S3B

Affordable Sustainable
Housing Unit in Brazil

A project by Mariana Cobucci Paolucci

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S3B - An Affordable Sustainable Housing Unit in Brazil

A master thesis by Mariana Cobucci Paolucci for the masterprogram Design
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My name is Mariana Cobucci Paolucci and I was born and raised in Brazil. This project has given me the great opportunity to apply the knowledge I gained from this Master Program to develop a product that could benefit middle class families and promote sustainability practices in my home country.

Thinking about the various problems the Brazilian society has been facing through the years, as an architect and urban designer, I decided to develop a project related to my profession and that can make a difference in the quality of living of some middle class Brazilian families.

Therefore, I decided to develop a beautiful, low-cost, quality sustainable home unit for the emerging Brazilian middle class..

Introduction

S3B is a housing unit **prototype** made for the **Brazilian** context, with the goal to be flexible, **low priced**, solid quality, creative **customizable** and **sustainable** kind of living. S3B is directed to people with **lower income** or the "new middle class"

This master thesis is a research/ project/ analysis / comparison based work, minding the Brazilian aspects, construction aspects and social housing aspects using a particular housing program as a base, the Minha Casa Minha Vida (My house my life).

The research starts after the house prototype is placed in a context, the Brazilian context. Then when a stakeholder is chosen, the new Brazilian middle class. Then the Brazilian housing situation is analysed and boundaries are set defining which standards the developed house would fit into. The project follows limited by a certain budget and minding sustainable aspects, and it is constantly compared to the traditional constructions with the same propose, social housing. A conclusion is then taken from the comparison which resumes the final importance of the work.

This used method, investigation and comparison between the Brazilian federal housing programme "Minha Casa Minha Vida" My House My Life, was important to point out what was missing, what could be improved, and specially encountering in one design, the S3B a way of improving not only the physical design itself, but how the future user will understand the concept of living in a energy efficient house which was never accessible for him before, both physically and theoretically.

S3

Abstract

The objective of this Master Thesis is to design a, beautiful, low-cost and good quality sustainable home unit for the emerging Brazilian middle class. This sustainability project features energy efficiency, water reuse and sustainable food production elements, always considering an affordable budget. Customizable and modular, the S3B housing project will be available in three different versions, small, medium and large.

The S3B housing project is named after an old Brazilian saying used to define something that is BOA (good), BONITA (beautiful) and BARATA (low-cost). That is normally what a consumer hopes to find while shopping for anything.

Social housing projects are important at the moment because Brazilians have been undergoing a housing shortage. Therefore, designing a sustainable housing unit is an effort to reduce the Brazilian housing deficit which is estimated at five million homes.

A well-developed design is a key to help reducing the housing shortage problem that was also aggravated due to extremely poor quality of construction done on government housing projects, culminating in non-delivered housing units. The Brazilian government housing program "Minha Casa Minha Vida" (My House my Life) was created to attend the demands of lower income or the "new middle class" families. Following some of the requirements of the Brazilian housing program "Minha Casa Minha Vida" (MCMV) (broadly explained along the MT), the S3B project offers an extra option for families seeking for a more flexible, quality, creative and sustainable living. On a limited budget, the MCMV type 3, a basic house model, can be financially accessible for these middle-class families to purchase.

Foreword

Two years ago I arrived in Sweden full of expectations and very anxious, I had been accepted for the Masters I pleaded since the second semester of college in the city of Göteborg.

I met a whole new world while entering Chalmers, a world that I only saw in magazines and international architecture documentaries. I went to a wonderful school that had all the possible resources to contribute to my education, and I studied for free due to my Italian citizenship.

There I learned a lot. Learned new software in a few days, I got to know about matters that had never heard before and I had to face school with the same seriousness that I would face my professional life.

It was a very interesting but long and tiring process. For this goal to be achieved, I spent two years in a totally different country from mine in every possible aspect. I had to learn to live with the cold, the lack of light, and missing my family. I had to understand and accept the silent and enigmatic way the Swedes were, and stop trying to guess what they thought of me.

But now I look at my finished master's thesis, I see that everything was worth it. I have made it! But I haven't made it on my very own; it was a journey together with all the people that somehow and sometime gave me strength and energy to keep on going.

I thank my fantastic parents who first supported me in this "crazy" decision to move to the far north and finance my dream. They didn't only give me wings so I could fly, but the courage just so I wanted to fly.

Mom, because of you I've never felt lonely even though there were moments I was alone. I'll never forget the frequent and never ending skype calls just so you could keep me company. It was so good to me to know that you were always there for me. Needless to say, you are my direct source of inspiration, and because of such admiration, as you, I became an architect. Dad, your strength, common sense and reason helped me in difficult times, when problems occurred or I was missing home, and my greatest desire was to just leave. You were always there with you " loving strength" to put me back on track helping me to see things clear again.

I thank Simon, my friend, my companion of all times, always patient, helpful, understanding and sweet. I thank you Simon for taking care of me making me so happy. Regardless of what happens, I will never forget and I will always be grateful for everything. My brother Pedro, his visit brought me much joy and motivation. Thank you for visiting me and demonstrating your joy and excitement for being there with me. Thanks to Bengt, Eva and Vanja for literally receiving me as part of the family, giving me support, love and lots of attention. Tack Mormor för att du va min mormor och den underbara tiden vi hade tillsammans, våra fika stunder var bäst! (Thanks Mormor for being my mormor and for the wonderful times we had together, our "fikas" were the best).

I thank everyone who was in Brazil sending positive vibrations up here and cheering for me. Aunt Melane , Uncle Arthur , Gab , Lucas, my beloved, distant but always present. The Us 8 group allowed me to be part of your everyday life and made me laugh and cry because I missed you. Thank you for your unconditional support.

Godparents Aunt Dauta and Uncle Magnus, thank you for always being around. Aunt Dauta, our chats always fun and dynamic at the craziest times will stay in memory.

I would also like to thank the ones that besides all the emotional support, stopped what they were doing to help me along this MT. Aunt Flávia and Uncle Stephen, thank you for kindly checking the spelling my entire work, 72 long pages of texts properly corrected by you. Tinaninho, your help has given me a perfect closure for my thesis

My talented friends, the economist Paty Vargas and the architect and expert in MCMV Livia Marielle, thanks for providing me precious information. What you all did means a lot to me.

The staff of Chalmers and colleagues, especially my Coordinator Sylvia Pompe , my tutor Emilio and friend Dani Gonzalez thanks for the support .

Anyway, dear friends, especially the constant Whatsup companions Lucas Pagel and Carol Bicalho, my family: my grandmother, uncles, aunts and cousins who were cheering for my success, my sincere and profound gratitude.

The Project **Context**

is a sustainable affordable housing unit prototype, developed for the southern hemisphere more specifically for the south eastern Brazil.

Geographic Zoom

Brazil is the location context where the S3B prototype will be placed, therefore a brief introduction about Brazil's geographical and economical aspects are presented along this page.

Location

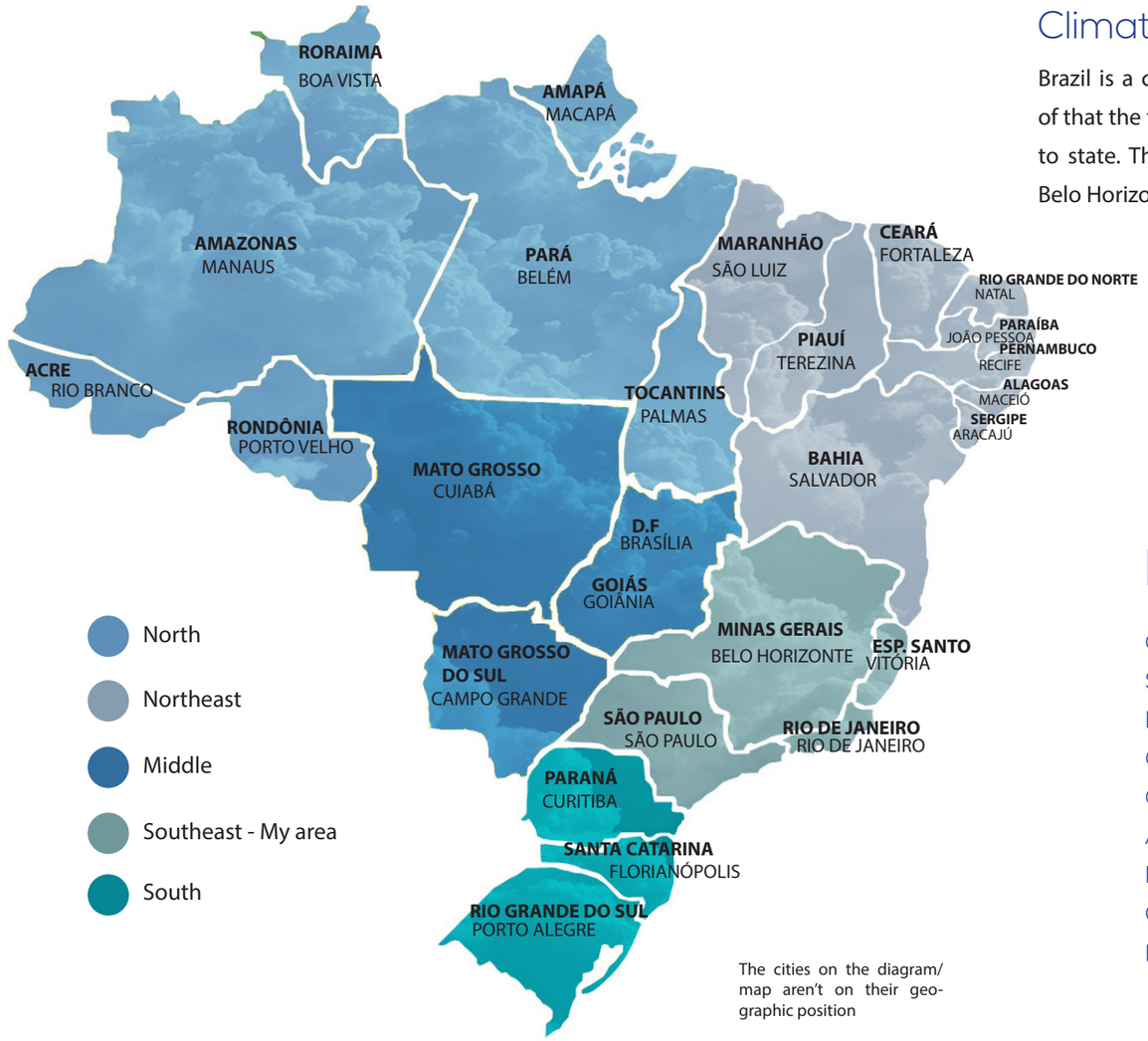
Brazil or Federative Republic of Brazil is the largest country in South America and Latin America. It is the world's fifth largest country, geographically and population wise.

The official language is Portuguese. Brazil is the biggest Portuguese speaking country in the world and the only one in the Americas. Bounded by the Atlantic Ocean on the east, Brazil has a coastline of 7,491 km and occupies 47 percent of the South American continent.

Economy

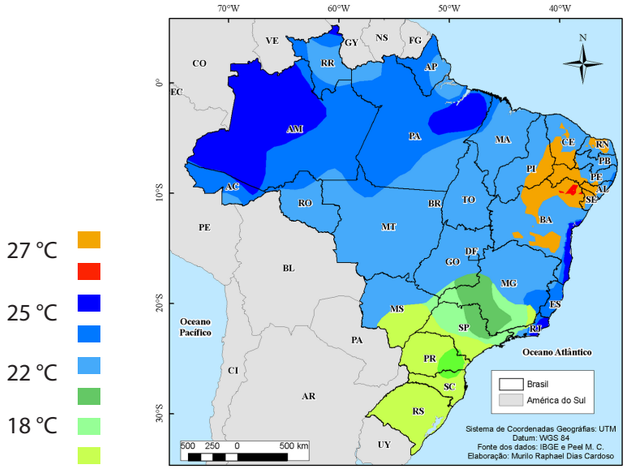
Brazil has been enjoying a strong and solid economy lately. The country is a major producer and exporter of various types of goods, mainly minerals, agricultural and manufactured commodities.

Considered an emerging/under development country, Brazil occupies 7th place in the ranking of the largest economies in the world with a GDP of 2,253 trillion USD (IBGE Brazilian Institute of Geography and Statistics, 2012).



The cities on the diagram/ map aren't on their geographic position

Brazilian Climate Map



Climate

Brazil is a continental sized country, because of that the temperatures differ a lot from state to state. The yearly average temperature for Belo Horizonte, MG for example is 21 °C .

Brazil

Capital: Brasília
States: 26 + Federal District
Biggest City: São Paulo
Official Language: Portuguese
Government: Presidential Rep.
Area: 8.515. 767 km2
Population: 201.032.714 (2013)
Currency: Real – (R$) – BRL
HDI (2012): 0.730 – 85th

Social Aspects

The S3B prototype is meant to be affordable to a certain share of the Brazilian population, therefore a brief introduction about Brazil's social aspects are presented along this page.

Education

According to the Brazilian Institute of Geography and Statistics - IBGE, in 2011, the population's literacy rate is 90.4%, meaning that 13 million (9.6% of the population) people were still illiterate in the country; functional illiteracy has reached 21.6% of the population. According to PNAD, 2007, the percentage of children in school, was 97% in the age group 6-14 years old and 82.1% among 15 to 17.

HDI

Brazil´s HDI (Human Development Index) is 0.730, placing the country in the 85th place on the HDI list. Even though 85th is not a good ranking position, a document called Atlas of Human Development in Brazil (UNDP, IPEA, João Pinheiro Foundation, 2013) has analysed that, since the late 90's, Brazil has showed big improvements in the HDI.

GINI and Inequality

The Gini coefficient measures income inequality in a range from zero to one, closer to one indicating bigger inequality. Brazilian Gini index is 0.54. Income inequality in Brazil is very big, placing the country among the 15 countries in the world with worst income distribution.

According to the Atlas of Human Development in Brazil (UNDP, IPEA, João Pinheiro Foundation, 2013), the Gini coefficient has raised 2% from 1990 to 2000.

Social Classes

Since 2014 Brazil has adopted a new concept for the social classes definition elaborated by professors Wagner A. Kamakura (Rice University) and José Afonso Mazzon (FEA-USP). It divides the citizens into seven different socio-economic classes listed on table 1. The concept is based on the proved income taking in consideration the type of the family and members of the family and how they use their income.

"Social class (or simply "class"), as in a class society, is a set of concepts in the social sciences and political theory centred on models of social stratification in which people are grouped into a set of hierarchical social categories the most common being the upper, middle, and lower classes."
(Grant, 2001)

What is the importance of social classes divisions in the Brazilian context?

Brazil is among the fifteen most unequal countries in the world. Its Gini coefficient shows a complex and diverse reality of most EU countries; Sweden for example, is among the 5th most egalitarian countries in the world with a Gini of 0.24 (2012). How to analyse a society where the social and economic reality of the population is so diverse?

Since the country is continental in population and size, there is the need of dividing people into groups with similar characteristics, profiles and income.

With this tool it is possible for the government to act where is needed. By knowing the different groups and their context of life it is easier to find the most efficient way to benefit them. Socioeconomic stratification is important in developing countries because societies tend to be more hierarchical, showing greater separation between social classes and class distinctions play a larger role than in more economically developed societies (Burgess & Steenkamp , 2006)

The Brazilian Socioeconomic Class Definition

SOCIO ECONOMIC CLASS	INCOME PER CAPTA	AVERAGE FAMILY INCOME
EXTREME POOR	Up to R$ 81	Up to R$ 854
POOR	Up to R$ 162	Up to R$ 1.113
VUNERABLE TO POVERTY	Up to R$ 291	Up to R$ 1.484
LOW MIDDLE CLASS	Up to R$ 441	Up to R$ 2.674
MIDDLE MIDDLE CLASS	Up to R$ 641	Up to R$ 4.681
HIGH MIDDLE CLASS	Up to R$ 1.019	Up to R$ 9.897
LOW UPPER CLASS	Up to R$ 2.480	Up to R$ 17.434
HIGH UPPER CLASS	Over R$ 2.480	--

Source: SAE and Estratificação e Consumo no Brasil (KAMAKURA, MAZZON, 2013)

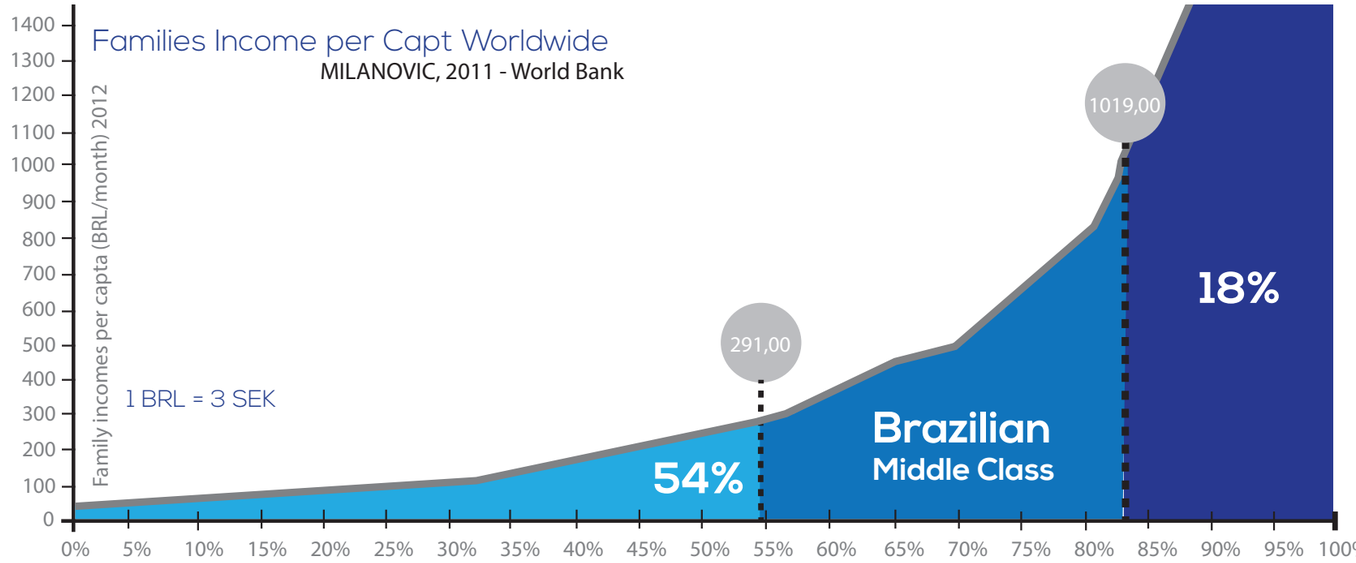
Table 1 - The social classes relevant for the S3B project are highlighted in blue

The new Brazilian **Middle Class**

The S3B prototype is meant to be affordable to the new Brazilian middle class, therefore a brief introduction about Brazil's new middle class are presented along this page.

Over the past 10 years, 35 million people entered the Brazilian middle class - which went from 38% of the population in 2002 to 53% in 2012, now totalling more than 100 million Brazilians. During this period, the country has developed and implemented a set of social programs to reduce poverty and promote inclusion.

Extreme poverty was reduced to less than half and the middle class now represents more than half of the Brazilian population.



Source: World Bank, estimations based on Milanovic, 2011 (The Have and the Have Nots) Currency Brazilian Real 2012

Were considered as belonging to the middle class all those citizens with a low probability of becoming poor in the near future. Those are households with income per capita between R$ 291,00 and R$ 1,019,00 per month.

It is recognizable the value and usefulness of limits to evaluate the historical transformations that the Brazilian income distribution has faced, but are these income limits adequate? Should Brazilian classes size be measured as established by SAE?

This reasoning leads to questioning whether the set lower limit is mistakenly too low, considering middle class people who actually belong to the lower class. Same for the upper limit, considering high class, people who should be considered members of the middle class.

The explanation, for such defined limits are presented in the picture above - income distribution across the world based on family per capita income. The light blue (54 %) shows the families in the world who live in households with a per capita income of less than R$ 291,00 per month (Brazilian criteria to define low class).

Increasing middle class limits over R$ 291,00 transforms the concept of middle class into something unreal.

International comparisons also show how appropriate is the upper limit .

Only 18 % of the world's population lives in households with per capita income above R$ 1,019,00 per month. If the limits rise, it would reduce the number of people worldwide who fall into the definition of Brazilian upper class, which would also make the county's limits questionable.

The Graphic 1 shows where the Brazilian middle class fits in the word's economy. 54% of the world earns less then the Brazilian middle class and only 18% earns more.

Faces of the Brazilian Middle Class

The S3B prototype is meant to be affordable to the new Brazilian middle class, therefore a brief introduction about who is the Brazilian new middle class are presented along this page.

Education:

More than 90% of the population has some sort of education. 59% has completed middle school education and 30% higher education.

The ones with higher education normally have income levels so high that they are under-represented in the middle class.

These results reveal a strong relation between average levels of education and the middle class.

Work:

Work and middle class are closely related. In fact, 57% of employed workers (formal and informal) are in the middle class.

In other words, more than half of the Brazilian working class today is in the middle class.

THE MIDDLE CLASS YOUNGSTER

With higher levels of education than those achieved by their parents, young people are now the real opinion formers of the Brazilian middle class. They were the ones who opened the door to technology to family, friends and neighbours. Phones, computers and internet are now part of the family reality thanks to these youngsters. They are directly involved with their families consumption habits. Even buying a new refrigerator, for example, is not done before going through the youngsters. They make virtual searches for the best terms of payment, preventing the mother from having to do this in stores. It is these young people who accompany their parents when seeking any right whether in the private sector, whether in public power. This connection between domestic interests and the market is one of the reasons that makes these young people are so valued by their family today. These emerging youngsters are heavy users of social networks and have become involved in key democratic discussions, such as e-government and education quality.

Renato Meirelles . researcher and managing director of Data Popular institute, pioneering research in the study of the emerging Brazil

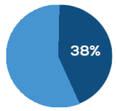
Source: SAE - Vozes da Clásse Média - Caderno Vozes da Classe Média - Marco Zero

Work

Percentage of Brazilians working legally in the middle class.

Health

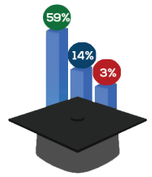
Percentage of Brazilians with private insurance.
(private often has better quality)



Consumerism and income

Percentage of the middle class on the Brazilian income and consumerism.

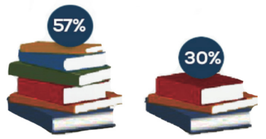
The New Brazilian Middle Class



Type of Education

Percentage of the middle class students in private institutions.
(private often has better quality)

- A and B class
- C or middle class
- D and E class



Education Level

Percentage of the middle class education. 57% high school education and 30% College education.

38% 52% 55%

Middle Class size percentage in the country's population 2002, 2012 and estimated 2022

Future environmental preservation vision:

Even though global problems are usually the result of local actions (or lack of), the concern with environmental preservation according to SAE (Brazilian Strategy secretary) , in local and global dimension. Local dimensions would be water, sewage and solid waste treatment issues. Global issues would be climate (global warming), deforestation, air pollution, biodiversity and genetically modified substances.

The lower class, main concerns regarding environmental issues are related to local solutions, while the middle class and high class, the high priority is related to global issues, with no statistically significant differences between the two classes. Therefore, it confirms that the middle class, unlike the lower class, find the time, motivation and interest in identifying global environmental solutions especially because local problems related to water, sewage and solid waste treatment are already solved.

The Brazilian **Housing Status**

The S3B prototype is for the Brazilian context, therefore a brief introduction about the Brazilian house situation presents the needs of a affordable, simple and fast construction house such as the S3B house.

Brazil is going through a period of housing deficit and, to address this problem, the government is taking steps, through the availability of funds and programs, to ensure more homes are built. According to a study released by the Institute for Applied Economic Research (IPEA) Brazilian housing deficit decreased between 2007 and 2012 due to 7 million new households in the country. The deficit has reduced from 5.59 million to 5.24 million house units. Housing shortage was reduced from 10 % to 8.53 %.

Based on data from the National Household Sample Survey (PNAD), the IPEA survey showed that the deficit of households for families with income up to three minimum wages decreased 2.4% - 3.95 million units to around 3.85 million. The variation is much smaller than observed in other segments – there was a household raise of almost 17% for those earning between three and five minimum wages and 32.5% for those earning 10 minimum wages or higher. Therefore, unlike what happened with all other income groups, the share of the poorest households in the total deficit was the only one that grew in the period, from 70.7% in 2007 to 73.6 % five years later.

The concept of housing deficit is very often related to determining appropriate housing standards, so very low living standards can be considered inadequate and, therefore, likely to be counted as housing deficit.

