



# FO<sub>2</sub>TPRINT

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MPARC  
Matter space studio  
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**CHALMERS**

## Introduction:

The idea of working with a mountain refuge as a master thesis came to me during the summer of 2014, when I together with a friend went for a hike in the french Alpes. We spent one night in the refuge «Temple Ecrins», situated in the national park «Des Ecrins». As an architecture student the night in this refuge was an interesting experience, since this specific place treats several questions in both social, environmental and constructive aspects. I saw great potential for a master thesis in this place. Indeed this refuge work as a perfect case study in order to test new ways of building in extreme situation. Because of its location in a national park the refuge has to be an example, a model of virtuous approach.

## Hypothesis:

By managing to solve constructional, social and environmental issues in such a complex area, new ideas and solutions will be developed, which also can be implemented in more normal conditions. The exemplary level of this refuge could become an argument, a strength regarding its attractiveness.

## Problematic:

How can we limit the impact of a new construction in such sensible environment and besides that offer good qualities of comfort, adapted to the needs of the users?

After having tested several strategies and balancing advantages and disadvantages regarding replacing the existing refuge with a new building, I got the conclusion of conserving the existing building as much as possible. The refuge is however after 65 years not adapted to its user's needs anymore and seems to be abandoned. Therefore it's important to give it a new architectural value and a higher standard. The guidelines of this project is to optimize the building already on site and to explore the

possibility of transformation in order to get a high-energy performance building.

During a preparatory course I got the opportunity to deeply analyze the specificity of the site, balance strengths and weaknesses and to take into consideration the historical aspects. This course gave me time to explore several strategies instead of giving a first and too early answer. By contacting mountain architecture experts and analyzing architecture references I clarified the aim of the project and identified the real issues. I concluded that architecture should not challenge nature but compose with it.

By working in different scales I investigated how to optimize space, how to make people with different expectations live together and how to bring a level of comfort and individual privacy in a such small space?

Throughout the project I worked with a sustainable approach. When choosing materials I for example took in consideration the materials different impact on the environment. I also took into account the impact of the the transportation of materials by helicopter and the benefits of using prefabricated elements.

This project is the result of accurate analyses of the site and its extreme conditions, social interactions between users, constructive solutions and environmental impact. I believe that my project can work as inspiration to others by being an example of virtue and by its pedagogical impact, showing a new way to deal with architecture together with nature.

## FO2PRINT

The renovation field is one of the biggest challenges that we face today if we want to reach the energetic aims for 2050. In order to facilitate a project and/or for saving money we often choose to destroy the building without taking care of its value or the impact on the environment that a new building would cause.

For my master thesis I therefore propose an approach to analyze and study the strength of an old mountain refuge, located in the french Alps and built in 1945. This refuge takes place in an out of time location, perched into the mountains. It is a place dedicated to rest, an intermediary step of the long hikes passing through this region. Sixty-five years after its construction, this refuge is not longer adapted to the user's needs.

The aim of my work is to show the possibilities of transforming an old and unsuitable habitat to a functional and efficient building. The fact that the refuge is hard to access makes it even more important to contemplate the possibilities of keeping as much as possible of the old one, since transportation of both old and new material will be difficult. This inaccessibility aspect has guided and restrained my choices, since the more transportation of new material that I propose, the bigger the CO2 footprint gets. Through keeping most parts of the consisting building I create an unique atmosphere where the visitor can contemplate a confrontation between the historical ruff materials (concrete and local stone) and the new, contemporary elements (wood, glass and iron). This merge will give an architectural identity that expresses the specificity of the site.

This project includes all the aspects of sustainable development, since it contains social, environmental and economic conditions. This refuge is a laboratory in order to test new solutions, find a responsible design for tomorrow and being a case study in order to test several behaviors in extreme situations. This project proofs that we can combine energetic performance, comfort and respect the history of the site at the same time. We don't find happiness in the increasing consumption!

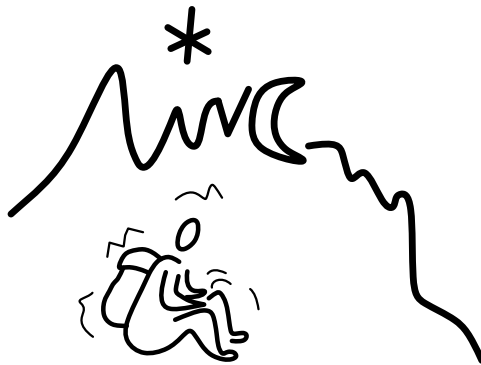
# Research

## What is a refuge?

It's an accommodation, isolated due to its location in altitude, which makes it inaccessible by vehicles. It is permanently open and provide shelter and food for people practicing sport in the mountain. The identity and the soul of the refuge is based on the mountain identity (ruff and harsh). This atmosphere requests from the users to have an autonomy approach in a community dynamic. In the refuge there is a constant tension between the consolation to find shelter and the aggression feeling due to the promiscuity with people.

Note:

- Should the refuge be adapted to the users or in the opposite adapt the users to the refuge? - Should the refuge offer something specific instead of just answering a basic question?



## Refuge history

Nowadays we can differentiate two general types of refuges. The first kind of refuge is situated close to inhabited areas in the bottom of a valley (on the same altitude as the pasture). The second kind of refuge is built at the beginning of the access road to the peak, where no construction, has never been built.

The evolution of the refuge is closely related to mountaineers history. In the second part of the 18-century, the very first mountaineers aimed to conquer high mountain peaks, called "accursed mountain". The first constructions of shelters starts to be built during this time of discovering new land in high altitude, when the discoverers had to protect themselves

from night, cold and bad weather. During the first expeditions the word “refuge” is born, since it better than “shelter” describes the needs of the mountaineers who were up in the mountains during days trying to reach different peaks.

During the last two centuries mountaineer’s activities keep on progressing, influencing and changing the way of building a refuge. At first, refuge constructions were quite basic, including four walls and a roof. There was only one collective room, the refuge was always open and not maintained by any guardian. This first generation of refuges were built out of concrete or in wood. The framework was assembled and disassembled in the valley then brought on site by foot.

At the beginning of the 20th century, with the increasing development of mountain hikes mountains became more and more attractive. Since that time refuges are made for hosting several tens of people and need to be maintained. The architecture begun to be more complex, with an addition of several rooms around one big. This new kind of refuge maintained by a guardian, had for the first time a separated room from the kitchen, an airlock to protect the inside from the cold, separate dormitories for men and women and usually one room reserved for guides.

After the Second World War mountains start to be democratized and more accessible for everyone. Paths and roads were made more accessible. The program of the refuge gets bigger and old refuges need to be extended or demolished. The new generation of refuges has emerged to become public equipment. The control of air transportation introduces a new way to design and build in the mountain. In the middle of the 20th century the refuge become a self-sufficient building, allowing heating and light. The building becomes a laboratory and the support of new technologies experimentations.

At the beginning of the 21st century mountain activities are multiplied. There is now a distinction between mountaineers and simple hikers. Now the refuge is not only a functional shelter but also a part of the mountain and need to bring a contribution for the site and revealing the landscape. Nowadays managers of the mountain refuge have two opposite ideas of a refuge. Some see it as an extension of the society, a tourism product that need to be promoting, while others think that it should still be connected to the site and keep a good balance between comfort and harshness.

## **The topography**

Buildings situated in mountains are hard or impossible to access due to the steep slope. Bringing material on site is really difficult. That's why light material and prefabricated systems have always been used for refuges. The utilisation of concrete should be used as little as possible because of the complexity of implementation and to minimize the human footprint on the site. Nowadays all the elements used for a refuge are brought on site by helicopter, so the size of each element has to fit with the weight load of the machine.





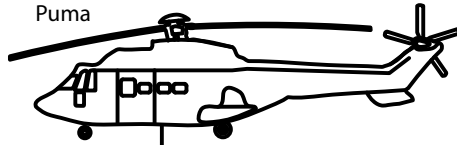
Regular helicoptere



Cost -600euro of prep  
and 26 euro/min  
-Need at least 5 person

650kg

Puma



Cost -1500euro of prep  
and between 50 and 80 euro/min  
-Need at least 5 person

1500kg

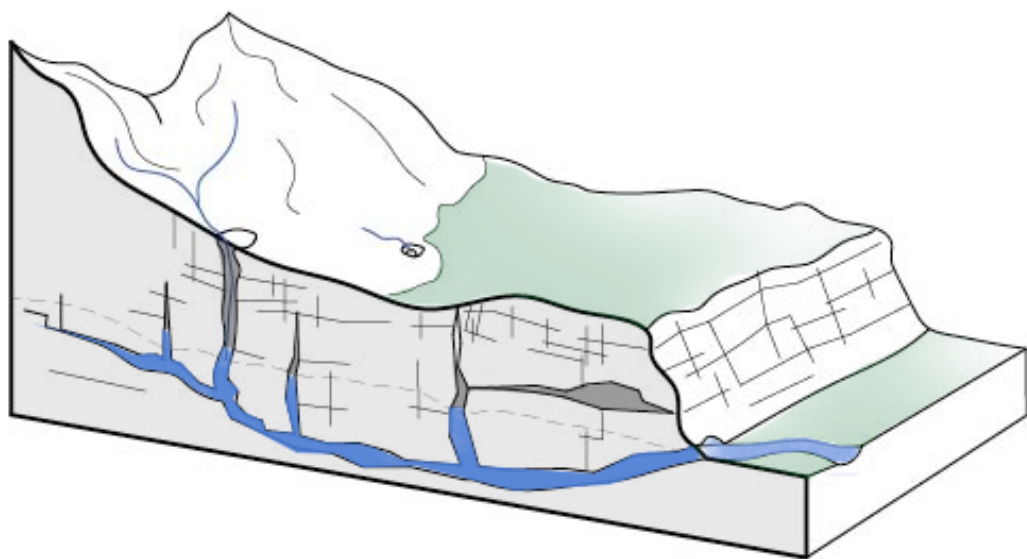


## Water

After a long, painful and cold hike, everybody wants to have a warm dinner, a warm shower and a place to dry their clothes. Basically everybody would prefer the everyday comfort. All those comfort aspects will come with needs of fresh water; which will generate a big volume of used water and a big amount of energy loss.

Refuges always need a huge amount of water and energy during the summer season, due to the short rushing tourism time. The wintertime needs shouldn't be forgotten even if it's technically more difficult to solve them because of the mountain climate. Supplying water during winter and the beginning of the spring, turn out to be really tricky due to the high altitude. The climate has a quite strong influence on the water management. During the cold and long winters there is a big accumulation of snow, which could hide water intake points. Soil and water are both frozen so there is no infiltration towards the aquifers\*. The aquifers are quickly filled up between spring and summer when the snow and ice melt. A problem could occur during storm periods, when the water is being mixed with small solid particles. Those particles make the water undrinkable, and then the collected water has to be treated before being distributed. To be able to use water for a human consumption from a natural area in France, you have to ask for a special authorisation. Water used for drinking must follow a quality standard set up by the administration.

\*An aquifer is a geological formation constituted by permeable rock, which contains a huge amount of water.



## The guardian

As his clients the guardian love the mountain, but for him the mountain is a living and working area and not just a leisure activity. As a captain of a boat, the guardian has the authority of the refuge. He/she is there to make everything work and to transmit the mountain legacy spirit.

The guardian has two main tasks, controlling and maintaining the refuge but also to welcome the user. The welcoming function has increased and begins to be one of the major aspects. Everybody agrees that the guardian's personality and his way to act with visitors is really important in order to make the refuge more attractive. The aim is to create a community for a night.

The profession of guardian has changed over time, now he is more a trader than a simple host. This new status has come from the development of service, like dinner, which is an additional aspect of the historic accommodation function.

The guardian and the manager are linked by a contract that balance the economical interests between them to cover the costs of construction and maintenance. Since a couple of decades, this kind of contract allows the guardian to administer a restaurant service and impose him to do the maintenance and also to be in charge of all the economic managements of the refuge. That is why the guardian refers to the mountaineers as "clients" while the manager speaks about "users".

Note: The guardian should be in the centre o the refuge in order to facilitate his visual control on the on coming situation. This is essential in order to keep a good atmosphere. He should have his own private space to be able to welcome everybody in good condition.



## **Who are the users?**

The refuge is a place where different kinds of users are mixed all together in a small place, which could easily generate conflicts. These are the different kind of users and their specificity:

### **The mountaineer**



The standard mountaineer is a man around 50 years old. He is a heir of the pioneers from the tourist generation after the second world war. This thrill seeker enjoys surpassing his own limitations, loves to practice sport surrounded by nature, but his relation with the mountain is ambiguous. He is doing sport like he is doing war; nature is something to

conquer. He has good sport ability, a competition spirit, got control over the situation he's in and healthy way of living. He developed a great independence.

### **His expectations and his behaviour in the refuge**

He arrives quite late to the refuge (just before dinner), he goes to bed and wakes up early. From the guardian he is expecting to get information about weather condition and itinerary, in order to prepare for the fight of tomorrow. According to him the most important function of the refuge is the shelter aspect, and the refuge should be dedicated for resting and recuperation. In the refuge the mountaineer is self-sufficient, he just needs a small dinner and breakfast. He is not bothered by his own body odor or the lack of privacy, neither the rudimentary comfort.

### **The climber**



The mountaineer has a big admiration for the dexterity of the climber. The climber that you can meet in the refuge is the same as the one you find on indoor climbing walls. The climber could be any age or sex. He likes the mountain in a really good condition (dry, sunny and stable). He doesn't like

long and exhausting journeys and appreciates when the mountain is well equipped. As the mountaineer he has the satisfaction of effort and has a good technical control of himself. He is fighting against the rock.

When he succeeds in his climb, it's a victory! Even if he takes time to contemplate and enjoy the nature around him.

### **His expectation and his behaviour in the refuge**

He expects the refuge to be a relaxing and comfortable place. He doesn't wake up early and like to spend time on the terrace during a sunny time.

### **The backpacker**



The backpacker could be alone or in a group, male or female and any age. They are from the middle class of the society (for example a teacher). The backpacker has a naive image of a mountain with lakes and pastures. His motivations are the contemplation of nature, the physical aspect, discovering new places and to meet strangers. He prefers leisure before competition. He is not always a big fan of sports, since his physical condition and technical control (handling orientation instruments, reading maps, evaluate risks) are not the best.

### **His expectation and his behaviours in the refuge**

The backpacker arrives quite early to the refuge and like to be outside when there is good weather. He likes to wake up pretty early to have a walk and be surprised by the ecosystem and the wildlife all around him. In the refuge he is expecting to sleep and eat well, be secure and meet other people. He support his body odor but he will enjoy to take a bath in the river or in a lake that he will find close to the refuge in spring. He is spontaneously attracted by nature life and is not bothered by the outdoor toilet. The backpacker group is increasing constantly since twenty years.

### **The neo hikers**



It's usually a family, for them the refuge represent the aim of the hike or just a break in a two days hike which should normally take one day. They are young and have children, they are not really confident in this new environment. They are more focused on discovering the mountain as a new environment and to meet people than doing a real effort.

## **Their expectations and their behaviour in the refuge**

They arrive pretty early but go to bed and wake up late. They don't do the distinction between hotel, cottage and refuge. They are not really self-sufficient in the refuge. They see the mountain as a consumption place where people will take care of them (TV, food etc.). They prefer to be indoors and like to have a separated room. They can't stand their own odor and need to take a shower. They find it hard to adjust to this new and harsh world. This experience of the refuge is somehow an initiatory rite that will perhaps turn them into great hikers, if they can see and seduced by the beauty of this lifestyle.

## **V- The other client**



- Le "lost one»

He is here by error; there is a big gap between him and the other users. He doesn't know any thing about the mountain or refuges. This radical confrontation with the new world is too harsh for him. He can't succeed his integration if he manages to join another category otherwise he will never come back.

- The "daily visitor»

He could be part of any categories: Mountaineer, climber, backpacker, neo hiker. For him the refuge is a place where he can get information (meteo, itinerary), or shelter when it rains, or just be useful for the toilet.

