</td>
<td>AR 301</td>
</tr>
<tr>
<td>Entrance Sunspace door</td>
<td>1100/2270</td>
<td>AR 311</td>
</tr>
<tr>
<td>Mechanical module door</td>
<td>965/2101</td>
<td>AR 002</td>
</tr>
<tr>
<td>Hallways and ramps</td>
<td>1.40m</td>
<td></td>
</tr>
</tbody>
</table>

Table 371: Evacuation component’s dimensio
Smoke detector features

- Compliance with European and French Norms: CE, EN 14604, NF 192
- It includes 3 batteries of 3V (lithium)
- White colour ABS boxes of 70x70 mm with a height of 40 mm
- Emergency alarm of 85 dB at 3m distance.

This equipment is intended to be used in public buildings, Casa FENIX exhibition during SDE competition, according to the regulations L15 and L16 articles on SSI-France [Figure 372].

4. Structure Fire Resistance:

Please refer to Appendix 14.1 “Structural Appendix”
### 12.4.2 SAFETY IN USE

#### Table

### Safety against falls

<table>
<thead>
<tr>
<th>Type of floors</th>
<th>Where [Location in the project]</th>
<th>Floor classification - Specifications in PD and PM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry interior area: Surface's slope less than 5%</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Dry interior area: Surface's slope equal or greater than 5%, Stairs included</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Humid interior area: Surface's slope less than 5%</td>
<td>1% bathtub</td>
<td>AR-021</td>
</tr>
<tr>
<td>Humid interior area: Surface's slope equal or greater than 5%, Stairs included</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Exterior areas</td>
<td>Slope average of 4%, in the ramps.</td>
<td>AR-002</td>
</tr>
</tbody>
</table>

Table 373: Floor class slipperiness

<table>
<thead>
<tr>
<th>Where [in the project] and difference in floor level, holes and opening that represent a risk of falling</th>
<th>Type of protective barriers</th>
<th>Height of protective barriers where the difference in the floor level are more than 400mm - Specifications in PD and PM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ramps</td>
<td>Handrails</td>
<td>90 cm / AR-101</td>
</tr>
<tr>
<td>Entrance Deck</td>
<td>Handrails</td>
<td>90 cm / AR-101</td>
</tr>
<tr>
<td>Service Deck</td>
<td>Handrails</td>
<td>90 cm / AR-101</td>
</tr>
</tbody>
</table>

Table 374: Differences in the floor level, holes and opening [limit the risks of falling]

<table>
<thead>
<tr>
<th>Value</th>
<th>Specifications in PD and PM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Width of the tread</td>
<td>N/A</td>
</tr>
<tr>
<td>Height of the riser</td>
<td>N/A</td>
</tr>
<tr>
<td>Depth of the tread</td>
<td>N/A</td>
</tr>
<tr>
<td>Height of handrails</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Table 375: Restricted Areas stairs
### Value Specifications in PD and PM

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
<th>AR Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Width of the tread</td>
<td>360 cm</td>
<td>AR-002</td>
</tr>
<tr>
<td>Length of the tread</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Height of the riser</td>
<td>14.3 cm</td>
<td>AR-103</td>
</tr>
<tr>
<td>Depth of the tread</td>
<td>28 cm</td>
<td>AR-002</td>
</tr>
<tr>
<td>Height of handrails</td>
<td>90 cm</td>
<td>AR-103</td>
</tr>
</tbody>
</table>

**Table 376: Public Areas staircases**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
<th>AR Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Width of the tread</td>
<td>360 cm</td>
<td>AR-002</td>
</tr>
<tr>
<td>Length of the tread</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Height of the riser</td>
<td>14.3 cm</td>
<td>AR-103</td>
</tr>
<tr>
<td>Depth of the tread</td>
<td>28 cm</td>
<td>AR-002</td>
</tr>
<tr>
<td>Height of handrails</td>
<td>90 cm</td>
<td>AR-103</td>
</tr>
</tbody>
</table>

