ICELANDIC GUEST HOUSE

This thesis investigates the intimate meaning of what the identity of a place is expressed through, with the ultimate aim of transposing its values and potentialities into architecture. With this work, it was intended to dig into the feeling of identification, which naturally belongs to the human being, and in particular to the people who are distant from their nest and have the constant opportunity to reflect upon the shortcomings and the riches of their identity places. The work is therefore dedicated, on behalf of all three authors of this Master thesis, to their families, friends and dear places.

Icelandic Guest House

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Abstract

This thesis presents the proposal for a Guest House in the Northernmost region of Iceland, in the proximities of the volcanic area of “Mývatn Lake”. The Guest House will serve as a privileged spot for the Aurora Borealis’ observation and it takes inspiration from the “Iceland Northern Lights Rooms” competition. It will be developed according to the Competition Brief requirements and the personal design intentions: because of the extreme and breathtaking landscape, Iceland represents the inspiration for critical reflections concerning the crucial aspects of Identity in Architecture and the relation between natural landscape and the Architecture itself. The project requirements include the design of accommodations for hosts and visitors, saunas, barns for horses and other activities connected to the Guest House business. The skills achieved during the Master program in Architecture at Aalborg University will be applied to the design process in order to generate conscious and sustainable architecture throughout the design of high quality spaces. The methodological approach of the project derives from a critical reading of the Integrated Design Process in Problem Based Learning, developed by Mary-Ann Knudstrup: through an intense research of esteemed theorists of the architecture, this is implemented with some additional parameters, in order to fit the specific purpose and beliefs of this thesis.

01.01 Theme
Brief

The project takes inspiration from the International architecture competition “Iceland Northern Lights Rooms”; this acts as a guideline in the definition of the project’s main requirements that need to be pursued in the design process. Nevertheless, the final project brief and building program, are also enriched with some additional requirements, according to the design intentions and vision of the authors of this thesis. This has the scope of defining an exhaustive final documentation which not only satisfy the Competition intentions, but also perfectly fits with the philosophy of the Architecture program implemented at Aalborg University: thus, the integration of solutions focused on ambience and technical requirements is what characterizes the intentions of the documentation.

According to the Competition Brief, the Guest House should serve as a privileged spot for the observation of the Aurora Borealis, facilitating the visual experience from the indoor spaces of each guest room. The competition’s building program gives a guideline of the general requirements, differentiating them in the ones for the Guest House and the ones for the Host House: in the latter, will permanently live the family who will run the Guest House business. The program should also include the design of separate guest bedrooms for a maximum of 20 guests, a dining area, a kitchen and some service facilities, while the Hosts House should include a master bedroom, a smaller one, a living room, a bathroom and a small kitchen. Some extra facilities should also be included, like a barn for ten horses, a terrace for summer events and an optional sauna.

The mentioned Competition Brief is flexible and open to the consideration of additional strategies, where the building complex organization can either be spread in a series of separate guest bedrooms, detached from the shared facilities, or compacted in a single complex, close or separated from the Hosts area.

In terms of sustainable strategies, the complex is asked to be environmentally responsible and energy efficient, guaranteeing a high level of indoor and outdoor comfort: to be specific, it should be able to generate its own power and to provide safe drinking water. However, some different arrangements are finally defining the final building program of this Master thesis, as it is shown in the following page.

Taking part in this competition represents the opportunity of integrating sustainable strategies in an extreme environment and testing the skills acquired during the architectural education in the real practice. Based on the mentioned considerations, the final project requirements and Building Program, are listed in the next page.

Building Program:

Guest Zone

- Movable and Detached guest Bedrooms
- Dining Area
- Kitchen
- Sauna
- Toilets
- Geothermal bathing amenities
- Greenhouse

Private Zone

- Master Bedroom
- Two children bedrooms
- Living Room
- Bathroom
- Kitchen
- Toilet
- Sauna
- Laundry

Administration Zone

- Reception Area
- Laundry
- Storage
- Staff toilet
- Techincal Room

External Facilities

- Barn for 10 Horses
- Parking

Public Facilities

- Public Terrace
- Restaurant
- Observatory

Project Requirements:

- Adaptable and movable types of bedrooms
- Able to provide comfortable shelter for several days to all occupants in all weather conditions
- Cost effective construction for remote areas with no limited road access
- Resistent to heat, cold, rain, snow and wind
- Environmentally responsible and energy efficient for providing bathing amenities
- Able to generate its own power
- Low maintenance in terms of efforts and costs
- Low emissions of CO2 during the building running phase, and highest possible reduction during construction and dismantling phases

Architectural Approach

As architecture students at the last year of the MSc degree, we are strongly convinced of the importance of working in an integrated environment, thanks to which it is possible to exploit the strengths coming from the knowledge of both technical and structural expertise, together with the aesthetical and cultural suggestions of the humanistic field, applied to the Architecture.
This belief, determines the approach with which this Master Thesis will be developed. Moreover, the cultural overlap that comes from different points of view it is an important aspect for this thesis process.
We consider the architecture as a discipline with a long tradition, which socially acts on the territory as a manifestation of culture.
For this reason, the research that precedes the design process, should deeply focus on the specific place's characteristics, not only in the scientific and objective sense of the climatic and topographic studies, but also, and above all, in the approach of the architectural matter with a cultural curiosity towards the peculiar characteristics of the local traditions. All of us, authors of this Master Thesis, believe that the decision to study architecture abroad has profoundly influenced our cultural approach to the matter, enriching our perspectives, with aspects that are not part of the Mediterranean didactic and architectural tradition. At the same time, we consider our cultural and humanistic background as an equally valuable contribution to the conception of a qualified architectural project: for this reason, our approach to the architectural design, it is supported by a strong sensitivity to the integration of different cultural aspects, trying to convey them within the project.
Our interest lays on the authenticity of the architecture towards its place and its time. Therefore, while including environmental principles and strategies within the design itself , we focus on how to convey these aspects into a valuable piece of architecture, this is what trickle us for this Master thesis project.

• Ill. 001 Design phase

Sustainable Approach

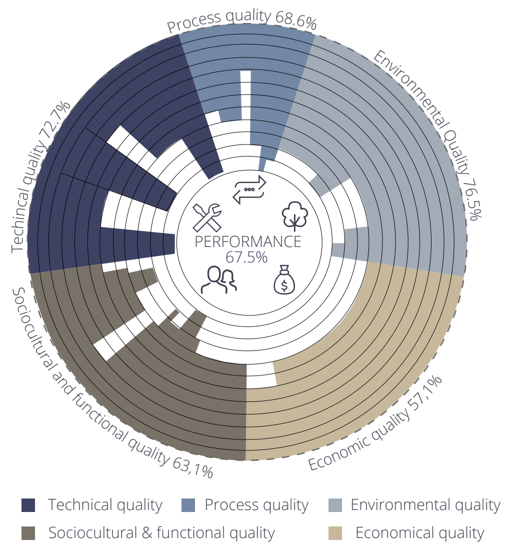
Zero Energy Emission building

The Danish Building Regulations 2020, state the ambitious goal to make Denmark free from the use of fossil fuels by 2050 (denmark.dk). Architects and engineers are therefore called to take part in this challenge, which necessarily changes the traditional way of making and thinking architecture. In this scenario, it becomes essential the timely integration of strategies aimed at reducing the energy consumption since the early stages of the design process.

In the context of this thesis, the Danish legislation standards are applied to the reality of Iceland, in order to make the design reach the goal of a Zero Energy Building (ZEB), with a great reduced energy demand, balanced by the generation of energy coming from renewable resources (Pomianowska A., 2016). Obviously, the geographic and geologic reality of Iceland, places some limits in the application of the Danish laws: in fact, on one hand the Icelandic soil is extremely rich in terms of available renewable resources, such as geothermal and hydroelectric energies, but on the other hand the country is dramatically lacking of local construction materials. In this scenario, it emerges that the main issues related to sustainable architecture in Iceland, does not only need to be described in terms of energy consumption, but also considering the reduction of the CO_2 emissions related to the shipping of overseas construction materials.
This state of affairs, stimulates specific reflections towards the conscious use of materials, trying to exploit, in the best possible way, the strengths of the few available ones.
In this sense, it will be the challenge of this project, to design in a logic of low CO_2 emissions and to check the final amount related to the building intervention through an LCA calculation.
In order to fulfil this aim, a set of passive and active strategies will be applied. The IT tools of B18 and BSim, will be fundamental throughout the whole design process, both in the definition of the building's energy consumption and for the study of the thermal comfort; while the daylight conditions will be monitored through the use of Velux Daylight Visualizer.

DGNB Criteria

The DGNB System is a discretional commitment towards the achievement of sustainability in the building industry. The System and the relatives Criterias were developed in Germany, and they are internationally applied in most of the European countries "partners" of the DGNB community. For these countries, including Denmark, the DGNB criteria are adapted to fit the local language, climatic conditions and local requirements (dgnb-system.de).
Not being Iceland one of the DGNB community partners, we asked to the organization how to proceed in order to still reach the DGNB standards, while acting on a non-partner country. The answer led to the selection of 14 of the International Criteria which refer to the non partners countries guidelines, with the aim of including them in the design of the Icelandic Guest House.



• Ill. 002 DGNB DIAGRAM SYSTEM

Environmental Criteria

DGNB/ ENV 1.2 Local Environmental Impact
The choice of the construction materials should take into account the eventual harmful chemical compositions and the physical characteristics, to avoid or minimize the risks for humans and the local environment.
(Share of total score: 2,3 %)

DGNB/ ENV 2.1 Life Cycle Assessment (LCA)
The LCA consists in the evaluation of the complete primary energy requirement of the building: the goal tends to the maximization of renewable energy use and the overall reduction in the use of non renewable primary energies. Legal local regulations sets the final goal to reach in the calculations. In the case of this project, Danish standards will be taken into account.
(Share of total score: 5,6 %)

DGNB ENV 2.3 Land Use
This criterium takes into account the irreparable use of the soil. Ideally, it is preferable to build on soils which were previously used for construction, and therefore already made impermeable by the use of materials such as concrete: in this way it would not be subtracted from the earth any further surface. In the practice of virgin soils, this principle translates, as much as possible, into the use of permeable surfaces.
(Share of total score: 2,3 %)

Social Criteria

DGNB/ SOC 1.1 Thermal Comfort
The thermal comfort of a room is determined by the absence of moist and draught, with no excessive cold, nor warm temperatures. It affects the livability and the general comfort of the place, thus the pleasure of being or not in a place.
(Share of total score: 4,3 %)

DGNB/ SOC 1.2 Indoor Air Quality
Users health and well being is affected by the quality of the air; the level of indoor pollution need to be calculated in order to prevent unpleasant smells and harmful substances.
(Share of total score: 2,6 %)

DGNB/ SOC 1.4 Visual Comfort
Users comfort is also linked to the amount of daylight that they are able to catch indoor. This in fact affects people in terms of health and on a psychological side.
(Share of total score: 2,6 %)

DGNB/ SOC 1.6 Quality of Outdoor Spaces
Including est and recreational areas in the design of buildings increase the acceptance of the structure by the users and greatly affects their perception of the place.
(Share of total score: 0,9 %)

DGNB/ SOC 2.1 Design for All
Both external and internal spaces need to allow the maximum le vel of accessibility for everyone, including them into the design to allow disabled persons not to ask for assistence and to fully take part to the social life of the place.(Share of total score: 1,7 %)

DGNB/ SOC 3.3 Layout Quality
The capability of floor plans to be adapted to different uses increase the livability of the space itself and it is a strength for the whole project use: the use os some spaces could in fact be in need of being re-adapted during the life cycle of a building.
(Share of total score: 0,9 %)

Economical Criteria

DGNB/ ECO 2.1 Flexibility and Adaptability
In terms of economic success, the capability of the structure of being flexible and adaptable can reduce the risk of vacancy and to enhance the potential of the space.
(Share of total score: 9,7 %)

Technical Criteria

DGNB/ TEC 1.3 Building Envelope Quality
The heating demand of building is highly influenced by the design of the envelope: this criterium is then related to the indoor thermal comfort of the spaces. Temperatures and humidity levels need to be assessed in each component of the envelope itself.
(Share of total score: 1,7 %)

DGNB/ TEC 1.5 Cleaning and Maintenance
Maintenance and cleaning affect the building cost and the general environmental impact. The correct choice and use of construction materials, makes their life cycle lasting longer and cheaper. (Share of total score: 4,1 %)

DGNB/ TEC 1.6 Deconstruction and Disassembly
Construction sector is responsible for almost 50% of the waste advent in many developed countries: when addressing to the challenge of sustainable architecture, the reduction of material flow and waste result crucial: the possibility of materials to be re-used for secondary purposes after the life cycle of the building can have an high influence on the general environmental impact.
(Share of total score: 4,1 %)

The Application of these 14 criterias, would lead the project to achieve a total score of 58,4% in the DGNB Certification.

01.02 Identity
Architecture & Authenticity

Recently, the architectural panorama has started again to get involved into Regionalism thematic, both in its climatic and geographical aspects, and in its cultural ones: this aptitude expressively puts into relation the importance of the cultural movements going on with the architecture making. This renovated attention to Regionalism in architecture, seems to be connected to a general social condition of lack and uncertainty of identity, as a result of the recent financial crisis, of the important migratory flows and of the rise of strong nationalist tendencies; these factors brings us to start questioning about what the collective identity is, and in the architectural field, how to transpose this concept into meaningful architecture.
By the reading of the theorist Juhani Pallasmaa, some questions arise: is it possible to make authentic architecture in our globalized and post-industrial society? How to translate the authenticity of architecture into contemporary local languages? "Culture is not composed of elements which can be disassembled and re-composed: culture has to be lived. Cultures mature and sediment slowly as they become fused into the context and continuity of tradition. " [*Juhani Pallasmaa* (Canizaro V., 2007)]; and again, "Consequently, a culturally adapted architecture, is not only a matter of visual style, but of integration of culture, behaviour and environment. To deny cultural differentiation is foolish." [*Juhani Pallasmaa* (Canizaro V., 2007)].
Thus, in the course of this booklet, it will be deepen on the meaning of authenticity in architecture, trying to translate it into a practical level; in this sense, among other theorists of the Architecture, an important contribution will come from Pallasmaas' thoughts, which inspire the reflection upon the intrinsic meaning of Identity in the architectural matter.

• Ill. 003 Unique Icelandic building

Arctic & Iceland

In the world there are remote and hidden places that appear to the human eye in a moonlike landscape.
To these places belong fragile and mostly unexplored ecosystems, still rich in discoveries and in diversity.
Beyond the boundary marked by latitude 66° 33 ‘44 “, the Arctic region appears. A region consisting of a family of lands belonging to different continents: America, Asia and Europe, with the common point of all having an harsh climate, which has created an extreme environment. These countries, despite being on the edge of the earth, have suffered a great impact from human activities (Lonely Planet, 2017). The environment in this areas is rapidly changing, due to the globalisation, to the climate change and to the investigation on natural resources. Therefore, its nature is getting more and more transformed, and its identity is risking to get lost.

Is there any identity of Arctic in the architectural world? Perhaps there is no real definition of Arctic, and it can widely vary, being either defined under a climatic, biological, or political aspect, but never clearly referring to the humans interference. In fact, beside a few indigenous habitants, the region is mostly uninhabited, and in the field of architecture, the connection between these populations with the new and contemporary worlds technologies is mostly absent. Not implementing new foreigns systems in the architectural practice, is an idea embraced from Ralph Erskine, a well-known “Arctic Architect” (Hemmersam P., 2016). He believes that architecture should be connected to the place and create its own identity , not merely following a main-stream logic, with the risk of being defined “anti-climatic” (Hemmersam P., 2016).
On the other hand, a contemporary perception of architecture for the Arctic region, could be defined as a “new indigenous architecture” (Hemmersam P., 2016), where the mixture of local traditions with the most recent innovations in terms of technology and sustainability is considered, in order to make the region as a “next living” for people who originally came from elsewhere (Hemmersam P., 2016).

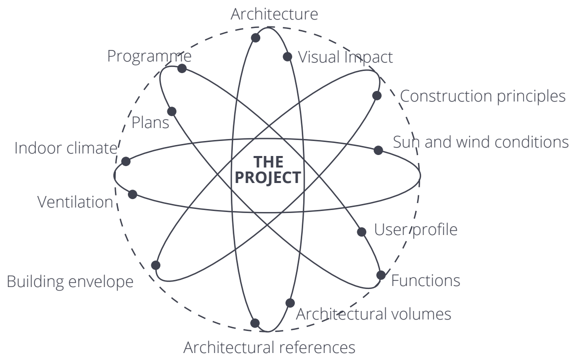
Despite being few kilometers below the Arctic circle, Iceland is considered as well part of the Arctic area: the country is a bearer of stories, stories of our world, of past ages and of the continuous evolution of the Earth, that is located in the middle of two continental plates, North American and Eurasian plates. This involves an active geological activity which enriches the natural landscape of volcanoes, glaciers, and geysers.

Nevertheless, what it makes Iceland different than the other countries within the Arctic circle, are the temperatures: indeed, these are affected by the Gulf Stream, which mitigate the climate, flowing along the Southern and the Western coast. At the same time, the cold East Greenland current affects the North-East and East coasts in an opposite tend. These features, result in average temperatures that fully belong to the Arctic area with maximum temperatures of 20-25 degrees in summer days. (Ingólfsson O., 2008).

• Ill. 004 Svalbard, Arctic scenery

01.03 Methodology

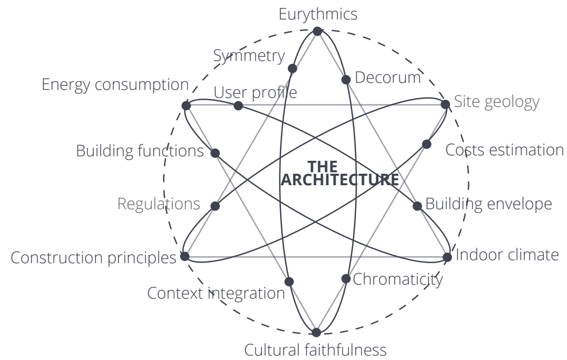
As a Methodological base to this project, the Integrated Design Process in Problem Based Learning is applied (Knudstrup M., 2005). However, for the specific purpose of this Master thesis, the process is implemented of additional parameters, that can fully support the conceptual and practical genesis of the project. This implementation, is the result of an intense theoretical research, concerning the thematic focus of Identity in Architecture. The detailed study that leads to the definition of the final Atom Diagram describing the design process, can be found in the Theory chapter of this booklet, at page 40.
The Integrated Design Process is defined by five iterative phases, which are respectively: Problem Statement, Analysis, Sketching, Synthesis and Presentation; the non-linearity of the process, ensures a constant increasing in terms of knowledge throughout the process itself, thanks to repetitive back and forth between the phases (Knudstrup M., 2005).
The interest on developing further specifications of the Integrated Design Process, arises from the critical observation of some aspects of the process itself, which, to some extents, seem to approach the architectural matter mainly in its "Quantitative Aspects", in the sense of scientific and measurable elements of the design. As a consequence, this seems to disesteem the Architecture in its cultural and "Qualitative Aspects" (Davis et al, 2016).
In detail, looking at the IDP's Atom Diagram, the term "Architecture" is considered as a generic entity, coequal to the other electrons, instead of being the core and final aim of the process itself: in this way, it seems that the focus of the process is not anymore placed on the design of architecture: this creates confusion and it makes lose the sight of the main objective (Davis



• Ill. 005 IDP atom

et al., 2016).
Working in an integrated manner, it is a general acknowledgment to consider the Architecture as a field that embrace the arts and the specializations of engineering, aesthetics and culture; and for this reason, it should represents the core of the design process.

This lead to the consideration of architecture as a flat hierarchy matter, which aims to be expressed through the definition of a new Atom Diagram exemplification: the structure of the atom, is indeed composed of three ellipsis, respectively giving directions to the main parameters involved to the Beauty, the Structure and the Comfort of the architecture.
Beauty includes the consideration of not measurable, cultural and subjective parameters, which all contributes to the perception of the final architecture; Structure is what it is inalienable to any project that deals with statics and that it exists in a world ruled by legislation; Comfort relates the project to the performances that are required in architecture to design livable and effective spaces, according to the ethic of sustainability.
The definition of the electrons, as well as the tripartition of the ellipsis, derives from a dedicate study of the Integrated Design Process by Knudstrup, as well as Vitruvius, Pallasmaa and Goethe philosophies related to architectural terminology, Identity characterizing elements and psychological sides of the colors. As previously mentioned, these specifications will be further described in the Theory chapter of this booklet.



• Ill. 006 Final atom

Thesis Statement

This thesis project exploits the strengths of working in an holistic and integrated environment, to solve the task of a Zero Energy Guest House in an Arctic, Icelandic context. Investigations regarding to the implementation of the Integrated Design Process arise, in order to completely support the genesis of this project, which deals with the meaning of Identity Architecture. The theme is approached through the endorsement of the majestic natural environment, not only in its quantitative aspects of technical and sustainable requirements, but also in terms of qualitative aspects, that expressly consider the local resources and values as tools for making meaningful and integrated Architecture. This belief aims to find its expression through the use of an architectural language which frame and enhance the natural landscape through the sharp geometry of the Architecture, while maintaining a respectful approach to the natural context.

// 02 Theor

y

02.01: Architecture & Environment

Architecture & Landscape

The design approach towards the study theme, has the aim of dealing with the landscape and the natural context, with an attitude of collaboration: where the architectural interventions should fit into the landscape as perfectly integrated objects, which frame and enhance the features of the context through the use of sharps geometrical forms. This approach, equally dignify nature and architecture both in terms of cultural faithfulness and visual aspects.

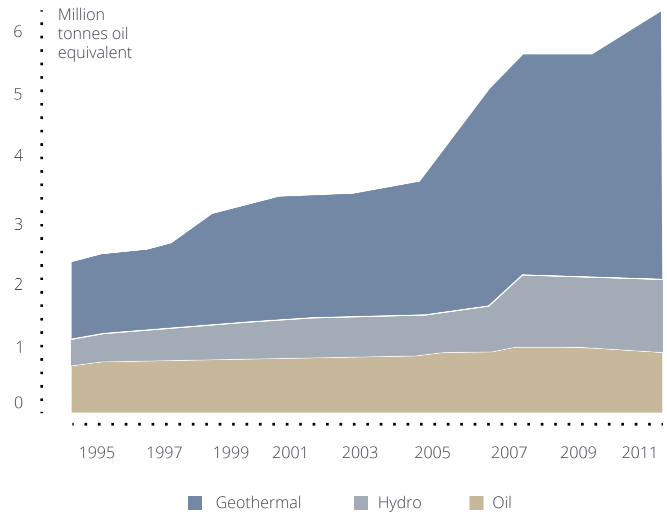
The French engineer and landscape designer Gilles Clement, inspire this attitude: in his “Manifeste du tiers Paysage”, in English “The Third Landscape”, the author gives some precautions to whom intervene on the natural environment, and therefore also to the architects. In defining what the Third Landscape is, he focuses on the importance of geographical isolation of the areas, as an added value in favor of preserving biological diversity; in fact, isolated and forgotten places usually play a fundamental role in the rescue of those animal and plant species that normally, in most of the places which are lived and regulated by man, succumb in favor of crops which are foreign to the characteristics of the place itself (Clement G., 2014). By extension of meaning, it is hereby considered the interest in the preservation of diversity, not only from a botanical point of view, but also from a cultural one, in regarding to the specific features of the territory where the architecture is inserted.
Again, in the “Manifeste du tiers paysage”, Gilles Clement also defines what the *residù*, in English residues, are: in rural areas, these are either lands not compatible with the machines for agricultural exploitation or waste land, which for their topographic/geographical difficulties, represent the best places to preserve biological diversity (Clement G., 2014). The parallelism between the mentioned conditions and the geographical reality of Iceland, as well as the project area, is immediate, and in particular, the plot where the Guest House it is going to be built, might be defined as an “ensemble primaire”, or in English: “primary set” (Clement G., 2014), which has never been subjected to exploitation because of its difficult characteristics. Therefore, it represents the optimal level of life for plants that naturally develops within the site.
As a result, this Master thesis project intervention, intends to exploit the peculiar natural characteristics of the place, as necessary conditions for the preservation of the local identity, with a specific focus on the respect of its culture, vegetation and economy. This behavior, is in fact not only environmentally responsible, but it also helps to make the architecture well received from the users and the locals.
Gilles Clement’s approach to the landscape theme, provides the opportunity to merge the natural space within the architectural planning considerations: being the Icelandic Guest House completely surrounded by natural landscape, Nature itself must represents its main cultural and physical reference. Although there are several ways to deal with the landscape, it is here intended to make a kind of architecture that while being as dignified as nature is, it represents an instrument to underline the beauty of the latter. By having this concept clear since the firsts stages of the design process, the whole process takes advantage of the features within the context, integrating them in the architecture. This is translated into the necessity for detailed analysis of the site vegetation life and of the soil properties, in order to preserve them and to exploit their features for technological and sustainable implications.

Ill. 007 Spostaneous vegetation in North of Denmark

Iceland & Sustainability

We are now living a time where climate change represents an undeniable reality: international research agree that the built environment is responsible for more than half of the energy consumption worldwide, resulting in high emissions of CO2. For millenniums our planet has had periods of relative stability in terms of climate conditions, allowing the development of human societies, and even though there have been variations in local weathers, the forms of life could adapt during the time. With the industrial revolution, the human environment is altering the basic natural conditions, causing some dramatically non-reversible changes. (Altomonte, S., 2008)

At this point, engineers and architects have to take the responsibility to investigate on new approaches to the building sector, according to the environmental demands; while local and global governments need to adapt their legislations according to the climate change: indeed, buildings largely contribute to the phenomenon: "Between 1970 and 1990, direct emissions[...] from buildings have increased by 26%. Considering also the electricity required for the functioning of mechanical systems and services (heating and cooling), the total increase of direct and indirect emissions from construction sector is much higher (75%) than direct emissions alone" (Metz B. et al, 2007).
A change of direction is possible by developing strategies where the concepts of "Mitigation" and "Adaptation" are integrated, to address long-term and short-term impacts: within the building sector, Mitigation refers to the act of reducing CO2 emissions during the construction process; while Adaptation refers to the capability of the buildings, to react to the consequences of climate change (Kress A. and Schibel K. L., 2017).

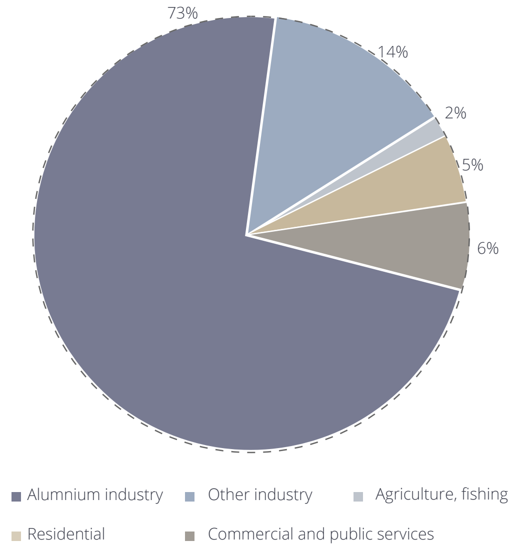


• Ill. 008 Icelandic energy sources

When addressing the issue of sustainability and sustainable challenges in architecture, it is equally important to consider the macroclimate and microclimate features of the site, as well as the specific assets and deficits of that region: in the case of Iceland, it must be considered that it is a country extremely rich in energy sources such as geothermal and hydroelectric energies, which makes it easy for the country to mainly rely on environmentally friendly resources; while instead, it is dramatically out of any construction material that is not cement, gravel and stone wood (Marteinsson B., 2002).

This aspect of course affects and affected the local traditional construction techniques: Mr. B. Marteinsson conducted a research concerning the "Material and Energy use in Buildings" within the Icelandic context, where he illustrates the material and energy

use in a typical Icelandic multi-family house; by going through his report, it emerges that due to the scarcity of materials, the harsh climatic conditions and the frequent earthquakes affecting part of the island, most of the semi-recent Icelandic constructions are made of concrete, and the large use of it is responsible for high energy consumption due to the excavations and transportation of the material on site (Marteinsson B., 2002).
Of course, this is not the only example of the issues related to the local procurement of construction material: Iceland is in fact almost devoid of forests and trees, and the main type of wood that it can be found, is the driftwood: this is mainly of Siberian origin, and it reaches the North coasts of the island through the North-Eastern currents; the species that reach the Icelandic coasts are mainly larch, poplar and spruce (nat.is). In the past, the driftwood represented, and it might still does, a great resource for the Icelandic construction sector, because it can be used as one of the few structural elements that can be found in the country, without generating a lot of CO2 emissions due to the overseas shipping. The structural strength of each driftwood trunk depends on the time that it floated in the sea, and consequently on the effect of salt, waves and wind: "The longer the trunks stay in the sea, the more saturated they get with salt, and grow very hard and enduring as a construction material" (nat.is). In the turf houses made during the Settlement Era, this was either used for bearing the roofs or in the vertical walls, and then covered by the soil, as a form of insulation.
The knowledge coming from these observations, represents a great potential for the design of the Icelandic Guest House, with the aim of minimizing as much as possible the CO2 emissions due to the transport of materials.



• Ill. 009 Iceland energy portal

• Ill. 010 Krafla Geothermal power plant station

Case study / Tennis and Padel School Office

Tennis and Padel School Office, by Beta.ø. Architects

The project realized in Madrid by Beta.ø Architects, represents an interesting hint for reflecting upon the design approach of the Guest House Cabins: Tennis and Padel School Office, is in fact a modular project, based on the principle of ease of deconstruction and disassembly. Moreover, through the use of an external double skin, it allows the vegetation to climb on the structure, merging architecture and landscape on a visual sense. The mentioned features are part of the main focuses of this Master thesis project and they aim to be expressed in the Icelandic Guest House, through an architectural language that is simple and geometric: both these characteristics find realization in this case study.

Atmosphere:

In Tennis and Padel School Office, the functions of the project are divided into two cabins rather than finding solution into one building. This is due to the intention of aligning and integrating the architecture with its natural context, following the alignment of the existing trees (domusweb.it): the feeling of dialogue between architecture and landscape is accentuated both by the use of a design scale not very different from the other elements present in the landscape, and by the choice of the construction materials' colors: these in fact recall the tones of the surrounding elements without making the structure appear as an alien object. Nevertheless, the modern architectural language, simple and geometric, gives dignity to architecture, not wanting to hide it, but using it as an integrated and non-invasive object, which frames the natural context, as a painting frame. Finally, the idea of considering the natural activity of plants within the architectural design, accentuates the visual integration of the two buildings in the landscape, and it fully reflects the meaning of a dialogue between Architecture and Nature.

Sustainability:

Regarding to the Sustainable Approach, the two cabins are designed for industrialized construction: a single steel module of 5m x 3m is used for the both structures. Referring to the project of the Icelandic Guest House, the use of modular elements, can facilitate the transport of materials on site and the simplicity of assembly/disassembling: this approach is confirmed as a smart way to go in the construction sector of green architecture, also in reference to the "DGNB / TEC 1.6 Deconstruction and Disassembly". By the consideration of such criterion within the design, it is hereby considered the hypothesis of eventual dismantling of the Guest House business: in this eventuality, it would be possible to reuse the construction materials, with consequent reduction of waste.

• Ill. 011 Padel school office façade

• Ill. 012 Padel school office cabin

• Ill. 013 Padel school office context

Case study / Hof House

Hof House, Studio Granada Architects

The Hof House, made by Studio Granada Architects, is a residential intervention based on an existent estate. The project is located in Iceland and its main peculiarity lays on the reuse of materials coming from the site. This approach does not only represents a challenge, but above all, an essential necessity. This is particularly true when thinking about testing the design of a building thorough an LCA calculation, where the CO2 emissions related to the transportation of construction materials are also calculated. For these reasons, the Hof House represents an interesting case study for the design of the Icelandic Guest House main complex.

Atmosphere:
When approaching the building from the outside, the visual perception is that of being in front of an object able to give the sensation of the passing time: in fact, the external concrete, ages gently with the passing of the seasons (inhabitat.com), and this give to the material a color more and more similar to the tones of the surrounding nature. The geometric language of the volumes is in contrast with the soft organic shapes of the mountains on the background, and this contrast gives the perception of the architecture as something different from the natural place that hosts it, but still, without being invasive. In fact, while not copying the forms of nature, the five parallelepipeds juxtaposed to each other, recalls the forms of the mountains behind them, thus acting as a negative of nature itself, and finally seeming almost like the structural skeleton of the soft shapes in the background. These elements give a positive overwhelming atmosphere to the visitors, which collide with the harsh Icelandic climate experienced on the way that lead to the building.

Sustainability:
The sustainable strategies applied to the Hof House are diverse and inspiring: above all, the energy supply of the Horf House, fully exploits the best features of the Icelandic soil: the wealth of geothermal energy. This in fact provides the supply of internal heating and the production of electricity, while the exploitation of hydroelectric power covers the remaining energy needs (Kain, n.d.).

• Ill. 014 Hof house façade

• Ill. 015 Hof house detail

• Ill. 016 Hof house context

Conclusions

When dealing with Sustainable Architecture, the Environment needs to be approached in a holistic manner: this means to consider the technical strategies that might influence the design in its context, and to also take a clear position on the issue from a visual point of view. In the previous pages, it has been defined the will to approach the environment and the landscape in a collaborative way, which enhance the fruition of the natural context and of the architecture itself. The conducted studies, lead to consider the exploitation of the soil, the preservation of vegetation within the area, and a clear architectural language which frame the landscape, as crucial aspects for the design process.