## Description of the refuge “Temple Ecrins”

The refuge “Temple Ecrins” is situated in the municipality of Oisans in France, at an altitude of 2410 meters, in the middle of the “national park des Ecrins”. It’s owned by the Club Alpin Francais (CAF) which was founded in 1874. To help mountaineers in their hikes of this area CAF and the “Société des Touristes du Dauphiné” (STD) started from the 19th century to supply shelter dedicated to people hiking in the mountains of the municipality of Oisans. Refuges from the first generation of shelters were placed according to the natural relief (cave, flat surface etc). Those refuges were made out of stone or wood. It is in this context that the “refuge du vallon” was built in 1925 in the current location of “temple Ecrins”. This is a strategic location that gives you access to the famous peak Coolidge. Thirteen years after the construction of refuge du vallon it was destroyed by a snow avalanche. It was replaced by a new one, Temple Ecrins, in 1948 with subventions from the French state who wanted to build a new generation of refuges built out of concrete. Since this time the refuge has never been redone. Now the refuge is quite deteriorated, there is infiltration of water, and it has been judged insalubrious by the CAF. This lack of maintenance is due to politic management which prioritized other refuges instead of “Temple Ecrins”. The refuge was initially made for 120 persons but then it shrank to 64 people for security reasons, which is ok since the attendance of visitors has been decreasing the last years. In comparison, the refuge de la Pillate situated at 3 hours by foot from temple Ecrins tuned to be really popular after its restoration in 1994. This example motivated the CAF to work on temple Ecrins in order to bring a new prestige to the park and to attract more people.

I want to have a global approach of the project and taking in count technical problems, the comfort for the users, try to increase the current attendance and deal with the constraint of the site.





## What is a national park des Ecrins?

A national park is a vast and protected place, maintained because of its landscape. Its biological diversity needs to be kept and preserved as a legacy.

Altitude : 710-4102 meters above the sea level

Highest peak : Barre des Ecrins (4102 meters)

Trail : more than 700 km

Flora : 1800 vegetal species

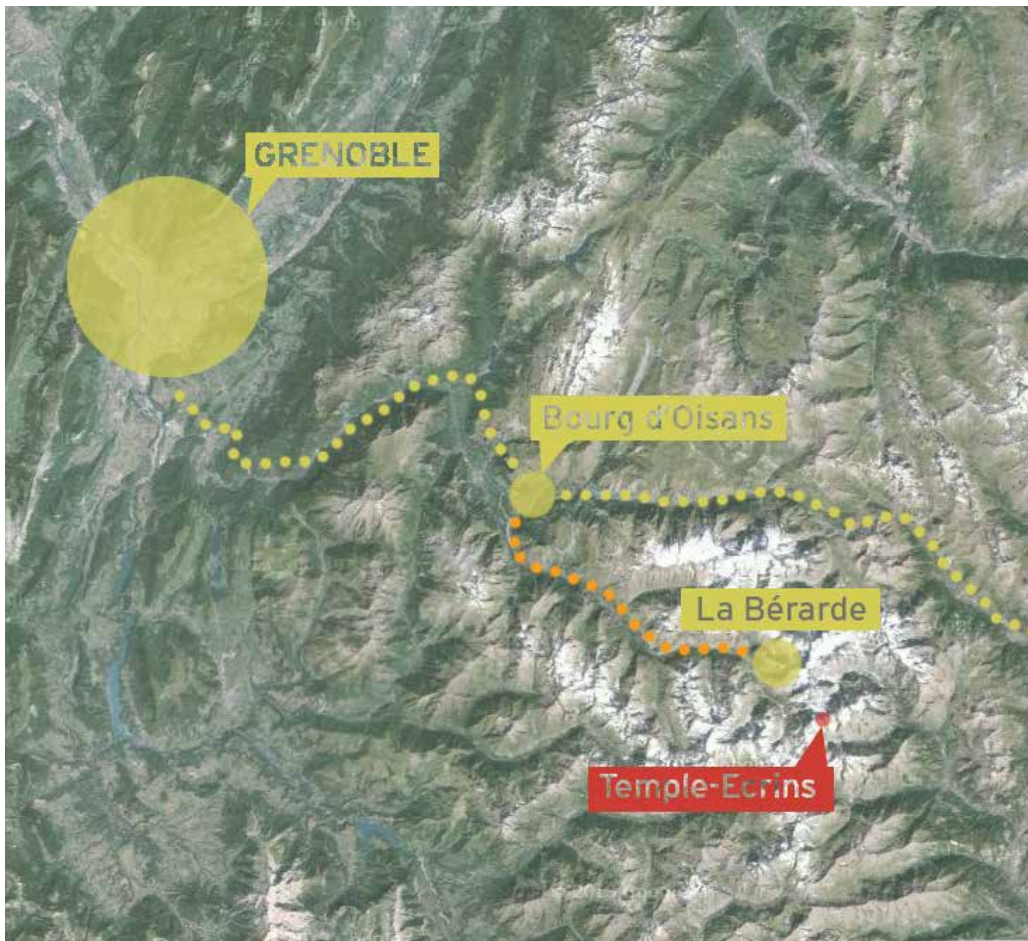
Fauna : 75 235 species

Glacier : 7120 ha

Forest : 41 422 ha



- ALTITUDE: 2410 m
- OWNER: FFCAM  
(fédération française des clubs alpins et de montagne)
- GUARDIAN: Guillaume Bailly and Florence Mauche
- MUNICIPALITY: Saint-Christophe-En-Oisans (isère)
- ACCESS: 2,5-3 hours from La Bérarde by foot
- USERS: mountaineers, hiker
- CAPACITY: 64 places
- SURFACE: 205.9 m2
- ATTENDANCE: 1491 guests in 2013



## Close to Grenoble

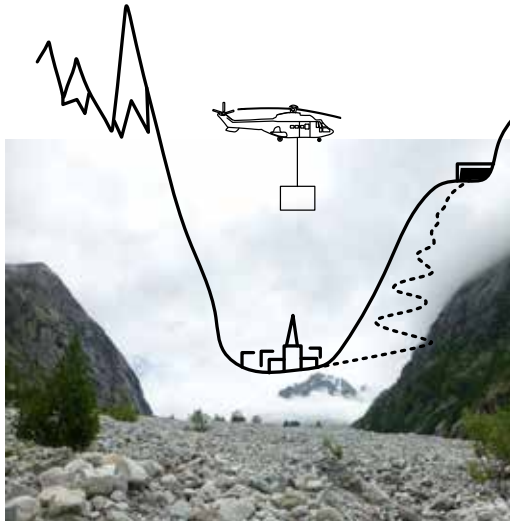
The refuge is easy to reach from a village called “la Bérarde” situated in the community of Saint Christophe en Oisans (1,5 hours by car from Grenoble). From la Bérarde it's a 2,5-3 hours walk with a difference of 700 meters in height before to reach the refuge. However the road which gives access to la Bérarde is closed from the first snow fall until the snow melts in spring. The trail that brings you to the refuge goes initially along the torrent called the “Vénéon” until the first refuge of the valley, “le Carrelet”. From this point the trail goes up to towards temple Ecrins. Further along the trail brings you to the last refuge of the valley, “la Pillate”.



The trail starts surrounded by shady leafy trees. Then it becomes more steep and dry. Later the trail crosses a forest of short pine trees, which let the visitor enjoy the view of the valley and the Vénéon. The amount of trees decreases with the altitude and disappear completely at a certain point. Then the visitor is really close to the refuge. Even if they can't see it yet, it's only one more loop of the trail before they can see the roof of a construction.



The evolution of the landscape along the trail.



By helicopter it takes only 5,5mn to go to the refuge, so 11mn for the back

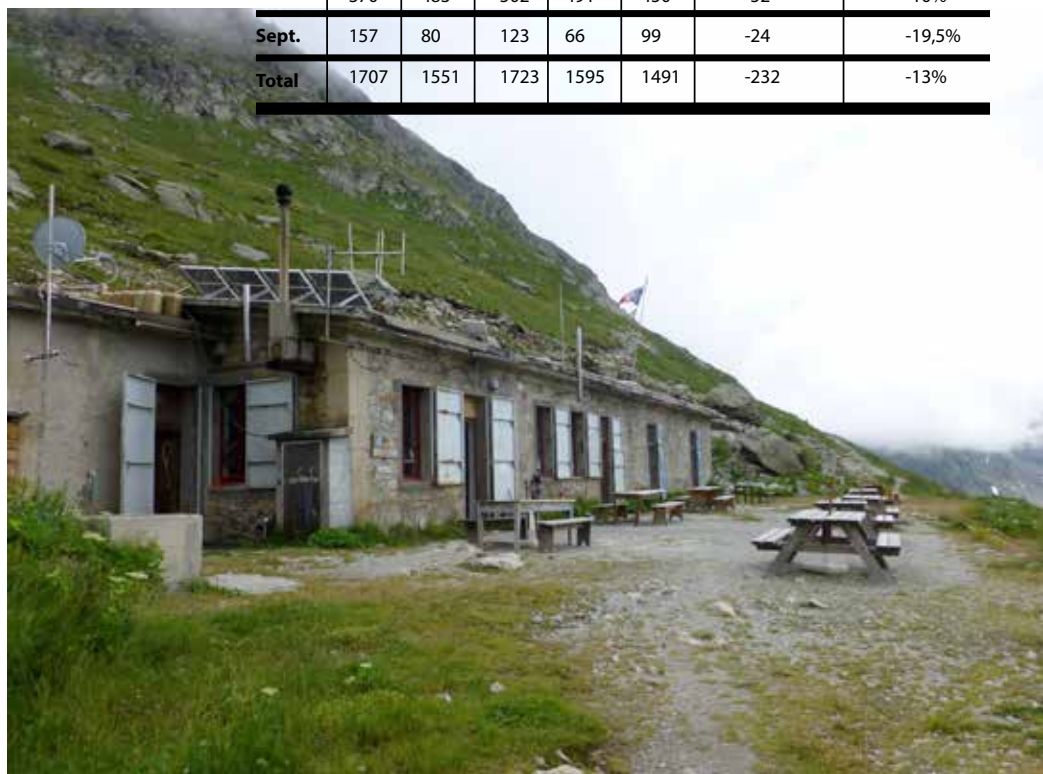


## The refuge

The refuge attracted a lot of users during the weekend (mostly from Grenoble), but not tat much along the week, the average attendance is about 13 person a day. From the refuge you can have access to some mythic peak (Barre des Ecrins, L'ailefroide, Pic Coolidge). That why there is 75 % of mountaineer.

**Attendance evolution between 2007 and 2012**

	2007	2008	2010	2011	2012	Difference between 2010 and 2012	Pourcentage between 2010 and 2012
<b>May</b>	56	22	19	5	14	-5	-26%
<b>June</b>	459	268	269	256	337	+68	25%
<b>July</b>	665	698	810	777	591	-219	-27%
<b>August</b>	370	483	502	491	450	-52	-10%
<b>Sept.</b>	157	80	123	66	99	-24	-19,5%
<b>Total</b>	1707	1551	1723	1595	1491	-232	-13%



**Main hikes around “Temple ecrin”**







From the refuge.

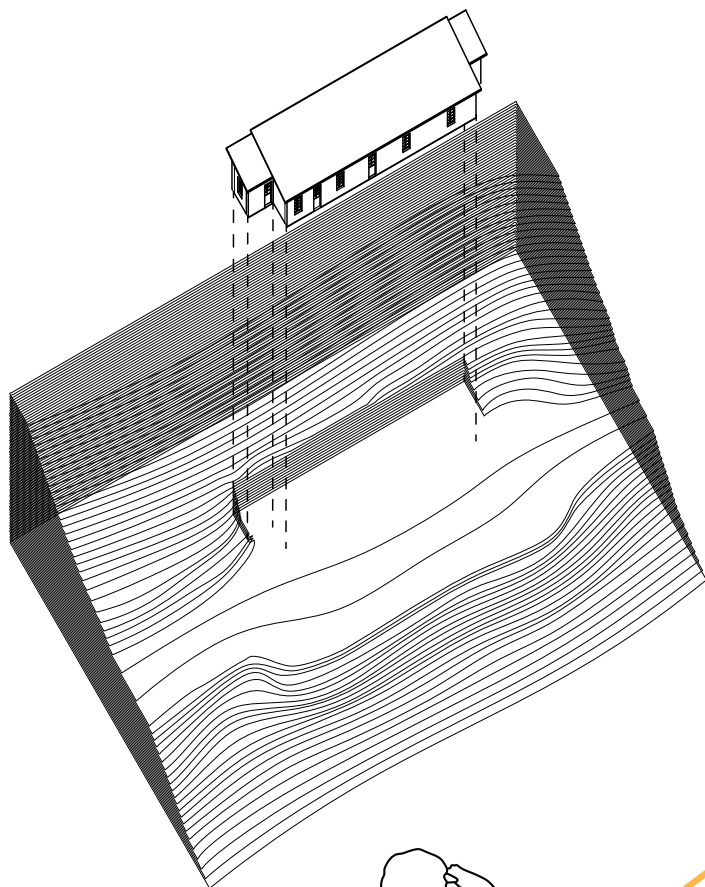
- Pic Coolidge:47%
- Barre des Ecrins:7,24%
- Pré de Mme Carles: 7%
- Col de la temple:3%
- Col des avalanches:4%

Smaller hikes

- Tour de la barre des Ecrins:7%
- Tour des Ailefroides:7%

Walks

- La Bérarde/Temple Ecrins 2h30-3h
- La bérarde/La Pilatte 4h
- Temple-Ecrins/La Pilatte 2h-230



L'Ailefroide  
3954m

Temple Ecrain is mono-oriented toward East. The drawing on the right represent the view from the terrace. It is important to analyse the hours of sunlight, in order to understand with which kind of light I have to deal and which system to set up.



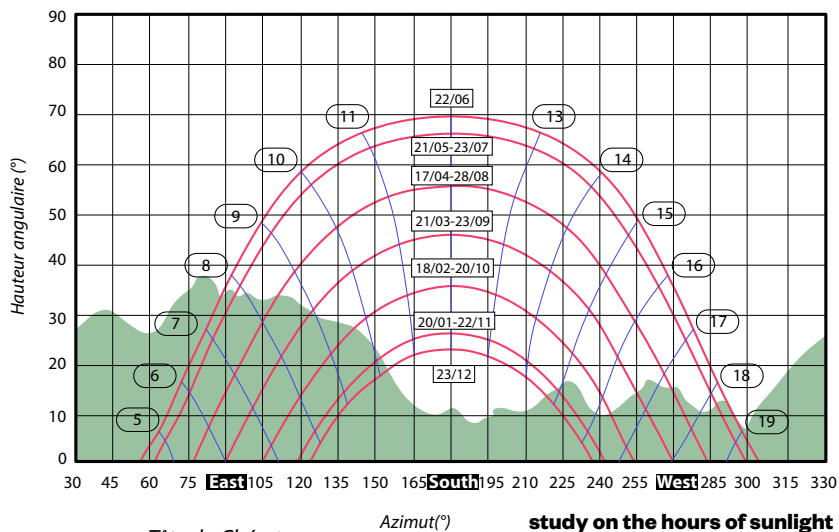
9h37

11h (the 23 sep. summer hours)

10h (the 21 mars winter hours)

11h





Les Bans  
3669m

Tête du Chéret  
3161m

Mont Gioberney  
3352m

Pic du SAYS  
3420m

Poine du vallon des  
etages 3309m

Cinte de l'encoula  
3421m

Grande Aiguille de  
la Bérarde 3421m

22 June  
10h55 of sun

21 March  
7h40 of sun

22 December  
4h55 of sun

15h50

18h40

20h30

## **Energy**

### *Electricity, gas, coal*

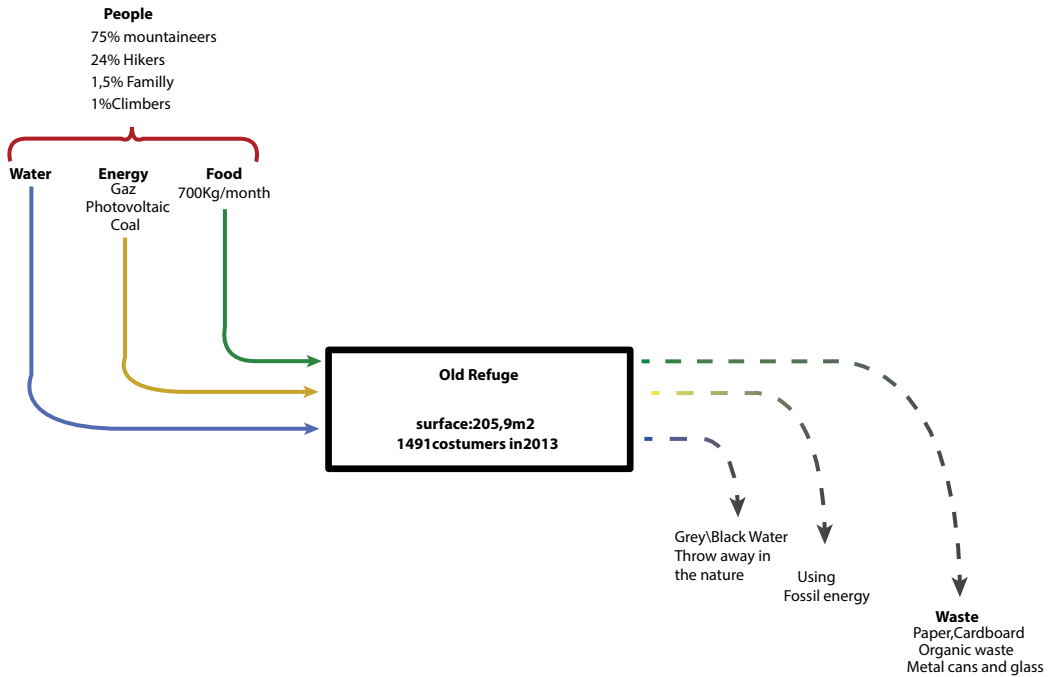
The refuge needs electricity for the kitchen, lamps and several other equipment such as phone, computer, printer, freezer and laundry machine. Since 1993 eight photovoltaic panels are installed on the roof during the guarded time and taken down in fall to protect them from a snow avalanche. They provide electricity for the phone and the rest of the energy produced is stored within 12 batteries. A generator supply the rest of the energy to the refuge, and refill the batteries of the solar cell. The oven gets energy from coal. The freezer is using gas from a bottle a stored outside. Right now there is no heating system in the refuge.