**Table 377: Public Areas staircases**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
<th>AR Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>% slope value</td>
<td>4% Average</td>
<td>AR-002</td>
</tr>
<tr>
<td>Length of ramp</td>
<td>Exit Ramp: 1280 cm</td>
<td>AR-002</td>
</tr>
<tr>
<td></td>
<td>Entrance Ramp: 1335 cm</td>
<td>AR-002</td>
</tr>
<tr>
<td>Width of ramp</td>
<td>160 cm</td>
<td>AR-002</td>
</tr>
<tr>
<td>Height of handrails</td>
<td>90 cm</td>
<td>AR-101</td>
</tr>
<tr>
<td>Size of the resting landings</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

**Table 378: Ramps**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
<th>AR Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>% slope value</td>
<td>4% Average</td>
<td>AR-002</td>
</tr>
<tr>
<td>Length of ramp</td>
<td>Exit Ramp: 1280 cm</td>
<td>AR-002</td>
</tr>
<tr>
<td></td>
<td>Entrance Ramp: 1335 cm</td>
<td>AR-002</td>
</tr>
<tr>
<td>Width of ramp</td>
<td>160 cm</td>
<td>AR-002</td>
</tr>
<tr>
<td>Height of handrails</td>
<td>90 cm</td>
<td>AR-101</td>
</tr>
<tr>
<td>Size of the resting landings</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>
# Safety for avoiding trapping and impact risk

<table>
<thead>
<tr>
<th>Minimum Value</th>
<th>Specifications in PD and PM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clearance height in house</td>
<td>2.34 m</td>
</tr>
<tr>
<td>Height of the doors threshold</td>
<td>2.05 m</td>
</tr>
<tr>
<td>Height of fixed elements projecting from facades</td>
<td>2.34 m</td>
</tr>
<tr>
<td>Projection of fixed elements in the walls that do not which do not start from the ground</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Table 379: Impact due to fixed elements [House Tours area]

<table>
<thead>
<tr>
<th>Value (circular freespace)</th>
<th>Specifications in PD and PM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sweep of the doors on the sides of the hallway</td>
<td>120 cm</td>
</tr>
</tbody>
</table>

Table 380: Impact due to opening elements [public tours areas]

<table>
<thead>
<tr>
<th>Location in the project</th>
<th>Type of glazing (safety)</th>
<th>Specifications in PD and PM</th>
</tr>
</thead>
<tbody>
<tr>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Table 381: Impact due to fragile elements and not very perceptible elements.
### Value (distance) Specifications in PD and PM

<table>
<thead>
<tr>
<th></th>
<th>Value (distance)</th>
<th>Specifications in PD and PM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance of manual sliding door to the nearest fixed element</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Table 382: Trapping

### Safety against the risk of inadequate lighting

<table>
<thead>
<tr>
<th>Light fittings for exterior areas</th>
<th>Where-min. illumination level</th>
<th>Specifications in PD and PM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corridors – 30lx</td>
<td></td>
<td>Lighting design [PM Pp. 89]</td>
</tr>
<tr>
<td>Light fittings for interior areas</td>
<td></td>
<td>Lighting design [PM Pp. 91]</td>
</tr>
</tbody>
</table>

Table 383: Safety against the risk of inadequate lighting
12.5 APPLIANCES AND HOME ELECTRONIC EQUIPMENT SPECIFICATIONS AND USER MANUALS

In the life cycle of an appliance, from 90% to 95% of its environmental impact is attributable to its use phase. This is why resource-efficient products make a lasting contribution to protecting the environment and avoiding climate change and are also beneficial to the household budget.

Indeed, appliances are responsible, on average, for half of a household’s energy consumption, so using new appliances, especially energy efficient ones, enables savings to be made throughout the lifetime of the device [Figure 384].

Team Casa FENIX has therefore opted to use highly energy efficient appliances in Casa FENIX. All of them have at least exceeded the A+ class energy label.

These appliances are undoubtedly more expensive to buy but considering their lifetime [between 10 and 15 years], it is interesting to study the purchasing cost and savings made in order to compare the profitability of an appliance according to its energy class.