02.02: Architecture & Methods

A critical reading to the IDP

As anticipated in the Prologue, the methodology behind this thesis research, lays its foundations within the Integrated Design Process in Problem Based Learning, developed by Knudstrup, M. and applied, as an educational and methodological tool, at Aalborg University, since 2005. The main concept behind this methodology lays on the integration between Architecture and Engineering: the term Architecture is hereby considered in its traditional sense of discipline mainly linked to the aesthetic and formal aspects of the buildings production; while with the term Engineering is meant the necessary technical and technological sides of the practice.

A fundamental feature of the Integrated Design Process, is its iterative nature: the phases which follow one to another within the process itself, do not follow a linear sequence, but are rather iterative: thus, the process is configured as a continuous loop, where each new notion and/or design option is tested. When conflicts between analysis and design options emerge, a new reflection is required, going back to the previous phases, with the hope of finding a synthesis in the final presentation of the project (Knudstrup M., 2005).

The ultimate goal of the IDP, is to support the genesis of a “good architecture” (Knudstrup M., 2005) and the phases in which it is divided are:

Problem Statement: in this phase, the theme of the project is identified, and the “problem” is described according to the goals that need to be fulfilled.

Analysis: the first analysis are carried out: these concerns the building location, the climate, the type of users and the room program. These aspects are fundamental to get the definition of some design parameters, that will be pursued in the following phases.

Sketching: various design proposals are tested: these already include aspects related to climate and construction techniques, in accordance with the design parameters established in the analysis phase. It might be possible that the first iterations are not able to satisfy the goals previously established for the project, and this starts questioning the results of the analysis previously made; as a consequence, it is needed to go back to the previous phase.

Synthesis: here, after the numerous iterations conducted during the Sketching phase, the design finally reaches the right compromise which allows the realization of the goals established in the Problem Statement phase.

Presentation: the project is finally presented in the form of a booklet, with the support of 2D and 3D drawings.
(Knudstrup M., 2005)

It has already been anticipated, that the IDP’s methodology is hereby applied with a critical approach, which recognizes the advantages related to both the iterative nature of the process itself, and to the timely integration of the technical aspects of the design since the very beginning of the design. In fact, this highly supports the genesis of a conscious project.

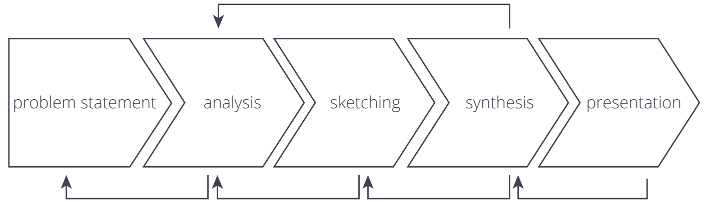
However, some limitations in regard to its application to this specific thesis project, are recognized: looking at the IDP Atom Diagram (ill. 018), it can be noted that the Architecture is considered as much as one of the others electrons/design parameters, which revolve around The Project, which in fact represents the final goal of the process.

As anticipated in the Prologue, this seems to downgrade the Architecture to the role of a generic design parameter, instead of recognizing it as the main driver of the process itself (Davis et al., 2016).
According to the Vision that is applied to this thesis project, the Architecture is an equally artistic and technical subject, and as such, it deserves to place the Architecture itself at the center of the design process; the design parameters, on the other hand, should then ensure the fair balancing of Technical, Aesthetical and Comfort factors.

This vision of the architecture, is endorsed by the 11 admission criteria to the Professional Qualifications, stated by the Danish Association of Architects (according to Art. 2013/55/EU): as these inspired this critical reflection upon the methodology in architectural production, they are listed below:

1. Ability to create architectural designs that satisfy both aesthetic and technical requirements.

2. Adequate knowledge of the history and theories of architecture and the related arts, technologies and human sciences.



• Ill. 017 PBL Diagram

3. Knowledge of the fine arts as an influence on the quality of architectural design.

4. Adequate knowledge of urban design, planning and the skills involved in the planning process.

5. Understanding of the relationship between people and buildings, and between buildings and their environment, and of the need to relate buildings and the spaces between them to human needs and scale.

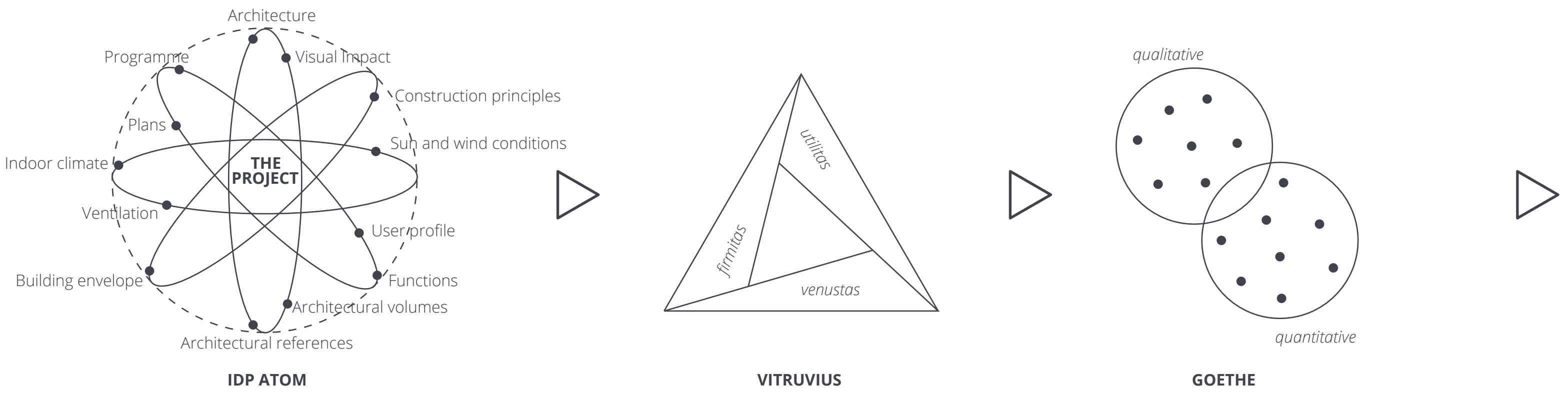
6. Understanding of the profession of architecture and the role of the architect in society, in particular in preparing briefs that take account of social factors.

7. Understanding of the methods of investigation and preparation of the brief for a design project.

8. Understanding of the structural design, construction and engineering problems associated with building design.

9. Adequate knowledge of physical problems and technologies and of the function of buildings so as to provide them with internal conditions of comfort and protection against the climate.

10. The necessary design skills to meet building users' requirements within the constraints imposed by cost factors and building regulations.

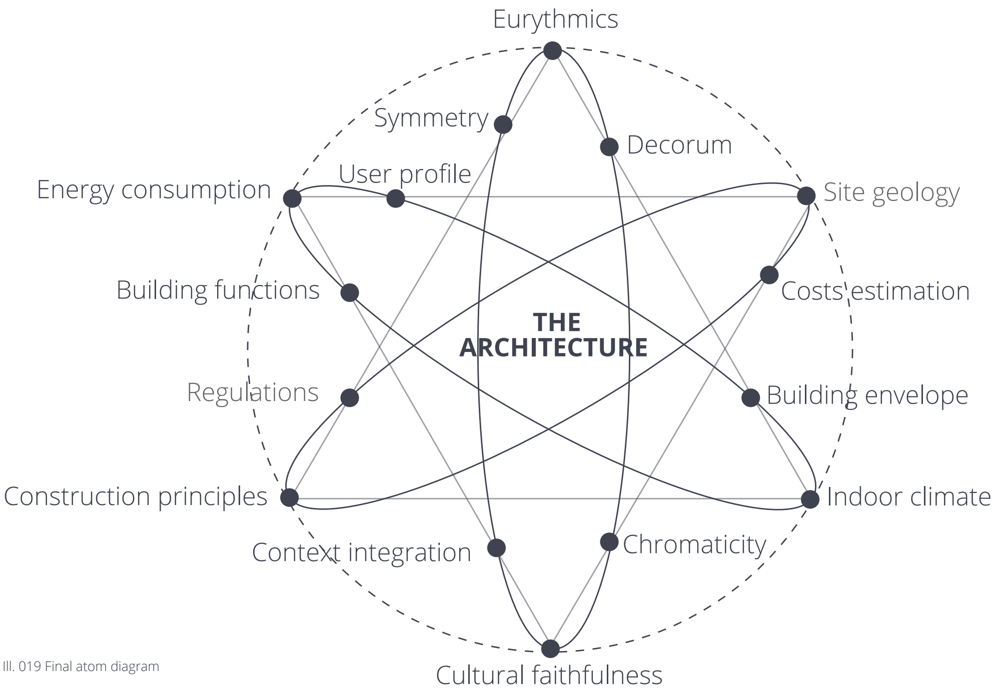


• Ill. 018 Methodology process

11. Adequate knowledge of the industries, organizations, regulations and procedures involved in translating design concepts into buildings and integrating plans into overall planning. (arkitektforeningen.dk)

The architect's profile that emerge from these criteria, perfectly describes what the authors of this thesis believe it answers to the task of working within an integrated environment: external fields, not directly associated with the profession of the architect, are indeed considered as a fundamental background which builds the skills of the professional. These includes the knowledge of arts, structural principles and economics: when acting in respect of all these principles, we can find the meaning of integration and consciousness.

Being the Integrated Design Process in Problem Based Learning, already a very detailed methodological guideline for what it concerns the most technical and technological aspects of the design process, the theoretical contributions in the following paragraphs, will be mainly focused on deepening the less weighable aspects that are included in the methodological definition of this Master thesis framework.



• Ill. 019 Final atom diagram

Vitruvius contribution

In this sense, a "Vitruvian vision" of the architecture might be considered: the intimate meaning of the Integrated Design Process, seems, indeed, to be completely enclosed within the Vitruvian Triangle: Firmitas, Utilitas and Venustas.

Although architecture is in fact a technical discipline, is not a Science like any other, and it must considers elements that are not quantifiable in numerical parameters, nor are they objective, but which are instead the result of an artistic and cultural awareness of the designer, which also calls for the interpretation of the features of the place where the project takes shape.

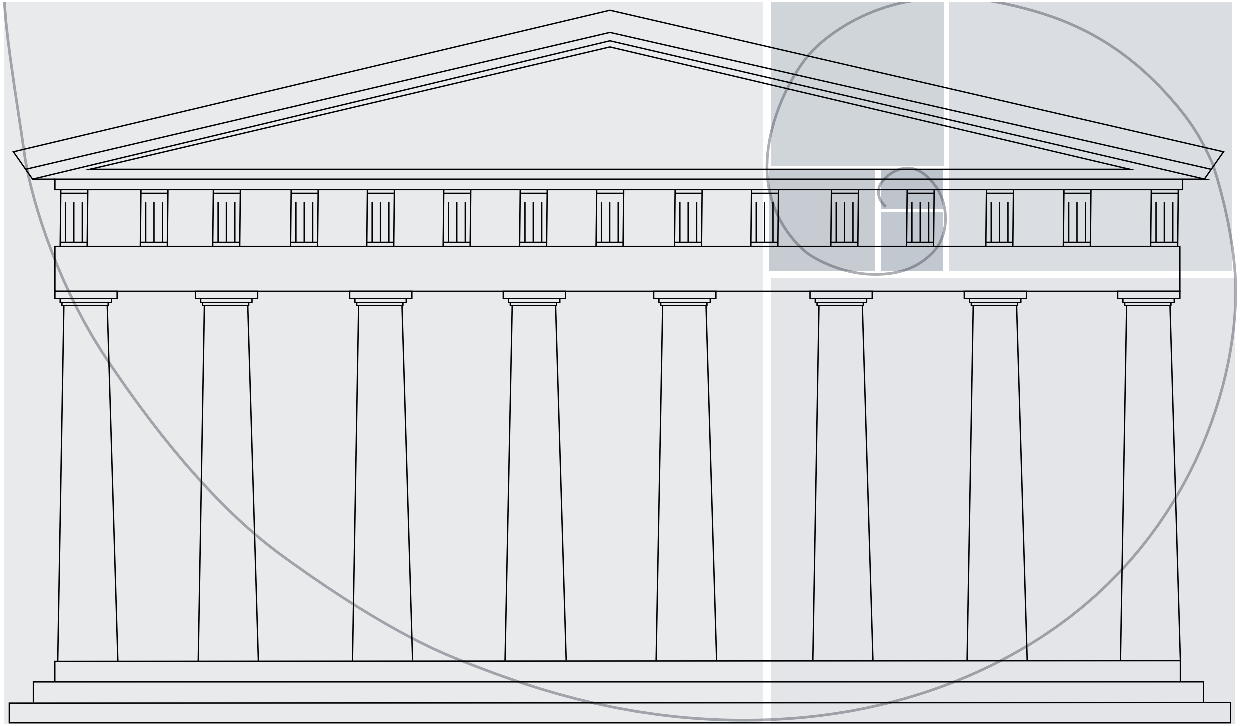
However, this consideration, seems to fail in the Atom that describes the Integrated Design Process, which appears, in this sense, as a mainly Engineering methodological process, applied to the world of Architecture, in the traditional sense of the term.

When it comes to Venustas, in English "beauty", Vitruvius analyses what it actually gives the perception of beauty itself, giving also an extensive description of the aspects which characterize it: Symmetry, Eurythmics and Decorum: Symmetry, takes the Greek meaning of Proportion; while Eurythmics is the lovely appearance of the elements which compose the Architecture, given by the Proportions. Finally, the meaning of Decorum is in fact exemplified by the function of the ancient architectural orders.

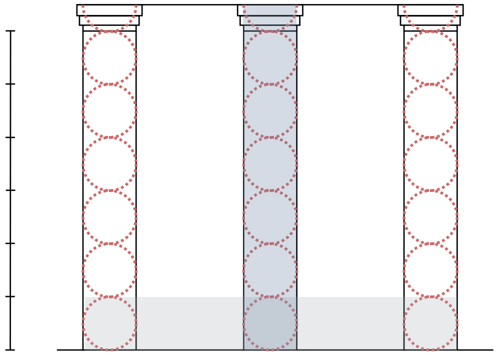
In the beginning, the orders were not only used as a mere decoration, but as a module to give the right and harmonious proportion to the structure.

Therefore, the three elements of Symmetry, Eurythmics and Decorum, when combined together, they give the perception of what Beauty means: this is perceived in a different way in every nation, according to the different cultural and aesthetic backgrounds (Galiani B., 1490).

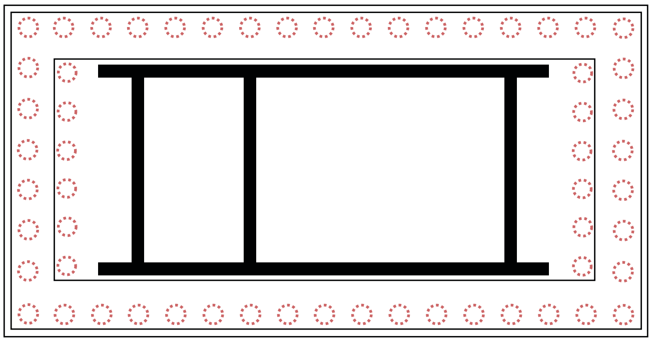
The re-discovery of this terminology, if included within the design process, underlines the importance of socio-cultural analysis of the place where the project is inserted, and it gives dignity back to the conception of aesthetics in Architecture, making clear the flat hierarchy between comfort, structural and beauty principles, considered as Utilitas, Firmitas and Venustas.



• Ill. 020 Eurythmics_the Symmetry in Greek temple's facade with its Golden Section proportion



• Ill. 021 Decorum_diameter of a column as a Module in Greek's temples facades



• Ill. 022 Decorum_diameter of a column as a Module in Greek's temples plans

Goethe’s contribution

The research for the right methodological approach to fit this Master thesis, is enriched with additional parameters coming from Goethe’s studies and terminology in his “Theory of Colours”: even not directly referring to the definition of a methodology for architectural processes, Goethe uses to refer to what he calls a “Qualitative Science”, which, if added to the considerations of the Newtonian Quantitative Science, it can implement the approach to scientific investigations, without removing the Man from his relationship with Nature. Hence, an approach that is “not merely mechanistic, not purely poetic” derives from it. (Zajonc G. A., 1975).
In the context of this thesis, it is believed that this additional approach to the sciences, might link the process of making artworks, as well as architecture, to a real integrated approach, aware of the double nature of the architectural matter: technical and artistic.

Furthermore, this finally arises the crucial observation regarding the subjectivity within the architectural process: being architecture a human product, it is indeed impossible for the designer to completely push himself back without making noticing some of his personality in the final work.

Manda tradition that Michelangelo Buonarroti, each time in the phase of completing the face of Gods statues, used to ask for 5 pupils to sculpt some details of the statue face: in fact, the representation of the Gods’ face was, as much as possible, not to resemble any aesthetic canon; if he alone had completed the work, he would have unconsciously inserted details of his personal taste. Thus, back to the architecture, if it is not possible to fight against subjectivity, why not to take advantage of it? Goethe’s “Theory of Colours” analyses colours as fundamental elements in the perception of artistic products, which also architecture is.

Embracing Goethe’s vision, colours are therefore instruments with “moral and psychological characteristics” in themself, which affect the perception of reality from the observator side.

“[...] Yet Goethe goes further. Course of nature, but more importantly, the colors tones, and forms all being fundamentally creative in nature”. (Zajonc G. A., 1975).

As a consequence, the importance of colours in architecture, does very much affects the harmony between all the elements that constitute the urban and the natural landscape; so the perception and the beauty.

• Ill. 023 Psychological sides of colours - William Turner

Pallasmaa's contribution

Finally, in accordance with the vision of Architecture that wants to emerge from this project, the methodology must take into account the Identity aspects of the place where the project takes shape: starting from the question "what is it that gives us the sense of location? ", the interest towards Pallasmaa's vision of Architecture arises: "A culturally adapted architecture, is not just a matter of visual style, but of integration of culture, behavior and environment" [*Juhani Pallasmaa* (Canizaro V., 2007)]. And again, referring to Alvar Aalto's architecture, Pallasmaa specifies how the perfect integration of Aalto's projects within the context and within his own time, is in fact linked to the clear historical and cultural references he uses. This is particularly true considering these aspects in a contemporary way, making a kind of architecture that is not traditional at any cost, but it can reinvent the traditional features.

"The interdependence of architecture and culture has not been sufficiently recognized. The international, consumerist architectural journalism of today, violently detaches buildings from their cultural contexts and presents them in an arena of individual architectural showmanship" [*Juhani Pallasmaa* (Canizaro V., 2007)]. From these words, it emerges therefore the conviction, shared by the authors of this thesis, that the interdependence between Architecture as a discipline, and its cultural and historical context, is essentially important for its successful integration with its context.

What it is here intended to study, is what Pallasmaa calls the "unexplainable sense of rootedness" [*Juhani Pallasmaa* (Canizaro V., 2007)] : as the word might suggests, it gets hard time to reduce this feeling into some parameters, since these would of course be very much under the limitation of interpretations.

In this sense, it is fair to interpret the whole Pallasmaa's vision, claiming the already mentioned value of subjectivity and culture as fundamental instruments for making successful architecture, well integrated within the context and well perceived from the users.

• Ill. 024 Architecture and Local Identity: “Muuratsalo Experimental House” by Alvar Aalto

Conclusions

The research conducted, lead to the definition of the final methodological framework of the project: this is based on the belief that Architecture is an interdisciplinary science, where culture, sensitiveness and subjectivity interfere with the building performance requirements and structural principles. These aspects cooperate together, in a flat hierarchical manner, towards the achievement of meaningful Architecture. The reflections coming by the study of Vitruvius, Goethe and Pallasmaa, increase the awareness of the whole design process, personalizing it with the specific connotations which define what Identity Architecture should be represented like, according to the authors of this thesis. The Architecture is here considered as a scientifically creative process, which requires a both scientific and subjective process development in the beginning stage of any project. Specifically, the ambition of this methodological approach, is to conjugate the principles of sustainable architecture, with the personal sensitivity of the designers.

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03 Analys

sis

03.01: Socio-cultural analysis

Evolution of Icelandic architecture

The history of Icelandic architecture can be said to be relatively recent. This has always been characterized by a very close attention to the climate, which, more than any other parameters, determines the architectural choices of the whole island.
Thus, in this brief historical overview, the emphasis is placed on how much Icelandic architectural evolution is mainly determined by the periodical changes in the choice of materials which respond the best to the climatic exigences, rather than in response to the changes of the artistic and architectural trends, as it is the case in most of the European countries. This brief excursus has then the purpose of exploring the background of Icelandic architecture, in order to get if some materials, more than others, have been ever re-proposed in the traditional use, because of some special features facing the harsh climate.
As mentioned above, there is no real fidelity of Icelandic architecture into any of the most renowned architectural movements over the last centuries, so it is difficult to categorize the buildings within defined style frames, and the local architects have, for a long time, been privately drawn to architectural styles and movements, responding to their taste and that of the client. (Guide to Iceland, 2017)

As a consequence of this tendency, the Icelandic architectural scene appears as a melting pot, a mishmash of styles, juxtaposed to one another, without an evident reason. This chaotic urban landscape determines the characteristic image of all the main cities of the island. The rural landscape, on the other hand, has always been circumscribed by isolated architectural interventions, so that the architectural melting pot is more sparse and less evident.

From the settlement era in 9th century, until the 18th, the Icelandic architecture was predominantly spontaneous, and the landscape was characterized by the typical turf houses, which are today among the major architectural attractions of the island itself. The construction techniques related to this type of buildings were modest, and the interior spaces extremely reduced; on the other hand, these were efficient in terms of indoor environment, taking advantage of the ground as a covering coat of the houses themselves. (Guide to Iceland, 2017)
Then, with the increased interest of the Danish Government into the implementation of some Icelandic industries, the city of Reykjavik slowly began to be built in stone, especially in the construction of churches and public buildings. As far as domestic architecture is concerned, in the 19th century, when the corrugated iron was discovered, this began to be widely used both as a cladding and as a covering of the interior walls. This material has been and it still is very much used, because besides of having technical characteristics well responding to the climate exigences, it also lends itself to be adorned, painted and aestheticized. (Guide to Iceland, 2017)
From the 19th century, up to the first decades of the 20th, both houses and representative architecture, have started to develop a tendency to historicism. The first buildings officially signed by architects are dated back to this period, and, as it happened in the past, the designers were drawing from a given artistic movement according to their taste, contributing to the meltig pot of styles, typical of the Icelandic urban landscape. (Guide to Iceland, 2017)
In 1915, the use of concrete entered in Iceland: from the first architectural experiments by Gudjon Samuelsson on, this has

been widely used both because of the particular local climatic conditions, and both for its good versatility in the architectural expression: this period is called "Steinsteypuöldin", or in English "Cement Age", and it is the period in which the Icelandic architecture began to characterize itself as Functionalist. (Guide to Iceland, 2017)
Therefore, while surviving some tendencies to Historicism, this represents the first period where Icelandic architecture sees its first architects growing (guidetoiceland.is).

Nowadays, it seems that the local architecture still cannot uniquely be ascribed to a specific architectural movement: this tends into favor of the rediscovery of some spatial features and ancient tradition, with a tendency to the vernacular and to a cautious approach towards the natural landscape: since this dominates the country, not only on a visual level, but it represents, in fact, the main difficulty and challenge of making architecture.

For this reason, the importance of chosing the right construction materials, still remains a crucial parameter in the making of architecture within the Icelandic context.

• Ill. 025 Arch. Timeline

Blooming of the tourism sector

Iceland has recently become a new busy tourism place. The increased flow of toursits has started after the Eyjafjallajökull volcano eruption in 2010: a rare and impetuous phenomenon that affected for several time the flight conditions all over Europe. Thanks to this event, a true rebirth of the country has been possible, after the 2008 financial crisis. Since then, the tourism industry has started to invest in the local economy. (Lonely Planet., 2017).
"The tourism boom saw a 264% increase from 2010 to 2015, with about 1.3 milions of visitors arriving in 2015 [...] and tourism now accounts for 31% of Iceland's export of good and services." (Lonely Planet., 2017)

This newly discovered business, has brought several benefits to the local community: as Icelanders confirm, tourism has brought new job opportunities, and it has generated a new interest and respect to the local natural environment. (Lonely Planet., 2017)

However, the flipsides must be considered as well: the villages where most of the touristic attractions are, are now often getting under pressure, because they need to adjust their facilities services in order to serve different kinds of tourists. For this reason, the Icelandic Government has recently established new laws regarding short-term rentals, in order to better monitoring the whole industry. (Guide to Iceland, 2017)

The primary touristic attraction of Iceland, is represented by the natural landscapes. However, the fragile natural environment, is now risking of being deturped because of disinformed tourists who are not always respectful and careful towards the dangers of the wild nature. For this reason, it is not uncommon that the local news reports about nature degradation. (Guide to Iceland, 2017)

This state of affairs, stimulates reflections towards the approach of a new sustainable tourism, able to ensure the visitors and the landscape safety. This approach is aligned to the Icelandic Government policy, that is now promoting sustainable and responsible tourism, increasing the tourists sources of information through several websites. Among the others: guidetoiceland.is, safetravel.is, road.is, nature.is, landvernd.is. (Guide to Iceland, 2017)

• Ill. 026 Myvatn nature baths tourist attraction

Transformation of the hospitality industry

As a consequence to the recent tourism blooming, the local hotel industry is currently adapting to the increased variety of visitors, expanding the range of accommodation options: the main hotel facilities span from the luxury hotels, to the adventurous site-campings and the rural farmhouses. Emerging typologies of accommodations are increasing as well: it is the case of hostels and guesthouses.
The business management of the guest houses is usually family-run, offering an intimate and warm atmosphere, ideally recalling the local houses features. This kind of accommodation can be classified depending on the type of social interaction between hosts and guests: indeed, a guest house can either be a family property which offers rooms for rent within the property itself, or an additionally custom-built block of guestrooms, detached from the host house.

This logistic difference, can greatly influence the type of experience lived by the guests: spending time in a guest house, can in fact give the opportunity to get in contact with the local cultural atmosphere, more than being in a traditional hotel.
In the specific case of Iceland, this last aspect can represents a strength in terms of security, taking advantage of the interaction between hosts and guests for teaching to the tourists how to respectfully act towards the natural landscape.

For the specific purpose of this Master thesis, one of the most significant examples of guest house business which inspires this work, is located in the South-East Region of the island and it is run by Eyrìn Axelsdòttir and Steindòr Siqurjònsson: from an architectural point of view, the structure is contemporary looking and built using lightweight materials, mostly prefabricated and subsequently transported on-site (See illustrations number 029 and 030 of the following page).

From a sustainable point of view, the design approach used in this project, supports the disassembly of the structures and the maximum respect towards the landscape, minimizing the foundations interaction of the cabins in the ground. (See Annex 1, page 184, for the interview to the owners).

• Ill. 027 Fosshotel Myvatn

• Ill. 028 Detail of Fosshotel Myvatn

• Ill. 029 Contemporary guesthouse I

• Ill. 030 Contemporary guesthouse I, profile

• Ill. 031 Contemporary guesthouse II

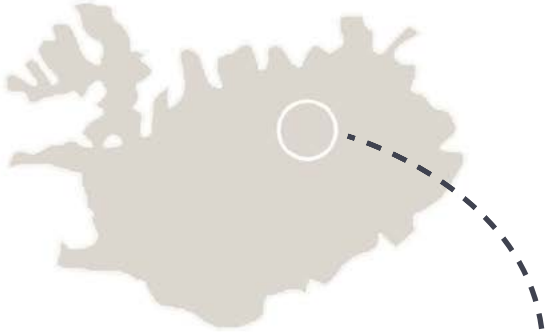
• Ill. 032 Contemporary guesthouse II, profile

Conclusions

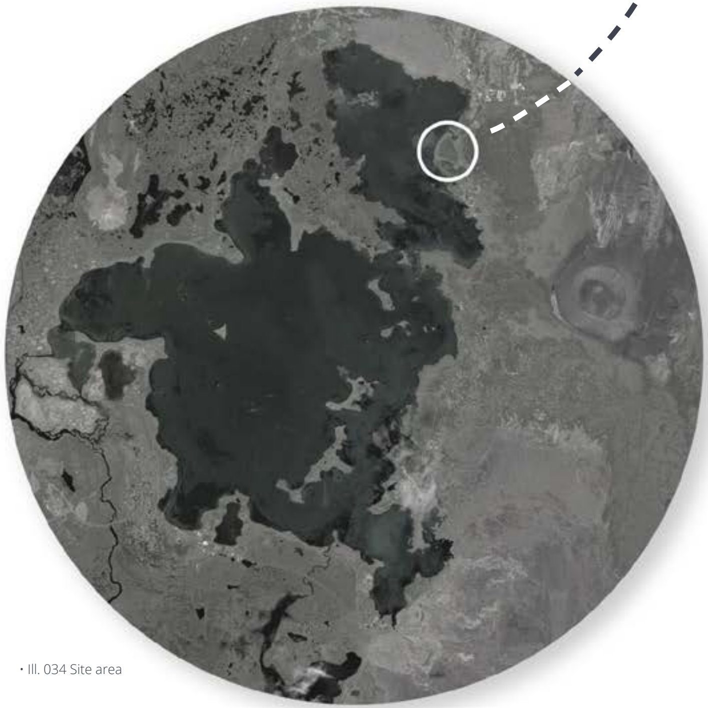
The research conducted in this section, concur to the definition of a fully integrated design within the Icelandic socio-cultural context: when dealing with Identity Architecture, is in fact crucial to understand the evolving social dynamics, such as the local architectural history and the economy related to the evolution of the tourism sector. Throughout the deepening of these aspects, it has emerged that Iceland, unlike the most of the European countries, has never developed its own artistic and architectural currents, but on the other hand, the selection of architectural materials has always represented the main temporal differentiation in the field of the local building sector. These aspects become interesting for the Icelandic Guest House project, suggesting a continuity in the use of essentially efficient materials, whose aesthetic potential must relate to the harsh outdoor climate and their maintenance, more than in any other country. The economic growth that the country is experiencing nowadays, has encouraged the proliferation of guest houses as emerging typology of hotel industry: in terms of design approach, this translates into the radicalization of guest houses as a kind of accommodation that is welcoming and familiar, without losing comfort aspects. Thus, being the aim of the project to fit the local Identity, these observations contribute to the definition of the desired ambience of the project.

03.02: Location framework

The site is located in the North/East region of Iceland, in the Myvatn area, about 50 km away from the sea, 270 meters above the sea level. The territory has been shaped over the last 10 000 years, through the intense, and still in progress, volcanic and glacial activity, which gives the understanding of the rich ecosystem of the area (Guðmundsson, 2002); these information will be further explained in the following analysis of this chapter. As previously mentioned, Iceland has an unique, fragile and majestic landscape that sets the major challenges of designing sustainable architecture in extreme environments. For this reason, all the geological and climate analysis conducted in this Master thesis, result more than ever necessary for a conscious design process.
The site topography is not completely flat and it reaches its highest point at an height of about 285 meters from the sea level. Moreover, the dimensions of the area are very large, for a total of 92 548 m2. This aspect, represents a great challenge for the project design, having to face the thematic of integration between architecture and landscape in such a wide context.
Within the 200 meters of distance from the west side of the lake, it is not possible to build any construction with deep foundations in the ground. Therefore, only removable construction can be built there (See illustration number 035 in the following page).



• Ill. 033 Project area,



• Ill. 034 Site area

• Ill. 035 Site plan

03.03: Site analysis

• Ill. 036 Local facilities

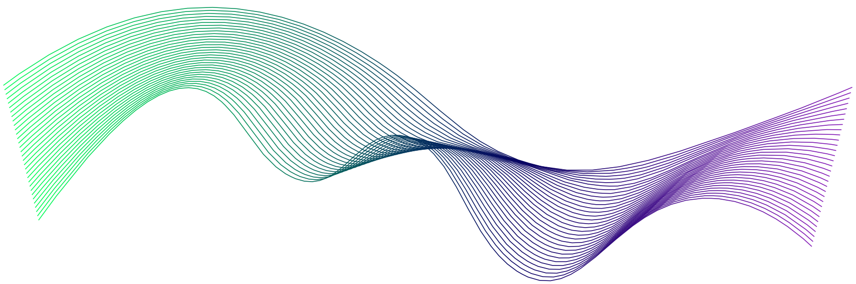
Infrastructure

The site is located in an isolated area next to Myvatn lake's shore and 9 kilometers away from the village of Reykjahlid: this accounts of 300 inhabitants and it is the seat of Skútustadahreppur's municipality. The area is lacking of public services, while there are several tourists accommodations, distributed mainly in the urban centre. In Reykjahlid there is an information point, a supermarket and a small post office. There are not other public services like hospitals or medical clinics. While the closest road to reach the site is the Myvatnsnvegur, and due to the remoteness of the area, the traffic does not seem to influence the isolation of the area.

Topography

The topography within the site area is not characterized by very wide height differences: the altimetry does not span more than 16 meters from the lake's shore to the highest point of the site, which is 285 meters high in the center of the site. There is no high vegetation in the nearest area, except for a small forest in the west side right outside the project site. In the illustration number 037 of the following page, the cross section of the area is shown.