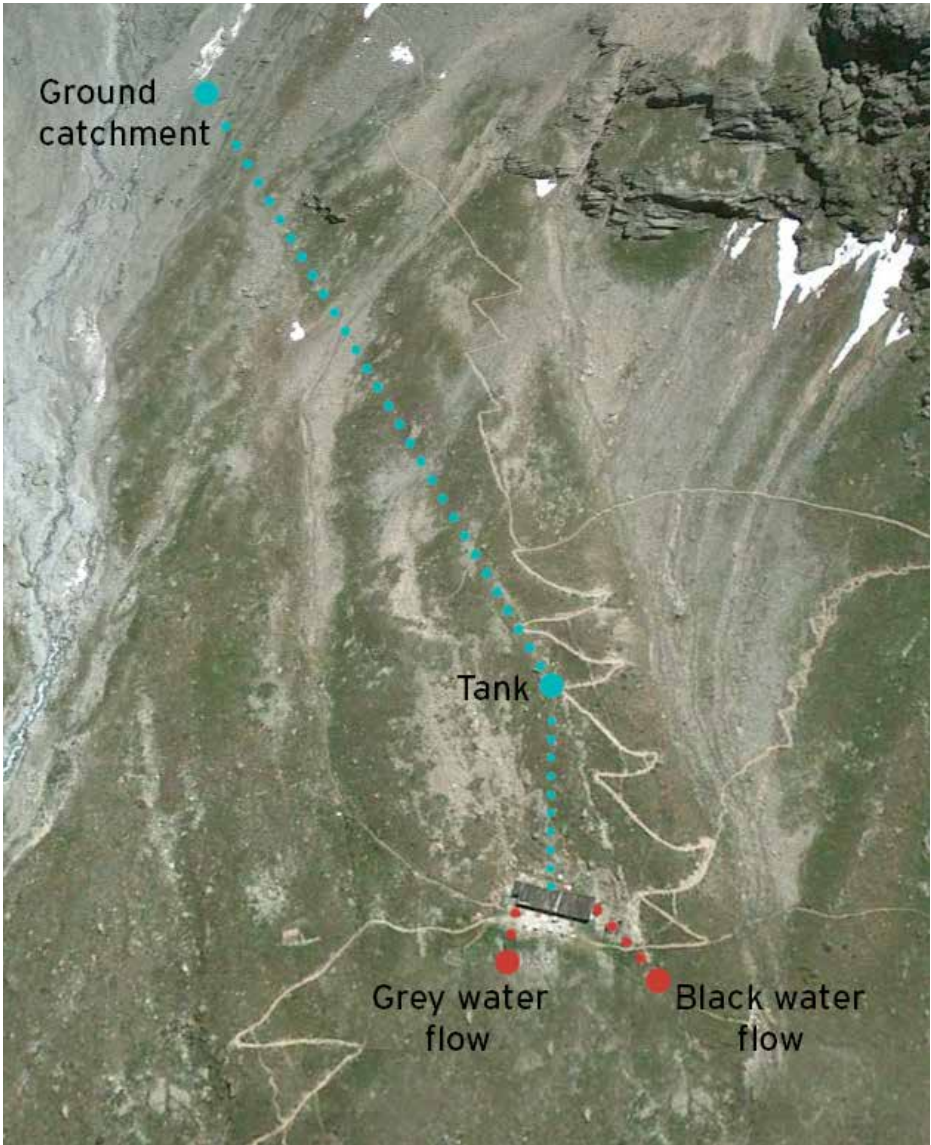
### *Water management*

There is stream that supplies the refuge with drinking water situated approximately 250 meters north-east of the refuge at 2485 meters of altitude. In 1978 a tank of 1,2 m<sup>3</sup> was set up 60 meters away from the refuge to store the water. It's still functioning today. The used water, "grey water", flows back to nature at approximately 11 meters away from the refuge without any treatment. The black water goes also back to nature without any treatment 35 meters away from the refuge.

### *Waste treatment*

- Organic waste is composted at site.
- Paper, cardboard and packaging are burned in an incinerator.
- Metallic cans and glass are brought down to the valley by helicopter.
- The coal is thrown away closed to the refuge.

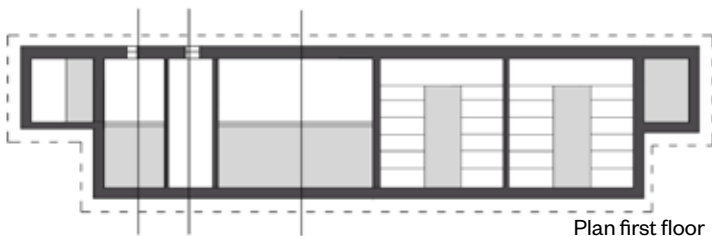




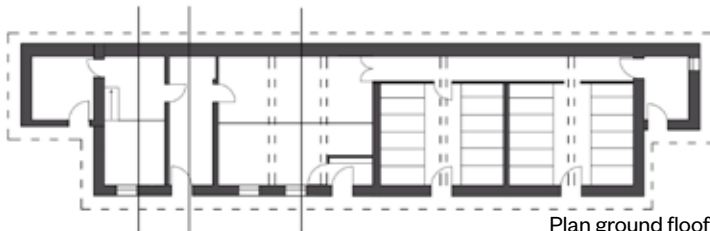
I analyse by drawing and modeling the the exesting building in oder to understand it's strengths and weaknesses. This analysis will help me to wright the program of my new refuge.



Table Area	
<b>Groundfloor</b>	
Storage	8,7m2
Kitchen	17,4m2
Entrance	13,45m2
Common room	40,5m2
Free cooking area	2,6m2
Corridor	13,15m2
Dormatory 1	27,2m2
Dormatory 2	28,4m2
Toilet	6,4m2
<b>Total groundfloor</b>	<b>157,8m2</b>
<b>Mezzanine</b>	
Storage	4,9m2
Guardian's bed room	8,5m2
Children's bed room	6,5m2
Storage	6,7m2
Guide's dormatory	21,5m2
<b>Total mezzanine</b>	<b>48,1m2</b>
<b>TOTAL REFUGE</b>	
	<b>205,9m2</b>



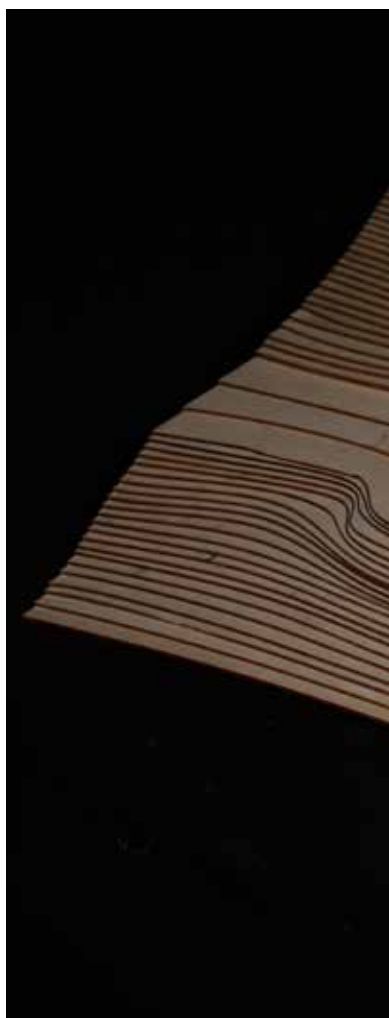
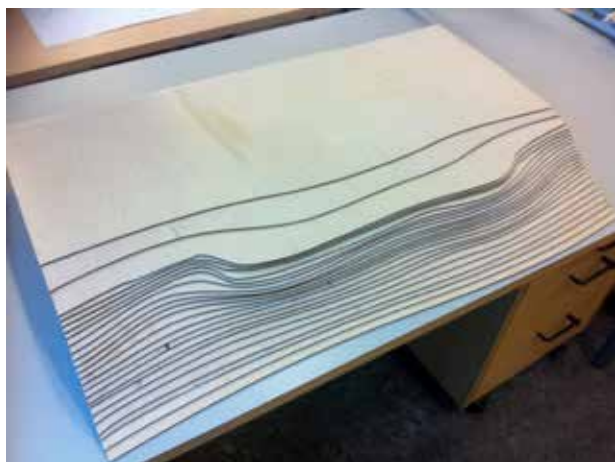
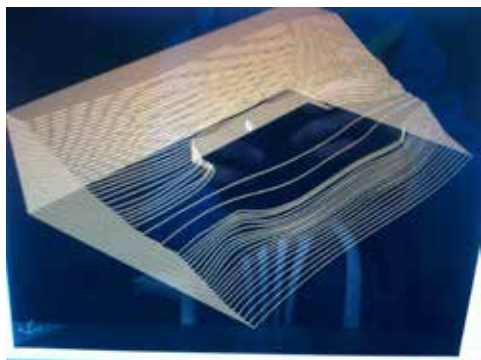
Plan first floor



Plan ground floor

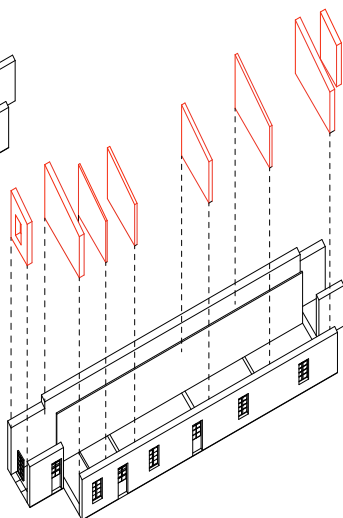
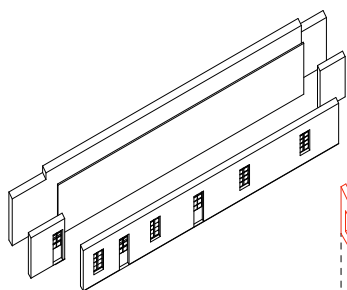


East Facade

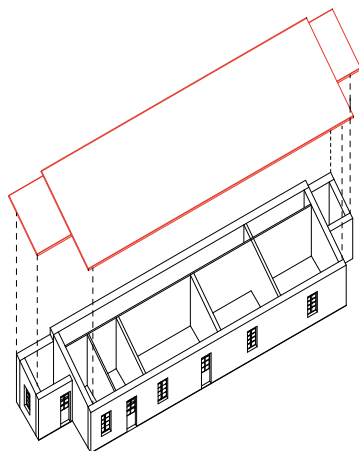




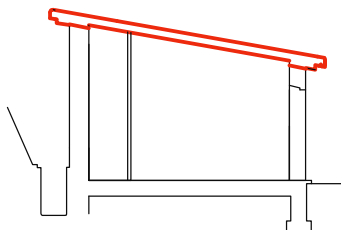
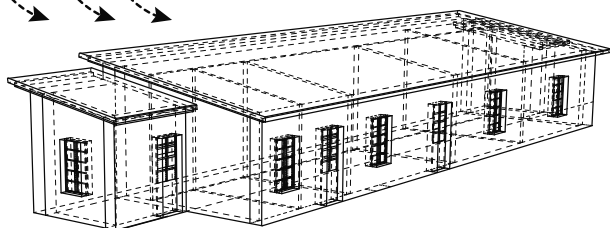
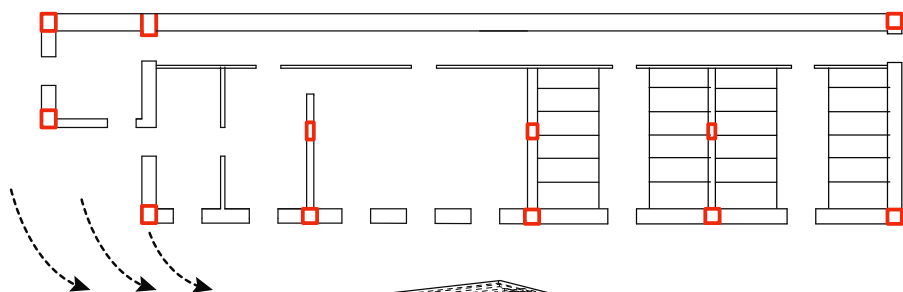




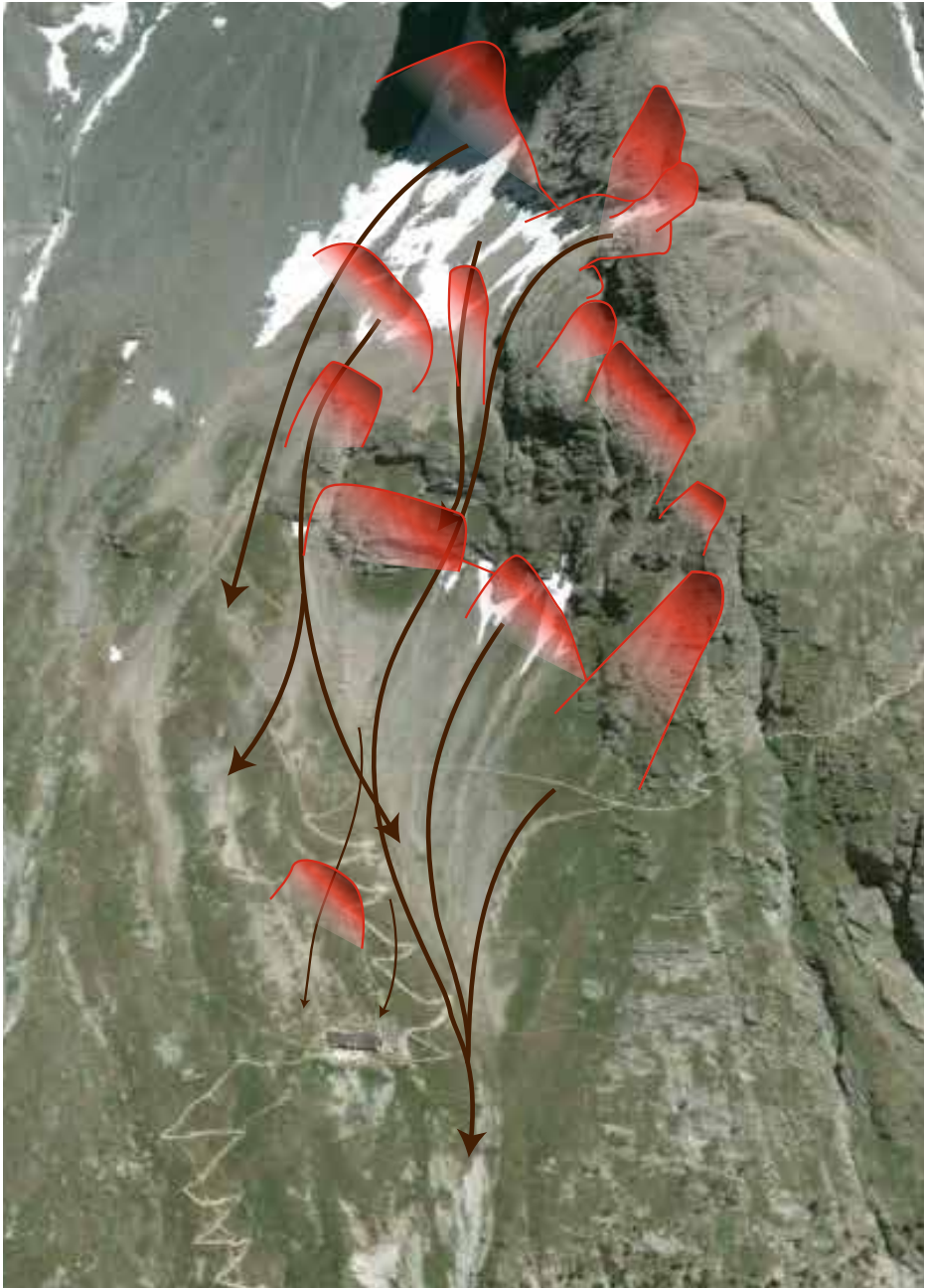
According to the analysis of the existing building, the all building has been built to resist against avalanches.



