TITLE PAGE

Project title:	ILLU NAASULIK [house with plants] - Growing families
Main theme:	Building in an arctic climate
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Also I would like to thank Jan Trysøe and Vibeke Sieborg from The Greenlandic House in Aalborg for helping me to get an understanding of the cultural context.
The orphanage in Uummannaq receives a special thank for inviting me to stay with them and giving me an unforgetable experience.

SUMMARY

This project focuses on a study of building design in an arctic climate in West Greenland. The project aims for a design of a family counseling centre in Uummannaq that relates to the cultural, topological and climatic context.
This aim is reached through a thorough analysis of the site and building tradition together with investigations of arctic building technologies in general. Calculations on the energy consumption are integrated in the process from the early design phase till the final detailing.

TABLE OF CONTENTS

READERS GUIDANCE

The report is divided into two parts. First part consists of the program and a description of the process. The second part is a presentation of the project with plans, sections and facades as well as spatial and atmospheric illustrations.

Throughout the report references are used in accordance to the Harvard Method [Author, year] for books and articles and [WEB XX] for web pages. References for illustrations are indicated by continuing numbers [Ill. #]. The references can be found at the end of the report. If nothing else is indicated the illustration is of own production. Appendices are referred to by their respective [name].

INTRODUCTION

The project is a proposal for “Illu Naasulik”, a family counseling centre in Uummannaq, West Greenland.

Family centres are presently planned in many Greenlandic cities as a result of many social problems within families. The municipality of Quaasuitsup is planning a counseling centre like this, to be placed in Uummannaq.

The project is based on a study trip to Uumannaq and collaboration with Helga Nielsen, manager of Health and Prevention in North Greenland, municipality of Quaasuitsup.
Uummannaq is like many other towns in Greenland subject to many social problems caused by poverty and unemployment.
As it is a small and very isolated town (1281 people) there are no counseling offers for socially weak families. The problems therefore often continue from generation to generation. To be able to stop this cycle the ”Illu Naasulik” should reach out both for children, young people and adults.
The house should therefore offer a flexible space which can offer space for larger meetings or arrangements and smaller, more private consultations in one house.

The context (both cultural and climatic) is very different from the danish and to be able to make a design under such circumstances a thorough analysis must be made. Both within the field of building technologies and also a more empirical analysis. It is necessary to understand these people and the place to make a qualified and successful design.
The building tradition has over time adapted to the climatic situation and a sort of archetype of the Greenlandic house has developed.
The proposal for the “Inneruulat” is based on an analysis of this building type but also introduces new ways of thinking when it comes to building in the arctic.

In a future perspective this proposal hopefully opens up the discussion about a family centre in Uumannaq and about what it should bring to the town. Also it serves as an example for other proposed family counseling centres around Greenland.

MOTIVATION

The interest in this project springs from an interest in the current social problems evident in the Greenlandic society today. My perspective and interest within this field focuses on the architectural elements and how physical surroundings can have a positive (or negative) influence on the way people react or inhabit the space.

The choice of this assignment is also based on the very extreme context. Both the cultural, topological and climatic differences are very challenging and interesting. The extreme climatic condition makes it necessary to incorporate considerations about energy consumption from the very beginning of the process.

METHOD

The main method used in this project is the IDP, Integrated Design Process, where the technical, functional and aesthetic considerations are made throughout the process. This strategy contains four phases; Programme, Sketching, Synthesis and Presentation. All these phases affect and influence each other in a continuous process which through multiple loops and iterations ensures an integrated design. [Knudstrup, 2005]

The programme is based very much on empirical investigations and on study trips both to the site but also to other project of interest. Analysis of the building tradition and mapping of the specific site is the main part of the programme.
Also studies on arctic building technologies have been done to get a more general overview of how to build in such an extreme context.
The program sets up a list of design criterias that works as a toolbox for the further sketching phase.

The sketching phase is based on both an architectural and a technical approach. These two approaches are equally evaluated throughout the process. This means that both calculation programmes on energy consumption (IES VE - Virtual Environment and Be10) and hand drawings, SketchUp and physical models are used as tools to test out ideas and concepts. All ideas are evaluated from the design criterias set up in the program.

In the synthesis phase the building reach its final form, expression and detailing. Calculations on the energy consumption play an important role in this process.

The presentation phase consists of visualizations explaining the final building.

PROJECT BRIEF

The town of Uummannaq has received a lot of negative attention in the last couple of years in the Greenlandic medias.

The reason for this is that they within a period of 10-12 month had 6 suicides, 3 kills and 4 fishing accidents. Apart from this there was several attempt of suicide mainly amongst young people and a lot of violence which in one case lead to severe invalidation.
These problems are rooted in the current increase in unemployment and also the fact that the society is changing. The climate changes makes it more difficult for the fishers to go out sealing during winter, as the ice does not settle as long as earlier. This means that they are unemployed most of the winter months.

The town has a population of only 1281 inhabitants and with the isolated location, qualified labor within the social sector is very scarce.

This situation made the need for a family treatment centre evident. The municipality took contact to UNICEF and Foreningen for Grønlandske Børn (FGB), two very experienced organizations in this field of social work.

The following is a summary of the program for the family treatment centre, "Væksthuset". The program [Væksthuset] is written by the three collaborators in the project.

unicef

Foreningen Grønlandske Børn

Giving the children and their parents stimulating and appealing offers.

Professional development of the employees and volunteers

Upgrading of qualification of the employees in the child- and family care

Coordinate and improve the cooperation with the municipality

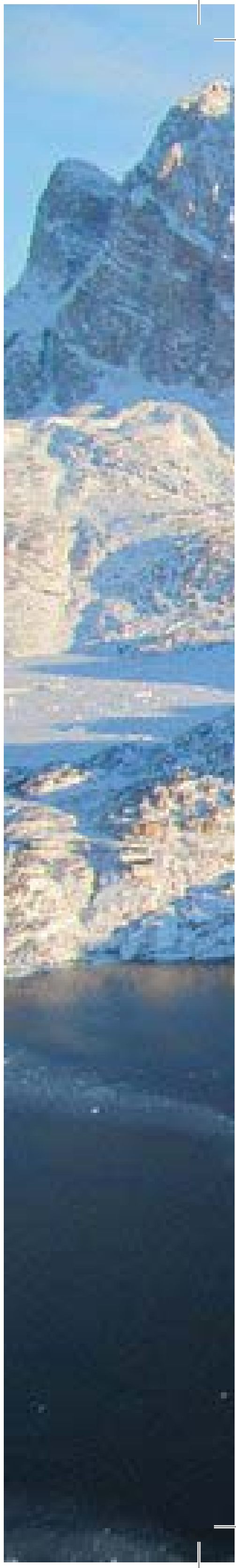
Early recognition of problems in the families

Early counseling and support for the families

The idea is to arrange activities for the families and educative offers for the employees.

[Program for Vækshuset]

PROGRAM



Uummannaq seen from south

GREENLAND - A HISTORICAL OVERVIEW

As an introduction to the project a short historical overview is nessecary. It clearly shows how the Greenlandic society as most other colonial states, has been subject to very large changes during the last 1000 years. [WEB1]

10.000 B.C.

Ill. 01 The Inuits immigrates from North America.

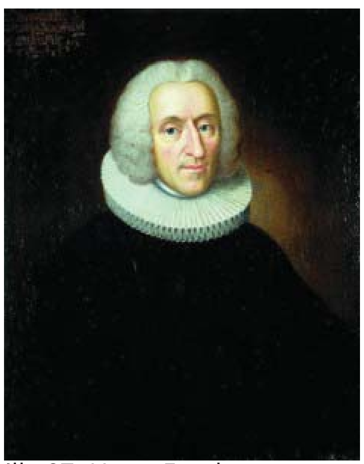
900 A.C.

Ill. 02 Farmers immigrates to South Greenland from Iceland. The Norsemen and Erik den Røde builds farms using stone and sod. They dissapear around 1500 because of a colder climate.

1000

Ill. 03 Christianity is introduced in Greenland without great luck.

1721-36



Ill. 07 Hans Egede comes to make the eskimos good christians.

1774

Ill. 08 The Royal Greenland Trade Company is established (KGH) as a danish trade monopoly to avoid import of diseases and harmful products like tobacco and spirits.

1835

Ill. 09 Greenland starts to use money for trading

1350

Ill. 04 Greenland becomes danish

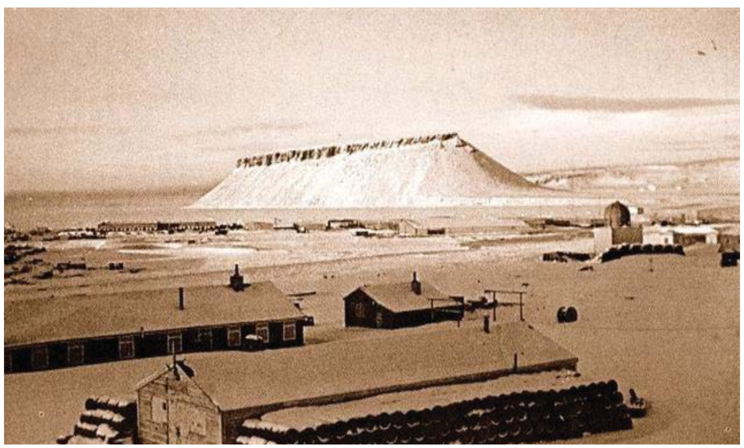
1500

Ill. 05 Trading with the eskimos opened Greenland for import of tobacco, spirits, weapons and so on. Mostly it was whale fishers trading these modern goods for bear and musk ox skins. They slowly became dependent on these guns and knifes.

1600

Ill. 06 The eskimo gets their own written language and many of them learns to read and write

1939-45



Ill. 10. 2nd world war. USA gets more involved in trading with Greenland and introduces new and modern building materials. They make military bases. Greenlanders control the country themselves.

1953

Greenland goes from colony to an equal part of Denmark. Greenland becomes more modern and GTO (Technical Orginasation of Greenland) starts building more housing and better education. The fishing becomes more developed and organised.

1979

Greenland gets partly self-governence. The foreign policy is still governed by Denmark

2009

Ill. 11. Greenland is acknowledged as an independent country. They still get economical support from Denmark until the government of Greenland is financially viable.

THE BUILDING TRADITION

Ill. 12 Sodhouse and a danish imported building tradition in the back.

Ill. 13 Whaleribs where used for construction

Ill. 14 Sodhouse with windows imported from Denmark

INTRO

The building tradition of Greenland dates back to the earliest Inuit immigration (10.000 b.c.). The colonization meant that a lot of knowledge about building and materials in an arctic climate was lost in favor of a Danish building tradition imported to Greenland. The living standards were seriously affected by this which was evident in the bad health amongst the Greenlandic people (tuberculoses epidemic 1949).
Finally today in 2011 we are opening our eyes more to the local traditions and culture and how to incorporate the modern building technology in the best way.

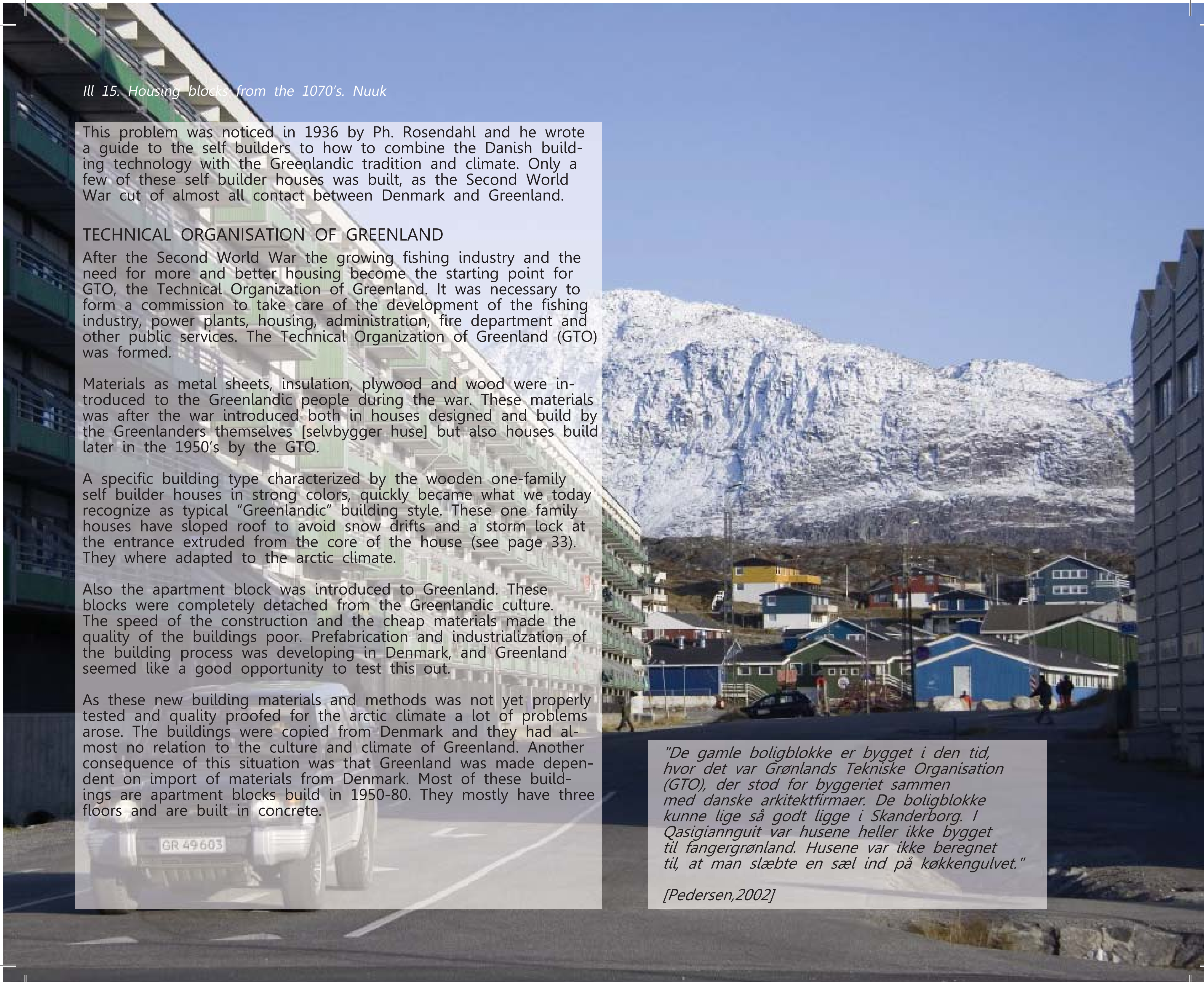
TRADITIONAL HOUSING

When the first people settled in the arctic they developed a building method fit for the climate. It was constructed purely from functional needs and from the materials available in the surroundings. The oldest remains of these houses are 4000 years old. When the first Inuit people arrived to Greenland from North America they where nomadic people and travelled for better hunting or fishing. In the winter period they lived in small huts made from snow, earth, sod or stone which insulated the room. The sod let the moist through the walls slowly. They used skin from intestines as windows and a small hole in the roof made it possible to control the room temperature and to ventilate. In summer they made tents from the skin of caribou. The structure was usually made from whale ribs or driftwood.

THE COLONISATION

In 1721 the colonization of Greenland meant a change in the traditional building method. The Danes brought with them the building technology of north European houses and mixed these with the sod and stone houses. They wanted to build houses that looked Danish. This was the beginning of a degradation of the living standards in Greenland.

"Naar en ny og en gammel
Kultur støder sammen, maa man huske, at
ikke alt i den gamle Kultur staar tilbage
for det nye, man ser, og at ikke alt det nye
er formaalstjenligt i Landet".
"I Grønland gælder dette i væsentlig
Grad for Boligernes Vedkommende. Fordi
et Hus af træ med højt Tag ligner
Huse i Danmark og ser moderne ud, er
det ikke sikkert, at det er bedre end det
grønlandske Tørvemurshus." [Andersen, 1976]



Ill 15. Housing blocks from the 1070's. Nuuk

This problem was noticed in 1936 by Ph. Rosendahl and he wrote a guide to the self builders to how to combine the Danish building technology with the Greenlandic tradition and climate. Only a few of these self builder houses was built, as the Second World War cut of almost all contact between Denmark and Greenland.

TECHNICAL ORGANISATION OF GREENLAND

After the Second World War the growing fishing industry and the need for more and better housing become the starting point for GTO, the Technical Organization of Greenland. It was necessary to form a commission to take care of the development of the fishing industry, power plants, housing, administration, fire department and other public services. The Technical Organization of Greenland (GTO) was formed.

Materials as metal sheets, insulation, plywood and wood were introduced to the Greenlandic people during the war. These materials was after the war introduced both in houses designed and build by the Greenlanders themselves [selvbygger huse] but also houses build later in the 1950's by the GTO.