• Ill. 037 Context Section

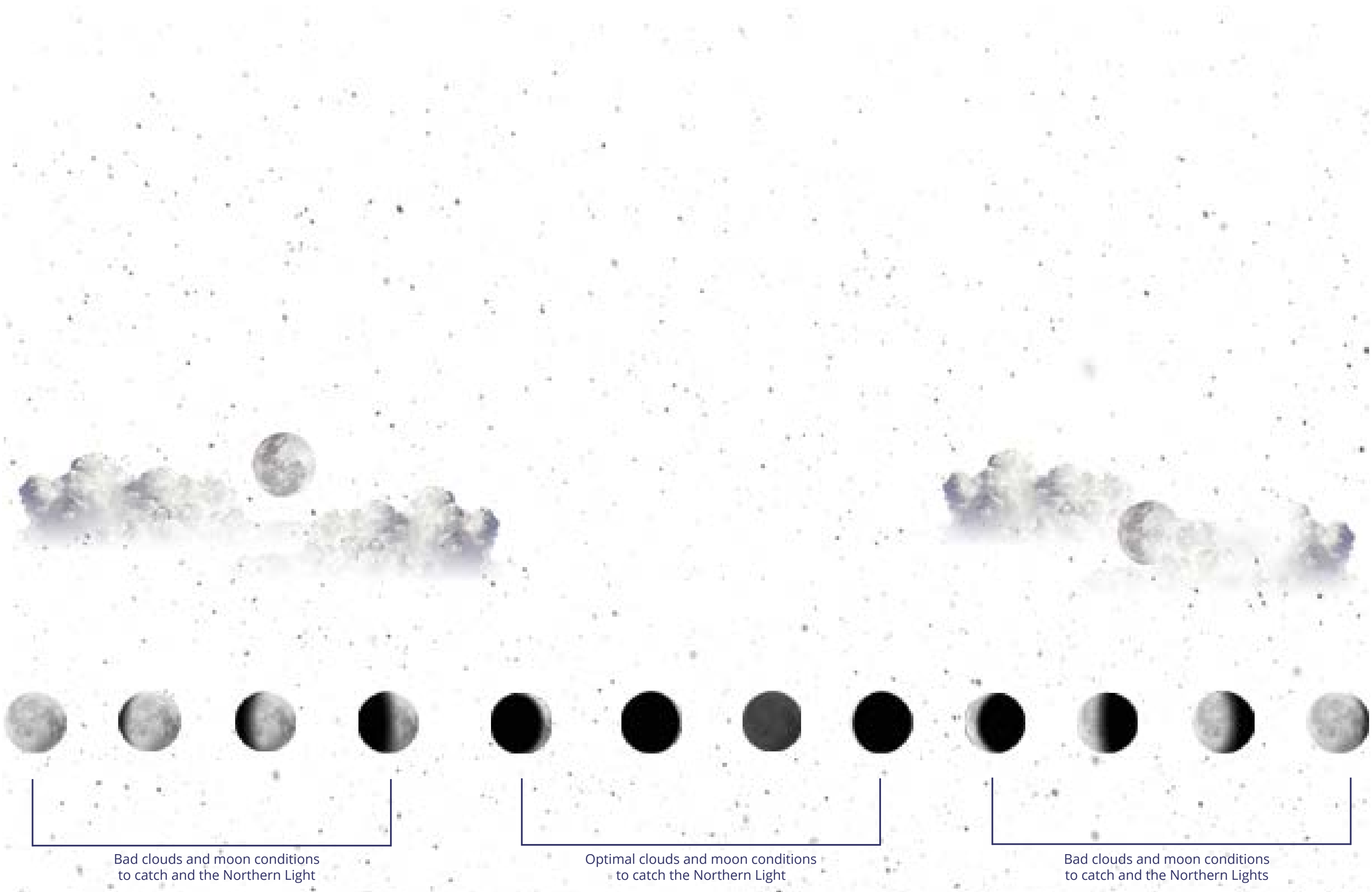


• Ill. 038 Aurora Borealis

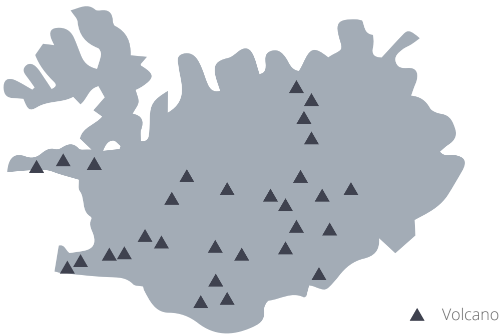
Aurora Borealis

The Aurora Borealis phenomenon has origin from the sun activity: during its solar cycle, the solar flares are throwed toward the space; after a magnetic phenomenon, the excited atoms and molecoles, “release their energy in the form of light”. (swpc.noaa.gov). This is the moment where the human eye is able to catch the phenomenon in the sky, in the forms of a lively flow of colours. This scenarious is mostly visible from extreme latitudes, along the two poles. For this reason, Iceland is in of the most recommended spots to catch the Northern Lights.

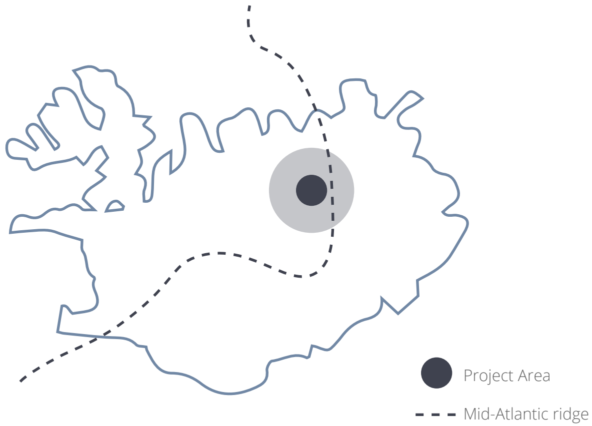
The event can potentially happens during the whole year, but due to sky conditions, it is most likely observable in Iceland from September to April, when the night darkness is enough to increase the chances. The Northern Lights experience is unpredictable, since the event depends on both uncontrollable factors and on the weather conditions (Wentzlaff, 2015): a dark and clear sky, free of clouds, represents the best condition. The moon brightness is influencing the phenomenon experience as well (Byrd, 2017). The illustration number 039 of the following page is showing bad and good conditions to catch the Northern Lights.



• Ill. 039 Moon and clouds condition affecting the Northern Lights view



• Ill. 040 Volcano map

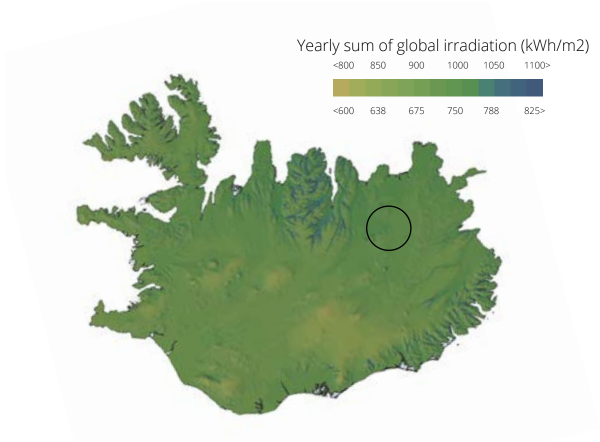


• Ill. 041 Mid-Atlantic ridge

Geology

In terms of geology, the area is relatively young and interested by an intense activity. In fact, the tuff mountains in the surrounding, are mostly due to volcanic eruptions during the most recent Ice Ages: where the magma was able to burst through the glacier, the mountains were consequently forming; where this did not happen, the magma formed many ridges which are now surrounding the site. From a broader perspective, Myvatn is located on the western edge of the active volcanic area which divide Iceland through the Mid-Atlantic Ridge, a belt of volcanic activity, dividing the tectonic plates of Eurasia and North America, and that it is the cause of the frequent eruptions in the Myvatn area (Guðmundsson, 2002).
The results of this intense tectonic activity, are also identifiable in the fissures on the ground, and in the costitution of the materials which are constituting the soil: mainly basalt lava and tuff.

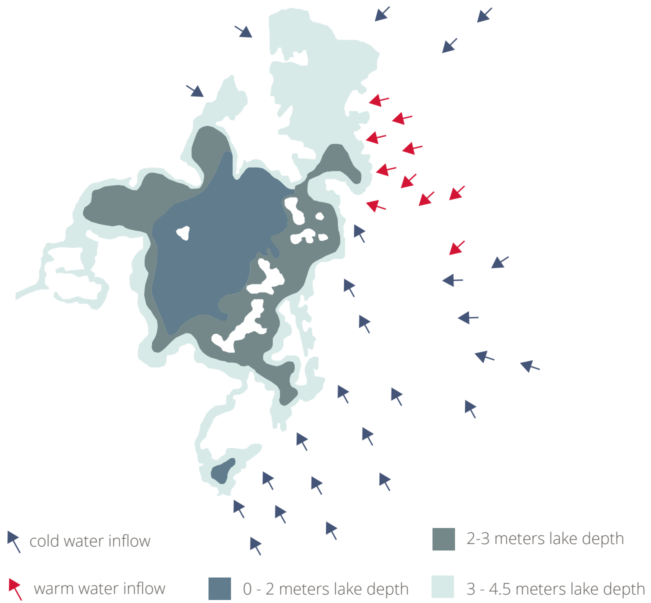
According to geologists, intense lava eruptions occurred 3800 years ago, shaping the size of the lake. Then, the shaping process continued around 2000 years ago, with the lava flowing towards the sea and with the formation of the characteristic pseudo-craters, which denote the Myvatn area. (Guðmundsson, 2002)
In the whole country there is a total of 32 volcanoes, and the activity of earthquakes, fumaroles and geysers is strictly connected to their presence. (icelandicvolcanos.is)
It is important to stress that the Icelandic seismic activity, while not being excessively aggressive, is still very frequent: in 2017, 15 earthquakes of 1.5 or greater magnitude, have been registered. (earthquaketrack.com)



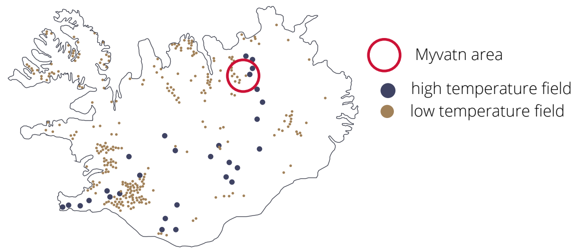
• Ill. 042 Global irradiation and solar electricity potential, kWh/m2

Global irradiation and solar electricity potential, kWh/m2

The graphic shows the yearly sum of global irradiation in Iceland and its relative solar electricity potential with optimally inclined photovoltaic modules (openei.org). Looking at the illustration number 042, it emerges that the yearly electricity which can be generated in the project area, by 1 kW peak system with a performance ratio of 0,75 kWh/kW peak, is in between 750 and 1000 kWh/m2. Thus, the eventual utilization of photovoltaic as an electricity source for the project, does not necessarily represents the most suitable supply strategy in Iceland, also considering the fact that applying photovoltaic systems, leads to the use of relatively large square meters areas to produce the electricity needed to cover the building energy consumption. Also, the initial costs investments should be taken into account (Pomianowska A.M., 2016) and these might not be justified by the potential of the source itself.



• Ill. 043 Water data of Myvatn Lake



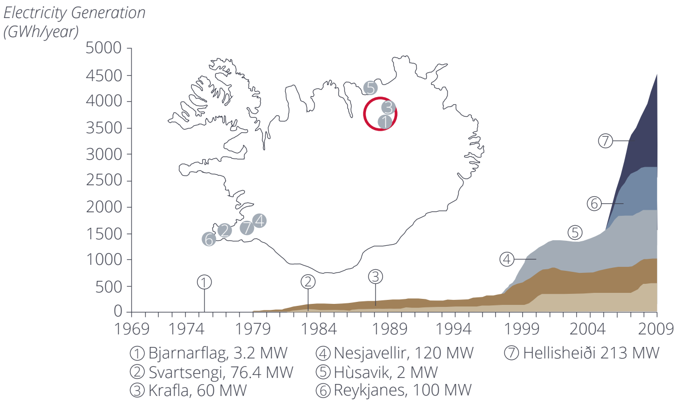
• Ill. 044 Local temperature

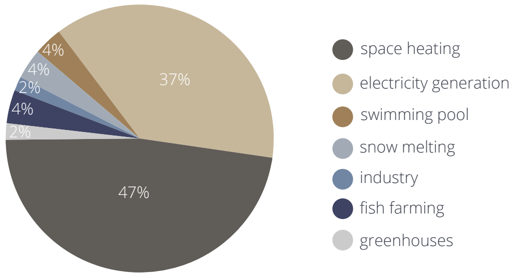
Hydrology

The site area is located on the North- East coast of the Myvatn Lake. This has a total surface of 38 km2, and it is situated 280 m above the sea level. The maximum depth of the lake is 4.5 m: not being very depth, the overall temperatures of the lake are very sensitive to weather changes, easily freezing on the surface during the winter and warming up in the summer. The lake inflow, mainly comes from underground springs located in the Eastern-Southern area, while on the North side, the springwaters are warm (Guðmundsson, 2002). The presence of hot springs right next to the site area, represents a great opportunity to exploit them for bathing purposes related to the Guest House activities.

Renewable Resources

The exploitation of indigenous renewable energies, has recently played an important role in the economic growth of the entire country, bringing it to high standards of living, almost entirely based on the energy supply deriving from stationary energies. Already in 2008, 62% of the energy supply came from geothermal resources, while 20% from hydropower (nea.is). As the illustration number 046 shows, the use of geothermal resources is widely applied in almost every sector, especially in the field of indoor heating and electricity generation; these data refer to statistics on a national scale, so in order to go in detail and to evaluate the actual potential of geothermal and hydroelectric power within the project area, it is necessary to focus on the adjacencies of the site: from the illustration number 044 it emerges that the Myvatn area is served both by high temperatures fields that reach the 200° degrees, and from low temperatures fields, up to 120 °

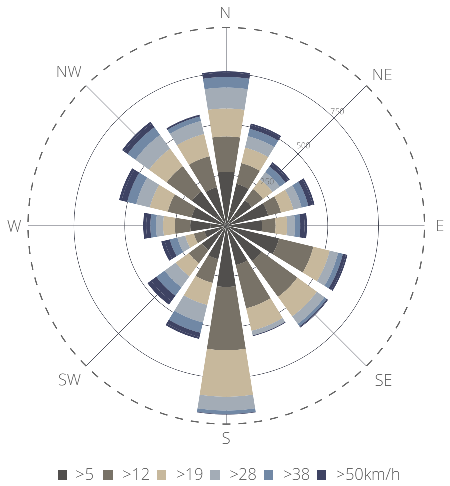




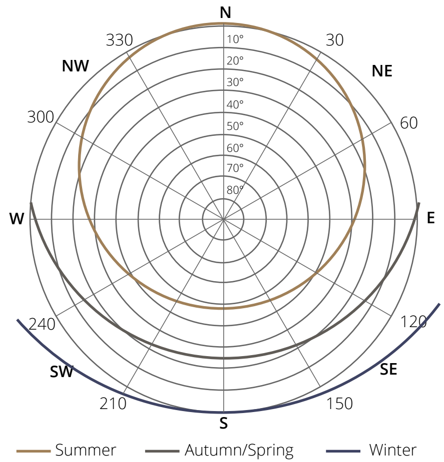
• Ill. 045 Icelandic energy sources

• Ill. 046 Icelandic consumes

degrees (nea.is); this favorable situation, can allows both the retrieval of electricity, through the exploitation of high temperature fields, and also the supply of energy for indoor heating, bathing and laundry, through the exploitation of low temperature fields. Specifically, as it can be noted in the illustration number 045, the most potentially usable power plants next to the Myvatn area, are Bjarnarflag and Krafla (nea.is).



• Ill. 047 Wind path



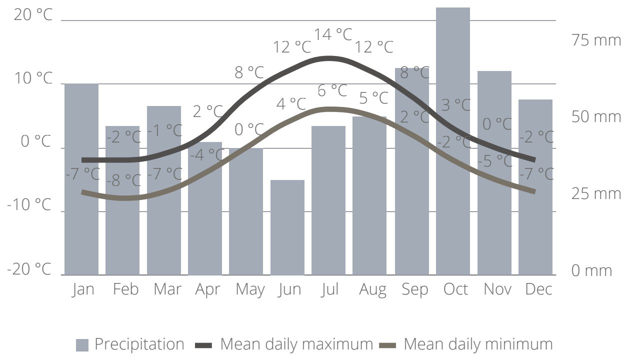
• Ill. 048 Sun path

Wind rose

The diagram shows the directions of the wind in the Reykjahlíð area throughout the year; it also shows how many hours per year the wind is blowing in that direction. As a conclusion, the predominant winds in the area are blowing North-South; while the less influenced areas are the ones situated on the South-West/North-East orientation. (meteoblue.com)

Sun path

The project site is isolated: there is no surrounding buildings and almost no vegetation shading on the area. This is a beneficial condition for the project, allowing the design to be free from external constraints due to shadows. The diagram shows that the path angle of the sun varys from 58° degrees in summer, to almost 3° degrees in winter. In the shortest day of the year the sun rise at 11:39 in the morning and sets at 14:42; while in the longest one, the sun rise at 02:55 and it sets at 00:03 (gaisma.com).
The mentioned conditions define the most favorable or critic periods for observing the Northern Lights. It is important to take this information into account, in order to design project facilities that are livable throughout the year.



• Ill. 049 Rain/ temperature graph

Precipitation

The chart number 049, shows the annual precipitation and temperatures in the Reykjahlið area. It emerges that the most rainy month of the year is October, while the less rainy one is June. The highest temperatures are reached in the month of July, with a maximum of 14° degrees and a minimum of 6° degrees. December and January result to be the coldest months of the year, with an average temperature of maximum - 2° degrees and minimum - 7° degrees (meteoblu.com).

• Ill. 050 Bottle sedge

• Ill. 051 Dwarf birch

• Ill. 052 Meadow buttercup

• Ill. 053 Wood cranesbill

Vegetation

Because of the harsh climate, the vegetation in Iceland does not account of many plant species. Among them, 250 out of 480 that lives in the island, are located in Myvatn area (Guðmundsson, 2002). Here, the volcanic nature of the soil, makes the ground very porous and not adapt to keep the moisture. Therefore, it is difficult for plants to root in the ground; also, the geothermal heat coming from the terrain, influence the vegetation life as well: in fact, most of the vegetation in Myvatn area, is limited to the ponds: the species that lives here are mostly Bottle Sedge; while on the East and North side of the lake, live mainly Birch and Thickets; in the South and in the West, there are Marshland and Heath. Close to the lava outcrops, grow Heathers, Dwarf Birch, Downy Birch and several types of Willows. In the lavitic area of the pseudo-craters, the vegetation mainly accounts of Musses and Lichens: some of these, like the Icelandic Moss, have been commonly used in Icelandic cuisine. Other samples of local vegetation used as food, include Angelica roots and Stems, mostly eaten with fish dishes (Guðmundsson, 2002). There are other important species that lives in the Myvatn area, both on mainland and vascular plants; among these, the Meadow Buttercup, common across Europe and Eurasia, the Erysimum hieraciifolium, and the Wood Cranesbill, a specie of wild geraniums. The illustrations from number 050 to 053, show some of the most common species that can be found within the site.

This analysis is interesting for the general knowledge of the site, as it allows to know the kinds of species to protect, in accordance to a respectful behavior towards the natural context.

• Ill. 054 Myvatn vegetation

Phenomenological Perception of the Site

When approaching the area from a tiny unpaved road, it is hard to predict that there might be something on the other side of the bushes that flank the lake. At the time of the site inspection, thick layers of snow and ice were covering the path and the ground, still keeping the visibility of the basaltic rocks. The lack of high vegetation and the predominance of dry grass contributed to underline a feeling of isolation and stillness since before entering the area. When finally approaching the centre of the site, on top of a small hill, the first impression that we had, was to find ourself in a lost and forgotten place, where the silence was only occasionally interrupted by the sound of a distant car or, eventually, by the rustling of the wind.

On the highest top of the hill, it is possible to see the lake Myvatn: at the time of the visit, this was was partially frozen, attracting our attention to its North side, from which instead some smoke were raising, making it possible to predict the presence of natural hot springs. This peculiarity, immediately appeared as a potential of the site, able to positively characterize the project. From the same observation point, also the tiny and faraway buildings of Reykjahlid were visible over the bushes, representing the only evidence of human intervention in the next area.
At the time of the inspection, the sky was covered of dense clouds, which seemed almost to melt with the colours of the surrounding, giving to the place a sense of mystery. The general perception that we had, is to have walked into a light fog, and the predominance of the white of the snow and the light grey of the sky, emphasized a feeling of desolation.

• Ill. 055 Entrance site project

• Ill. 056 Features of the site

• Ill. 057 First view of the site prokject

• Ill. 058 View lake

• Ill. 059 View internal lagoon

• Ill. 060 view of the volcano

• Ill. 061 hot spring, view I

• Ill. 062 hot spring, view II

• Ill. 063 hot spring, view III

Conclusions

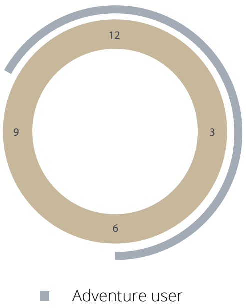
On the basis of the analysis conducted in this section, it emerges that the site area is characterized by very special conditions: favorable in terms energy supply, challenging in terms of outdoor comfort, and extraordinary from a geological point of view. All of these aspects not only define the already mentioned “extreme environment” of Iceland, and of the site area itself, but are also framing one of the best locations to catch the Northern Lights.
The role of these analysi is to direct the design approach towards a conscious behavior, environmentally responsible and aesthetically valuable.

The awareness that comes from the Site Analysis conducted, has also led to the precise choice of taking the most advantage out of the extraordinary soil where the Icelandic Guest House is located, this means that the aim of reaching the 2020 energy standards set by the Danish Building Regulations, need to be pursued by the exploitation of Icelandic natural renewable resources.

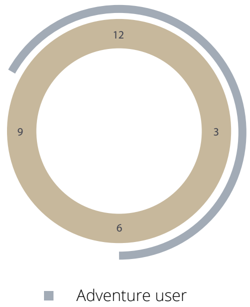
This choice aims to respond to a conscious behavior towards an unique environment, which sets challenges within the field of sustainable architecture, which are different from most of the other European countries. For this reason, while reducing the demand for the energy consumption, according to the Danish standard 2020, a special attention need to be paid to the CO2 emissions of the construction process, documenting it through an LCA calculation, which is able to put in light the main sustainability related issues of Iceland.

03.03: Function analysis
Users

• Ill. 064 Daily room usage, backpackers



• Ill. 065 Daily room usage, family



GUEST HOUSE

Backpackers

Being Iceland particularly interesting from a naturalistic point of view, most of the guest house's potential users might be the backpackers.
Alone or in a group, this type of user requires for both private spaces and common facilities, either to find some time to rest after a long journey, or to find companions for most of the extreme activities offered by the tour operators in the form of team ventures.

- *Small groups of friends*

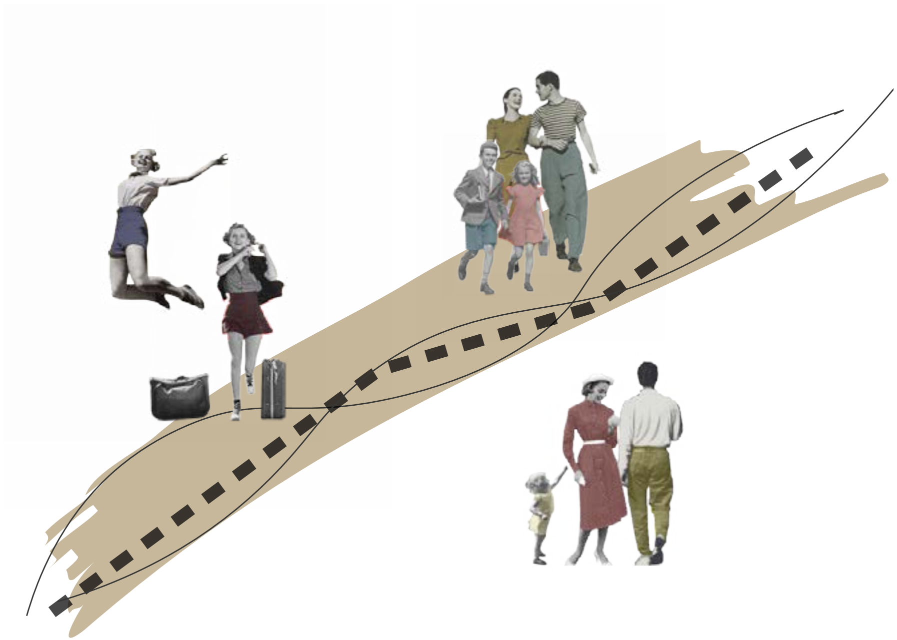
- *Solitary travelers*

Family

Iceland is not commonly known for being a family destination, but it has of course an internal tourism made up of locals who are traveling across the country for a few days. These users can either be families or couples, who are looking for a cosy and comfortable environment, which provides an authentic experience, without being extremely pretentious. These users are most likely going to represent the foundation of the Icelandic Guest House's guests during the whole year, regardless of high or low season logics.

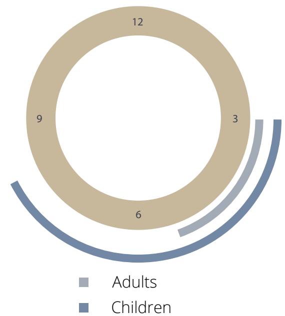
- *Couples*

- *Small families*



• Ill. 066 Users

• Ill. 067 Daily rooms usage, hosts



HOST HOUSE

Hosts

The project will not only host temporary users, but it will also be the home of a family who decided to share their living with adventurers looking for a familiar atmosphere, and couples looking for special intimacy lived in a local place. This decision can be exciting and tiring at the same time, since it requires for a constant involvement of the family into their daily business. Thus, it is crucial for these users to preserve a profound family feeling within a shared and always changing environment as the Guest House is.

- Small local family

Room program

		Amount	m2	Natural Daylight	Main Orientation	Direct/Diffuse Light	Max People Load	Natural Ventilation	Indoor / Outdoor	Total m2
Guest House Cabin	Bedroom Typology 1	4	63	yes	North	Diffuse	4	Cross and stack	Indoor	
	Bedroom Typology 2	4	51	yes	North	Diffuse	2	Cross and stack	Indoor	704
	Private Toilets	8	6	no	//	Direct	//	//	Indoor	
	Patio	8	25	yes	North	//	//	Outdoor	Outdoor	
Guest House facilities	Common Room	1	45	yes	South/West	Diffuse	20	Stack	Indoor	
	Dining room	1	56	yes	North/East	Direct	24	Single Sided	Indoor	
	Deposit	1	11	no	//	Direct	//	//	Indoor	
	Kitchen	1	24	yes	North/East	Direct	12	Single Sided	Indoor	
	Toilets	1	18	no	//	Direct	//	//	Indoor	
	Laundry room	1	7	no	//	Direct	//	//	Indoor	337
	Hot swimming pool	1	30	no	//	Diffuse	24	//	Indoor	
	Sauna	2	12	no	//	Diffuse	10	//	Indoor	
	Sauna's toilets/showers	2	14	no	//	Direct	//	//		
	Sauna's changing rooms	2	13	no	//	Direct	//	//	Indoor	
	Greenhouse	1	68	yes	South	Direct	//	//	Indoor	

		Amount	m2	Natural Daylight	Main Orientation	Direct/Diffuse Light	Max People Load	Natural Ventilation	Indoor / Outdoor	Total m2
Host House	Master bedroom	1	19	yes	North/East	Diffuse	1	Single Sided	Indoor	
	Children bedroom	2	12	yes	North/East	Diffuse	2	Single Sided	Indoor	
	Living room	1	21	yes	South/West	Diffuse	4	Cross Sided	Indoor	
	Kitchen/Dining room	1	18	yes	South/West	Direct	4	Cross Sided	Indoor	157
	Toilet	1	6	no	//	Direct	//	//	Indoor	
	Laundry room	1	4	no	//	Diffuse	//	//	Indoor	
	Sauna	1	5	no	//	Diffuse	4	//	Indoor	
	Barn	1	60	yes	South/West and South/east	Direct	//	//	Indoor	
Public facilities	Restaurant	1	114	yes	North/East	Diffuse	36	Stack/Croos sided	Indoor	
	Observatory	1	50	yes	North/East and North/West	Diffuse	15	Single Sided	Indoor	228
	Terrace	1	50	yes	//	//	//	Outdoor	Outdoor	
	Toilets	1	14	no	//	Direct	//	//	Indoor	

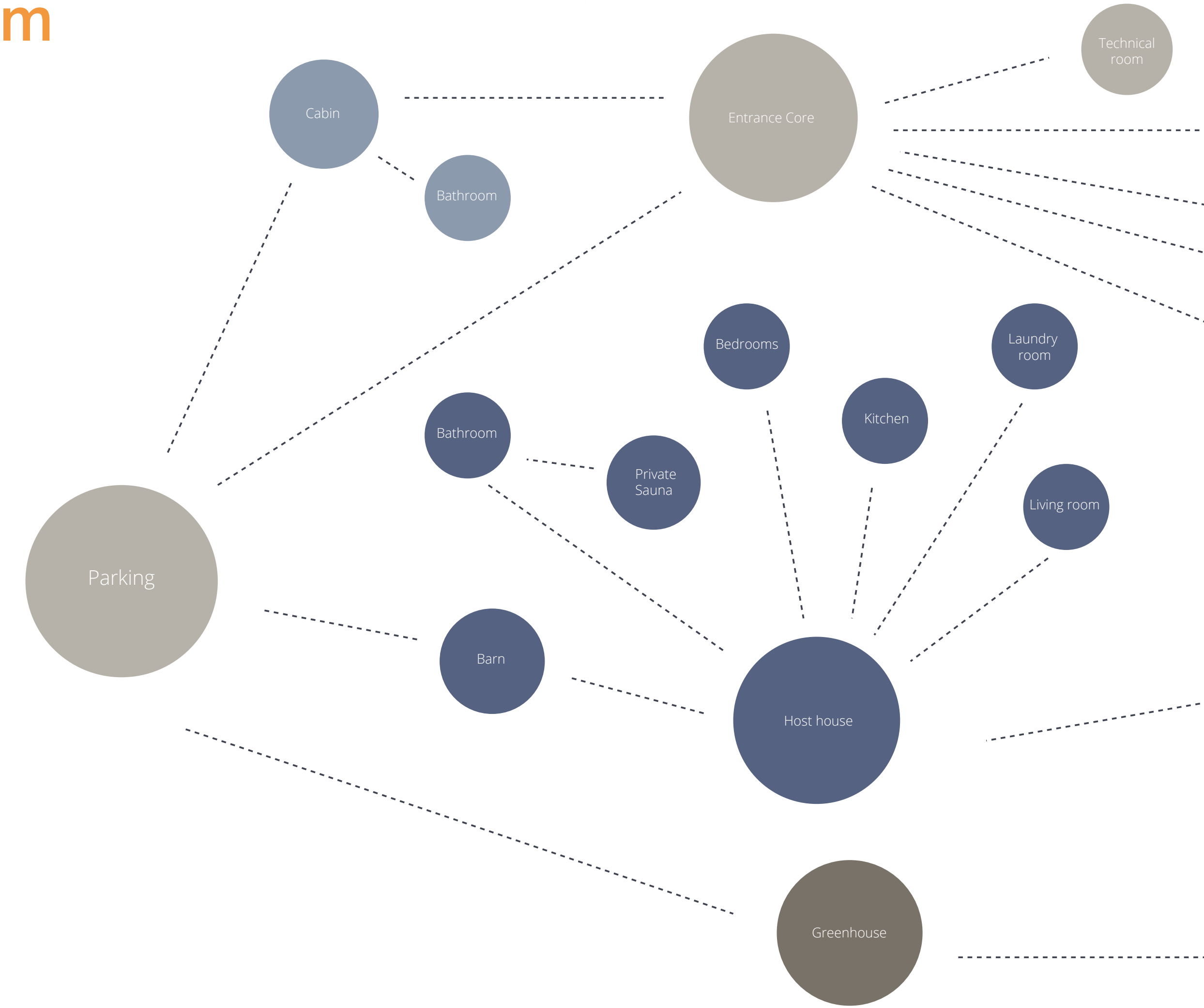
Staff and administration	Amount	m2	Natural Daylight	Main Orientation	Direct/Diffuse Light	Max People Load	Natural Ventilation	Indoor / Outdoor	Total m2
Reception	1	11	yes	South/East	Direct	1	Single Sided	Indoor	164
Restaurant's kitchen	1	23	yes	North/East	Direct	8	Single Sided	Indoor	
Storage	1	18	no	//	Direct	//	//	Indoor	
Toilets	1	6	no	//	Direct	//	//	Indoor	
Technical room	1	106	no	//	Direct	//	//	Indoor	

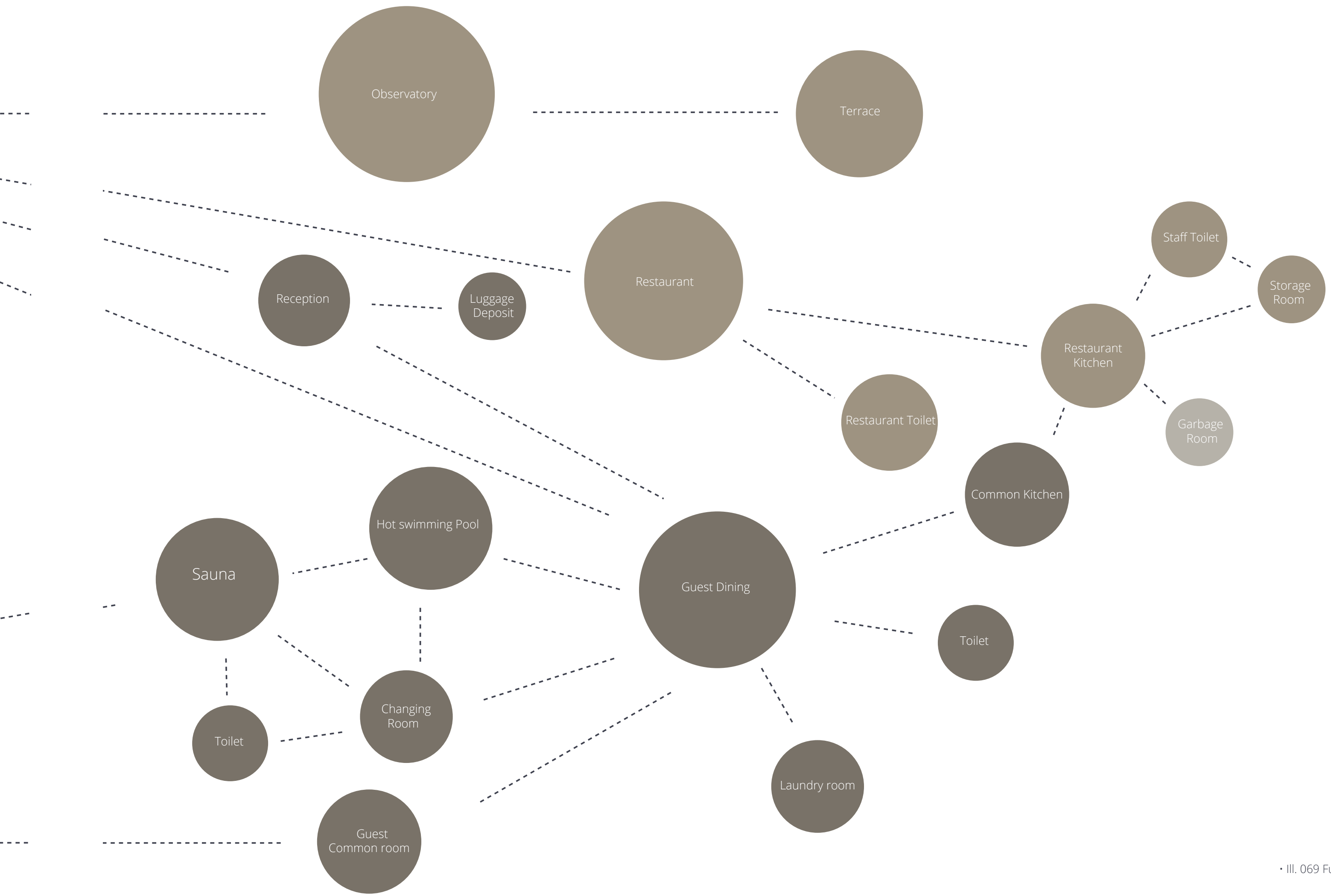
Total floor area: 1590

• Ill. 068 Room program

Function program

The function program describes the connections between the facilities designed for the entire project.
It can be noted that the design is organized in such a way to facilitate the mobility between functionally related services, so as to favor the users' experience.