The roof and some key points are made out of armed concrete. Those key points are structural element reinforcing the building.







This diagram show where avalanche risk come from over Temple Eorin. You can see that due to its strategical situation Temple Eorin avoid the main flow of the avalanche.

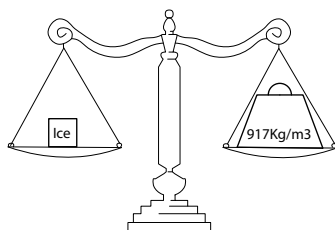
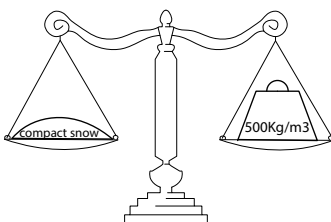
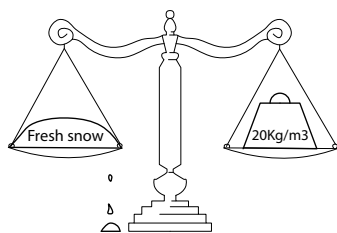


This risk should not be ignore, some left over part of avalanche could still come over the refuge.



Those historical pictures remind you that the risk is real !

## Snow weight



Average= 100kg/m3

**Average= 1000kg/m2**

## Risk

Snow avalanche.

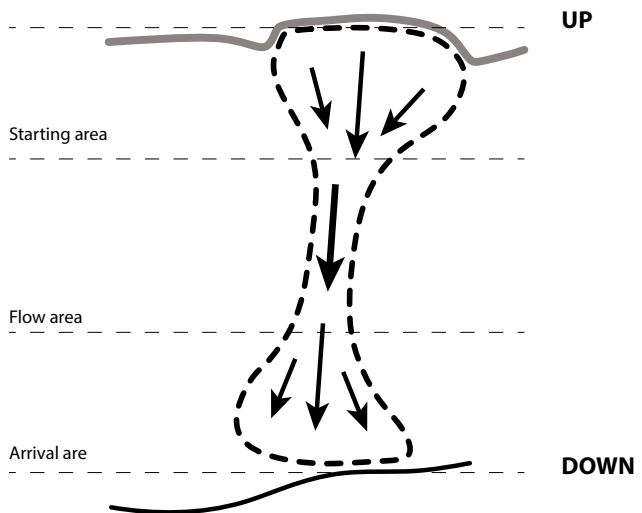
Avalanches are a mass movement of snow and ice down a hillside. The scientific world describes it as a complex and fast gravity movement of a mass of snow. The volume of the mass could be around some decade to several hundred thousand square metres.

3 distinct zones could compose a site with a risk of avalanche:

1 - the starting area or storage area

2 - the flow area

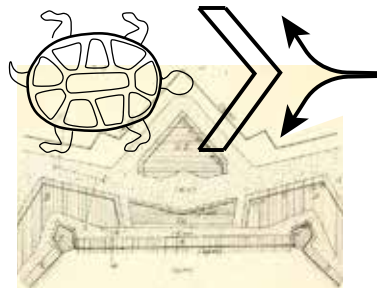
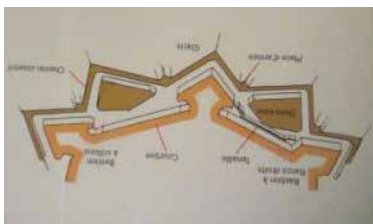
3 - The stop zone



First research about avalanche protection was made by the army on the 19 century after the destruction of a military hospital in the south of France.

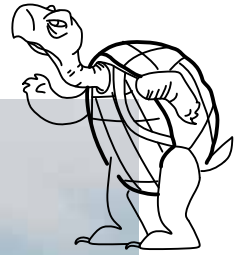
There are three main different behaviour against an avalanche reusing military strategies.

## Deviate



References: tracés bastionnés» military strategies in order to protect.

## Facing



References: Marquis de Montalembert le fort  
-le Fort de l'Enlon

## Hiding



References: -forts von Biehler  
-forts Brialmont

Avalanches could cause a really important damage. So the first rule when you want to build something in a such risky area, is to stay humble and modest. Even if we learn a lot about this subject, we still don't control all the aspect of the complex phenomenon.

## Modern references of architecture shaped against an avalanche



Mario Botta/Church of Mogno 1998



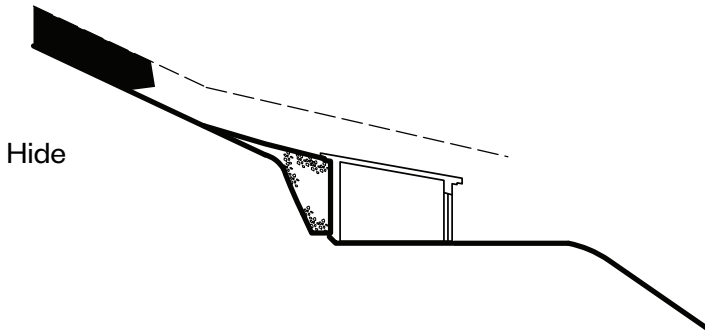
Peter Zumthor/ Saint Benedict Chapel



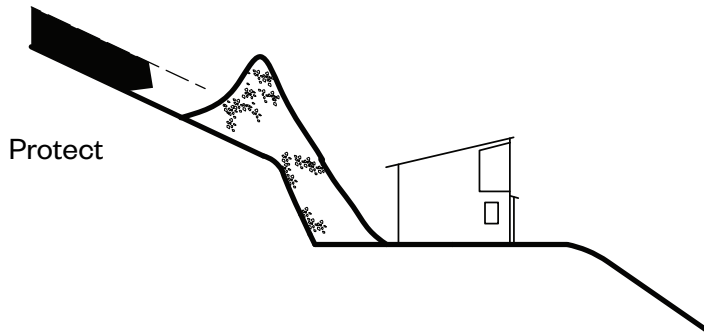
Refuge du couvercle



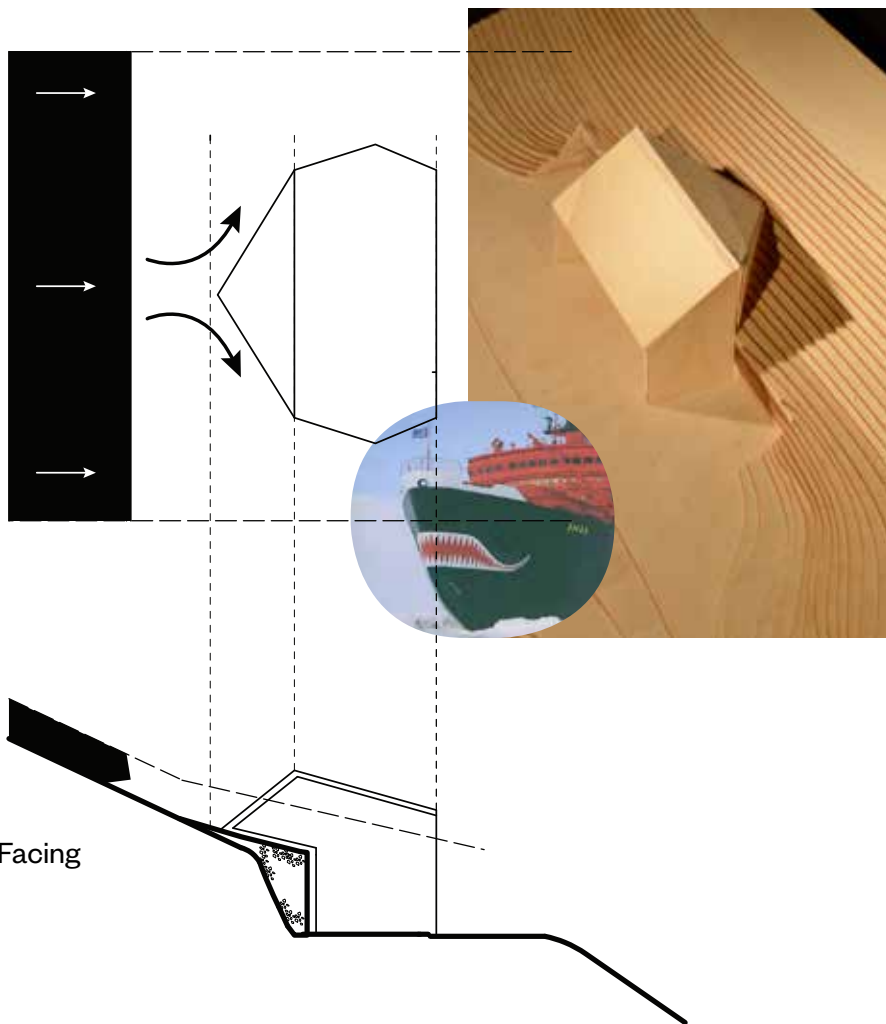




The location of Temple Ecrin allows different behaviour against the avalanche. The actual refuge hide from the avalanche, this strategie consists letting the snow coming over the roof. This strategy works quite well but the refuge turn to be hard to acess.

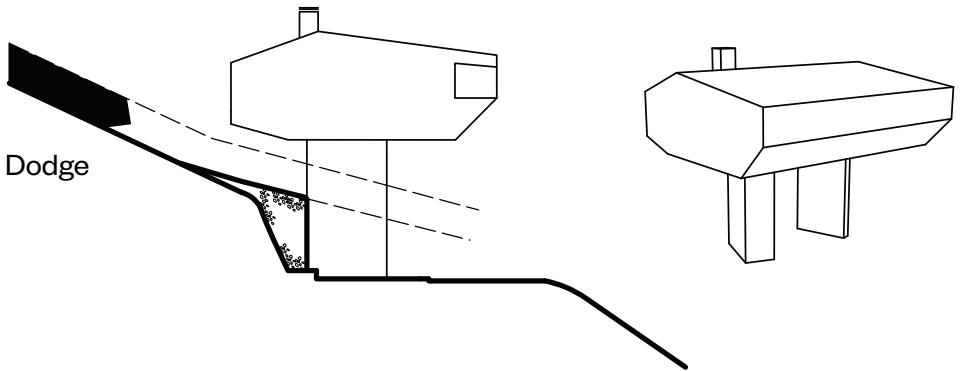


The “refuge du vallon” was the refuge built before Temple Ecrin in the same location. As you can see on the picture, the strategy is simple, a wall in order to protect a building.



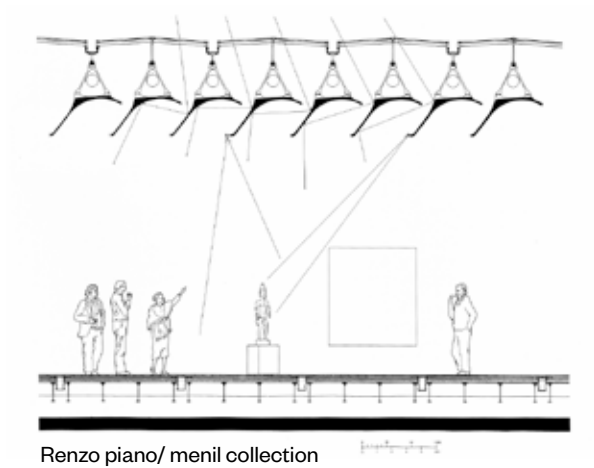
Inspired by the the icebreaker this strategy is bolder one. The building is shape to face and break the avalanche. The snow is supposed to flow around the building.





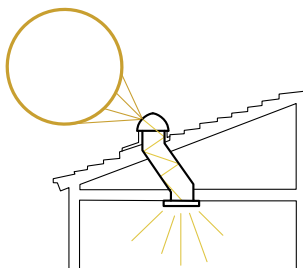
Dodging the avalanche by building something in high seems interesting in regard of the constraints imposing by the site. More over this strategy give the opportunity to have four real facade and to play with hight in views.

## Some references of architecture based on light effect.





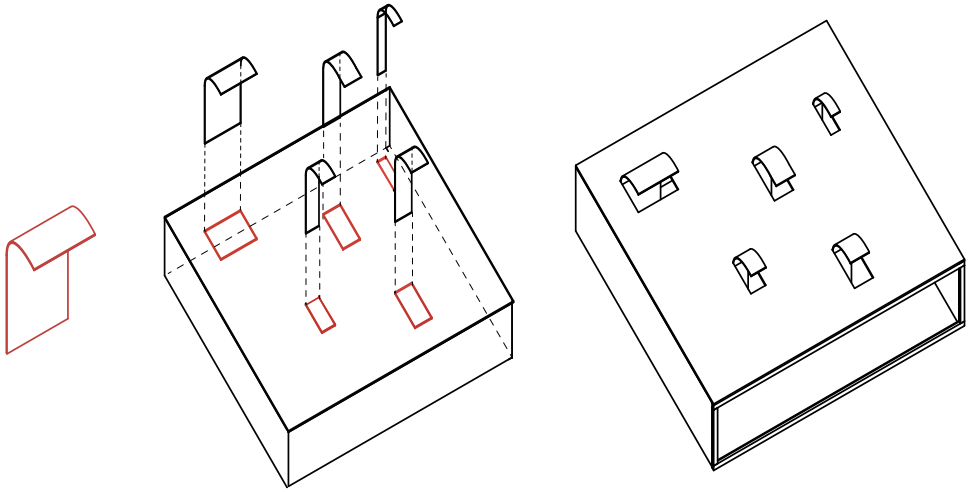
Shonan Christ Church / Takeshi Hosaka



Light well system



Pantheon (rome)

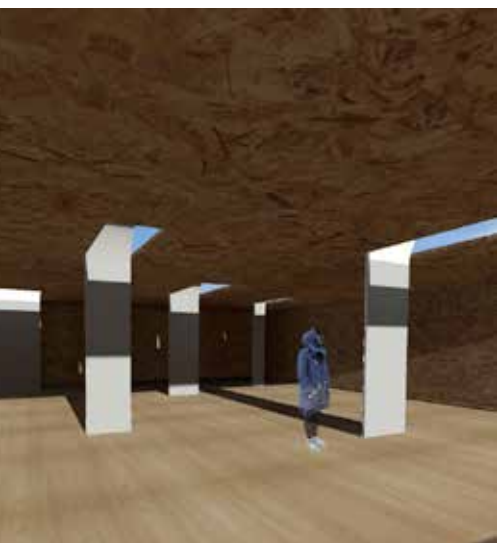


## Light experimentation

The movement of the light on white wavy surface is quite interesting, one of the challenge of my refuge would be to bring the light in. Some experimentations show different techniques and systems.

Here you can see the «screen system» supposed bring the light in the building.



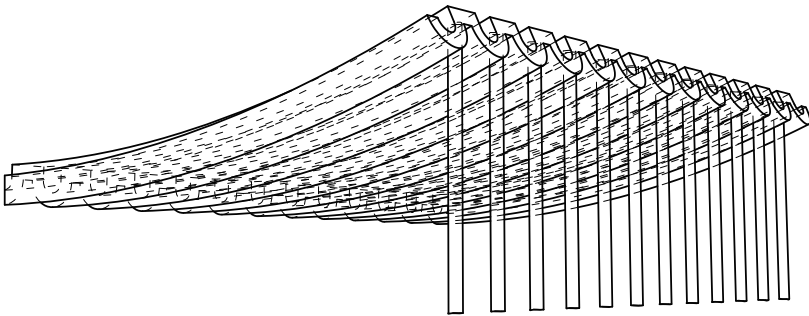
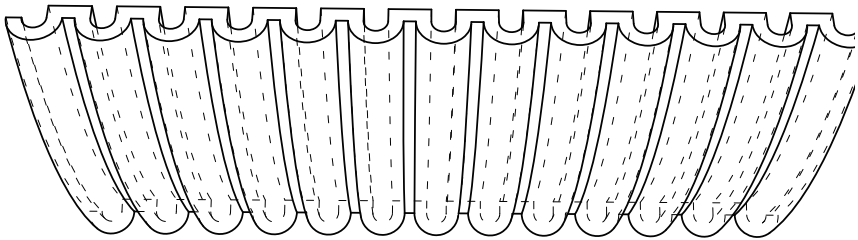




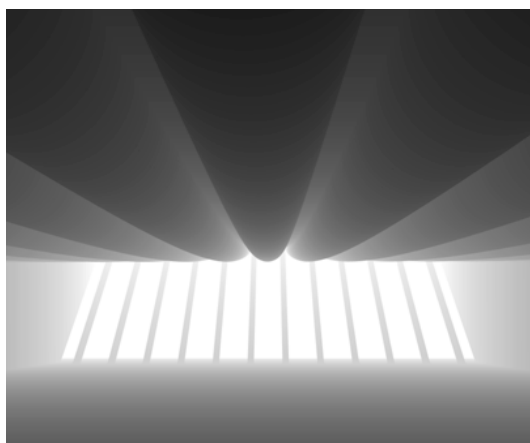
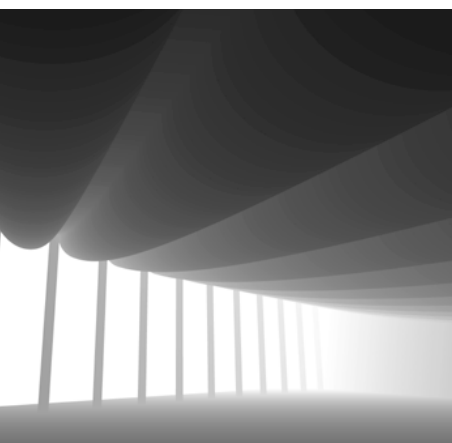
This system is close to the screen system. It's based on the light reflexion of round shapes. A roof like this could be a solution to bring light into dark and deep space.