The housing shortage indicator, according to Negrão e Garcia (2002), would aim to capture the result between the number of families minus the number of adequate house units. Vasconcelos Jr. and Candido (1996) define adequate housing as those constructions in which only one family lives (no cohabitation), which are served by drinkable water and wastewater systems, and housing that are not improvised settlements or in a despicable state. The chart from the Brazilian Institute of Geography and Statistics IBGE "Adequate living in Brazil from 1992 to 2009" chart 2 exposes through the mentioned years the percentage of housing that have water system, sewage system or septic tank, direct or indirect garbage collection and have maximum two people per bedroom. Those items are relevant for measuring the quality of the available housing.

The indexes have raised enormously through the years, the garbage collection in the house units grew from 66% in 1992 to 88% in 2009. The sewage system also raised more than 20% and the water system over 10%.

Even though there was a significant improvement in all the aspects related to the basics of housing quality , there is still a long way to go in order to guarantee a decent living for all the Brazilian citizens.

Adequate Living in Brazil from 1992 to 2009

Brazilian Institute of Geography and Statistics (IBGE)

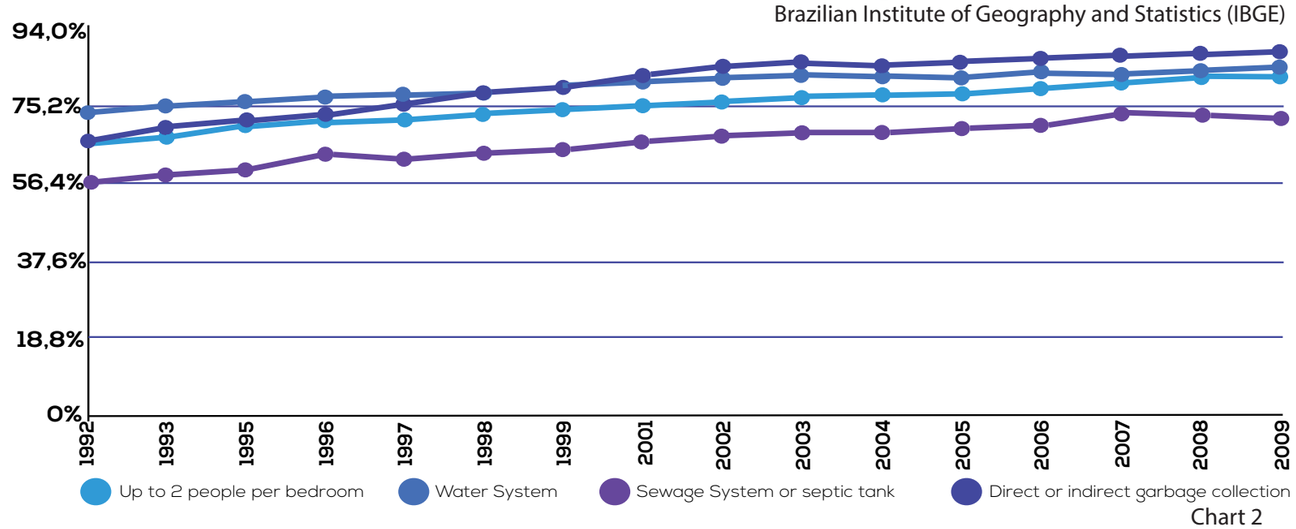
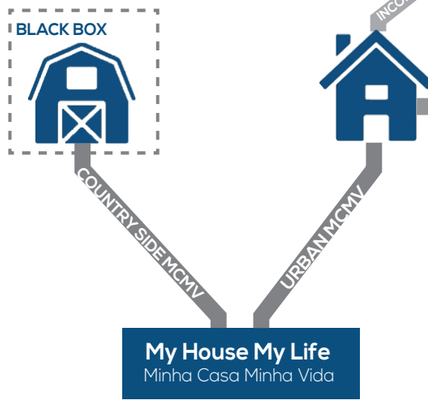


Chart 2

Programme Minha Casa Minha Vida
My House my Life

A introduction about the Program Minha Casa Minha Vida is presented since the budget for the project is based on MCMV loan. The idea of setting some sort of budget boundary makes possible to apply the S3B in a social housing context.

Typical MCMV house



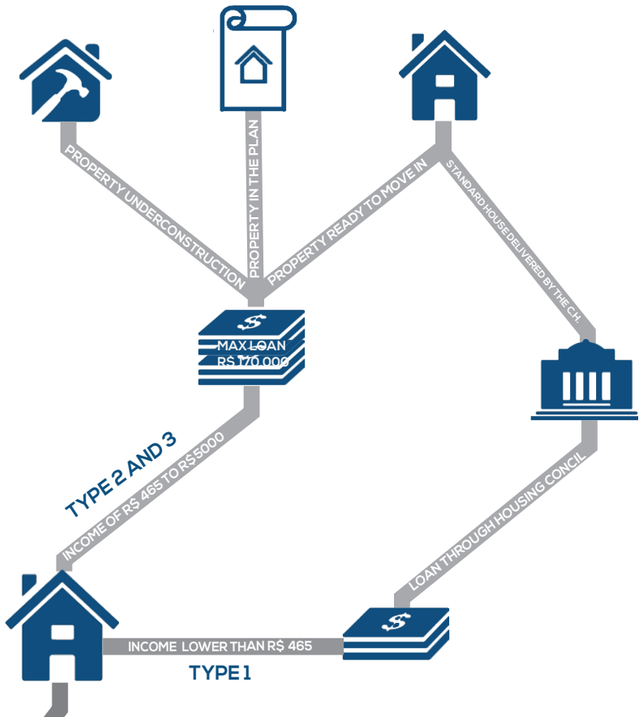


Diagram 1: There are country and urban MCMV, on the urban there are programs for families with very low monthly income (type 1) and for higher income (types 2 and 3). Loan values depend on the country area. The exposed is the Loan for Belo Horizonte MG

The *Minha Casa Minha Vida* (MCMV) (My House, My Life) is a federal government housing programme, dedicated to build housing units with priority to low-income families and aims to reduce the housing deficit. In general, the program takes place in partnership with states, municipalities, businesses and non-profit organisations. The funds for financing is provided by the state owned Caixa Econômica Federal Bank. The program, available for families with the income up to R$ 5,000.00, offers paying facilities such as discounts and reduction in the value of mortgage insurance.

The program is now in its second phase with the goal to build two million housing units, of which 60% geared to low-income families. In 2010, after a year of activity, the MCMV reached the initial goal of one million units.

The MCMV programme differs from state to state. In Minas Gerais state, for example, the maximum budget for the capital, Belo Horizonte, and metro area is R$ 170.000 for the MCMV Type 3 - families with income up to R$ 5.000,00. The program has a urban and a country version. In urban areas, is divided by 3 monthly income ranges: Up to R$ 1,600 (type 1), up to R$ 3100 (2) to R$ 5000 (3). In rural areas, income groups are annual:

Up to R$ 15 thousand (1) to R$ 30,000 (2) to R$ 60,000 (3). Besides the construction of housing units itself (My House, My Life), are also parts of the program the Brazilian System of Savings and Loans (Savings Accounts) and urbanization of slum areas.

Type 1:

For the citizens that do not own a property, have no income or the family's income is up to R$ 1,600.00, the MCMV program is made available through the cities' housing council.

The process of selection and appointment of the families is made by the Municipality where the property is being built after enrolment of the interested citizens. The families selected by the Municipality, after approval of by the Brazilian funding bank (Caixa Economica Federal), are invited to participate on the drawing of the units. The Program has quotas destined for elderly, or handicapped citizens.

Type 2 and 3:

Families with a monthly income up to R$ 3100,00 (Type 2) and R$ 5,000.00 (Type 3), have several options to choose for the housing financing that best suit their needs. They have up to 30 years to pay back the loan.

There are three types of financing:

- Houses / apartments already built
- Houses / apartments yet to be built
- Houses / apartments under construction

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The Project **Concept**

is a housing unit prototype with four main goals: low cost, beautiful, good quality and sustainable. Customizing, styling, energy savings and other sustainable features are part of this "tailor made" housing pack to create a personal concept of inexpensive, beautiful, good and sustainable.

Development of **the S3B term**

“While climate change mitigation may be the main driver for demands from the European Union, national governments and even clients for radically higher standards of building performance, green design offers several other advantages. The continuing financial savings which energy-efficient design will achieve can be of real importance in daily life. Well-insulated and efficiently ventilated buildings will provide more comfortable and more productive environments. The other reason for architects to promote green design is that of architectural quality.

Buildings with more natural and fewer artificial inputs are very often better. Day lit buildings are, in general, more enjoyable than artificially lit ones; natural ventilation, if clean air is available from a quiet external environment, is more acceptable than mechanical; the fewer heat emitters, the better; and so on. Mies van der Rohe said that ‘Less is more’; these days, a better way of putting it maybe, as Alexandros Tombazis says: ‘Less is beautiful’. Classic design elegance is found in the complete, simple solution”. (BROPHY AND LEWIS, 2011)

S3B is a sustainable housing unit prototype designed for the Brazilian middle class context. The main aspects of the house consist in being affordable, good quality and beautiful. Since the Brazilian society has been undergoing house shortage, developing a sustainable and affordable housing unit, seems to meet the Brazilian needs. A high quality and affordable housing project would help to partially reduce the possibility of housing shortage in the future, that can also be attributed to the extremely poor construction quality.

Following some of the requirements of the Brazilian housing program “Minha Casa Minha Vida” (My House my Life) directed to people with lower income or the “new middle class”, the S3B houses come as a extra option for families seeking for a more flexible, solid quality, creative and sustainable living. With a limited budget, under the MCMV type 3 category - the basic model - a family can purchase a S3B house.

B OA
GOOD

\+

B ARATA
LOW COST

B ONITA
BEAUTIFUL

3B

× S USTENTÁVEL
SUSTAINABLE

S(3B)

The S3B housing project is named after an old Brazilian saying used to define something that is BOA (good), BONITA (beautiful) and BARATA (low-cost). That is normally what a consumer hopes to find while shopping for anything.

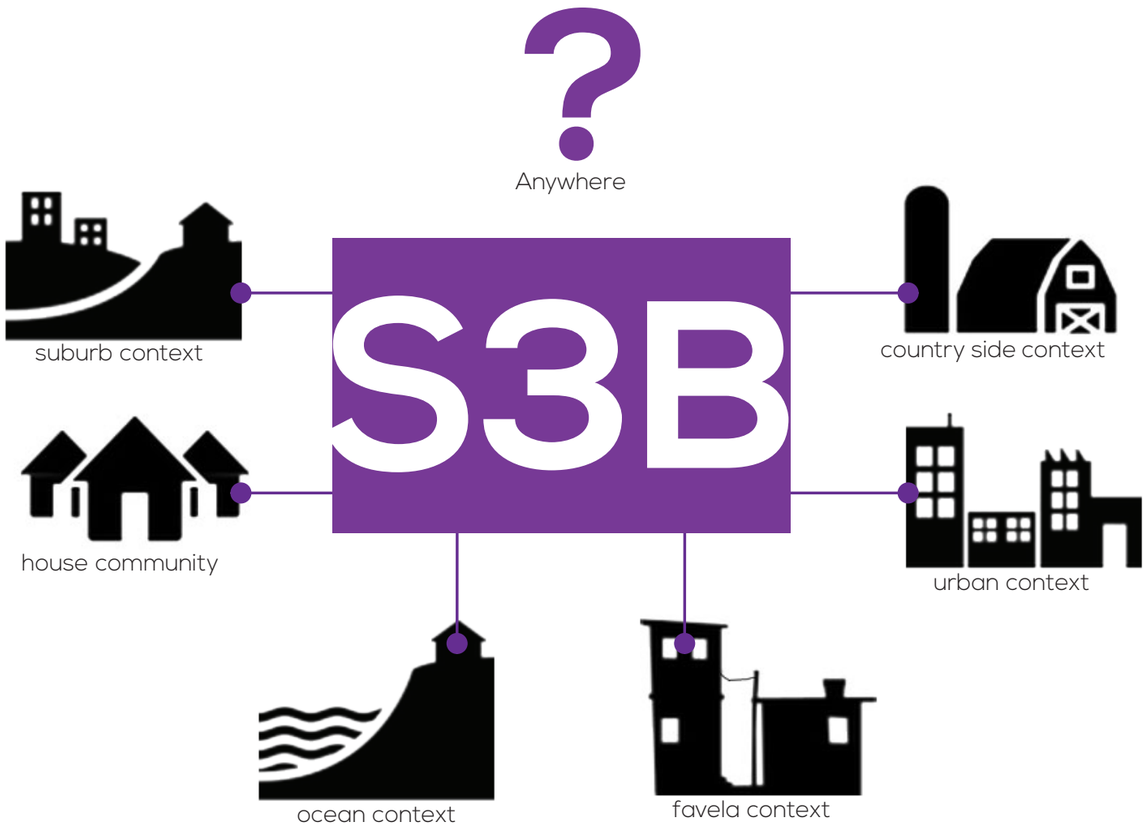
When looking to buy a house, it should not be any different, but nowadays the “S”, which stands for “sustainable,” is as important as the 3B . So, why not add the “S” to the 3B? Putting them all together, it becomes the S3B house.

Where is the **S3B going** to be placed?

S3B is a prototype and technically it can be built anywhere or used by any Brazilian housing programme.

However, the housing unit budget will be based on the "Minha Casa Minha Vida" programme. Since the loan offered by MCMV varies depending on the region, this project is based for the city of Belo Horizonte and metro area as an example. But of course the idea is to have the prototype usable in any other Brazilian region, especially the southeast.

S3B houses should be flexible enough to be built and placed in different urban contexts. They can be built as separate units or in the context of a village.
The idea is to make S3B houses fit wherever the home owners desires but minding some preset aspects such as size, inclination of the lot and optimal position, considering the lightning aspects to install the solar panels and plant the kitchen garden.



Who is the S3B
User and Stakeholder

The S3B home owner is someone that looks for a new life perspective, a better living quality, freedom of choice, home expenses savings and lower environmental impact. The S3B home owner is dynamic and seeks for an original, practical, suitable and unconventional type of house. S3B houses are going to be directed to families who fit "Minha Casa Minha Vida" profile types 2 and 3. The reason for excluding profile type 1 is the budget limitation and because the houses are built by the federal government and not by the home owner. Therefore, the home owner has no freedom of choice.

The S3B home is financially suitable for families earning up to R$ 5000. The home owner is able to take a loan in Caixa Econômica Federal for up to R$ 170.000 (Belo Horizonte and region, according to MCMV terms and conditions), to be paid in 30 years maximum .
The payment conditions are relatively easier when compared to other loan conditions: interest rate of 7,16% per year.
The S3B house is not only going to be available for the MCMV program, but also for other home owners who do not wish to take the MCMV loan.

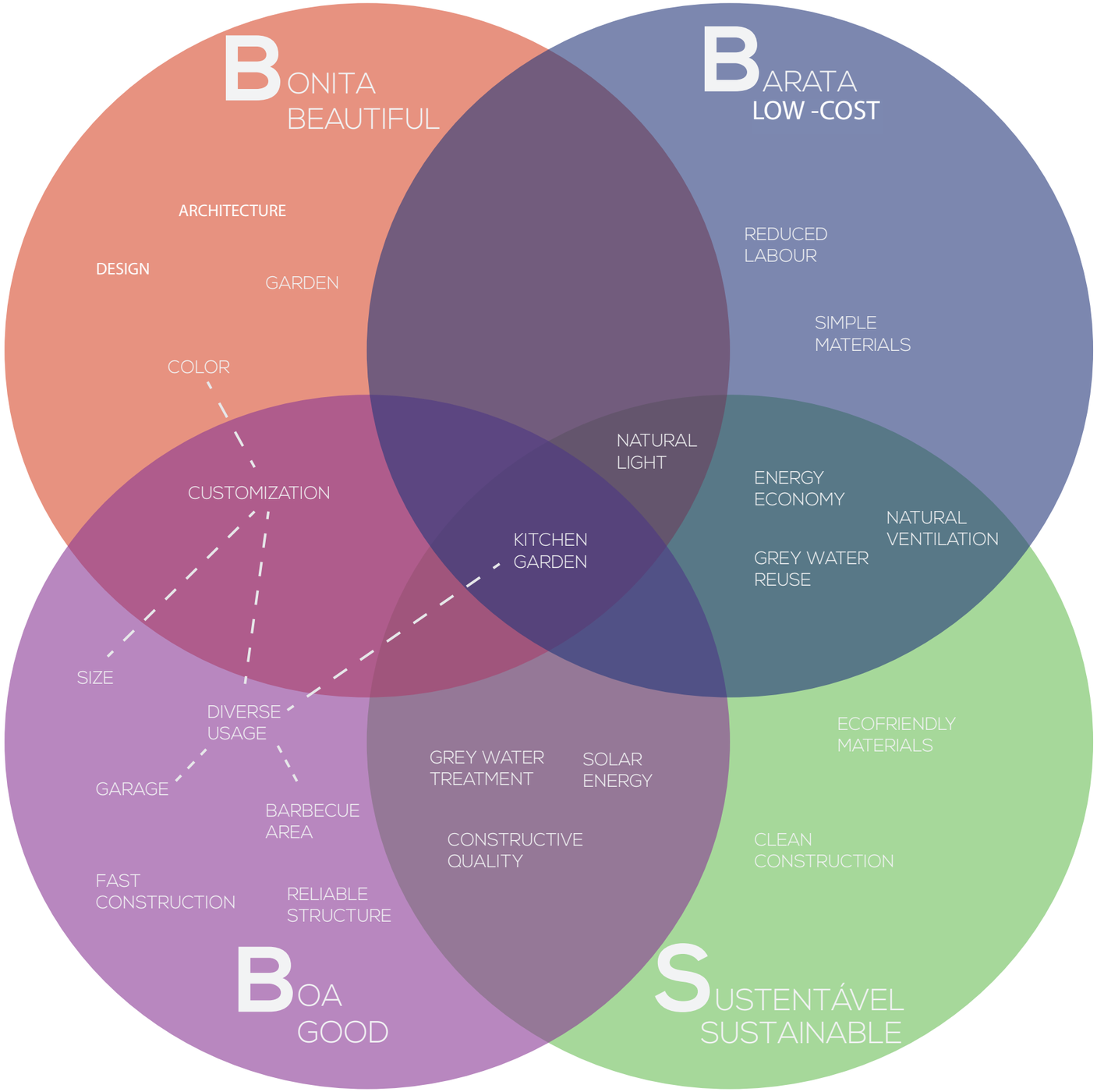
The stakeholder for the S3B house is mainly the home owner. Therefore, the S3B house concept can also be offered to home owners from the emerging Brazilian middle class in or out of the MCMV program.
If the home owner uses the federal government programme, for example, the construction company profit (circa 27%) is added to the final price (R$ 170.000) and is paid by the government. .
The S3B houses could also be suitable for military villas and industrial villas. In those cases, the stakeholders are no longer the final user.

Defining the **S and 3Bs** (the S3B context)

Defining that a house should be sustainable beautiful, low-cost and good quality is a tricky business.

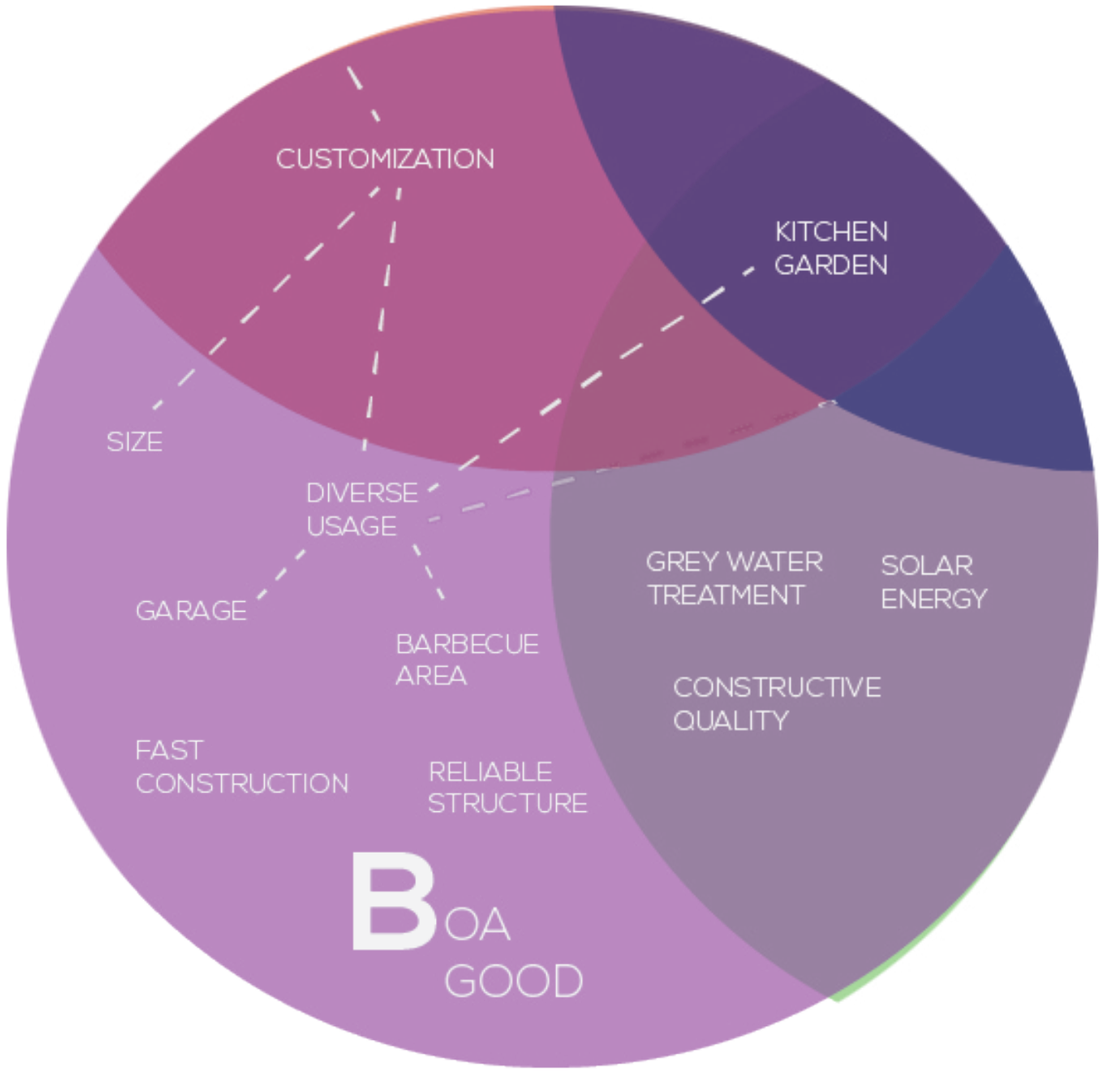
What each individual considers beautiful, low-cost, good quality and sustainable can differ from one person to the other, as well as the context, situation and many other aspects.

For the S3B project is important to define which boundaries are being taken in consideration. The main boundaries are the Brazilian context, more specifically south-eastern Brazil. The basic model of the house is focused on a specific share of the population with a monthly family income between R$ 2.674 to R$ 4.681.
In the diagram, the aspects considered were based on architectural knowledge, field knowledge and common sense knowledge to provide boundaries to the S3B concept.



What is good for S3B?

The perception of "good" can offer many different perspectives.
For the S3B project Boa is interpreted as freedom of choice along with high quality construction. People are different, families are different and houses should be made for the ones who will live in it.
Bigger families require bigger houses; therefore, an expandable house that can offer a variety of uses according to their owners' preferences. Highlighted in the diagram are some examples, such as a garage, a barbecue area and kitchen garden. The S3B project can include more rooms.



High quality construction is fundamental for the S3B project to lower the housing deficit. A big reason for the deficit is due to the low quality housing that can no longer be inhabited or even be considered as a house. They were poor quality constructions that ended up became a totally or partially destroyed over the years. That is why quality construction is so important in the "Boa" diagram, along with a reliable structure. The time factor is also important and a better quality construction does not mean that it should take much longer to finish it. The work can be done "fast" but in the proper way.

A frequent bogus excuse used to justify poor quality constructions is that there was not enough time available.