• Ill. 069 Function program

Vision

The vision for this project, is to design a Guest House in Iceland, which is able to fit the Identity of the place through its architectural expression, and from where to enjoy the beauty of the Northern Light. The conscious use of the construction materials should direct the design of the complex, taking the most advantage out of the local available resources. The same approach, should direct the energy supply choices of the building, contributing to the definition of a sustainable complex, specifically designed for the harsh Icelandic context. Capturing the identity of the place and expressing it through the architecture, should then be able to attract the locals, becoming a new pole, standing out and framing its natural context.

Design criteria

The following Design Criterias are the results of the theoretical and thematic research conducted in this booklet, through the study of both theorists and the sustainable guidelines of the DGNB criterias. Thus, the aim is to set the goals that the project need to pursue.

1. Identity of the area
The architectural language of the design should result as a contemporary reinterpretation of the local architectural expertise.

2. Respect the landscape
Considering the uniqueness of the site context, the architecture should fit the landscape without creating a fracture with the context itself, while creating a new identity pole for the users.

3. Northern lights view
Special attention must be paid to the design of windows so to increase the possibility to catch the Northern Light from indoor.

4. Ambience
The ambience should vary according to the space use, indoor and outdoor, always preserving a strong feeling of connection to the natural landscape.

5. Attention to materials
The choice of materials need to consider their technical and qualitative features. The colors are chosen taking into account the way they affect the internal perception of the space in terms of atmospheric comfort and visual pleasure.

6. Disassembly and Flexibility
The project must take into account the dismantling of the business and the environmental consequences that this entails. For this reason the cabins must be designed to be easy to transport by truck, in order to be reassembled elsewhere. The fruition of the internal space must be flexible to adapt to the users needs.

7. Sustainability connected to local potentials and reality
The exploitation of the local potentials must be undertaken from every point of view, also in terms of energy supply, taking advantage of the geothermal power and focusing on the reduction of the CO_2 emissions related to the life cycle of the building.

8. Indoor environmental conditions
High standards of indoor comfort must be achieved, in order to enhance the pleasure of the indoor experience.

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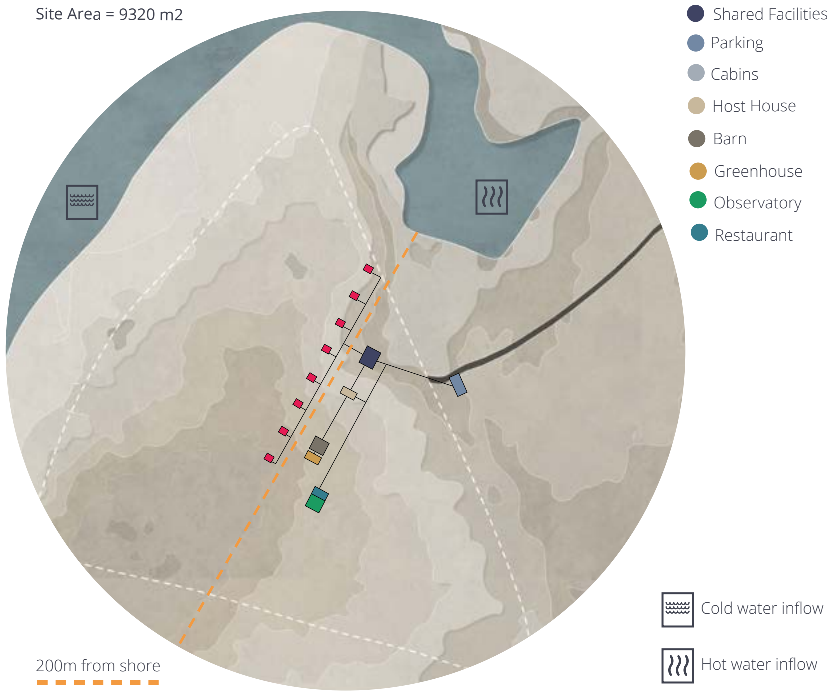
04 Proces

ss

04.01 Masterplan

Spread option 1
Interpretation of the Site

One of the approaches studied in the composition of the Masterplan, sees the placement of the shared facilities serving the guest house, not very far from the host house, so as to facilitate both the interactions between guests and hosts, and the daily management of the business by the hosts themselves. Nevertheless, the two facilities are detached to preserve the hosts privacy. The orientation of both the buildings is designed to have a direct view to the North, from where it is most likely visible the Northern Lights, and to the West, where the best view to the lake is. The observatory and the restaurant, where also external visitors can accede, are situated away from the facilities which are only pertaining to the guests of the guest house, at the highest point of the site, in order to favor the long distance view.
The cabins/bedrooms are far from the other facilities, beyond the 200-meters demarcation line from the lake, where it is not possible to build structures with foundations in the ground. The detachment of the bedrooms from the rest of the complex, aims to immerse the users in the natural context of the landscape. The cabins are also all detached from each others, in order to preserve the privacy of each group of guests.
The barn, the greenhouse and the parking lots, are all placed at the perifery of the built areas, so to create a clear distinction between the service areas and the zones where it is intended to recreate an atmosphere which emphasize as much as possible the relationship between people and natural landscape.



• Ill. 070 Masterplan Spread option 1

Strengths	Weaknesses
● Good privacy in the cabins ● North exposure all the cabins ● South exposure greenhouse ● Good privacy host house ● Limitation of the discomfort related to eventual smells and noises coming from the barn	● Large amount of dispersive surfaces ● Long walking distances between all the facilities may cause lack of practicity for the hosts running their business ● Under-exploitation of the observatory because of long distance from the shared facilities

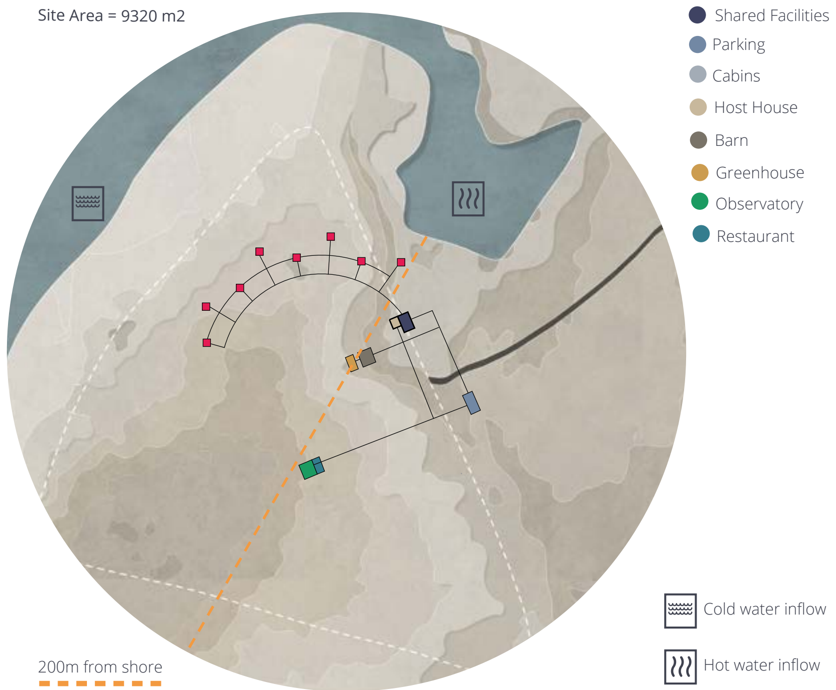
Spread option 2
Interpretation of the Site

Another approach to the spatial organization of the Masterplan, sees the placement of the shared facilities attached to the host house, in order to reduce the amount of dispersive surfaces, and consequently the heat losses through the envelope. The location of both the facilities is, as in the previous option, close to the perimeter of the site, both to bring as close as possible the view of the lake, and to reduce the walking distance from the parking lots, located at the entrance of the site.

The cabins are detached from each other and arranged in a radial pattern, beyond the 200-meter lake border. This solution aims to enhance the privacy experienced in each bedrooms.

The greenhouse and the barn, are located
at the center of the ideal circle where the cabins are disposed. Both greenhouse and barn can benefit of the large amount of heat gains coming from the South. The position of importance that the barn and the greenhouse assume, becomes therefore a way to emphasize the most rural services that the Guest House has, accentuating the importance of the natural landscape.

The observatory and the restaurant are still placed on the highest point of the site, in order to favor the long distance view to the lake.



• Ill. 071 Masterplan Spread option 2

Strengths	Weaknesses
• Reduction of dispersive surfaces having host house and shared facilities next to each other • Practical daily management by the hosts over of the shared facilities • North exposure all the cabins • Good privacy in the cabins • Greenhouse facing South • Limitation of the discomfort related to eventual smells and noises coming from the barn	• Long walking distance between host • house, barn and greenhouse • Large amount of dispersive surfaces in the cabins • Under-exploitation of the observatory because of long distance from the shared facilities

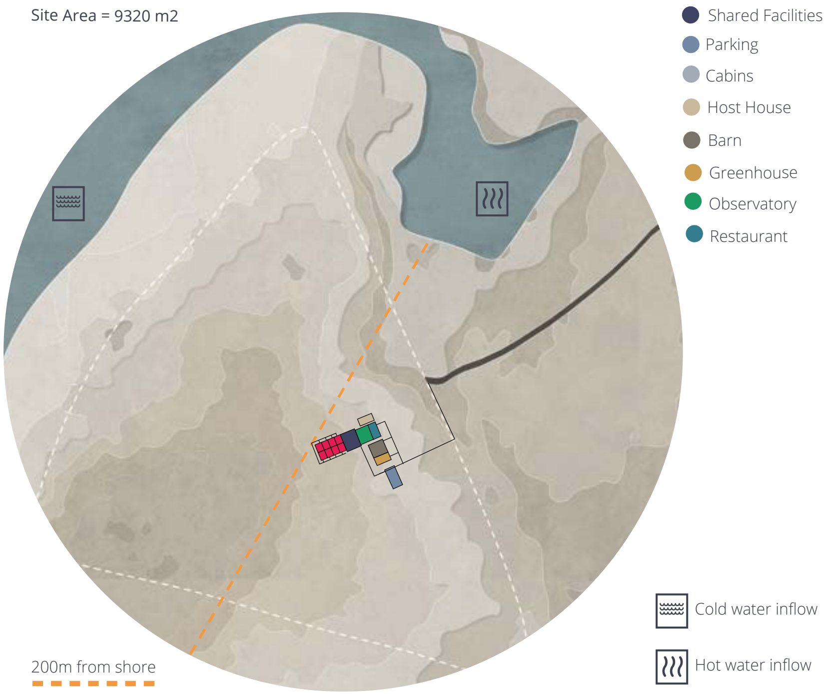
Compact option 1
Interpretation of the Site

In this option, the complex becomes more compact, with the aim of both reducing the dispersive surfaces, and to reduce the walking distances between all the facilities.

Specifically, the cabins are placed one next to the other, where four of them face North, and the remaining four are facing South. This type of arrangement, allows the direct communication between the guests bedrooms and the shared facilities where the guests prepare food and have their dining space, eliminating the inconvenience of an external route. The observatory and the restaurant are integrated within the complex, as well as the host house, which is in direct communication with the shared facilities of the guests, making easy the everyday management of the business.

On the other hand, the barn and the greenhouse, are slightly detached from the complex, and they constitute a separate block, which is very close to the other facilities.

As in all the previous options, the greenhouse faces the South, in order to increase the amount of heat gains that it can benefit from. While the parking area is here moved on the inside of the site, rather than at the entrance, contributing to the rationalization of the internal pedestrian circulation.



• Ill. 072 Masterplan Compact option 1

Strengths	Weaknesses
● Reduction of dispersive surfaces having all the facilities next to each other, a part from the greenhouse and the barn ● Practical daily management by the hosts over the whole complex ● Greenhouse facing South Integration of the observatory and the restaurant within the complex	● No North exposure for all the cabins ● Lack of privacy in the cabins ● No full exploitation of the best views in the site

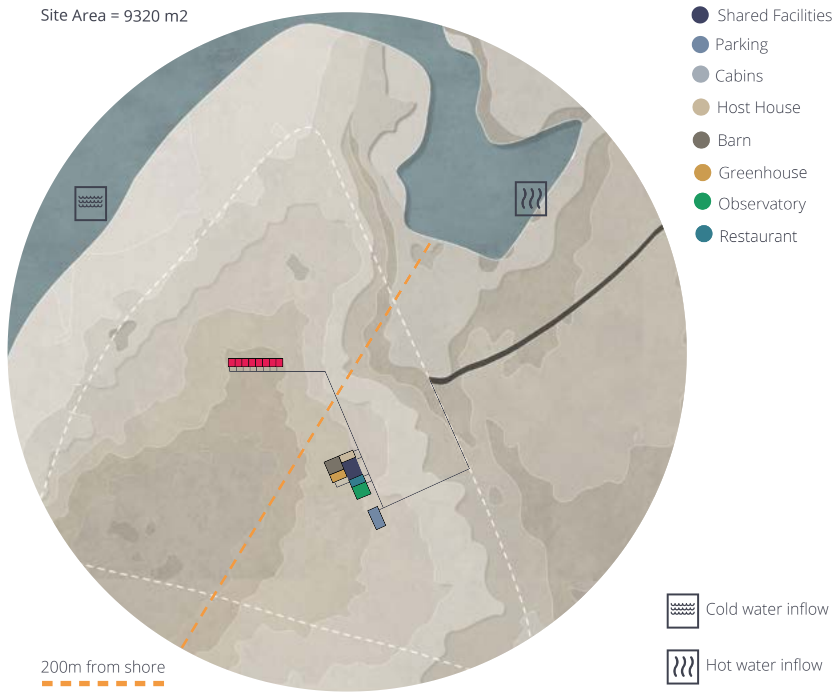
Compact option 2
Interpretation of the Site

In this option, the main complex hosts the shared facilities pertaining to the guests, the host house, the barn, the greenhouse, the observatory and the restaurant.

The cabins are attached to each other, but detached from the main complex, beyond the demarcation line of 200 m from the lake.
In this way, it is possible to preserve the North exposure of all the cabins, while limiting the amount of dispersive surfaces and bringing them back closer to the lake. Nevertheless, being the cabins placed next to each other, there might be experienced a lack of privacy for each group of guests while being in their bedrooms. This is especially true in terms of soundproofing.

The pedestrian paths within the site are rationalized, reducing the outdoor movements, but still maintaining a good relationship with the site and making it possible to enjoy the landscape while moving from the cabins to the main complex.

The parking lots are located next to the main complex in order to link all the main services next to each other.



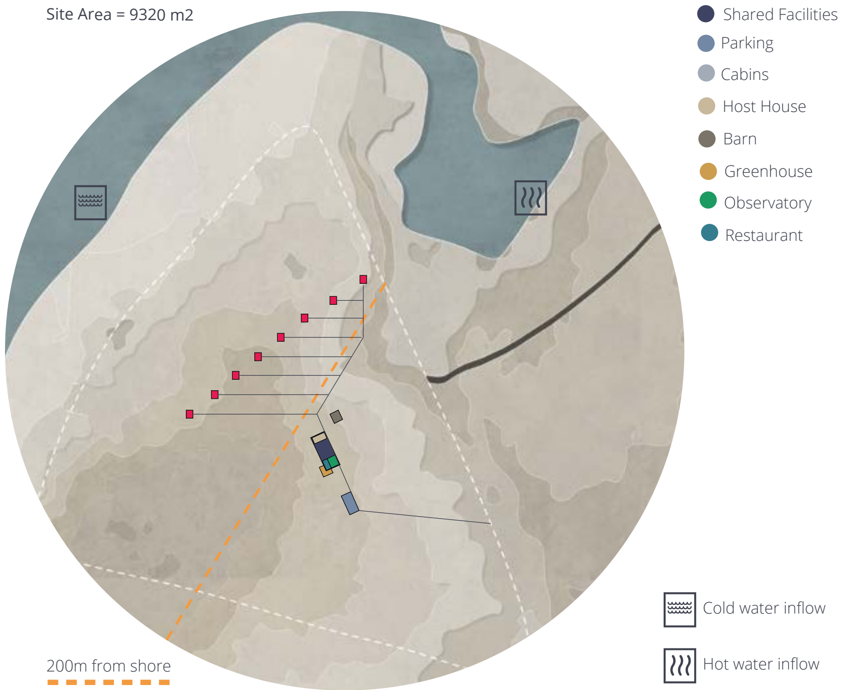
• Ill. 073 Masterplan Compact option 2

Strengths	Weaknesses
● Reduction of dispersive surfaces in the main complex ● Reduction of dispersive surfaces having the cabins next to each other ● Practical daily management by the hosts over the whole complex ● North exposure all the cabins ● Greenhouse facing South ● Integration of the observatory and the restaurant within the complex	● Lack of privacy in the cabins ● Potential discomfort related to eventual smells and noises coming from the barn

Final option
Interpretation of the Site

At the end of the design process, the strengths of each option, converge in a final proposal where all the functions that need an internal heating, are compacted within a two storeys main complex, in the center of the site. The cabins instead, not having permanent foundations in the ground, can be located within the 200 meters of distance from the lake. The barn, is detached from the main complex, not disturbing the daily activities of guests with eventual strong smells and noises, but still being visible and easy accessible from the hosts.
Since the beginning of the design process, detaching the cabins from the main complex has resulted the most effective way to preserve the privacy of each group of visitors. Furthermore, the mutual detachment of the cabins allows to expand their windows area to the North, keeping the ability not to look into the others bedrooms.

The orientation of each facility, is the result of a constant increasing of awareness regarding the visual and climatic potentials of the place: for this reason, most of the windows in the cabins look North to capture the Northern Lights from the inside, while the greenhouse, designed as an additional space for the guests leisure time, is oriented to the South to increase the amount of heat gains; the host house, at the second floor, faces the view over the cabins and it is directly directly connected to all the guest house facilities through an internal path. This makes the daily management of the business easier in bad weather conditions.

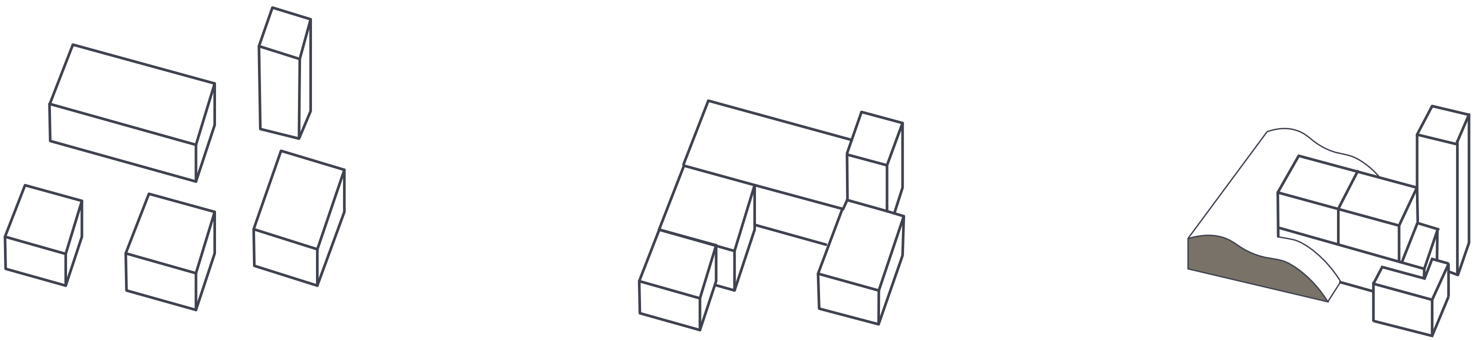


• Ill. 074 Masterplan Final option

Strengths	Weaknesses
• Reduction of dispersive surfaces in the main complex • Practical daily management by the hosts over the whole complex • Good privacy in the cabins • North exposure all the cabins • Greenhouse facing South • Integration of the observatory and the restaurant within the complex • Limitation of the discomfort related to eventual smells and noises coming from the barn	• Large amount of dispersive surfaces in the cabins

04.02 Main Complex

Volume Process



One Floor Detached Units	One Floor Attached Units	**Two Floors Compat Units**

One Floor Detached Units

Strenghts :

- Possible achievement of effective natural ventilation strategies because of not excessive volumes depth
- Possibility to create an outdoor courtyard, accessible from all the facilities

Weaknesses:

- No indoor connection between host house and guest house facilities
- Large amount of dispersive surfaces
- Lack of internal connection between the facilities, suitable in bad weather conditions
- Reciprocal shading between the buildings

One Floor Attached Units

Strenghts:

- Reduction of dispersive surfaces
- Improvement of internal connections between the facilities
- Possible indoor connection between host house and guest house
- Possibility to create an outdoor courtyard, accessible from all the facilities

Weaknesses:

- Reciprocal shading in parts of the complex
- Difficult application of effective natural ventilation strategies because of excessive volume depth

Two Floors Compat Units

Strenghts:

- Reduction of dispersive surfaces
- Improvement of internal connections between the facilities
- Possible indoor connection between host house and guest house
- No reciprocal shading between the building elements
- Possible achievement of effective natural ventilation strategies because of not excessive volumes depth
- Exploitation of the ground altimetry to give more privacy to the host house entrance
- Exploitation of the ground as an heating source

Weaknesses:

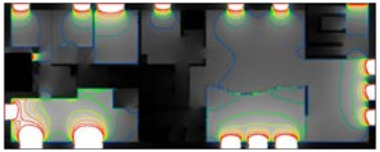
- Digging costs
- Excavated rooms not facing the outside

• Ill. 075 Main complex Volume Process

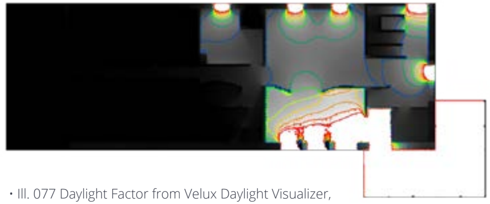
Windows Placement and Room Orientations

The location and orientation of all the facilities within the complex, has been studied in order to take the most out of the solar heat gains and from the natural altimetry of the ground. Thus, the partial excavation of the building, led to the evaluation of different iterations where to locate the rooms that do not require natural lighting, nor natural ventilation, such as the toilets, the swimming pool and the storages. The windows placement in the rest of the complex, takes into account the different ambiences intended to be emphasized in each room, and the atmospheric comfort in terms of air exchange.

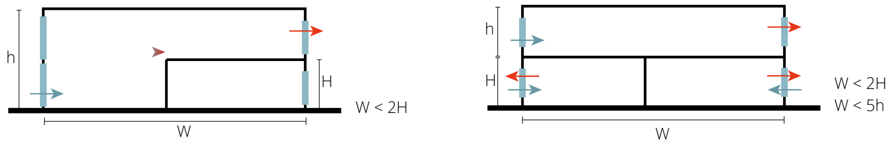
Initially, the use of relatively small windows area was tested to see how these were affecting the general performances of the main complex. Although the heat losses occurring through the windows were not causing any thermal discomfort, the interior lighting and the air quality levels did not satisfy the reference standards, nor the desired atmosphere for the project. In the illustration number 076 and 077 the daylight analysis related to this first design phase is shown: at this stage, the observatory tower was still included within the main complex volume.
These considerations led to the replacement of the windows for a larger surface area and to the study of new natural ventilation strategies, whereby the double high that visually unites the restaurant and the common room in the final project proposal, represents the synthesis of a path where aesthetical and technical aspects are balanced together.
As shown in the illustration 079, the excavation and orientation process of the rooms, develops toward the exploitation of the warmest exposure in the greenhouse and in all the living spaces, and to the North - West exposure for the bedrooms.



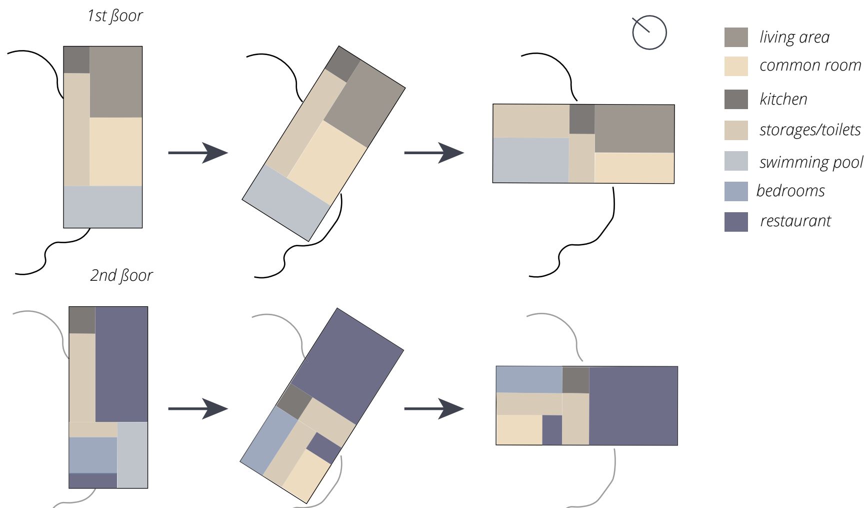
• Ill. 076 Daylight Factor from Velux Daylight Visualizer, 1st floor main complex: first iteration



• Ill. 077 Daylight Factor from Velux Daylight Visualizer, 2st floor main complex: first iteration



• Ill. 078 Ventilation strategy process



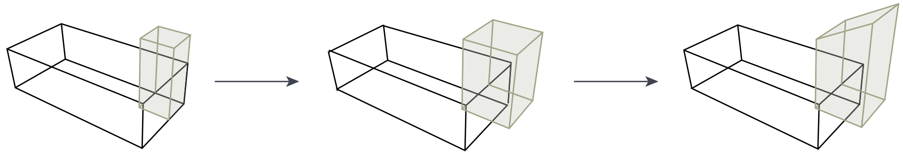
• Ill. 079 Complex process orientation

Not Heated Spaces

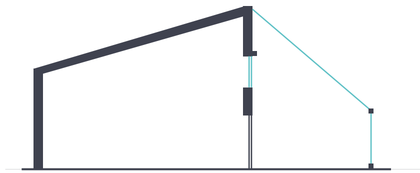
The not heated spaces of the projects are the observatory, the greenhouse and the barn. The indoor heating is only relying on passive solar heat gains through the exploitation of the high thermal mass concrete surfaces.

Greenhouse and Barn detachment

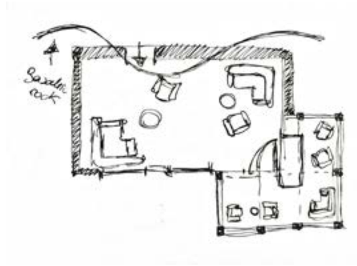
Initially, these were designed to be in direct contact with each other, and detached from the main complex. This approach intended the use of both the functions for the exclusive use of the host family (See ill. number 081).
In the subsequent phases of the process, it was then realized that this design approach was under-exploiting the greenhouse's spatial and technical potentials: thus, the greenhouse has been reunited to the main complex once again, attaching it to the common room, in order to expand the leisure space belonging to the guests (See ill. number 082). This new approach also takes advantage of the night release of the heat gained by the greenhouse itself. The glass structure is in fact leaning against a concrete wall, exploiting its high thermal mass features. (See ill. number 083).
In this way, the barn becomes the only detached element from the main complex, and it is placed in a central position of the masterplan, capturing the visitors view since from their entrance to the site, being close to the pedestrian path that leads to cabins, and not far from the main door of the host house and the guest house as well (See ill. number 084).



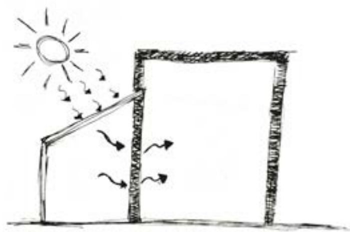
• Ill. 080 Observatory volume shaping process



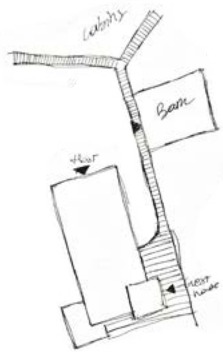
• Ill. 081 Detail attachement barn and greennhouse



• Ill. 082 Greenhouse connection to the Common room



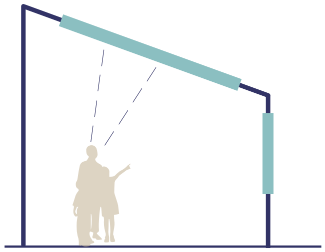
• Ill. 083 Solar gain through greenhouse and shared concrete wall



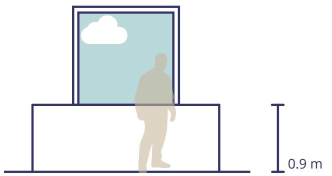
• Ill. 084 Close barn location from host house

Conclusion on windows placement

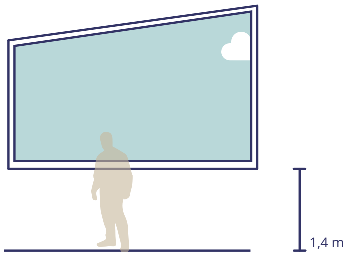
As a conclusion, the window placement in the process, is meant for guaranteeing the best possible light conditions everywhere, while differentiating the kind of ambience according to the room function and the kind of human interaction with the space. For instance, as shown in the illlustration number 088, the windows placement in the tower is considering a very small area, in order to create an expectation in those who climb towards the observatory, giving them the chance to only look out a little during the ascent, and appreciate the view once they reach the top floor. In the illustrations number 085 and 087 the large windows in the observatory are shown: these are meant to give the feeling of being completely immersed in the landscape. The common area in the main complex, is a place of conviviality, for where a large daylight is desired and it should be given by large double height windows, shown in the diagram number 089. These kinds of requirements are not necessary for the service spaces as the kitchen (ill. number 086) and thus, these can be resized for allowing a good air change.