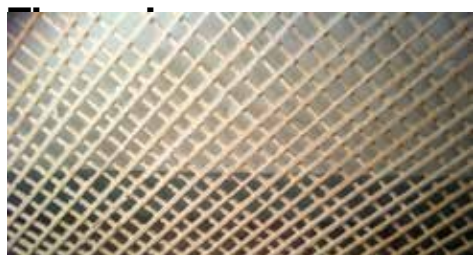
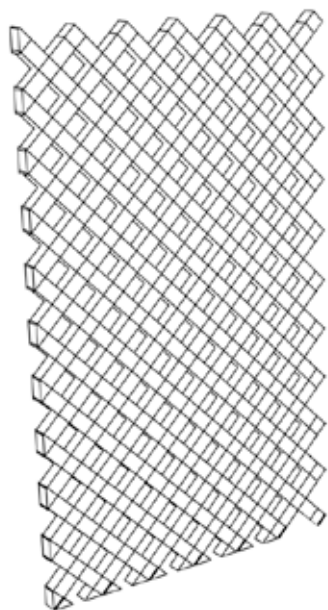




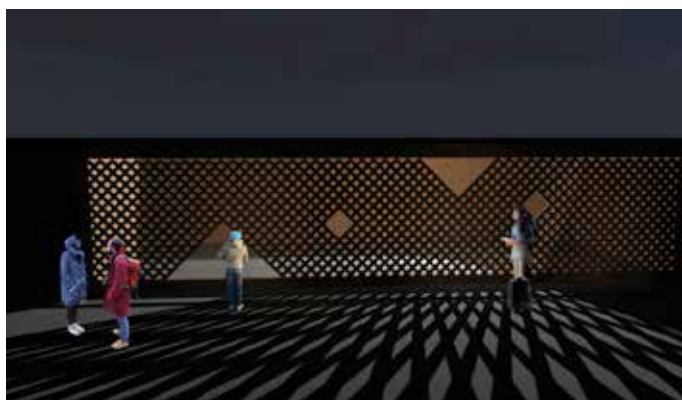






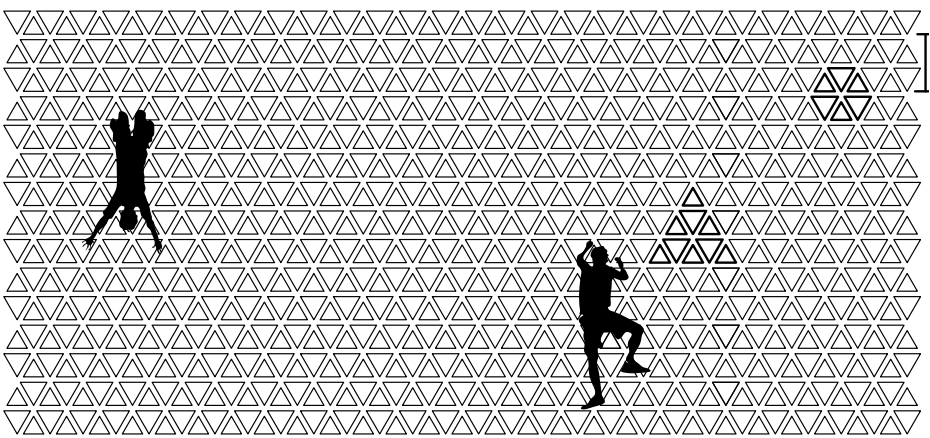
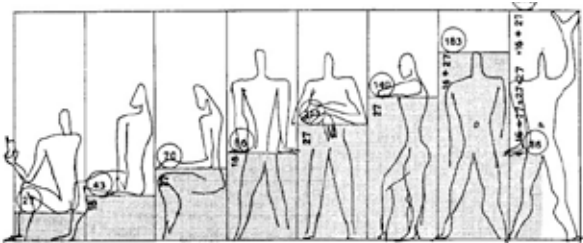
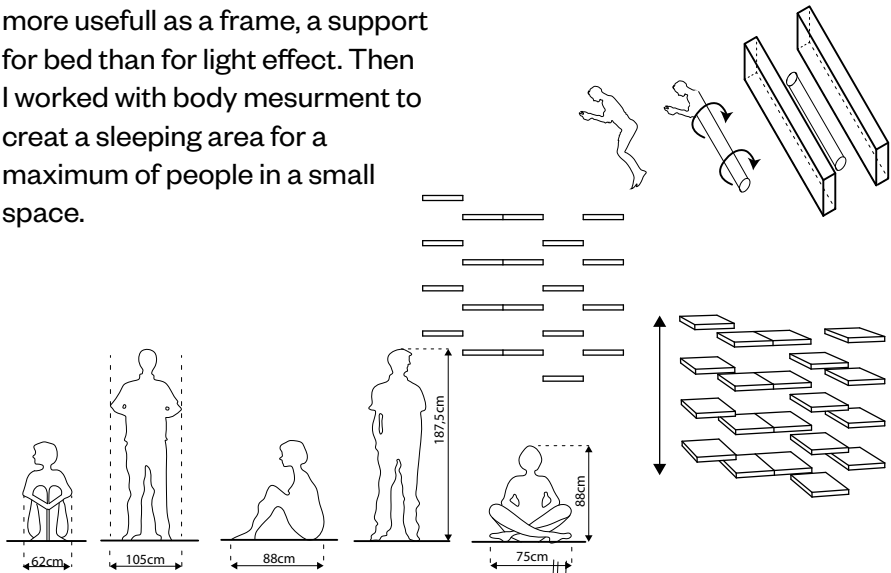


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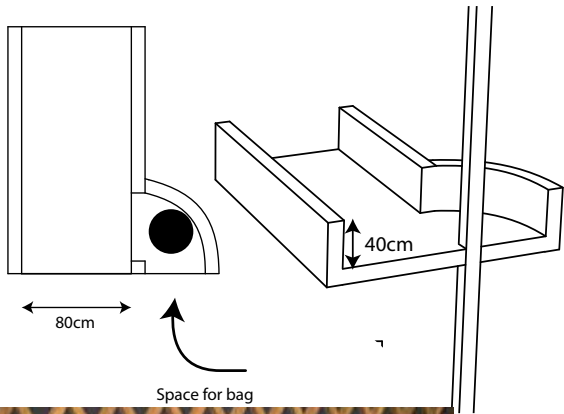
**Mesh experimentation.**

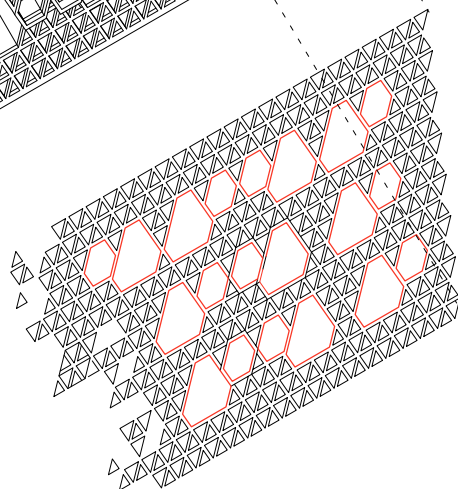
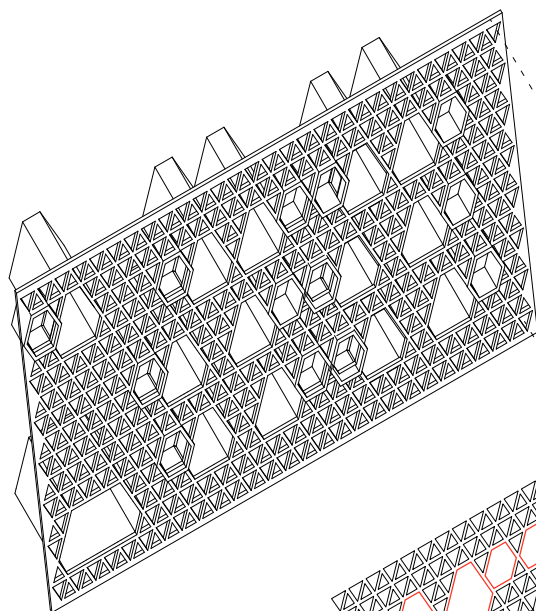
The idea of mesh turned out to be more usefull as a frame, a support for bed than for light effect. Then I worked with body mesurment to creat a sleeping area for a maximum of people in a small space.



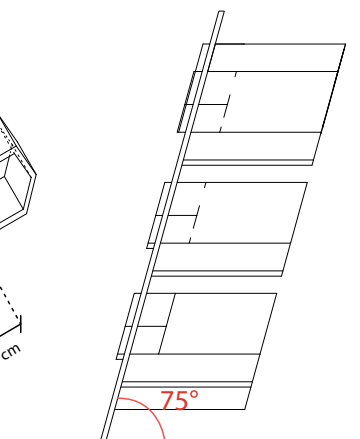
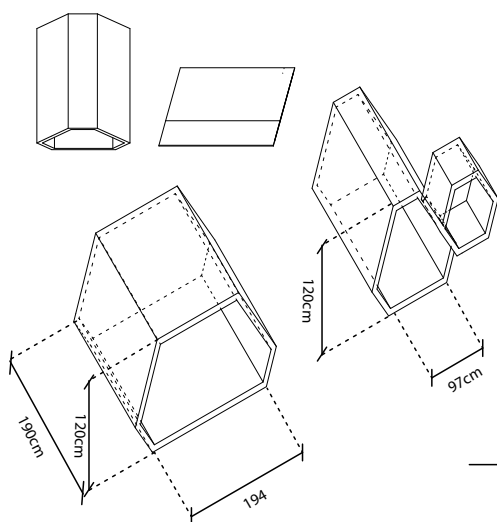


The mesh should be something suitable and easy to appropriate.  
Bags of hikers are really important, so it could be nice to find a system to be able to keep its own bag close to his bed.



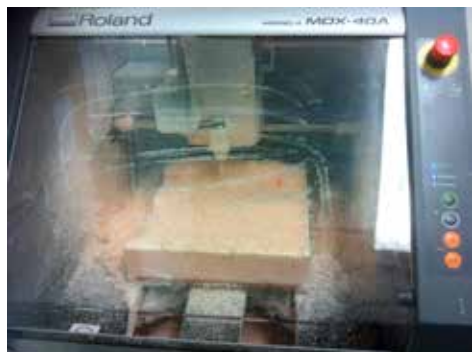
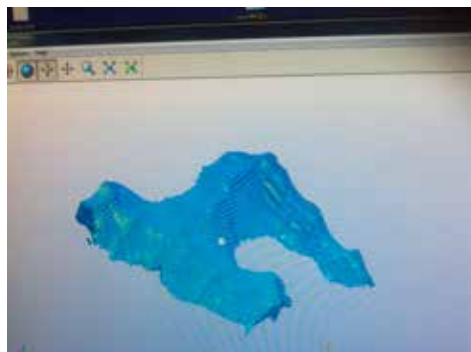


This is the evolution of the grid. I improved the pattern of the mesh to make it more suitable. I tried to optimize the space, cabin have generous mesurment and their is a box dedicated a bag close to each bed.