The S3B project challenge will show a fast high quality construction system.
According to MCMV technical specifications, the houses should have at least 50 years of perfect quality buildings.

good

satisfactory in quality, quantity, or degree: a good teacher; good health. of high quality; excellent. right; proper; fit:

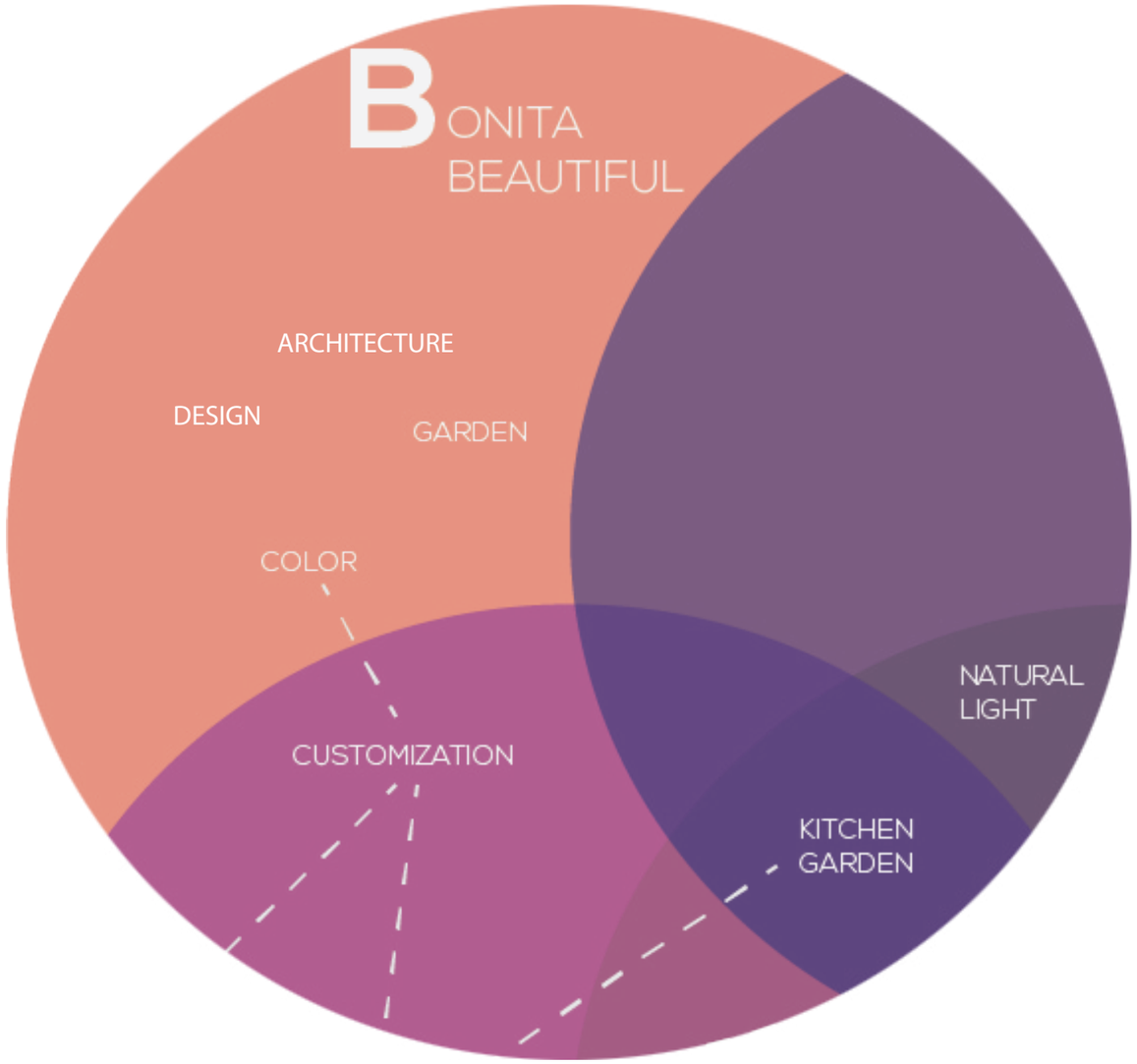
Dictionary.com

What is beautiful for S3B?

The B for beautiful can provide many definitions, depending on what people like, appreciate or consider. It is extremely connected to the "feel good" when people find their definition of beautiful. It is a comfortable feeling, a mix of happiness, pride, confidence and high self-esteem. Brazilians are a mix of everything! People like to have things their own way. It is part of the culture: many religions, many ethnicities, many accents, many races and people from all over the world. An example of this mixture, can be seen in the colourful facade in Brazil.

The main goal of the S3B project is to give people the chance to customize some parts of their house. The colour, type of garden, maybe even the shape could be considered.

Along with the beautiful aspect, with some architectural designs that include items such as natural lightning, to the brighten the rooms, and decorative plants and gardens to bring some nature and green to the house.



beau·ti·ful

having beauty; possessing qualities that give great pleasure or satisfaction to see, hear, think about, etc.; delighting the senses or mind:

Dictionary.com

What is low-cost for S3B?

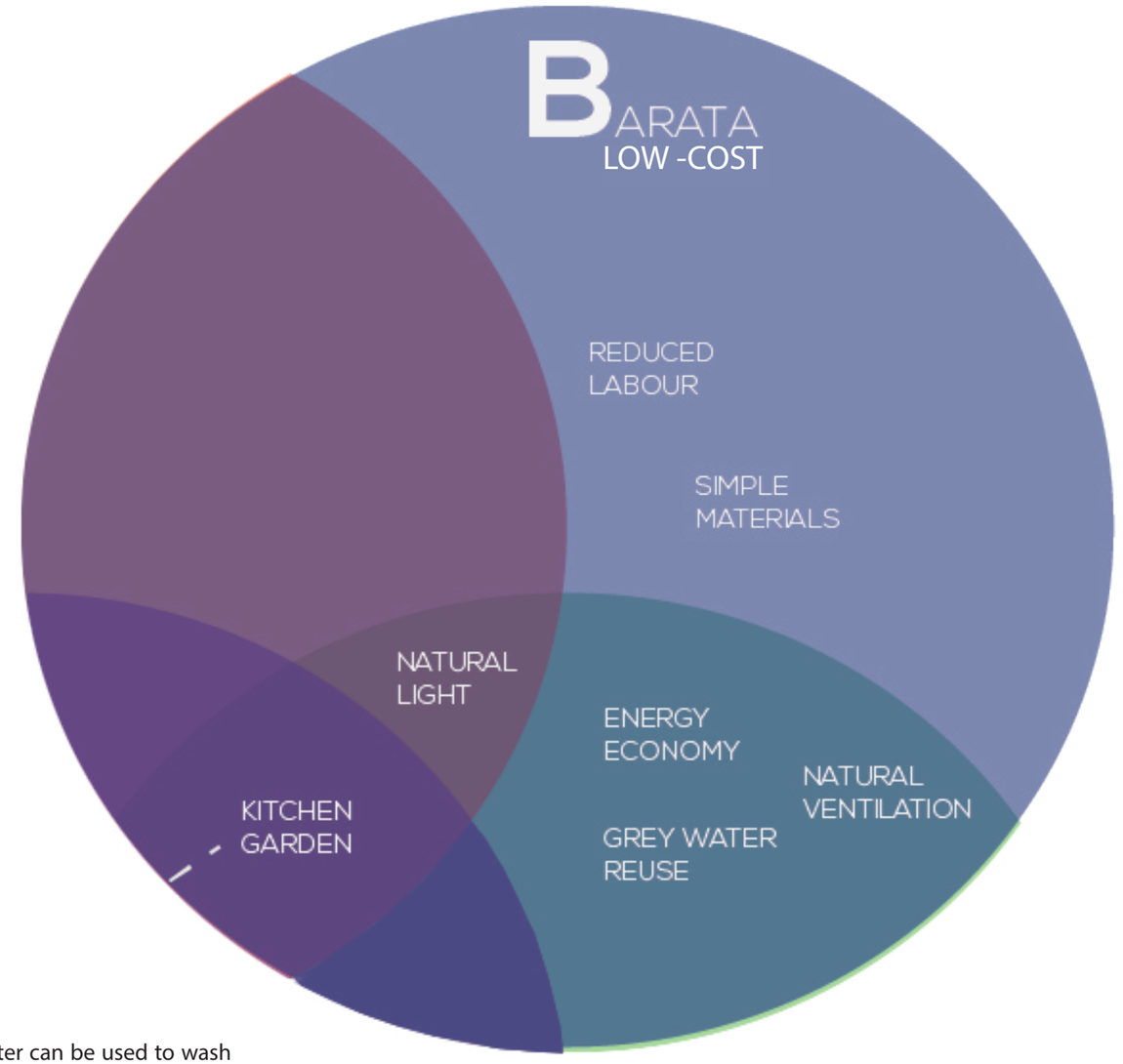
In Brazil, it is a very big deal to be able to save on the house expenses.
Even if the savings are little, during some periods of the year, power companies like CEMIG (power provider company of Minas Gerais) offer bonus and reductions in the bills when users lower their consumption for several months. This is a way to motivate the user to save energy. It is common for people to change their habits to achieve that. Even if they get very small savings in the end of the month, for some families, it makes a big difference when considering their annual savings.

On the aspects of barata (low-cost), the S3B project would provide a house where people could save on energy, water bills, and even on the weekly grocery shopping.

Most aspects pointed out in the diagram are connected to natural ways of savings, such as natural ventilation, as an option for A/C systems, natural light, to reduce the need of artificial light during the day, and grey water reuse to help saving on water bills.

The treated grey water can be used to wash the exterior areas, as well as watering plants and gardens. The kitchen garden and chicken house can help reduce costs with groceries.

On the construction aspect, simple materials and reduced labour would drop the construction price.

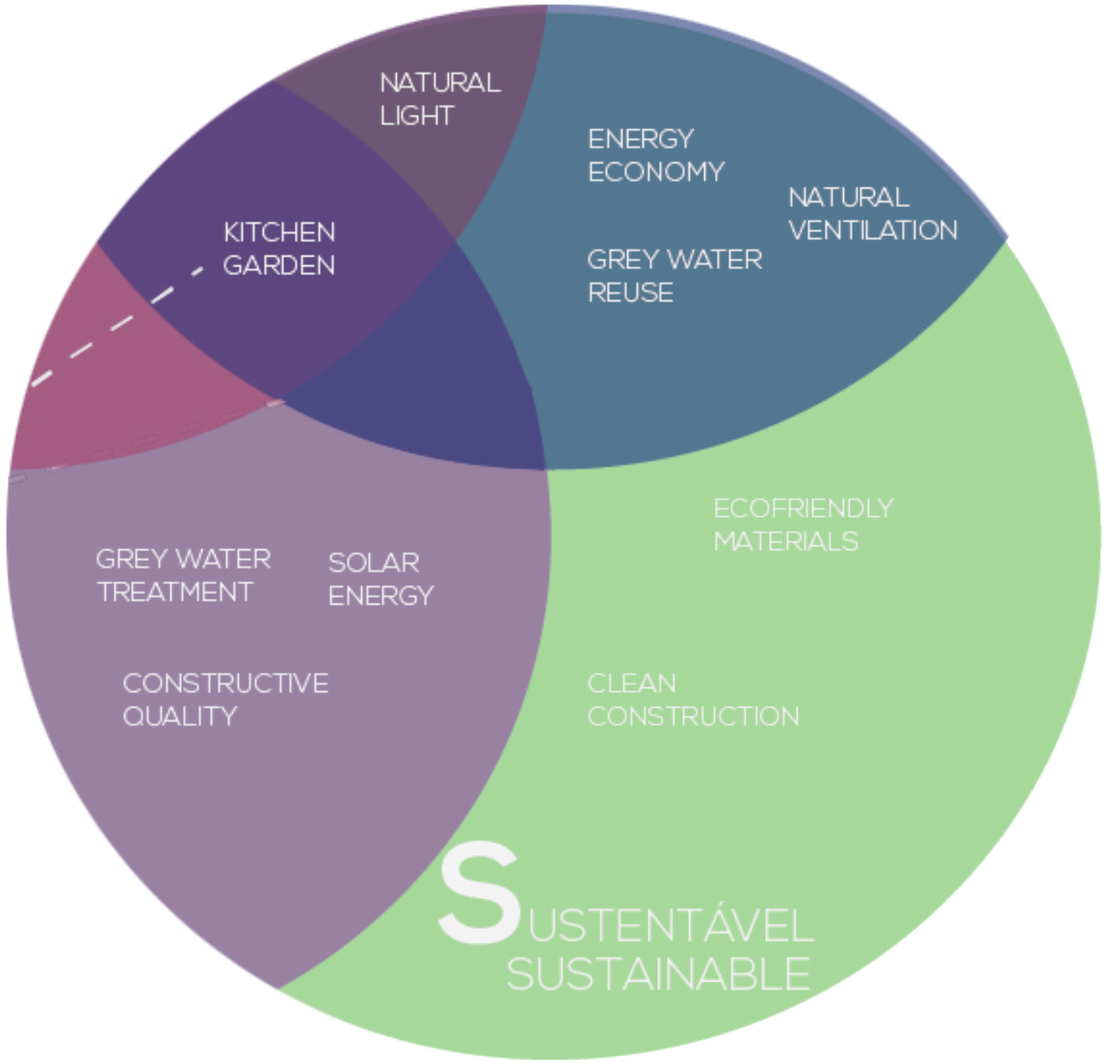


low-cost

costing very little; relatively low in price; inexpensive: a low-cost dress.
costing little labor or trouble:
charging low prices:

Dictionary.com

How Sustainable
Relates to the S3B



The sustainability of the house is defined in the form of sustainable systems. The systems benefit the users both financially and in terms of life quality. Sustainable systems also benefit the environment around the construction.
The S3B systems will benefit the three aspects together. The grey water treatment and reuse, solar energy, and kitchen garden are items that, even though requires some upfront investment, they pay themselves off in the short term and will eventually provide the user savings benefits in their bills while adhering to a sustainable living.

Another example is the quality construction item. At first, better quality materials cost more, but in the long run they last longer, reducing the need of intense repair and remodelling.

To balance and reduce construction costs, natural lightning and natural ventilation projects are fundamental for end user savings and do not need any extra investment. Clean construction and eco-friendly materials are items that affect positively the environment directly.

Less construction waste and materials made by companies with green building practices reducing the environmental impacts will be key elements to achieve the S In S3B.

sus·tain·a·ble

Pertaining to a system that maintains its own viability by using techniques that allow for continual reuse: able to be maintained or kept going, as an action or process:

Dictionary.com

S3

The Project
Design

is a sustainable affordable housing unit prototype, developed for the southern hemisphere more specifically for the south eastern part of Brazil.

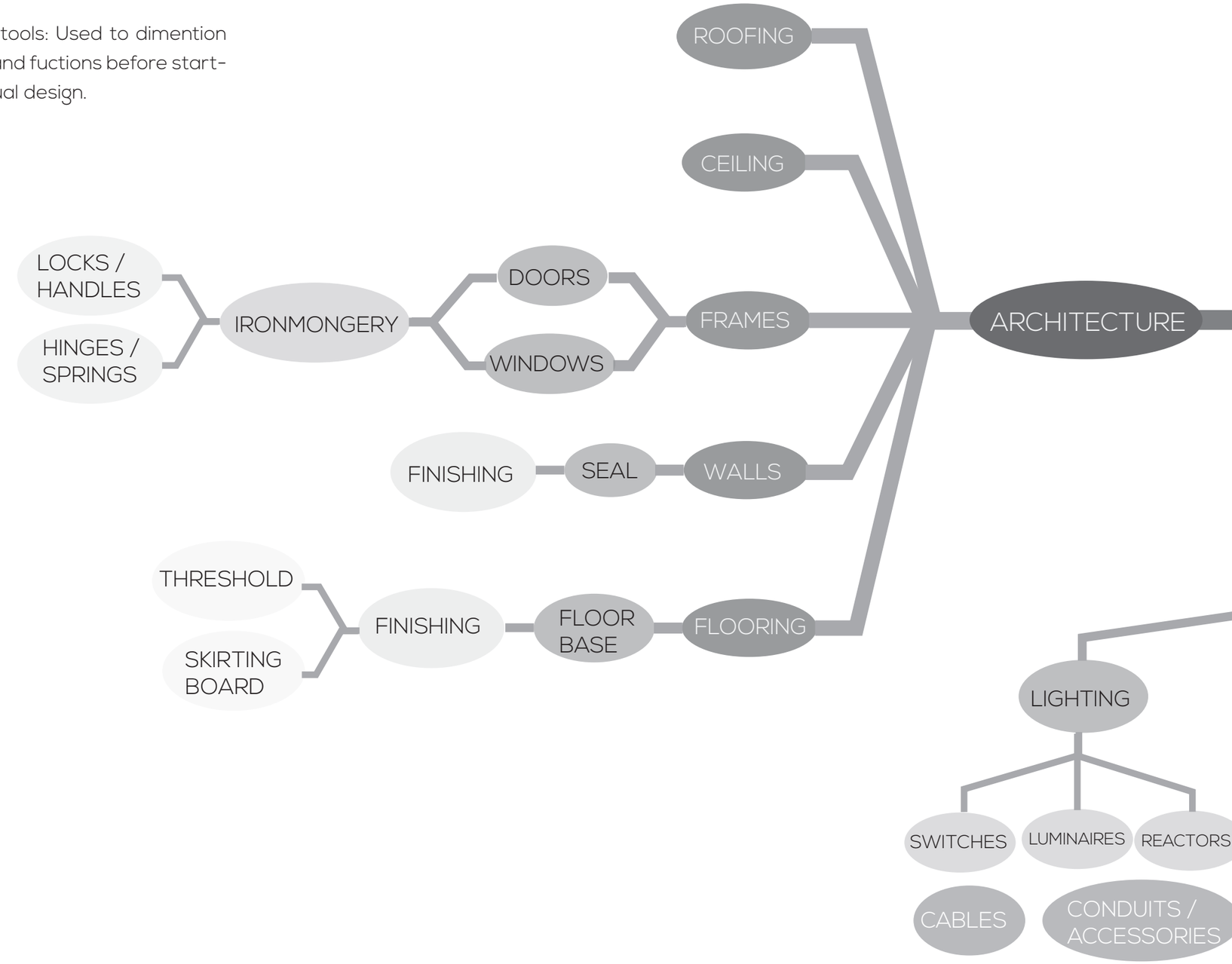
S3B Design Diagram

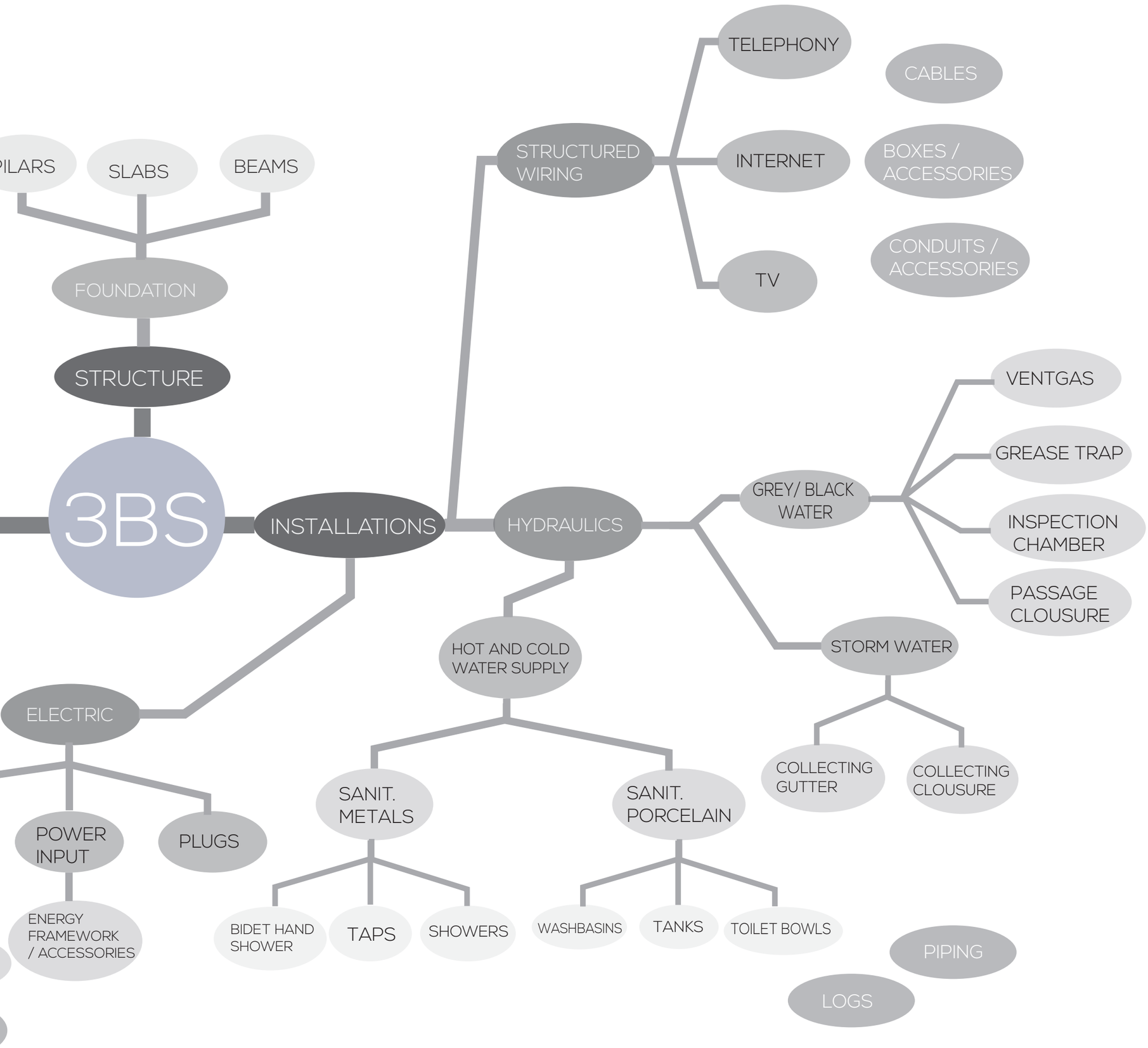
Pre design tools: Used to dimention the shape and fuctions before starting the actual design.

The S3B physical diagram exposes all the items that will be taken in consideration along the project and it is also used as a guideline for the design of the main headlines like architecture, structure and installations.

The diagram is colour coded and it shows the items with the same hierarchy in the same colours, in a sub item system.

The lines connect the items and the ones without connection relate to a bigger item.




PILARS
SLABS
BEAMS
FOUNDATION
STRUCTURE
3BS
INSTALLATIONS
ELECTRIC
POWER INPUT
PLUGS
ENERGY FRAMEWORK / ACCESSORIES
STRUCTURED WIRING
TELEPHONY
INTERNET
TV
CABLES
BOXES / ACCESSORIES
CONDUITS / ACCESSORIES
HYDRAULICS
HOT AND COLD WATER SUPPLY
SANIT. METALS
BIDET HAND SHOWER
TAPS
SHOWERS
SANIT. PORCELAIN
WASHBASINS
TANKS
TOILET BOWLS
GREY/ BLACK WATER
VENTGAS
GREASE TRAP
INSPECTION CHAMBER
PASSAGE CLOUSURE
STORM WATER
COLLECTING GUTTER
COLLECTING CLOUSURE
PIPING
LOGS

Design Assumptions

Pre design tools: This design assumptions extracted from Minha Casa Minha Vida Programme were taken in consideration for the design and develop of the S3B house projects.

The following project assumptions are the minimum requirements for the MCMV houses.

House with living room / main bedroom and 1 bedroom for two persons / kitchen / service area (outdoor) / circulation / bathroom.

Room Dimensions: this specification does not establish minimum comfortable area, leaving architects the competence to design the house area, minding the required furniture, and to comply with state or local laws that deal with minimum room dimensions.

Main Bedroom

Minimum amount of furniture: one bed (1.40m x 1.90m), one night stand (0.50m x 0.50m) and one wardrobe (1.60 m x 0.50 m). Minimum circulation between furniture and /or walls, 0.50m.

Bedroom for Two

Minimum amount of furniture: 2 beds (0.80 m x 1.90 m), one night stand (0.50m x 0.50 m) and one wardrobe (1.50m x 0.50m). Minimum circulation between the beds, 0.80m. Other circulations minimum, 0.50m.

Kitchen

Minimum width of the kitchen: 1.80m. Minimum items: sink (1.20m x 0.50m); cooker (0.55 m x 0.60 m) and refrigerator (0.70m x 0.70m). Forecast cupboard under the sink and cabinet.

Living / dining

Minimum width lounge / dining: 2.40m. Minimum amount of furniture: sofas with number of seats equal to the number of beds, table for 4 people and bookcase / TV / wardrobe.

Bathroom

Minimum width of bathrooms: 1.50m. Minimum items: one washbasin without column, one toilet, one shower - (0.90m x 0.95m) with possible installation of grab bars and articulated seat. Maximum unevenness 15 mm.

Service Area

Minimum items: one tank (0.52m x 0.53m) and one wash machine (0.60m x 0.65m).

Examples of Minha Casa Minha Vida Houses

MCMV house

MCMV house

GENERAL FEATURES

Area (internal area without counting areas of walls) minimum , 36.00m2
Minimum high 2.30m in the bathrooms and 2.50m in the remaining rooms.

Roofing:

Tiles concrete or ceramic with ceiling (minimum thickness of 6 mm) slab on metallic or wooden structure and with minimum eaves, 0.50m.

Internal coating

Plaster, gypsum (except bathrooms, kitchens and service areas) or concrete settled for painting.

External coating

Plaster or concrete settled for painting.