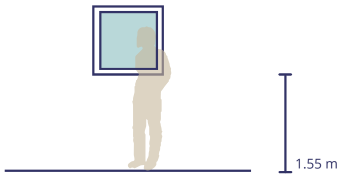
• Ill. 085 Human interaction: Observatory



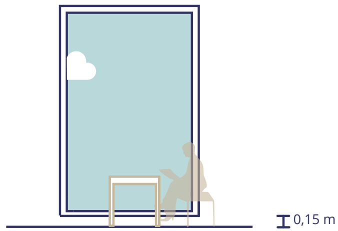
• Ill. 086 Human interaction: kitchen



• Ill. 087 Human interaction: observatory



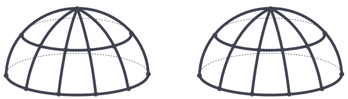
• Ill. 088 Human interaction: tower



• Ill. 089 Human interaction: common room

04.03 Cabins

Volume Process



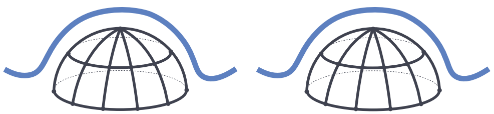
Detached Domes

Strenghts:

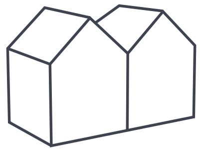
- Preservation of the privacy
- Ease of disassembly
- Good deviation of the winds

Weaknesses:

- Organic shape in contrast with the sharp geometry that should characterize the architectural language



• Ill. 090 Detached domes, wind deviation



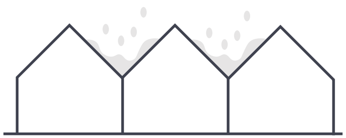
Attached Boxes

Strenghts:

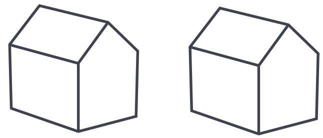
- Efficient cubic geometry
- Reduction of dispersive surfaces due to attached walls
- Sharp geometry, that should characterize the architectural language

Weaknesses:

- Lack of privacy
- Difficult disassembly for reuse
- Snow accumulation between pitched roofs



• Ill. 091 Attached boxes, snow stacked between the roofs pitches



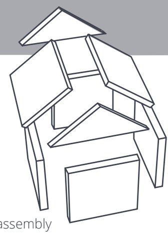
Detached Boxes

Strenghts:

- Preservation of privacy
- Ease of disassembly
- No snow accumulation between pitched roof
- Sharp geometry that should characterize the architectural language

Weaknesses:

- Large amount of dispersive surfaces, then risk of transmission losses



• Ill. 092 Detached boxes, assembly

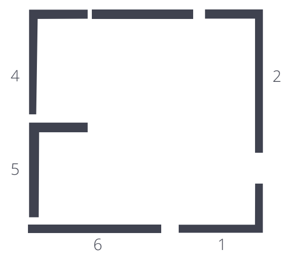
Boxes Assembly and Modules Process

Since the beginning of the design process, some design principles were stated. Among the most relevants criteria, the flexibility, the ease of disassembly and transportation, directed the design process of the cabins.

The loyalty to these criteria, has therefore led to the use of lightweight modular elements that fit the standard dimensions of road transportation. According to the International Transport Forum, the maximum dimensions permitted for road transport in Iceland must not exceed 4.20 meters in height, 2.55 meters in depth and 12 meters in length, assuming that the transport takes place with a lorry or a trailer (itf-oecd.org).

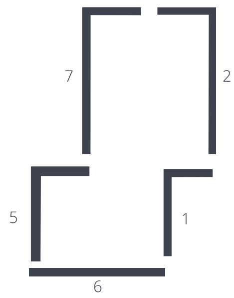
In the following, the process that led to the final design is presented. One of the advantages of using modules, is the possibility to disassemble them during the dismantling phase of the building, facilitating their reuse and assembly elsewhere. As it can be noted from the illustrations 094 and 096, the first modules combination did not provide a rational spatiality in the 4 people cabin typology. This led to a reconsideration of the vertical modules and to rethinking the flexibility in terms of furnitures scale. Moreover, at this stage of the process, the roofs were not solved yet as part of the modular system. In the following page, the illustration number 097 the single detached modules are also shown.

4 people Cabin Tipology

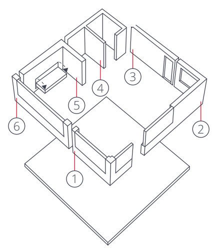


• Ill. 093 Plan, preliminary modules applied to the 2 people cabin typology

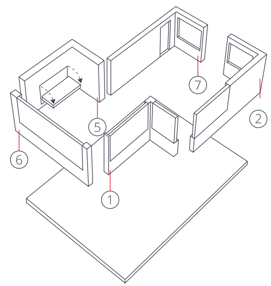
2 people Cabin Tipology



• Ill. 094 Plan: preliminary modules applied to the 4 people cabin typology

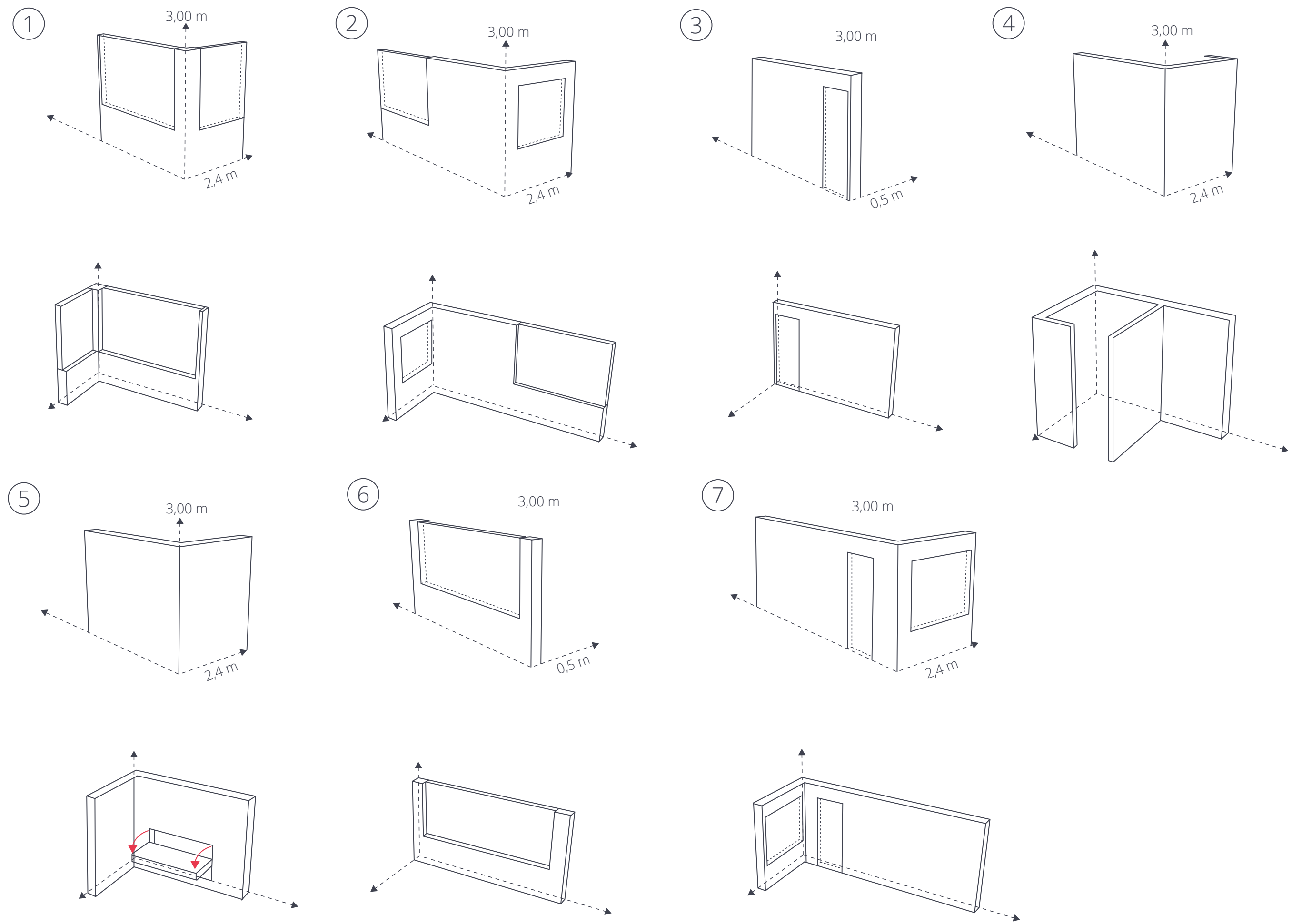


• Ill. 095 Axo, preliminary modules applied to the 2 people cabin typology



• Ill. 096 Axo, preliminary modules applied to the 4 people cabin typology

7 Removable Modules



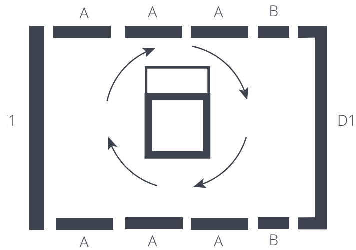
• Ill. 097 7 Modular panels

After a series of iterations, the final solution of the cabins is found through the use of simplified modular elements, which allows to have a plan that is completely free from internal walls, lending itself to the customization of the spaces and to the possible reuse of the cabins.
The articulation of the internal space, instead, becomes the engine of flexibility, satisfying the multiple needs of the users through the mobility of the furnitures modules, which are able to perform different functions within the same object.

In order not to make the internal circulation complicate because of the movable furnitures, these are limited in their movements through some rails on the floor. The only internal room that is separated from the open space, is the toilet, which drives the internal circulation and directly face the skylight as a privileged spot to catch the Northern Light.

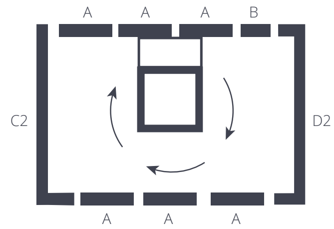
The light weight materials used in the cabins are drifwood, timber and corrugated iron for the external cladding, which is chromatically related to the basaltic rocks in the context and low cost in terms of maintenance.

4 people Cabin Tipology

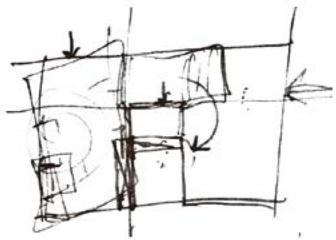


• Ill. 098 Plan: final modules and circulation in 4 people cabin typology

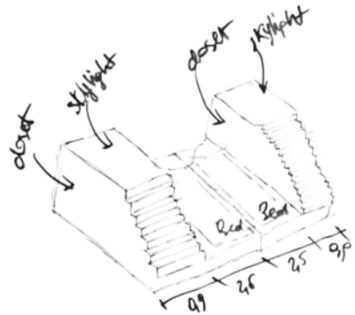
2 people Cabin Tipology



• Ill. 099 Plan, final modules and circulation in 2 people cabin typology



• Ill. 100 Sketch: Movable furnitures studies



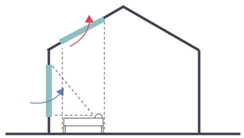
• Ill. 101 Sketch: Furniture module iteration study

Windows Placement Process

When evaluating the windows orientation, both the sun light, the wind conditions and the architectural design criteria have been balanced to ensure the aesthetic and ambience intentions with the performances of the cabins. Indeed, since the beginning of the design process, the intention of placing the windows facing North was clear, in order to enhance the possibilities of catching the Northern Lights from indoor. From one side, this choice set a challenge in facing the indoor overcooling, while on the other hand, it encourages the natural ventilation in summer, according to the main winds direction studied in the wind analysis of this booklet. (See page 72)

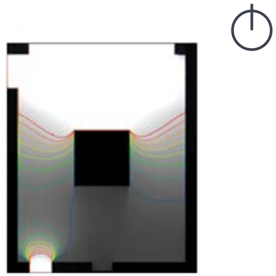
In light of this requirement, the windows orientation, dimensions and shading were tested on BSim and Velux to reach the optimal compromise. In the illustrations of this page, the preliminary studies on the windows placement are summerized:

In the beginning, the windows were placed in correspondence with ideal visual cones starting from the bed, both achieving a good visual connection through the outside and allowing the explotation of the stack ventilation. Then, the strategy was tested to its extreme, joining the walls windows and the skylight. As a result of the thermal comfort and daylight analysis, this concept is resized, reaching the conclusion of a central skylight and still large windows facing North. The shading systems are applied out of the hours of usage not to affect the daylight conditions, and ensuring the right balance between performance and architectural design. The detailed final performance of the Cabins are documented in the Presentation of this booklet (See page 148).

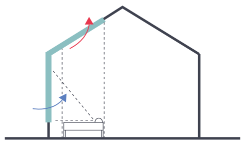


• Ill. 102 Separated windows, visual cones from the bed and stack ventilation

• Ill. 105 Plan diagram, 1st windows placement, tested on BSim

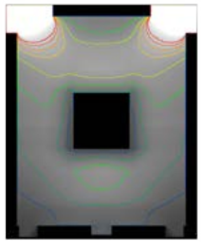


• Ill. 108 Daylight factor from Velux Daylight Visualizer, First iteration windows placement

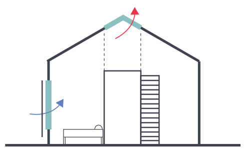


• Ill. 103 Joined windows, visual cones from the bed and stack ventilation

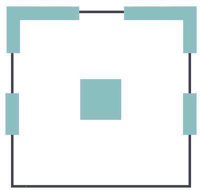
• Ill. 106 Plan diagram, 2nd windows placement, tested on BSim



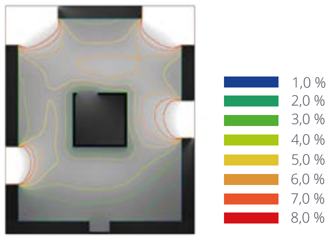
• Ill. 109 Daylight factor from Velux Daylight Visualizer, Second iteration windows placement



• Ill. 104 Windows orientation on the North



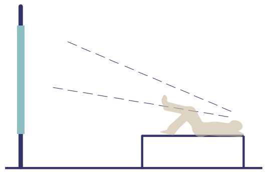
• Ill. 107 Plan diagram, final windows placement, tested on BSim



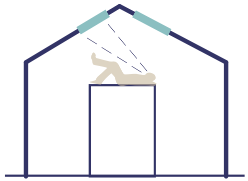
• Ill. 110 Daylight factor from Velux Daylight Visualizer, Third iteration windows placement

Conclusion on windows placement

As a conclusion, the windows placement in the cabins is directed by the desired ambience of freedom and plyfulness that it is intended to make the users live. In the diagrams of this page, the human interaction with the space is shown. In the illustrations number 113 and 114, two different uses of the same window are exemplified: if carefully designing the windowsill depth, it is possible to use that space to support plans or various object or either be a cosy spot to sit and from where to enjoy the outdoor landscape.



• Ill. 111 Human interaction: bed view



• Ill. 112 Human interaction: skylight view

• Ill. 113 Human interaction: windowsill for plants

• Ill. 114 Human interaction: windowsill for sitting

05 Presen

ntation

Concept

05.01 The final design

Masterplan
Main Complex Floor Plans
Barn Floor Plan
Cabins Floor Plans
Main Complex Elevations
Barn Elevations
Cabins Elevations
Main Complex Sections
Cabins Sections

05.02 Building performance

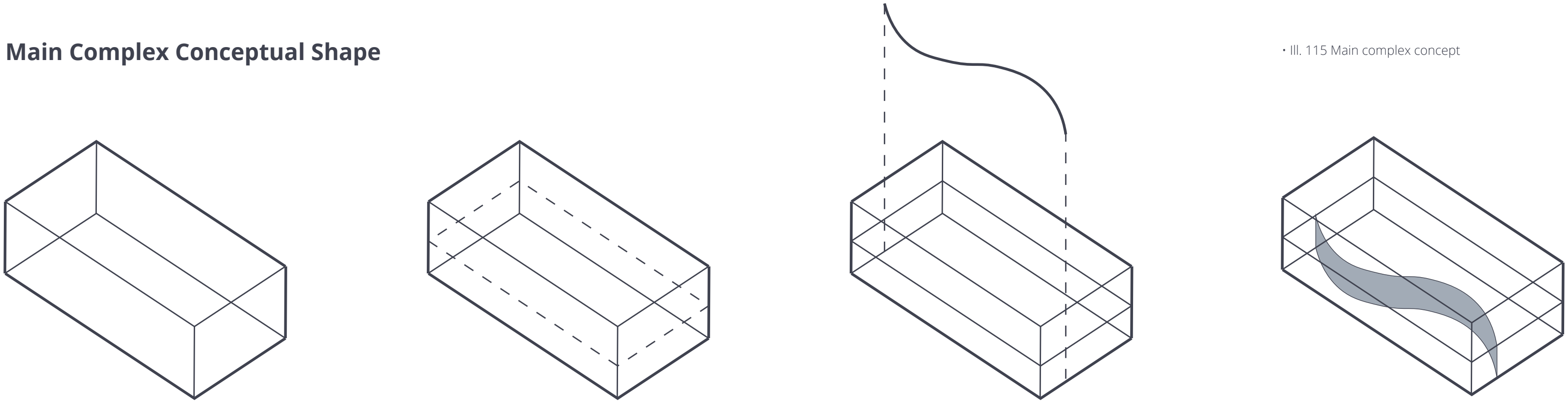
Details

Concept

The concept of the project derives from the interpretation of the site as a virgin and hostile place, lacking of an apparent identity, unconscious recipient of an extremely rich land. The attempt to reconstruct the identity of the place, is approached through a strongly geometrical architecture with only a very light organic gesture in the indoor space, as a reminescence of the outdoor geometries. The peculiarities and riches of the subsoil are reflected in the material and materialistic constitution of the project, able to show to the visitors of the guest house, the double face of Iceland: hostile, like the sharp lines of geometry and florid as its soil.

Main Complex Conceptual Shape

• Ill. 115 Main complex concept

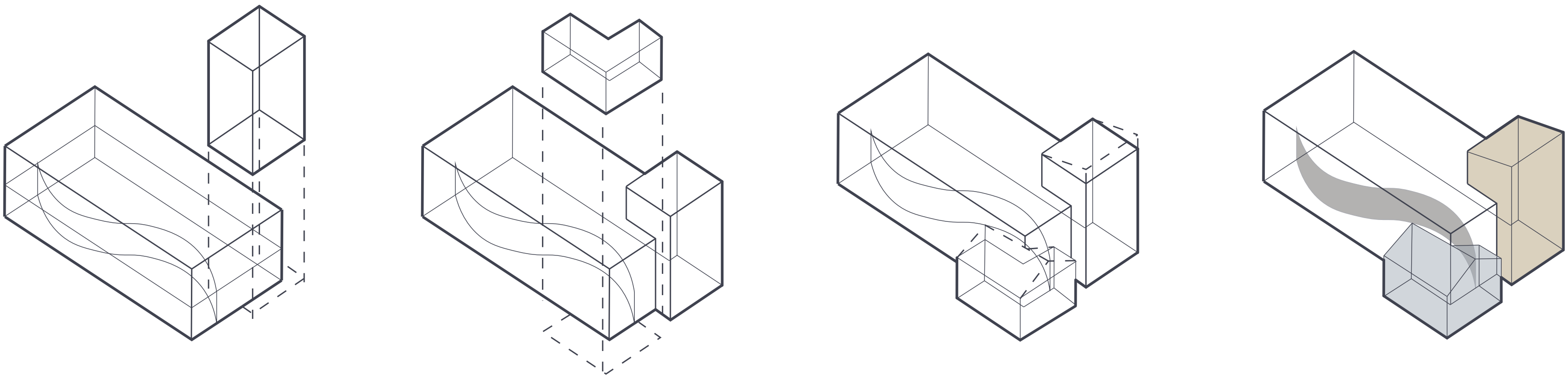


1 The simple geometry of a box is the efficient starting point of the volumes shaping.

2 This is divided in two floors to avoid excessively deep internal rooms.

3 A light organic gesture is inserted in the indoor space, as a reminescence of the natural organicity.

4 The curve becomes an interior wall, directing the layout of the plan.



5 On the North - East side an additional box shaped volume is intersecting the main complex, hosting the observatory and standing out from the context.

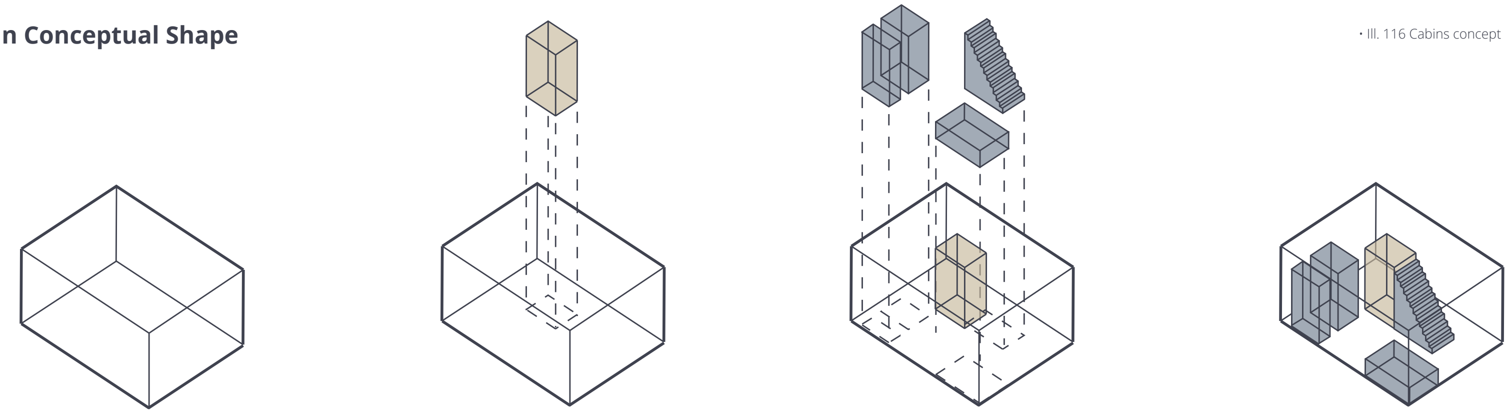
6 On the South - West side, the greenhouse volume is intersecting the main complex, completing the volume shaping of the front facade.

7 The roof shaping of the greenhouse and the observatory are tilted to follow respectively the South and North exposure, optimal for their respective uses.

8 The final main complex shape is completed with a strongly geometrical gesture in the outdoor and a light organic indoor gesture.

Cabin Conceptual Shape

• Ill. 116 Cabins concept

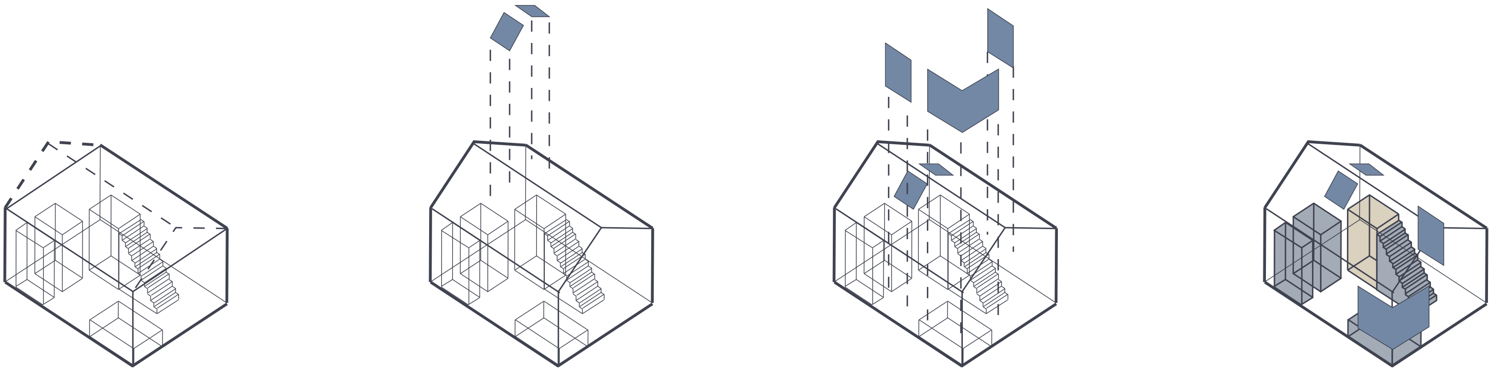


1 Following the same logic used in the main complex, the main volume of the cabin is an efficient box shape, made of modular external walls.

2 A central box, that will become the bathroom, is directing the internal circulation of the cabin.

3 The movable furnitures are dividing the cabin open space, creating different livable places, without using any internal wall.

4 The cabin has reached its final main volumetric constitution.



5 The roof is raised to be double pitched: well facing the snow incidence and allowing the implementation of the ventilation strategies.

6 The design of a central skylight, is both defining a new livable space on top of the bathroom box and allowing the stack ventilation.

7 The windows orientation is studied according to the movements of the furnitures modules and the daylight studies.

8 The final volumetric design is shaped.

05.01 The final design
Masterplan

As a result of the research conducted in the previous pages, the final Masterplan reflects the intention of only using pure geometries to frame the organic natural landscape. This is visible in the pedestrian and driveway paths, which relates to the context creating a long percourse that allows the enjoyment of the surrounding landscape, without invading and imitating it.
In respect of the existing vegetation, no species of high vegetation has been inserted, in order to preserve as much as possible, the visual appearence of the area, as it was before the architectural intervention. This approach does reflect a respectful gesture towards the local context and its nature.

Looking at the illustration number 117, it can be seen that the road leading to the site entrance, is completely immersed in the pre-existent forest, contributing to the create a feeling of contrast in the visitors reaching the site.

The feeling of estrangement and mystery described in the Phenomenological Perception of the Site (See page 76), is in fact describing the perceived essence of the place, and thus it is intended to be preserved to the site identity.

• Ill. 117 Masterplan

100m

1 Main complex
2 Host house
3 Barn
4 2 people cabin typology
5 4 people cabin typology
6 Greenhouse
7 Observatory
8 Parking
9 Driveway
10 Pedestrian path

▶ Main complex entrance
▶ House house entrance
▶ Barn entrance
▶ 2 people cabin entrance
▶ 4 people cabin entrance

• Ill. 118 site plan

Main Complex

The visualization shows the Main Complex as it appears to the visitors when entering the site from the driveway. The corrugated iron is characterizing the appearence of the main body and of the barn.

The tower shows its naked concrete structure, standing out of the context. On the other hand, the greenhouse extrusion is making noticeable the timber that it is constitued from.

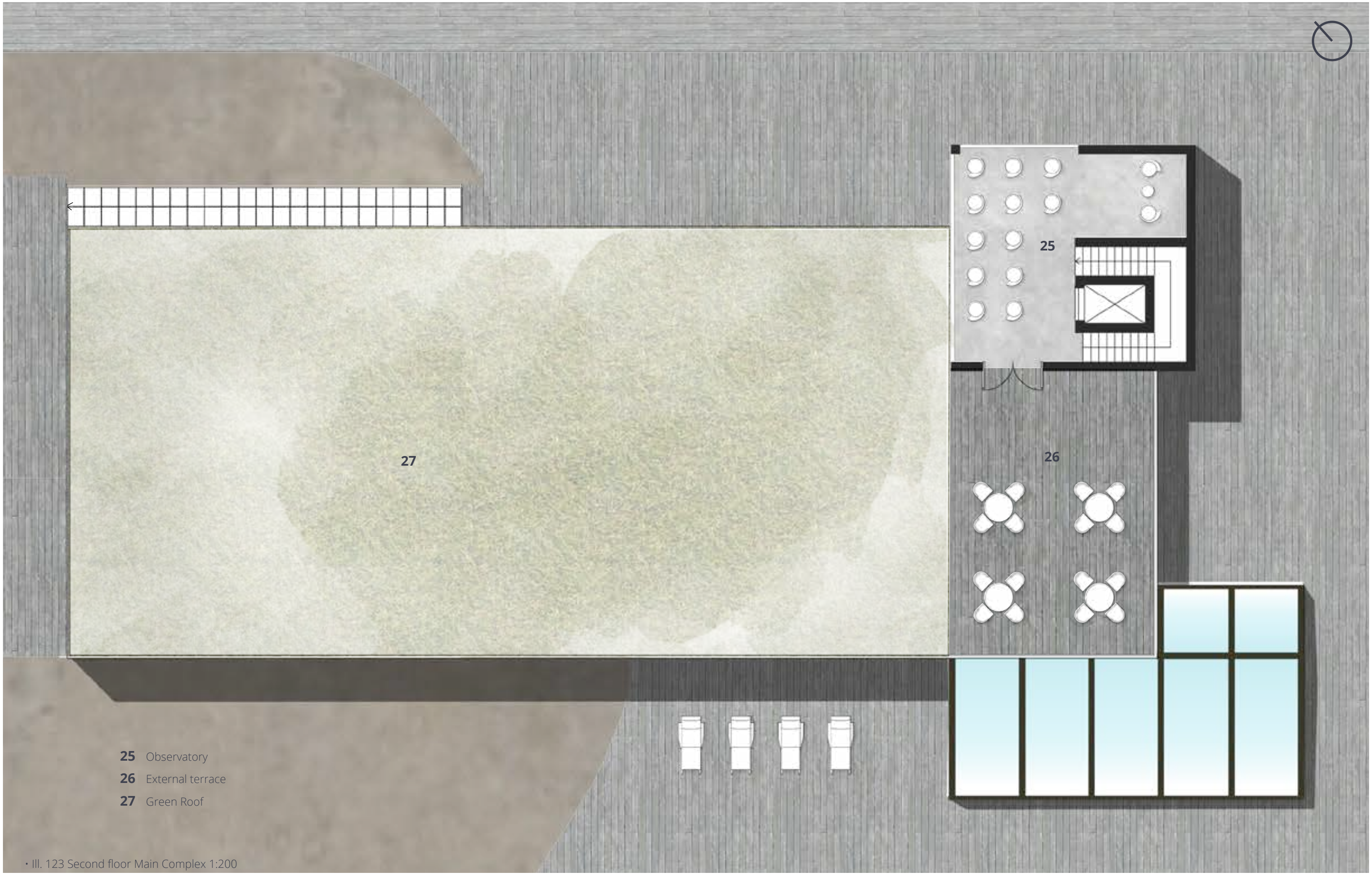
The characteristics use of the corrugated iron within the Icelandic architectural tradition, is reinvented in a contemporary key and is accompanied, by contrast, to a more traditional positioning of the windows.

Main Complex Floor Plans

• Ill. 120 Ground Floor Main Complex 1:200

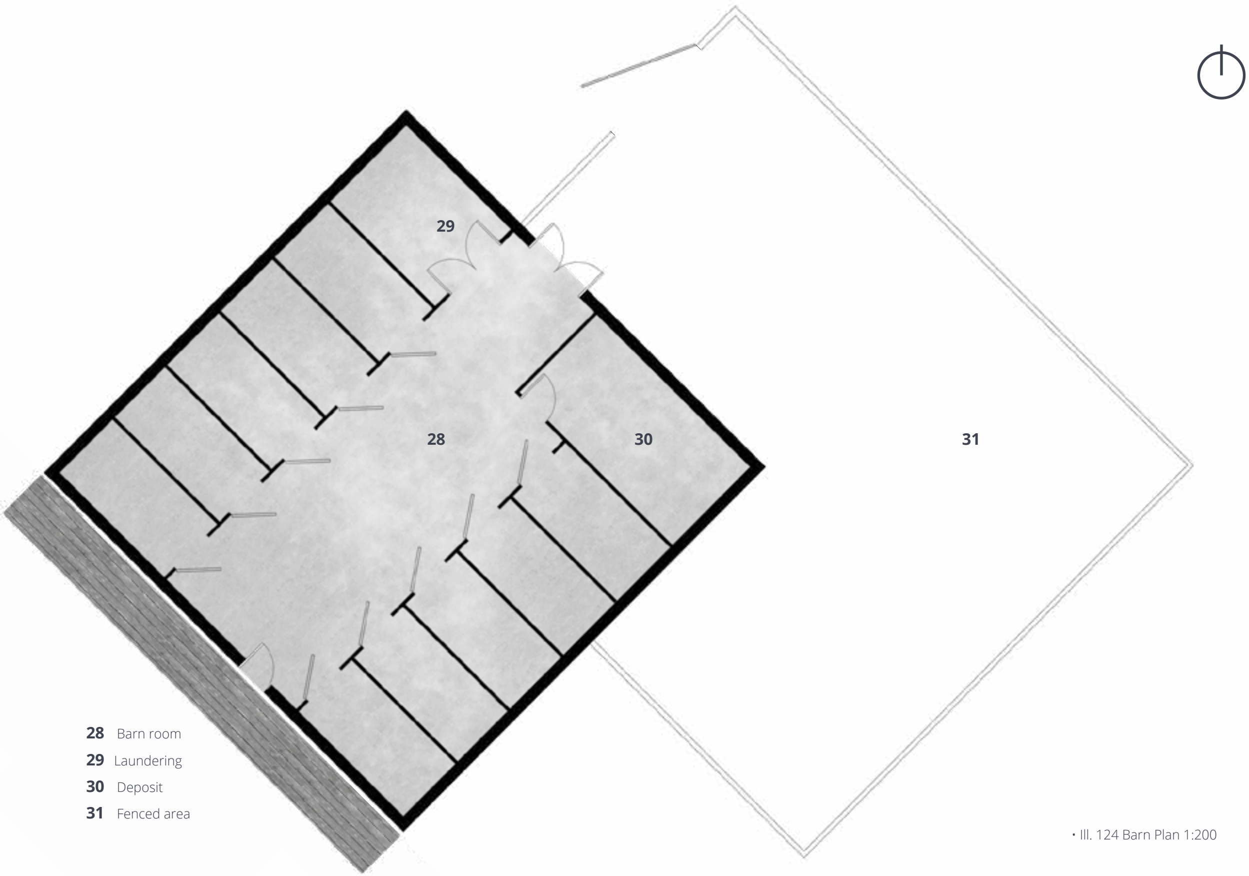
• Ill. 121 First Floor Main Complex 1:200

• Ill. 122 interior view: Common room



• Ill. 123 Second floor Main Complex 1:200

Barn Floor Plan



28 Barn room
29 Laundering
30 Deposit
31 Fenced area

• Ill. 124 Barn Plan 1:200

Cabins

The visualization shows the Cabins at night from the pedestrian path which connects the main complex to the guests bedrooms.

The night view allows to show the inclusion of the cabins within the natural context for which they are designed: the observation of the Northern Lights.

The traditional appearence of the cabins volumes, contrasts with the playful use of the colorful doors and tape on the flooring: these have the dual function of identifying the cabin responding to each group of guests, and to reinterpretate the traditional Icelandic house shape.

A design approach of contrast between tradition and contemporary reinvention, is applied to the windows of the cabins: in fact, these have very large areas placed to the North corners of the cabins themselves in order to catch the Northern Lights from indoor.