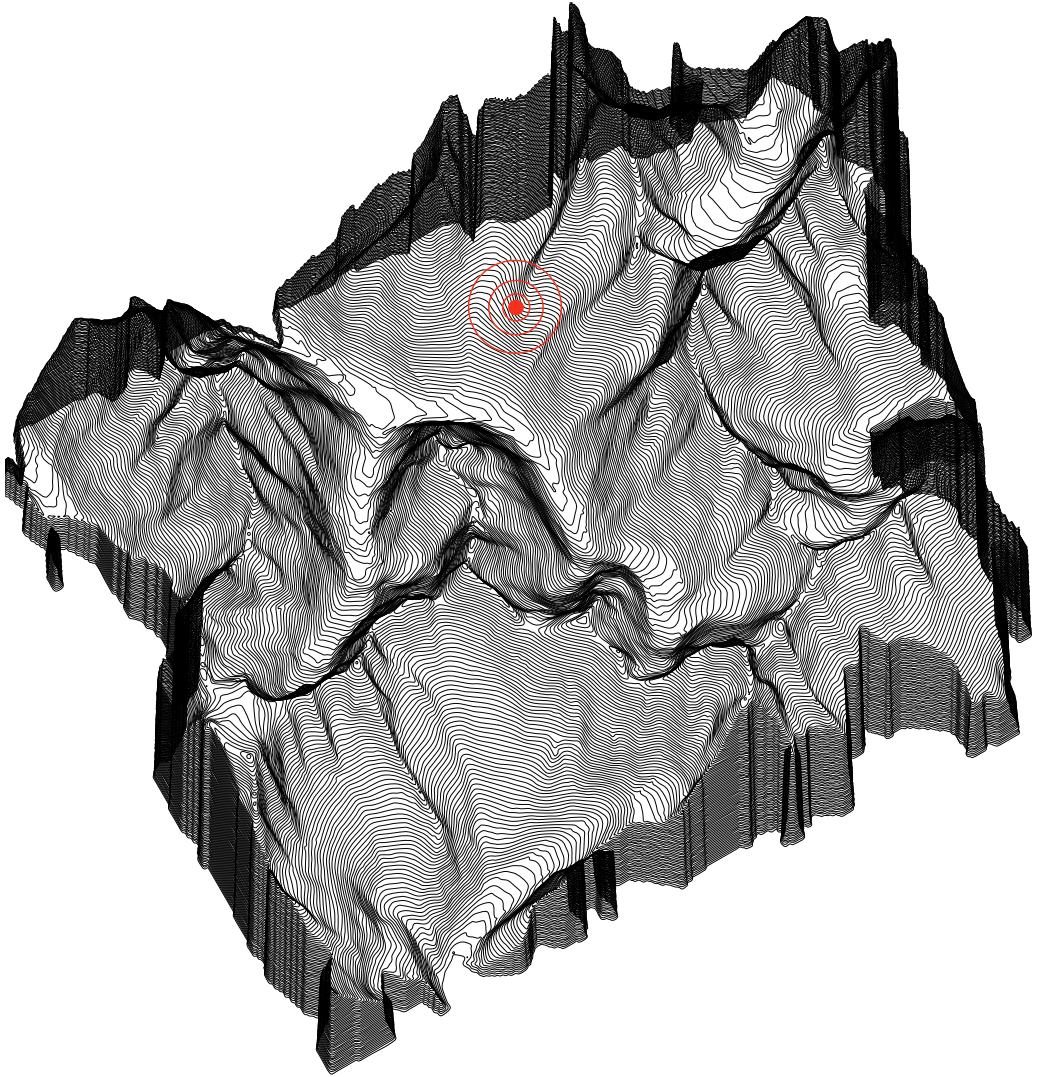




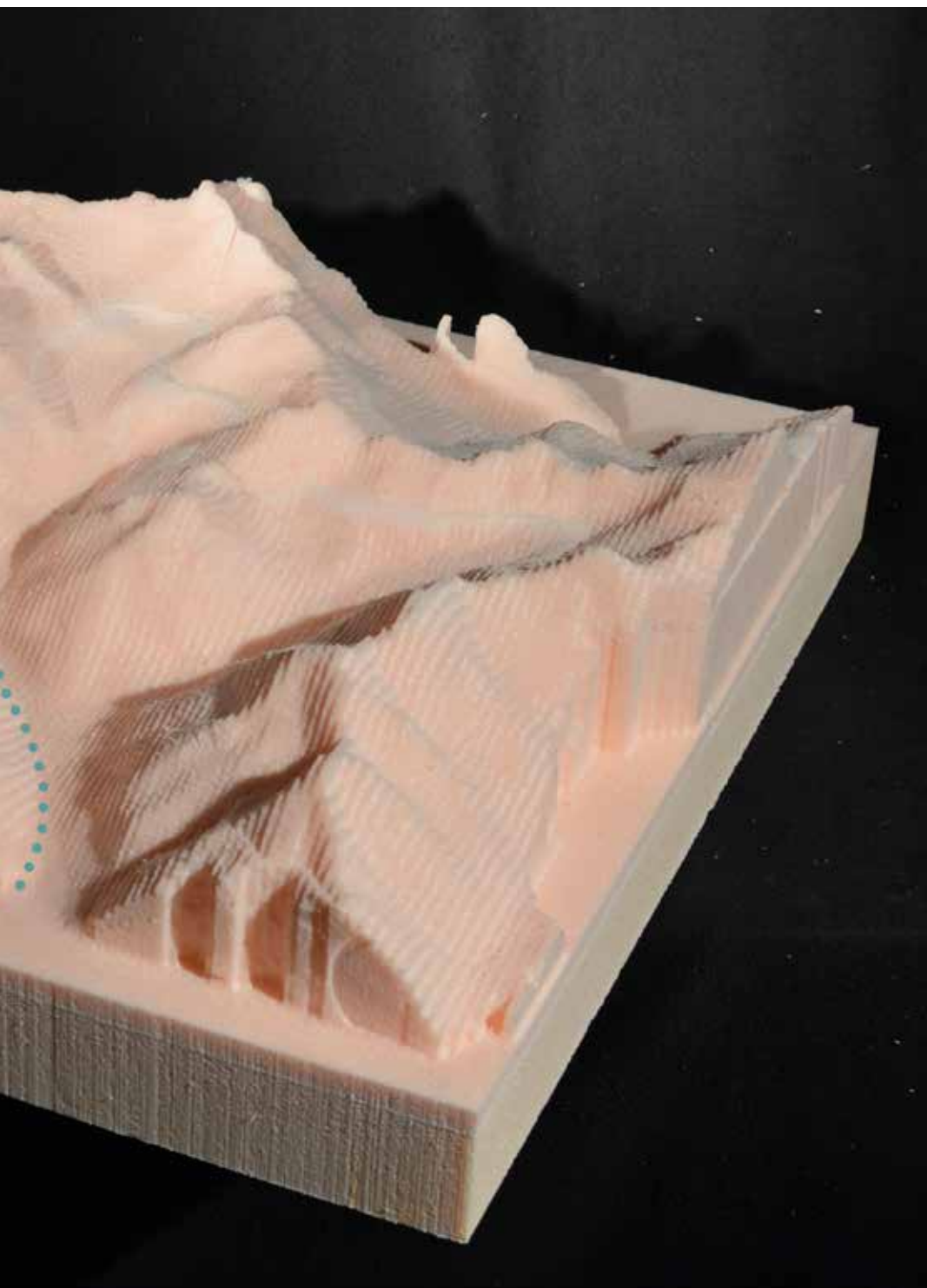




This semester has also been the opportunity to test new tools and new ways of representation by drawings and models. I had time to work from digital file to real object.







## What is Grey energy?

Grey energy is all the energy used all along a life of a material, an object or a Building

Life cycle analysis is a tool which take in consideration the extraction of raw material and the several step of the fabrication process, its used time, its recycling, its demolition and also all the other input.

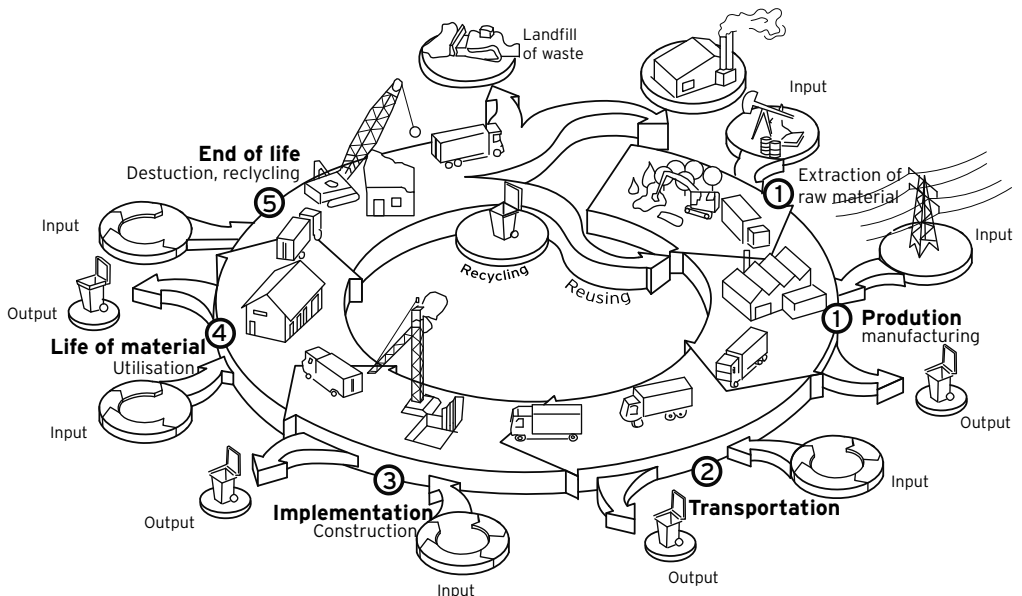
In architecture or in the construction field in general the grey energy is hard to evaluate due to all the transformation step of a material. Moreover the calculation method changes according to the country.

But some basic guideline could help you to understand this new notion and reduce the impact on the environment of a building through a clever material choice and a better implementation process

### Building life-cycle in 5 POINTS

- ① **PRODUCTION** (extraction of resources, material manufacturing)
- ② **TRANSPORTATION** (used between each step)
- ③ **IMPLEMENTATION** (construction )
- ④ **LIFE OF MATERIAL** (consommation pendant l'utilisation et pour l'entretien)
- ⑤ **END OF LIFE** (demolition,recycling of materials)

The life cycle of a material include in each step of transformation some output and input.





## What is its impact?

Grey energy represents a big part of the impact on the environment.

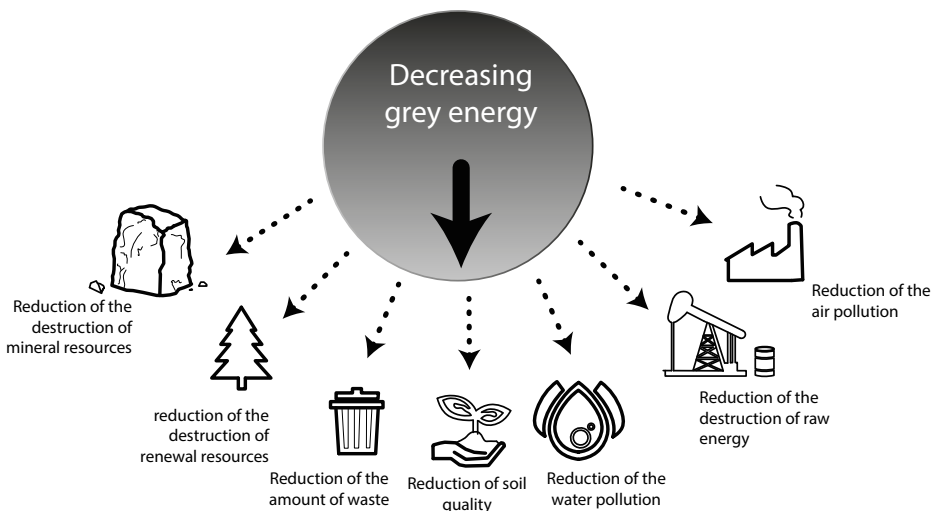
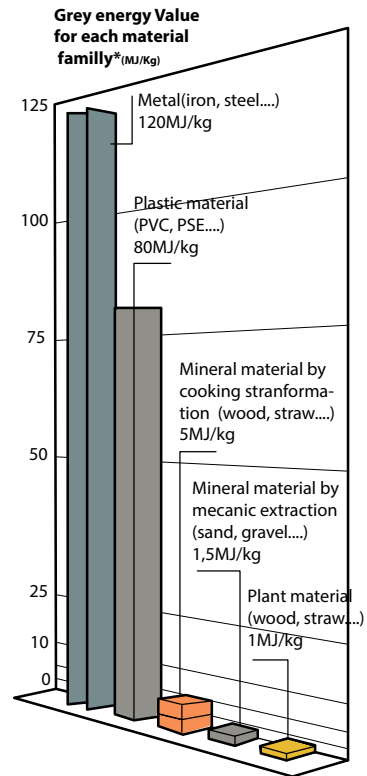
In order to evaluate the impact of a construction you can use some clue taking in consideration the amount of waste material, the air, water and soil pollution, preservation of renewable resource, transportation.

It's important to keep all those step in mind in order to take better decisions. The grey energy is present in all those different aspect so if you decrease the grey energy you minimize the impact of the environment.

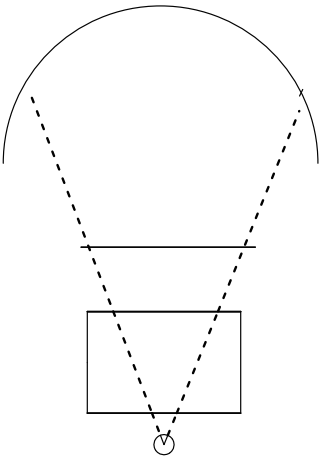
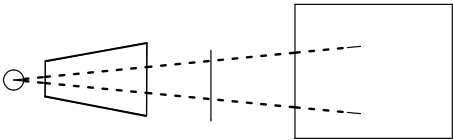
How to reduce it?

In order to improve the global energetic balance (using energy and grey energy) (you have to evaluate the needs, this evaluation should oriented all your choice from the beginning of the conception.

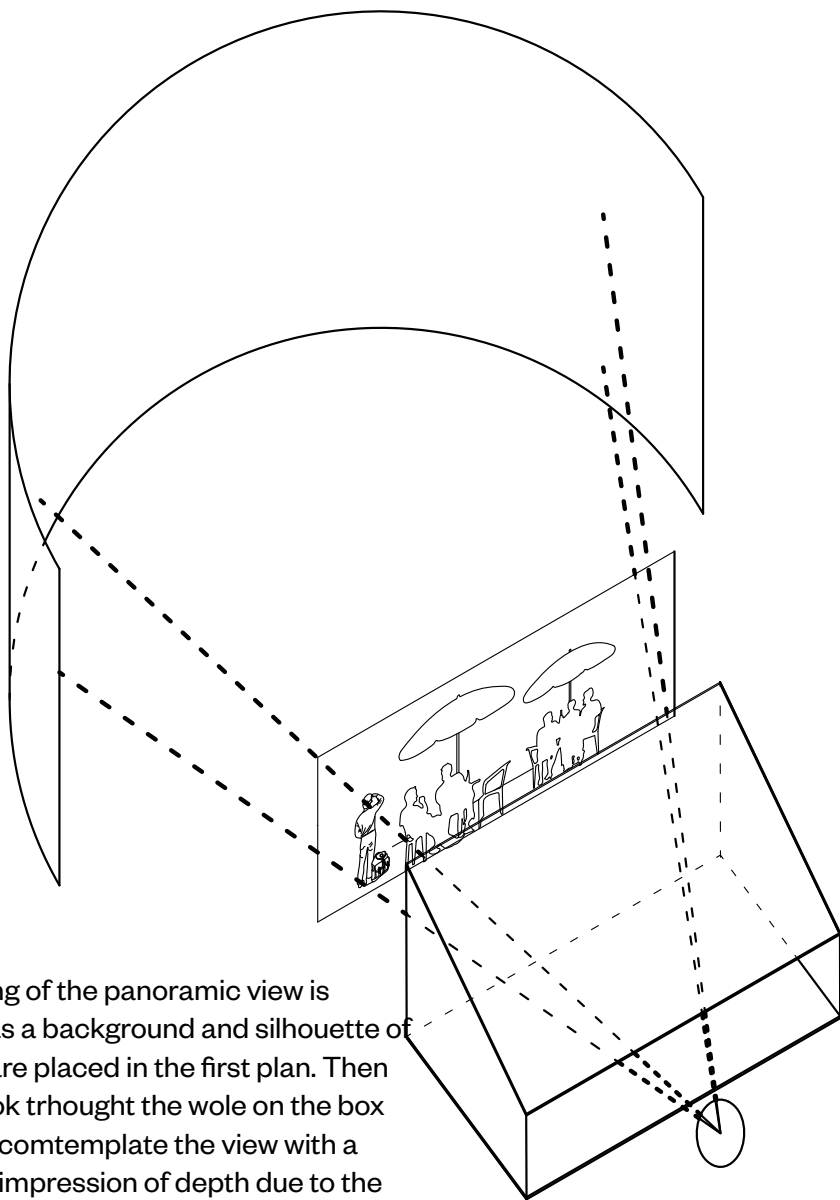
- Do a renovation every time it's possible.
- Find the good balance between grey energy and energy use.
- Preferring a material with low impact instead of something which impact a lot



This semester has been the opportunity to try and test several technics of representation. This diorama give you the opportunity to see how the view from the refuge will looks like.







A drawing of the panoramic view is placed as a background and silhouette of people are placed in the first plan. Then If you look trthought the wole on the box you can comtemplate the view with a realistic impression of depth due to the succession of plan.



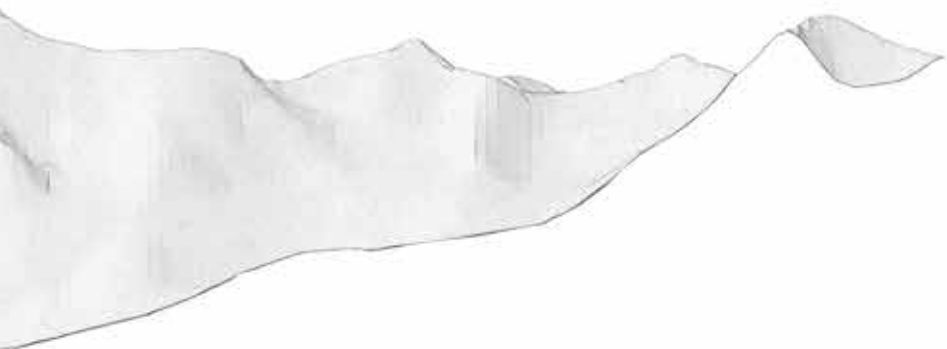
View from inside

Master thesis

# FOTO 2

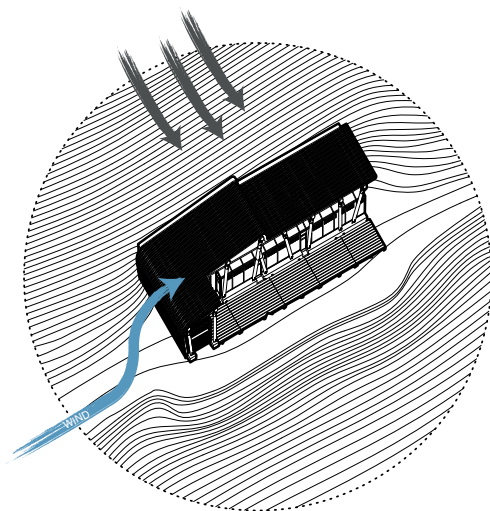


# PRINT





## THE NEW BUILDING



Axonometry

### Table Area

#### Groundfloor

Storage	15,5m2
Kitchen	30,8m2
Entrance	17,2m2
Common room	40,5m2
Galery	37,6m2
Dormatory 1	32,3m2
Dormatory 2	32,6m2
Toilet	25,4m2

**Total groundfloor 231,9m2**

#### Mezzanine

Corridor	2,6 m2
Guardian's bed room	8 m2
Children's bed room	8,3m2
Bathroom	7,7m2
Guide's dormatory	21,5m2
<b>Total mezzanine</b>	<b>48,1m2</b>