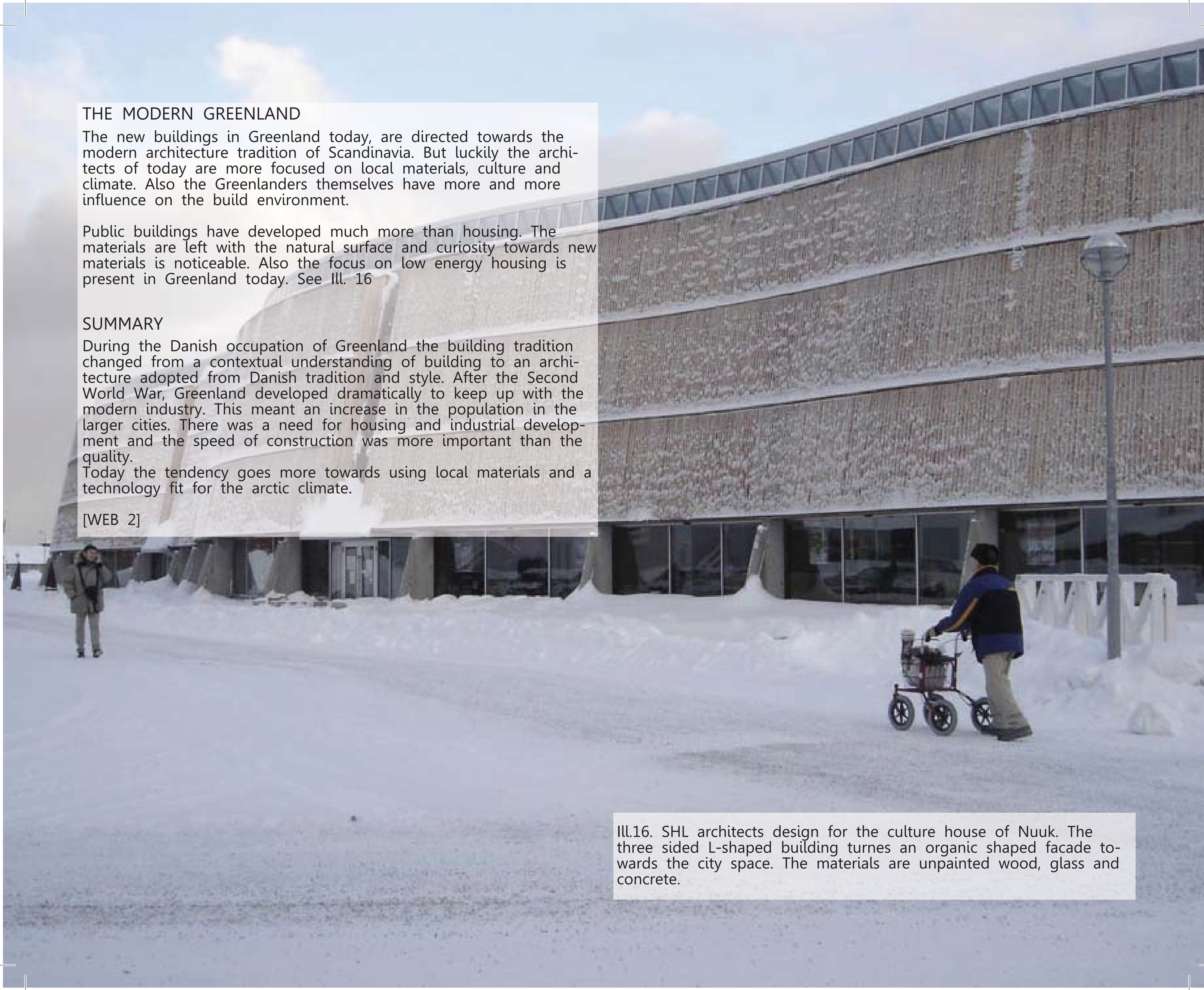
A specific building type characterized by the wooden one-family self builder houses in strong colors, quickly became what we today recognize as typical "Greenlandic" building style. These one family houses have sloped roof to avoid snow drifts and a storm lock at the entrance extruded from the core of the house (see page 33). They where adapted to the arctic climate.

Also the apartment block was introduced to Greenland. These blocks were completely detached from the Greenlandic culture. The speed of the construction and the cheap materials made the quality of the buildings poor. Prefabrication and industrialization of the building process was developing in Denmark, and Greenland seemed like a good opportunity to test this out.

As these new building materials and methods was not yet properly tested and quality proofed for the arctic climate a lot of problems arose. The buildings were copied from Denmark and they had almost no relation to the culture and climate of Greenland. Another consequence of this situation was that Greenland was made dependent on import of materials from Denmark. Most of these buildings are apartment blocks build in 1950-80. They mostly have three floors and are built in concrete.

"De gamle boligblokke er bygget i den tid, hvor det var Grønlands Tekniske Organisation (GTO), der stod for byggeriet sammen med danske arkitektfirmaer. De boligblokke kunne lige så godt ligge i Skanderborg. I Qasigiannguit var husene heller ikke bygget til fangergrønland. Husene var ikke beregnet til, at man slæbte en sæl ind på køkkengulvet."

[Pedersen,2002]



THE MODERN GREENLAND

The new buildings in Greenland today, are directed towards the modern architecture tradition of Scandinavia. But luckily the architects of today are more focused on local materials, culture and climate. Also the Greenlanders themselves have more and more influence on the build environment.

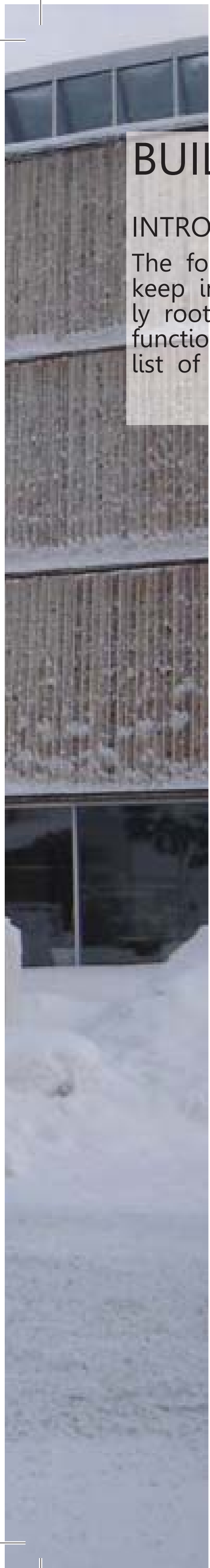
Public buildings have developed much more than housing. The materials are left with the natural surface and curiosity towards new materials is noticeable. Also the focus on low energy housing is present in Greenland today. See Ill. 16

SUMMARY

During the Danish occupation of Greenland the building tradition changed from a contextual understanding of building to an architecture adopted from Danish tradition and style. After the Second World War, Greenland developed dramatically to keep up with the modern industry. This meant an increase in the population in the larger cities. There was a need for housing and industrial development and the speed of construction was more important than the quality.
Today the tendency goes more towards using local materials and a technology fit for the arctic climate.

[WEB 2]

Ill.16. SHL architects design for the culture house of Nuuk. The three sided L-shaped building turnes an organic shaped facade towards the city space. The materials are unpainted wood, glass and concrete.



BUILDING IN THE ARCTIC

INTRO

The following chapter gives an introduction to what is important to keep in mind when building in the North. The factors are commonly rooted in a traditional practice or logic and are based on both functional, socially and energy saving considerations. They work as a list of parameters which can be used in the sketching phase.

Ill. 17-21

THE PLACE

When building in the arctic the understanding of the strong relation between man and nature is of great importance. As the building isolates the people from the outside, the view is the only direct connection still maintained. The five images on the right show the most important views.

1. Community life
2. The axis of aurora (parallel to the coast)
3. Remote headlands/landscape
4. The water
5. Children playing

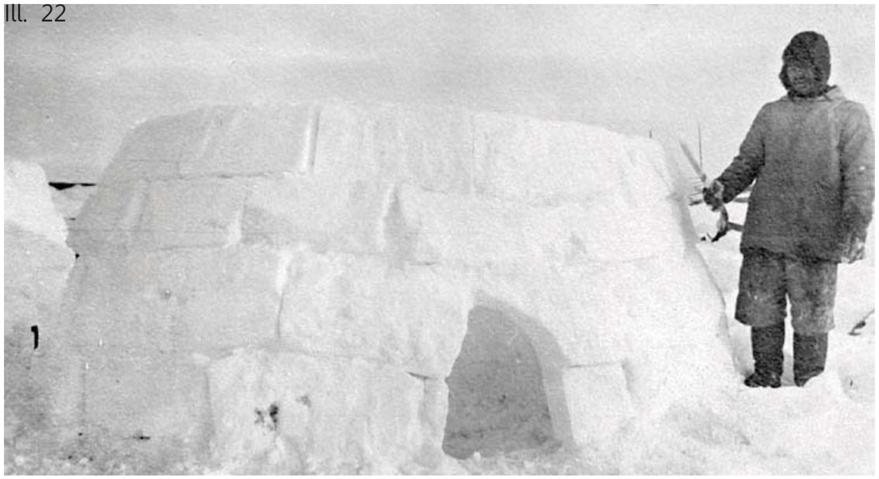
VIEWS

The following list states the 7 fundamental factors to be considered when choosing a site:

1. Face the sun.
2. Face away from the polar wind.
3. Locate next to the water.
4. Choose a slope that drains melt water and cold air.
5. Avoid depression in terrain that accumulates blowing snow.
6. Find solid ground, preferably in continuous permafrost, or in soil without permafrost.
7. Select a place with room for expansion.

[Strub, Bare Poles, page 90]

Ill. 22



KEEPING WARM

Minimizing the surface area saves energy. This was known by the Inuits. The dome shaped and very small snow houses was optimized for their needs. They had a minimum of surface area and the snow was well insulating.

Well insulated building parts is a must when building in the arctic.

Ill. 23

CONSTRUCTION - THERMAL STRESS

The construction materials should be homogenous. As materials changes a lot when exposed to the arctic climate, it is important that the entire construction reacts and works in the same way.

The construction should be either completely inside or outside to avoid cold bridges.

Ill. 24

BUILDING SEASON

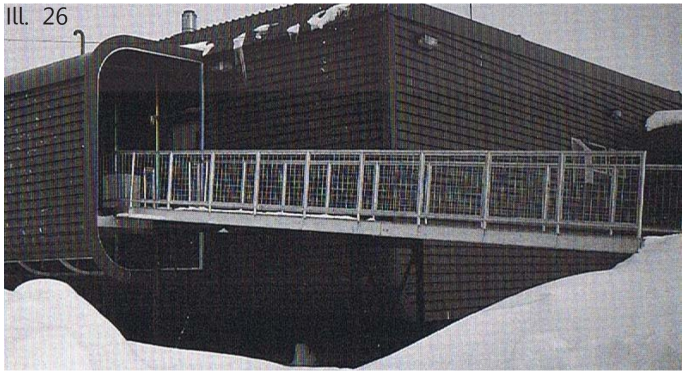
The relatively short building season makes fast assembled buildings a good choice. The climate makes it very difficult and sometimes impossible to build during winter.

Ill. 25

WINDOWS

All windows MUST have a purpose. As the window lets out a lot of heat (the U-value is around 1 W/m2K, compared to a highly insulated wall with a U-value of as low as 0.1 W/m2K) it must have a functional purpose, for example beacon, passive solar heat and daylight. Window should be sealed and ventilation taken from another source. Add an outer pane to distance the chilling wind. This outer pane should be permeable for vapor, but impermeable for snow.
Wood frames perform better in the arctic climate than plastic. If the building has no eaves, make overhangs above windows to protect from precipitation.

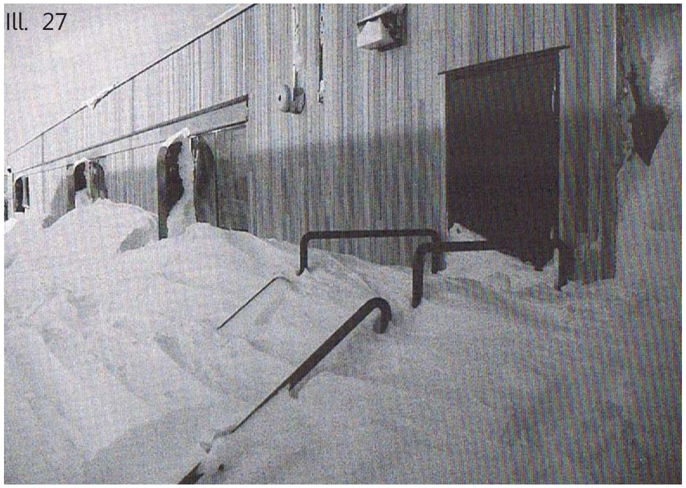
Ill. 26



ENTRIES

The entrance is important because it is the first direct contact between building and resident. It must be welcoming and give the expression of shelter. The users must be able to distinguish the entrance even in a heavy blizzard.
When talking about the entrance it is important to note that snow drifts and strong wind force should be avoided around the entrance. This can be achieved by sheltering the door itself and by connecting the entrance and the ground using a ramp. In this way the entrance is emphasized while at the same time kept away from snowdrifts. The entrance should have a vestibule serving as a storm lock.
The doors could adapt to summer/winter. For example a sliding door which can be left open completely during summer.

Ill. 27



WIND

The long axis of the building should be aligned with the prevailing wind direction to avoid snow drifts and increased heat loss.

MATERIALS

Three general types of building materials may be used in arctic regions: concrete, metal, and wood. The short building season (summer period only) often dictates the choice of construction. It must be quick and easy to construct and therefore standardized and prefabricated construction elements are often preferred.
Concrete performs well in arctic climate though the high thermal conductivity can be a problem and can cause condensation on interior walls. Also the risk of breakage and surface cracks can make building maintenance quite expensive. But if properly installed and maintained concrete is very durable.
Metal can easily be prefabricated and assembled on site. The high thermal conductivity can be a problem and can cause condensation on interior walls.
Wood is a well-known building material in the arctic. The low heat conduction and ease of construction makes it perform well in the arctic climate. Wood components can be fabricated on site or in factories. Construction wood structures have less need for technically skilled labor.

For all materials the price can differ from place to place, caused by factors like transportation, availability, weight, need for special tools and so on.
[UFC, 2004]


Ill 28 Svalbard Science centre, Jarmund/Vigsnæs AS Architects, The Cobber cladded facades resists the strong polarwind while reflecting the light.

Scheme 29

	Easy to construct	Fast to assemble	Durability	Thermal mass	Thermal conductivity
Concrete			X	X	
Steel	X	X	X		
Wood	X	X			X

WALLS AND ROOFS

It is very important to avoid trapped vapor, as it leads to accelerated decay and then loss of thermal resistance. The building should be completely wrapped to avoid the moist to travel through the construction.
Another important issue is to insulate walls and roofs well. The heat loss from the building surface is a major factor when building in the arctic.

To avoid snowdrifts the roof should be sloped, minimum 1:25.

SUMMARY

This chapter sets a list of parameters that can be used in the following sketching phase as a toolbox with design principles.
When selecting the site and the building orientation parameters like view, wind, sun and town activity should be considered. The harsh arctic climate also implies a certain attention towards the building designs energy performance. Strategies like thermal storage, insulation and building shape can help to lower the energy use.
Implementing these design principles early in the project will ensure an integrated design.

TOOLBOX

1. Face the sun
2. Face away from the polar wind
3. Keep in mind the views
4. Keep the surface/volume area as small as possible
5. Shape and place the building to avoid snowdrifts on walls and in front of entries
6. Avoid cold bridges
7. Insulate the envelope heavily and make it impermeable to moist
9. Place and design windows carefully. All windows MUST have a purpose
10. The entrance should be kept free of snowdrifts and have a storm lock

[Strub, 1996]

Ill 30 Indre Finnmark tingrett, Finnmark, by Stein Halvorsen.

Ill 31 Chipperfields Anchorage museum. The facade mirrors the sorrounding mountains. The building is skinned in double-glazed, mirror-fritted glass, with a third interior wall of glass enclosing a heated space 1 foot deep on the transparent areas of the façade to prevent condensation in Alaska's extreme climate

PREPARING FOR A SUSTAINABLE ARCTIC FUTURE...

The temperatures are rising in Greenland. This is caused by the global warming, which is particularly obvious in Greenland. Since 1980 the spring temperatures in North-east Greenland are now in average 4 degrees higher and it is expected to rise up to 10 degrees more within the next 100 years. Snow and rainfall will increase and the air will become moister. These climate changes make the conditions worse for some animals and better for others. The polar bear will have less ice to catch seals from and the shrimp fishing might completely die out. The ice will not settle enough during winter to be passable for the hunters and fishermen to go on dog sledge or snow scooter.
But it also opens up for new possibilities. In South Greenland they started farming potatoes and cabbage. Also the sheep production has had a big upturn.
Melting inland ice makes hydropower an obvious alternative energy source. The Greenlanders must adapt to this new climatic change and make the most of it.

When looking at building in the arctic, the more moist air should be considered. Overhangs and better ventilated constructions are some of the elements which most likely will be the future in arctic building technology.
[WEB 3]

SAVING ENERGY IN THE ARCTIC CLIMATE

WHY IS IT IMPORTANT

The climate changes today are very visible in Greenland. These changes are partly caused by CO_2 emission.
This is the background for the focus today on energy use in buildings. Energy use in buildings stands for 40% of the total energy use in Denmark. This makes it an obvious place to save energy and CO_2.
But as the focus on energy supply in Greenland mostly has been on security of supply instead of energy efficiency, low energy buildings are not a common sight. But as the low energy prices in Greenland are increasing like in the rest of the world the focus will now change and go towards low energy building. An example is the low energy house in Sismiut made by the Arctic Technology Centre (ARTEK) on DTU.
[WEB 4]

BUILDING REGULATION IN GREENLAND

The building regulations in Greenland are equivalent to the Danish BR06, which means that the regulations for energy use are not up to date compared to Scandinavia and Europe.

The BR06 standards in Greenland states the following regulations for energy use north of the Polar circle (Zone 2):

Energy use for heating and ventilation for institutions, office and schools:

98 kWh/m^2 pr. year plus 91 kWh/m^2 pr. year divided by number of storey's and plus 4444 kWh pr. year divided by the built area (footprint of heated area).
[BR06 - Greenland]

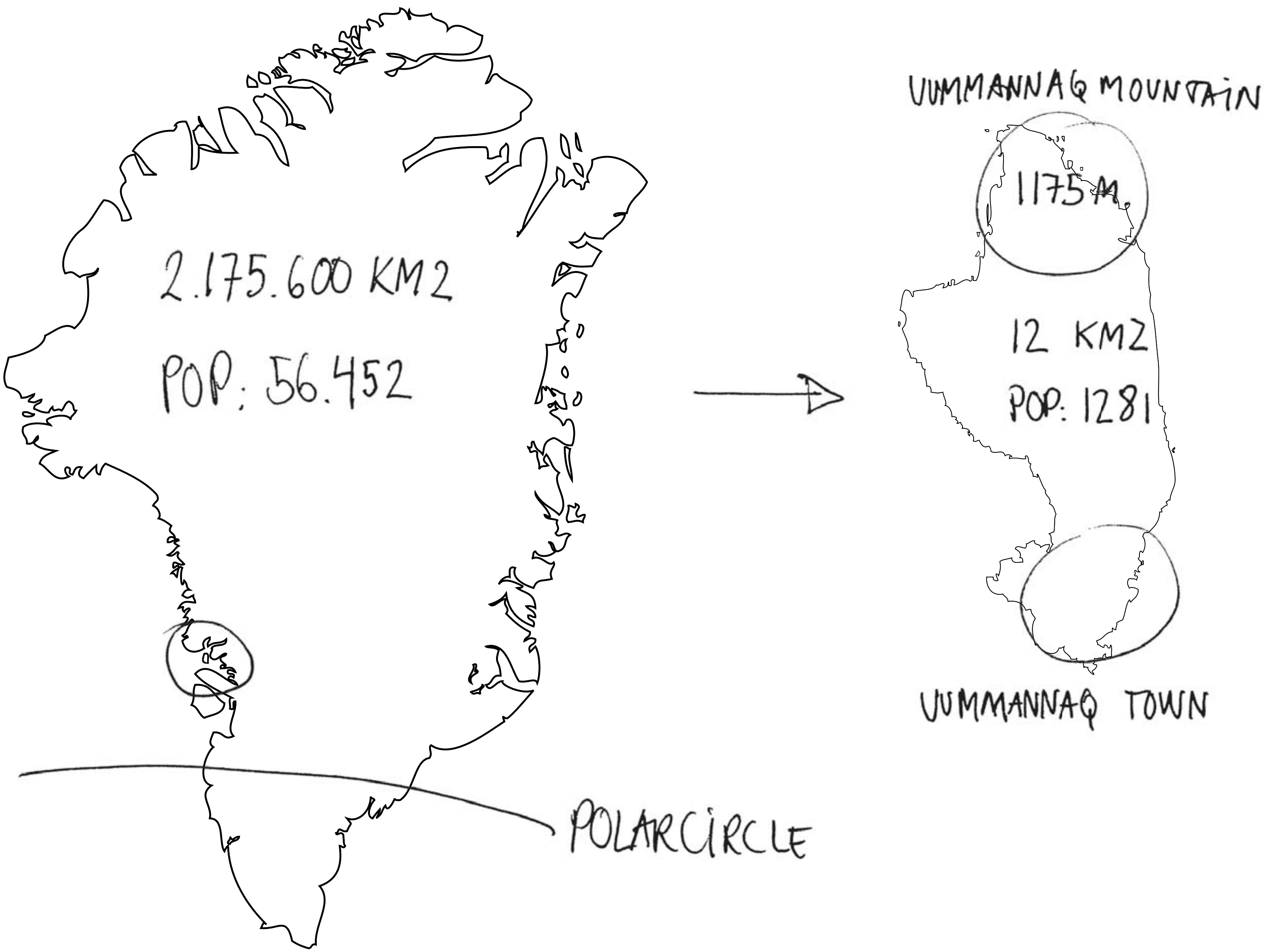
ARTEKS LOW ENERGY HOUSE

The low energy house in Sisimiut designed by ARTEK has an energy use of 140 kWh/m^2. The aim was 80 kWh/m2 but as a result of unqualified labor and therefore high infiltration the result ended up with much higher energy consumption than expected.

