FENIX 2.0

TEAM CHILE / USM

JURY NARRATIVES
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UNIVERSIDAD TÉCNICA FEDERICO SANTA MARÍA

Valparaíso, Chile.

U.S. DEPARTMENT OF ENERGY SOLAR DECATHLON 2020

Resilience Jury Narrative

Team Chile is participating in the Solar Decathlon 2020 [1] with a solar-powered representative dwelling called "Casa FENIX 2.0", a single-family unit of mixed-use multifamily and multi income development that is innovative, cost-effective, and energy-efficient. Casa FENIX 2.0 starts from the "Metamorphosis" concept, which sees housing as a process that adjusts to the family life cycle and changes of family profiles, fostering high flexibility by continuous architectural transformability from an early stage of design. Originally, Team Chile's approach was to target urban infill issues with solar housing development. However, faithful to its resilient philosophy, our current prototype has adapted to respond to a post-disaster reconstruction after a devastating fire last December in Valparaíso, Chile. This version FENIX 2.0 will be the Uribe-Troncoso family home as part of the reconstruction program of the Ministry of Housing and Planning, MINVU, through the subsidy given by Housing and Planning Regional Authority, SERVIU of Valparaíso. The present project will continue later to build more FENIX 2.0 as a triplex and small residential clusters for the reconstruction of 245 lost homes.

Resilience and Social Resilience

Casa FENIX 2.0, due to its location, must respond to the recurrent seismic events given Chile is the most seismic country in the world and it always registering events of greatest energy release[1]. As it can be observed in the figure 01 of the subduction of the Nazca Plate under the South American Plate, as described by Cisternas (2011), where the contact between plates corresponds to an inverse fault in which the continent rises on the ocean floor. The volcanic zone and compression faults are shown in the Andes Mountains. In addition to the highly seismic condition, the whole world today is facing the climate crisis, therefore, we must be prepared for climate change. Then, the concept of "resilience" becomes very broad and cover many fields, according to UNISDR "The ability of a system, community or society exposed to hazards to resist, absorb, accomodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions" (UNISDR, 2009, p24)

Then, the way the concept of resilience is applied depends on the field of study. Team Chile applied it from the technical and social points of views subjected to the different features and scales of the project: on one side, at the construction and structural building features and on the other, at the community, the housing complex and the housing unit scales. For Chileans the concept of resilience is widely used by most of the population and it is mostly related to the various types of natural and provoked catastrophes that often occur in Chile, such as earthquakes, tsunamis, volcano eruptions, floods, landslides, forest and urban fires, being the latter one of the most recurrent after earthquakes. Some of these catastrophes today are becoming more severe and devastating to the presence of climate change, adding climatic new phenomena like rains and floods in regions like the Atacama desert, where they were very escarse, or droughts in the extreme South producing huge fires, that results in Antarctica melting and hazardous situations to cities nearby those areas.

Community Scale. The last great earthquake of magnitude 8.8 on the Richter scale occurred more than a decade ago, in February 2010, it affected the central area of Chile revealing the fragility of the social order and how quickly the inhabitants panic[3]. This was reflected in the "social earthquake"

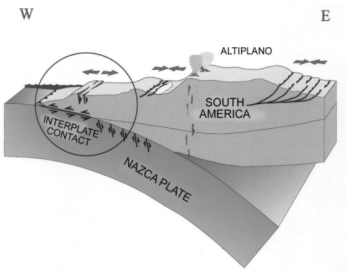


Figure 01: Subduction of the Nazca Plate under the South American Plate; Source: "The Most Seismic Country of the World" Cisternas, A., 2011

Figure 02: Picture of the 1960's Valdivia mega-earthquake[2]; Source: The Most Seismic Country of the World, Cisternas, A. , 2011

1.- 9.5 Earthquake magnitude in Richter scale in 1960. Seismic activity is generated by the process of subduction between plates, mainly Nazca plate and South American plate which have caused the greatest earthquakes. Added to this is the presence of geological faults, volcanic activity and effects of local geology, can also produce earthquakes.