**TOTAL REFUGE 280m2**

Surface/ pers 5,6 m2

### The SHEILD

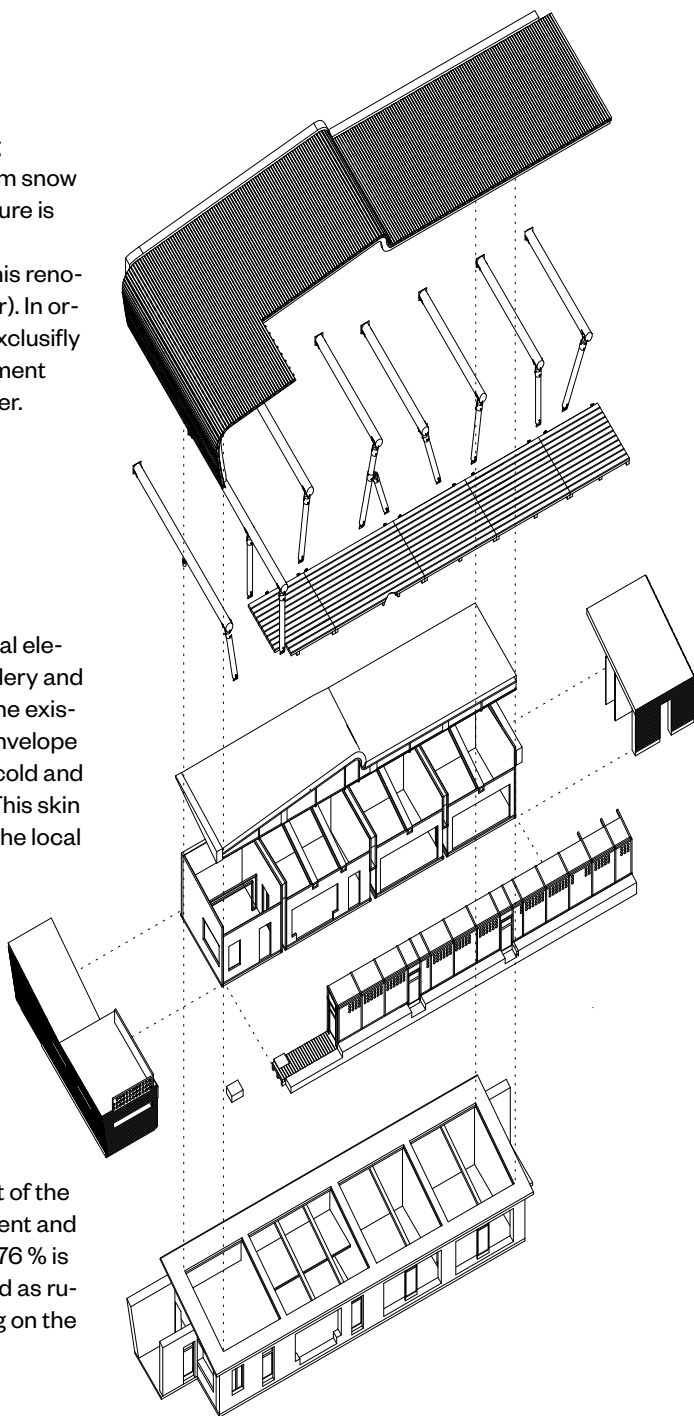
The «sheild» is a protecting element, preserving the refuge from snow avalanches and wind. This structure is shaped by those natural constraints. Every part of this renovation is made out of local wood (fir). In order to limitate the CO2 footprint, exclusifly massive wood is used. This element support the snow during winter.

### The SKIN

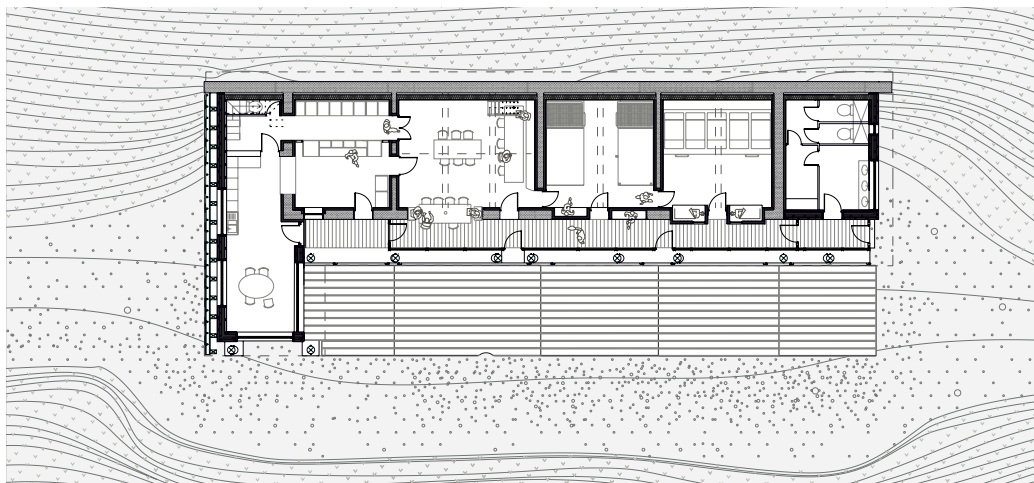
The «skin» is composed by several elements: 2 extentions, an exterior gallery and a new well isolated box placed in the exisiting building. This box is the new envelope of the building, giving the previous cold and dark refuge a warm wooden skin. This skin is insulated by wool from sheep in the local valley.

### The CORE

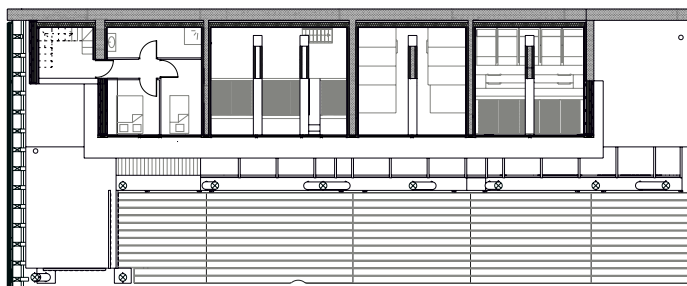
The «core» is the the left over part of the exisiting building made out of cement and stone. From the exisiting building 76 % is kept, and the other 24 % are reused as rubble to raise the level of the gourng on the back of the refuge.







Plan groundfloor



Plan first floor



V  
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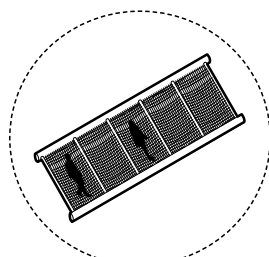
Longitudinal section



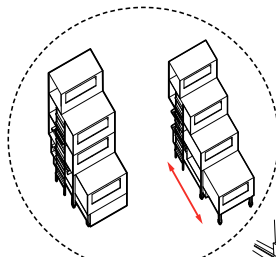
Facade



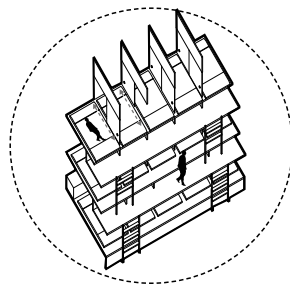
Section



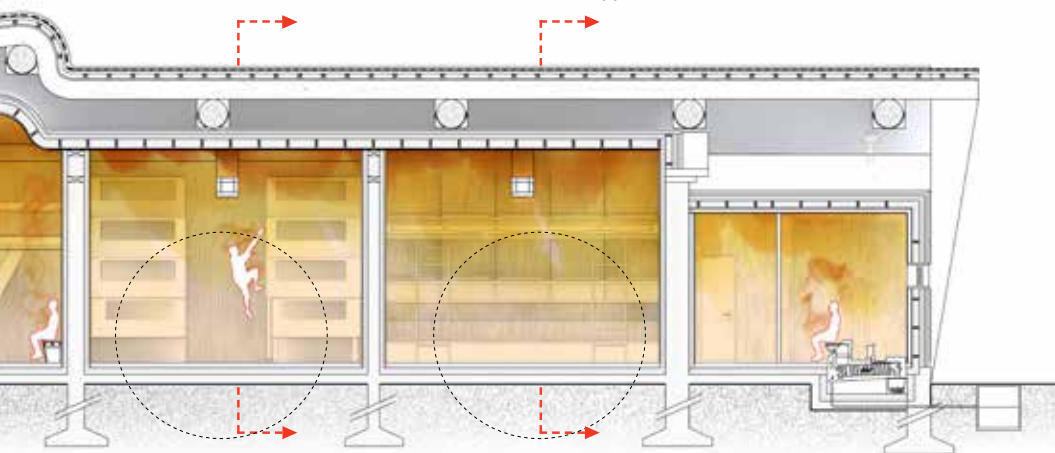
System of the net

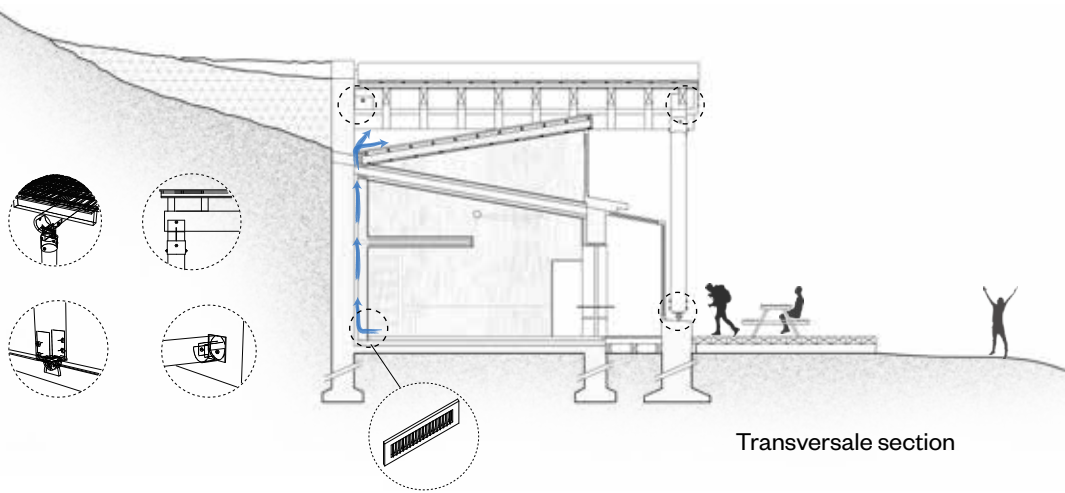


Adjustable system  
on rail in bedroom (1)

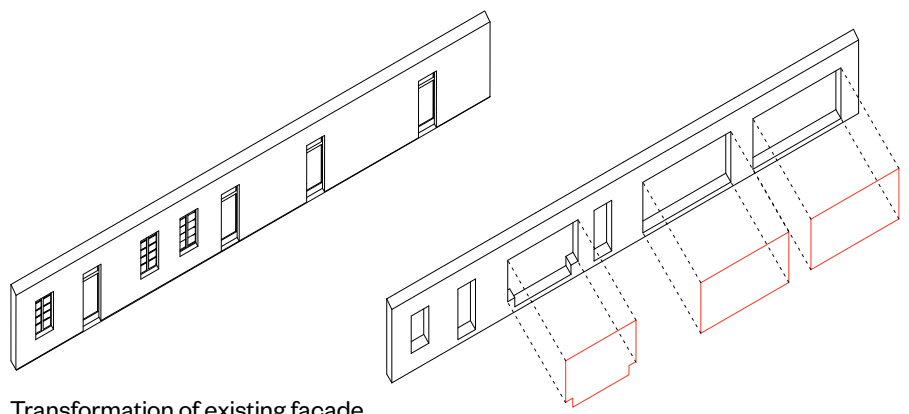


Fixed system bedroom (2)





Construction details



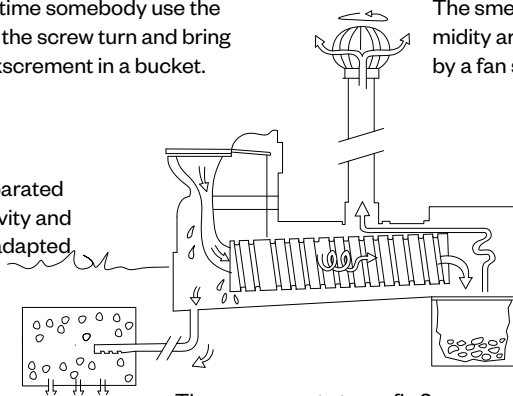
Transformation of existing facade

## Dry toilet system

Everytime somebody use the toilet, the screw turn and bring the excrement in a bucket.

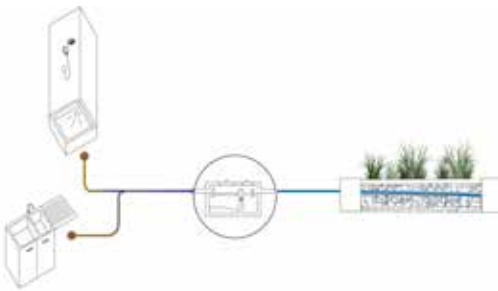
The smell and the humidity are evacuated by a fan system.

The liquid part is separated from the solid by gravity and will be treated in an adapted system.

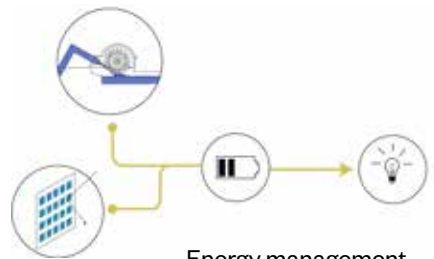


The excrement stay rufly 2 weeks in the screw system and are dehydrated by the ventilation system.

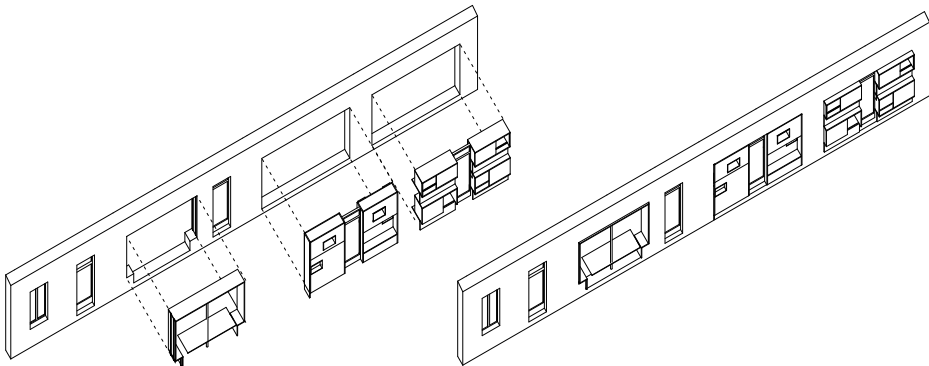
After a couple of months you just have to collect the waste which is dry and odorless.



Water management



Energy management





Section airlock



Section livingroom



Interior perspective of bedroom (2)





Section Bedroom 1



Section (Bedroom 2)



Interior perspective of the living room



THE WINTER REFUGE

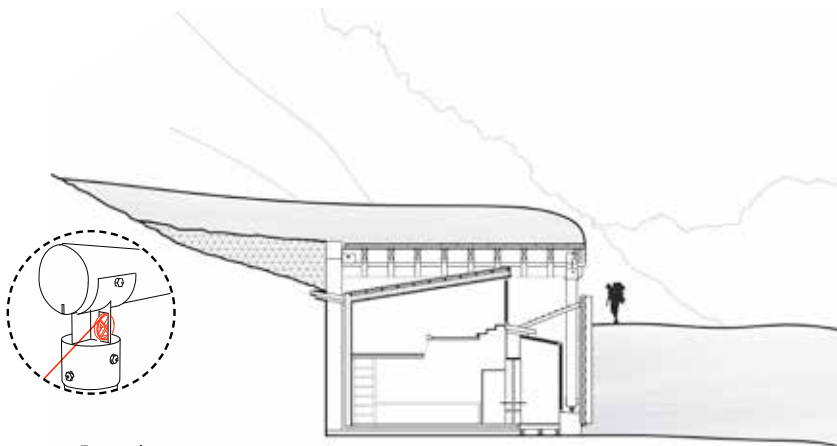


Winter facade

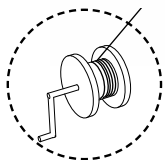


Winter facade, under the snow

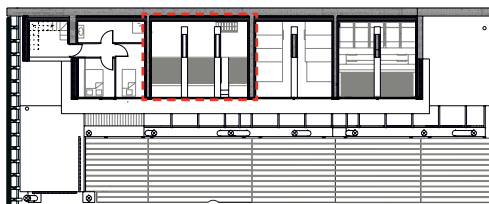




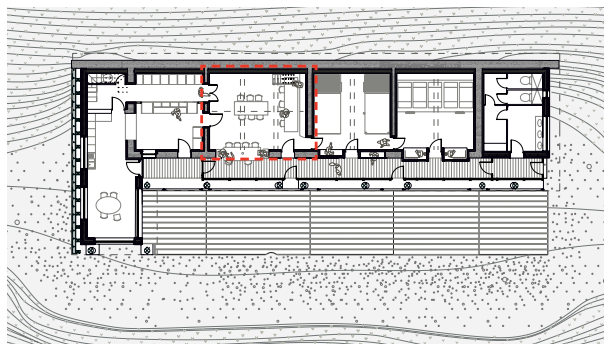
Transversal section (showing the winter entrance)