Indeed, cost-price analysis shows that it is better to invest in an energy-efficient appliance in order to realize economies in its energy bill than to buy a cheaper appliance which consumes more electricity and water throughout its life.

12.5.1 THE COMBINED REFRIGERATOR AND FREEZER

Refrigerators and freezers are appliances which remain in service 24/7. It is thus very important to look at the energy they consume because they account for the most important part of the energy consumed by global home appliances [32%].

We therefore selected an appliance which has achieved A+++ class [40% energy saving compared to class A+]. The combined SIEMENS KD33EAI40 consumes 139kWh/year [226L refrigerator and 67L freezer] and costs €899.00.

By way of comparison, the combined LG GC5410NS in A+ class consumes 303kWh/year [227L refrigerator and 73L freezer] and it costs €549.00.

Figure 384: Distribution of the appliances’ consumption
The difference in consumption between the two of 164kWh/year. If we take as a hypothesis 15 years of use and €0.14/kWh, the difference in consumption amounts to a total cost of €344.4. So over its lifetime, for just €5.6 more, we can save 2460kWh.

We chose a combined fridge-freezer rather than two separate appliances because it is more compact and costs and consumes less. Indeed for the same class, if you have a separate refrigerator and freezer, they will consume more than the same appliances combined. By way of comparison with our combined SIEMENS, the LIEBHERR IKP2350 [222l] fridge, which has achieved the A+++ efficiency rating, consumes 71kWh/year and costs €1199 and the LIEBHERR GP148615J [104l] freezer, with A+++ rating, which costs €599 and consumes 101kWh/year. Therefore these separate appliances cost twice as much as the Siemens model proposed and consume 33Wh/year more.¹

12.5.2 THE WASHING MACHINE

The washing machine was chosen because of its low consumption of both energy and water. Indeed this is the household appliance that consumes the most water. We chose the LG F74932WH washing machine, which has been rated A++. It consumes only 0.62kWh/cycle and 40.5L/cycle of water.²

12.5.3 THE DISHWASHER

In Chile very few families have dishwashers. Furthermore Casa FENIX is an emergency house for people of more modest means. It was however a requirement that we install a dishwasher for the Solar Decathlon competition. It is for this reason and for reasons of space in the kitchen that we chose to install a small dishwasher, the EssentielB ELVC531B, which has achieved an efficiency rating of A+ and is for just 6 place settings.

While they are uncommon in Chile, using a dishwasher does enable significant water savings to be made. Washing dishes by hand uses on average 50 litres of water, whereas the dishwasher needs only 7 litres. Furthermore, we use hot water when we wash dishes manually, thereby using electricity or gas, whereas, thanks to its economic mode, the dishwasher uses less energy as it has a programme which can regulate its consumption according to the amount of dishes loaded and the degree of soiling. Therefore the dishwasher saves water and is more economical than the water heater.
12.5.4 INDUCTION COOKER

The hob has 3 burners of different sizes. It functions with an induction system. This system is more reactive than the others and it has better output. Induction is also very safe because it has a safety mechanism to avoid the appliance overheating, residual heat indicators, keypad lock, and detection of pans. For example if you remove a saucepan or casserole dish and forget to turn off the burner, the induction heats up. This avoids wasting electricity. Finally it has an easy to clean surface which does not require detergent, making it environmentally friendly.

12.5.5 THE OVEN

The WHIRLPOOL PG AKZM7530/S [67L] oven has been rated A+++ class. Its door is cold. With the 4 windows, there is no risk of burning and the thickness of glass provides excellent insulation to limit its electricity consumption.

This is a convection oven. The additional circular resistor placed at the propeller ensures fast and homogenous cooking. With convection, it is even possible to cook two different dishes simultaneously without their smells becoming combined. This allows savings in both time and electricity. Furthermore the oven is equipped with a pyrolysis system which facilitates its maintenance, so less water is used to clean it and no detergent is needed.

12.5.6 THE AUDIOVISUAL EQUIPMENT

For the television we tried to satisfy several criteria: low consumption, size and comfort.