This project is used for comparison concerning the energy demand.

Ill 32, Heatloss from the surface is of main concern when building in the arctic

Ill 33, The lowenergy house in Sisimiut, ARTEK, DTU. The consumes 140 kWh/m^2


2.175.600 KM2
POP: 56.452
POLARCIRCLE
UUMMANNAQ MOUNTAIN
1175M
12 KM2
POP: 1281
UUMMANNAQ TOWN

INTRO

Uummannaq is an island just off the coast of West Greenland.
The island is positioned 460 km north of the polar circle.
The main source of income is fishing and sealing.

The town has an active harbor environment. This is the centre of the town both physically and mentally. Even the topography is centered around the harbor. The main part of the town lies on the southern tip of the island.
The talk of the town always concerns the fishing situation and the nature in general takes up a very great part of their lives. The extreme climate forces people to respect and consider the nature always.

The study trip to Uummannaq gave me an understanding of this town and what is important for the people living there. My discoveries are based on observations, talks and sensing the atmosphere. Staying at an orphanage during my stay I got a very good and honest look into the results of the heavy social problems which are the reality in many Greenlandic towns.

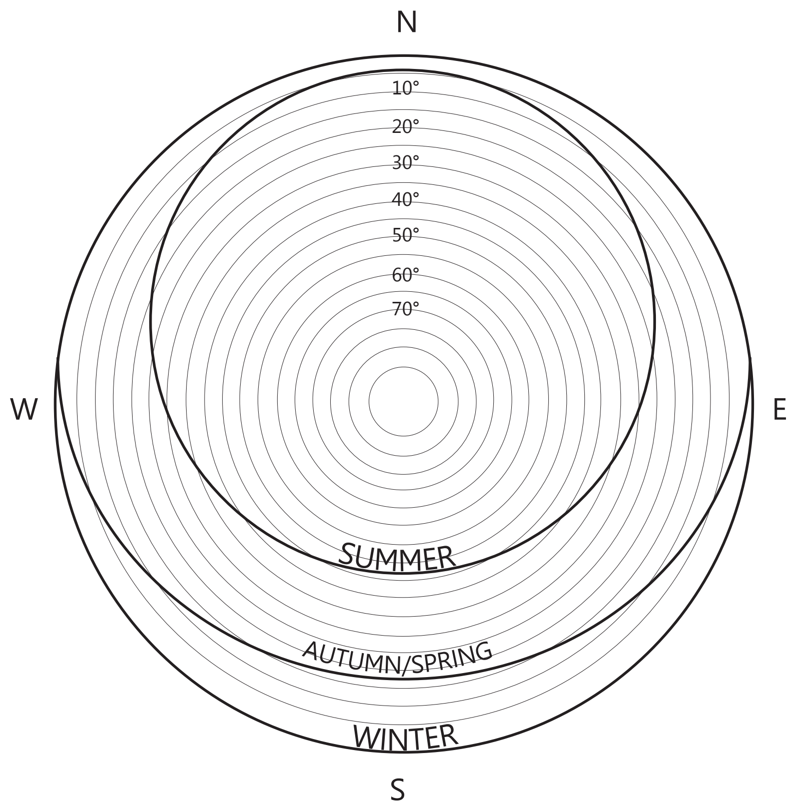
The following chapter describes both the empirical and the more analytical investigations made during my 10 days stay in West Greenland.
[WEB 5]

SUN DIAGRAM

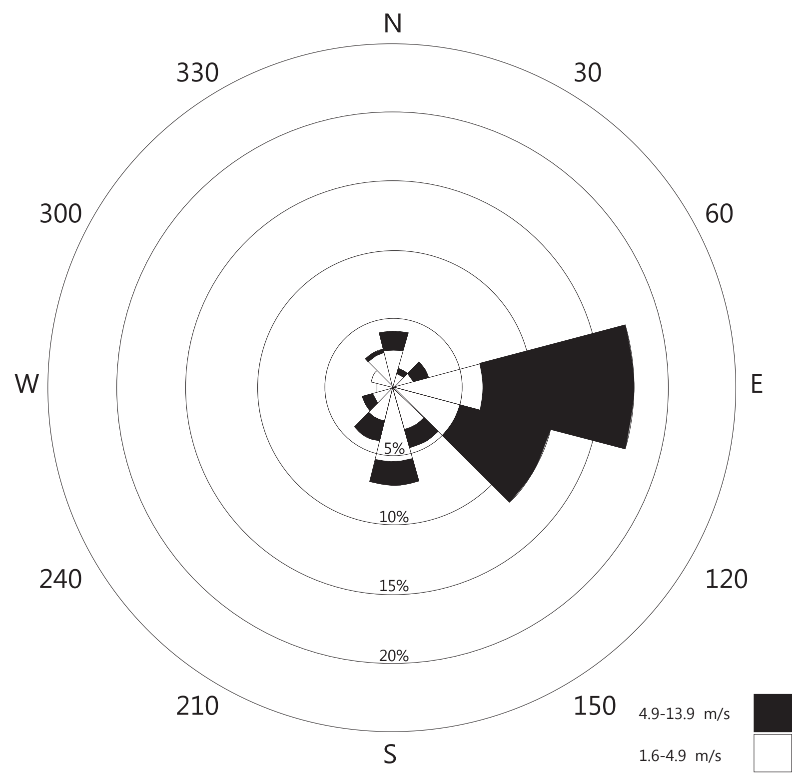
As the island of Uummannaq lies 460 km north of the polar circle, it is subject to 24 hour darkness from 7th Nov. – 4th Feb. In return they have midnight sun from 16th May – 28th July. The sun is very strong in Greenland caused by reflections from the snow. In addition to this they actually have around 2000 hours of sun every year (Denmark has around 1500 hours per year).

WIND ROSE

The wind along the west coast of Greenland mainly comes from east/southeast. These sometimes very strong winds can make the temperatures seem colder than they are (chill factor).
Greenland has very powerful and unpredictable winds. The foehn wind from the southeast can bring wind speeds of up to 50 m/s. The strongest wind is felt mainly in the north or in the south of Greenland.



Ill 34



Ill 35

CLIMATE GRAPH

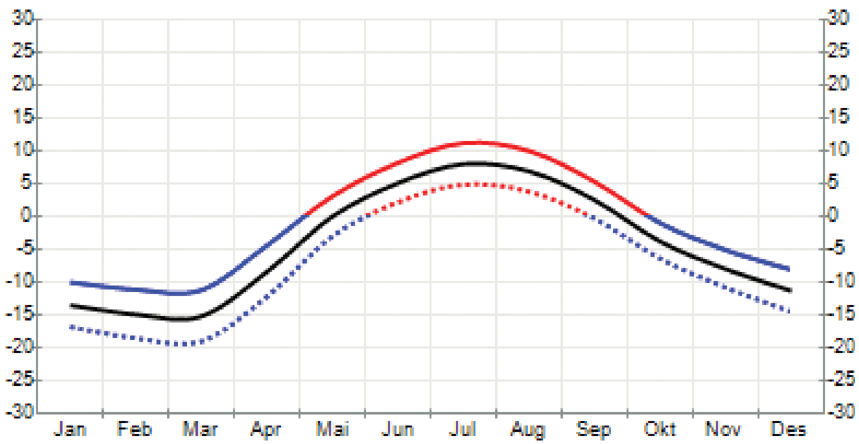
The relatively stable climate gives a temperature interval of around -20°C to 10°C. As the climate is dry arctic the temperatures seem warmer than they are. The precipitation usually comes as snow.
The climate data shown below are from Illulisat. The weather here is comparable to the weather in Uummannaq.
[WEB 6]

WEATHER FILE DATA

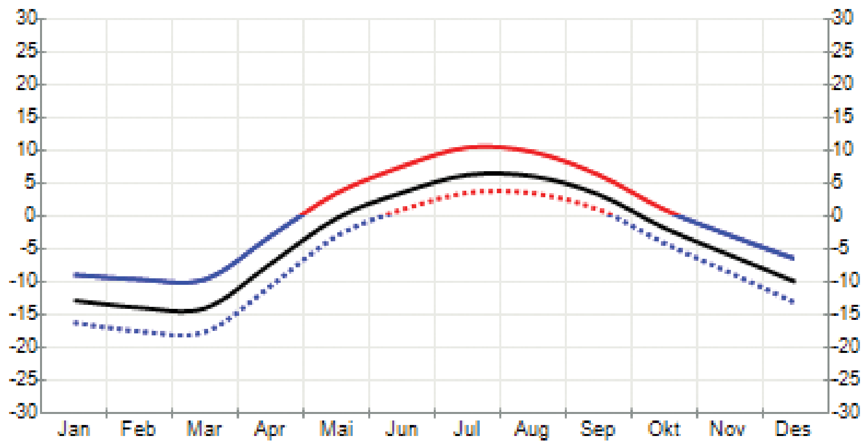
The isolated position of Uummannaq made it difficult to find a weather data file to be used in IES VE, from that exact position. A weather file from Sisimiut which is situated more south than Ummananaq, is used for all energy calculation done in IES VE. This makes the results differ from what the real results might be. This fact is taken into consideration in the verification of the energy consumption.

Below is shown the weather data from Sisimiut.
The climate is a few degrees warmer and more humid.

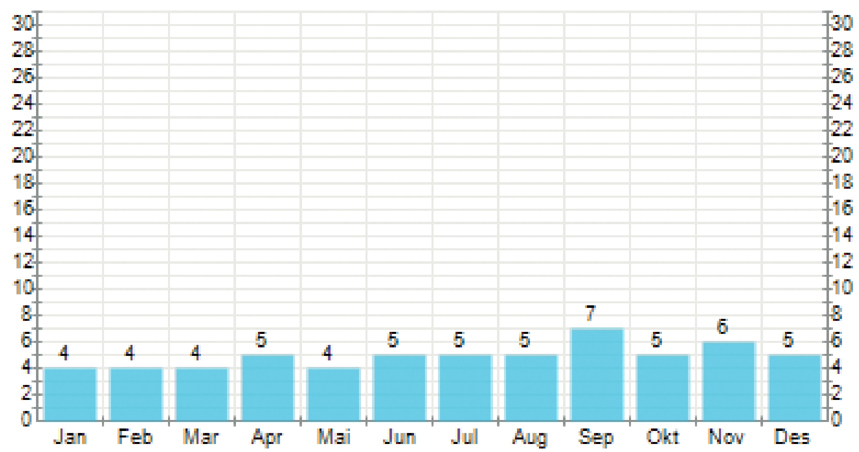
Temperatures Illulisat (200 km south of Uummannaq)



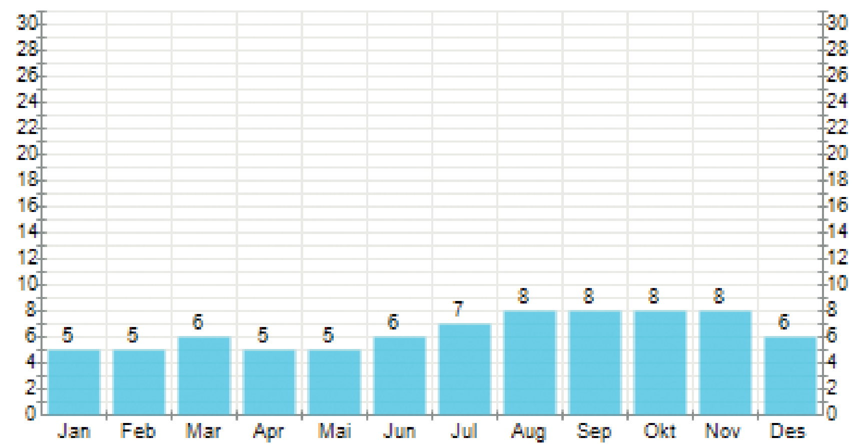
Temperatures Sisimiut (500 km south of Uummannaq)



Days with precipitation Illulisat (200 km north of Uummannaq)



Days with precipitation Sisimiut (500 km south of Uummannaq)



Ill 36-39


Wooden houses

Granite and mineral quarry


Gnejs


The Ummannaq mountain


Archaic mountains

Ill 40-45 Impressions from Uumannaq

After travelling three days I finally reach my destination. 460 kilometers north of the polar circle, the helicopter makes a left turn around the island before landing, and the heart shape of the Uummannaq Mountain reveals itself. The island has only two arriving helicopters every week so we were all expected in the heliport.

A few days later I was already a known face in the town. People talk and news travel fast in a small town like Uummannaq. But what was the most important subject to talk about was the ice. The time for my arrival was the period where the ice has not settled yet. The boats where stuck in the ice, but it was still not strong enough to carry the dog sledge or the snow scooter. This means no fish and no money for a lot of people.

In Uummannaq nature is more than just pretty. The main source of income still comes from fishing and sealing by boat or dog sledge. Therefore they are very dependent on the weather. This also means that they are very closely connected to nature. The fishermen know the currents and the patterns of the fish and sea mammals.

But all this is changing. Temperatures are rising and the Greenlandic people are the first to feel this change. The sea fauna is changing behavior and some species even diminish. But the main problem is the long period of time with unsettled ice. This time is a big problem for the fishermen because they don't have any possibilities to go hunting seal or fishing long line. This makes a large group of people unemployed for a long period of time every year.

The isolation and the feeling of being so small in the greatness of nature is what make Uumannaq so special. Spread out on a small island with some of the tallest mountains in Greenland makes people squeeze together and take good care of each other. Scientists from NASA, archeologists and filmmakers travel many kilometers to reach this place. But the people of Uummannaq have been here always. And they are not going anywhere.....

Typical self-builder house

Graffiti on the "town wall". Ummannaq is build on solid rock.

The boats are pulled on shore during the winter.

STORIES FROM UUMMANNAQ

Part of my visit in Uummannaq was to discover what the everyday looks like. I wanted to meet the people and make them talk. What is important to them and what are their thoughts of the future in the town?

Jens Frederik, 51 years

"It is important that the ice sits very soon so we can go with the dogs on the ice to do long-line fishing."

Jens Frederik has always been fishing in Uummannaq. He sells his fish at the local fish market.
This in-between period where the there is ice, but not thick enough for sledging is not a good time for the fishermen. They can't go out either with boat or with sledge.

"The last two years the ice hasn't been thick enough to do long-line fishing. So many of us are unemployed all winter."

Anna Marie, 69 years

Ane has lived in her small yellow house (50m2) through 40 years. She lived here with her three children also. Her husband died in a fishing accident. From her living room she has a south turned view of the harbor where she likes to sit and watch the fishermen coming and going.
She likes to have visitors and invited me in for a slice of a whale and some home baking.
Anna Marie goes out one time every week to play cards.

Nukarak 24, Louis 20 and Iviaanna 4 month.

Nukarak and Louis lived at the orphanage since their childhood. Now they have a child together and are about to start a family in Uummannaq.
They are both in close contact to the nurses and the midwife at the hospital to make sure their little family gets the right start and that Iviaana is taken good care of.

Hansigne, 26 years

Hansigne is studying at the Pittarsafik School which is corresponding to the Danish 10th grade.
She comes from a smaller town close by moved to Uummannaq when she started school.

"Uummannaq is very boring for young people. Usually we meet at a friend's house to play computer games or watch TV. There is nothing else to do."

I made Hansigne take photos of her day. It offered me a look into the normal day of a young person in Uummannaq.
She gave me the impression of a very closely connected and social people. They spend a lot of time together, but they need stimulating offers in their free time.

"There are no offers for young people in Uummannaq. I think it could be nice to have an internet cafè or just somewhere to hang out with my friends".

Hansigne tells me that a lot of young people move to Nuuk or other larger cities because they are bored in Uummannaq.

CLIMBING THE TOWN

The town of Uummannaq sits on a steep slope, with the harbor as the town centre. The houses are spread with a considerably large amount of space between them. The space is needed for dogs, shelters, drying lines for fish and tools. This gives all houses a spectacular view and direct sunlight from both east and south.

Roads make truck driving in the town possible, while pedestrian's climbs the terrain using smaller paths and wooden stairs.

These paths takes you through people's backyards, passing close to front doors, the dogs tied outside bark for attention, you smell the dried whale meat hanging from the drying line and try to figure out which path to follow next. The town environment and atmosphere is very interesting and you want to explore.