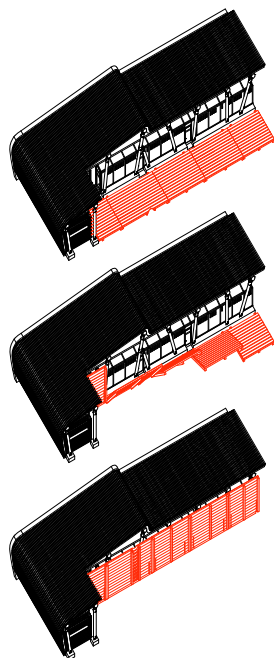
Mechanism detail



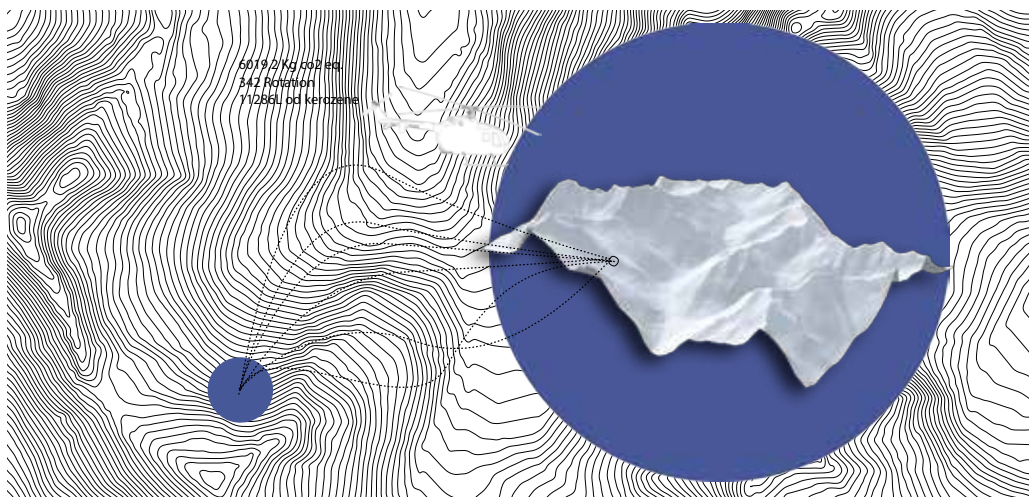
Plan firstfloor



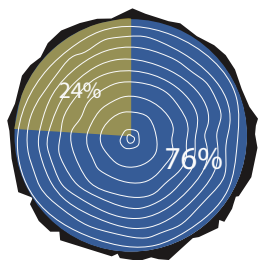
Plan groundfloor



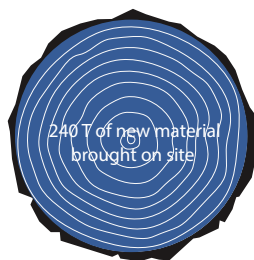
Protection system



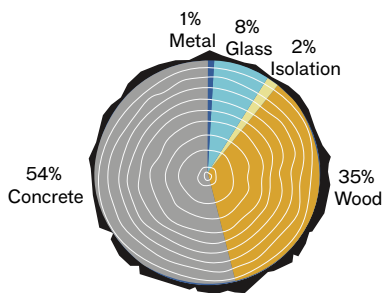
## CO2 FOOTPRINT



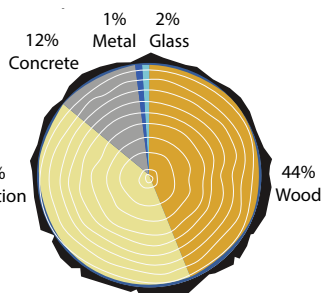
76% of the existing building is save



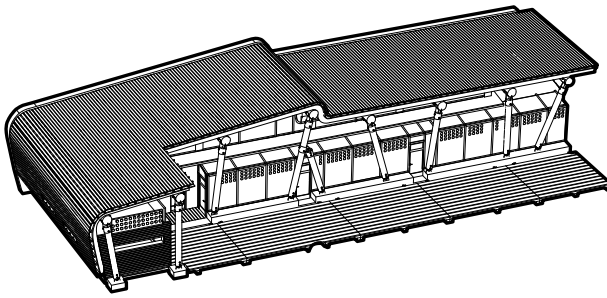
All of the rubble are reused to reshape the site (117,6T)



Weight of material



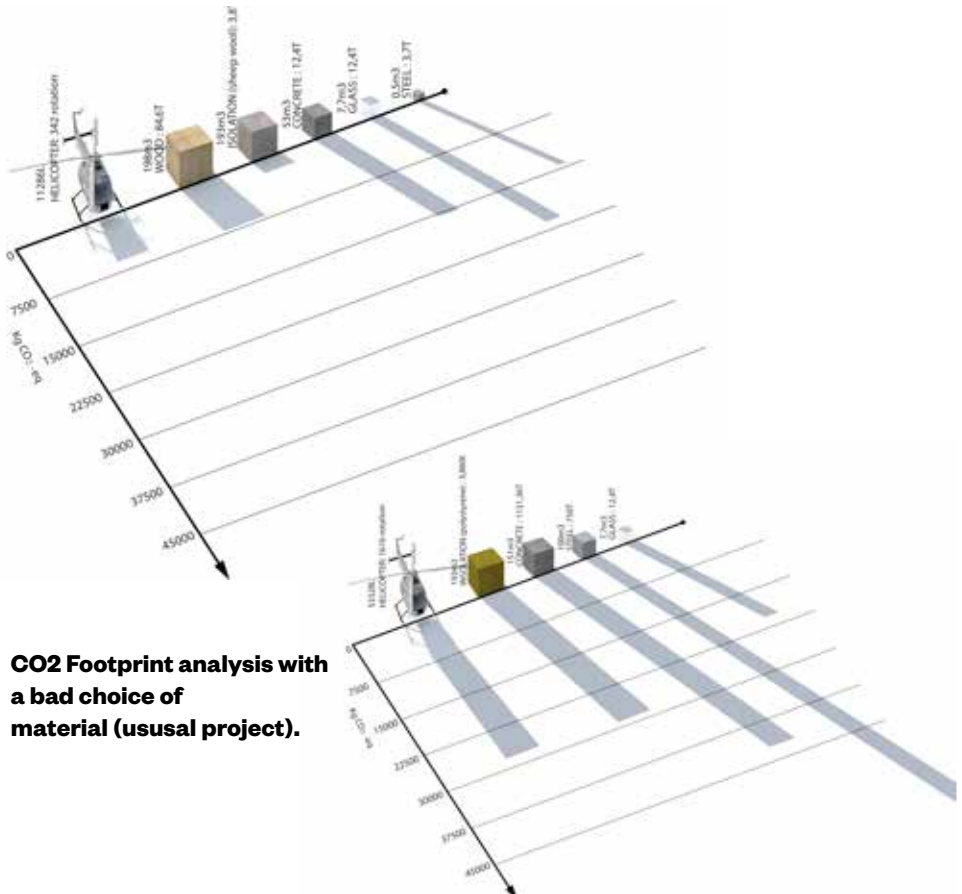
Volume of material



$$= \text{CO}_2 \times 6599$$

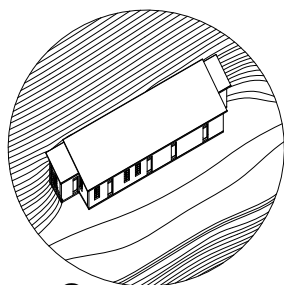
To balance the rejected co2 of this renovation 6599 trees absorbing co2 during one year are needed.

### CO2 Footprint analysis

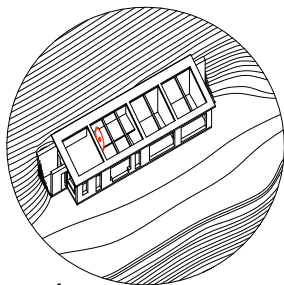




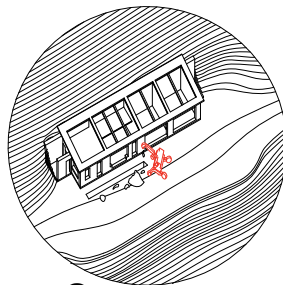
## PROCESS



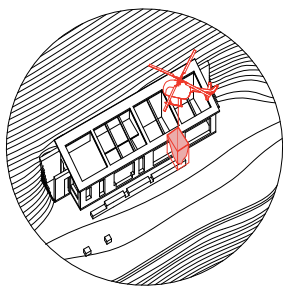
0



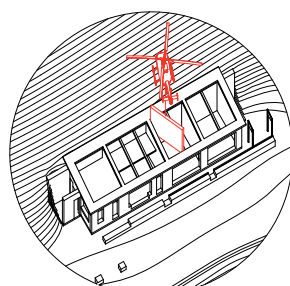
1 Sawing



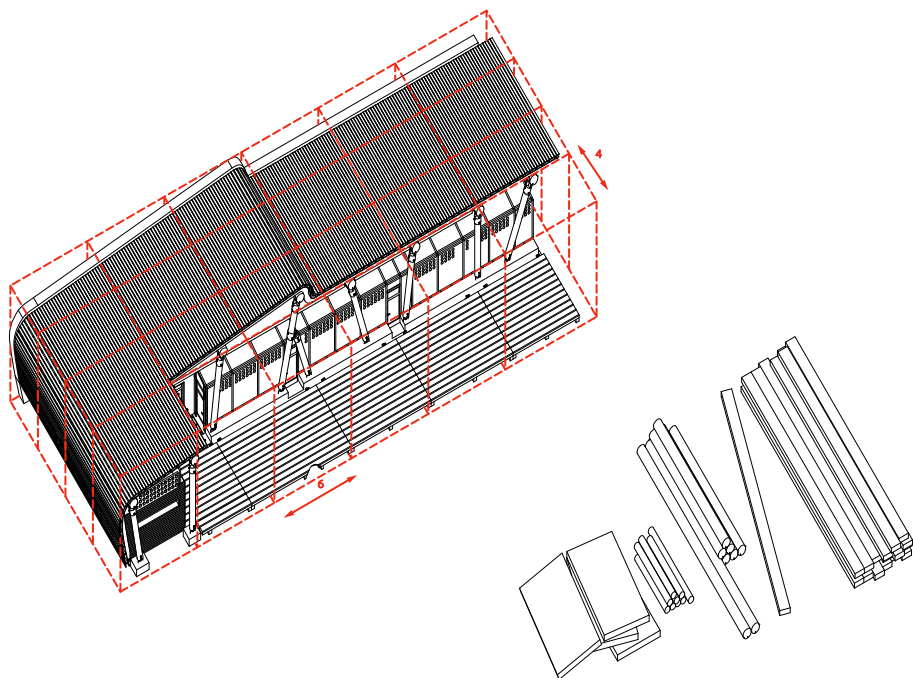
2 Digging



3 Pouring concrete on site with the helicopter



4 Bringing prefabricated element by helicopter.



The building is divided in modules in order to facilitate the transportation by trucks and helicopter. All those prefabricated elements are prepared in a factory. They will be numbered and assembled on site like a giant puzzle. This technique reduce the construction time and the amount of waste material on site.

## FO<sub>2</sub> TPRINT project :

Factory

On site



2 months



## Usual project :

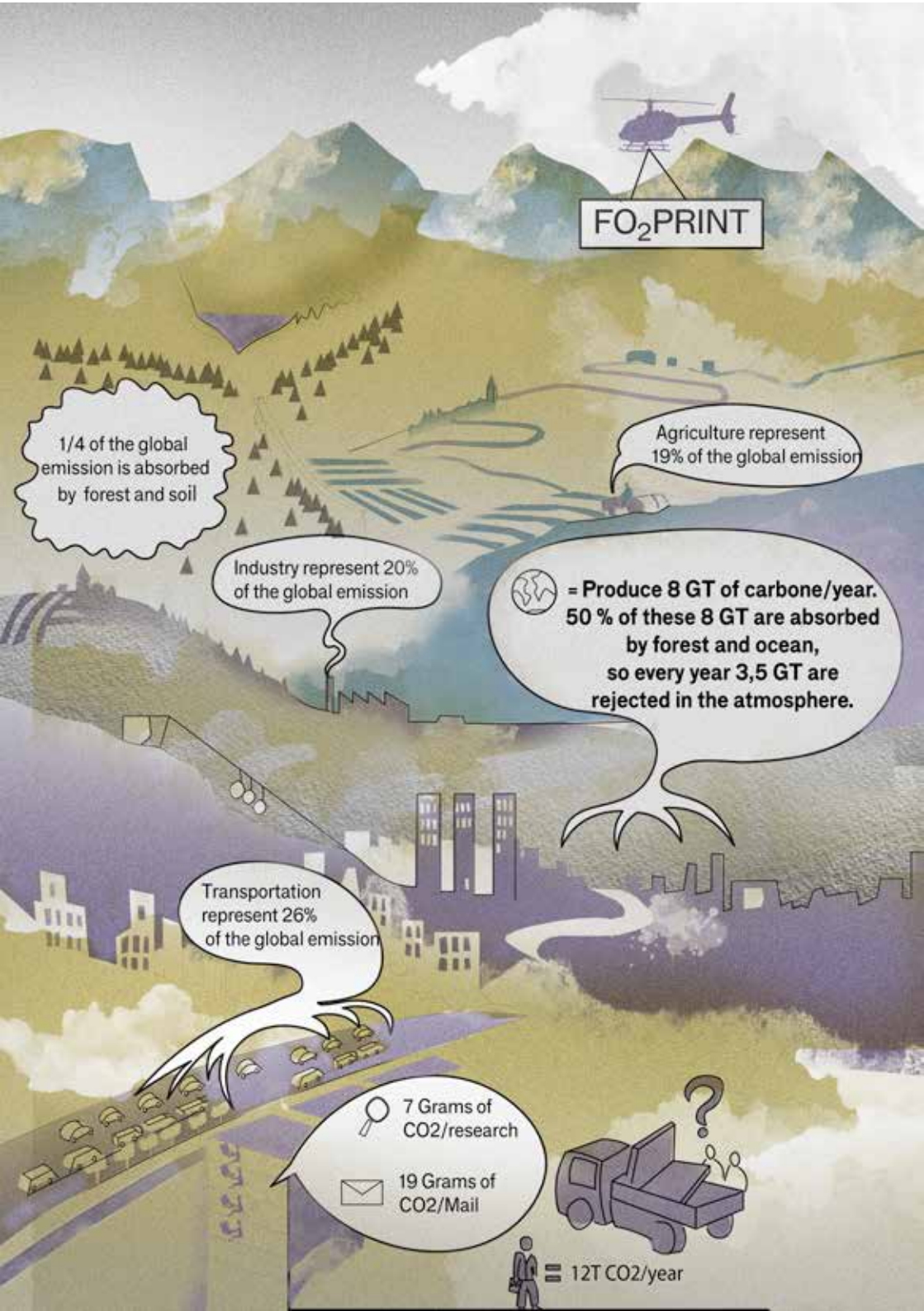
On site



9 months







## FO<sub>2</sub>PRINT

1/4 of the global emission is absorbed by forest and soil

Agriculture represent 19% of the global emission

Industry represent 20% of the global emission



**= Produce 8 GT of carbone/year.**  
**50 % of these 8 GT are absorbed by forest and ocean,**  
**so every year 3,5 GT are rejected in the atmosphere.**

Transportation represent 26% of the global emission



7 Grams of CO<sub>2</sub>/research



19 Grams of CO<sub>2</sub>/Mail



= 12T CO<sub>2</sub>/year



## The responsibility of the designer

The green house effect is a natural phenomenon. These gases are essential, since they maintain an average temperature of 15 °C in the atmosphere, which would without them be -18 °C. Our planet is warmed by the sun. A part of sun ray is absorbed and the other part is rejected in the space. Green house gas provoke a green house effect by sending back infrared ray to earth instead of letting them pass out to the atmosphere. The two main natural gases responsible of the green house effect are the water vapor (H<sub>2</sub>O) and carbon dioxide (CO<sub>2</sub>). Since the beginning of the industrial era the economic development is based on the utilisation of fossil energy which had strongly increased the amount of green house gas in the atmosphere. The life time of CO<sub>2</sub> in the atmosphere is one hundred years! Between 1970 and 2007 the global emission increased by 70%. The construction field is one of the sector producing most of the green house gas rejected in the atmosphere. To decrease that emission and slow down the global warming we have to rethink our mode of production. As designers we have to be aware of the situation and understand the importance of our decisions. It's our responsibility to do the best choice for the planet, to choose eco friendly materials or for example renovate an existing building instead of demolishing it and rebuild.

# Thanks

I want to thank everyone who contributed to this master thesis and helped me during this period!