We chose the Philips 32PFL3088H TV which has been rated class A++. This 32” screen fits perfectly in Casa FENIX. It consumes only 34kWh/year thanks to LED. A LED screen is an LCD screen which is backlit by LED. This technology makes the screen finer and brighter screens and reduces their electric consumption.

The DVD player, on average, consumes 21.2 kWh/year.

3 The data sheet is available in the appendix 14.12 “Construction specification appendix”

4 The data sheet is available in the appendix 14.12 “Construction specification appendix”

5 The data sheet is available in the appendix 14.12 “Construction specification appendix”
12.5.7 THE COMPUTER

Finally we chose the Odroid-U3 computer. It has a tiny development board designed to run an android Operating System or a light version of GNU/Linux Ubuntu. We chose to use an Ubuntu 13.10 with the LXDE [i.e. very light and easy to use even for beginners]. The main advantage of this board is its very low power consumption and its low price, only 59€ for the board and 30€ more for optional devices and 130€ for the screen. Another advantage is the very small space needed to store it. It measures just 83mm x 48mm and weighs a mere 48 grams. It is also very quiet: whether the power is off or on, it doesn’t make any difference [Figure 385]^6.

For a solar house, it is very important to use as little energy as possible. It is one of the reasons why this device is probably one of the best you can currently find on the market [Table 387].

There are some devices like RaspberryPi which consume less power, but they are not suitable for everyday family usage. This device has capabilities which are close to those of the popular smartphone Samsung Galaxy S3.

Indeed Odroid-U3 will enable you to do what you need to do. You can watch high definition video, listen to music and surf on the internet, check your e-mail, do office work [spreadsheets, write documents, prepare presentations, etc].

12.5.8 THE CLOTHESLINE

In Chile very few families have a drying machine. Furthermore Casa FENIX is an emergency house for people of more modest means. Therefore the Team FENIX choses a clothesline how drying method, this will be instaled in the north facade of the Survival Module, and the design is very simple, because the main idea is to show the tipical way that the people from valparaiso dry them cholthes.

The figure 355, show a tipical house in Valparaiso, and the cothesline how the main way to dry the clothes.

---

^6 The data sheet is available in the appendix 14.12 “Construction specification appendix”
STRUCTURAL CALCULATIONS

[Casa FENIX]

[Solar Decathlon Europe] [Team FENIX]
CASA FENIX
For Emergency post-Natural Impact eXtreme REMINDER

One of the most outstanding geographical features of Chile is the relatively constant threat of earthquakes, among other natural disasters, such as volcano eruptions, landslides and fires in urban areas. The regularity with which these events occur does not make them any less catastrophic for people. Many homes are lost and the people who are most affected are low-income families. The post-catastrophe situation throughout the year has indeed been non-sustainable, therefore to develop and implement the concept of sustainable reconstruction is a big challenge for our country, where Casa FENIX ambition is to propose and offer a tangible solution.

THE PROBLEM While Chile is a political and geographical location where natural disasters are recurrent and affect a great part of the most socially vulnerable population, there are no official policies which outline a quality response to such events.

“When disaster strikes, the problems are resolved with quick, cheap, short-term solutions, such as the mediagua emergency houses” which end up causing more problems than they solve and lead to a great deal of waste in the long term.

HYPOTHESIS Casa FENIX is a design process that responds to a catastrophe, delivering energy efficient strategies to ensure quality of life as a key factor in a sustainable reconstruction; these strategies are not currently considered in post-catastrophe national policy. Sustainability factors include locally specific environmental, cultural and geographical issues, and also consider accessible and viable solutions for the most vulnerable sector of Chilean society. Therefore, the original objective behind this proposal is:

“to create emergency dwellings that offer quick, good quality and sustainable homes for the families who are the victims of a disaster.”

Thus the architectural and urban concepts that shape the proposal at both individual and collective levels are: Modularity, progressivity, flexibility and affordability.
Modularity
Casa FENIX evolves from a basic Survival Module to a complex Eco Village/Housing Complex. This process covers the stages of Emergency, Relief and Reconstruction.

Progressivity
Casa FENIX progression allows the Survival Module unit to become a final home. This incremental and evolving logic is assumed by the urban design strategy.