Coating Wet Areas

Tiles with a minimum height of 1.50m at all bathroom walls, kitchen and service area. In areas outside of the building, titles should cover minimum 120m, height of the tank and washing machine.

Doors and Hardware

The internal doors should be made of wood. It is allowed metallic door to access the unit. 0.80m x 2.10m to all doors. Predicting the approach area to open the doors of social access and service door handles from 0.90m to 1.10m from the floor.

Floors

Ceramic title with absorption index of less than 10%, and for wet areas, dynamic friction coefficient exceeding 0.4, with plinth and unevenness maximum of 15 mm is required.

Windows

Made of aluminium for coastal regions (or aggressive environment) and steel in other regions. Minimum openings of 1.50m2 for the bedrooms and 2.00 m2 in the living room are required, accepting a variation of up to 5%. The windows must meet the Performance Standard NBR 15575 law (tightness and acoustic insulation, for example).

Expansion of the house

Projects must provide plan for expansion to the houses.

MCMV house

MCMV house dining, living room and kitchen

MCMV house bethroom

PAINTINGS

Internal walls:
PVA paint

Wet areas walls:
Acrylic paint.

External walls
Waterproof acrylic paint or texture.

Ceilings
PVA paint.

Sanitary metals and porcelain
Sink without column with minimum size 30cm x 40cm and chromed metals.

Toilet
Two-piece toilet

Tank
Minimum capacity of 20 litres, made of pre-cast concrete, PVC, or synthetic marble granite with chromed faucet

Kitchen sink
Workbench 1.20m x 0.50m with granite or synthetic marble sink and chromed faucet.

Electrical Installations / Telephone
Minimum number of electrical outlets points Two in the living room, four in kitchen, one service area, two in each bedroom, one outlet in the bathroom and one outlet for electric shower (even in the case of solar heating).

Number of different outlets:
One telephone outlet, one antenna outlet (dry pipe)

Lightning Outlets
Provide nozzle installation for all lightning fixtures and outlets in the house for the common areas use.

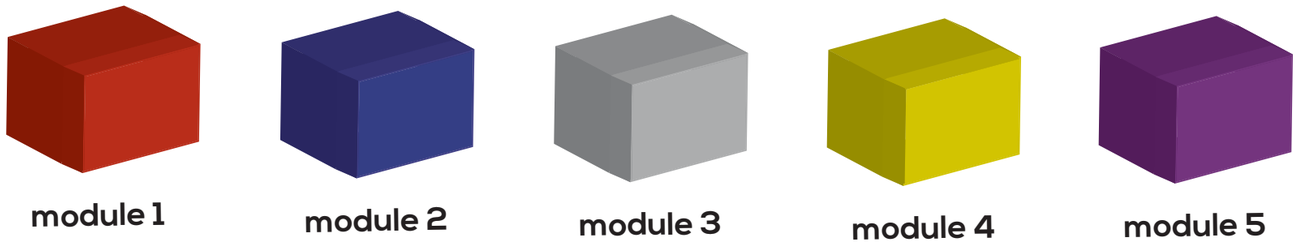
Number of circuits
Provide independent circuits for lighting outlets, sockets, general purpose outlets for specific use for kitchen and shower, scaled to the usual power of the local market.

General
Install jacks 0.40m from the finished floor, switches, intercoms, buzzer and others 1.00m from the finished floor.

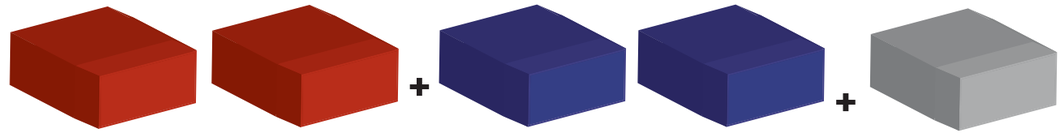
Reservoir
Water tank with capacity for 500 litres or larger when required by local supplier.

Shape
Process

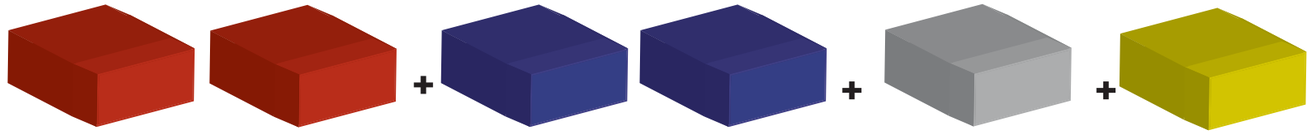
S3B is a modular house. Working with modules make the construction cheaper, easier to build and expandable. The shape of the house is made by the combination of different modules each of them measuring 3,60 x 3,60. The dimensions were defined by the material used for the walls described on this MT. Combining the modules together, 3 house typologies are created: S3B S, S3B M and S3B L. On the S and M typologies, the structure for expansion remains ready in case need or desire.



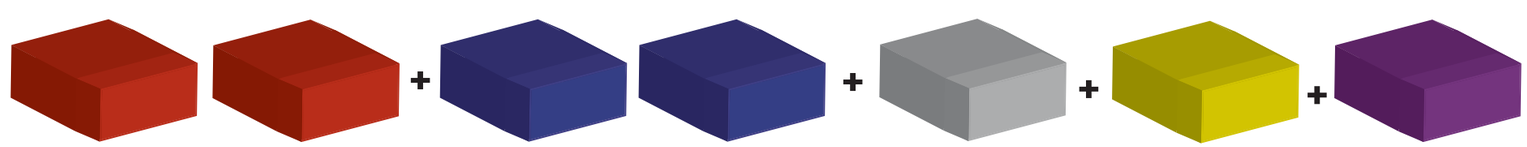
S3B S =
SMALL

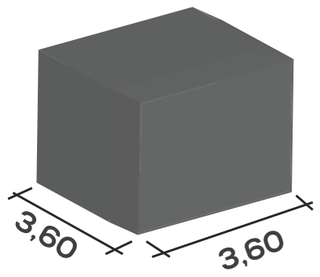


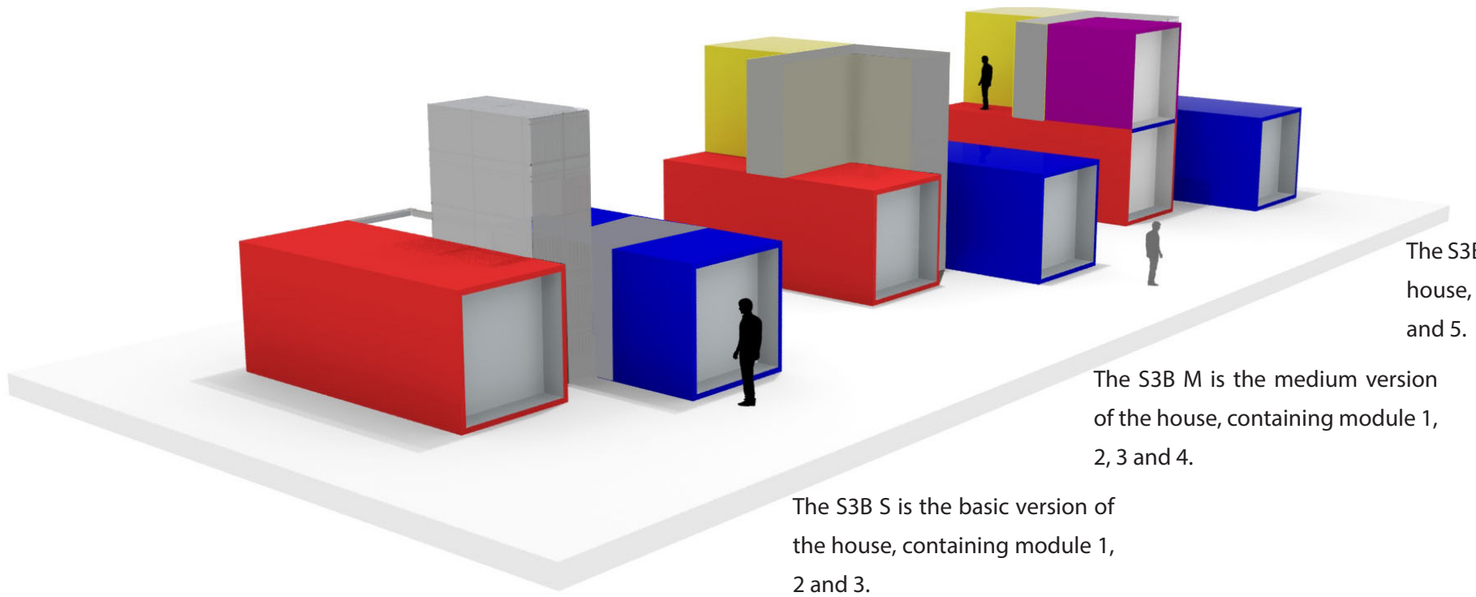
S3B M =
MEDIUM



S3B L =
LARGE







The S3B L is the bigger version of the house, containing module 1, 2, 3, 4 and 5.

The S3B M is the medium version of the house, containing module 1, 2, 3 and 4.

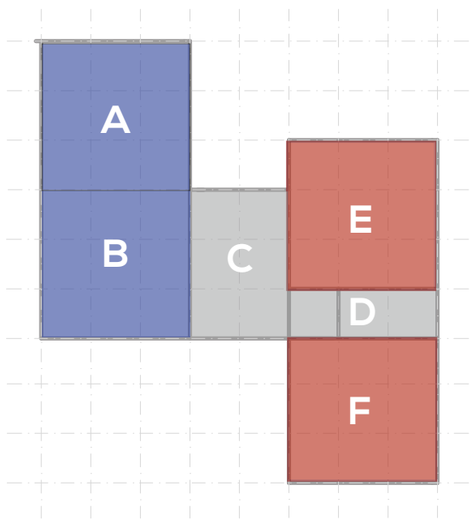
The S3B S is the basic version of the house, containing module 1, 2 and 3.

Plans
Development

Grid 120 x 120

Since the material chosen for the walls was the EPS panel, there is a pre-set size 120 x 250/275/300 cm.
The plan started from the grid of 120 x 120 cm. Then 360 x 360 cm modules were defined to the major spaces.
All the rooms from A to H are made with the same size module. The only difference are C and D, even looking diverse from the other blocks, are still the 360 x 360 cm modules but sectioned and 1/3 of it rotated.

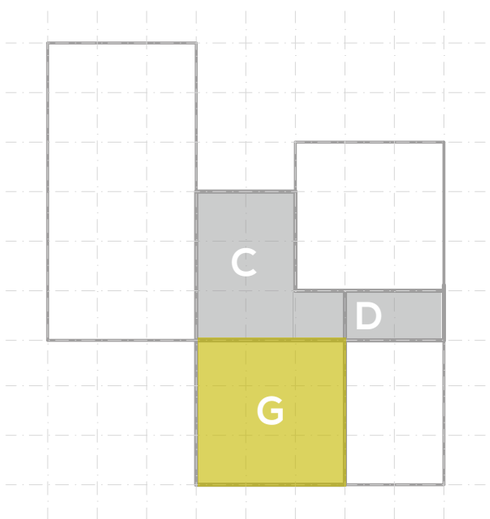
1° Plan - S3B S - S3B M - S3B L



The first floor plan is the same for all types of S3B houses, and it has the living area on the left, entrance, hall and staircase in the middle and bathroom and two bedrooms.

A - Kitchen, Laundry and dining area
B - Living room
C - Staircase
D - Bathroom
E - Bedroom 1
F - Bedroom 2

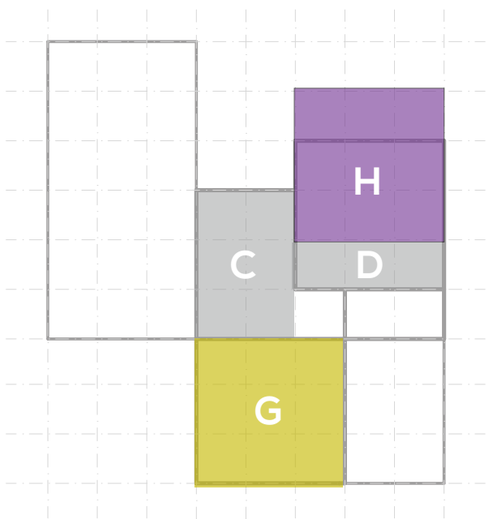
2° Plan - S3B M



This second floor plan is only for the S3B M, and it has a second bathroom and a third bedroom. This bedroom has a balcony.

C - Staircase
D - Bathroom
G - Bedroom 3

2° Plan - S3B L



This second floor plan is only for the S3B L, and it has also a second bathroom and a thrid bedroom with a balcony. The difference from the S3B M is that there is a forth room.

C - Staircase
D - Bathroom
G - Bedroom 3
H - Bedroom 4

Plans
S3B S

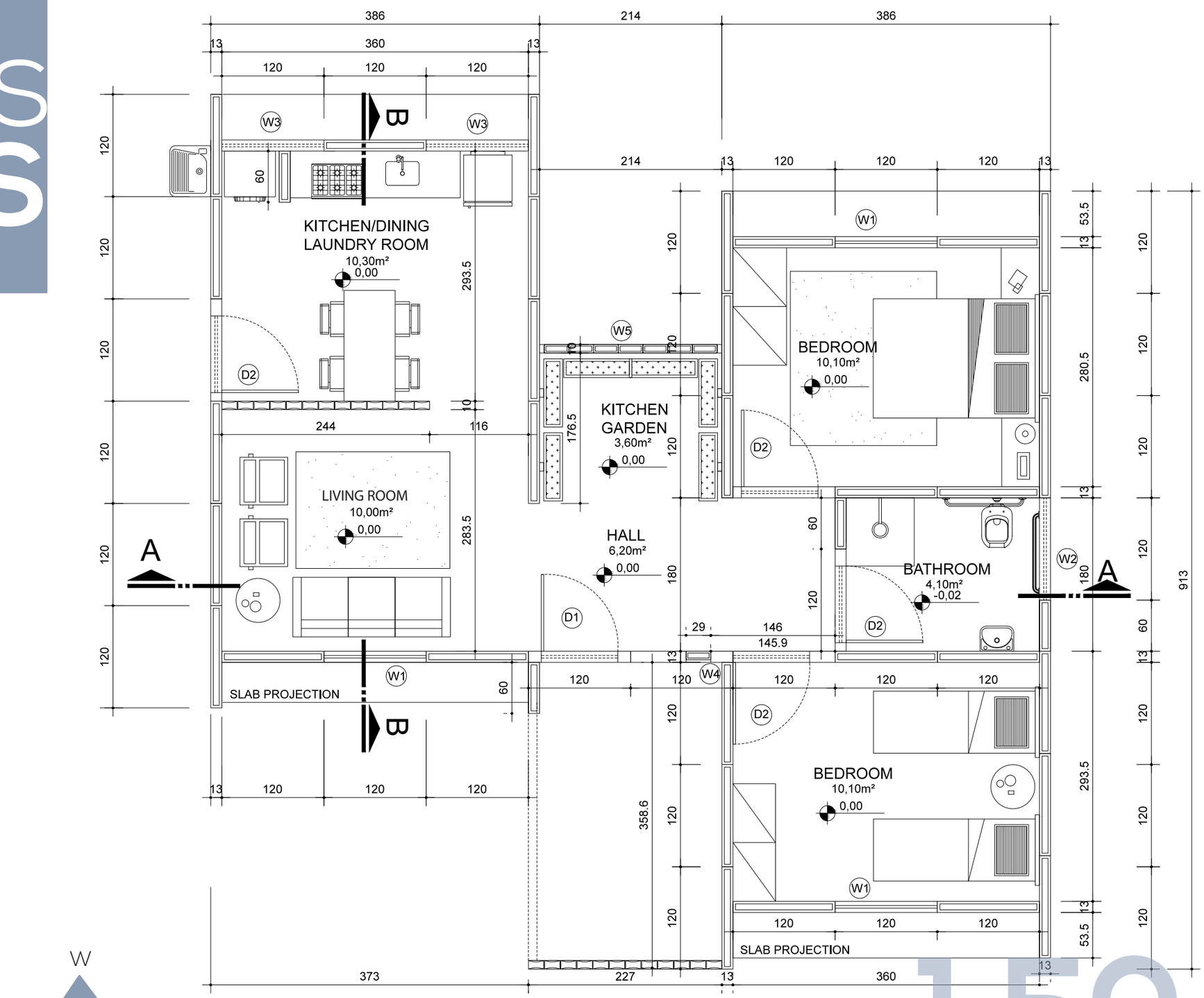
Ground Floor S3B Plan
Area: 54sqm

S3B S is 100% accesible for disabled people.

Frames Listing

- D1 — 90x210cm wooden vent door + 60cm wooden and glass top
- D2 — 90x210cm wooden vent door + 60cm wooden vent top
- W1 — 120x150cm wooden window + 40cm wooden vent bottom
- W2 — 120x60cm wooden window + 40cm wooden vent bottom
- W3 — 120x60cm wooden window + 40cm wooden vent top
- W4 — 29x261cm concrete vent frame
- W5 — 203x261cm concrete vent frame

D = Door W= Windows



W
S N
E

1:50

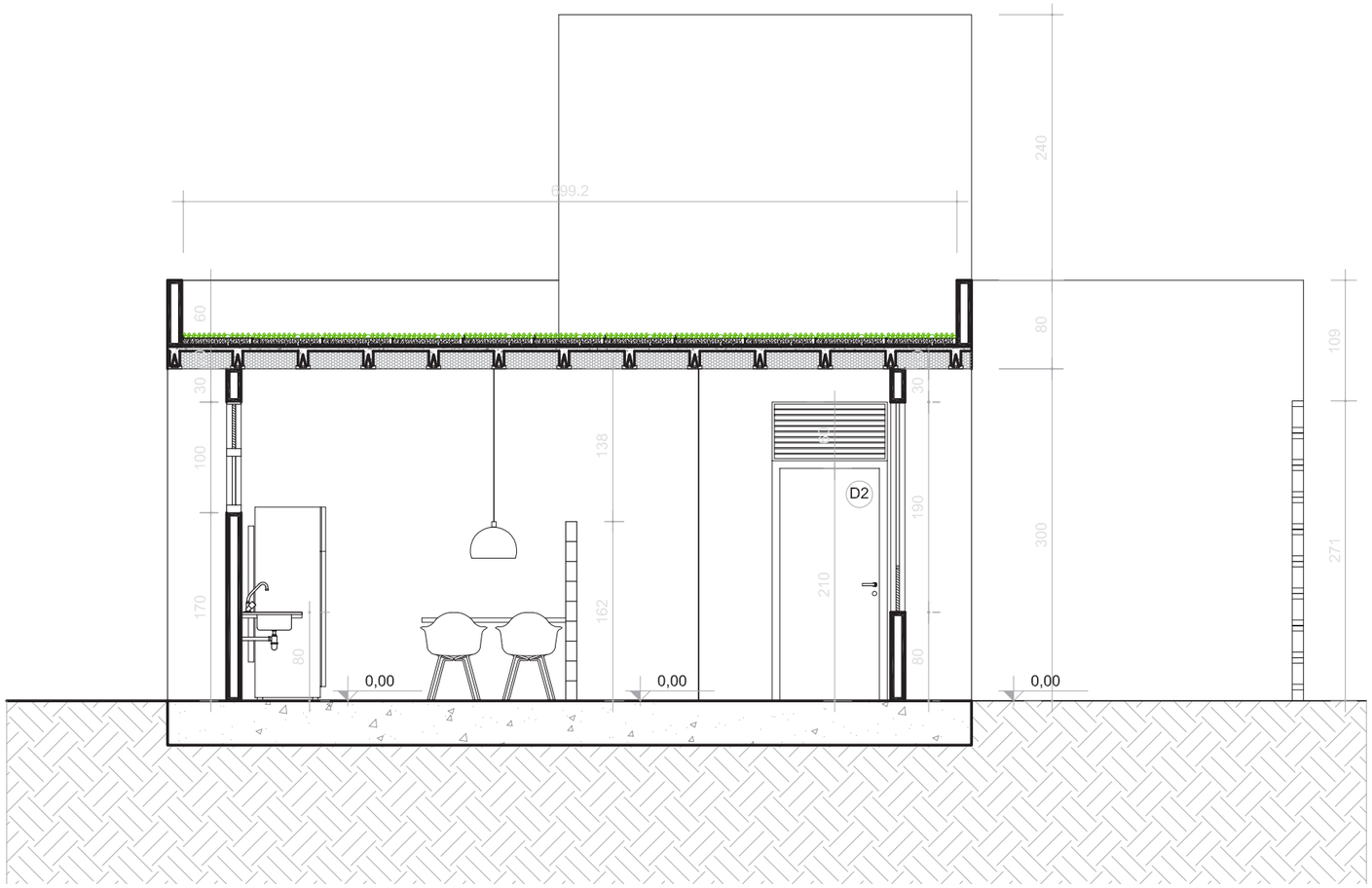
PROJECT DESIGN

Sections
S3B S

Frames Listing

- D1 — 90x210cm wooden vent door + 60cm wooden and glass top
- D2 — 90x210cm wooden vent door + 60cm wooden vent top
- W1 — 120x150cm wooden window + 40cm wooden vent bottom
- W2 — 120x60cm wooden window + 40cm wooden vent bottom
- W3 — 120x60cm wooden window + 40cm wooden vent top
- W4 — 29x261cm concrete vent frame
- W5 — 203x261cm concrete vent frame

D = Door W= Windows



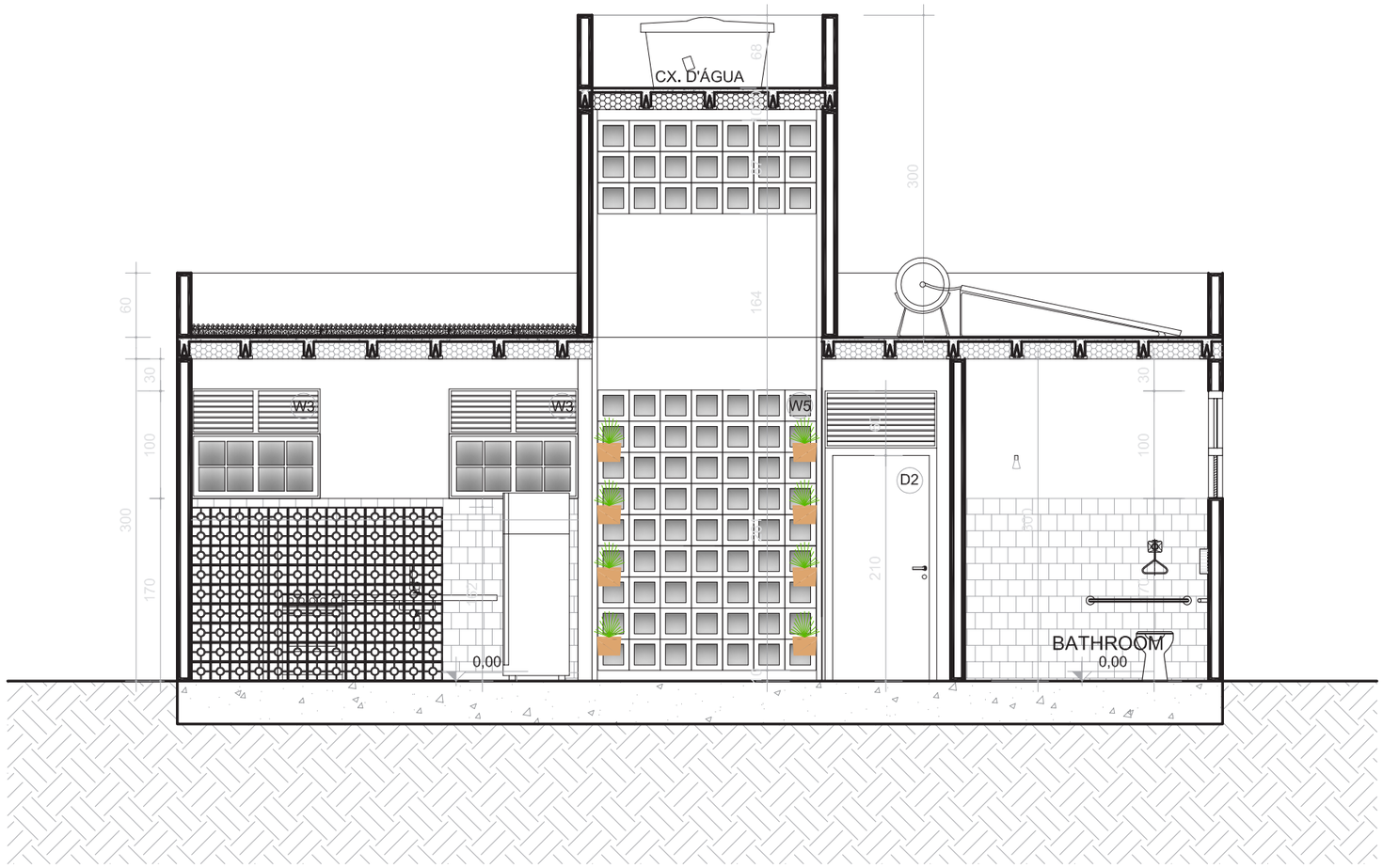
Section AA

Sections
S3B S

Frames Listing

- D1 — 90x210cm wooden vent door + 60cm wooden and glass top
- D2 — 90x210cm wooden vent door + 60cm wooden vent top
- W1 — 120x150cm wooden window + 40cm wooden vent bottom
- W2 — 120x60cm wooden window + 40cm wooden vent bottom
- W3 — 120x60cm wooden window + 40cm wooden vent top
- W4 — 29x261cm concrete vent frame
- W5 — 203x261cm concrete vent frame