Cabins Floor Plans

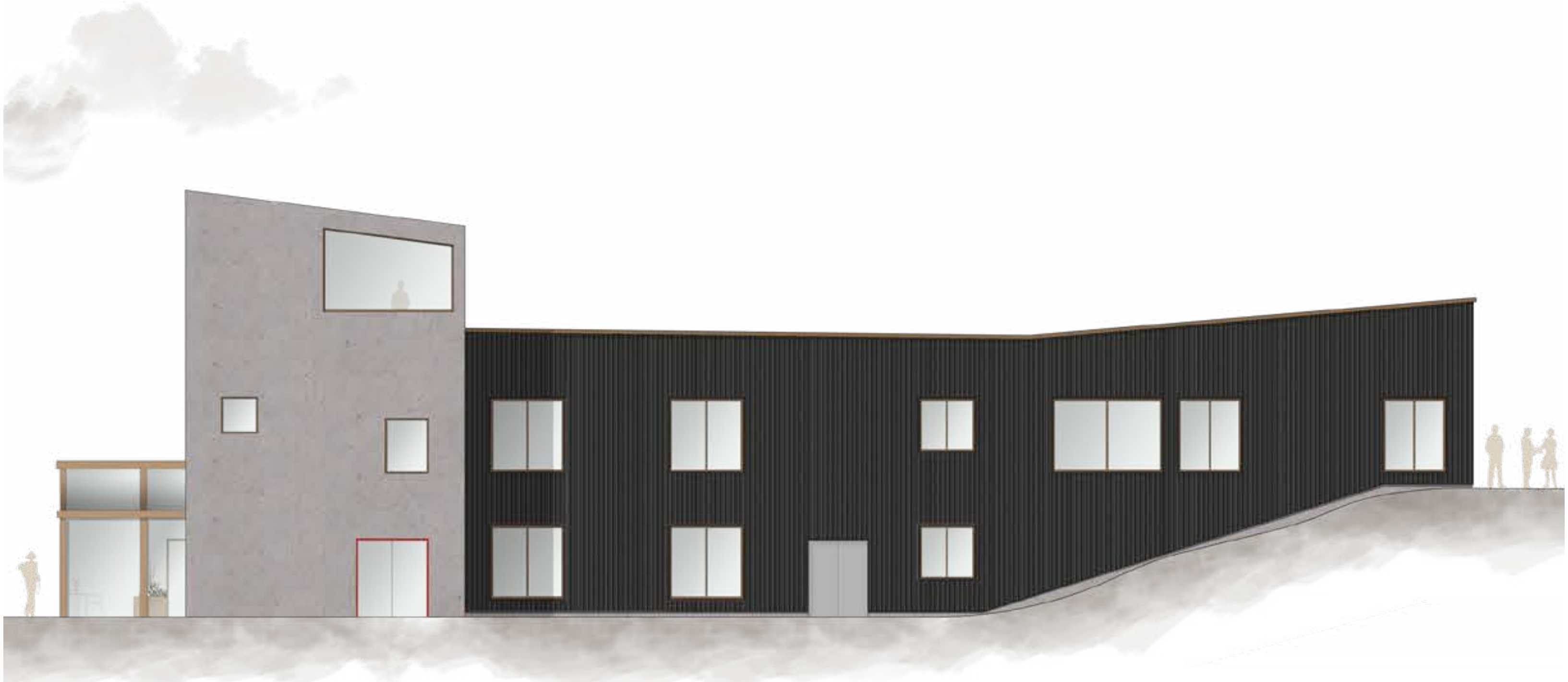
• Ill. 126 Cabin typology for 4 people - Plan 1:200

• Ill. 127 Cabin typology for 2 people - Plan 1:200

• Ill. 128 Interior View: Cabin Open space

Main Complex Elevations

• Ill. 129 Main Complex South - East Elevation 1:200



• Ill. 130 Main Complex North - East Elevation 1:200

• Ill. 131 Main Complex North - West Elevation 1:200

• Ill. 132 Main Complex South - West Elevation 1:200

Barn Elevations

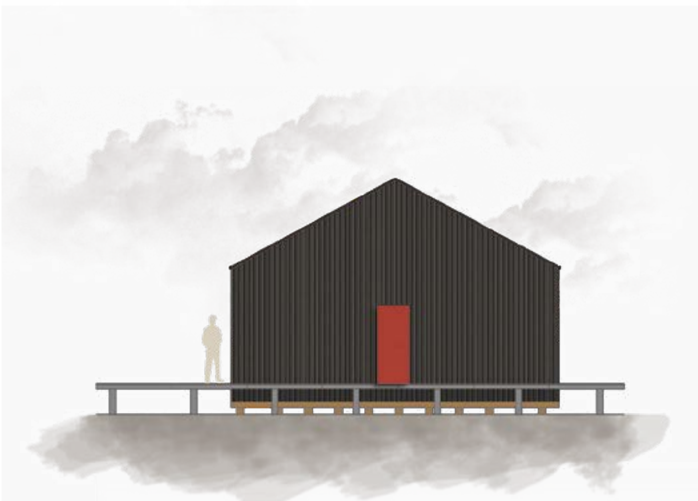
• Ill. 133 Barn South - West elevation 1:200

• Ill. 134 North - East elevation Barn 1:200

• Ill. 135 South - East elevation Barn 1:200

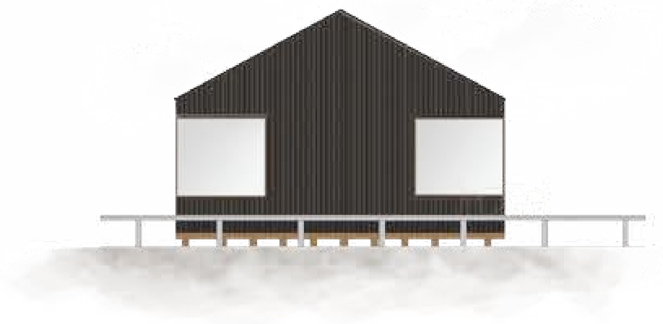
• Ill. 136 North - West elevation Barn 1:200

Cabins Elevations



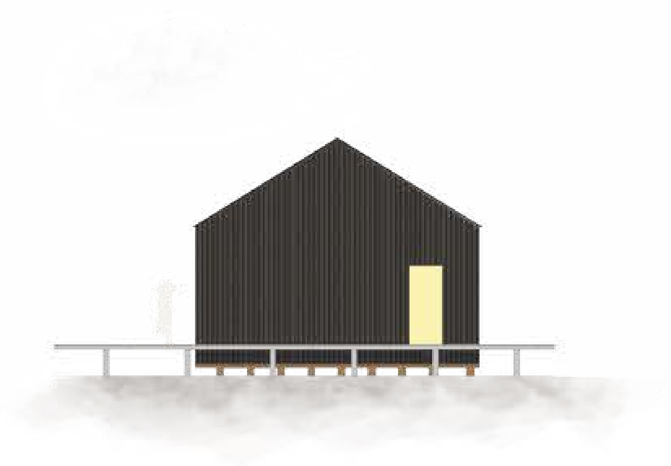
• Ill. 137 Cabin for 4 people South elevation 1:200

• Ill. 138 Cabin for 4 people West elevation 1:200



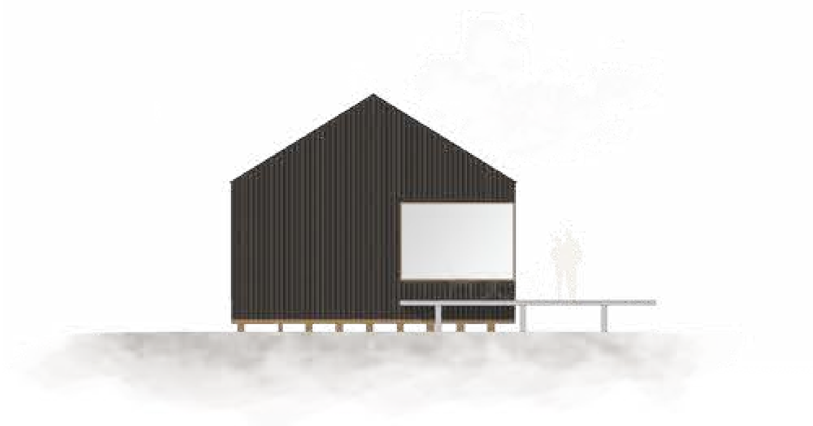
• Ill. 139 Cabin for 4 people North elevation 1:200

• Ill. 140 Cabin for 4 people East elevation 1:200



• Ill. 141 Cabin for 2 people South elevation 1:200

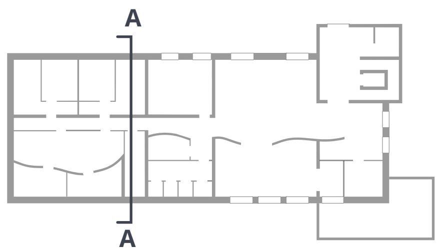
• Ill. 142 Cabin for 2 people West elevation 1:200

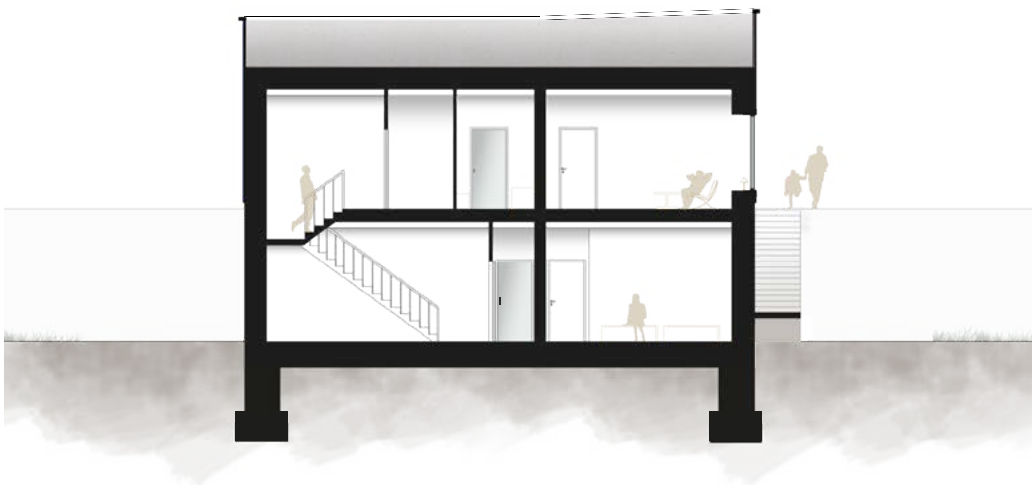


• Ill. 143 Cabin for 2 people North elevation 1:200

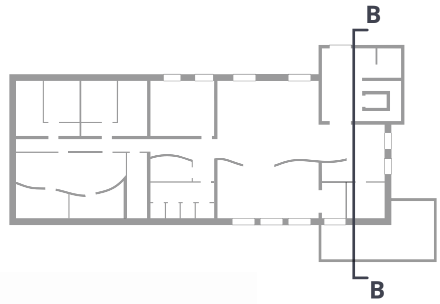
• Ill. 144 Cabin for 2 people East elevation 1:200

Main Complex Sections

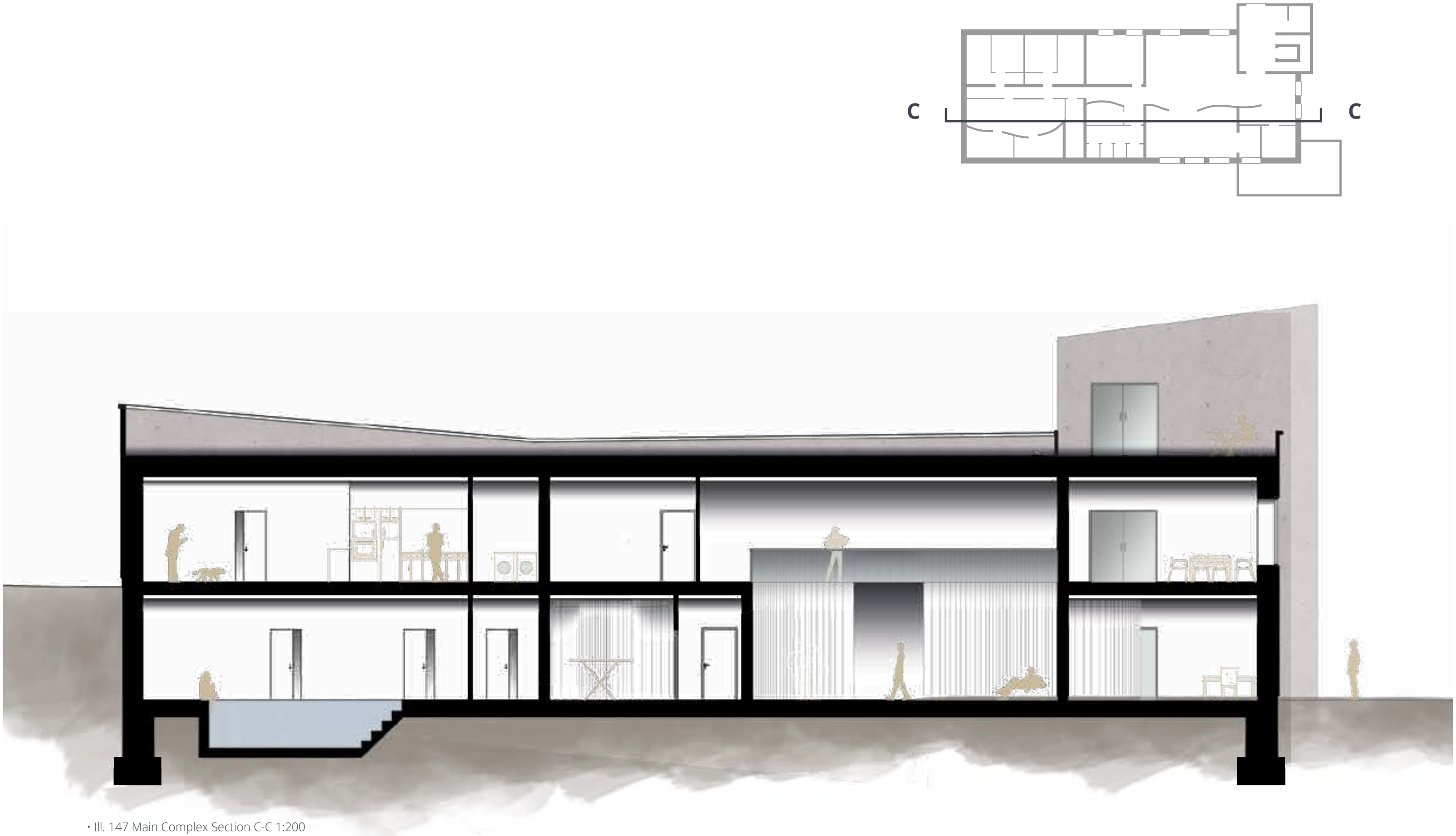




• Ill. 145 Main Complex Section A - A 1:200

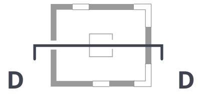


• Ill. 146 Main complex Section B - B 1:200

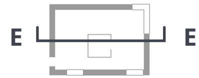


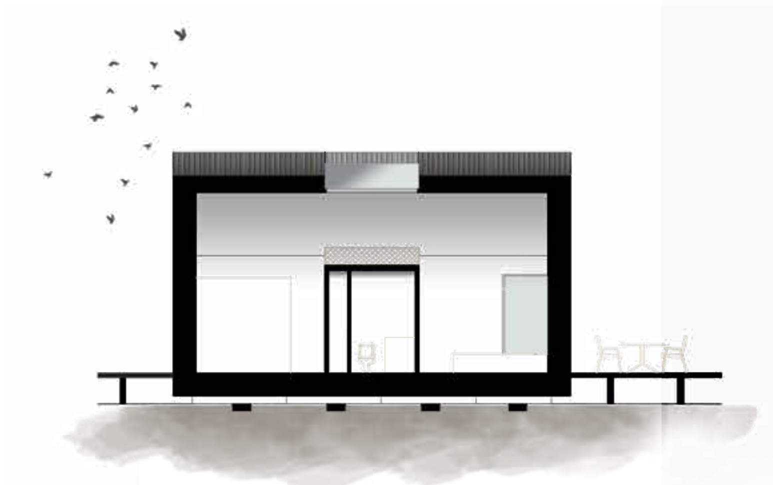
• Ill. 147 Main Complex Section C-C 1:200

Cabins Sections

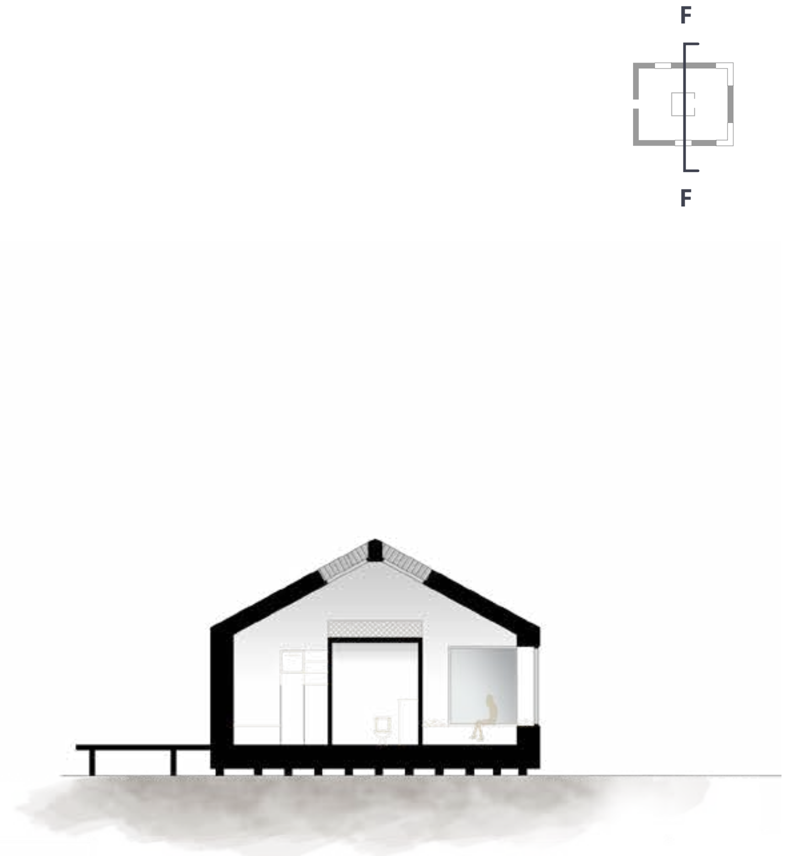


• Ill. 148 Section D-D Cabin for 4 people 1:200

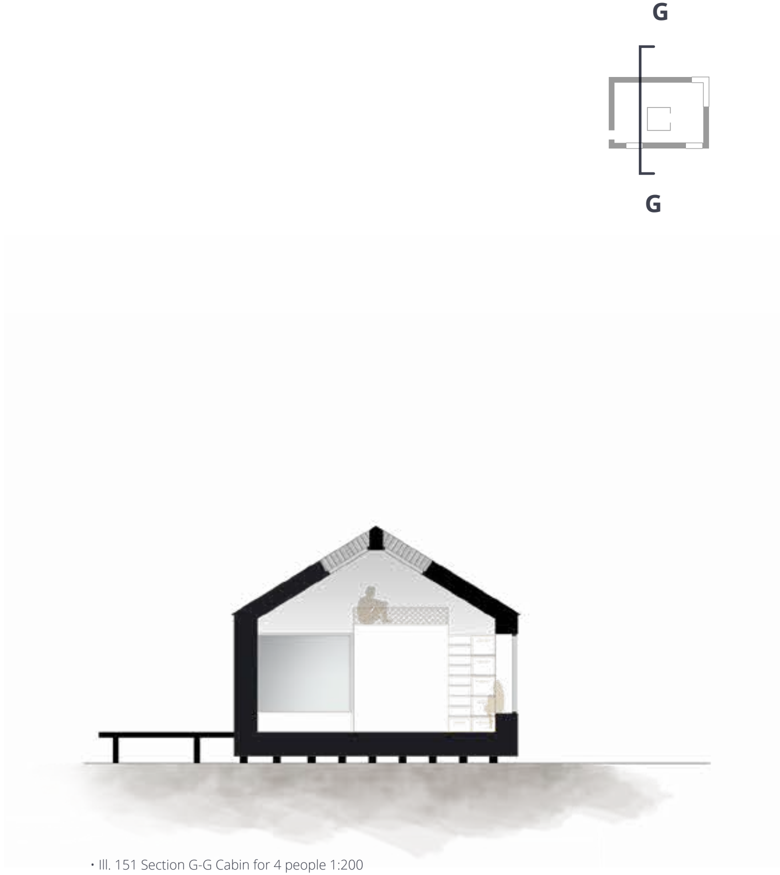




• Ill. 149 Section E-E Cabin for 4 people 1:200



• Ill. 150 Section F-F Cabin for 4 people 1:200



• Ill. 151 Section G-G Cabin for 4 people 1:200

• Ill. 152 Cabins Interior view: Furnitures flexibility

• Ill. 153 Cabins Interior view: Furnitures flexibility

05.02: Building Performance

Framework

The project's performance are documented in compliance with the Danish Building Regulations 2015, the Buildings class 2020 standards and the design criteria of the project. To be specific, the Energy Performance framework of the whole intervention is designed not to exceed 20 kWh/m2 of energy consumption destinated to heating, cooling, ventilation and domestic hot water systems.
In regarding to the indoor climate, as stated in the Danish Building Regulations 2015, the maximum amount of hours above 26 °C cannot be more than 100 hours per year and no more than 25 hours above 27 °C, while for the atmospheric comfort, the maximum levels of CO2 per months do not have to exceed 850 ppm, and the daylight factor in the center of the rooms does not have to be lower than 2%.
All of these arrangements are meant to enhance the experience and livability of the spaces, without sacrifying the aesthetical appereance of the design, while instead being integrated in the project, since the very early stages of the design process.

Energetic Performance

The calculation of the building's energy consumption, is the result of an intense process that sees the timely application of the passive strategies since the very early stages of the design. The implementation of an Heat Pump system fon indoor heating/domestic hot water and the exploitation of the electricity coming from the Krafla geothermal power plant, finally allows the project to fulfill the energetic standards of a Zero Energy Building, according to the 2020 energy frame.

Step 1
The illustration number 154 shows the result of the cabins energy consumption, equal to 33.3 kWh / m2. In consideration of the cabins requirements, these must be light, transportable and removable; therefore, the use of heavy materials with high thermal mass features, is not allowed. Thus, in order to help the structure keeping indoor the heat gains, a set of good choices of the construction layers with very low U Values, a ventilation strategy dotated of heat recovery system and the correct

Energy frame Buildings 2020		
Without supplement	Supplement for special conditions	Total energy frame
20,0	0,0	20,0
Total energy requirement		33,3

Contribution to energy requirement		Net requirement	
Heat	0,0	Room heating	15,8
El. for operation of bulding	18,5	Domestic hot water	0,0
Excessive in rooms	0,0	Cooling	0,0

• Ill. 154 Cabins Total Energy Requirements, with only Passive Strategies Applied

Energy frame Buildings 2020		
Without supplement	Supplement for special conditions	Total energy frame
20,0	0,0	20,0
Total energy requirement		19,7

Contribution to energy requirement		Net requirement	
Heat	0,0	Room heating	8,4
El. for operation of bulding	10,9	Domestic hot water	0,0
Excessive in rooms	0,0	Cooling	0,0

• Ill. 155 Global Complex Total Energy Requirements, with only Passive Strategies Applied

Energy frame Buildings 2020		
Without supplement	Supplement for special conditions	Total energy frame
20,0	0,0	20,0
Total energy requirement		7,1

Contribution to energy requirement		Net requirement	
Heat	0,0	Room heating	8,4
El. for operation of bulding	4,0	Domestic hot water	0,0
Excessive in rooms	0,0	Cooling	0,0

• Ill. 156 Global Complex Total Energy Requirements, Heat Pump Applied

Energy frame Buildings 2020		
Without supplement	Supplement for special conditions	Total energy frame
20,0	0,0	20,0
Total energy requirement		-4,9

Contribution to energy requirement		Net requirement	
Heat	0,0	Room heating	8,4
El. for operation of bulding	-2,7	Domestic hot water	0,0
Excessive in rooms	0,0	Cooling	0,0

• Ill. 157 Global Complex Total Energy Requirements, Electricity and Heat Pump applied

use of the shadings systems, contribute to the good performance of the cabins (See Annex 3, page 193, for U Values calculations). The 2020 energy standards will be finally fulfilled through the integration of the whole complex into the energetic calculations.

Step 2

In fact, as shown in the illustration number 155, the result of the energetic performances of the whole complex, with the only application of passive strategies, is perfectly aligned with the 2020 energy standards. The result is equal to 19.7 kWh / m2, thanks to the exploitation of concrete's high thermal mass capacity, the correct positioning of the windows, a ventilation system equipped with heat recovery and a good choice of the construction layers (See Annex 3, page 193, for U Values calculations).

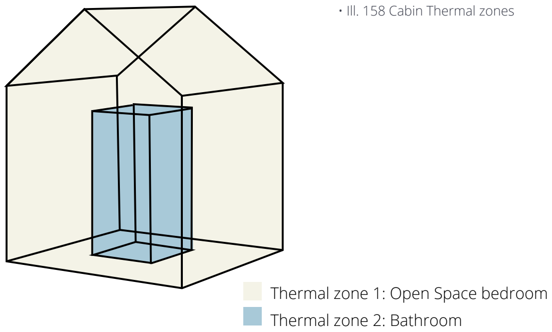
Step 3

Through the implementation of a brine-to water heat pump, the energy consumption drops, reaching 7.1 kWh/ m2. The heat pump supplies both the requirements for indoor heating and domestic hot water; while its capacity is based on the heat requirements values of the project, as they were before the application of the heat pump itself. The highest heating requirement, equal to 3.96 MW, is found to be in December. So the heat pump is calibrated with a nominal effect of 3960 kW, assumed for both indoor heating and domestic hot water.

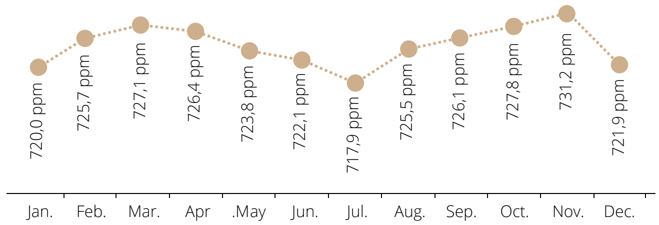
Step 4

Finally, the electricity coming from the Krafla geothermal power plant is calculated (See Annex 3, page 190, for calculations). In Be18, this is simulated through the implementation of solar cells, covering the whole electricity need. In the illustration number 157, the final energetic performance of the Icelandic Guest House is shown with a final value of - 4,9 kWh/m2.

Cabins Indoor Climate

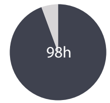


• Ill. 158 Cabin Thermal zones



• Ill. 159 Monthly average of ppm in a year (max 850 ppm per month)

• Ill. 160 Months per year above 26°C in critical months



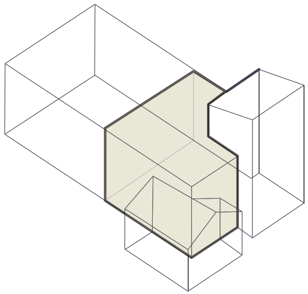
• Ill. 161 Total of hours above 26°C per year (max 100h)

In order to test the Indoor climate of the cabins, the cabin typology for 4 people has been chosen, as worse possible case, due to the relatively high windows area facing North. The North/West location of the windows is in fact responding to a design criteria set since the very early stages of the design process, so to increase the chances to catch the Northern Lights from indoor. The final dimensions of the North-facing windows and the location of the other windows placed on the East and West side, has been the result of several iterations.
In the beginning of the process, the cabins were experiencing overcooling during winter and overheating in the summer: the resolution has been achieved through a 0,33 m thick sheep wool insulation in the walls, 0,4 m in the floor and 0,33 m on the roof.

The final windows area facing North is 2 m x 2.10 m, and it still allows a large visual space to see the Northern Lights. Two windows has been placed on the East side and the West side, both improving the daylight conditions and eradicating the discomfort due to overcooling. Three shutters are placed on the skylight, on the East and on the West windows during the summer season, out of the hours of use of the building, so to avoid overheating, but still not affecting the daylight experience of the room. The people load set in the software is 4 people, according to the users capacity of the cabin.

The criteria set from the Danish standards are met, with a maximum of 98 hours of temperatures above 26 degrees, 0 hours above 27° degrees, and less than 850 ppm CO2 emissions every month. There are no temperatures below 21 degrees through the whole year (Ill. number 159, 60,161).
It is important to stress out that working with a light wooden structure in Iceland has of course influenced the reduced capacity of heat storage through the envelope and this choice has been influenced by the requirements of flexibility, ease of transportation and aesthetical reasons. The final indoor quality is then the result of an intense series of iterations which preserve the ease of disassemble of the structure, the ability to have large windows facing North and a valid easthetical appereance.

Main Complex Indoor Climate



• Ill. 162 Main complex thermal zones

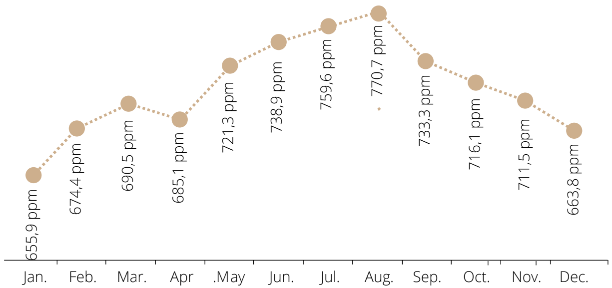
Thermal zone 1: Open Space

With the same logic applied to the cabins, the worse possible case has been chosen for the indoor climate investigations of the main complex. The open space connecting the dinining area to the common room, is in fact located next the greenhouse and South exposed. The thermal zone set in BSim also includes the upper floor restaurant, since the first and the second floors are openly connected through a double height. (See Annex 5, page 198, for Neutral Plane calculations). Thanks to a good choice in the construction layers and to the right placement of the windows, exploiting the stack ventilation, the complex has since the beginning had a very good indoor environment, never resulting in overheating nor overcooling, and with the CO2 levels always below 850 ppm.

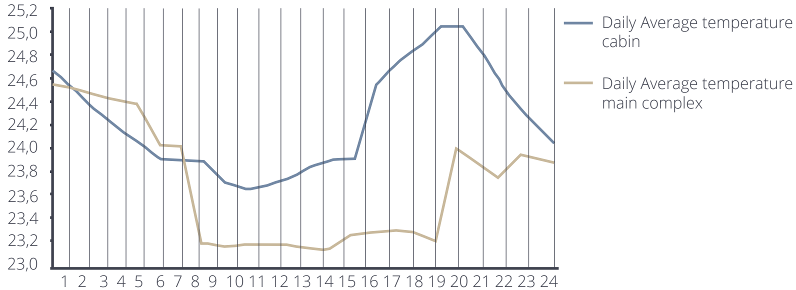
The use of a thick layer of concrete in both the external walls and in the roof, favors the internal storage of heat gains, exploiting the high thermal mass of the material.

The overall hours above 26 degrees are 12 during the whole year. In the same time frame, the hours above 27 degrees are 5 (See ill. 167 and 168).

The illustration number 164, shows the temperatures variations in the cabin open space and the complex common areas on the 13th of June. The use of an high thermal mass structure in the main complex, makes the building keep an uniform temperature during the day and

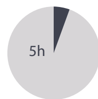


• Ill. 163 Monthly average of ppm in a year (max 850ppm per mounth)



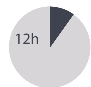
• Ill. 164 Comparison: Temperature variation in the cabins and in the main complex common areas, 13th of June

• Ill. 165 Hours above 26C in critical months



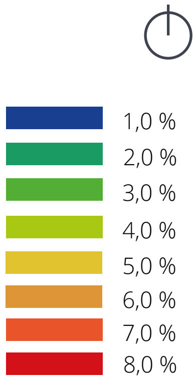
• Ill. 167 Hours above 26C per year (max 100h)

• Ill. 166 Hours above 27C in critical months



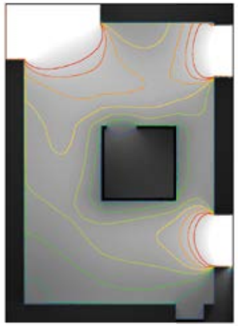
• Ill. 168 Hours above 27C per year (max 25h)

it release at night the heat gained during the day, causing an increase of temperatures from 20.00 to 07.00; this is compared to the temperatures swing in the cabins where the daily average varies more, still preserving the overall atmospheric comfort below 26 degrees.

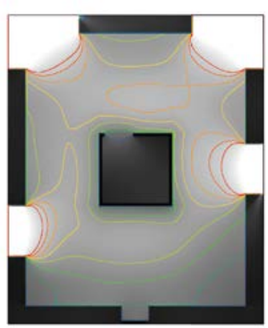


Cabins Daylight Factor

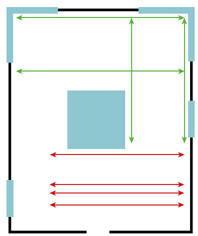
The daylight factor of the cabins is tested for both the two typologies. The process that led to the final daylight conditions, has been strictrly related to the atmospheric comfort calculations runned on BSim: In the illustrations number 173 and 174, the location of the shutter systems used are marked: these are only applied in summer, outside the hours of usage of the cabins, in order to not influence the daylight experience of the users.
In the illustrations number 169 and 170, it can be noted that the daylight conditions of both the typologies is more than sufficient in the entire space, never going below 3%. These conditions satisfy the requirements stated in the Danish Building Regulations 2015.
Therefore, the design of the daylight conditions, results as a balance between atmospheric comfort and design choices. In fact, the windows placement is set up taking into account the movable furnitures paths, in such a way that none of the window can ever be blinded. In the illustrations number 171 and 172 the furnitures rails are marked, highlighting the possible movements for high furnitures (1.90 m) and for low ones (0.50 m).
The software used for the daylight analysis is Velux Daylight Visualizer 2.