2.- Also known as the Great Chilean Earthquake, occurred on Sunday May 22, 1960 at 3:11 p.m. local time (CUT-4). The earthquake was felt at a planetary level and produced a series of tidal waves, the scope of which was spread to various locations along the Pacific Ocean, including Hawaii and the shores of Japan, and the eruption of the Puyehue volcano covering with ashes the homonymous lake. It is estimated that this natural catastrophe cost the lives of 1,655 to 2,190 people, and left more than 2 million victims, (Cisternas, 2011).

3.-"Environmental and Psychosocial Factors Linked to Symptoms of Panic Attack After the Earthquake and Tsunami of February 27th, 2010 in the Central Zone of Chile". (Leiva & Quintana, 2010).

lived after the catastrophe, where poor management of communications by authorities, looting of supermarkets and curfew in some affected cities were consequences of this phenomenon (Grandón et Al, 2014).
The looting associated to catastrophes fundamentally considered a myth in first world nations, where, when they occurred, they happened in a covert way, done by isolated groups whom received a strong moral condemnation from the rest of the population (Barsky et Al, 2006; Sun, 2011; Tierney, 2007). While in developing nations, like Chile, these actions tend to frequently occur (Quarantelli, 2008). Other research states that looting is more likely to occur when the level of devastation is very high, the governmental institutions are inefficient in regard to deliver clear information to aid victims and the existence of previous social inequality conditions is present (Barsky et Al, 2006; Quarantelli, 1994)

For instance the following image of the CNN news for the 2010 earthquake, depicting the lack of accurate and timely information from the authorities regarding the tsunami that occurred after the earthquake, caused that many people did not evacuate to a safe area, those who decided to evacuate did it under their own initiative even though there was no a tsunami alert.

Figure 03: The CNN screenshot showing news on "the investigation for failed tsunami warning" declaring that "the prosecutor presumes culpable crimes of those working for ONEMI and SHOA while in emergency; Source: CNN Chile Archive

Figure 04: Earthquake victims camping within ruins while the national army is patrolling and aiding on the streets[4] ; Source: CIPER Chile

Forest and urban fires

In recent decades urban and forest fires in Chile have increased steadily, the largest number of burned hectares are concentrated in the Central and Southern areas of the country, Valparaíso is located in the central area of the country.
The graph in figure 5 compares the number of fires and the burned hectares in the country since 1997. The largest amount of affected area was reached in the 2016-2017 season, when the mega-fire occurred in the O'Higgins and Bio-Bio regions, exceeding the average of the last four decades with more than half a million hectares burnt, reaching an increment of more than 900%.

4.- A press article from the same year 2010 analyzed: "In the absence of authority, everywhere people sought refuge in their neighbors. Those who did not even say hello, now took turns in the guards. They protected their children, shared the food they had. And they were alert. The fear did not let anyone realize that in the neighborhood next door they were going through the same. In moments of extreme need, what made us feel safe was not the feeling of being Chilean, it was not the idea of a Nation celebrating 200 years of independence the very same 2010, instead it was the sense of neighborhood, the clan, something that is even older than the Chilean independence."