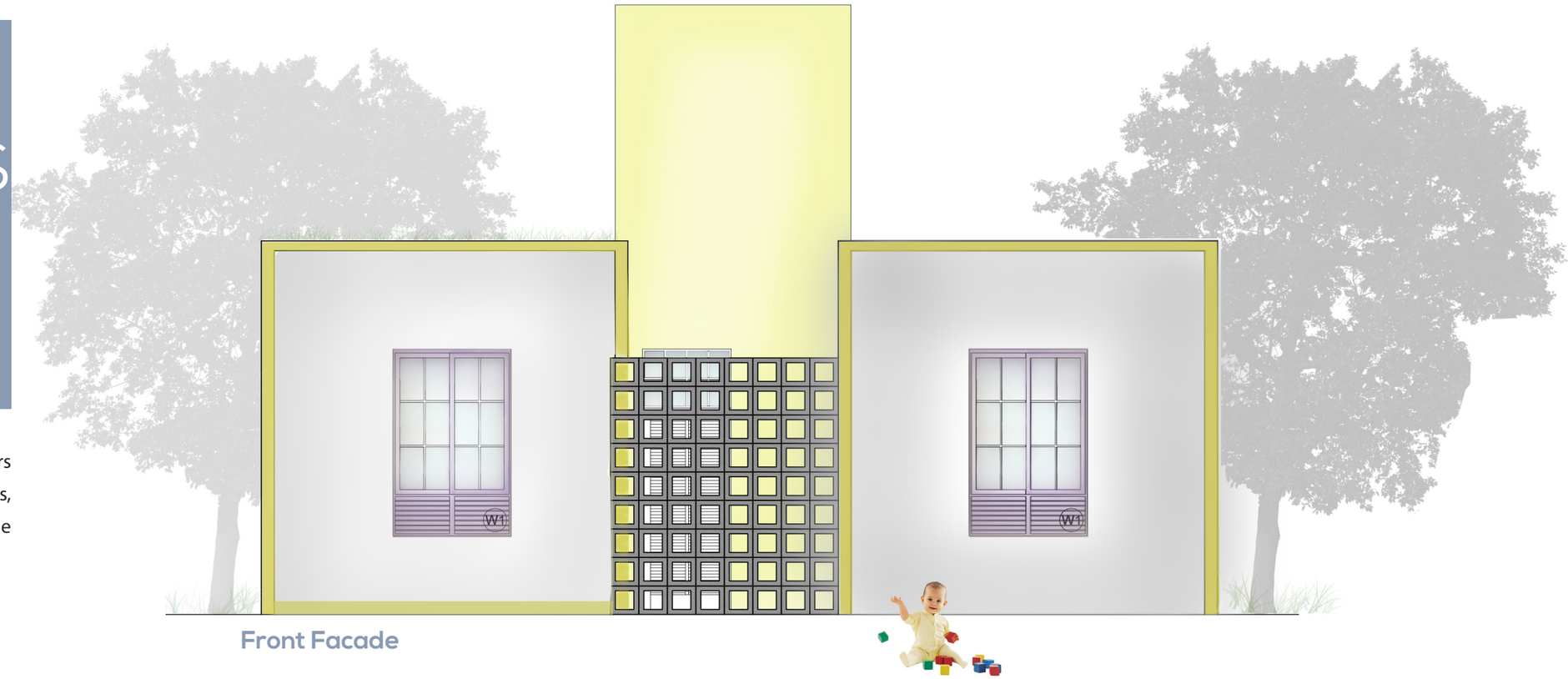
D = Door W= Windows



Section BB

Facades
S3B S

The facades are very flexible in terms of colors and finishings. All the items such as the frames, walls and concrete frames can be colored as the owner wishes.



Front Facade

Frames Listing

- **D1** 90x210cm wooden vent door + 60cm wooden and glass top
- **D2** 90x210cm wooden vent door + 60cm wooden vent top

- **W1** 120x150cm wooden window + 40cm wooden vent bottom
- **W2** 120x60cm wooden window + 40cm wooden vent bottom
- **W3** 120x60cm wooden window + 40cm wooden vent top
- **W4** 29x261cm concrete vent frame
- **W5** 203x261cm concrete vent frame

D = Door W= Windows

Back Facade

Right Facade

Left Facade

Expantions S3B M,L Ground Plan

Ground Floor S3B M and L Plan
Area: 54sqm

Frames Listing

- D1 — 90x210cm wooden vent door + 60cm wooden and glass top
- D2 — 90x210cm wooden vent door + 60cm wooden vent top
- W1 — 120x150cm wooden window + 40cm wooden vent bottom
- W2 — 120x60cm wooden window + 40cm wooden vent bottom
- W3 — 120x60cm wooden window + 40cm wooden vent top
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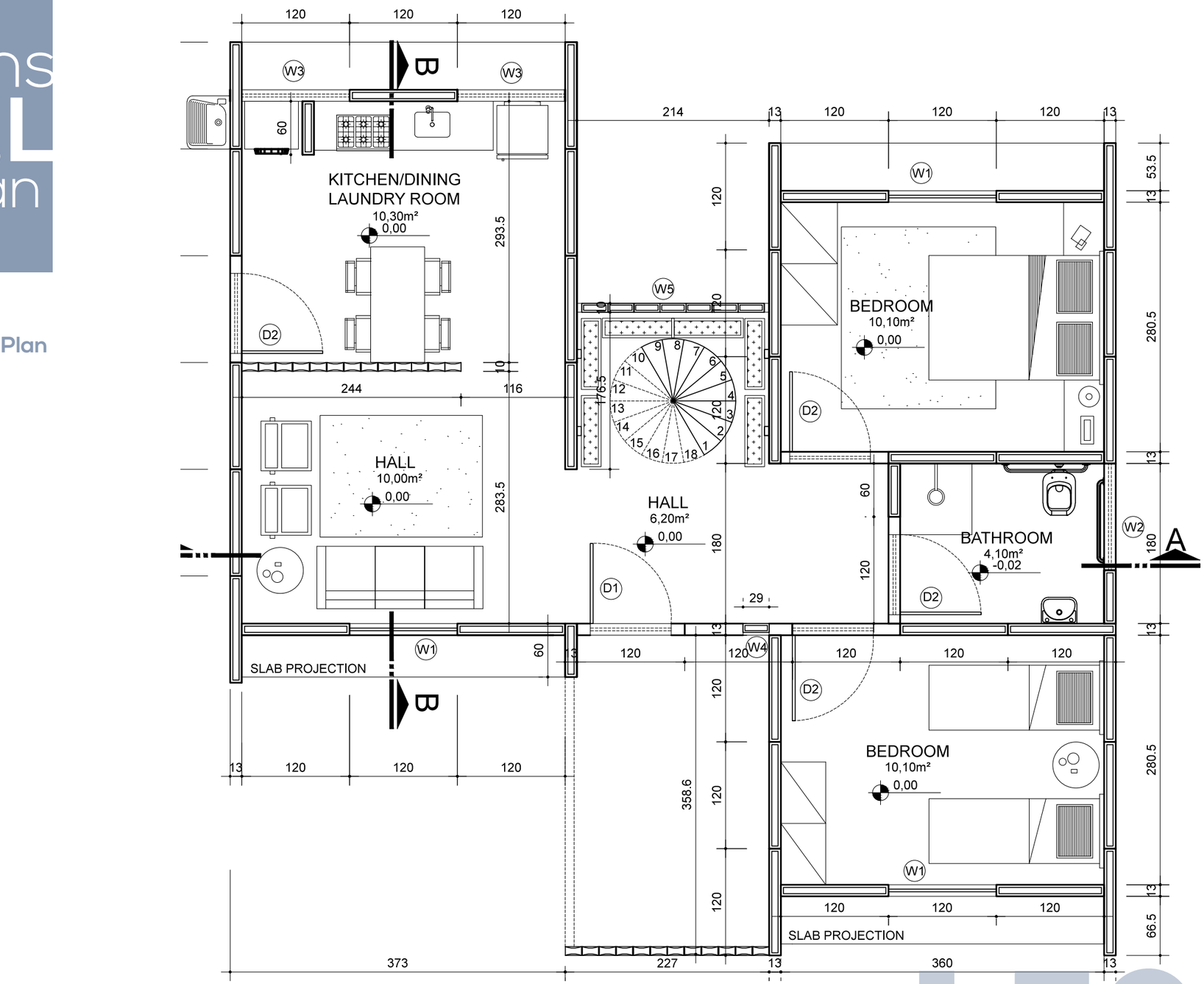
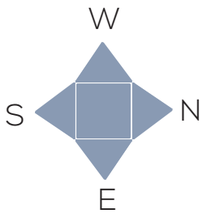
D = Door W= Windows

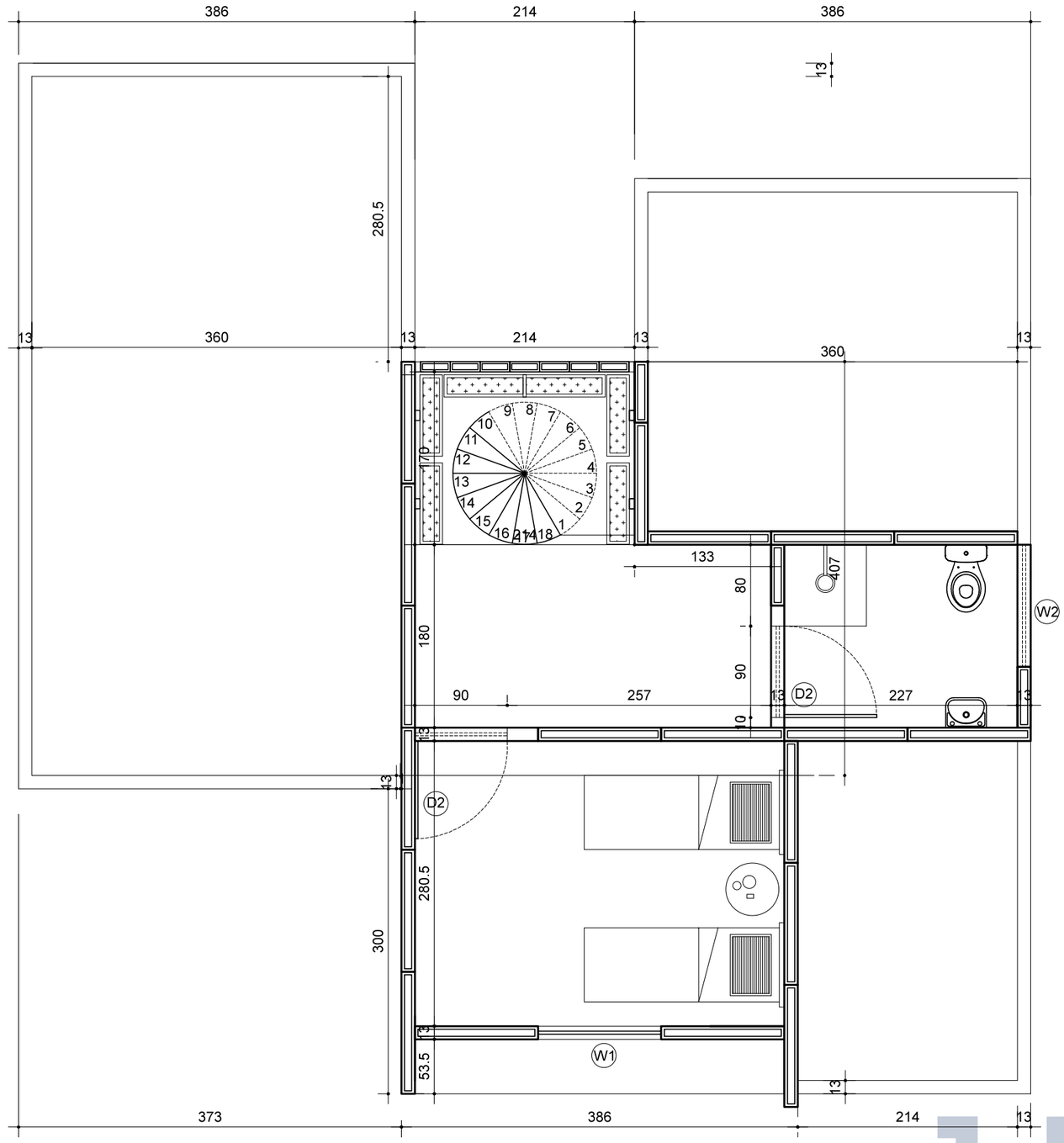




PROJECT DESIGN

Expantions
S3B M
Second Floor

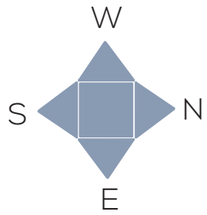
Second Floor S3B M Plan
Area: 20,4sqm



Frames Listing

- **D1** 90x210cm wooden vent door + 60cm wooden and glass top
- **D2** 90x210cm wooden vent door + 60cm wooden vent top
- **W1** 120x150cm wooden window + 40cm wooden vent bottom
- **W2** 120x60cm wooden window + 40cm wooden vent bottom
- **W3** 120x60cm wooden window + 40cm wooden vent top
- **W4** 29x261cm concrete vent frame
- **W5** 203x261cm concrete vent frame

D = Door W= Windows



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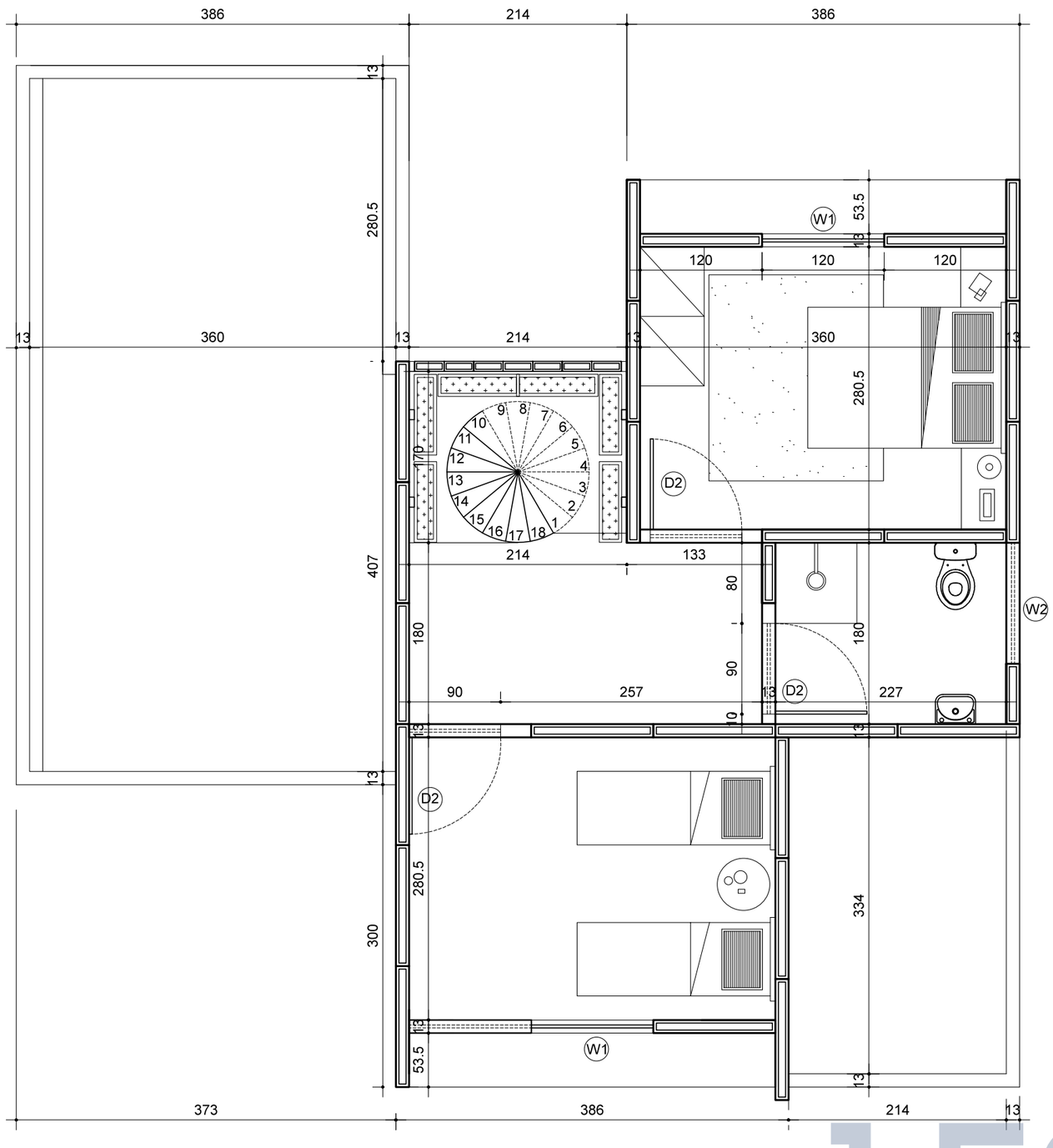
Expantions S3B L Second Floor

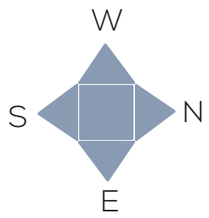
Second Floor S3B L Plan
Area: 30,5sqm

Frames Listing

- D1 — 90x210cm wooden vent door + 60cm wooden and glass top
- D2 — 90x210cm wooden vent door + 60cm wooden vent top
- W1 — 120x150cm wooden window + 40cm wooden vent bottom
- W2 — 120x60cm wooden window + 40cm wooden vent bottom
- W3 — 120x60cm wooden window + 40cm wooden vent top
- W4 — 29x261cm concrete vent frame
- W5 — 203x261cm concrete vent frame

D = Door W= Windows





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PROJECT DESIGN

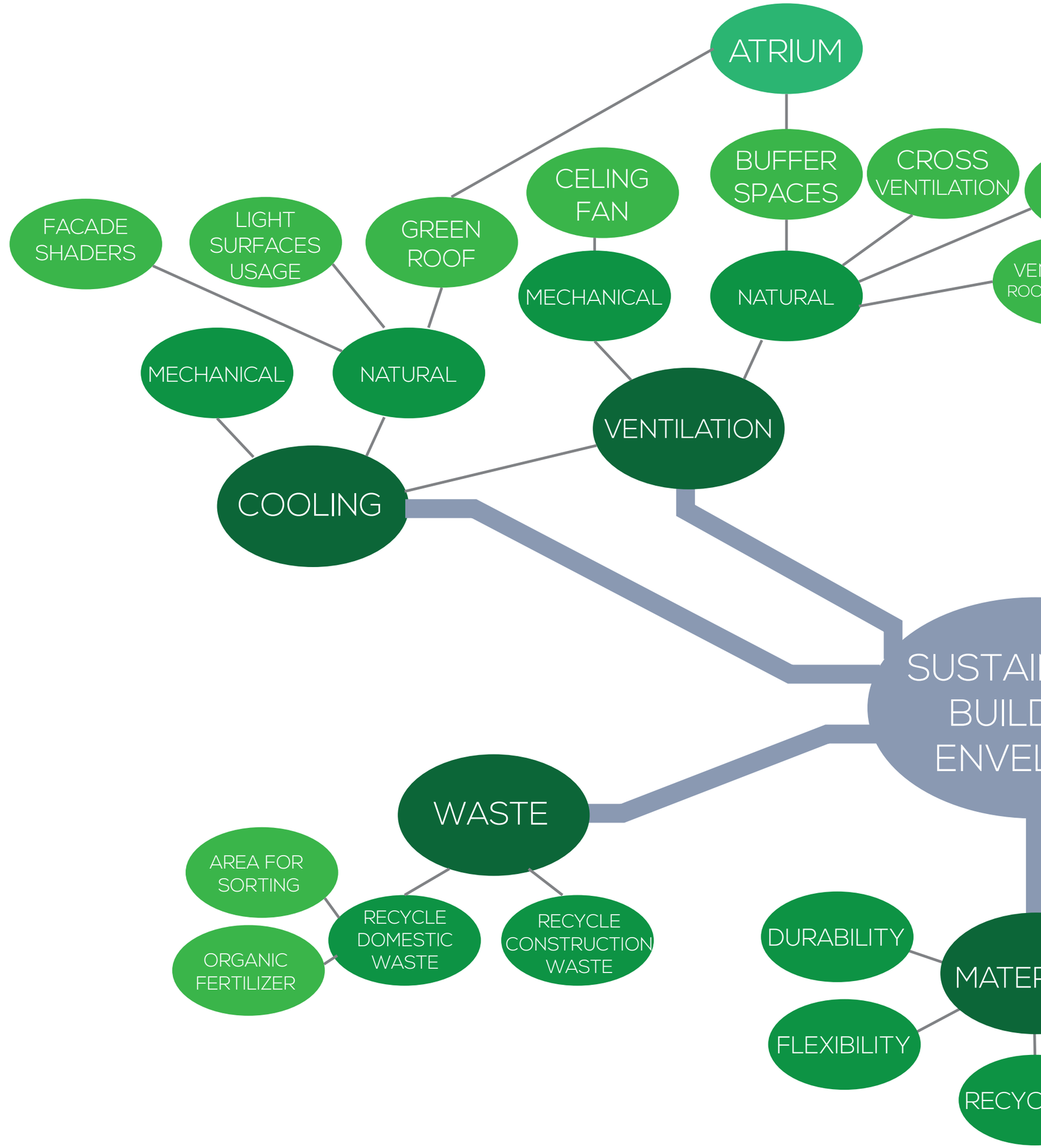
S3

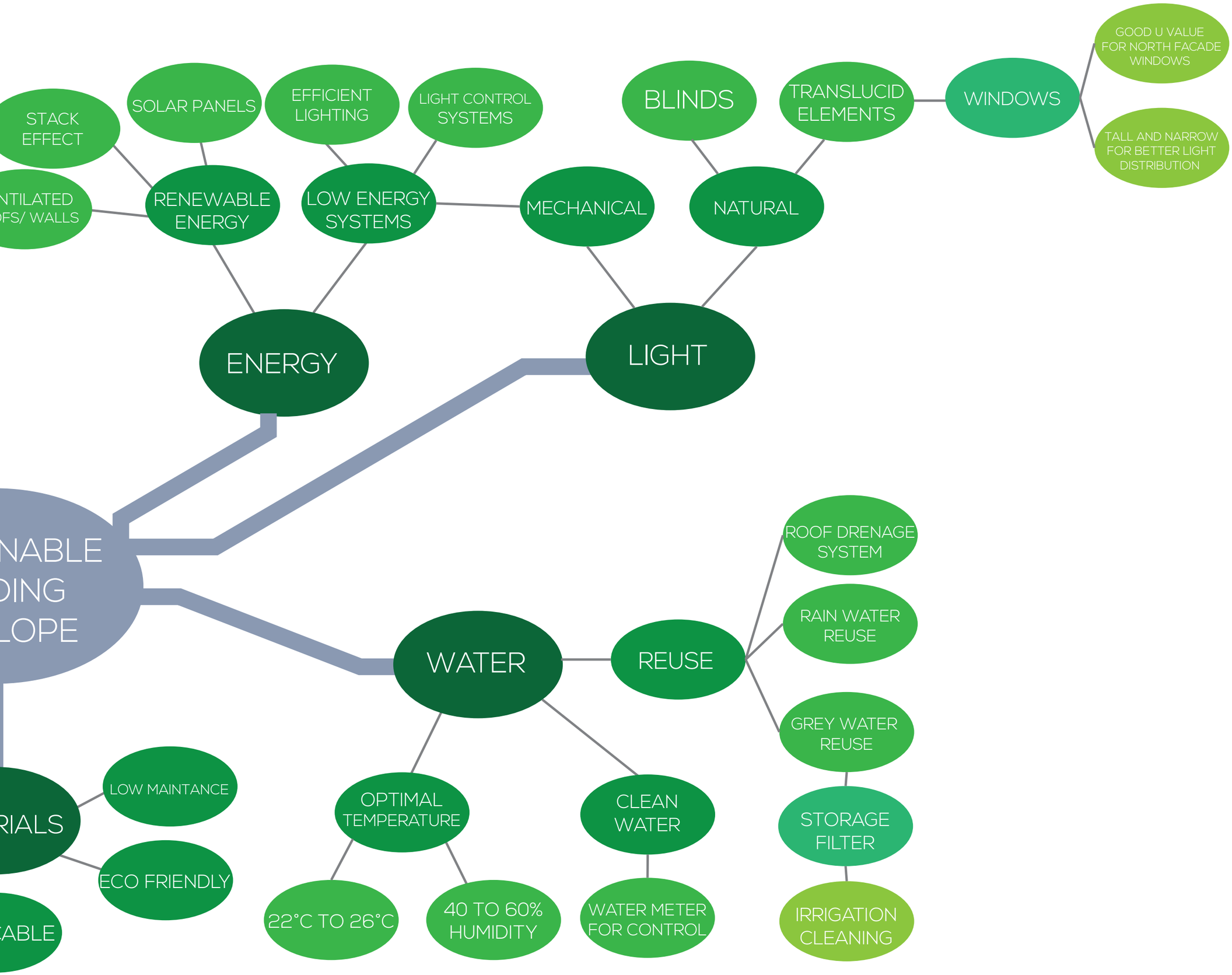
Sustainable **Systems**

has a great range of sustainable systems and materials always focused on the environmental protection, energy economy and waste management.