Flexibility
Casa FENIX has the capability to adapt to different latitudes and climates, given the geographical characteristics and diversity of climates Chile possesses, from north to south.

Affordability
Casa FENIX is an affordable home. Each unit may be acquired through the progressive subsidy addressing the total cost of the home.

ARCHITECTURAL PROGRAMME For the SDE competition, the Casa FENIX Team proposes to bring a house that represents reconstruction as a growth progression and is configured to perform well in the Versailles climate. The basic structure and its components will subsequently be configured to meet the solar passive design strategy for the specific local climate where it is to be installed.

The programme represents the core concept of Casa FENIX, which takes a progressive approach to Emergency, Relief and Reconstruction, with sustainability in mind. It uses a passive solar design driven by a sunspace, which acts as the energy engine of the completed house and is a key spatial element which allows the articulation of the different modules.

Casa FENIX is a modular design in which each 11 m² module can be progressively attached and easily assembled during a post-disaster period, to form a dwelling measuring 60 m².

The modules are as follows:
Survival Module
This is the quick initial response for the emergency period, immediately after a catastrophe strikes. Its main objective is to provide shelter, safety and a quality solution to the affected family.

Mechanical Module
This is the first module to be attached to the Survival Module as a progression during the relief period. It consists of the services and a technical core. It includes a bathroom and kitchen.

Living Module
This is the module that enables the house to expand and cover more than the basic needs during the reconstruction period, transforming the sum of modules into a definitive home.

Sunspace
The passive solar design strategy enables the regulation of the indoor climate by articulating the different modules with the exterior climate; this space grows with the addition of each module.

At a collective level, the group of emergency houses, which the FENIX team has called “Temporary Village FENIX, TVF” and the progression to a housing complex, which the FENIX team has called “Eco-Village FENIX, EVF” are conceived following the same logic. They have an open and flexible design that allows for the adaptation of modules and means that Casa FENIX can be adapted to different climatic, topographical, territorial and cultural realities.

THE GEOGRAPHICAL DIMENSION
Chile has 9 different climate types and the country stretches from latitude 18°S to 50°S. 90% of the population is located in areas where solar radiation is over 1000kWh/year. To address this climatic diversity and take advantage of the opportunity for solar radiation, the conceptual idea for

“Casa FENIX is similar to a skeleton or basic structure, an innovative structural design developed by students, where different components can be configured and assembled according to the users’ demands”
All the components to be attached to it respond to the demands for the different latitudes and to patterns of self-construction.

**SUSTAINABILITY FOR US** It is important to mention that the understanding of sustainability in the case of developing nations differs much from the one used in developed nations, in the sense that the problems that needs to be addressed are much different, respect of priorities and urgencies. For the Chilean case the deterioration produced by natural disasters and the anthropic urban degradation produced by informal settlements and poverty are the immediate problems to solve in a sustainable way. To teach the general public about sustainability issues that go beyond recycling, energy efficiency and achieving a low carbon footprint, Casa FENIX proposes to focus mainly on local cultural aspects, quality of life and social relationships. In this case the sustainability aspects are focused on using technology and urban planning to enhance the intuitive know-how of a particular local population.

“The choice of site: Man’s physical freedom manifests itself no doubt in his ability to choose the place on earth where he wants to live”.

People act, build and adapt through self-construction to the different latitudes and geographical conditions over time using their intuitive and basic knowledge.

“Neither privations nor danger will deter man from selecting a spot [...]” to settle on (Rudofsky, 1964).

This recognition of the appropriateness of the way informal settlements and self-construction take place is basic and seen to be positive; however it is extremely precarious and unsustainable in many other
aspects and in extreme situations could produce complete devastation. This was the case in April 2014 when a wildfire ravaged Valparaíso for three days; 2,900 homes were destroyed and 14,000 people - 4% of the Valparaíso population (IMV, 2014) - were made homeless.

The reasons for the unsustainable settlements can be traced back to many issues related to post-disaster rehabilitation and poverty and a major factor is the lack of a sustainable urban code for areas of vulnerability. This sustainable urban code would need to respond in a general way to the emergency and in a particular way to the post-catastrophe situation that begins right after an emergency occurs.