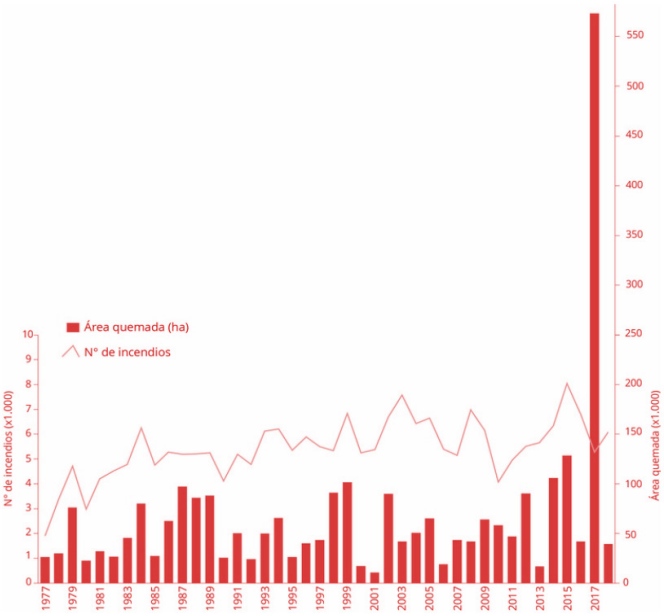


Figure 5: Fires in Chile 1977 - 2017; Source: www.conaf.cl

In Valparaíso in April 2014, 9 of the 42 hills were quickly consumed by fire, being considered the largest disaster in the history of this region to date. Many claims begin with forest fires in the unpopulated areas of Valparaíso or also begin in the garbage deposit areas, ending with a large number of green areas. The strong winds propagated the flames reaching the outskirts and the urban areas of the city, spreading easily with the help of bushes, garbage and jumping ravines from one hill to another, burning a total of 3,000 homes and leaving 12,500 people homeless. After this fire, a series of forest and urban fires have occurred every summer as shown on the timeline in figure 6.

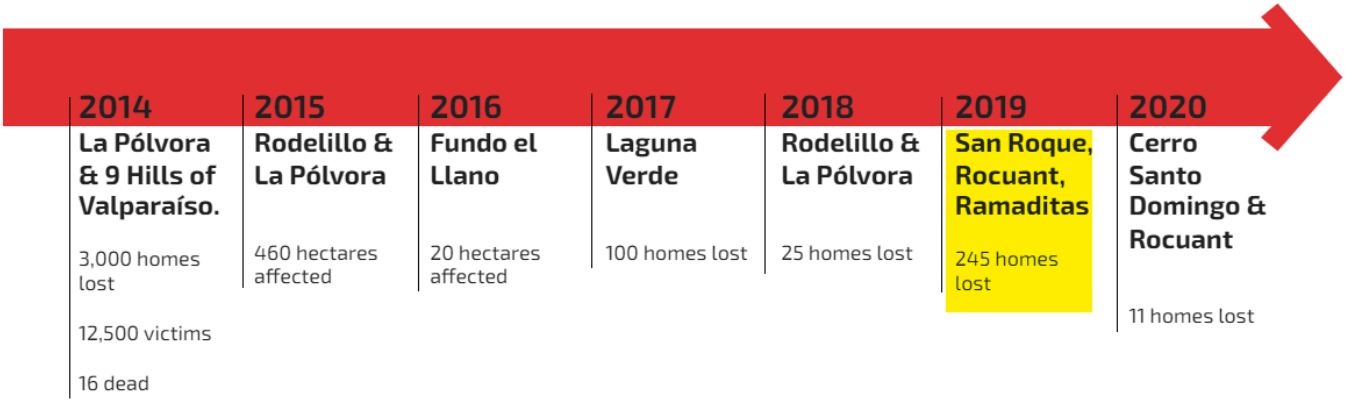


Figura 6: Fire Timeline in Valparaíso since the Big Fire of 2014; Source: TeamChile

Casa FENIX 2.0 is a proposal for social housing located on the Rocuant hill in Valparaíso, for a family affected by the fire of 2019. It should be mentioned that this hill faces the problem of houses built by the residents themselves without building permits and most time without complying the Chilean Building Code, located on ravines with high risk of being captured by forest fires. It is common for many Latin Americans country that people settle themselves taking vacant land, which become regularized after years. These vacant lands are normally close to main cities where people are able to find a job. Therefore, in the Rocunt Hill there are houses that still do not have the basic services, water and power and others that do not have property titles, nevertheless a great percentage becomes property owners after years and those property owners are the one eligible for reconstruction subsidy after a disaster.