Sustainability **In a Diagram** for S3B house

This diagram has the same framing as the S3B physical diagram but, in this case, it exposes all the items sustainability-related that were taken in consideration along the project. It is also used as a guideline for the sustainable design seen along the project. The diagram is colour coded and it shows the items with the same hierarchy in the same colours, in a sub-item system.
The lines connect the items and the ones without connection relate to a bigger item.
The diagram is used in the following pages as a guide map to show the reader which part of it is being developed.




GOOD U VALUE FOR NORTH FACADE WINDOWS
TALL AND NARROW FOR BETTER LIGHT DISTRIBUTION
WINDOWS
TRANSLUCID ELEMENTS
BLINDS
NATURAL
MECHANICAL
LIGHT CONTROL SYSTEMS
EFFICIENT LIGHTING
SOLAR PANELS
STACK EFFECT
NTILATED FS/ WALLS
RENEWABLE ENERGY
LOW ENERGY SYSTEMS
ENERGY
LIGHT
NABLE DING LOPE
RIALS
LOW MAINTANCE
ECO FRIENDLY
CABLE
WATER
REUSE
ROOF DRENAGE SYSTEM
RAIN WATER REUSE
GREY WATER REUSE
STORAGE FILTER
IRRIGATION CLEANING
OPTIMAL TEMPERATURE
22°C TO 26°C
40 TO 60% HUMIDITY
CLEAN WATER
WATER METER FOR CONTROL

Sustainable **Materials**

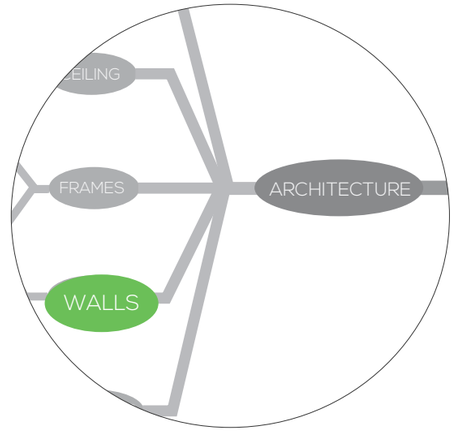
Architecture Project **EPS Panels**

Walls

EPS construction - Monoforte is a new and smart technology for the Brazilian context. The system includes an integrated model of modular panels whose structural function is ensured by two galvanized steel mesh. Hydraulic plumbing, electric and sewage are placed between the EPS panels and metal mesh, resulting in a resistant, fast and economical construction. It is recommended for any type of construction and can be used both as structural element and closure.

Why Monoforte EPS Panels?

- It is cheaper, easy to assemble, less labour required, less electricity consumption on the construction site, no use for any other form-work
- Offers good Thermal and acoustic comfort
- It is a flame retardant material
- Allows no proliferation of termites and fungus
- Can be used as structural wall or just envelope
- Plumbing can be easily inserted
- Clean and dry construction method
- Panels are flexible and easy to be modified
- Lightweight and easy to transport



Sustainable Aspects

- Is a 100% recyclable material
- More than 80% of waste reduction
- Water economy of up to 75% during the construction comparing to traditional ceramic blocks.

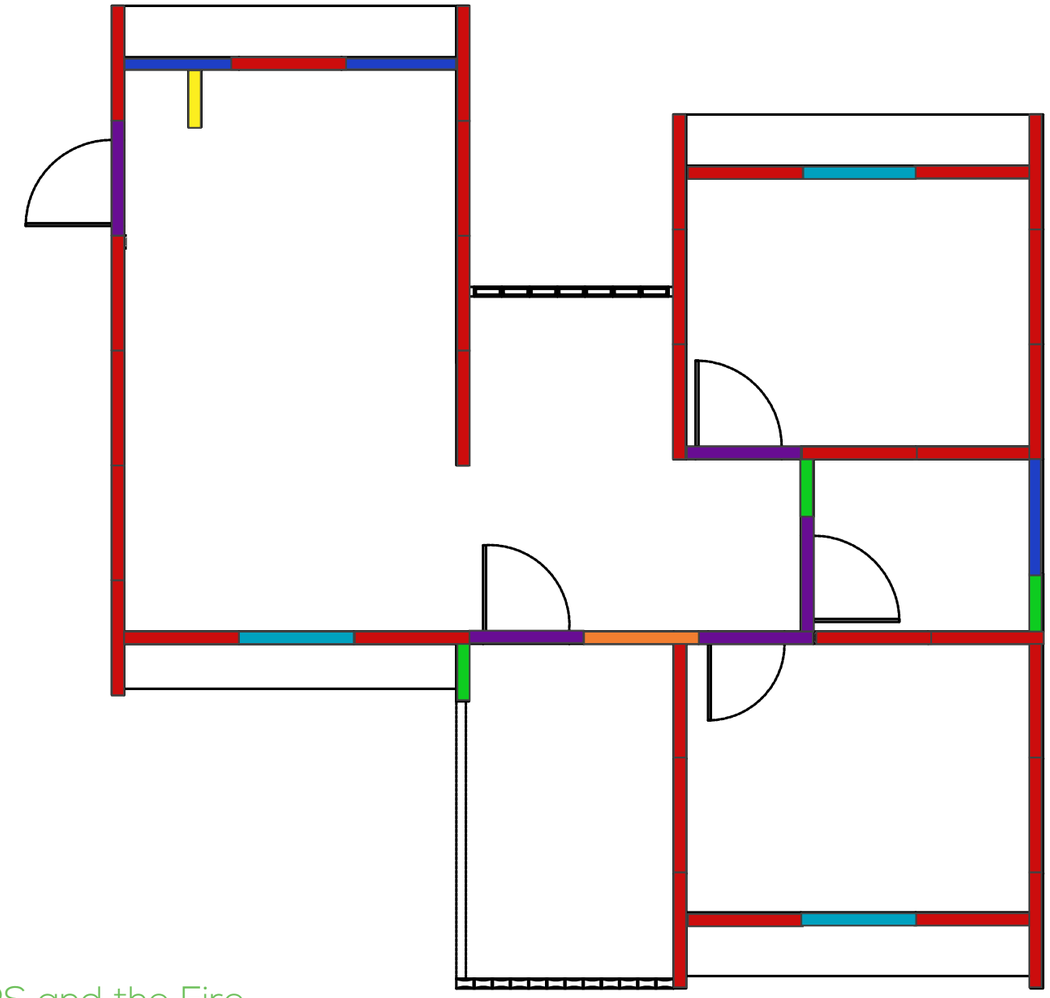
Mounting System

Foundation is made according to the project, leaving in hardware guides (gauge 10 mm) with a height of 50 cm, where the EPS panels fit in

Electrical, plumbing and sewer pipes should be positioned and fixed between the galvanized steel mash and the EPS panel.

For larger diameter pipes, room is opened with hot air blowers.

Afterwards, the grout is added to finish the system. Over the grout can be applied paint, ceramic, texture or whichever material prefered.



The basic model S3B model has a total of 46 panels. The standard size are 120x300 and 13cm thickness finish. The panels that need cuts for the door or windows come to the construction size on the standard size and are cut in loco.

Types of panels in the project

- **32 x** Panel 120x300 cm
- **5 x** Panel 120x300 with door 90x210 + vent 90x60
- **3 x** Panel120x300 cm with window 120x150+40
- **3 x** Panel 120x300 cm with window 120x150+40
- **3 x** Half panel 120x300
- **1 x** Panel 120x300 with concrete vent 29x261
- **1 x** Panel 60x170

EPS and the Fire

Many everyday objects that surround us, offer the risk of catching on fire. However, since we cannot live without them, we adopt the necessary security measures to allow their usage with less fire risks. When it comes to fire safety in buildings the elements "fire resistance" should evaluated in their full "end-use conditions" rather than "reaction to fire" of isolated components.

The EPS has a very low heat load due to its low bulk density. A unit volume of EPS contains 1.5 to 2.5% of plastic material and 90% of air, the wood for example, in a possible fire has numbers 10 times higher than the EPS, and considering a complete combustion, the 15 kg/m3 EPS would need 150 times its own volume in air, that makes very hard to the EPS to unleash it's full potential heat.

The EPS with flame retardant is rated by national and international standards, as "Fire-resistant" or "flame spread extremely low." When the EPS is inside the walls, protected by plaster or placed between plates of concrete floors, does not produce combustion since there is not enough oxygen. The construction elements made with cellular concrete with EPS show excellent behavior in case of fire It is strongly recommended that Expanded Polystyrene is always protected by coating, or totally enclosed. The EPS can not be ignited by sparks or burning metal from welding, short circuit or lighted cigarette ash.

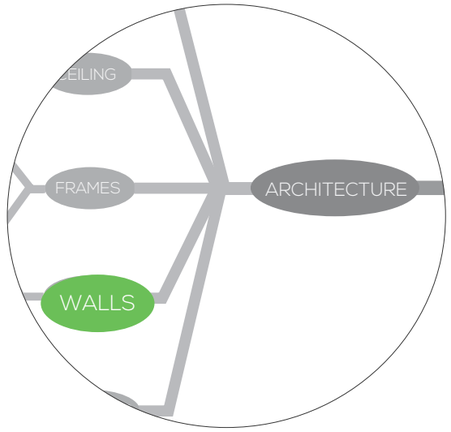
The smoke is an important factor in a fire. The EPS itself, can produce more smoke per unit mass than other materials should; however it should be considered that the EPS products contain only 2% of solid matter.

In terms of toxicity in case of fire, gases released during the EPS combustion (both standard and those retardant treated) are less toxic than those generated in the combustion of "natural " materials such as wood, linen, wool and cork, and also most plastics.

When considered all these factors, conclusion leads that the Polystyrene Expanded EPS when installed correctly in the recommended application, does not represent a particular risk of fire, or stand out as significant increase in density smoke or toxicity.

Sustainable **Materials**

Achitecture Project **Concrete vent frame**

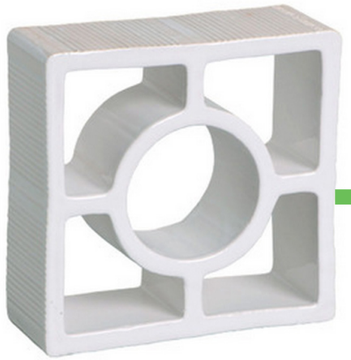


Cobogó

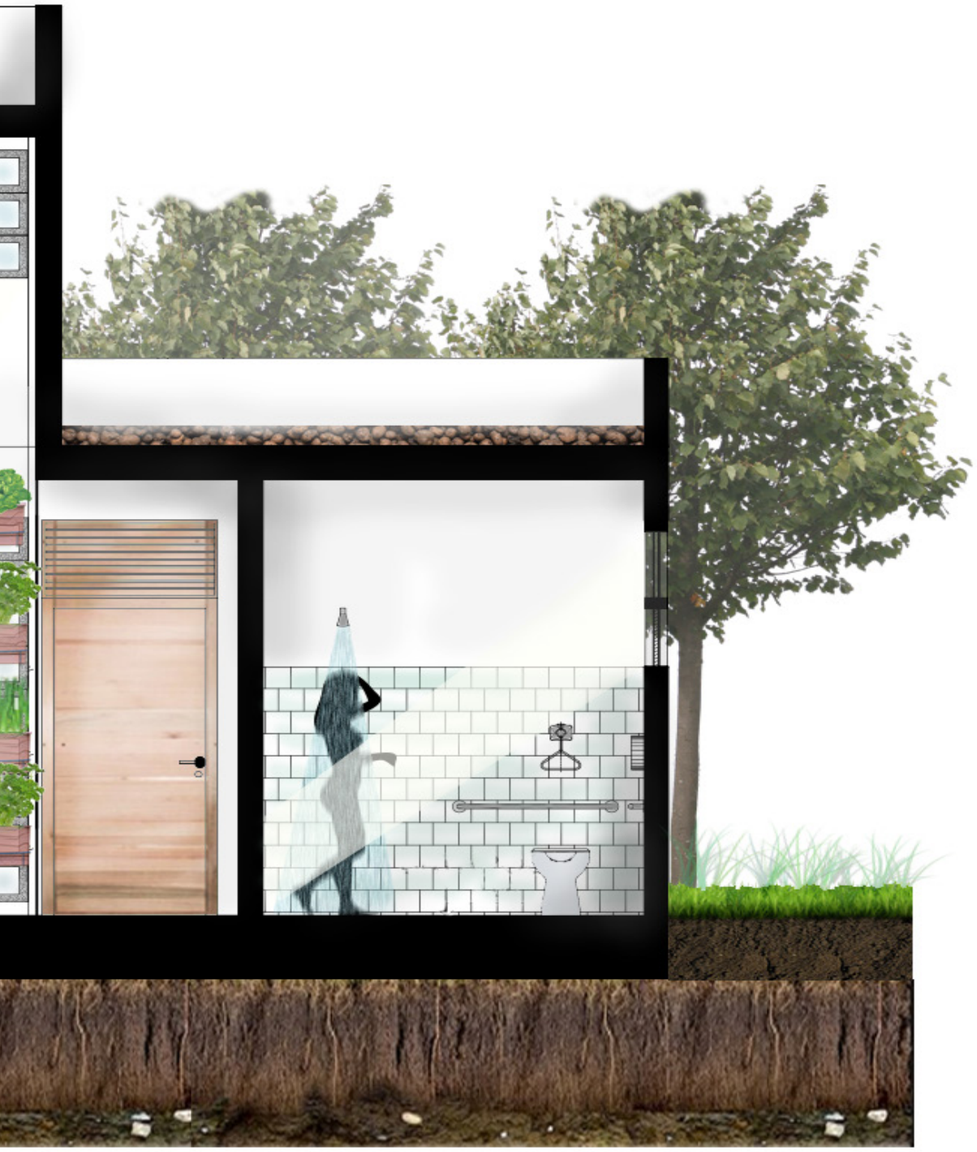
The Cobogó is a Brazilian Latticework normally made out of ceramic. Developed in the north-east of the country, they became a signature of the genuine Brazilian architecture. Cobogós are titles with no structural function but work as barriers separating one area from the other. Besides being very functional, they are delicate and gracious and add a decor touch wherever they are placed.

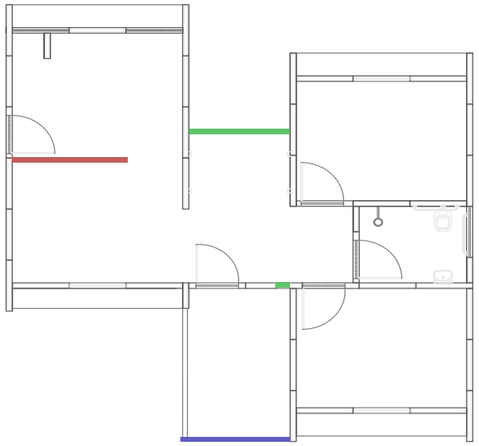
Sustainable Aspects

The Cobogó has the same principles as the concrete vent frame, it allows the wind to come through between the gaps but still keeping the visual barrier. The Cobogó used in the house is ceramic and they are produced manually in small local factories.



The Cobogó is placed to separate the kitchen / dining room from the living room instead of using regular panels. The Cobogó sections the areas without blocking the ventilation flow between the rooms.





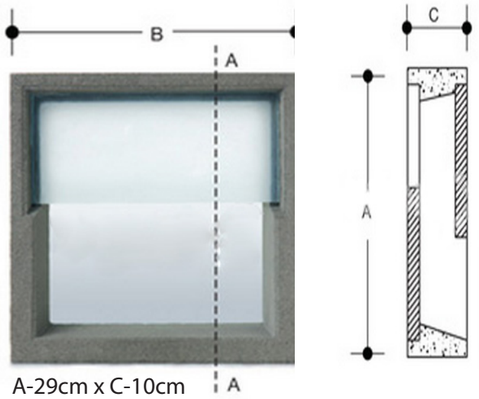
117 x Ceramic Latticework title 18x18cm

72 x Concrete Frame 29x29cm

79 x Concrete Frame with glass vent 29x29cm

Concrete Vent Frame

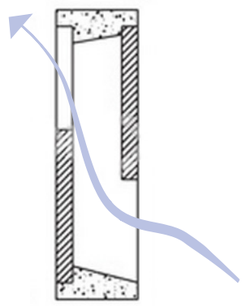
Concrete vent frames are small concrete boxes with a placement for pieces of class, creating a shutter effect. They have high durability and low maintenance besides contributing to increase natural lighting and ventilation, improving thermal comfort environments and reducing energy consumption.



A-29cm x C-10cm

Sustainable Aspects

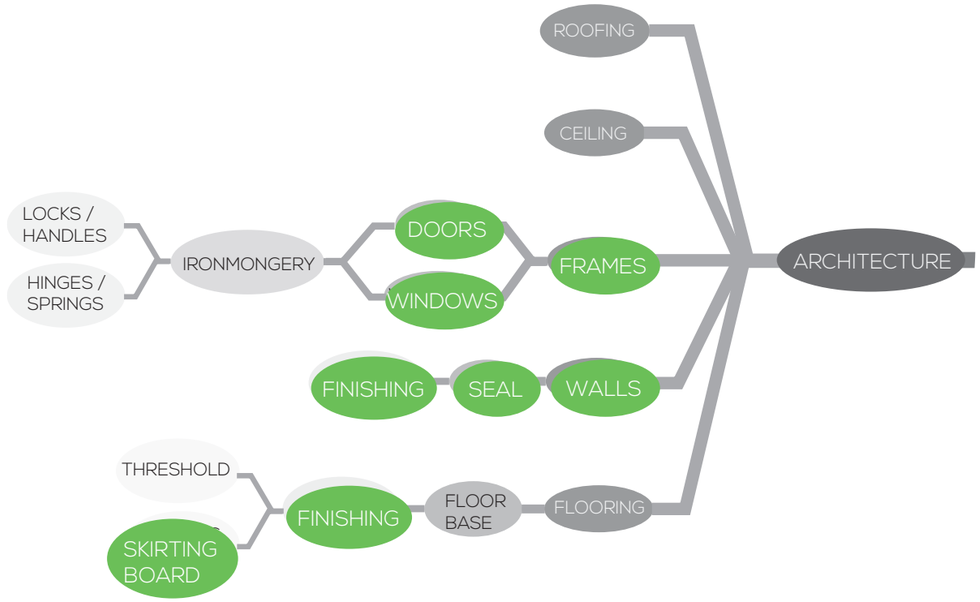
The concrete vent frame is already sustainable for it's shape, that allows the wind to come through the wall between the gaps but still keeping the building protected from direct wind and rain. Besides, this specifically block is partially made of construction waste. Also part of the water used on the process is rain water.



The image shows the ventilation flow going through the piece. The pieces can also be used without the glass, then the air flow is much bigger but the building gets exposed.

Sustainable **Materials**

Achitecture Project



Doors

The doors chosen for the project are made of two different types of wooden materials, the external doors are made of Eucalyptus and the internal doors are made of wood.

Sustainable Aspects

The internal wooden doors are made of reforested wood and their interior stuffing is made of HDF high density fibre board that allows bigger impacts and gives the product longer durability. The doors are recyclable and biodegradable.

The external doors are made of Eucalyptus wood and are also recyclable and biodegradable and have good resistance to impacts.

Windows

All the windows frames are made of Eucalyptus wood together with a single-layered glass.

Sustainable Aspects

The aspects are identical to the Eucalyptus wood and are also recyclable and biodegradable and have good resistance to impacts.

Indoors Flooring

Concresteel will be used in all the house flooring.

It comes in blocks of 100x100 cm, and is monolithic. That makes it practical and clean.

Sustainable Aspects

The Concresteel uses technology to extract from the environment high-polluting power, such as construction debris, broken glass, crockery, broken ceramics, marble factory scrap and shredded tires, incorporating their inputs in the concretsteel production process. Alternative materials such as synthesized termite, silica rice husk ash and waste cellulose are also used. These wastes combined are transformed into aggregate and used to manufacture of the flooring.

Skirting Board

All the skirting boards are made of wood.

Sustainable Aspects

The skirting board are made of reforested wood, are recyclable and biodegradable.

Outdoors Flooring

For the path that leads to the house, the flooring made of recycled and granulated tires. It can be made in many colours, it is anti impact and non skid.

Sustainable Aspects

This flooring is made of a recycled material and is 100% recyclable. Since the raw material is tires, is is a very resistant and durable floor and the most important, it is waterproof. It is easy to install and it can be placed right over compressed earth.

Finishing - Paint

The paint used on the walls is the Mineral Ecopaint. It is a natural and high quality finish, it is also odourless and free of solvents or substances derived from petroleum and VOC (volatile organic compounds). The paint is used both indoors and outdoors.

Sustainable Aspects

Mineral Ecopaint is produced from raw materials of mineral origin, selected aggregates and special polymers. Unlike oil paints derived, Ecotinta allows the wall to breath, helping to control humidity indoors.

Ecopaint does not form bubbles, is a natural fungicide, and contains no synthetic chemical preservatives. Its finish is thin, washable and has high resistance to exposure to rain and UV rays.

Sustainable **Materials** Electric Project

Lamps

All the fluorescent lamps in the house must have the Procel Label or be LED lamps.

Sustainable Aspects

All the fluorescent lamps in the house must have the Procel Label. They use less energy, least up to 10 times more than the conventional kind and have a one year warranty.

The LED can be more expensive, but it is always worth it when minded the sustainable aspects related to it. No heat is expelled to the room due to it's dissipation technology, they least much longer than any other lamp and while old it loses the light power, but never shuts and the main aspect, they represent superior energy economy than any other lamp.

Switches

The house has two different types of switches, the ones with sensors and the ones without.

For the service area, hallway and front door hall there will be presence sensors. The other areas which are long permanence areas have regular switches.

Sustainable Aspects

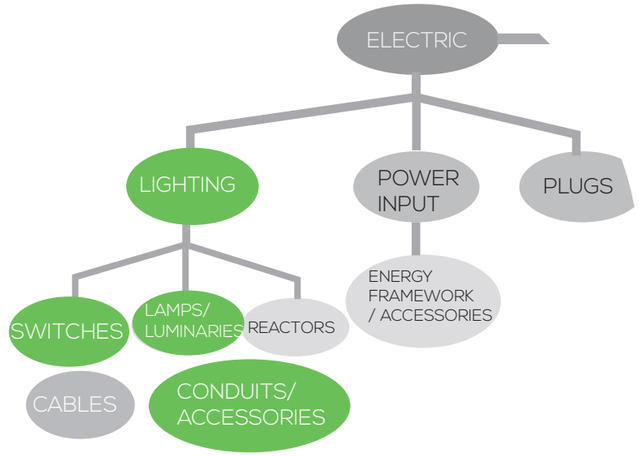
The switches with presence sensors turn on the lights when someone approaches and turn them off after a few seconds when the person leaves the room, avoiding unnecessary usage. It is an inexpensive device and powersavvy.

Conduits and Accessories

The conduits used are made of polyethylene semi-rigid and provide insulation. It is suitable for the house due to its low-voltage installations. It is used indoor and outdoor and the conduits are always built into the walls or floor.

Sustainable Aspects

The polyethylene conduits used in the project are made from recycled materials and it are certified by a big diversity of labels and companies. One of them is the Swedish construction company Skanska.