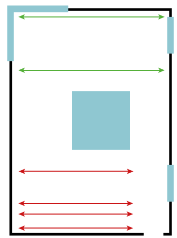
• Ill. 169 Two people typology, Daylight factor hours of usage



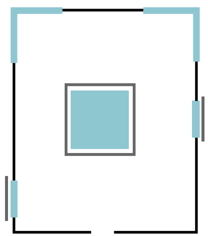
• Ill. 170 Four people typology, Daylight factor hours of usage



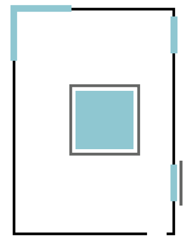
• Ill. 171 Plan Diagram,max furniture movement in the 4 people typology cabin



• Ill. 172 Plan Diagram,max furniture movement in the 2 people typology cabin



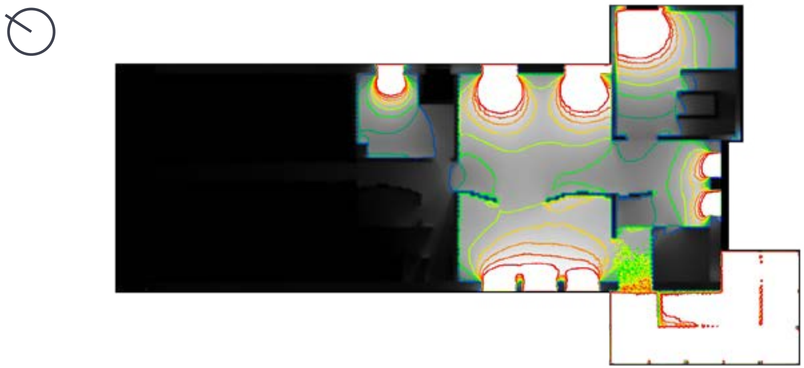
• Ill. 173 Plan Diagram, location of the shutters in the 4 people typology cabin



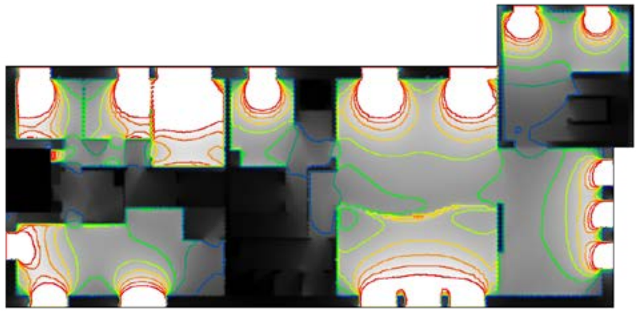
• Ill. 174 Plan Diagram, location of the shutters in the 2 people typology cabin

Main Complex Daylight Factor

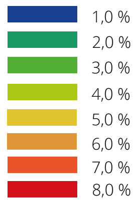
The first floor of the main complex is partially excavated in the ground, taking advantage of the natural altimetric difference of the area. The service spaces, the swimming pool and the saunas, which do not require natural daylight, are therefore placed in that side of the building. On the other hand, the kitchen, the common area, the dining room, the reception and the entrance, they all benefit of an excellent daylight, never below 3% in the center of each room. This is due to the right exposition of each room and to the relatively large windows area. To the South, the common room and the greenhouse take full advantage of the warmest exposition of the building, to both store the heat gains and to achieve an excellent daylight factor.
At the second floor and in the observatory as well, the daylight factor always reach the atmospheric standards set by the BR15. In particular, in the observatory at the third floor, the skylight fully illuminate the room during the day and it provides a large visual connection through the outside, particularly useful to increase the chances of catching the Northern Lights.



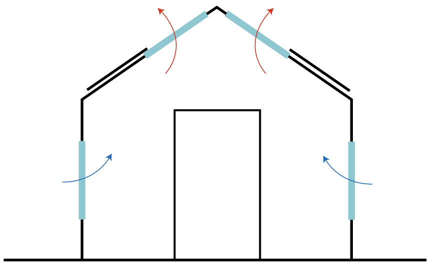
• Ill. 175 Main Complex Ground Floor, Daylight Factor



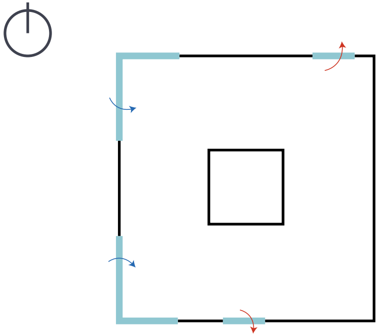
• Ill. 176 Main Complex First Floor, Daylight Factor



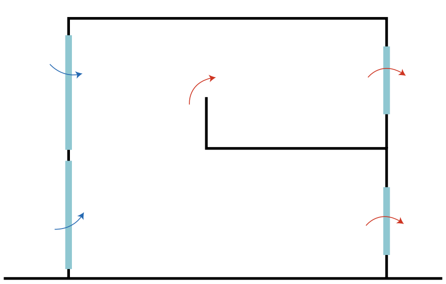
• Ill. 177 Observatory, Daylight Factor



• Ill. 178 Natural ventilation system in the cabins, Section diagram



• Ill. 179 Natural ventilation system in cabins, Plan diagram

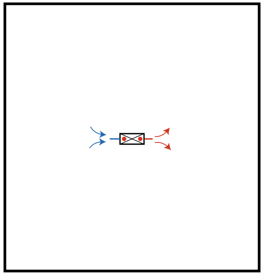


• Ill. 180 Natural ventilation system in the main complex common spaces, Section diagram

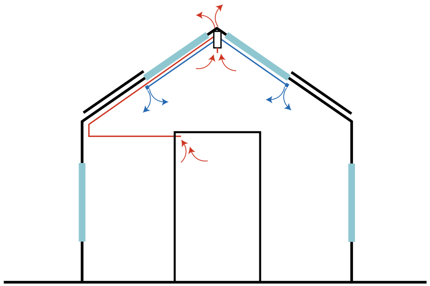
Natural Ventilation

Cabins
The natural ventilation system, takes full advantage of the cabins orientation: in fact, as shown in the Wind Alaysis of this booklet (See page 72), the wind in the site area mainly blows in the direction North-South. Being the biggest windows of the cabins placed on the North side, the wind can naturally blows in the indoor space, contributing to the good indoor air quality. Due to the harsh climatic outdoor conditions, the natural ventilation is only thought for summer use, and it takes advantage of both cross and stack ventilation (See Annex 5, page 198, for the neutral plane calculation). As already mentioned, the shading systems, blocking the windows openings, are activated only outside the hours of usage of the cabins, thus not affecting the natural ventilation.
(See Annex 5, page 196, for air change calculations in the cabins).

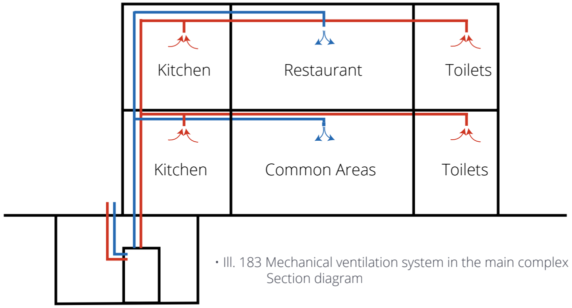
Main Complex
The Natural Ventilation strategies applied to the main complex are taking advantage of both stack, cross and single sided ventilation, according to the air change needs of the space and the rooms use. The double high in the common room, allows all the most lived places, such as the common area at the first floor, and the restaurant at the second, to benefit of a air pressure difference which easily drives out the polluted air (See Annex 5, page 198, for location of the neutral plane calculation). Being right in front of the common room, the dining area can benefit as well of the cross ventilation, while the kitchen is experiencing single side ventilation. At the first floor, the rest of the complex is partially included within the ground, therefore, there is no natural ventilation in the toilets, the sauna and the swimming pool.
The host house at the second floor, benefit of cross ventilation in the open space and single sided ventilation in the bedrooms. (See Annex 5, page 197, for air change calculations in the main complex).



• Ill. 181 Mechanical ventilation system in the cabins, Plan diagram



• Ill. 182 Mechanical ventilation system in the cabins, Section diagram



• Ill. 183 Mechanical ventilation system in the main complex Section diagram

Mechanical Ventilation

Cabins
Due to the harsh outdoor conditions, the mechanical ventilation system of the cabins is on during the whole year. Each cabin is served by a decentralised aggregate equipped with heat recovery system. The external outlet and inlet are both placed on the roof, in two opposite sides of the aggregate, in order to always allow the correct functioning of the system without mixing the exhausted air and the clean one. The dimensioning of the mechanical ventilation system capacity is based on the airflow calculations of the cabins (See Annex 5, page 196, for airflow calculations). A product that might satisfy each cabins needs, is called AM 150 H, with a capacity of 115 m3/h and produced by AIR MASTER (airmaster-as.com).

Main Complex
As in the case of the cabins, the main complex as well is served by mechanical ventilation during the whole year. In this case, the system is as well equipped with a heat recovery system, but it is centralised. The pipes are all covered at the height of the ceilings to minimize their visual impact. The exchanger is located in the technical room on the basement, with the outdoor inlet and outlet located on the ground. The dimensioning of the system is based on the airflow needs of the main complex (See Annex 5, page 196 and 197, for airflow calculations) and it can be covered by the use of a system called HR A400, (with a capacity of 400 m3/h) produced by Viessmann company (viessmann.co.uk).

Materials

• Ill. 184 Pine driftwood

• Ill. 185 Sheep wool

• Ill. 186 Corrugated iron

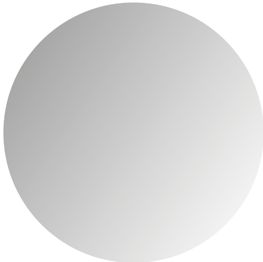
• Ill. 187 Concrete

Pine driftwood
The internal walls of the whole project, are made out of driftwood: this choice is related to the fact that this material is directly available in Iceland, contributing in lowering the CO2 emissions due to the overseas shipping. Moreover, according to the need for the structure of being movable and flexible, the use of wood well responds to this criterion.

Sheep Wool
Together with the driftwood, the sheep wool is as well chosen for being directly available in Iceland and because, as documented in the BSim analysis, its insulating properties ensure the good indoor environment of the whole project. Moreover, rather than using a more traditional kind of insulation, this choice is directly linked to the local potential, exploiting the resources of the area.

Corrugated Iron
The corrugated Iron has been chosen as external cladding for both the cabins and for the main complex, because of its low maintenance costs and for its potential to be aestheticized and painted. This material is already part of the Icelandic architectural practice and it is related to the architectural Identity of the place.

Concrete
The bearing structure of the main complex and the foundations as well, are made out of concrete. This choice is equally related to the specific feature of the material to have an high thermal mass, and to the ease of supply. In fact, even in this case, it was possible to retrace an Icelandic producing company from where to stock up, in order to limit, as much as possible, the CO2 emissions linked to the material shipping.



• Ill. 188 Glass

• Ill. 189 Basaltic rock

• Ill. 190 Timber

Glass

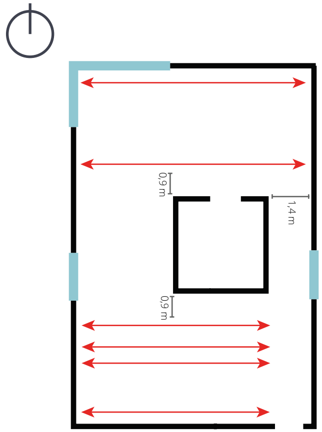
The glass used for the windows is a triple glazing. It has been chosen because of its insulation properties, which are enhanced by the two cavities in between the three pane layers: these provide insulation and reduce the condensation for a general better performance (carlson.ie). The windows glass is the only construction material of the Iceladic Guest House, which is not available in Iceland. Instead, it is imported from Ireland, Dublin. The retailer's choice is the result of a compromise between the performance of the material and the distance between the retailer and the site project.

Basaltic Rocks

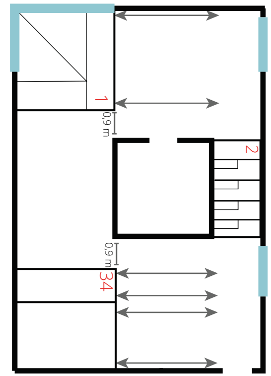
The curved walls dividing the shared facilities within the main complex, are made out of basaltic rocks. These are available on-site and do not need of elaborated processing. The collection and assembly of the material, in fact, can be done directly on-site, overlapping the rocks on top of each other, and fixing them together through the mortar. The main purpose of the basaltic walls in the main complex, is aesthetical and conceptual at the same time, making visible the usage of the local riches and claiming a clear reference to the outdoor landscape.

Timber

Timber is used for the load-bearing structure of the cabins. Its structural properties combined with the lightness of the material make it suitable for the composition of the cabins structure. Also in this case, the ease of retrieval of the material has assumed a fundamental role, to reduce CO_2 emissions related to the transport.



• Ill. 191 Plan Diagram 2 people cabin, max. allowed sliding movement of the furnitures on rails

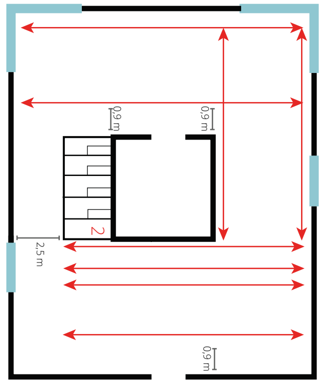


• Ill. 192 Plan Diagram 2 people cabin, furniture modules and rails direction

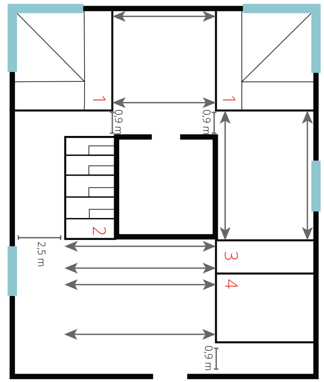
Cabins Flexibility

One of the design criteria adopted for the cabins, is the principle of flexibility: this allows the costumization of the space, depending on the users needs. The design strategy adopted to maximize the flexibility of the space rely on the design of modular furnitures, which can slide on rails placed on the floor: in this way, it is possible to increase the free space available on every side of the cabins. This feature of the project is particularly efficient considering the eventuality of users using large camera equipments to capture the Northen Light from indoor. Having the ability to move the furitures, allows to both experience the Northern Lights laying on the bed or placing instead the camera equipment in front of the big windows.

The furnitures modules can only move on one axis each, in order not to make the internal circulation difficult and not to close the access to the main door and the toilet door.
These precautions are designed in compliance with the safety of the users and to guarantee the accessibility for all (See DGNB Criteria at page 17).

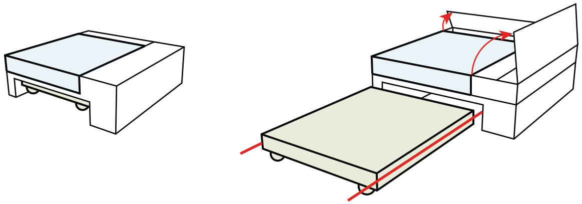


• Ill. 193 Plan Diagram 4 people cabin, max. allowed sliding movement of the furnitures on rails

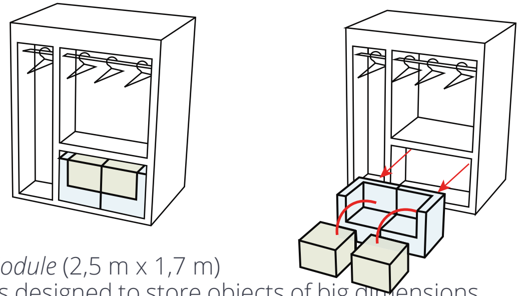


• Ill. 194 Plan Diagram 4 people cabin, furniture modules and rails direction

• Ill. 195 Bed Module



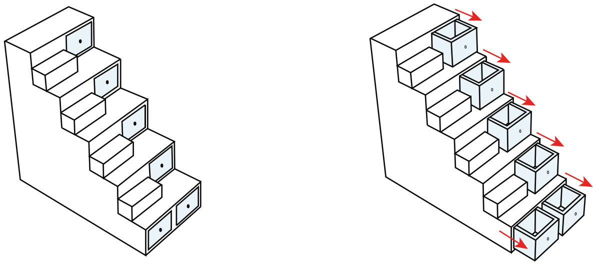
• Ill. 196 Big Closet Module



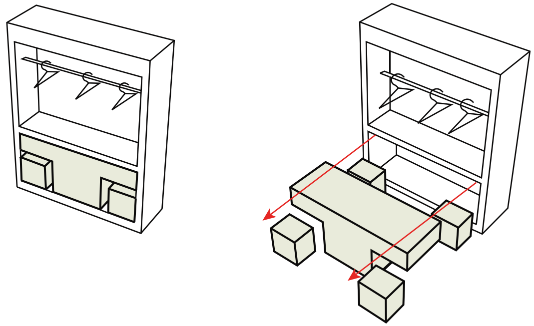
1 *Bed Module* (2,5 m x 2,5 m)
The primary function that it plays, is to host the double bed; then, integrated into the structure, there are two retractable drawers 45 cm deep, designed to accommodate small objects of everyday use. In the lower part of the structure, a foldaway double bed can eventually increase the capacity of the room beds, where this last function is mainly thought for the future reuse of the cabins. Module height: 0,55 m.

3 *Big Closet Module* (2,5 m x 1,7 m)
This module is designed to store objects of big dimensions, such as backpacks and suitcases. For this reason the depth of the cabinet at the top of the structure is greater than the standard depth, reaching 1.5 m. This depth allows the use of the lower part of the module to store two armchairs, which can be combined as a sofa, and two comfy poofs. Module height: 2,5 m.

• Ill. 197 Stairs Module



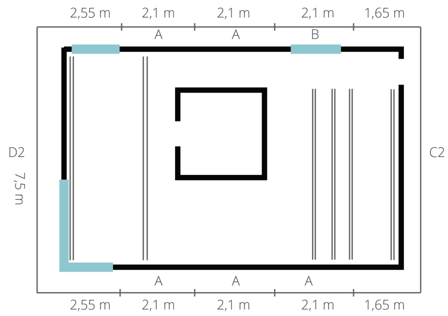
• Ill. 198 Small Closet Module



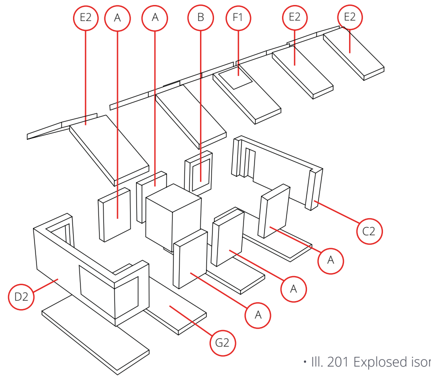
2 *Stairs Module* (2,5 m x 1,25 m)
This is the only module which does not slide on rails and that is instead thought to be fixed. This choice contributes to the simplification of the possible movements within the space, still allowing multiple functions within the same object. The main purpose of the stairs is to reach the toilet ceiling, that is directly facing the skylight, creating a new livable spot either to look at the Northern Lights in winter or the stars during the whole year. Six extractable drawers are placed at the height of each double tread. The drawers have a size of 45 cm x 45 cm. Module height: 2,56 m.

4: *Small Closet Module* (2,5 m x 0,8 m)
The upper part of the structure acts as a wardrobe measuring with a standard depth of 60 cm. Instead, in the lower part of the module, there is a foldaway table, with dimensions 2.25 m x 0.8 m, which allows to eliminate the encumbrance of a fixed table when not needed, in continuity with a logic of maximum flexibility of the space. Moduel height: 2,5 m.

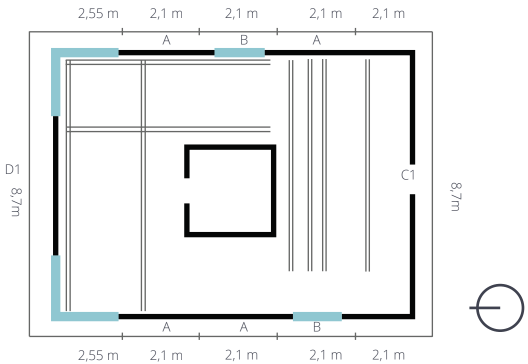
Cabins Disassembly



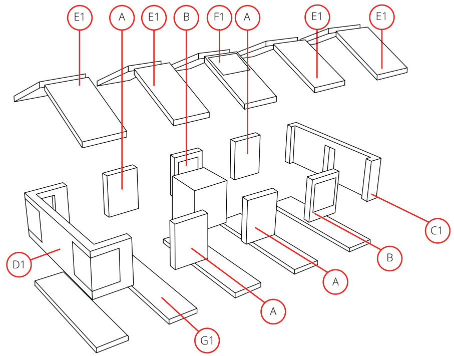
• Ill. 199 Plan Diagram 2 people cabin, external walls modules dimensions



• Ill. 201 Explosed isometric 2 people Cabin



• Ill. 200 Plan Diagram 4 people cabin, external walls modules dimensions



• Ill. 202 Explosed isometric 4 people Cabin

As already mentioned, during the dismantling phase of the Icelandic Guest House, the cabins are meant to be disassembled for being reused elsewhere. For this reason, the dimensions of the structural modules respect the standard dimensions of road transport, according to the Icelandic standards (itf-oecd.org).
The cabins are built on-site by composing each wall packet module. The maximum width of each module is 2.1 m. This applies both to vertical walls, the roof covering panels and to the floor modules. The modules A and B indicated in the illustrations number 201 and 202 are repeated in both the cabins typologies, while the modules C1, D1, E1, F1, G1 are applied only to the 4 people cabin type and C2, D2, E2, F2, G2 to the 2 people cabin type. In the illustrations number 199 and 200, the exact dimensions of each module is shown.

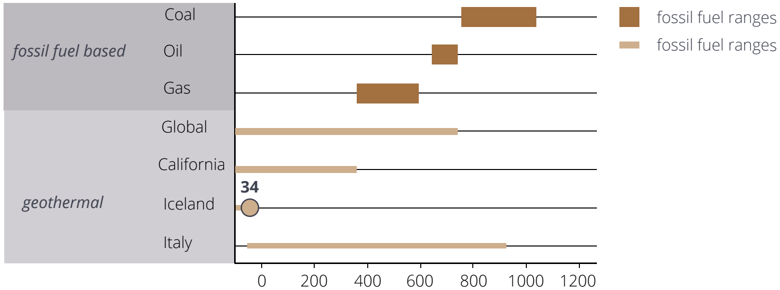
Critical Reading of the LCA Results

As a further proof of the effective sustainability of the Icelandic Guest House, a "Cradle to Gate" LCA calculation has been attempted. The LCA is a standardized procedure that allows to assess and quantify the environmental footprint related to a given product, from the construction phase up to the dismantling phase (Striegel, G. 2000). In the specific case of the Icelandic Guest House, a rapid tool was used for the estimation of the carbon footprint of the project, related to the construction materials used (LinkCycle, 2016). In the following diagrams, the results of the calculation and the interpretation of the results are presented. For details and the general overview of the calculations, see the Annex 4, page 194.

	Emissions from each phase
Cradle to Gate	238949,98
Use Phase	10898,037
End of Life	360325,66
TOTAL	610173,677

• Ill. 203 Icelandic Guest House, Life Cycle Emissions, CO_2 tons per year

The final results of the LCA analysis are shown in the illustration number 203.
What it emerges, is that the total CO_2 emissions of the building, on an average life time of 10 years from construction to dismantling, correspond to 61 tons, which are mostly related to the Cradle to Gate phase (construction) and the End of Life phase (dismantling).
In fact, thanks to the good heating and electricity supply strategies applied, the CO_2 emissions impact related to the Use phase are relatively low. The illustration number 204 shows a comparison between the emission factors related to different kinds of energy supplies: it can be noted that for heating and electricity supply, the average range of emission factors related to geothermal power plants in Iceland is only of 34 g/kWh, compared to other fossil fuel based sources as gas, oil and coal which instead



• Ill. 204 Emission factors related to fossil fuel based power plants and geothermal power plants

rech over 1000 g/kWh (pangea.stanford.edu). Thus, the exploitation of the geothermal power within the project, is in fact responsible in terms of CO_2 emissions savings.

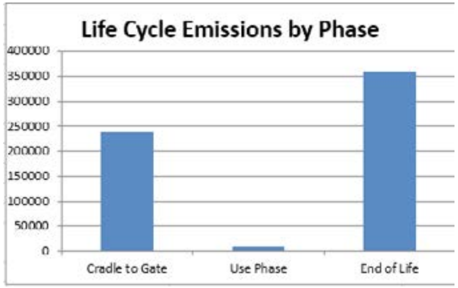
On the other hand, another important aspect that emerge from the analysis is that the geographic isolation of Iceland, and in particular of the project site, makes the procurement of materials an inalienable criticality in reducing the CO_2 emissions due to the transportation of the materials themselves.
In fact, from the calculations related to the construction phase, (See Annex 4, page 194), it can be noted that all the materials used, with the exception of the basaltic rock, come from a minimum of 90 km of distance from the site, up to 1522 km. This means that, despite the design choices, the only materials transportation by truck and by plane, is responsible for more than two times the emissions that the whole building is responsible for, during its phase of usage.
This criticality is inalienable to any project carried out in desolate areas such as the site of the Icelandic Guest House, as the companies able to supply the building material are few and far. Therefore, in an attempt to minimize the carbon footprint of the building, the choice of materials to be used in the project is also considering the actual availability of the materials closest to the area

Corrugated Iron	*FerroZink Company,* Hafnarfjordur, IS	*96 km*
Driftwood	Stršndum shore, IS	*90 km*
Sheep Wool	*Istex Company*, Reykjavik, A4 - Kringlan, IS	*475 km*
Glass	*Carlson & Company Ltd.*, Dublin, IR	*1522 km*
Wooden Frames	*Sogin Ehf Company,* Smiðjuvegi 16, Reykjavik, IS	*478 km*
Concrete	*HeidelbergCement Company*, Akranes, IS	*445 km*
Basaltic Rock	On-site	*0 km*
Timber	*BYKO Company*, Skemmuvegi 2a, 200 K—pavogi, IS	*479 km*
Concrete Foundations	*HeidelbergCement Company*, Akranes, IS	*445 km*
Landfill Location	*Gestastofa,* Hraunvegur 8, 660 Mývatn, IS	*5 km*

• Ill. 205 Materials retailers and landfill location, distance from the site

in relation to their specific emission factors. In the table number 205, the materials retailers chosen for the project and the relative distances of their locations from the site area are listed.
Finally, looking at the results related to the dismantling phase, it emerges that this is the most critical moment of the building's life cycle in terms of carbon footprint estimation (See ill. 206).
The reason is linked to a high emission factor related to the dismantling of construction materials in landfills, which might in fact encourage to the practice of reuse, thus reinforcing the reason why the cabins are designed to be disassembled. In the calculations, the worst case scenario was analysed, where all the materials are moved to the closest landfill, including the cabins, which are instead meant to be moved and reused.

As a comparison, in the illustration 207, it is shown the average fossil emissions (kgCO2) arising from running a single room during the user stay in the hotel industry (hotelfootprints.org). It is clear that the benchmark with which to evaluate the CO2 emissions of the Icelandic Guest House, defines the project as absolutely performing. In fact it emerges that the average CO2 emissions worldwide related to the only running of a single room is 12285 kgCO2, while the entire life cycle of the Icelandic Guest House produces 610 tons in total, like saying that about 50 visitors staying in an average hotel room are inducing the same amount of CO2 emissions that the Icelandic Guest



• Ill. 206 Life Cycle Emission by phase

Germany	6628 kgCO2
USA	6378 kgCO2
England	6774 kgCO2
Saudi Arabia	51072 kgCO2
Canada	3661 kgCO2
Mexico	11401 kgCO2
Russia	10398 kgCO2
France	1967 kgCO2

• Ill. 207 Average KgCO2 emissions related to one room running for a single stay in the hotel industry

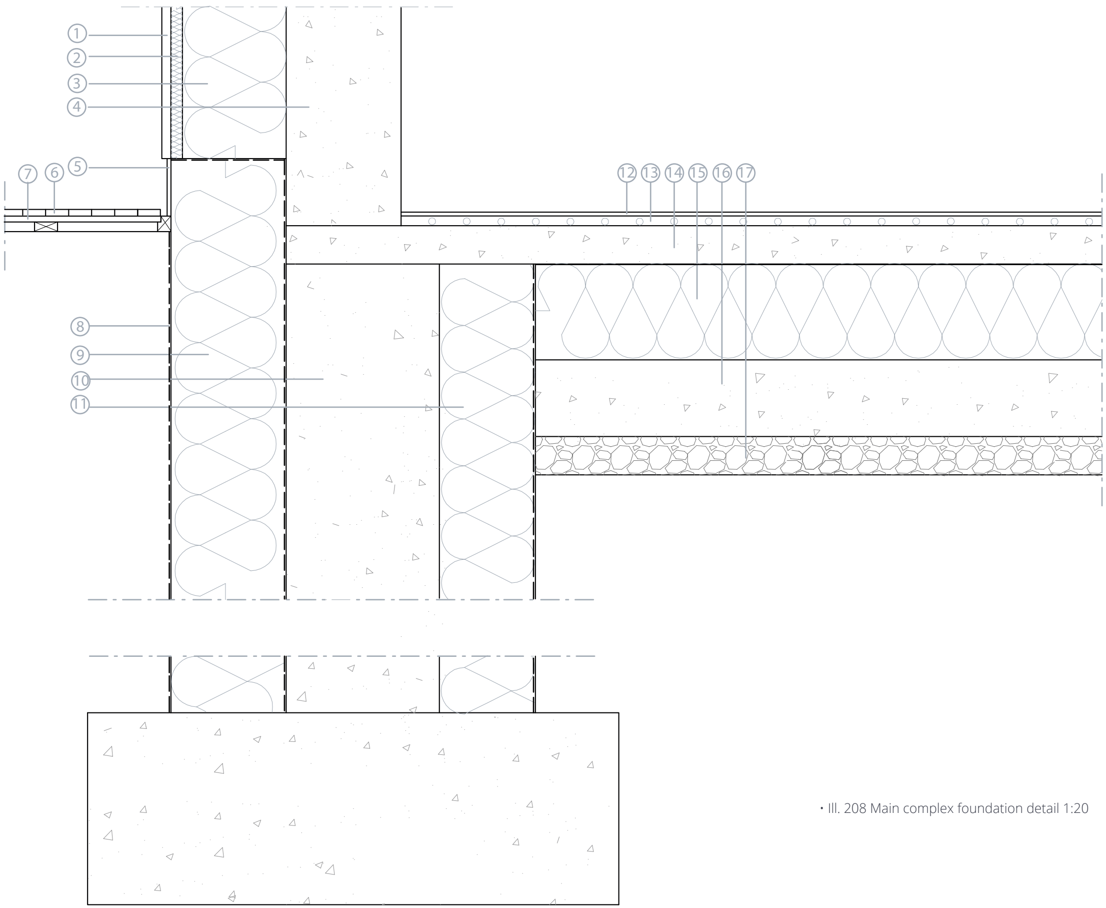
House is producing in 10 years. Unfortunately, the average data for Icelandic hotel industry were not available.

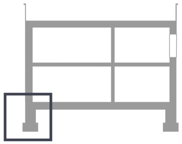
Conclusions

With the aim of keeping under control the CO2 emissions through a new construction process in Iceland, it is advisable to exploit geothermal energy resources, in order to balance the extensive use of fuel necessary for the transportation of the materials by truck or plane. Furthermore, the choice of construction materials themselves influences the amount of CO2 emissions related to the type of processing to produce them, so the use of wood and concrete is optimal for this purpose (See emission factors related to materials in Annex 4, page 194).