The informal settlements on the hills of Valparaiso, has been the way the city historically has developed and grown, it is also what makes this port unique in its features, however the accessibility and topographic conditions are difficult and complex, and when natural or provoke disasters occur they end up being very devastating, and of course, most of these sectors are the poorest of the city. The COVID19 pandemic period has affected also more severely these sectors, having the city of Valparaiso the worst rates of death and contamination of our region.

Resilience during COVID19 quarantine

For Casa FENIX 2.0 to be built in Rocuant Hill it was necessary to carefully analyze the legal situation and the basic services accessibility, otherwise building permits would have been impossible. Nonetheless, there is always issues involved in all these processes, which for the case, the fact that we were quarantined favored the paperwork and the obtention of the building permit, which certificate of approval is shown in figure 7.

The design contemplates preserving the collective character of the life of the hills, as well as being designed with neighbor's participation, which is normally and intuitively done when they first come to settle on these places. We selected a site seeking to become a landmark within this place, like a figurehead of a ship, proud and definitely improving the quality of life of people, as Mrs. Susana said "it will be the most beautiful home ever", offering diversity and new reality to the neighborhood, hope for a new beginning. Since a strong, organized community that relies on support networks and allows a place for social organization and interaction is much more likely to be resilient in the event of a disaster, this is "Pasaje 8" where Casa FENIX 2.0 will be located. Team Chile has projected for Casa FENIX 2.0 to be autonomous capable to work off-grid in the event of a disaster, providing lighting and security not only to the inhabitants of the house, but also to some of the neighbors. However, these features will have to be developed in a second phase, giving the difficulties related to materials and systems scarcity Chile is going through due to COVID19.

RESPONSES TO DISASTERS

Housing Complexity. The architectural concept of *flexibility* is responsible for preventing the programmatic obsolescence of the project and allowing variation to respond to the needs of families. Our proposal sustains that a building is not resilient when its durability and function is static, when the building is incapable to *accommodate* and *adapt to the real needs* of the users. Besides, from the climate change perspective, a resilient building is the one that in its lifespan, from cradle to cradle, includes less polluting building materials both in its embodied energy as well as in its natural degradation. For this reason the main construction material is wood.

Figura 07: First reconstruction house in affected area; Source: SERVIU files.

Seismic-proof Standard. Also, all the buildings built in Chile are subjected to very strict regulations and must comply with the seismic-proof Chilean Code, NCh433. Timber construction is a flexible and highly efficient material that responds quite well to earthquakes forces given its anisotropic properties. For our proposal the modular characteristics of the construction and structural components utilized for the primary and secondary structures, envelope and all the reconfigurable walls, will be manufactured by taking advantage of the industrialized methods and technological advances.

Casa FENIX 2.0 uses manipulative robots (see Innovation section) through the CAR system (Robot Assisted Carpentry) allowing wooden components to be moveable, removable and easily repairable in case of a catastrophe and they are potentially upgradable with the advancement of technology.

For the construction, it was necessary to carry out the previous structural analysis for both the main and secondary structures by a certified civil engineer, graduated from our university. Analyzes were carried out for both the timber joints, for the combined joints of timber joints with steel elements, and for the structural floor and walls. Additional structural reinforcements were established both to protect form the seismic and wind forces, previously calculated and in compliance with Chilean regulations as shown in figure 8.