BUILDING MATERIALS AND METHODS

The general building material is wood, known for its qualities in the arctic climate [Chapter, Building in the Arctic]. Wood was introduced by the Danes and is now the main building materials used in the self builder houses. This type of house has become what most people think of as the typical Greenlandic home.
Even though this type of housing is in many ways accommodated to the arctic climate the insulative performance is quite low. The reason for this could be poorly qualified labor, low prices on oil or that the building regulations are not updated.
[WEB4]

THE HOUSES

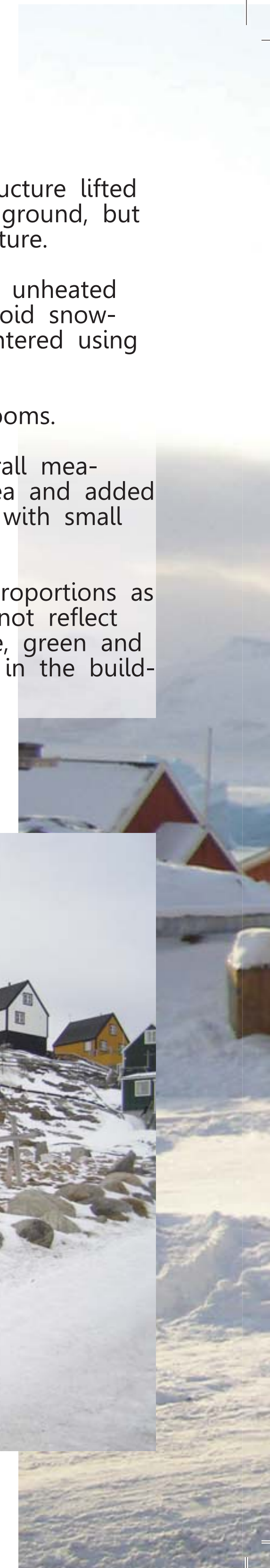
The typical greenlandic home is a compact wooden structure lifted on a concrete base. This is done to level the building ground, but also to avoid moist from penetrating the wooden structure.

The entrance is pulled out from the volume leaving an unheated space serving as windlock and room for storage. To avoid snowdrifts in front of the door the entrance is lifted and entered using stairs.

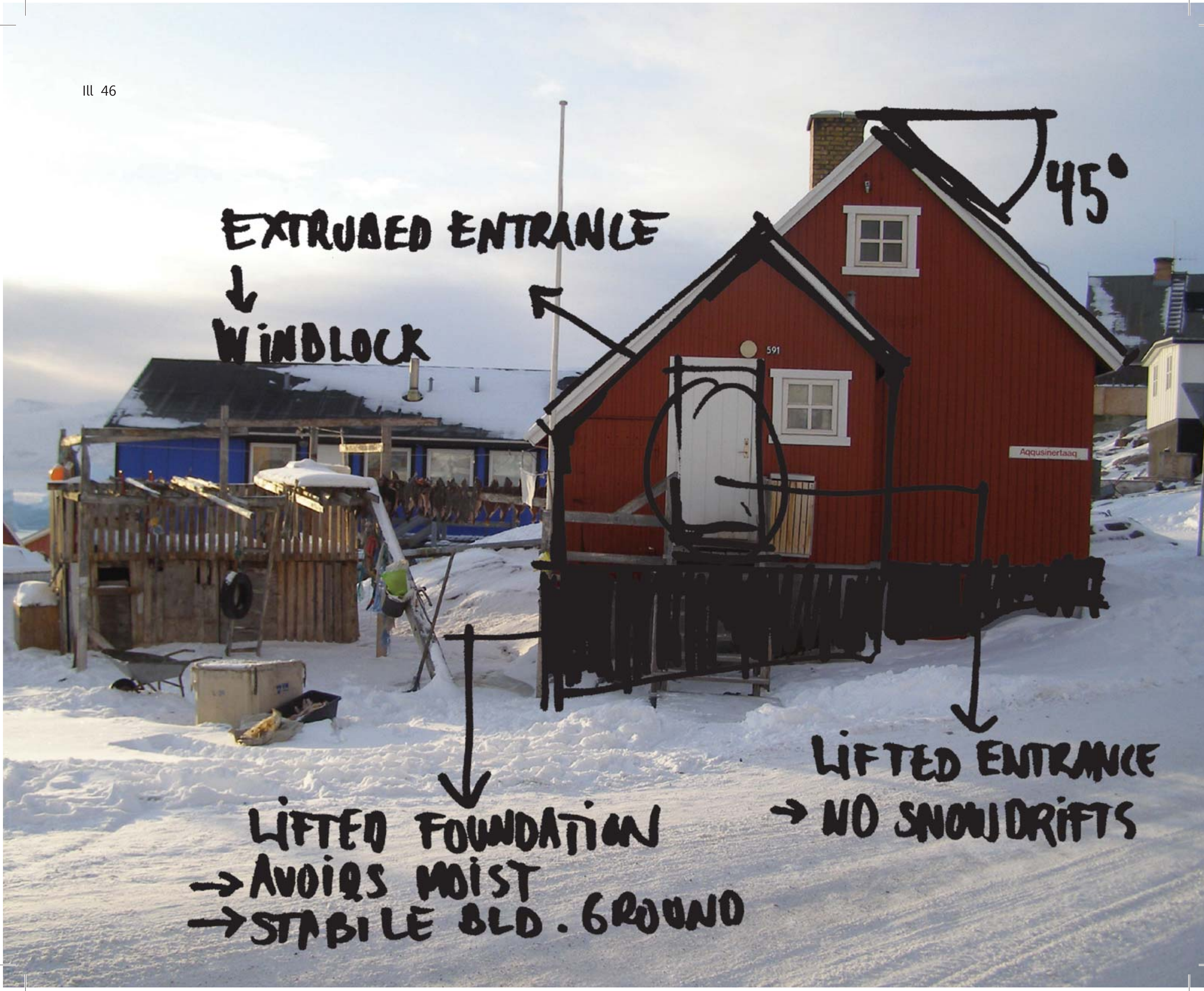
Inside the dwellings are very compact and has small rooms.

The fact that most of the houses follow the same overall measures but with small differences like colour, window area and added building parts, gives the town a homogenic expression with small differences in detailing.

Also the public buildings has the same typology and proportions as the dewellings, just in a larger scale. The facade does not reflect the use of the building. Therefore the colours red, blue, green and yellow was earlier used to represent different purposes in the buildings.



Ill 46


EXTRUDED ENTRANCE
↓ WINDLOCK
45°
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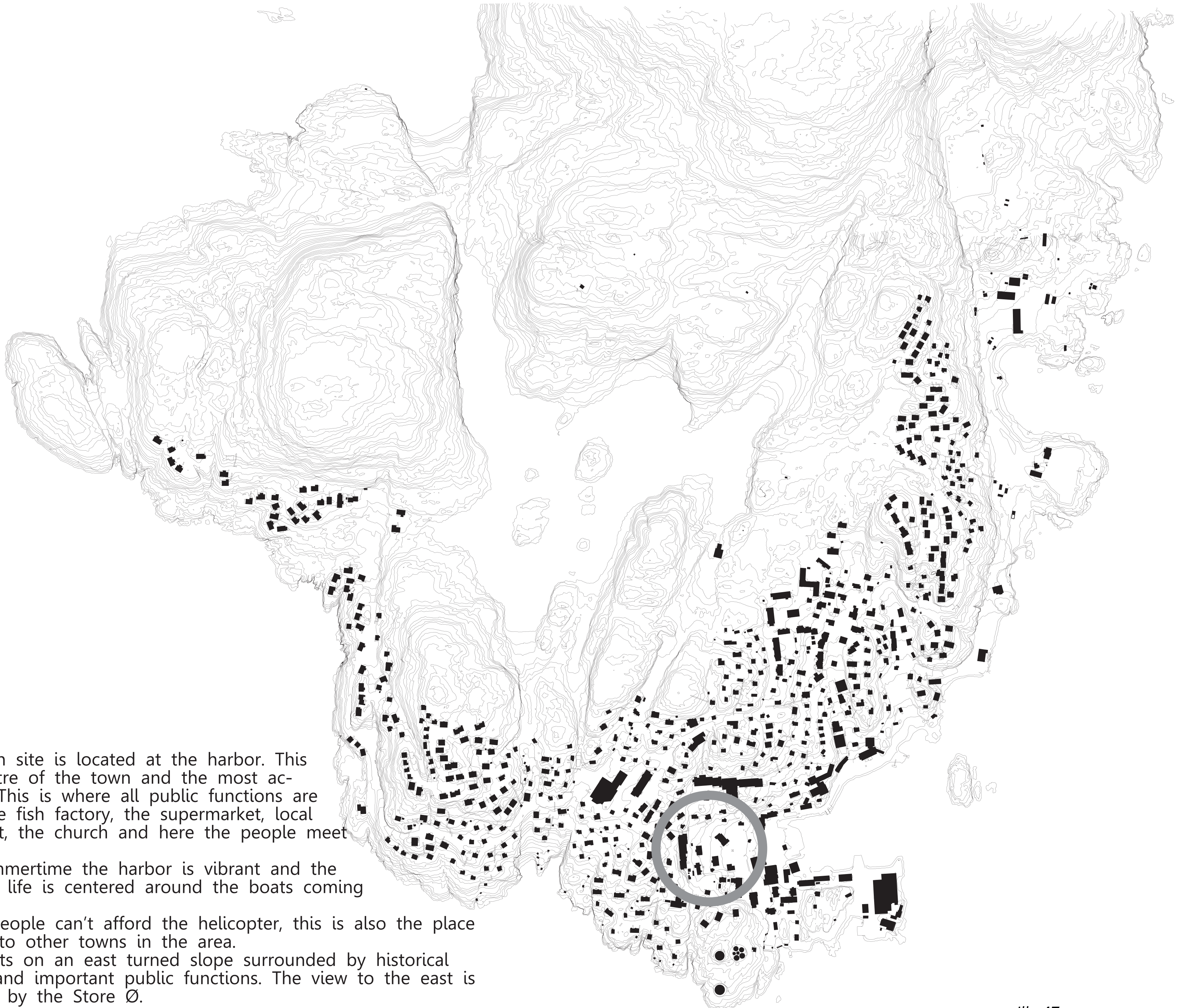
Aqqusinertaaq
LIFTED FOUNDATION
→ AVOIDS MOIST
→ STABILE BLD. GROUND
LIFTED ENTRANCE
→ NO SNOWDRIFTS


Ill. 47

THE SITE

The chosen site is located at the harbor. This is the centre of the town and the most active area. This is where all public functions are placed. The fish factory, the supermarket, local fish market, the church and here the people meet to talk.
In the summertime the harbor is vibrant and the local town life is centered around the boats coming and going.
As most people can't afford the helicopter, this is also the place for traffic to other towns in the area.
The site sits on an east turned slope surrounded by historical buildings and important public functions. The view to the east is dominated by the Store Ø.

Ill. 48 The site and how it relates to the surroundings

THE SITE TOWARDS WEST

Ill. 49

THE SUPERMARKET.
-SOCIAL MEETINGPLACE!

GRANITE CHURCH
-GRANITE FROM LOCAL QUARRY
-VERY BEAUTYFUL!!

HISTORICAL STONEHOUSE
-CURRENTLY USED FOR STORAGE

HISTORICAL SOD HOUSES.
-CURRENTLY NOT USED.
-NOT USABLE AS LIVING SPACE!

THE GRILL BAR.
-VERY IMPORTANT SOCIAL MEETING PLACE.

ROYAL GREEN LAND.
-THE SOURCE OF INCOME.

LOCAL FISHMARKET.

The importance of fishing and sealing is evident when looking at the plan of Uummannaq. Most public functions like shops, fish market, hotel, cafe, church, schools, fishing industry and the municipality office surrounds the harbor in a horseshoe shape with sloping sides towards north and west. This place is the town centre and the place of most activity. Most people cross the harbor daily and the activity of the Royal Arctic fishing industry adds a lot of life to the place.
The harbor has the Store Ø as a dramatic background setting.

STORE Ø

WAREHOUSES

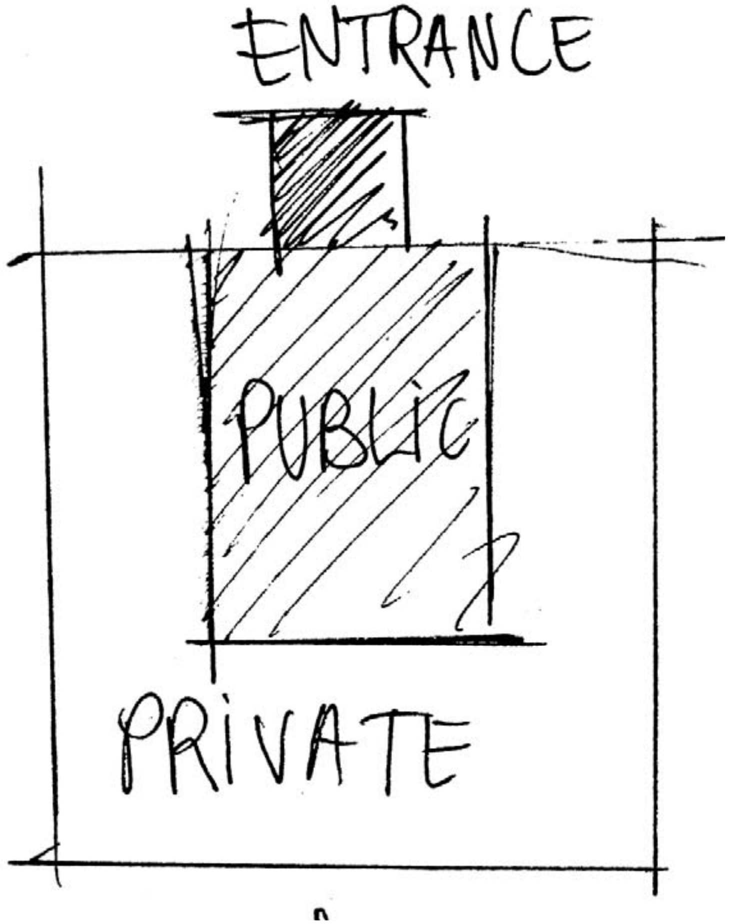
Ill. 50

CASESTUDIES AND REFERENCES

INTRO

The following selected projects are studied to create a frame of reference and inspiration for the following design process. These projects represent examples of room organization, relation to site and climate and energy saving principles.

Ill. 51, overall plan layout



"When doing social work it is very important to attract the socially well established people as well as the ones that actually needs help..." - Vibeke, social worker, The Greenlandic House in Aalborg.

THE GREENLANDIC HOUSE IN AALBORG

Functions
The Greenlandic House in Aalborg is an organization that takes care of various social work and arrangements aimed towards helping Greenlandic people based in Aalborg.
They have been able to make this house a natural meeting point for a lot of people.
They make arrangements like community dinners, homework cafes, lecture nights, courses for young mothers, meetings for alcohol abusers and knitting groups. They express the importance of attracting socially established families and people to make the place successful.

Room organization
The house holds a big common social room with student apartments, meeting rooms of different sizes, a small shop and office spaces organized around this main social room.

Ill. 52, Community meetng in the Greenlandic house in Aalborg

HEJMDAL CANCER COUNSELING CENTRE, AARHUS

BY FRANK GEHRY

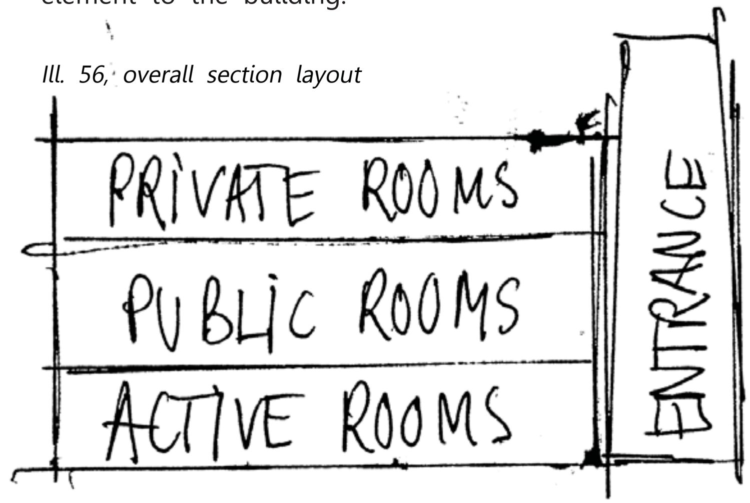
The vision
This project is a restored old building situated next to the hospital. The Hejmdal centre wanted to modernize and change their profile from the conventional institution with closed rooms and a hospital-like atmosphere, to a more open and friendly house where people can walk in from the street and have a friendly chat with one of the employees. The house should have a recreational and homely atmosphere and encourage casual stays.

The spaces/atmosphere
From the outside, the building is kept with the same overall external shape, even the old stone walls are kept. But when entering the house, it is a completely different world. 14 meter long wooden logs carry two floors and a glass roof. A wide variation of rooms gives space for both private conversations and more relaxed stays. The large glass roof ensures pleasant naturally lit spaces and the indoor climate are controlled by natural ventilation and inside blinds. [WEB 7]

Room organization
The house is divided into three floors. The lower floor has functions like workshops and fitness. The middle floor is also the entrance floor and serves as a casual social space. The top floor holds the more private functions. On this floor the rooms are closed.

Materials
The wooden beams give the house a soft, homely touch, and the glass roof ensures a soft natural light all over the building. The massive 30cm x 30cm wood logs give a very pleasant feeling of being safe and protected. The large construction elements become a part of the spatial experience. The stone walls add a historical element to the building.

Ill. 56, overall section layout



Ill. 53-55 Hejmdal cancer centre

TORKILD KRISTENSENS GLASSHOUSE, ODENSE

The vision
The project is the product of the architects dream about saving energy while enjoying a good indoor climate all year round.

The spaces/atmosphere
Inside the glasshouse the dwelling itself is build from simple materials. By detaching the climate screen and the insulated house itself, comfortable stay outside the house is made possible. In the Scandinavian climate long term outdoors stay is possible only in summer, but using this principle the outdoor spaces can be in use most of the year (when the sun is out)caused by the greenhouse effect.
The visit was made in March with outdoor temperatures around 6-7ºC degrees, but the climate inside the glasshouse seemed Mediterranean and very pleasant and the threes where in bloom.
The separated climate screen gives great freedom in the design of the house itself. More window area is possible because the heat loss from the building surfaces is smaller than in a normal house.

Materials
The house itself is made from gypsum with 25 cm of insulation. As the walls does not have to withstand rain, wind or snow there is a great freedom in the choice of materials.

Energy use
The glasshouse is the same type as used for industrial purposes. It is climate controlled automatically by ventilation and blinds. Torkild Kristensen says that his energy use is 1/5 of the average, while the cost of the construction has been the same as an average single family dwelling.

[Beim, 2002]

Ill. 57-58 Torkild Kristensen, house in a greenhouse

SWIM BATH, NUUK, TEGNESTUEN NUUK, KHR ARCHITECTS

Ill. 59 The large window facade towards south

Relation to the context
When building in the arctic, it is important that the building relates to the surroundings both with regards to climate and nature. This project is designed from this vision.
The south turned double glass facade lets in the sun and lights up the deep space, while allowing great views over the bay. The north facade is completely closed towards the mountains to minimize heat loss. The construction and orientation is optimized to resist the tough climate. The building respects the wind and snow patterns of the site.

Technical solutions
The double facade is ventilated with warm dry air to avoid vapor on the glass. The air gap between the two glass walls is highly insulative while still allowing natural daylight and an extraordinary view.
[WEB 8]

MAGGIES CANCER CENTRE, LONDON, BY RICHARD ROGERS

Ill. 60-61 Flexibility and a green relaxing environment is the main concept of the project.