Casa FENIX TEAM ORGANIZATION Team Casa FENIX is a bi-national team composed of students and faculty members from the Universidad Técnica Federico Santa María [UTFSM], Valparaíso, Chile and from the Institute Universitaire de Technologie [IUT], Université de La Rochelle, France. In addition to all the opportunities that arise out of any international collaboration between academic institutions, team Casa FENIX seeks to respond coherently to SDE’s energy conservation objectives.

The proposal has been designed to address the circumstances and needs of Chile. However, transporting the house from Chile to France would entail a significant amount of CO2 emissions and the team has therefore set itself the goal of making a “PROTOTIPE” in Chile and a “REPLICA” in France, generating a dualism and a double challenge for our project. So, while the conceptual proposal is Chilean, the production of Casa FENIX is French.

TEAM Casa FENIX FRANCE
The French part of the team is in charge of all the practical, construction, building and technology applications of the project. One of the strengths of IUT is their research into and work with wooden structures and construction. A complete version of a replica of Casa FENIX is being built in La Rochelle and this is the version that will compete in Versailles.

The design of Casa FENIX has been developed in Chile with the participation of the students from the French team during the process. Half of Casa FENIX will constitute the prototype built and tested in Valparaíso.
The roof is supported by wood rafters with bigger timber sections [BM 45*220, centerline distance of 0.60m].

The wooden floor is made of wood joists [section BM 45*145], distance of axes 0.50 m. This floor is supported by a two-part-section central beam [2BM 45*145] bolted down on two central stakes for each building block. The remainder of the main frame is composed of 8 crossed stakes, assembled with 4 sections BM 45*95. Those 4 sections are linked together by three levels of bolted unions. Stakes are placed at the 4 corners, as well as on the side midlines. They are bolted down, on the floor, ceiling and roof, by two-part-section peripheral horizontal sill plates [2BM 45*95]. Each stake is supported by a glulam block foundation, to ensure the load transmission to the ground.

The structural withstanding is ensured by the bracing of primary frames. At roof and floor level, a bracing board sheathing [OSB: Oriented Strand Board] is nailed on rafter lumbers, as well as to the floor joists. Into walls, struts ensure the building vertical stability. These struts are a two-part section of massive wood [2BM 45*95] bolted on.

The first module [life module] remains in stable position thanks to this system, as well as other building blocks. The whole system follows the architect’s drawings, and structural bracing is effective with those two solutions.

Secondary frames are composed of timbers, section BM 45*95, bolted on the primary structure.

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1. BM stands for “bois massif”
13.1.2 CODES USED FOR THE DESIGN AND CONSTRUCTION

**Eurocode 1: Actions**

Eurocode 1 provides comprehensive information on all actions that should normally be considered in the design of buildings and civil engineering works.

- EN 1991-1-3 + EN 1991-1-4
  - NF P06-113-1 & NF P06-114-1+ National appendix
- EN 1991-1-1 + National appendix
  - NF P06-111-1
- EN 1991-1-4 + National appendix
- NF P 06-111-2 Clause 6.3.1.2
- NF EN 1991-1-3/NA Appendix
- NF EN 1991-1-3 Article 5.3.2

**Eurocode 3: Steel**

Eurocode 3 is wider in scope than other Eurocodes due to the diversity of steel structures, the need to cover both bolted and welded joints and the possible slenderness of construction.

**Eurocode 5: Timber**

Eurocode 5 covers the design of timber buildings and civil engineering works. As with other

Eurocodes, it uses the limit-state concept, unlike the traditional permissible stress method in BS 5268.

13.1.2 DESCRIPTION OF THE MATERIALS AND ITS RESISTANT PROPERTIES

**Eurocode 8: Earthquake**

Eurocode 8 explains how to make building and civil engineering structures resistant to earthquakes, though the UK is deemed to have very low seismic risk.