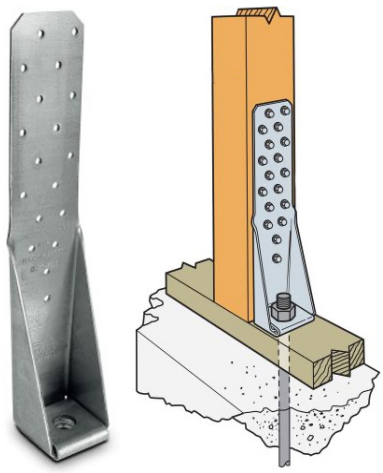


Figura 8: Simpson DTT1Z anchor in different parts of house; Source: Simpson Strong-Tie

Fire fighting components

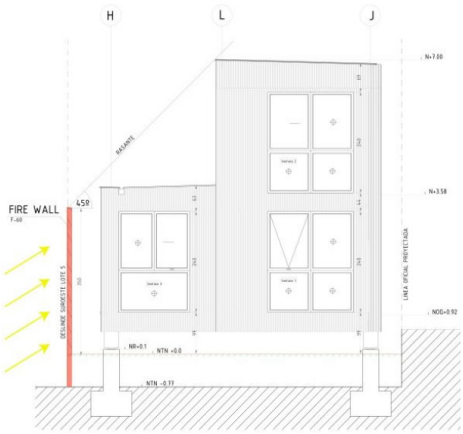


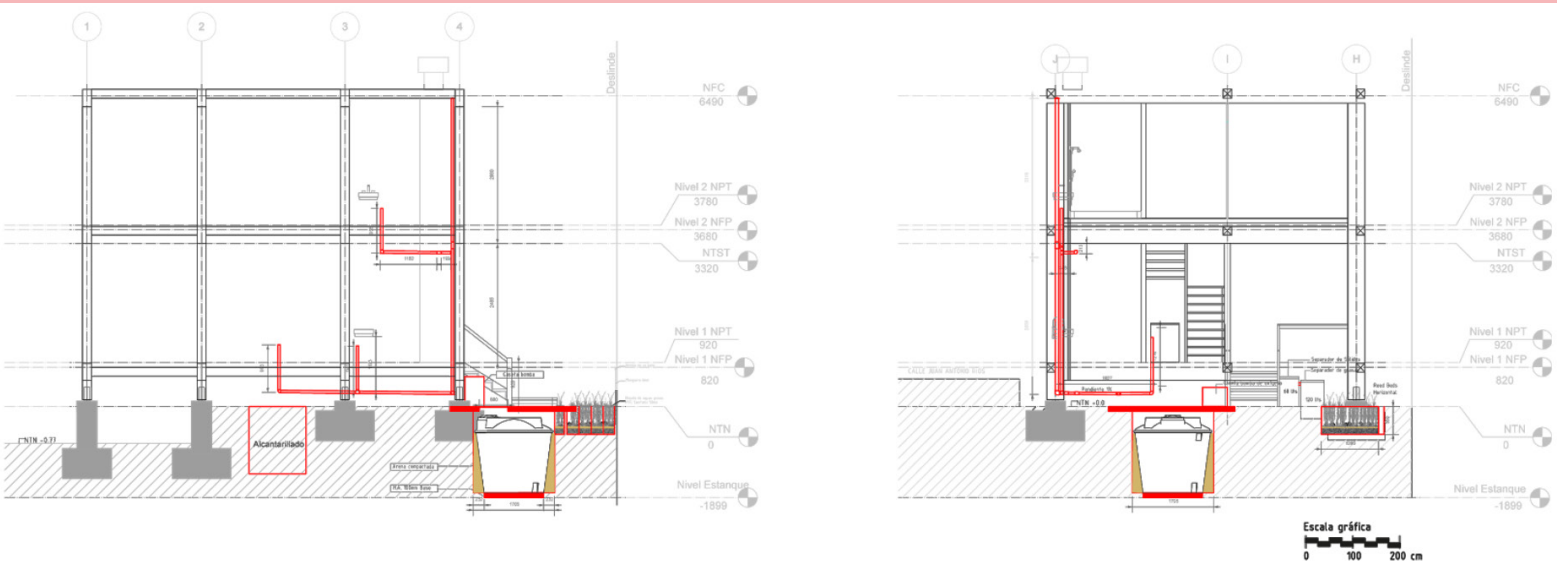
Figure 9: Firewall; Source Team Chile.