Richard Rogers awarded cancer centre, focuses on the private atmosphere and flexibilty in the plan.
Interior walls lets in daylight along the ceiling to avoid exposure to the outside and while still allowing the daylight to fill up the space.
Small inner courtyards and a surrounding garden gives a recreational and private atmosphere. [WEB 9]

COMPLEX ORDINARINESS

As a theoretical background for the project the following chapter describes an architectural thinking outlined by the term "complex ordinariness". A contextual approach which praises the aesthetic of traditional architectural elements.

"Complex ordinariness" is the title of a book written by Bruno Krucker. The book is about the work of The Smithsons and it describes a tendency within architectural thinking that intentionally refrains from the spectacular architecture and instead aims for a contextual interpretation of traditional architectural elements.

More contemporary architects following this tendency are amongst others, the English firm Sergison Bates and the Swizz, Miller & Maranta. The characteristics of their architecture are a subtle and refined reinterpretation of well known architectural elements in the context. The buildings look familiar but with a slight distortion.

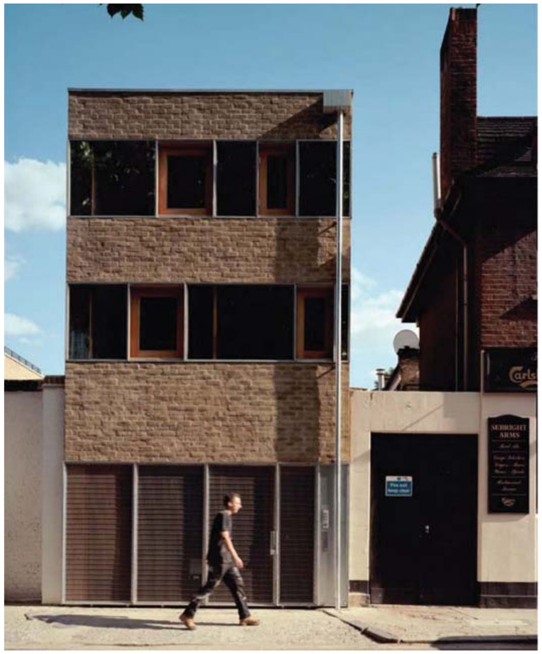
This "everyday" aesthetic aims to make the user aware of place and time as opposed to blinding him in the confrontation with a complete new and different architectural language. This is done by working with nuances and details like the example shown on ill. 62.

This swizz guesthouse in Castasegna is in its architectural language closely connected to its surrounding building volumes, but when looking closer, the well-known elements are distorted and tailor-made to fit the interior concept of a spiral staircase surrounded by irregularly scattered rooms.
Also the tower shaped extrusion of the surrounding geometry makes the building stand out will still fitting into the context.

Another example of this tendency is Sergison Bates multifunctional townhouse placed in East London. Traditional elements like the rainwater pipe and the brick wall are taken out of their typical position. The heaviness of the brick wall is dissolved into layers by the long bands of windows and the variation in window depth gives the facade a three-dimensional expression.
This layering of the facade tells the story of a multilayered house offering space both for housing, ateliers and therapeutic clinique.

These two modern examples of "complex ordinariness" shows architecture which has sprung from its place, time and function. It takes advantage of its surroundings but it also breaks from it and takes a standpoint.
[Krucker, 2002]
[Kristensen, 2006]

Ill. 62, Villa Garibaldi, by Miller & Maranta



Ill. 63, Studie House, by Sergison Bates Architects

ROOM PROGRAMME

The room programme divides the building into three different types of spaces. The community room, the social rooms and the private rooms.

The room programme is based on a plan layout of a family house in Ilulissat [Appendice: Proposal for family centre, Ilulissat], the programme written for "Væksthuset" [Appendice Væksthuset] and on talks with Helga Nielsen, manager of Health and Prevention in North Greenland, municipality of Quaasuitsup.

	BR06 - Greenland standards	CR 1752 - Indoor climate standards
Comfort category		B
Ventilation rate (min)	0,35 l/s	
Daylight levels (min)	10% of floorarea	
Operative temperature - summer (1,2 MET)		23°C-26°C
Operative temperature - winter (1,2 MET)		20°C-24°C

Room category	Use	People load	Number of rooms	Area	Total area
Community room	Community events	20-40	1	50 m^2	50 m^2
Social rooms	Toilet Common room Storage Meeting room	- 10 - 20-30	1 1 1 1	5 m^2 50 m^2 5 m^2 50 m^2	5 m^2 50 m^2 5 m^2 50 m^2
Private rooms	Office Bedroom/apartment Toilet/shower Staff room Storage Stay Private talk rooms	1-6 1-2 - 6 - 10 6	3 2 1 1 1 1 3	10 m^2 15 m^2 10 m^2 20 m^2 5 m^2 20 m^2 10 m^2	30 m^2 30 m^2 10 m^2 20 m^2 5 m^2 20 m^2 30 m^2
Total area					285 m^2

ATMOSPHERE PROGRAMME

COMMUNITY ROOM

Community dinners 20-40 people
Visually connected to outside
Space for active use

SOCIAL ROOMS

A place for encounters
Casual stays and meetings
Welcoming and homely atmosphere

PRIVATE ROOMS

Private talks
No visual contact to outside
Homely and recreational atmosphere
Flexible

Ill. 64-66

DESIGN CRITERIA

Based on the program and the plans for the "Væksthus" developed by UNICEF, FGB and the municilpality, the design criterias listed below serves as guidelines for the further design proces.

ARCHITECTURAL/SPATIAL FEELING

THE PRIVATE SPACES SHOULD:

Give the feeling of being at home and safe.
Be adaptable to different needs. Flexible.

THE SOCIAL SPACES SHOULD:

Have a strong relation to the outside
.
Be a natural meeting point.

Emphasize a recreational atmosphere.

Express the seasonal changes in the surroundings.

IN GENERAL THE DESIGN SHOULD CONSIDER:

The sloping terrain.

The extraordinary view to the East (Store Ø and the harbour)

Keeping the movement and activity on the site.

The spatial qualities of the urban outdoor spaces of the town.

The historical buildings in the near context.

Using some of the same elements as used in the Greenlandic building tradition.

Be a natural part of the site, but also stand out at attract attention.

TECHNICAL CONSIDERATIONS

THE BUILDING SHOULD:

Represent regional qualities and arctic building tradition referencing materials, typologies and structure.

Take into consideration the relatively short building season.

Face the sun.

Face away from the polar wind.

Minimize the surface/volume area.

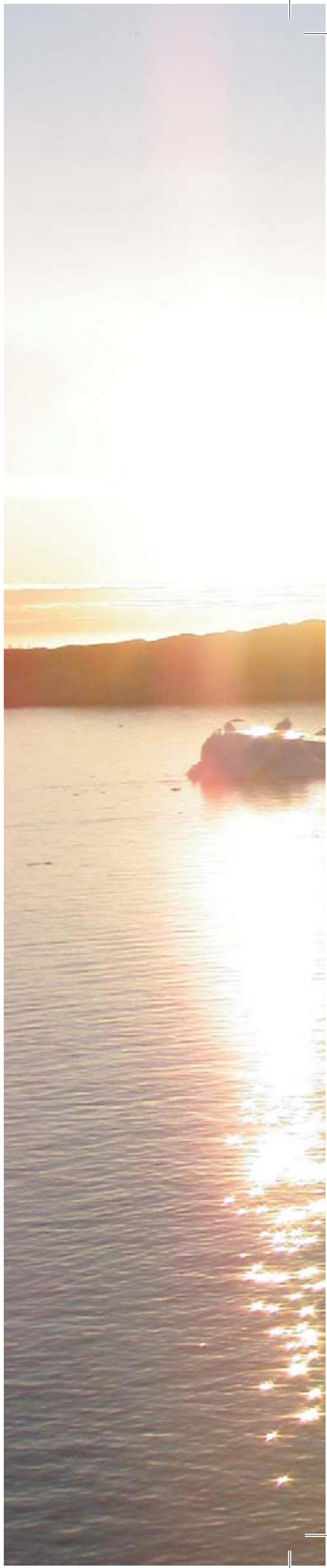
Avoid snowdrifts in front of entrances.

Avoid coldbridges.

Be heavily insulated.

VISION

The vision is to give a proposal to the planned family treatment centre in Uummannaq. The proposal offers space for both public and private functions.
The design refers in structure, typology and materials to the Greenlandic building tradition and the characteristics of the site. Taking the arctic climate into consideration the building uses energy saving principles.



INITIAL SKETCHING

As described earlier in the program, much of the work in this project is based on a studytrip to Uummannaq and on empirical investigations on site. To make a design that fit into this very extreme context it was necessary to go there to get a sense of the place and the people.

Therefore, the design process has taken departure in what is already there. The many years of adapting to this extreme arctic climate is seen in the way they chose to build their own houses.

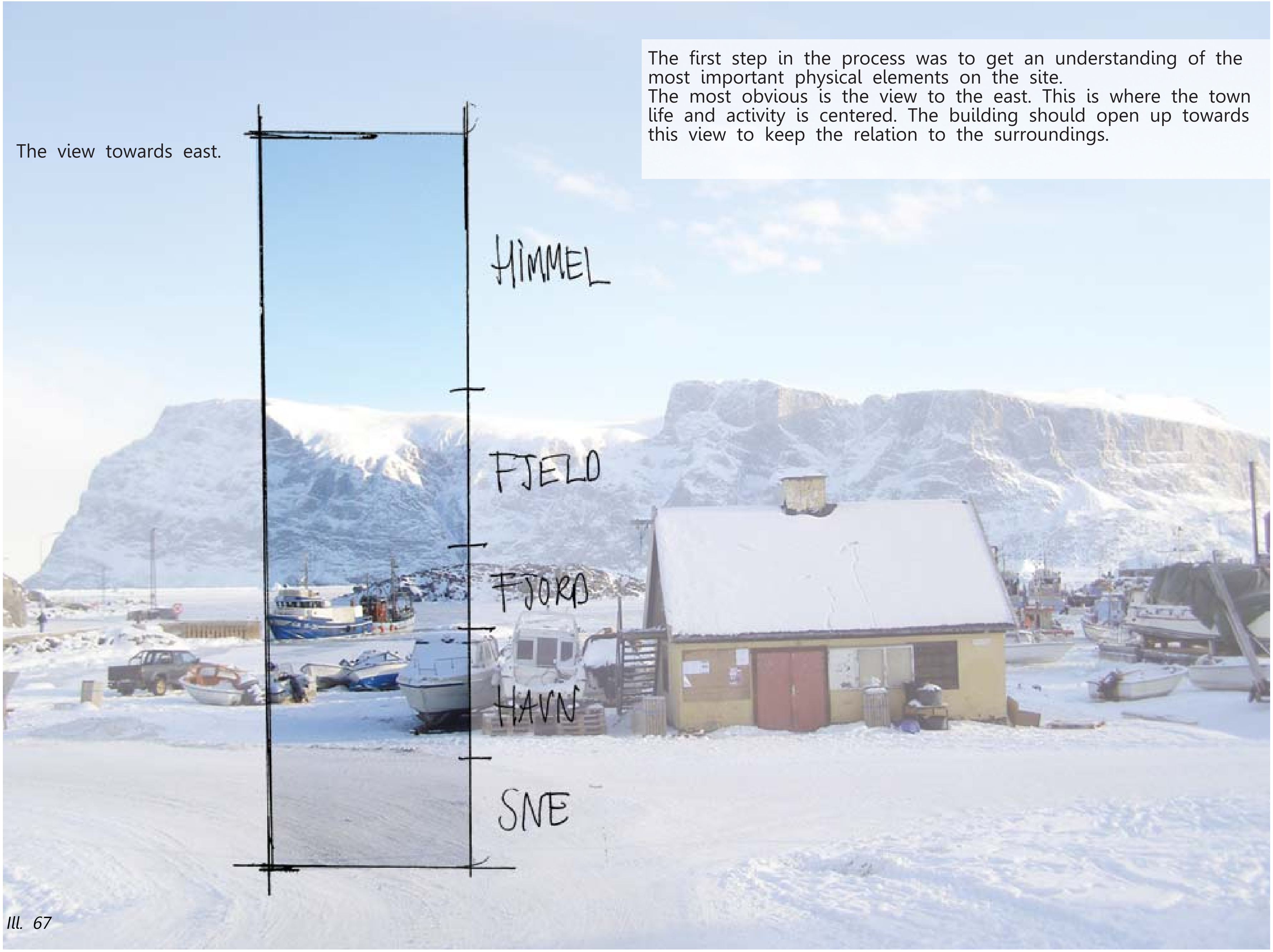
These early investigations were the starting point of the design process. Parallel to this, the toolbox of arctic building strategies stated in the program, was integrated in the early sketching phase. Considerations about saving energy and minimizing heat loss from the building surface has generated early design proposals as well as the more intuitive ideas.

The division between private and public spaces has been a leading parameter through the entire design phase. Form the overall concept sketch to the interior spatial expression.
The relation to the context has also been a consistent parameter in all scales. The flow and activity on the site as well as the view and character of the place have been important elements through all levels of the design.

UNDERSTANDING THE SITE

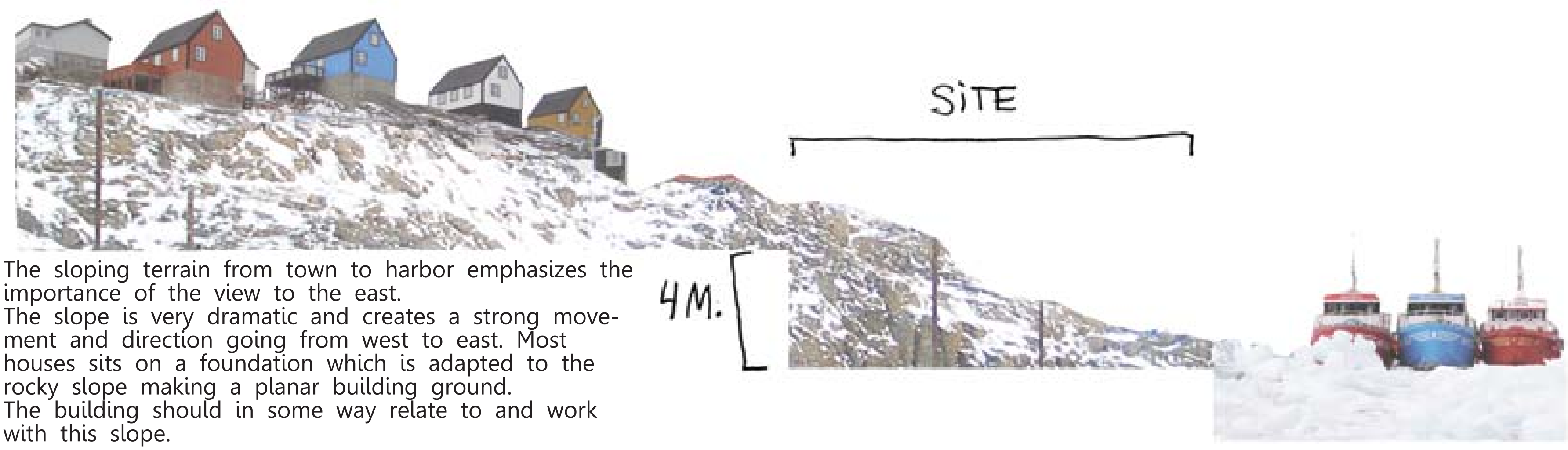
The first step in the process was to get an understanding of the most important physical elements on the site.
The most obvious is the view to the east. This is where the town life and activity is centered. The building should open up towards this view to keep the relation to the surroundings.

The view towards east.



Ill. 67

Ill. 68. The sloping terrain



The sloping terrain from town to harbor emphasizes the importance of the view to the east.
The slope is very dramatic and creates a strong movement and direction going from west to east. Most houses sits on a foundation which is adapted to the rocky slope making a planar building ground.
The building should in some way relate to and work with this slope.

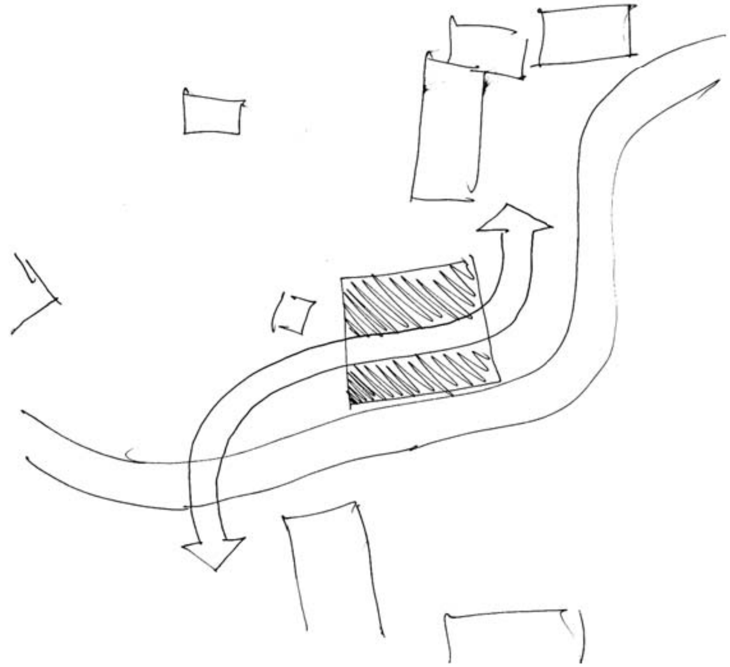
Ill. 69. Flow and movement

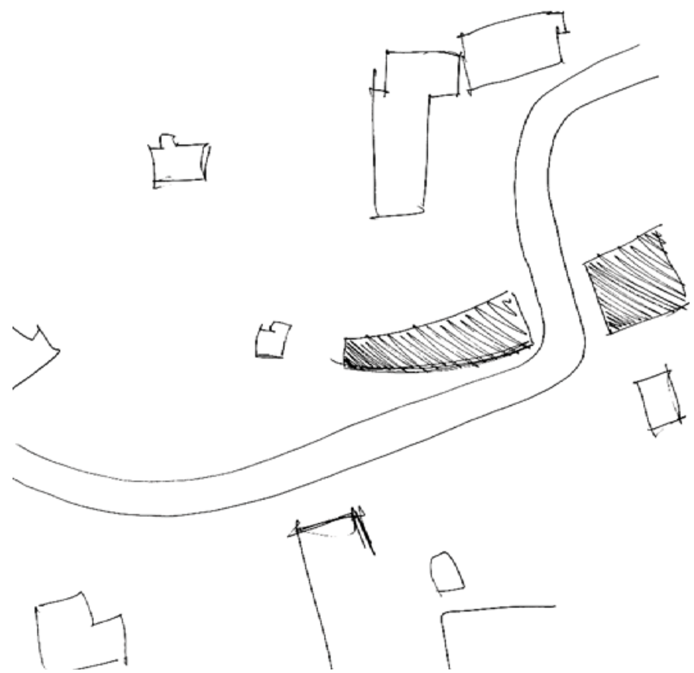
The activity and life on the site is very important. The movement between functions and the encounters between town people should be maintained and strengthened. Opening up the building to the present flow makes a new interesting town-space profiting from the central position of the site.