BM of strength class C24 and glulam wood graded GL28h have been chosen. [For more details see APPENDIX 14.1 “STRUCTURAL CALCULATIONS FOR CASA FENIX RÉPLICA MADE by ARCABOIS Pp 5]

OSB panels are described from product information [For more details see APPENDIX 14.1 “STRUCTURAL CALCULATIONS FOR CASA FENIX RÉPLICA MADE by ARCABOIS Pp 145-146]. NF EN 300

Wood varnishes—LURIE Alphacoat and Alphaflam underlayer [For more details see APPENDIX 14.1 “STRUCTURAL CALCULATIONS FOR CASA FENIX RÉPLICA MADE by ARCABOIS Pp.140-144; Lurie]
13.1.3 DIFFERENT WIND HYPOTHESIS OF PRESSURE/SUCTION – LOADS COMBINATIONS – LOADS DURING TRANSPORTATION

Wind hypothesis

Different coefficients and safety factors have been used, according the Eurocode 1. [For more details see APPENDIX 14.1 “STRUCTURAL CALCULATIONS FOR CASA FENIX RÉPLICA MADE by ARCABOIS Pp. 8-13; Wood load Standard]

Loads during the house transportation

Loads concerning the assembling and dismantling processes are detailed on the «lifting tackle verification» [For more details see APPENDIX 14.1 “STRUCTURAL CALCULATIONS FOR CASA FENIX RÉPLICA MADE by ARCABOIS Pp. 108-118]

13.1.4 SOFTWARE

Using Software Description

To model the main structure, the ACORD Bat 3d Software [Itech Soft Editor] has been used. It allows the analysis of the mechanical performance and the code verification of any three-dimensional frame which could be modelled within a system of stakes and beams elements.

To compute assembles, the combined forces from the aforementioned software are use as inputs to ACORD Express Software, from the same editor. It allows to verify the construction provisions and the assemble resistance criteria.

Editor’s logo Itech Soft Software

Main assembles, those where in-bars loads are the most important, will be verified: Stake / Struts Stake / Joist support

[For more details see APPENDIX 14.1 “STRUCTURAL CALCULATIONS FOR CASA FENIX RÉPLICA MADE by ARCABOIS p.102-107; ACCORD-Express]

13.1.5 CRITICAL EFFORTS

For more details see APPENDIX 14.1 “STRUCTURAL CALCULATIONS FOR CASA FENIX RÉPLICA MADE by ARCABOIS «Linear combination results: Forces max and min following ELUSTR» Pp. 55-61
13.1.6 DEFLECTION AND DISPLACEMENT

To see the deflection and the displacement of points, follow the APPENDIX 14.1 “STRUCTURAL CALCULATIONS FOR CASA FENIX RÉPLICA MADE by ARCABOIS Pp. 54; knot displacement ELS UFIn.

13.1.7 FOOTING

The support reactions in Versailles are verified in APPENDIX 14.1 “STRUCTURAL CALCULATIONS FOR CASA FENIX RÉPLICA MADE by ARCABOIS Pp. 119-137

The Glulam block verifications are shown in the APPENDIX 14.1 “STRUCTURAL CALCULATIONS FOR CASA FENIX RÉPLICA MADE by ARCABOIS Pp. 137-138

13.1.8 STRUCTURAL FIRE RESISTANCE JUSTIFICATION

Fire structural Justification

During the SOLAR DECATHLON contest at Versailles, this building will be opened to people, with the exception of the room “Bedroom”. That is why the building is considered as an “établissements recevant du public” [ERP] and graded 5th category, as it is a one storey construction, with no sleeping accommodation and not considered as a little care establishment. As far as PE5 §3 of security regulation against fires about [ERP book III; Applicable dispositions to a 5° category establishment; chapter II; section 1] is concerned, no fire resistance requirement is imposed. Concerning the walls of the room called “Bedroom”, a layer of LURIE Alphacoat varnish [with an intumescent AlphaFlam underlayer] is applied on the massive wood siding of 13.5 mm thickness. It allows to obtain a M1 Classification for these walls

Classification for these walls

Technical details as APPENDIX 14.1 “STRUCTURAL CALCULATIONS FOR CASA FENIX RÉPLICA