The Firewall F-60 Requirement. is mandatory to responds to two Chilean standards NCh 1914/1 (of non-combustible materials for fire walls) and NCh 935 (quality control of materials and their resistance), and to comply with the Chilean building regulation O.G.U.C. (Chilean General Urban Planning and Construction Ordinance) according to their distances and minimum heights. In Chile, it is necessary to have firewalls when the houses are less than 1.4 meters from the property lines with neighbor properties when there are no openings in that direction, for Casa FENIX 2.0 this condition exists in one of the property lines of the house. The reason for having firewalls is to delay the action of fire in case of fires and prevent them from spreading to neighboring buildings as shown in figure 9.

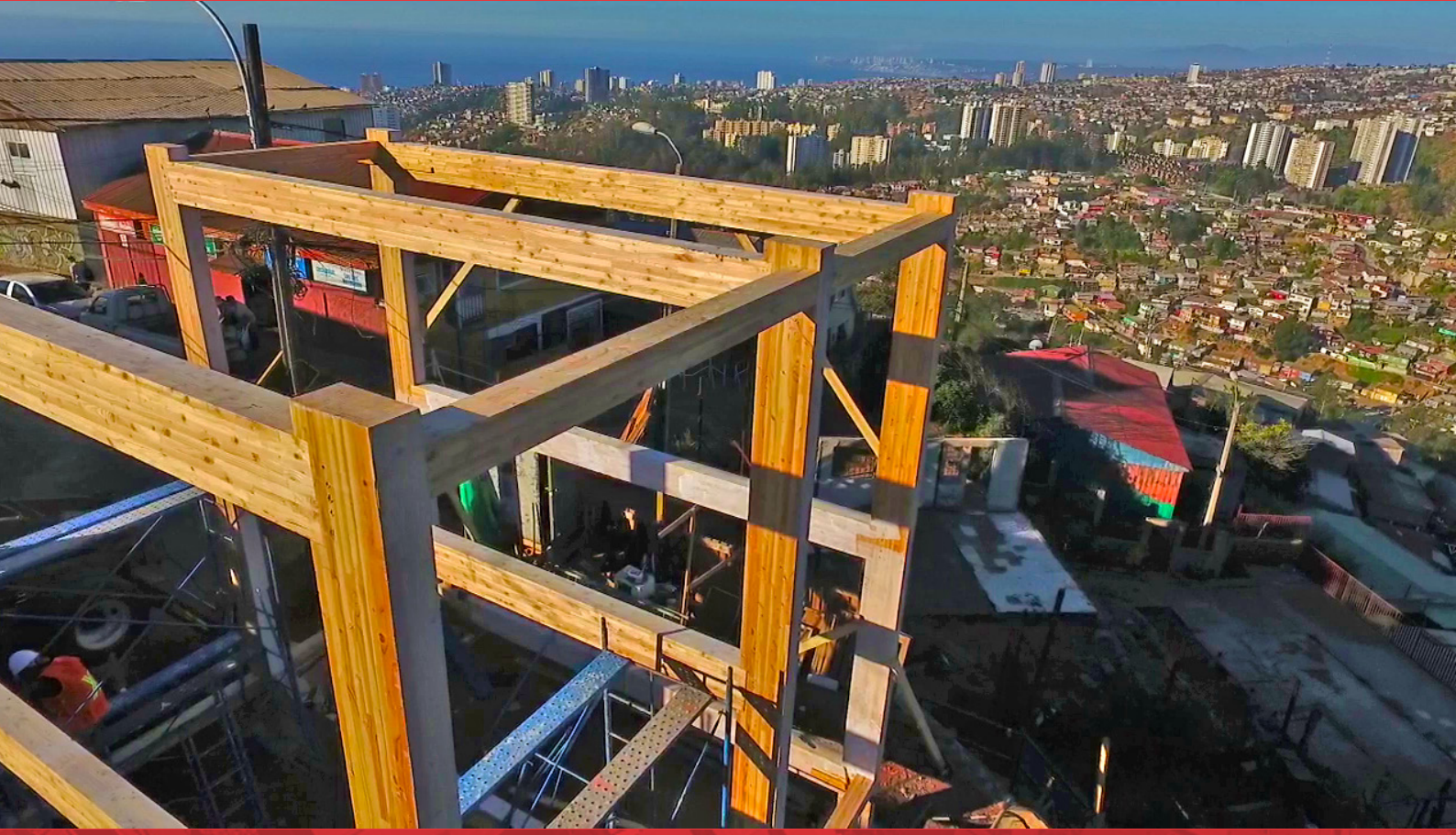
Water recycling and treatment system for fire mitigation and irrigation. This project has an innovative system never used in housing in Chile, which performs a greywater treatment system[5] (recycled water from the sink, dishwasher, shower and washing machine) and rainwater, to be accumulated underground, and connected to an ejection pump and be used during a possible fire catastrophe. Depending on the number of people, an average monthly total of 9,540 liters of water can be recycled, which due to the conditions of the land will only accumulate 2,400 liters of water under the surface of the soil as shown in figure 10. The main idea is not to interfere in the uses that the family has of the land and does not visually interfere with the space. The family can freely circulate over the entire surface of the terrain, finding only the connecting elements at certain points.