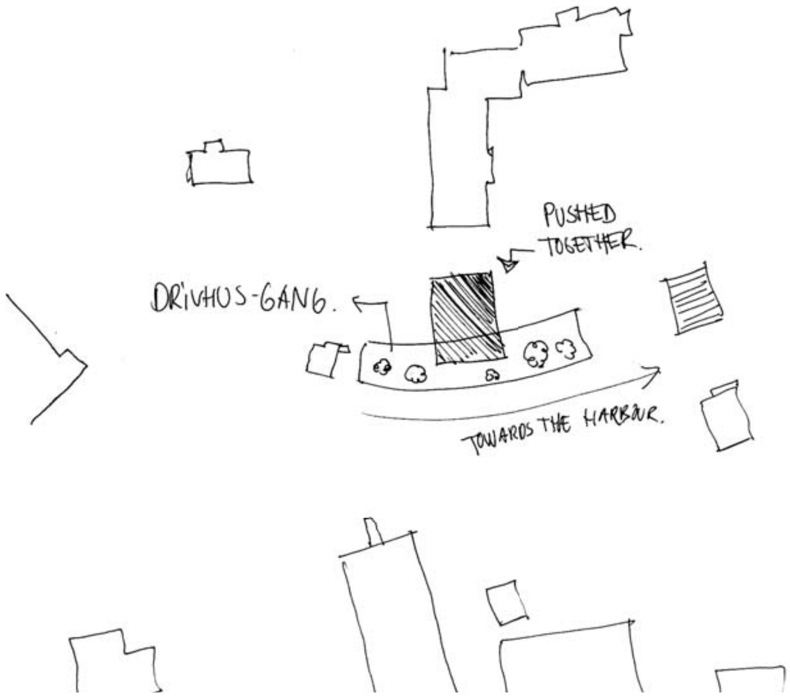
RELATIONS TO SITE

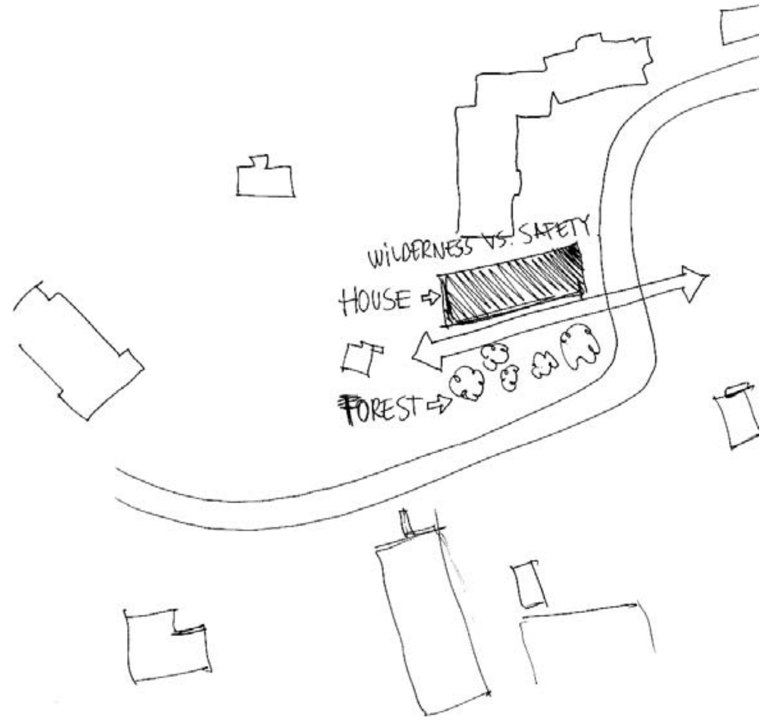
The next step was to find the overall concept for the relation to the site. One of the most important factors here are the flow through the building. The sketches show ideas with both one and multiple volumes. The fact that the building should contain both public and private spaces was important to incorporate from the beginning.
Some of the sketches also work with the building volume itself, creating a dynamic movement directed towards east.

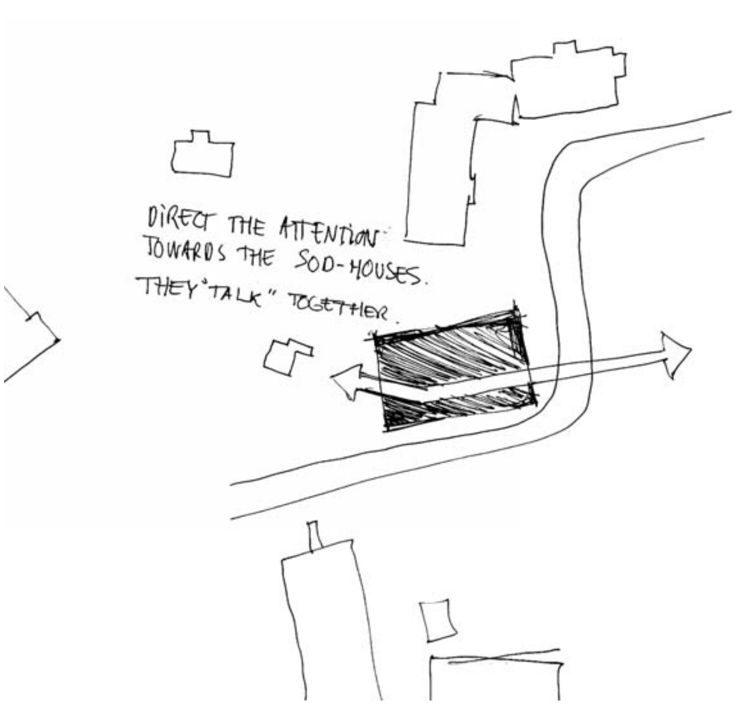
Basic design principles like minimizing surface area and heatloss, facing south and keeping a short edge towards the polar wind from east has been used for evaluation of the concept ideas.

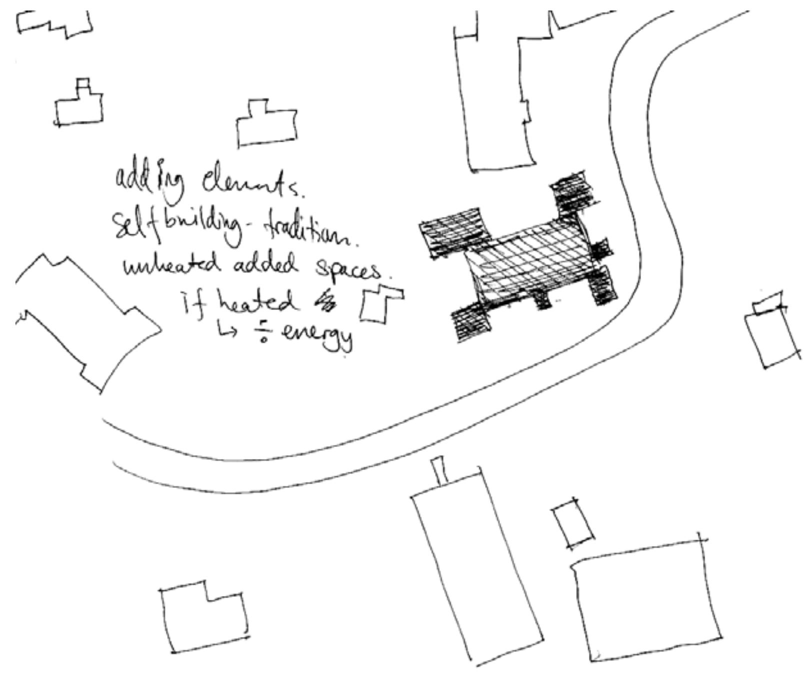




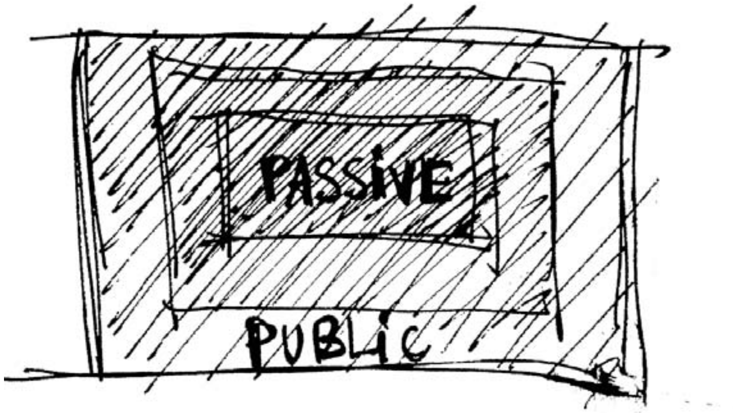

PUSHED TOGETHER.
DRIVHUS-GANG.
TOWARDS THE HARBOUR.

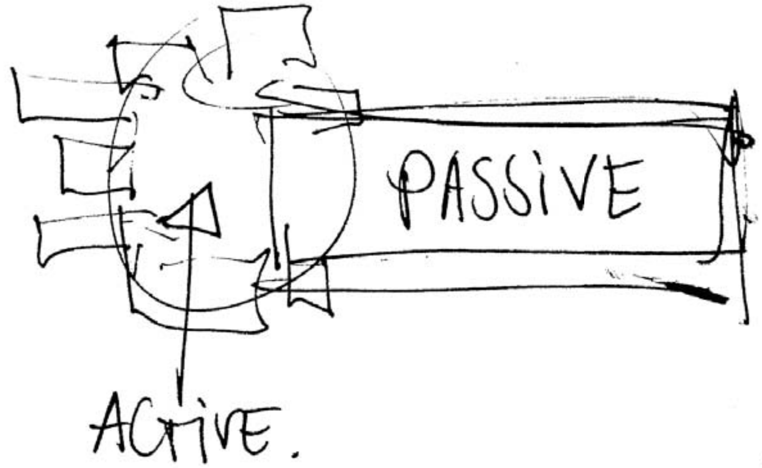

WILDERNESS VS. SAFETY
HOUSE ⇨
FOREST ⇨


DIRECT THE ATTENTION TOWARDS THE SOD-HOUSES.
THEY "TALK" TOGETHER.

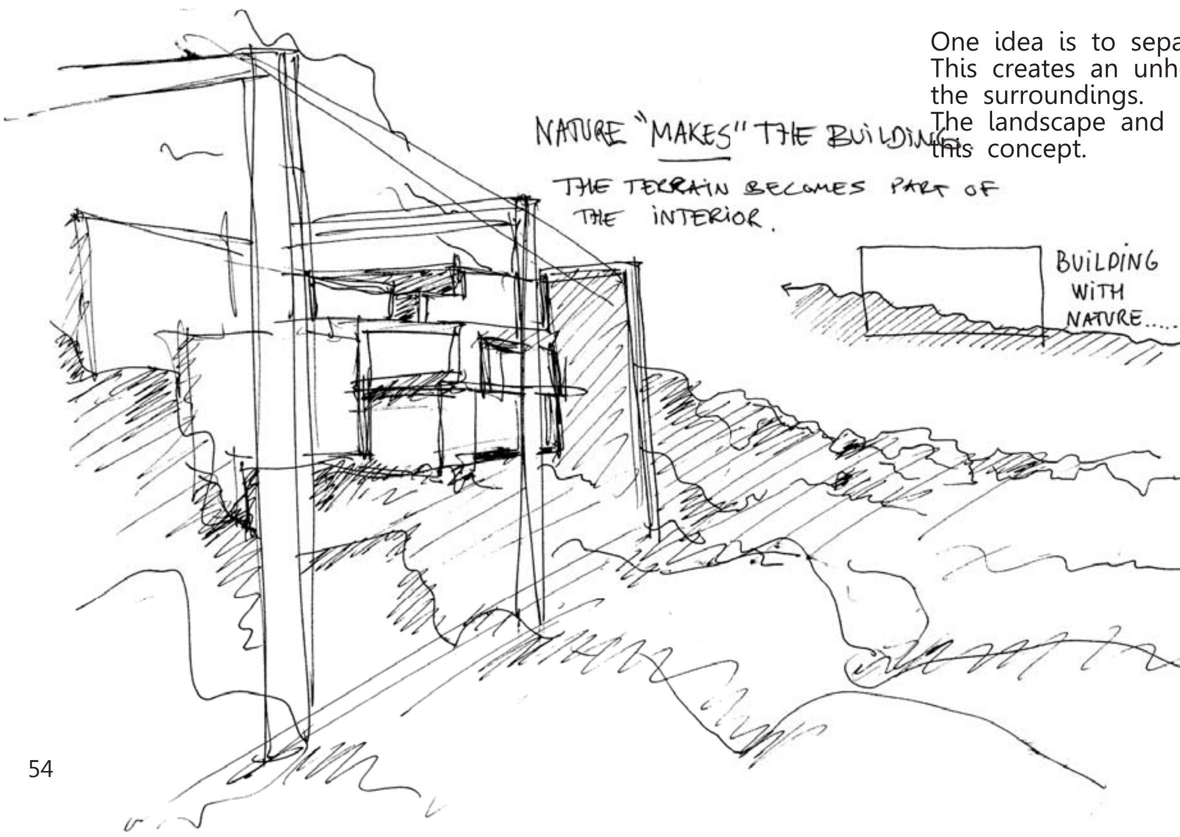

adding elements.
Self building - tradition.
unheated added spaces.
If heated 𝄽
↳ ÷ energy

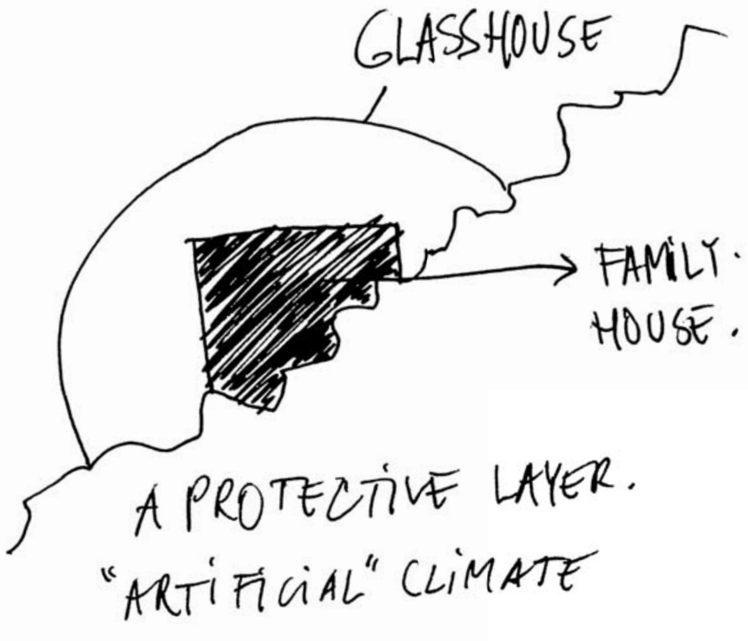
Zooming in and working more with the layout of the building volume itself, the issue of flow lines and private and public spaces are tightly connected to considerations about energy consumption.
The idea of having different climatic zones in the building volume are developed.

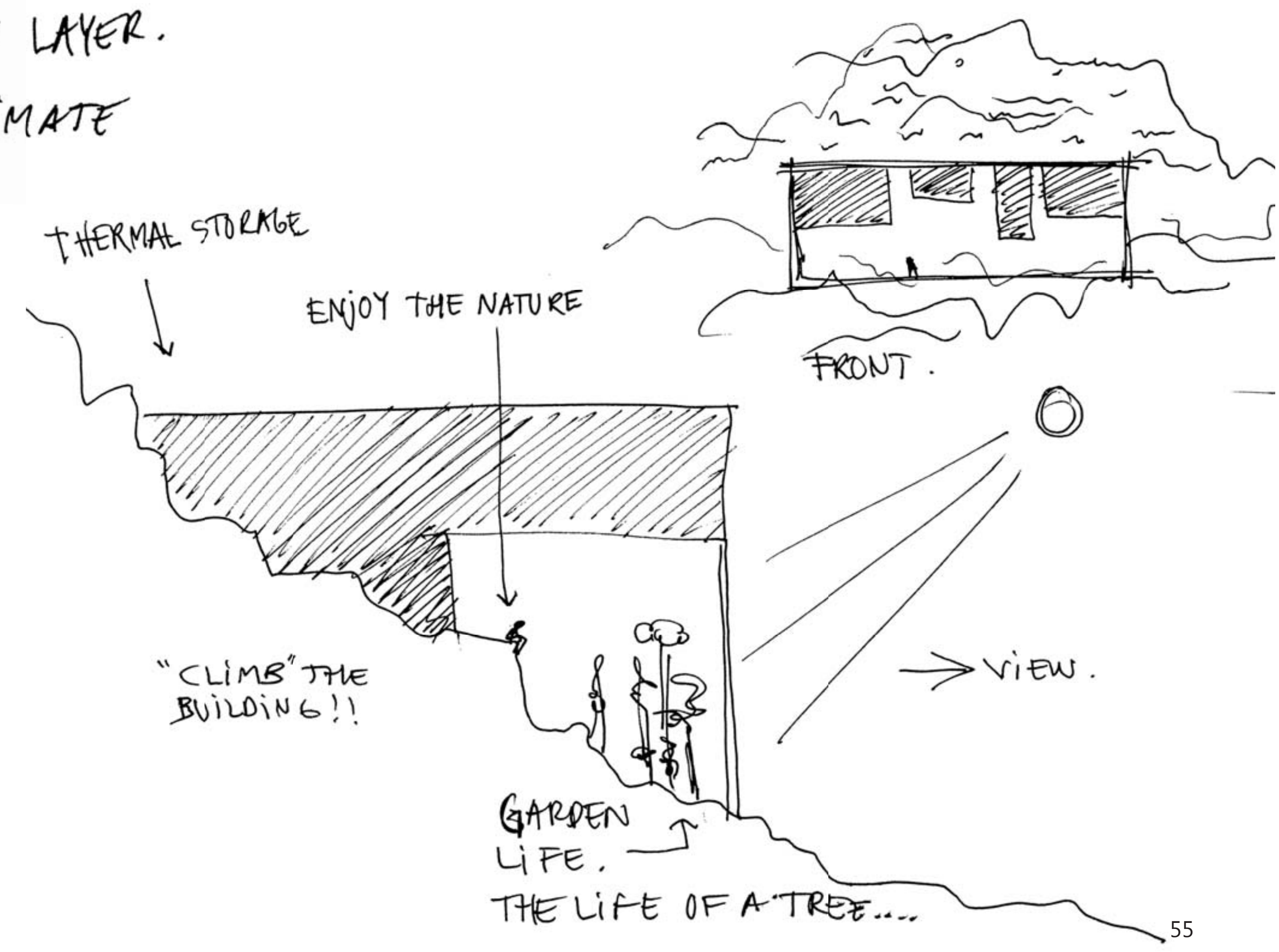




One idea is to separate the building envelope from the insulation. This creates an unheated semi outdoor space with a strong relation the surroundings.
The landscape and terrain becomes the interior of the building in this concept.