Sustainable **Materials** Hydraulic Project

Pipes

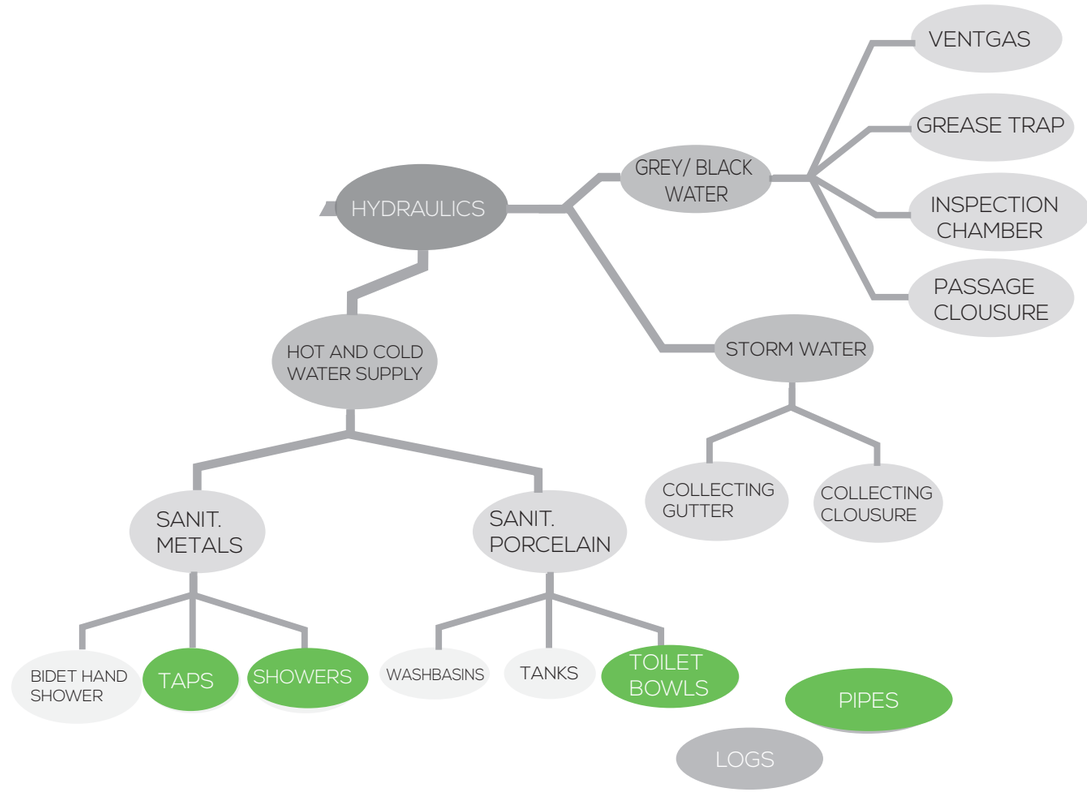
PPR is used for the house water system. The pipes are made from latest generation resin, Polypropylene Random Copolymer Type 3. The joining is made by heat fusion process, merging molecularly at 260ºC, forming then a continuous pipe line without leaking risks, eliminating the use of welds, screws and adhesives.

Sustainable Aspects

The PPR pipe system is a non-toxic material, because of the extremely smooth internal walls provides an installation without build up and without reduction of the pipe diameter over time.

With the heat fusion technology there is no need to use adhesives plastic and sandpaper, making the construction site much cleaner.

PPR is recyclable and provides better sound-proofing, helping in the acoustic comfort of the house.



Taps and Showers

The showers are shower head models without any type of heating system connected to it.

The bathroom faucets are pressmatic type.

The kitchen and service faucets have water economy aerators.

Sustainable Aspects

The shower hot water is powered by solar panels from the roof, instead of the commonly used electrical showers in Brazil, which will result in significant savings on the electrical bills.

The Pressmatic faucets have a hydro drive system that with a slight hand pressure activates the water which closes in approximately six seconds. A practical system that guarantees no waste of water.

Toilet Bowls

All the toilet bowls used in the house are close-coupled white porcelain toilets and are equipped with dual flush.

Sustainable Aspects

Close-coupled toilets can be more expensive but the pipes for this kind of installation cost less than the conventional model. There is also a great water economy specially combined with the dual flush, since the flow is limited. Another advantage is the maintenance: if there is any problem, there is no need to break the masonry to repair it, since the flush bottom is completely external.

Sustainable **Systems**

Indoors kitchen garden

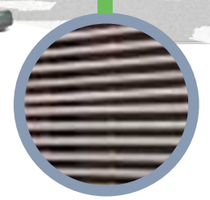
Kitchen Garden

The kitchen garden is the green part of the house, it is placed in between the two main blocks and brings freshness to the air. It provides a small amount of vegetables but enough to bring the family together around nature.

The reason it is placed inside is that since S3B is a prototype, there is no guarantee that all the terrains to place the houses would have an external area.

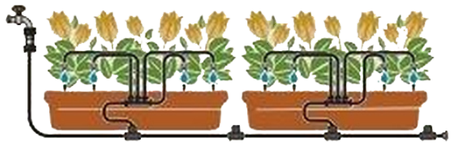
The supports for the kitchen garden is made of a ecoblock structure. The Ecoblock is an environmentally friendly and sustainable product consisting of 70% of industrial and domestic waste plastics and waste 30% of natural fibers such as rice husk, coconut shell, scrapes of leather, jute, among many others. It's appearance, is much alike the natural wood.

Impact resistant, does not crack and not loose splinters. It is immune to the action of termites, pests, germs and mold. Does not rot, is waterproof and can be exposed to extreme weather conditions without changing its characteristics and, for cleaning, soap and water.
Furthermore, remission maintenance and painting.



Ecoblock

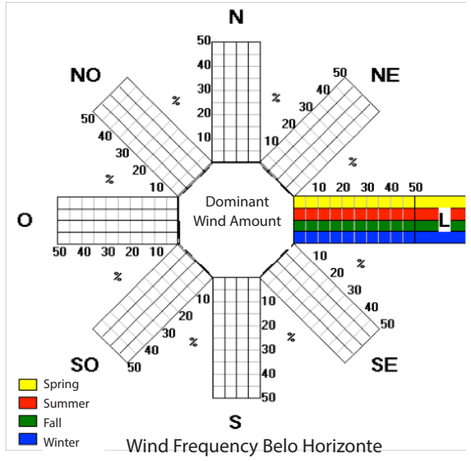
Attached on the ecoblock are the vases with the vegetables. The vases are irrigated by a small and practical irrigation system that is based on 24 drippers skewer each vase has a set of 4 drippers A hose connects all the sets and there is a pressure reducer adapter to tap. Connected to the adapter there is an electronic valve that controls the time with a timer.



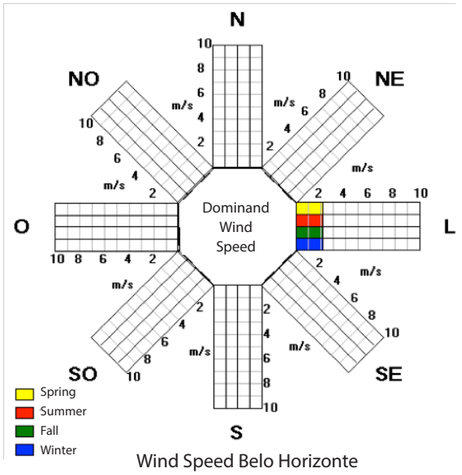
Mini Irrigation Kit

Sustainable Systems

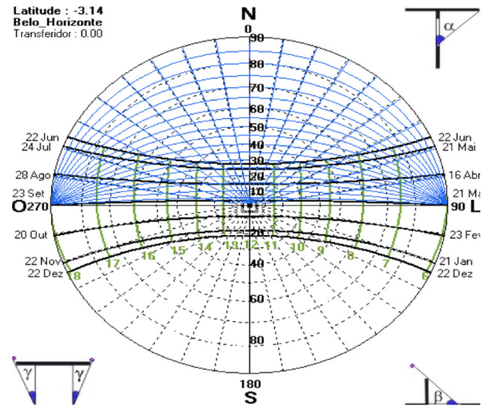
Cooling/Light/Ventilation



Wind Frequency Belo Horizonte



Wind Speed Belo Horizonte



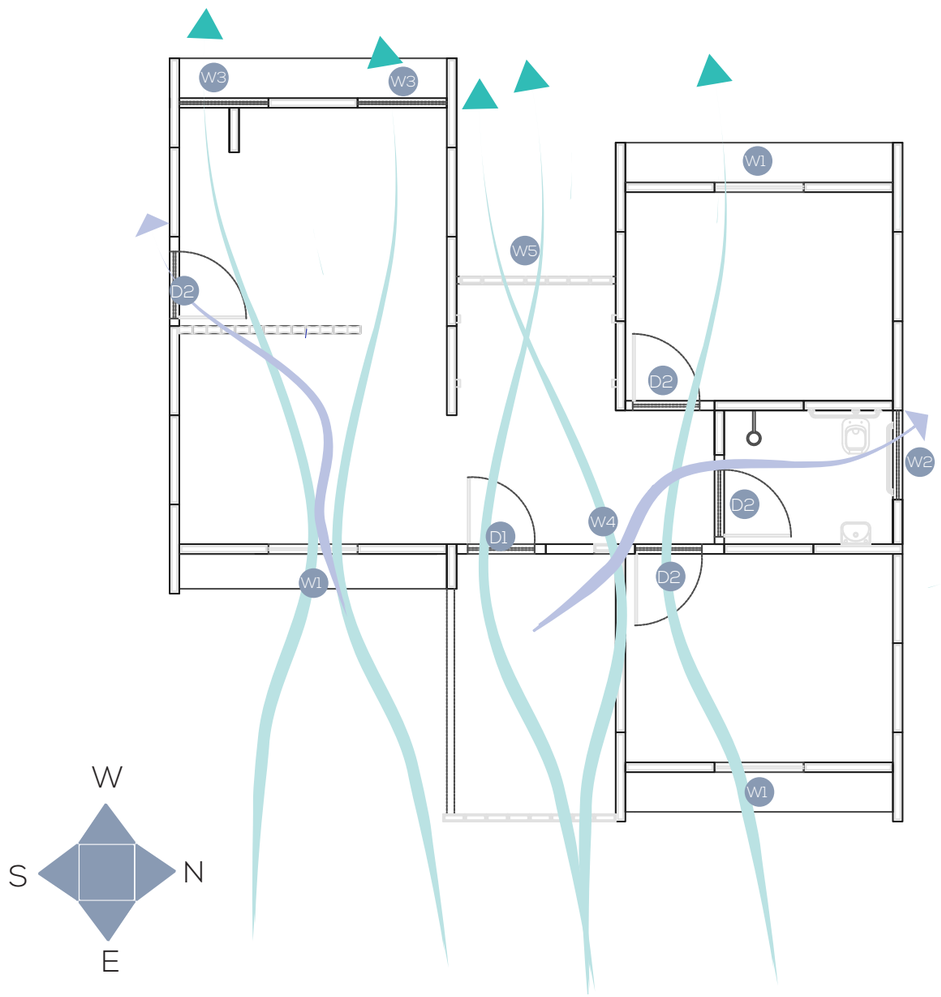
Solar board Belo Horizonte

Optimum Position

The house positioning allows the building to get the best out of the wind. The dominant wind in Belo Horizonte blows SE (Southeast). Therefore, the best position for the house is to have the windows facing east and west to promote cross ventilation, with the lower openings to east and the higher openings to west.

Ventilation and Cooling

The wind to is always used to cool down the house. A system of crossed openings will be made to provide cross ventilation. The idea is to always allow the wind to flow, therefore, all the windows and doors have permanent blinds and the concrete vent is used to allow the wind to blow across the hall. The constant air circulation makes the air inside of the house always fresh and cool.

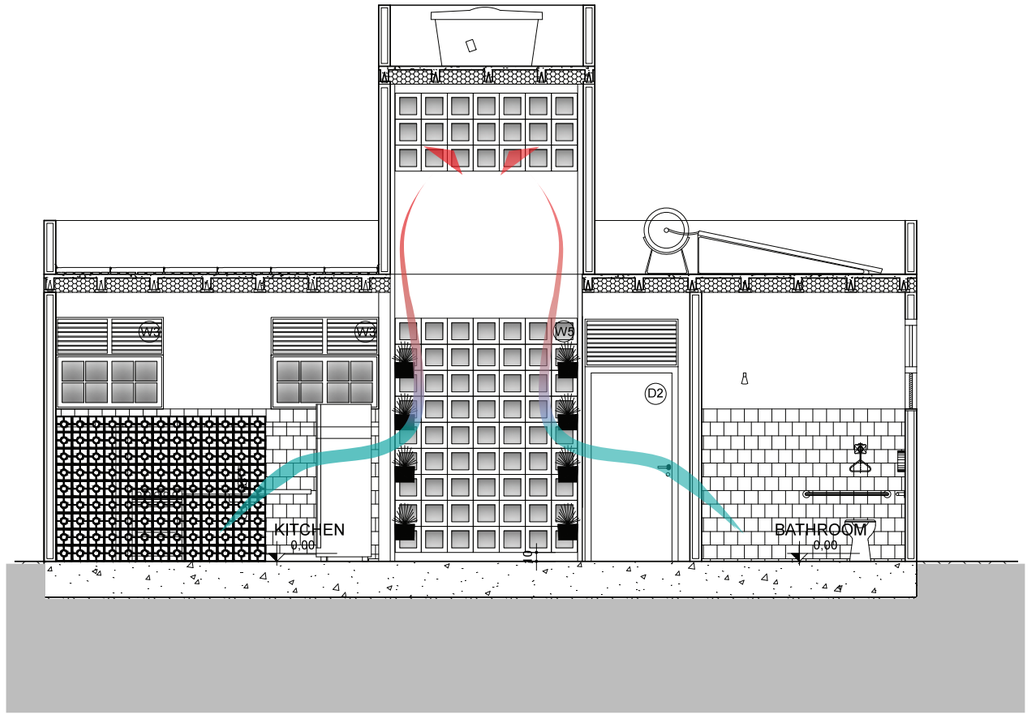


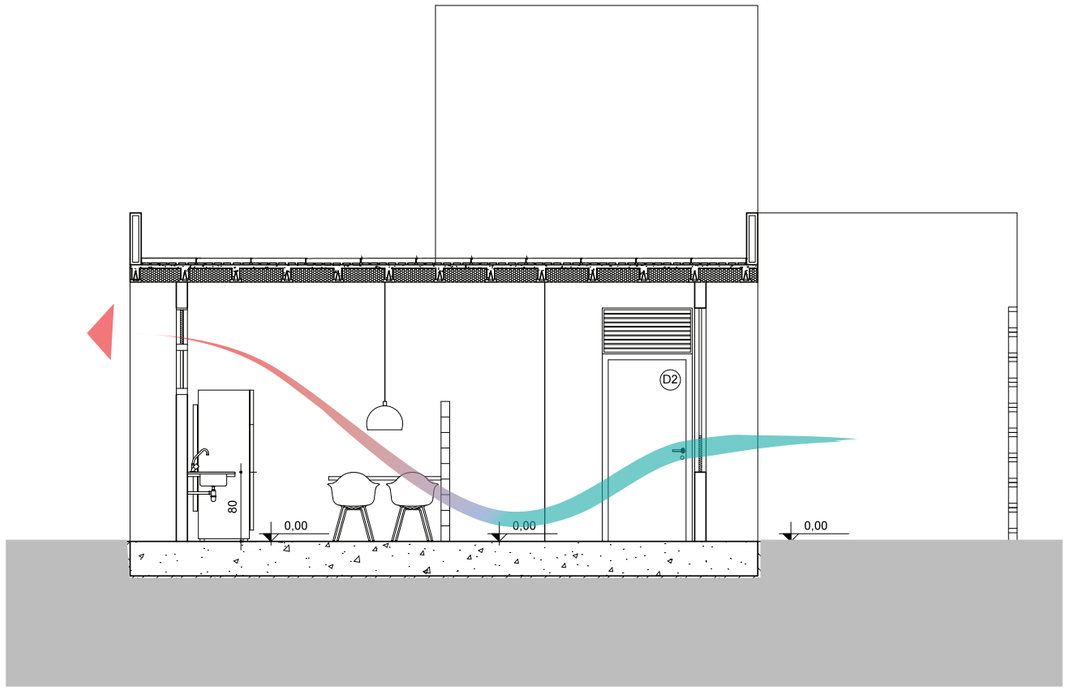
Natural Light

All the openings are calculated based on the minimum light incidence allowed per square meter according to MCMV standards.

The openings have to total 1/6 of the rooms square meters for the hall, living, dining and bedrooms. For the bathrooms, kitchen and laundry room, the openings need to total 1/8 of the rooms square meters. Between the common area and private area, the hall works as a buffering area, and the concrete frame vents are made of glass, allowing the light to come through the house in the majority of the wall.

D1 90x210cm wooden vent door + 60cm wooden and glass top





The staircase box is also used as the water tank tower and as a cooling and ventilation device. All the hot air inside of the house tends to go up, and escape from the top of the chimney through the concrete and glass vents.

The cold air always flows inside the house, coming through the wooden vents located on the bottom of the windows, and leaves the house warm through the wooden vents located on the top of the windows.

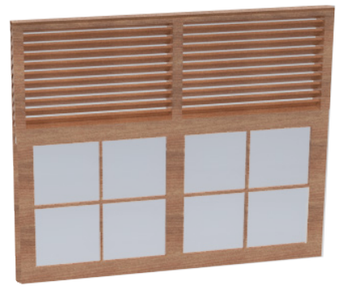
To prevent the warm air from getting stuck inside of the house, all internal doors have a permanent wooden vent. In the living room, the division between the living room and the dining room/kitchen is made with Cobogó.

Thus, the wind flows freely through the titles and leaves through the kitchen. The house walls are 300 meters high to avoid hot air flow near the living spaces.

D2 90x210cm wooden vent door + 60cm wooden vent top

W1 120x150cm wooden window + 40cm wooden vent bottom

W2 120x60cm wooden window + 40cm wooden vent bottom



W3 120x60cm wooden window + 40cm wooden vent top

Sustainable **Systems**

Water/Energy/Waste

Solar Shading

S3B has solar shading for all the windows in the west and east façades. The rooms and the long permanence areas, such as living and dining room, have protection for direct solar exposure. The slab is prolonged for about 60cm creating a protection for the windows, therefore, will reduce the amount of energy required for cooling by keeping the excessive heat of the sun out, avoiding overheated rooms. They can also cut back on the amount of energy required for lighting by optimizing the admittance of freer, natural indirect daylight.

Rain Water Reuse

S3B has a tank to collect rainwater. The rainwater can be used for the green roof and kitchen garden irrigation or for general cleaning.
The rainwater is collected in the roofs filtered before getting into the underground reservoir. The water is pumped whenever needed.
A water reuse system will be dimentioned for the house and the calculation are based on a paper called Águas Pluviais: Método de Cálculo do Reservatório e Conceitos para um Aproveitamento Adequado.

Context:

39,4 sqm roof

Irrigation Usage:

30 sqm green roof and kitchen garden = 30m2 x 3l/m2 = 0,09m3 p/day and 2,7m3 p/month 32 p/year

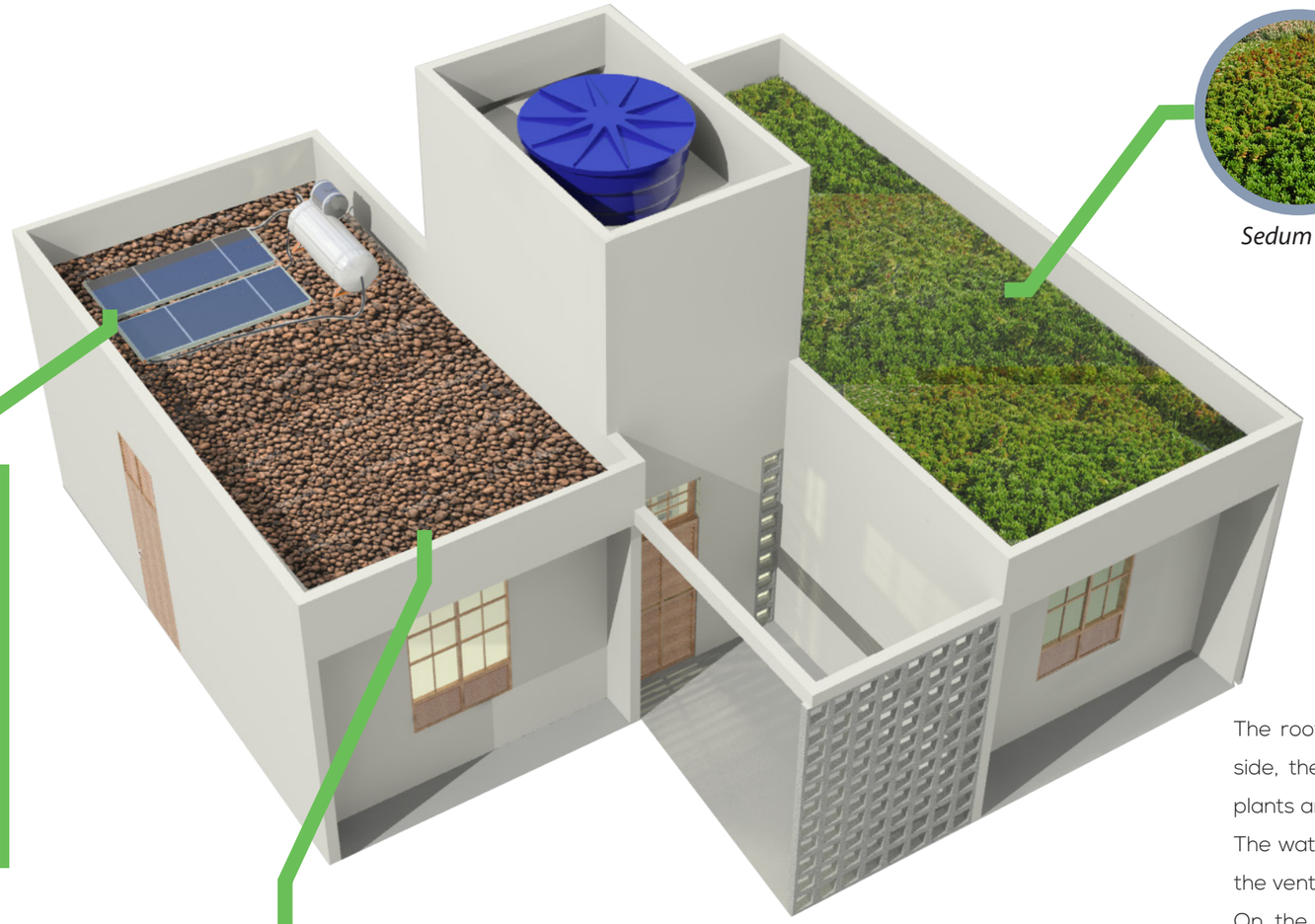
Collection Capacity:

7 mm rain: 39,4 sqm = 0,27m^3 - 5% runoff = 0,25m^3
10 mm rain: 39,4 sqm = 0,39m^3 - 5% runoff = 0,37m^3

Tank size:

10m^3

With a rain event of 10 mm is possible to collect approximately 0,37 m3 of water, so considering guaranteed seven events of 7 mm on the rainy months (6 months per year) it will be possible to collect at least 10,5 m3 of water per month, more than what is needed for the system to work all year round.
Considering that the water prices are R$ 8,84 per m3 x 2,7 x 6, the contributions represent a economy of R$ 143,20 in at least 6 month of the year.
The investment for constructing a 9m3 water saving system is approximately R$ 5850 so divinding the system cost for the monthly economy the payback is defined.
Dividing the investment for the monthly saving:
R$ 5850 / R$ 143 = 40 months
The system is payed back in 3 years and 4 months.



Sedum acre

Expanded Clay

4 people x 80 liters shower =
320 liters/day

320 liters/day x 25° C (^T)= 8000 kcal/h.day / 860 = 9,30 kW/day x 30 = **279 kw/month**

279 kWh/month / 80 kWh.m² =
3,48 m² of collectors

Solar Energy

S3B uses solar energy to warm up the showers water. The amount of water is dimensioned for four people taking one individual hot shower per day. An optimum angle based on latitude calculations, is provided by the solar panel companies. For Belo Horizonte, the optimum angle is 20° and solar panels facing north. The panels will then be placed facing the north façade, over one of the bedrooms. The solar collector used is a compact version with all the components included. According to the calculations, two collectors with a heating capacity of 1,6 sqm are needed.

Green Roof

S3B has the living, dining room and kitchen's roof covered by a modular green roof. The modules are 50x40cm and 8cm deep planted with Sedum acre or "Estrelinha Dourada". This is a resistant plant that doesn't require water daily.

The green roof benefits are both in a micro and macro dimension. In a Micro dimension, green roofs not only retain rainwater, but also moderate the temperature of the water and act as natural filters for any of the water that happens to run off.

The roof has vegetation on the south side, the green roof modular and the plants are planted inside of vases.
The water tank is placed on the top of the ventilation tower in the middle slab.
On the north side solar panels were placed.

They can improve biodiversity and also help reduce the distribution of dust and particulate matter in the air, thus, improving air quality.