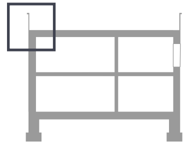
Details

1 Corrugated in iron external cladding: 20 mm
2 Sheep wool insulation: 30 mm
3 Sheep wool insulation: 270 mm
4 Concrete load bearing wall: 300 mm
5 Plaster external finishes: 10 mm
6 Driftwood external flooring: 30 mm
7 Driftwood rafter: 30 mm
8 Bituminous sheath
9 Sheep wool insulation: 300 mm
10 Concrete plinth: 400 mm
11 Sheep wool insulation: 250 mm
12 Concrete internal flooring: 10 mm
13 Radiant floor heating: 25 mm
14 Screed: 100 mm
15 Sheep wool insulation: 250 mm
16 Concrete load bearing subbase: 200 mm
17 Granular capillary break: 100 mm





• Ill. 208 Main complex foundation detail 1:20



1 Corrugated iron external cladding: 20 mm

2 Sheep wool insulation: 30 mm

3 Plaster parapet: 44 mm

4 Gutter

5 Sheep wool insulation: 270mm

6 Concrete load bearing wall: 300 mm

7 Soil with plantings

8 Filter felts layer

9 Protective dranage storage layer: 50 mm

10 Waterproof membrane

11 Sheep wool insulation: 400 mm

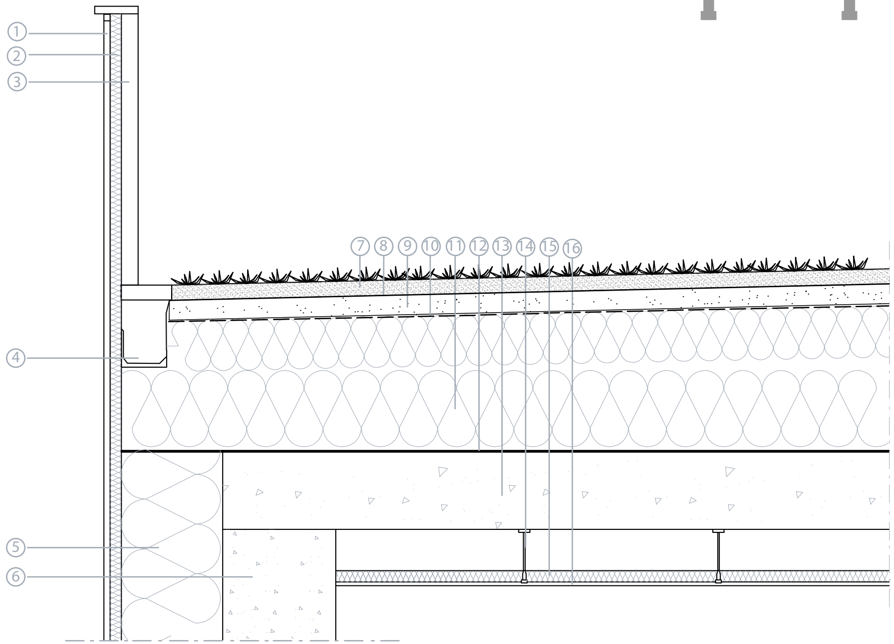
12 Vapor barrier

13 Concrete load bearing layer: 200 mm

14 Suspended ceiling gap: 100 mm

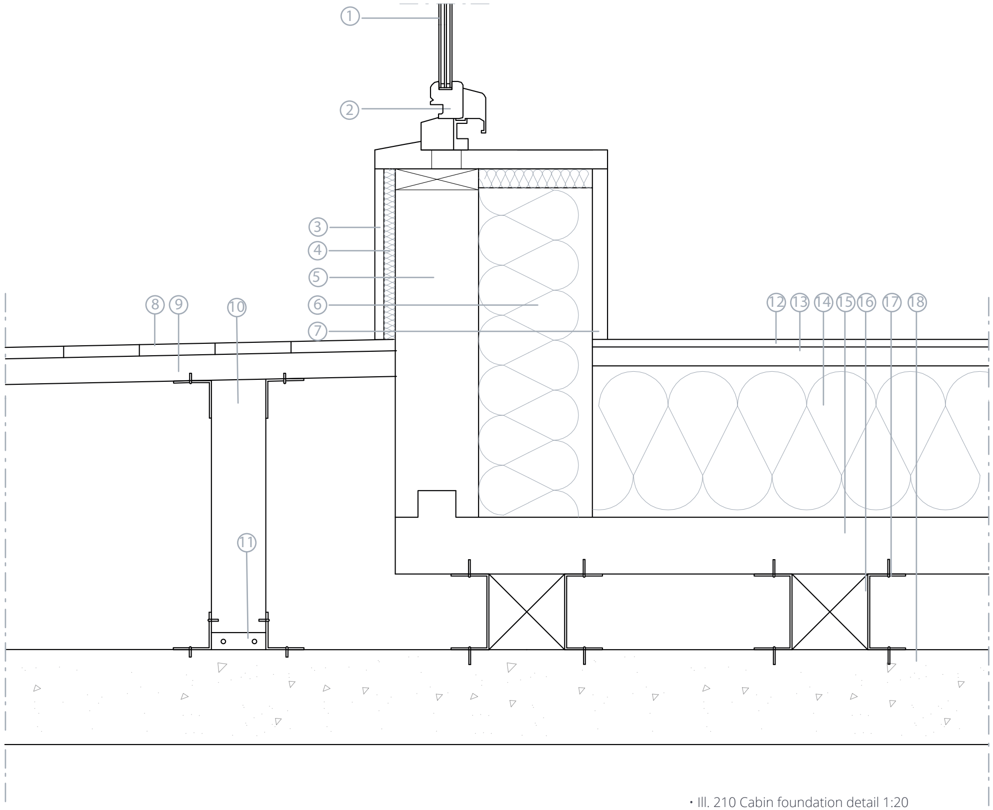
15 Sheep wool insulation: 30 mm

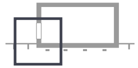
16 Gypsum ceiling finishes: 10 mm



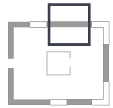
• Ill. 209 Main complex green roof detail 1:20

1 Triple glazed window
2 Wood frame
3 Corrugated iron external cladding: 20 mm
4 Sheep wool insulation: 30 mm
5 Timber load structure: 220 mm
6 Sheep wool insulation: 300 mm
7 Internal driftwood wall finishes: 40 mm
8 Driftwood external flooring: 30 mm, with a gradient of 1:20
9 Driftwood rafter: 100 mm
10 Timber bearing pole
11 Steel joint
12 Driftwood internal floor finishes: 20 mm
13 Radiant floor heating : 50 mm
14 Sheep wool insulation: 400 mm
15 Timber load bearing base: 150 mm
16 Timber base beam: 200 mm
17 Steel joint
18 Concrete beam: 250 mm





• Ill. 210 Cabin foundation detail 1:20



1 Corrugated iron external cladding: 20 mm

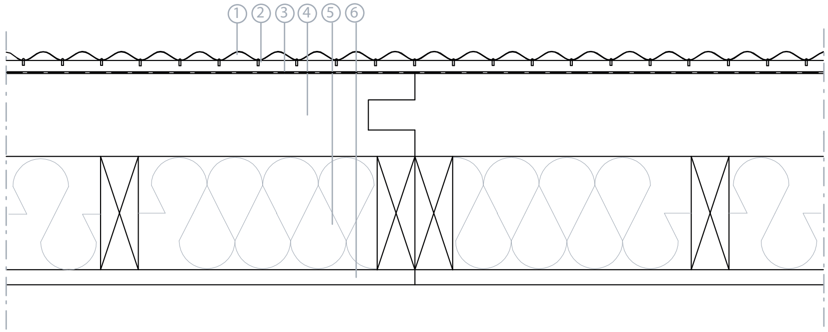
2 Timber sheet: 30 mm

3 Bituminous sheath

4 Timber structure: 300 mm

5 Sheep wool insulation: 300 mm

6 Internal driftwood wall finishes: 40 mm



• Ill. 211 Cabin plan detail - Modules connection 1:20

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06 Epilogu

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06.01 Conclusions

06.02 Perspectives

06.01: Conclusions

The main challenge of this project, has been from the very beginning to design a sustainable architectural complex, that was proved for being environmentally responsible and from where to admire the beauty of the Northern Lights. A special attention had also to be paid in applying a set of technical strategies and architectural choices able to reflect the identity of the place.

As it emerges from the Vision of the project (See page 88), the design aimed to build a new pole of functions, standing out of its natural context, able not only to attract the Guest House visitors, but the locals as well.

The intense analysis phase that preceded the design of the project, has represented in itself a fundamental knowledge moment to understand the potential and the difficulties of the area, as well as the cultural and historical background that influences the Icelandic architectural identity. In this sense, the quality of this work must be recognized since from the meticulous research of information and theoretical foundation that directed the design choices.

The main objectives and achievements that the project reached are described below, following the design criteria that were set in the beginning of the design process. (See page 90).

Identity of the area

The Icelandic Guest House is designed in continuity with the local architectural practice: a very compact but widespread building, which cope with the harsh climate and that stands out from the natural context in which it is immersed. This is complemented by the design of the cabins, which recall the appearence of the traditional Icelandic domestic architecture: small and scattered in the natural context. The choice of the construction materials used, such as the corrugated iron, concrete, driftwood, and basaltic rock, represent a contemporary interpretation of elements which are already present in the architectural local identity. These elements are visually inserted in the context in a contemporary but respectful way, which respects the prevailing and existent chromaticity.

Respect the landscape

The project is inserted within the natural context as a clearly recognizable object, which instead of trying to imitate the organic geometries of nature from the outside, it emphasizes and frame them by the use of a very sharp geometry, which brings inside a light gesture of organicity. In the approach to outdoor spaces, any kind of alien vegetation species is added, and even in the interior spaces, as in the greenhouse, the local vegetation is put on display and dignified.

Northern Lights view

The orientation of the bedrooms is designed to face the North exposure from where to see the Northern Lights. Despite this requirement has set initial challenges in achieving the indoor thermal comfort, it has been pursued to the benefit of the guest house visitors experience.

Ambience
The differentiation of the experienced ambience is reflected in different design choices depending on the intended use of the space: among others, the design of the convivial spaces benefits from generous sizes and excellent interior lighting to foster the conviviality, while the connective spaces within the main complex are accompanied by the organic gesture of the rock wall, adding an architectural quality to a purely connective environment. The cabins benefit from the indirect lighting coming from the skylight, which emphasizes the intimate character of the space.

Disassembly and Flexibility
The design of the cabins respects the criterion of ease of disassembly and removal, in accordance with the competition brief requirements and to the DGNB criteria ECO 2.1 and TEC 1.6. The goal is achieved through the use of a lightweight modular structure with no deep foundations in the ground, and through the design of customized multi-functional furnitures.

Sustainability connected to local potentials and reality
The use of geothermal power, exploits the local wealth in terms of a responsible energy supply. To further prove the appropriate use of this source, the LCA calculation shows its beneficial impact on the environment, specifically in terms of CO2 emissions, that are extremely low when related to the use phase of the project.

Indoor environmental conditions
The atmospheric, thermal and visual comfort standards are all met according to the DS/EN 1525 (Danish standards), both in the cabins and in the main complex, ensuring a good internal atmospheric quality of the spaces.

06.02: Perspectives

The design of an architectural project can be approached in many different ways, resulting in multiple aesthetic possibilities. The research for a balance between the requirements of the competition brief, the personal design intentions and the academic requirements, within a very restrict time framework, asks for a compromise that, in the eventuality of a future deepening of the project, could be different.

In light of these considerations, it is recognized that the project, while satisfying the intentions of the designers and most of the DGNB criteria set in the initial phase of the design process, could further investigate the shaping of the volumes for the main complex, through an articulation of the external volumes that, while remaining compact, could be more unscrupulous.

Moreover, the harsh weather conditions of Iceland have imposed the use of large quantities of materials for the composition of the construction layers: in the perspective of future investigations, the challenge of reducing the amount of material used, represents an interesting element.

Finally, since the project includes the design of a geothermal indoor swimming pool pertaining the guest house services, it would have been relevant to deep into this aspect of the project as well, exploiting its ambience potential to the thematic research of this Master thesis.

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07 Refere

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Illustrations

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08 Annexe

es

08.01: Annex 1 / Interviews

During our journey in Iceland, we got the opportunity to make a site inspection and to gather information regarding the project theme and ambience. An important part of the experience was the possibility to talk with some locals who told us about some relevant aspects for the design of the Icelandic Guest House. In the following pages, the interviews that influenced our perception of the place and that contributed to increase our awareness of the site, are reported.

Helgi

Helgi is a man living in the countryside of the North-West Region. When travelling around the area, we got interested in his house because we could see that within the property there were two greenhouses, a barn for horses and some fumes coming out of the ground. This last element, suggested the potential presence of on-site hot water steams. Once we approached the place we had the confirmation that those facilities were pertaining to the single family house we were looking at, and so we decided to ask for more information.

Did you use any kind of local construction materials for building your house? If yes, which ones?
Unfortunately not very much. There is really few local construction materials available in Iceland. I built the house on my own when I got married and I almost bought everything from abroad, apart from the insulation: I used to have sheeps and I made the insulation out of the sheep wool. There was an old tradition in the past about it. The corrugated iron I have all over the walls perimeter comes from Bulgaria, because it is the cheapest place where to import it from, and it is very good to face the Icelandic weather.

• Ill. 212 Portrait of Hengi

Which kinds of vegetables do you grow in your greenhouses and why?
I mostly grow cucumbers and I run a business with my wife selling them all over the country; in the past I was used to grow other few kinds of vegetables but it is easier and more efficient to specialize in the production of only one product.

Which kind of energy do you use to heat up the greenhouses?
I am using geothermal power both to heat up my house and to provide energy to the greenhouses.

Why do you have horses within your factory?
Most horse farm are purely in it for breeding horses for competition and quality riding horses so for entertainment. There are few farms that keep horses for blood/medical use.

Alex

Alex is the chef working for the Vogafjos guest house.
We decided to interview him for some information, because the business is very close from our site area, and thus the mean features of the place concerning atmosphere, climatic conditions and energy supply are the same.

How many people do you usually serve in an average working day?
This is an isolated place, so a part from the guests who are coming every day for breakfast and dinner, I have usually around 20 people for the daytime service, who drop by for fast lunches to take a break from their driving, and a bit more of people for dinner. The capacity of the restaurant is anyway bigger because it happens that the locals living in Reykjahlið are sometimes coming for family celebrations.

Is this area a good spot to catch the Northern Lights?
Yes, as far as I know, is one of the best spots in Iceland. All the North of Iceland is in general most likely interested by the phenomenon, compared to the south of the island. Of course you can not expect to catch it every night in winter, because the possibility varys a lot according to the sky conditions of each day.

Do you think is it a good idea to make guests bedroom facing North so to increase the chances of catching the Northern Lights from indoor?
Yes it is, both because the Aurora is usually visible on the North direction and especially because it is cold outside and it can takes a lot of time waiting before being able to catch the Northern Lights. You should also consider that the phenomenon sometimes can lasts for several minutes and it is nice to be in a warm place to enjoy it.

• Ill. 213 Portrait of Alex

Do you know where the drinking water supply of the guest house comes from?
We have an outdoor rainwater collector and a depurator to make it safely drinkable.

Do you know where does the hot water supply for the indoor heating and the electricity of the guest house comes from?
I know we use geothermal power for both indoor heating and electricity supply. The Krafla power plant provides the electricity and the Bjarnarflag power plant supplys the hot water which flows in our radiators.

Eyrìn

Eyrìn and Steindor are mother and son, owners of a family-run guest house business that we visited in the South-East Region of the island. The business is not running yet, and it still is in the phase of construction; this situation made the visit extremely interesting from a technical point of view, because we have had the opportunity to look at some construction details which were not completed yet.

Which kind of structure did you use for the guests cabins and why?
The cabins are made of wood and they are prefabricated by a construction company based in Iceland, that is called Landshùs. We bought the cabins and transported here by track, because all of them can be disassembled and divided in several modules, so it is possible to regularly transport them on the road. This is the main reason why we decided to buy from that construction company.

Is there any other reason why to use movable and modular structures for your cabins?
This is the first time we are running a business like this and we can not be sure if it will be successful, so the fact of using movable cabins allow us to eventually move the business in another place if it does not work out well here.

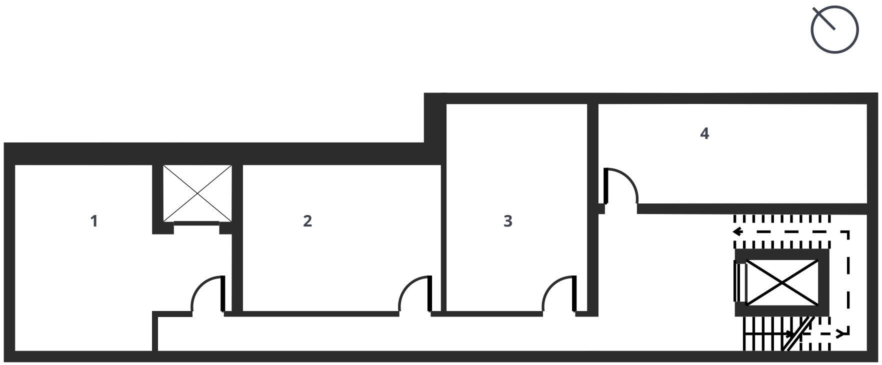
How does the foundations system of the cabins works?
There are no foundations digged into the soil. We have only raised the cabins from the ground, to make sure that the wood would not rot, if in contact with the ground.

• Ill. 214 Portrait of Eyrìn

08.02: Annex 2 / Technical room plan

In the basement, there are the staff service functions such as the changing room, the garbage room, and the the technical spaces necessary for the heating and ventilation systems.
The sizing of the technical rooms is calculated based on the capacity of the Heat Pump boilers and of the centralized ventilation system, for a total area of about 30m2 for each of them.

1 Garbage room
2 Heat pump techincal room
3 Ventilation, Utility room
4 Staff changing room



• Ill. 215 Technical Floor 1:200

08.03: Annex 3 / Energy Consumption

Energy frame cabins:

The illustrations from number 216 to 219 show the process that lead to the final energy consumption of the Icelandic Guest House.
The project rely on the energy supply coming from a brine to water Heat Pump, and from the electricity supply coming from Krafla geothermal power plant that is 3 kilometers away from the site area.
Below, the amount of kWh/year of electricity required from the cabins, to cover their energy consumption, is calculated.
The calculations below, are taken from the 8th lecture of the ZEB course implemented at Aalborg University in 2017, "PVydelse - excell ark".

Total Electric Consumption Calculation:

Contributions to energy requirements:

Heat = 8,4 kWh/m2 year x 0,6 = 5,04 kWh/m2 year
Electricity for operation of the Building = 10,9 kWh/m2 year x 1,8 = 19,62 kWh/m2 year

Total Energy Consumption

5,05 kWh/m2 year + 19,62 kWh/m2 year = 24,67 kWh/m2 year

Remove of the Primary Energy Factor, since the electricity comes from renewable sources:

21,67 kWh/m2 year : 1,8 =13,70 kWh/m2 year

Final Total Energy Consumption that need to be covered by Electricity:

13,70 kWh/m2 year x 1450 m2 = 19873,05 kWh/year

Thus, the electricity need of the Cabins is assumed to be 19873,05 kWh/year, supplied by Krafla geothermal power plant. In light of the fact that Be18 settings cannot take into account geothermal power plants as electricity supply source, it is assumed that the electricity supply is coming from PVs, in order to make the calculations possible for the software. Below, are reported the calculation related to the Peak Power that will be set up in the Be18 calculations:

Peak Power Calculation:

IE = Installed Effect
SolCover = Solar Cover of Energy
A = Total Solar Panels Area = 324 m2 (east area of the cabins roof)
Rs = System Factor (Integrated) = 0,75
Wp = Peak Power
H = Solar Radiation (for Iceland) = 1000 kWh/m2 (openei.org)
r = Solar Panel Efficiency = 80 %
Performance Ratio = 0,75

IE = SolCover / Rs x H —› 7 19873,05 kWh/year = IE x 0,75 x 1000 kWh/m2 —› IE = 26,49 kW peak

Wp = 26,49 kW peak/ 324 m2 = 0,08 kW/m2

In light of these calculations, the energy consumption required from the whole complex, can be simulated in Be18 through the implementation of 324 m2 of PVs, corresponding to the east facing slope of the cabins roof, with a Performance Ratio of 0,75, 0,08 peak power and 80% efficiency, with an inclination of 45 degrees.

Key numbers, kWh/m² year

Renovation class 2

Without supplement	Supplement for special conditions	Total energy frame
114,9	0,0	114,9
Total energy requirement		46,2

Renovation class 1

Without supplement	Supplement for special conditions	Total energy frame
55,0	0,0	55,0
Total energy requirement		46,2

Energy frame BR 2015 / 2018

Without supplement	Supplement for special conditions	Total energy frame
31,5	0,0	31,5
Total energy requirement		46,2

Energy frame Buildings 2020

Without supplement	Supplement for special conditions	Total energy frame
20,0	0,0	20,0
Total energy requirement		33,3

Contribution to energy requirement		Net requirement	
Heat	0,0	Room heating	15,8
El. for operation of bulding	18,5	Domestic hot water	0,0
Excessive in rooms	0,0	Cooling	0,0

Selected electricity requirements		Heat loss from installations	
Lighting	80,9	Room heating	0,0
Heating of rooms	15,8	Domestic hot water	0,0
Heating of DHW	0,0		
Heat pump	0,0	**Output from special sources**	
Ventilators	2,6	Solar heat	0,0
Pumps	0,0	Heat pump	0,0
Cooling	0,0	Solar cells	0,0
Total el. consumption	49,1	Wind mills	0,0

• Ill. 216 Cabins with only passive strategies applied

Key numbers, kWh/m² year

Renovation class 2

Without supplement	Supplement for special conditions	Total energy frame
112,2	0,0	112,2
Total energy requirement		27,4

Renovation class 1

Without supplement	Supplement for special conditions	Total energy frame
53,6	0,0	53,6
Total energy requirement		27,4

Energy frame BR 2015 / 2018

Without supplement	Supplement for special conditions	Total energy frame
30,7	0,0	30,7
Total energy requirement		27,4

Energy frame Buildings 2020

Without supplement	Supplement for special conditions	Total energy frame
20,0	0,0	20,0
Total energy requirement		19,7

Contribution to energy requirement		Net requirement	
Heat	0,0	Room heating	8,4
El. for operation of bulding	10,9	Domestic hot water	0,0
Excessive in rooms	0,0	Cooling	0,0

Selected electricity requirements		Heat loss from installations	
Lighting	94,3	Room heating	0,0
Heating of rooms	8,4	Domestic hot water	0,0
Heating of DHW	0,0		
Heat pump	0,0	**Output from special sources**	
Ventilators	2,5	Solar heat	0,0
Pumps	0,0	Heat pump	0,0
Cooling	0,0	Solar cells	0,0
Total el. consumption	41,6	Wind mills	0,0

• Ill. 217 Whole project with only passive strategies applied

Key numbers, kWh/m² year

Renovation class 2

Without supplement	Supplement for special conditions	Total energy frame
112,2	0,0	112,2
Total energy requirement		9,9

Renovation class 1

Without supplement	Supplement for special conditions	Total energy frame
53,6	0,0	53,6
Total energy requirement		9,9

Energy frame BR 2015 / 2018

Without supplement	Supplement for special conditions	Total energy frame
30,7	0,0	30,7
Total energy requirement		9,9

Energy frame Buildings 2020

Without supplement	Supplement for special conditions	Total energy frame
20,0	0,0	20,0
Total energy requirement		7,1

Contribution to energy requirement

Heat	0,0
El. for operation of bulding	4,0
Excessive in rooms	0,0

Net requirement

Room heating	8,4
Domestic hot water	0,0
Cooling	0,0

Selected electricity requirements

Lighting	94,3
Heating of rooms	0,0
Heating of DHW	0,0
Heat pump	1,5
Ventilators	2,5
Pumps	0,0
Cooling	0,0
Total el. consumption	34,6

Heat loss from installations

Room heating	0,0
Domestic hot water	0,0

Output from special sources

Solar heat	0,0
Heat pump	8,4
Solar cells	0,0
Wind mills	0,0

• Ill. 218 Whole project with heat pump applied

Key numbers, kWh/m² year

Renovation class 2

Without supplement	Supplement for special conditions	Total energy frame
112,2	0,0	112,2
Total energy requirement		-6,9

Renovation class 1

Without supplement	Supplement for special conditions	Total energy frame
53,6	0,0	53,6
Total energy requirement		-6,9

Energy frame BR 2015 / 2018

Without supplement	Supplement for special conditions	Total energy frame
30,7	0,0	30,7
Total energy requirement		-6,9

Energy frame Buildings 2020

Without supplement	Supplement for special conditions	Total energy frame
20,0	0,0	20,0
Total energy requirement		-4,9

Contribution to energy requirement

Heat	0,0
El. for operation of bulding	-2,7
Excessive in rooms	0,0

Net requirement

Room heating	8,4
Domestic hot water	0,0
Cooling	0,0

Selected electricity requirements

Lighting	94,3
Heating of rooms	0,0
Heating of DHW	0,0
Heat pump	1,5
Ventilators	2,5
Pumps	0,0
Cooling	0,0
Total el. consumption	34,6

Heat loss from installations

Room heating	0,0
Domestic hot water	0,0

Output from special sources

Solar heat	0,0
Heat pump	8,4
Solar cells	6,7
Wind mills	0,0

• Ill. 219 Whole project with heat pump and electricity supply applied

U VALUES CABINS

External Walls:

1/ (0,13 + 0,006/59 + 0,33/0,038 + 0,25/0,12 +0,014/0,12 + 0,004) =
= 1/ (0,13 + 1,01 + 8,68 + 2,08 + 0,11 + 0,04) = 1/ 12,05 = 0,08 W(m2K)

Floor:

1/ (0,13 + 0,09/0,12 + 0,4/0,038 + 0,02/0,33 + 0,04) =
= 1/ (0,13 + 0,75 + 10,52 + 0,06 + 0,04) = 1/ 11,5 = 0,08 W(m2K)

Roof:

1/ (0,13 + 0,006/59 + 0,02/0,33 + 0,078/0,12 + 0,02/0,1 + 0,33/0,038 + 0,04) =
= 1/ 0,13 + 1,01 + 0,06 + 0,65 + 0,2 + 8,68 + 0,04 = 1/ 10,77 = 0,09 W(m2K)

U VALUES MAIN COMPLEX

External Walls:

1/ (0,13 + 0,006/59 + 0,3/0,038 + 0,3/1,6 + 0,04) = 1/ 0,13 + 1,01 + 7,89 + 0,18 + 0,04 = 1/ 9,25 = 0,10 W(m2K)

Floors:

1/ (0,13 + 0,05/1,6 + 0,1/0,038 + 0,2/1,6 + 0,04/0,038 + 0,01/0,32 + 0,04) = 1/ 0,13 + 0,03 + 2,63 + 0,125 + 1,05 + 0,03 + 0,04 = 1/ 4,035 = 0,2 W(m2K)

Green Roof:

1/ (0,13 + 0,04/1,4 + 0,04/0,17 + 0,4/0,038 + 0,01/0,33 + 0,2/1,6 + 0,04/0,038 + 0,01/0,32 + 0,04) = 1/ 0,13 + 0,02 + 0,23 + 10,52 + 0,03 + 0,125 + 1,05 + 0,03 + 0,04 = 1/12,175 = 0,08 W(m2K)

08.04: Annex 4 / LCA

The reference values used for the calculations are listed in the following:

- Geothermal emissions factor: (pangea.stanford.edu)
- Truck fuel emission: (key2green.dk)
- Aviation fuel emission: (factorunece.org)
- Emission factors related to construction materials: (winnipeg.ca)
- Dismantling emissions factors: (ghgprotocol.org)

The tool used for this simplified LCA calculation is: LinkCycle Quick LCA Tool, made by Alex Loijos and uploaded online on 2016. (Contact support available at http://www.linkcycle.com).

Cradle to Gate Inventory

Material	Quantity (in kg)	Emission Fac	Incoming Transport (in k	Transport Emissions (per kg*km)	Total Emissions
corrugated iron	9572,5	1,91	96	2,3	18504,275
driftwood	10120	0,3	90	2,3	3243
sheep wool	8156,7	0,15	475	2,3	2316,005
glass	52350	0,73	1522	3	42781,5
wooden window frames	2800	0,3	478	2,3	1939,4
concrete	896998	0,15	445	2,3	135573,2
basaltic rock- tuff	14835	0	0	2,3	0
parquet flooring	3250	0,3	478	2,3	2074,4
timber	29760	0,3	479	2,3	10029,7
foundations	143100	0,15	445	2,3	22488,5
					238949,98

• Ill. 220 Cradle to Grave phase

Use Phase Inventory

Assumptions (i.e. Operating 6 hours per day, for 5 years)	Electricity usage (kWh)	Emission Factor (CO2 per kWh)	Total Emissions
(10h per day x 7 days per week x 10 years) 8736 - electricity	19873,05	0,34	6756,837
(10h per day x 7 days per week x 10 years) 8736 - heating	12180	0,34	4141,2
			10898,037

• Ill. 221 Use Phase Inventory

End of Life Inventory

Material	Quantity (in kg)	Emission Fac	Outgoing Transport (km)	Transport Emissions (kg*km)	Total Emissions
corrugated iron	9572,5	0,3	5	2,3	2883,25
driftwood	39880	0,3	5	2,3	11975,5
sheep wool	8156,7	0,3	5	2,3	2458,51
glass	52350	0,3	5	2,3	15716,5
wooden window frames	2800	0,3	5	2,3	851,5
concrete	896998	0,3	5	2,3	269110,9
basaltic rock - tuff	14835	0,3	5	2,3	4462
parquet flooring	3250	0,3	5	2,3	986,5
timber	29760	0,3	5	2,3	8939,5
foundations	143100	0,3	5	2,3	42941,5
					0
					360325,66

• Ill. 222 End of Life Inventory

	Emissions from each phase
Cradle to Gate	238949,98
Use Phase	10898,037
End of Life	360325,66
TOTAL	610173,677

• Ill. 223 Total

08.05: Annex 5 / Ventilation

Air Change Rate, Sensory Calculation per 4 people cabin:

C = Co + 10 x q / Vl

Where:
Vl = Air Flow Supply
N = Sensory Air Change Rate
C = Experienced Air Quality = max. discomfort = 1,4 dp
Co = Experienced Air Quality Outdoor = 0,005 dp
q = Pollution Load (people + building materials and furnitures) = 1 olf x 4 people + 0,2 olf/m2 x 87 m2 = 21, 4 olf
Average Room Height = 4 m
Vroom = 348 m2

Calculation:
Vl = (0,005 dp + 10 x 21,4 olf) / 1,4 dp = 152,89 l/s
n = (Vl x 3600 sec) / (1000 l x Vroom) = 550 404 / 348 000 = 1,45 h-1

The assumptions made for this calculations are taken from the Danish Standards DS/EN 15251 and the Grundlæggende klimateknik og bygningsfysik guide.

Conversion l/s in m3/h for sizing the decentralized mechanical ventilation system:

152,89 l/s / 3,6 m3/h = 42,46 m3/h

Air Change Rate, Sensory Calculation in the main complex:

C = Co + 10 x q / Vl

Where:
Vl = Air Flow Supply
N = Sensory Air Change Rate
C = Experienced Air Quality = max. discomfort = 1,4 dp
Co = Experienced Air Quality Outdoor = 0,005 dp
q = Pollution Load (people + building materials and furnitures) = 1 olf x 20 people + 0,2 olf/m2 x 871 m2 = 194, 2 olf
Average Room Height = 3 m
Vroom = 2613 m2

Calculation:
Vl = (0,005 dp + 10 x 194,2 olf) / 1,4 dp = 1387,14 l/s
n = (Vl x 3600 sec) / (1000 l x Vroom) = 4 993 704 / 2 613 000 = 1,91 h-1

Conversion l/s in m3/h for sizing the centralized mechanical ventilation system:

1387,14 l/s / 3,6 m3/h = 385,31 m3/h

Air Change Rate, Sensory Calculation in the dining room, common room and restaurant:

C = Co + 10 x q / Vl

Where:
Vl = Air Flow Supply
N = Sensory Air Change Rate
C = Experienced Air Quality = max. discomfort = 1,4 dp
Co = Experienced Air Quality Outdoor = 0,005 dp
q = Pollution Load (people + building materials and furnitures) = 1 olf x 40 people + 0,2 olf/m2 x 267 m2 = 93,4 olf
Average Room Height = 3 m
Vroom = 801 m2

Calculation:
Vl = (0,005 dp + 10 x 93,4 olf) / 1,4 dp = 667,14 l/s
n = (Vl x 3600 sec) / (1000 l x Vroom) = 2 401 704 / 801 000 = 2,99 h-1

Conversion l/s in m3/h for sizing the centralized mechanical ventilation system:

667,14 l/s / 3,6 m3/h = 185,31 m3/h

Pressure Coefficient		Windfactor	0,57	Pwind	7,3 pa	
Windward	0,06	Vmeteo	6 m/s	Pmin	2,8 pa	
Leeward	-0,38	Vref	3,42 m/s	Pmax	0,4 pa	
roof	-0,38					
Location of neutral plan, I	2,3 m		Buildingvol.	m3		
Outdoor temperature	12 C		Volume	m3/section/floor		
Zone temperature	22 C					
Discharge coefficient	0,7		Internal pressure,	pa	0,22	0,22
Air density	1,25 kg/m3					

	Area m2	Eff. Area m2	Height m	Thermal Buoyancy pa	AFR (thermal) m3/s	Pres Coefficient	Wind pressure pa	AFR Wind) m3/s	Wind pressure pa	AFR total m3/s
1. floor	18	17,250	2,1	0,068	5,70	0,06	0,220	10,226	0,220	11,707
Roof	5,75	4,670	4,5	-0,930	-5,70	-0,38	-2,997	-10,23	-2,997	-11,706
				Massebalance	0,00		Massebalance	0,00		0,00

• Ill. 224 Cabin Neutral Plane Calculation

Pressure Coefficient		Windfactor	0,57	Pwind	7,3 pa	
Windward	0,06	Vmeteo	6 m/s	Pmin	-2,8 pa	
Leeward	-0,38	Vref	3,42 m/s	Pmax	0,4 pa	
roof	-0,38					
Location of neutral plan, I	3,9 m		Buildingvol.	m3		
Outdoor temperature	12 C		Volume	m3/section/floor		
Zone temperature	22 C					
Discharge coefficient	0,7		Internal pressure,	pa	-1,16	-1,16
Air density	1,25 kg/m3					

	Area m2	Eff. Area m2	Height m	Thermal Buoyancy pa	AFR (thermal) m3/s	Pres Coefficient	Wind pressure pa	AFR Wind) m3/s	Wind pressure pa	AFR total m3/s
1. floor	28,77	24,470	2,1	0,733	26,50	0,06	1,596	39,100	1,596	47,232
2nd. Floor	28,51	24,280	5,65	-0,744	-26,50	-0,38	-1,621	-39,10	-1,621	-47,232
				Massebalance	0,00		Massebalance	0,00		0,00

• Ill. 225 Main Complex Neutral Plane Calculation