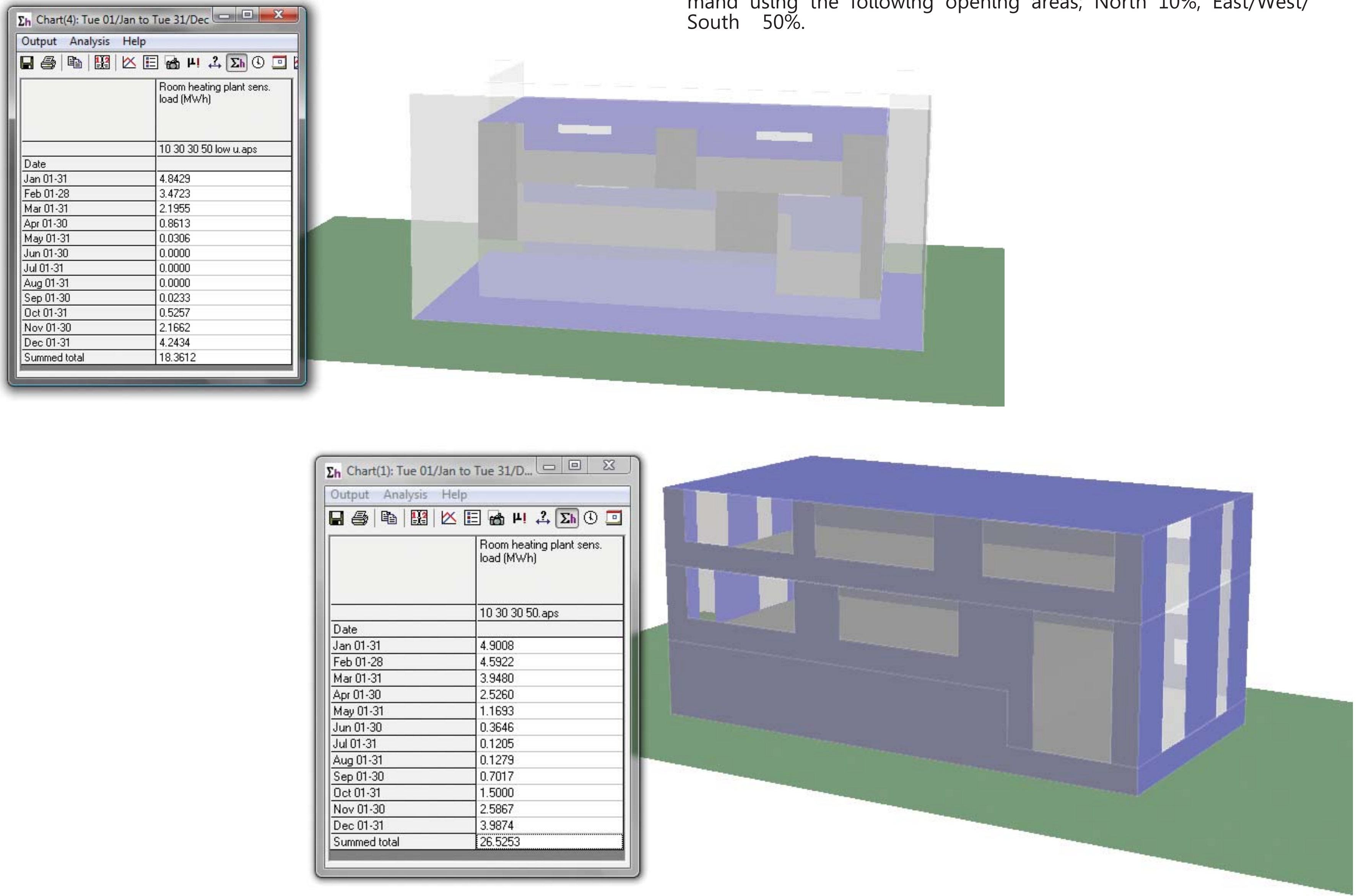

GLASSHOUSE
FAMILY.
HOUSE.
A PROTECTIVE LAYER.
"ARTIFICIAL" CLIMATE


FRONT.
THERMAL STORAGE
ENJOY THE NATURE
"CLIMB" THE
BUILDING!!
VIEW.
GARDEN
LIFE.
THE LIFE OF A TREE....

TESTING THE CONCEPT

The concept of separating the envelope from the insulation, creating two different thermal climatic zones is further developed and tested out using IES VE for calculating the energy consumption.

Testing the gain in energy savings by adding an extra layer of glass on all facades shows a reduction of 30% in the energy demand using the following opening areas; North 10%, East/West/South 50%.



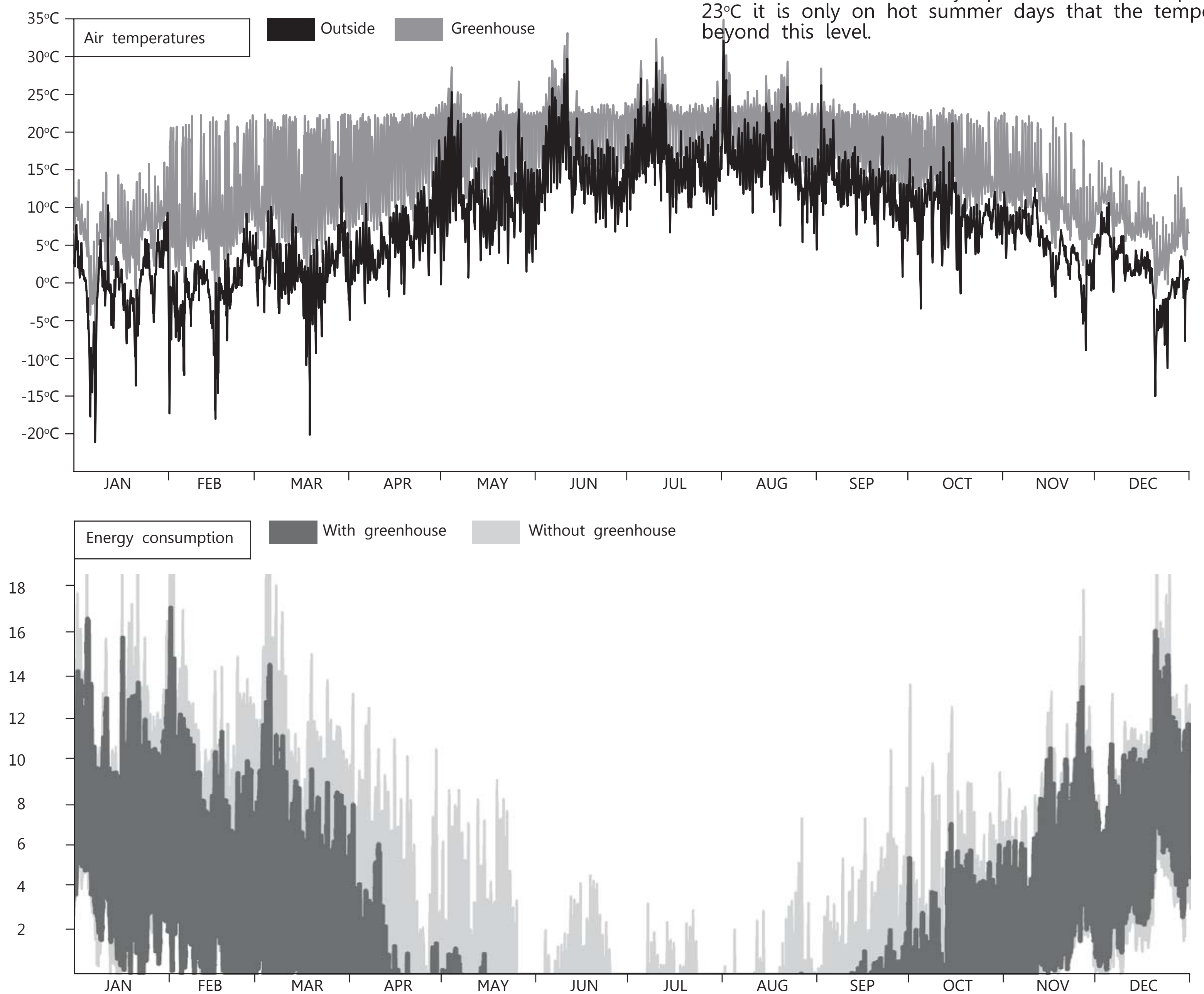
	Room heating plant sens. load (MWh)
	10 30 30 50 low u.aps
Date	
Jan 01-31	4.8429
Feb 01-28	3.4723
Mar 01-31	2.1955
Apr 01-30	0.8613
May 01-31	0.0306
Jun 01-30	0.0000
Jul 01-31	0.0000
Aug 01-31	0.0000
Sep 01-30	0.0233
Oct 01-31	0.5257
Nov 01-30	2.1662
Dec 01-31	4.2434
Summed total	18.3612

	Room heating plant sens. load (MWh)
	10 30 30 50.aps
Date	
Jan 01-31	4.9008
Feb 01-28	4.5922
Mar 01-31	3.9480
Apr 01-30	2.5260
May 01-31	1.1693
Jun 01-30	0.3646
Jul 01-31	0.1205
Aug 01-31	0.1279
Sep 01-30	0.7017
Oct 01-31	1.5000
Nov 01-30	2.5867
Dec 01-31	3.9874
Summed total	26.5253

Ill. 70 Testing the concept in IES VE

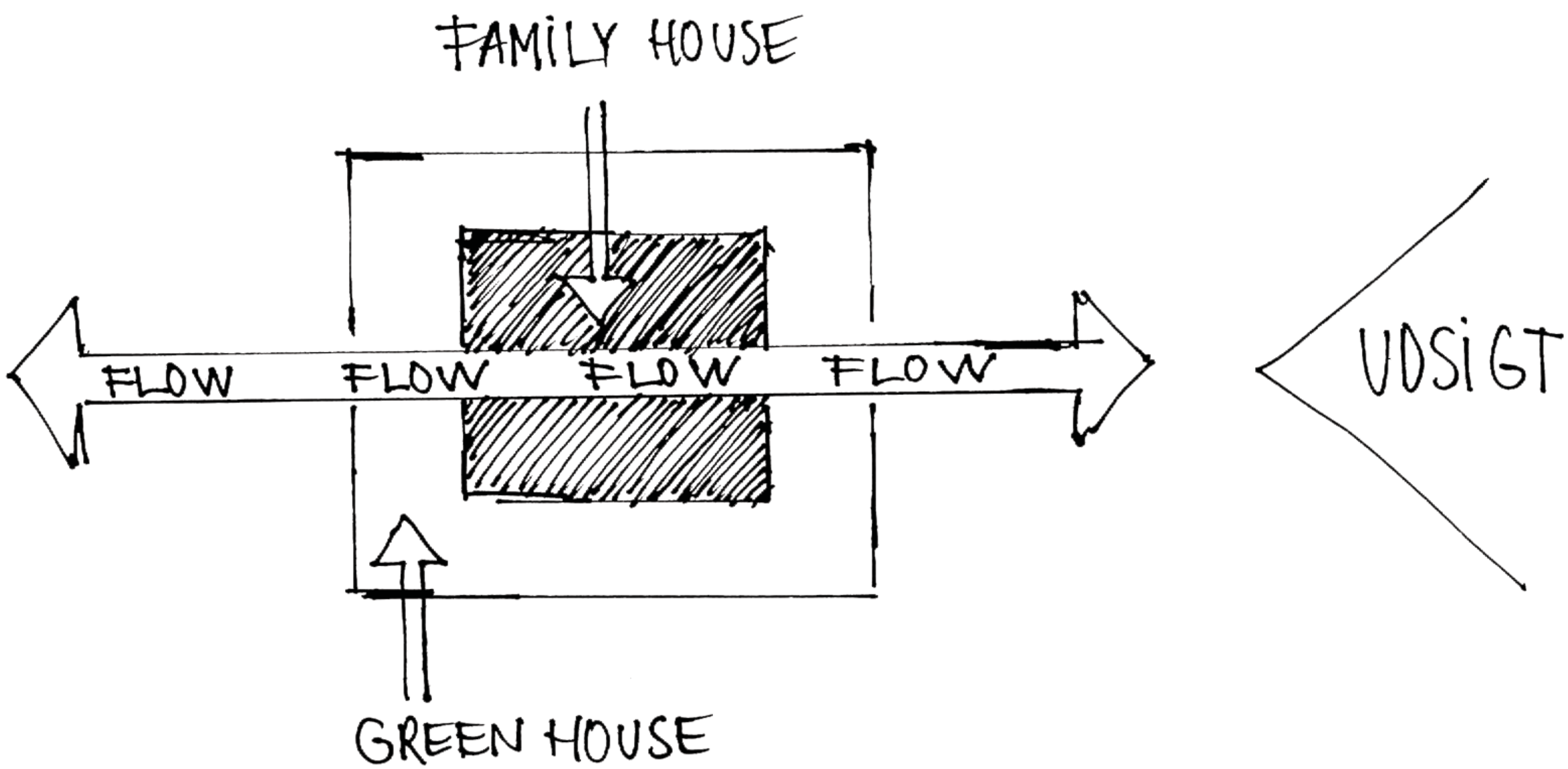
Ill. 71. The temperatures and energy consumption with and without the greenhouse

Figure 71 shows how the greenhouse creates a warmer climate only from solar gain and the heat emitted from the house inside. The temperatures lies around 20°C from march until October. As the roof windows automatically opens when the temperatures reaches 23°C it is only on hot summer days that the temperatures goes beyond this level.



CONCEPT SKETCH

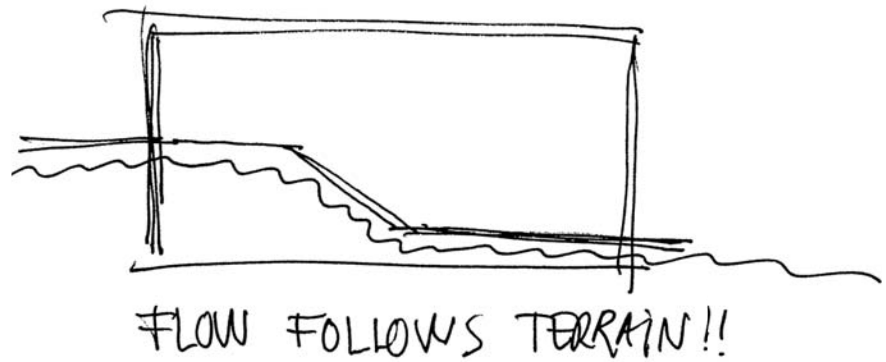
The concept sketch shows the very basic elements of the building; The external envelope separated from the inner insulated volume. Furthermore it shows the flow going through the entire volume in the direction west-east emphasizing the view to the harbour.

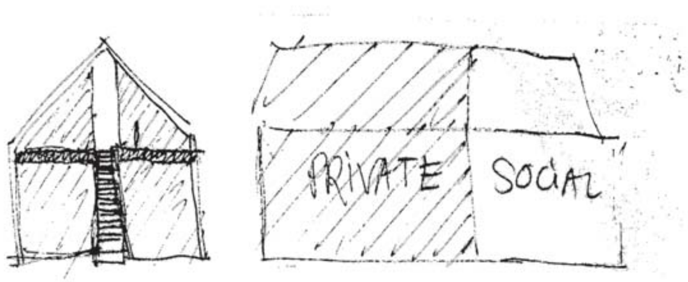


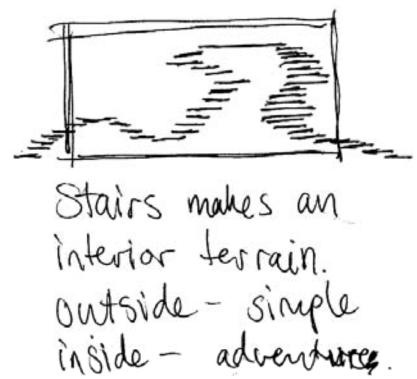
Ill. 72. Initial concept in plan

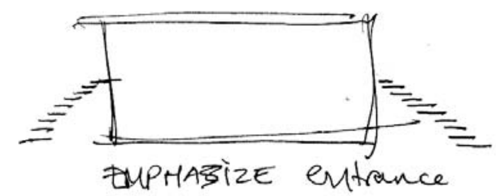
FLOW AND OVERALL ORGANISATION OF ROOMS

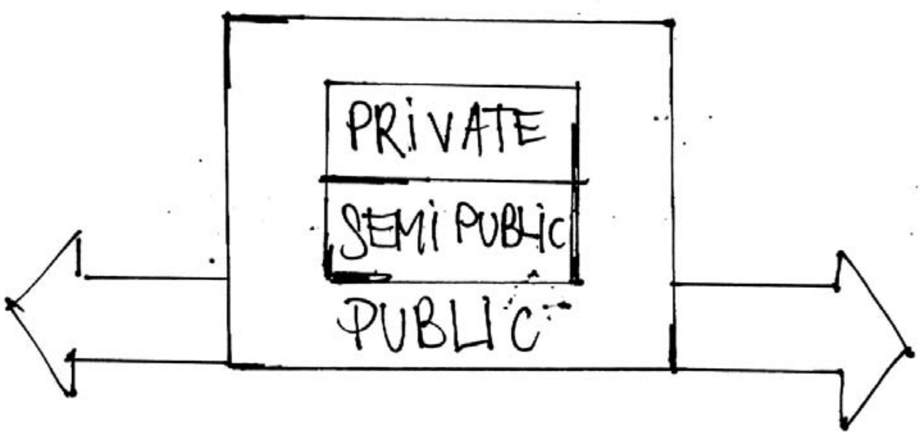
The concept sketch is further developed both in plan and section. Working with the entrances and the flow concept inside the building gives ideas to how to divide the social spaces from the private. The entrances are important elements in an arctic climate as they must be free of snow and serve as wind locks.