At last, we would like to tight up the social resilience concept as part of the Chilean culture and our society is well known for fulfilling partially some aspects of this resilient capacity, given Chile is a country continuously affected by several types of catastrophes, natural and provoked ones, we as a society have the abilities to: first, develop the capacity of coping with and overcome many types of adversities, this ability is developed from childhood on; however, if we take a second social capacity as "being adaptive to", we adapt easily to catastrophe but it takes much to developed the ability to learn from past experiences and adjust ourselves to daily future challenges, in regard to earthquakes, we do learn from one big to another one, and the norms and people as actors do respond to it, but in regard to fires, we still need to be much more resilient. In this way, Casa FENIX has taken two main adversities (earthquakes, urban fires and energy efficiency) and has addressed this resilience factor through its design, material and system specifications. Finally, if we take a third social capacity as "being transformative", this resides much more on institutions in charge of social and sustainable development of the society, preparedness for future crises and disasters, and sadly when we focused on the more vulnerable sector of society, as we have been working with, it is evident that this capacity is in debt, and this is not just a technical issue, it is definitely a political one, for Team Chile, the way we are addressing this social resilient capacity is through being able to work in collaboration with the local housing authority, and open new opportunities on this joint venture.

Figure 10: Water recycling and treatment system for fire mitigation. Source Team Chile.



5.- The water reuse process is under Chilean law 21.075.



From our previous experiences of participatory design of Casa Metamorfosis (2018) and FENIX HC (2014), Team Chile originally focused the proposal on a community affected by gentrification. Then, as the project evolved, a devastating urban fire in Valparaiso that affected 128 low-income families became our new objective. In a country marked by social and natural disasters, the resilience factor becomes an opportunity for reconstruction after any of these catastrophic and recurrent events that affect the most vulnerable sector of our society. The reconstruction of houses after a disaster that has affected any poor sector of our society is normally assumed by the government. Therefore, the housing authority demands creative and fast solutions to house the people that have become homeless. Our local housing authority, SERVIU, knew well about our past and current participation in SD and invited Team Chile to use the new and revised version of Casa FENIX 2.0 to build the first reconstruction home after this last event. Consequently, Team Chile agreed and took this new challenge of demonstrating that solar and energy efficiency features must be part of social housing, by providing an affordable, creative and innovative solar home, to be financed with the available housing subsidy for reconstruction with the further agreement of converting this project in a timber social housing typology, and build triplex and duplex in the near future. After a year of a severe catastrophic pandemic period that is ventilating the most crude reality of the inequalities of our nations, projects like Casa FENIX 2.0 become an opportunity for the re-thinking of social housing in Chile.

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