On an individual perspective, they offer great insulation, reducing the amount of energy needed to moderate the temperature of a building, cooling down on the hot days and warming up on the cold days. Therefore, the long permanence public areas of the house benefit from the green roof as well.

Additional Sustainable **Systems**

Sewage Treatment System

This optional item is indicated for tS3Bs located in areas without public sewage.

The mini sewage treatment system makes the water clean enough to run into rivers and penetrate the ground. Therefore, is not enough to make the water drinkable, but the water can be used for the green roof, cleaning and flush toilets.

The mini station is a modular system made of non-toxic, lightweight and recyclable plastic.

Being modular and adjustable by the number of users, the mini stations can be used for a household with for one person or as many users needed. Their size may vary, depending on the amount of users. It keeps the water free of pathogens, avoiding the risk of disease transmission by poor sanitation.

Sewage Dimention

Vu = 1000 + N (CT + KLF)

V = volume in liters

N = number of people

C = sewage production, l/per person x days

T = days to full capacity in days

K = decomposing volume

Lf = area of decomposing volume, l/per person x days

Vu = 1000+4 (130x1 + 65x1) = 1780L = **1,78m3**

Diameter: 1,50m, volume: 1,78 m3 h=1,2m

Filter Dimention

Vu = 1,6 x N x C x T

N = number of people

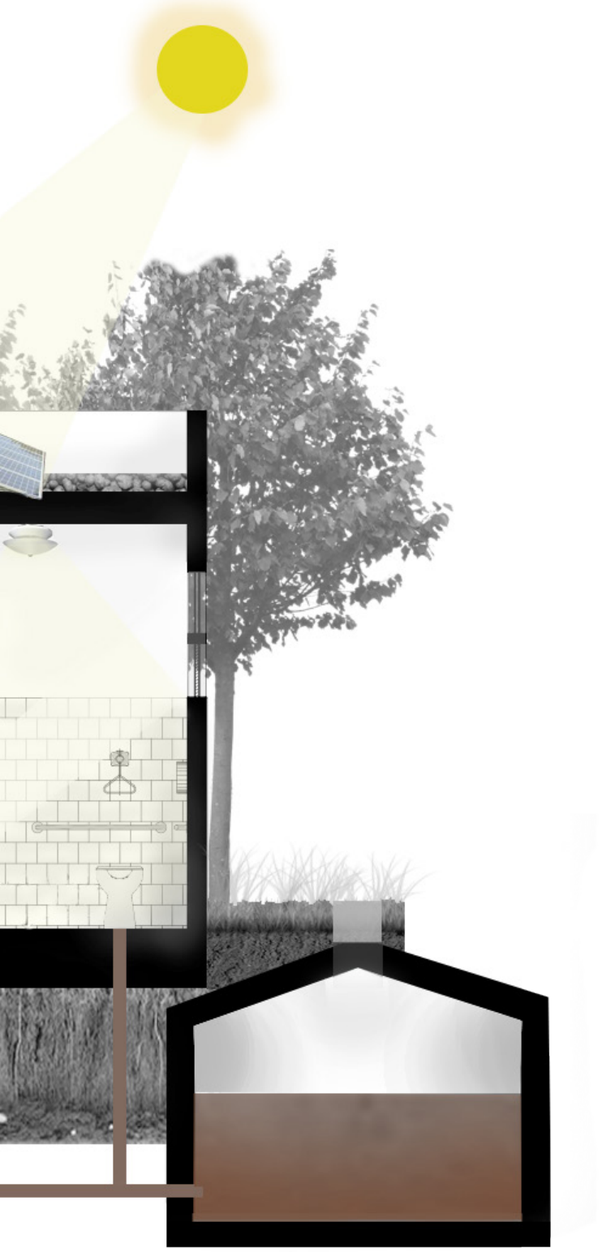
C = sewage production, l/per person x days

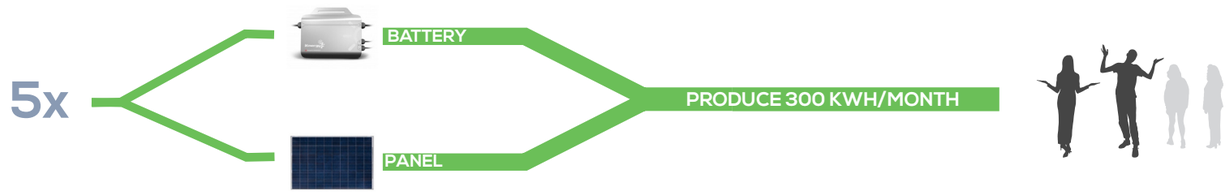
T = days to full capacity in days

K = decomposing volume

Vu = 1,6 x 4 x 130 x 1,17 = 973L = 0,97m3

Diameter: 1,20m, volume: 0,97 m3 h=1,2m





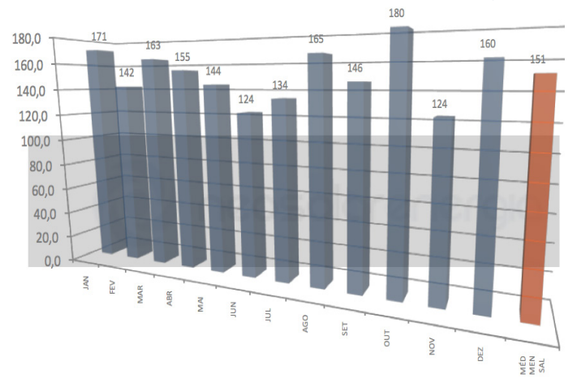
Photovoltaic System

S3B estimated a photo-voltaic system, but due to its high price, it becomes impossible to fit the system into the basic model of the house. Therefore, it comes as an optional item for families that want to invest on energy savings systems.

The system was dimensioned to produce around 50% of all the energy used montly in the house.

That means that in a house of four people, only two would be actually consuming energy from the utility company.

Estimated Production for the Photo-voltaic System



liação: INPE (Instituto Nacional de Pesquisa Espacial) e LABSOLAR (Laboratório de Energia Solar/UFSC) - Brasil

MONTH	Horizontal Global Radiation Kwh/m²	Ideal 18° Rad. 180° (N) Kwh/m²	18° Rad. 180° (N) Kwh/m²	Specific Production (kWh/kWp) Kwh	System Production Kwh	Estimated Usage Kwh	Solar Coverage %
JAN	206,5	190,5	190,5	142,9	171,5	300 Kwh/month	57,2%
FEB	164,2	158,2	158,2	118,7	142,4	300 Kwh/month	47,5%
MAR	177,9	181,6	181,6	136,2	163,4	300 Kwh/month	54,5%
APR	156,0	171,8	171,8	128,9	154,7	300 Kwh/month	51,6%
MAY	136,2	160,0	160,0	120,0	144,0	300 Kwh/month	48,0%
JUN	113,2	137,5	137,5	103,1	123,7	300 Kwh/month	41,2%
JUL	125,3	149,3	149,3	112,0	134,4	300 Kwh/month	44,8%
AUG	161,5	183,4	183,4	137,5	165,0	300 Kwh/month	55,0%
SEP	155,0	162,4	162,4	121,8	146,2	300 Kwh/month	48,7%
OCT	203,5	199,6	199,6	149,7	179,6	300 Kwh/month	59,9%
NOV	146,4	138,0	138,0	103,5	124,2	300 Kwh/month	41,4%
DEC	194,3	177,7	177,7	133,3	159,9	300 Kwh/month	53,3%
TOTAL	**1.940,1**	**2.010,1**	**2.010,1**	**1.507,5**	**1.809,1**	**3.600 Kwh/Year**	**50,3%**
MONTHLY AVERAGE	**161,7**	**167,5**	**167,5**	**125,6**	**150,8**	**300,0**	**50,3%**

S3

Cost and **production**

is a high quality house with prime and sustainable material, but still always affordable comparing to the same level of construction and quality.

Housing
Aprox. Cost

The chart shows a detailed price estimation for the S3B house taking in consideration all the construction aspects: administration and construction site, (instalations, cleaning and final checking, possible earth movements), fundation, concrete structure, roof, impermeabilization, walls, flooring, frames, paint, hydraulic, electric and structured wiring instalations.

The construction company gain estimated for the house was 28,87% a nomal margin for the MCMV Programme. With the gain the estimated total of the house is R$ 70 288 and without the gain the house costs R$ 55 824,88.

S3B HOUSING UNIT			Month of Ref. FEB/14			GAIN (%)	28,87%
	Service Discription	UN	QUANTITY	COST PER UNIT WITH GAIN	TOTAL COST WITH GAIN	UNIT COST WITHOUT GAIN	TOTAL COST WITHOUT GAIN
1	**ADMINISTRTION AND CONSTRUCTION SITE**						
1.1	**INSTALATIONS**						
1.1.1	WOODEN CONSTRUCTION SITES CLOSING 6 MM 2,20 X 1,22 M, H = 2,20 M, OPENINGS AND GATE	M2	80,00	47,05	3.764,03	36,51	2.920,80
1.1.2	BUILDING LOCATING	M2	62,00	10,76	667,16	8,35	517,70
	1 - SUBTOTAL - INSTALATIONS				**4.431,19**		**3.438,50**
1.2	**CLEANING AND FINAL CHECKING**						
1.2.1	CLEANING AND FINAL CHECKING	M2	62,00	1,73	107,07	1,34	83,08
	1.2 - SUBTOTAL - CLEANING AND FINAL CHECKING				**107,07**		**83,08**
2	**EARTH MOVEMENT**						
2.1	CLEANING AND LAND PREPARATION	M2	80,00	2,60	208,25	2,02	161,60
2.2	MATIRIAL TRANSPORTATION OF ANY KIND ON TRUCK DMT > 5 KM (INSIDE OF THE URBAN PERIMETER)	M3	16,20	1,47	23,80	1,14	18,47
	2- SUBTOTAL - EARTH MOVEMENT				**232,05**		**180,07**
3	**FUNDATION**						
3.1	MANUAL DIGINS H <= 1,50 M	M3	3,89	36,57	142,27	28,38	110,40
3.2	MANUAL LAND COMPRESSION AND ADJUSTMENT, WITH SOCKET	M2	3,29	3,44	11,32	2,67	8,78
3.3	SLIM CONCRETE BALLAST	M3	2,96	373,12	1.104,43	289,53	857,01
3.4	CUT, FOLD AND FRAMING STEEL CA-50/60	KG	40,50	8,00	324,11	6,21	251,51
3.5	RESINATED PLYWOOD MOULD AND deformation THICKNESS 14 MM, EXCLUSIVE SHORING (3X)	M2	12,60	58,84	741,41	45,66	575,32
3.6	SUPPLY AND LAUNCH OF CONCRETE STRUCTURAL MACHINED PUMPED FCK> = 20 MPA, GRIT 1 IN STRUCTURE	M3	1,63	408,56	665,95	317,03	516,76
3.7	TRANSPORT OF MATERIAL OF ANYKIND BARROW DMT <= 50 M	M3	3,89	37,62	146,33	29,19	113,55
	3 - SUBTOTAL - FUNDATION				**3.135,82**		**2.433,32**
4	**CONCRETE STRUCTURE**						
4.1	PRE CASTED BEAM WITH CONVENTIONAL FLOOR WEIGH CAP. 350KG/SM2 INTERSPACE UP TO 3,50M	M2	70,00	46,16	3.231,29	35,82	2.507,40
	4 - SUBTOTAL -CONCRETE STRUCTURE				**3.231,29**		**2.507,40**
5	**ROOF**						
5.1	TRANSPORT AND INSTALATION OF NATURAL COVERING (GREEN ROOF)PLANTED WITH Sedum acre (ALVEOLAR MEMBRANE HDPE, GEOTEXTILE MEMBRANE, MEMBRANE ANTI-ROOT, SUBSTRATE AND VEGETATION), MODULAR BASED. REF.: ECOTELHADO OR SIMILAR	M2	24,74	203,64	5.038,06	158,02	3.909,41
	5 - SUBTOTAL - ROOF				**5.038,06**		**3.909,41**
6	**IMPERMEABILIZATION**						
6.1	SLAB IMPERMEABILIZATION WITH ASPHALT MENBRANE (POLYMERS TYPE APP), E = 4 MM	M2	70,00	71,01	4.970,52	55,10	3.857,00
6.2	SURFACE PROTECTION WITH MORTAR CEMENT AND SAND, CM 1:7, E = 3 CM	M2	70,00	23,62	1.653,53	18,33	1.283,10
	6 - SUBTOTAL - IMPERMEABILIZATION				**6.624,05**		**5.140,10**
7	**WALLS**						
7.1	EPS PANELS	M2	162,00	70,88	11.482,32	55,00	8.910,00
	7 - SUBTOTAL - WALLS				**11.482,32**		**8.910,00**
8	**FINISHINGS**						
8.1	TUG WITH MORTAR 1:2:8 CEMENT, LIME AND SAND	M2	324,00	22,71	7.357,03	17,62	5.708,88
8.2	SUPPLY AND INSTALLATION OF CERAMIC COBOGÓ	UN	117,00	3,80	444,79	2,95	345,15
8.3	SUPPLY AND INSTALLATION OF CONCRETE FRAME WITH GLASS VENT	UN	151,00	8,02	1.210,37	6,22	939,22
8.4	BRIGHT WHITE TILE	M2	18,17	24,51	445,37	19,02	345,59
8.5	SUPPLY AND INSTALLATION OF WOODEN BIOSYNTHETIC SLAT COATING MADE OF 70% PLASTIC BAGS AND 30% OF HULL COCOE AND OTHER ORGANIC WASTES, REF:. ECOBLOCK OR EQUIVALENT	UN	39,00	31,35	1.222,81	24,33	948,87
	8 - SUBTOTAL FINISHINGS				**10.680,38**		**8.287,71**
2.8	**FLOORING**						
2.8.1	TRANSITION BEAM E = 5 CM, NO BINDING, FCK = 10 MPA (MANUAL)	M2	62,00	26,71	1.656,31	20,73	1.285,26
2.8.2	SUBFLOOR IN MORTAR CEMENT AND SAND WASHED 1:3	M2	54,40	26,71	1.453,28	20,73	1.127,71
2.8.3	IN LOCO FRAMED FLOOR FROM RECYCLED MATERIAL CONCRESTEEL	M2	54,40	128,87	7.010,53	100,00	5.440,00
	2.8 - SUBTOTAL - FLOORING				**10.120,13**		**7.852,97**
9	**FRAMES**						
9.1	SUPPLY AND INSTALLATION OF DOOR - 90X210CM +60 - OPENING SINGLE LEAF VENETIAN IN EUCALYPTUS WOOD - COMPLETE	UN	1,00	469,50	469,50	364,32	364,32
9.2	SUPPLY AND INSTALLATION OF DOOR - 90X210CM +60 - OPENING SINGLE LEAF IN EUCALYPTUS WOOD - COMPLETE	UN	4,00	257,74	1.030,96	200,00	800,00

	S3B HOUSING UNIT		Month of Ref. FEB/14			GAIN (%)	28,87%
	Service Discription	UN	QUANTITY	COST PER UNIT WITH GAIN	TOTAL COST WITH GAIN	UNIT COST WITHOUT GAIN	TOTAL COST WITHOUT GAIN
9.3	SUPPLY AND INSTALLATION OF WINDOW 120x150 40-CM - TWO SLIDING SHEETS COMPLETE WITH GLASS	UN	3,00	470,12	1.410,35	364,80	1.094,40
9.4	SUPPLY AND INSTALLATION OF WINDOW-120X60 +40 CM - SIDE HUNG COMPLETE WITH GLASS	UN	3,00	344,08	1.032,25	267,00	801,00
9.5	SUPPLY AND INSTALATION OF IRON TRAPDOOR 70x70cm, HARDWARE INCLUDED	UN	1,00	94,80	94,80	73,56	73,56
	9 - SUBTOTAL - FRAMES				**3.943,06**		**3.133,28**
10	**PAINT**						
10.1	BACKGROUND PREPARER ECOSILICA SEALER - 1 COAT	BA	34,00	38,66	1.314,47	30,00	1.020,00
10.2	ECOSILICA PAINTING, COLOR SNOW WHITE - 2 COATS	BA	30,00	70,88	2.126,36	55,00	1.650,00
10.3	MATTE IMMUNIZING VARNISH IN WOODEN FRAMES MATTE - 2 COATS	M2	22,59	16,30	368,26	12,65	285,76
	10 - SUBTOTAL - PAINT				**3.809,09**		**2.955,76**
11	**HYDRAULIC INSTALATIONS**						
11.1	SUPPLY AND INSTALLATION OF WATER METER BOX IN PRE-CAST CONCRETE	UN	1,00	132,04	132,04	102,46	102,46
11.2	SUPPLY AND INSTALLATION OF PORCELAIN TANK INCLUDING METALS	UN	1,00	132,57	132,57	102,87	102,87
11.3	SUPPLY AND INSTALLATION OF COUNTER TOP IN SYNTHETIC MARBLE, SINKERS 2CM ON WALL AND SUPPORTED BY120x60cm METALON	UN	1,00	185,37	185,37	143,84	143,84
11.4	SUPPLY AND INSTALLATION OF CLOSE-COUPLED SANITARY BOWL WITH DUAL FLUSH	UN	1,00	214,34	214,34	166,32	166,32
11.5	SUPPLY AND INSTALLATION OF WASHBASIN IN WHITE PORCELAIN	UN	1,00	225,90	225,90	175,29	175,29
11.6	SUPPLY AND INSTALLATION OF FIBER WATER TANK 500L WITH LID, KEG, REPRESSION AND PUMP - MATERIAL	UN	2,00	415,49	830,98	322,41	644,82
11.7	SUPPLY AND INSTALLATION OF MICRO DEKIT IRRIGATION WITH 24 DREPPERS ELGO CDK 24	UN	1,00	183,00	183,00	142,00	142,00
11.8	SUPPLY AND INSTALLATION OF COMPACT SOLAR HEATER	UN	1,00	1.729,44	1.729,44	1.342,00	1.342,00
11.9	SUPPLY AND INSTALLATION OF TAP FOR BASIN AUTO LOCK TABLE, CHROME FINISH, DECAMTIC ECO LINE, CODE:. 1173C - DECA OR EQUIVALENT	UN	1,00	442,73	442,73	343,55	343,55
11.10	SUPPLY AND DISTRIBUTION OF WATER PLUMB	UN	1,00	770,62	770,62	597,98	597,98
11.11	SUPPLY AND DISTRIBUTION SEWER / WATER PLUVIAL PLUMBS	UN	1,00	584,86	584,86	453,84	453,84
	11 - SUBTOTAL - HYDRAULIC INSTALATIONS -				**5.431,83**		**4.214,97**
12	**ELECTRIC AND STRUCTURED WIRING INSTALATIONS**						
12.1	SUPPLY AND INSTALLATION OF CONDUITS AND BOXES IN SLAB	UN	1,00	146,59	146,59	113,75	113,75
12.2	SUPPLY AND INSTALLATION OF CONDUITS AND BOXESIN WALLS- QDC'S AND TELEPHONY	UN	1,00	372,82	124,83	289,30	289,30
12.3	SUPPLY AND INSTALLATION OF WIRING AND TELEPHONY DISTRIBUTION	UN	1,00	585,25	294,20	454,14	454,14
12.4	SUPPLY AND INSTALLATION OF FINISHUPS (SWITCHES, OUTLETS AND BREAKERS)	UN	1,00	495,21	750,64	384,27	384,27
12.5	SUPPLY AND INSTALLATION OF POWER INPUT	UN	1,00	329,47	15,13	255,66	255,66
12.6	SUPPLY AND INSTALLATION OF POWER MEASUREMENT FRAMEWORK	UN	1,00	406,34	279,65	315,31	315,31
12.7	SUPPLY AND INSTALLATION OF POWER CABLES	UN	1,00	662,43	362,32	514,03	514,03
12.8	SUPPLY AND INSTALLATION OF POWER CORDS QDC `S	UN	1,00	582,29	58,94	451,84	451,84
	12 - SUBTOTAL- ELECTRIC AND STRUCTURED WIRING INSTALATIONS				**2.032,30**		**2.778,30**
	GENERAL TOTAL				**70.298,63**		**55.824,88**

Economy Generated by the Sustainable Systems

Another price list that should be taken in consideration is the economy generated by the sustainable systems comparing to a traditional construction. The sustainable aspects such as solar energy, water reuse, and the cross ventilation, chiminee effect and green roof represent energy, water and cooling big savings. Solar panels in the S3B are used to heat up water for shower, and replace the traditional electric showers broadly used in Brazil.

Those showers are resposable for around 25% to 30% of the electricity bill.

The water saved for reuse is mainly for garden and cleaning and represents an economy of R$ 143,20 in at least 6 months every year.

The cross ventilation, green roof and chiminee effect keep the heat out and the temperature low, so it replaces the need of A/C, that alone represents a heavy parcel of the electricity bill.

As a simulation to estimate the A/C bill price, it is considered a 770w A/C x 8 hours per day x 30 days = 184,84 KW/h, x the price R$ 0,40 per KW = R$ 73,98 for only one of the a/c machines, if it is two of them the value raises to R$ 147,96. This value to a family that has an income of between R$ 2000 and R$ 4000 is heavy.

Project
Conclusion

The proposition of this project was to create an affordable house, minding the sustainable aspects. After analyzing the Brazilian housing status, finding out about a 5 million house deficit and that part of this deficit was due to low quality housing, I got the confirmation that this was the right project to develop.

Even though the government created the Minha Casa Minha Vida Programme, and the houses are multiplying, the house quality is dropping, the deficit will keep rising through the years and the "dream of the household" can become a nightmare. It is bad loop.
From hearing constructors from Minha Casa Minha Vida, benefiters from the programme, and also following the news about the subject, I am capable of making my own analyses of the sides of the case.

By analyzing what is available, and media news about social housing programmes, it is frequent news about bad quality "Minha Casa Minha Vida" constructions, benefiters complaining about how warm the houses are, how much sound from the neighbors passes through the walls and even about structural problems. It shows a total negligence with people and with the main concept of the programme and was a big motivation to search the reasons for these problems.

Looking deep into the construction part of view, I found out that the conventional materials used for affordable housing, are chosen by the price or simply because they resemble some materials that are considered noble in the Brazilian construction. For the constructors it is easier to keep it simple and the user maybe for not knowing any other alternative accepts the housing that is provided. But accepting does not mean giving up on trying to adapt it to their needs.

After I analyzed some housing programme communities, I found out that people have adapted their house to their family size, their taste and needs. Therefore the S3B house became also S3B M and S3B L.

Through the research I could notice that the sustainable aspects ventilation and cooling specially the cross ventilation, stack effect, solar shadings, window vents, cobogó used to be present especially in the Brazilian housing architecture until the early 70's, after that those essential aspects for Brazil, a tropical high temperature country started to be forgotten.
Mostly because of money, and ambition of earning more, constructions are built fast and with not so much thinking behind it.

Recently, those constructive aspects before widely used, started to be rescued by many architects involved by the sustainable thinking, or "green wave". The architects have the power and knowledge to convince the constructor with smart and clear arguments of why sustainable aspects should be taken in consideration. When it comes to materials, it is still a fact that the range of eco-friendly materials available in Brazil are starting to grow, but their usage is still very limited due to their high price in some cases, but most of the time for the population's lack of knowledge.

Typical MCMV house

Random and Dangerous and Illegal Expansions

constructions because of the population's lack of knowledge. This leads to a stagnated type of architecture, the user doesn't ask for something better and the constructor keeps using the same conventional materials over and over again.

Developing consistent price estimation for the S3B house allowed me to conclude important facts. The house final price is R$ 55 824,88 without the construction company gain. With the gain of 28,87% the S3B house would cost to the user R$ 70 298,63.
The S3B house costs then less than half of the maximum MCMV loan of R$ 170 000 allowed for Belo Horizonte region, available for families earning from R$ 3 275 to R$ 5000 or MCMV type 3. This house value leaves a great margin for the land purchase.

According to SINAPI (Sistema Nacional de Pesquisas de Custo e Indices da Construção Civil) national cost research system and civil contruction index, the low-income house cost per square meter for the month of February 2014 was R$ 829,45 without the construction company gain.

This is a traditional house with very few sustainable aspects. S3B with it's 62 sqm including walls has a cost of R$ 900,40.

I concluded that it is possible to make a house with sustainable systems and using sustainable materials for less than 10% extra of what is normally spent in a traditional low-income family's house unit. Something to be taken in consideration as well is that the payback for the sustainable systems is not even in account, if accounted the payback would rapidly make up to the extra price for the sustainable house through the years.

The objective of this Master Thesis which was to design an appealing, low-cost, good quality sustainable home unit for the emerging Brazilian middle class featuring energy efficiency, water reuse and sustainable food production elements, under the budget of R$170 000 was achieved.
S3B shows that it is possible for families to have a more flexible, solid quality, creative and sustainable kind of living with a short budget and careful, conscientious and environmental planning.

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