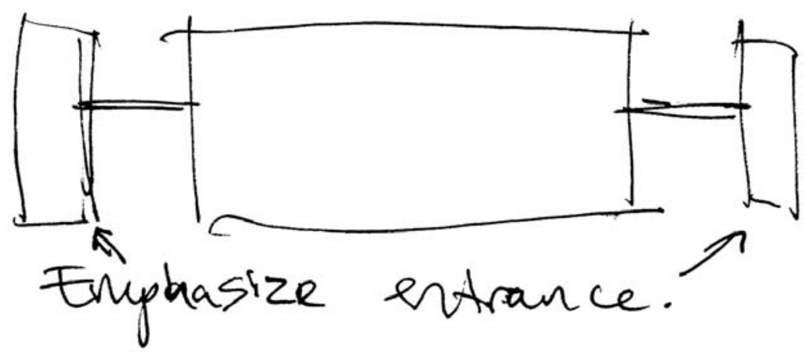




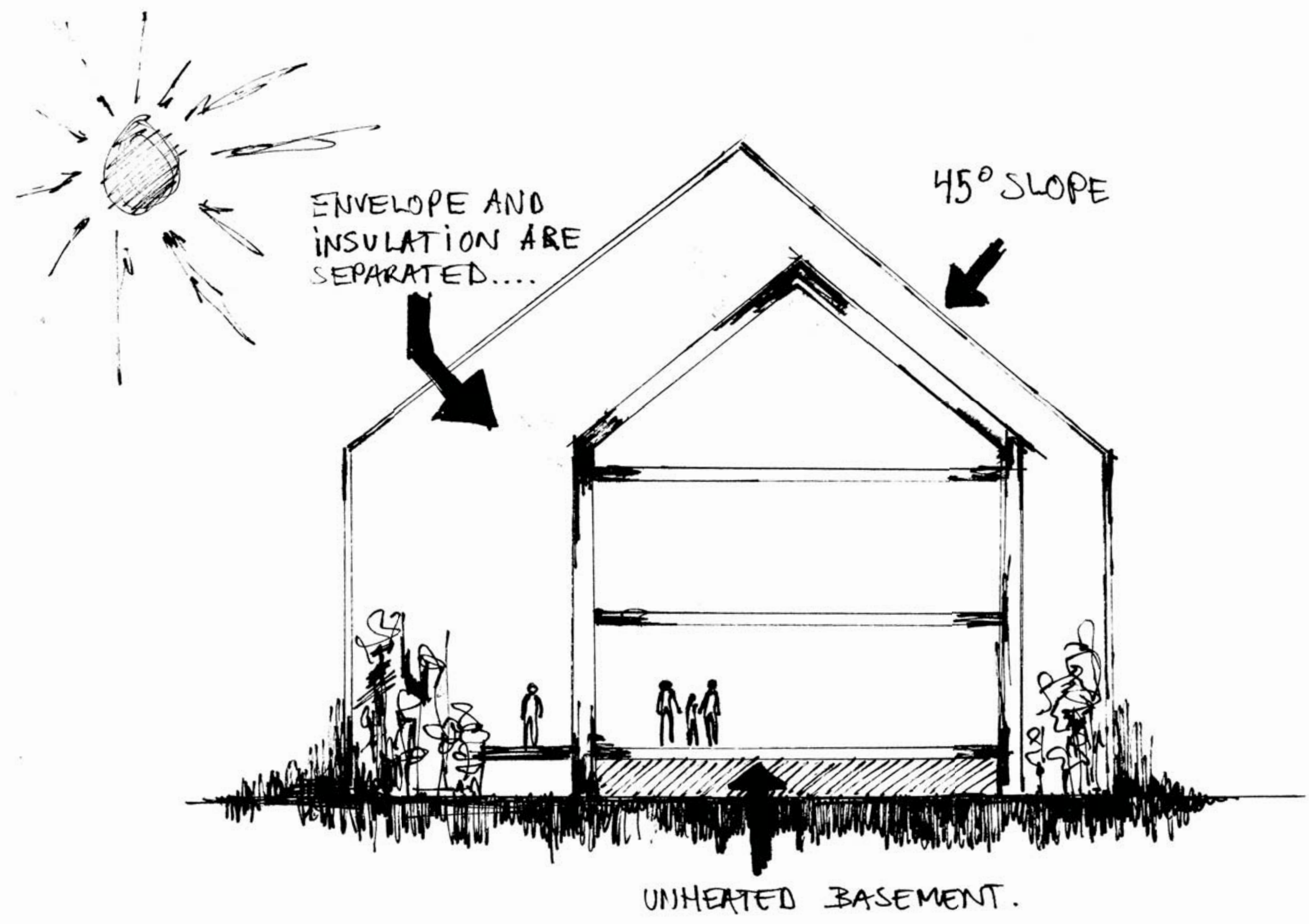








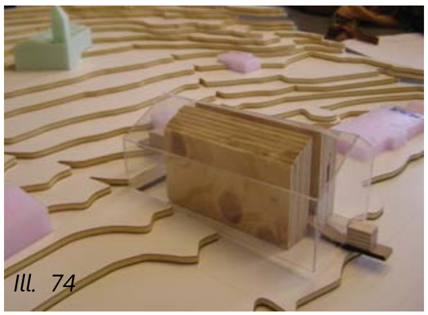
This sketch shows a section of the principle of separating the envelope with a protective layer of glass, from the insulation. The concept creates a semi outdoor space which as the same time works as a thermal buffer zone.
The thermal climate inside the glass layer gives the possibility of growing plants. Like in a greenhouse.



Ill. 73 Initial concept in section

SHAPING THE CONCEPT

The further development of the concept was to start working with physical models. It gave a better understanding of the buildings mass and its relationship with the transparent surfaces of the greenhouse. The heavy structure sits as a monolithic contrast to the light and transparent greenhouse.
Elements from the Greenlandic building tradition are reinterpreted into the functionality of the family house.
The sloping terrain is in different ways merged with the movement through the building.

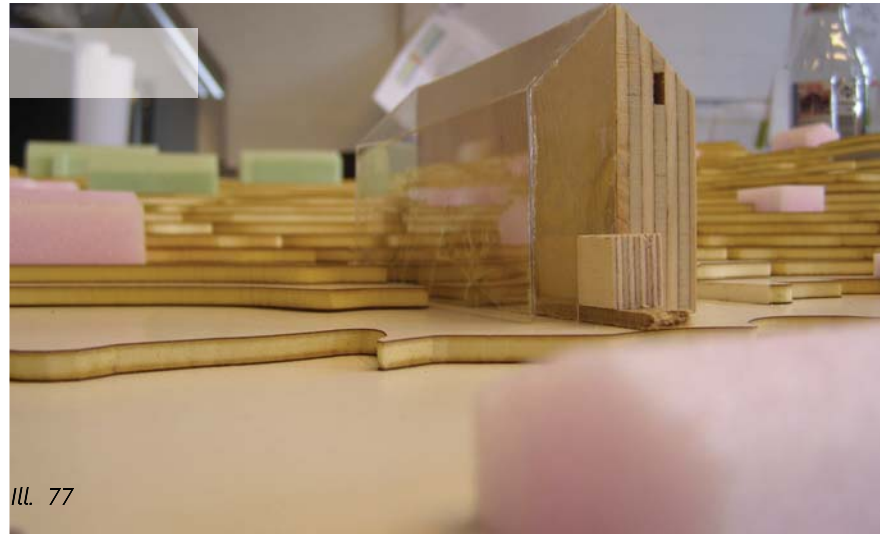


Ill. 74

Ill. 75

Ill. 76

The monolithic expression of the building is very strong in the idea shown on ill. 74-76 above. Cutting the volume through the middle making a very strong axis of direction east-west. The symmetrical and almost monumental shape brings the flow through the centre of the building and thus the division between private and public is not very strong. The flow through the building seems more formal as people are forced to pass through the building. Also the heat loss would be larger as the cold air from the green house will enter the building every time the door opens and people walk through.

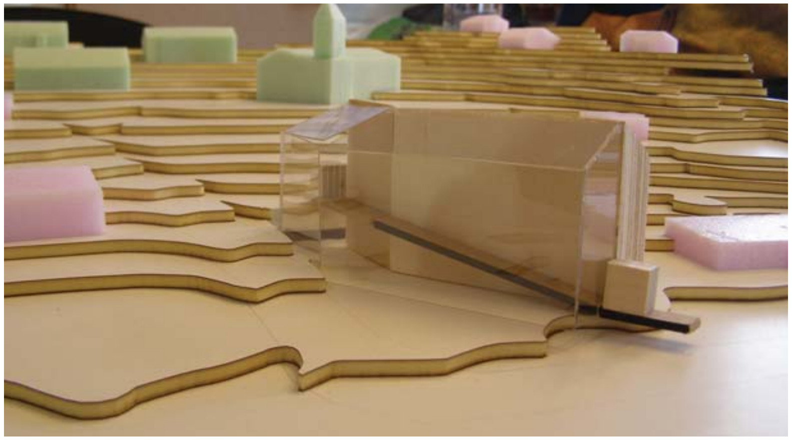


Ill. 77

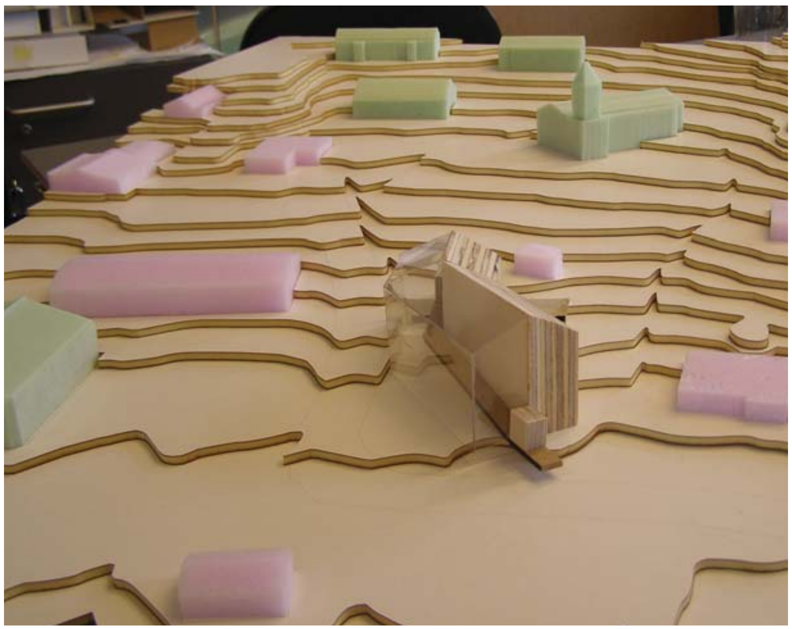
Ill. 78

This idea divides the green house and the family centre into two equally sized parts. The greenhouse only covers the south facade which means that the east, west and north facades have a larger heat loss. The iconic shape of the Greenlandic home is emphasized having a 45 degrees sloping roof. The flow through the building goes straight east west, and there is a clear division between private (the house) and public (the green house).

Ill. 79



Ill. 80



Ill. 81

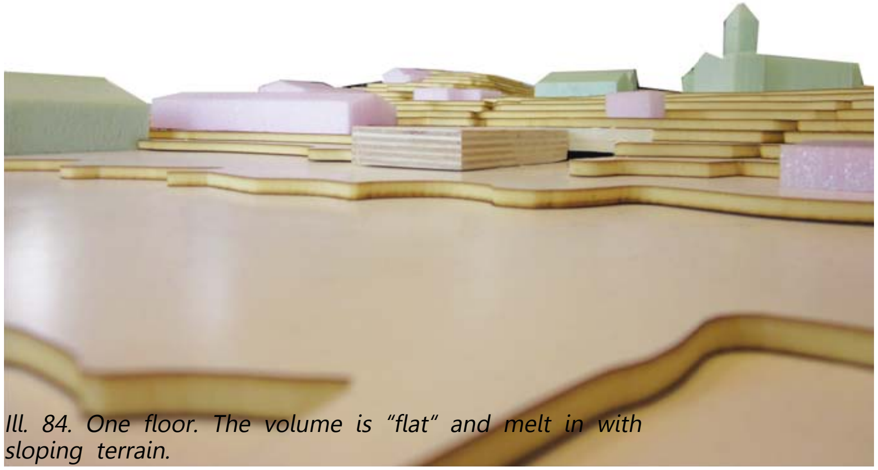
Ill. 82

Ill. 83

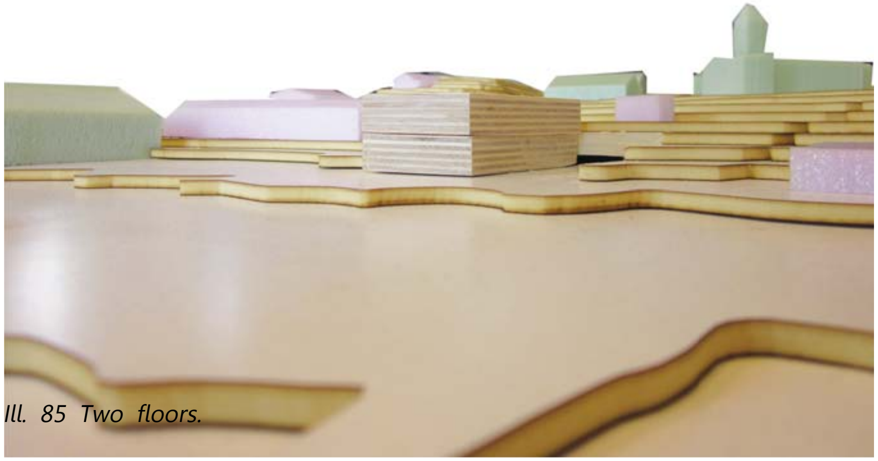
This proposal breaks up the strong east-west direction. The building turns towards the sod house situated next to the west facade. Making this turn, it dissolves the edge marking the street and breaks away from the grid lines of the larger building volumes in the context (the school, the warehouse, the nursing home, supermarket).
As the building has an "extra" corner, it also has increased heat loss caused by the linear thermal transmittance.

The iconic shape of the Greenlandic home is tested out in different variations. Changing this shape has a great influence and the result is an unfinished expression. The shape is unfulfilled.

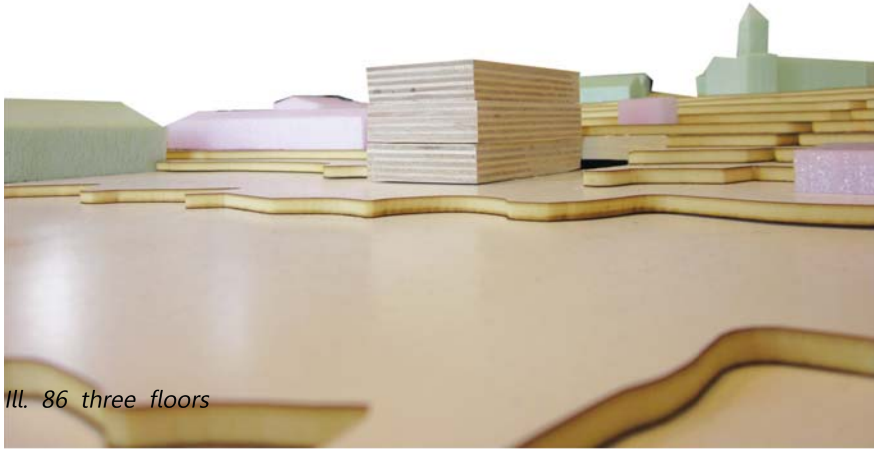
VOLUME STUDIES



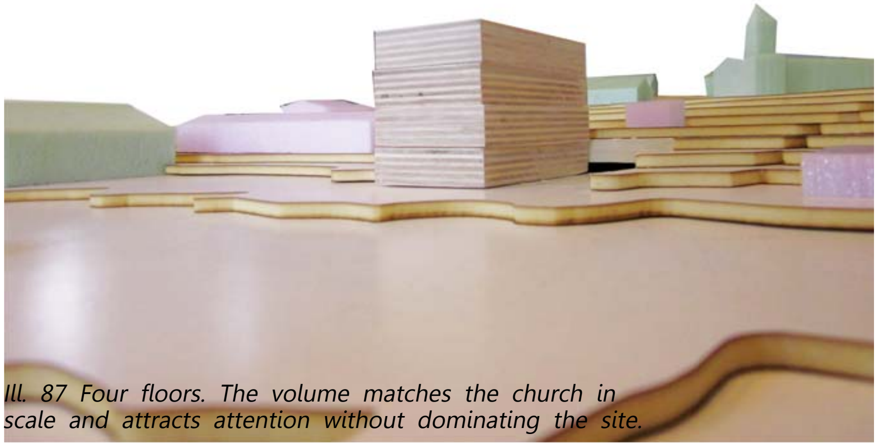
Ill. 84. One floor. The volume is "flat" and melt in with sloping terrain.



Ill. 85 Two floors.



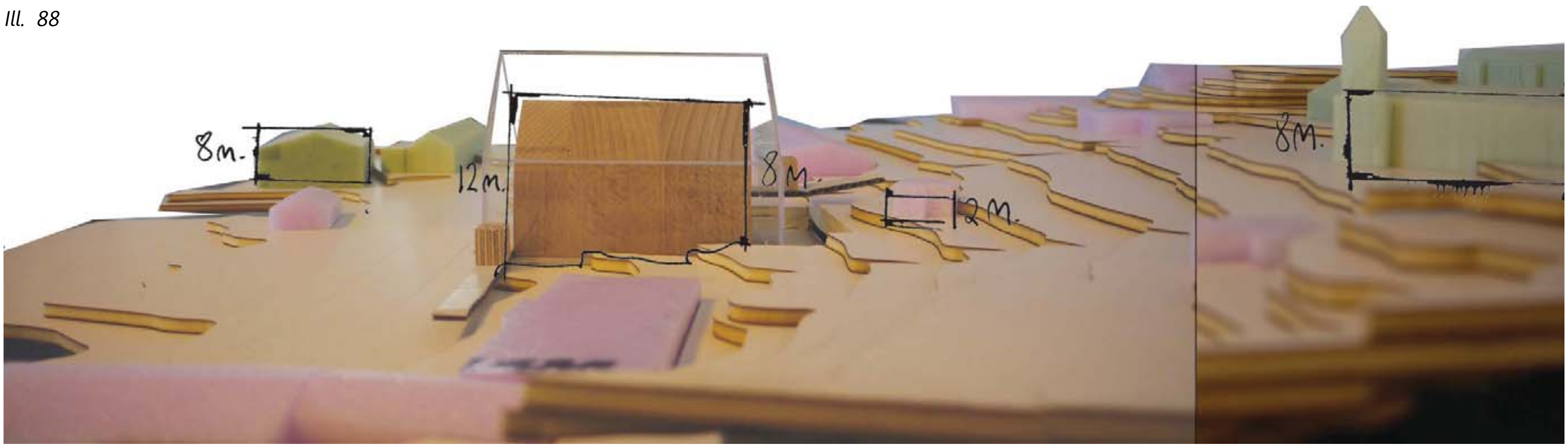
Ill. 86 three floors



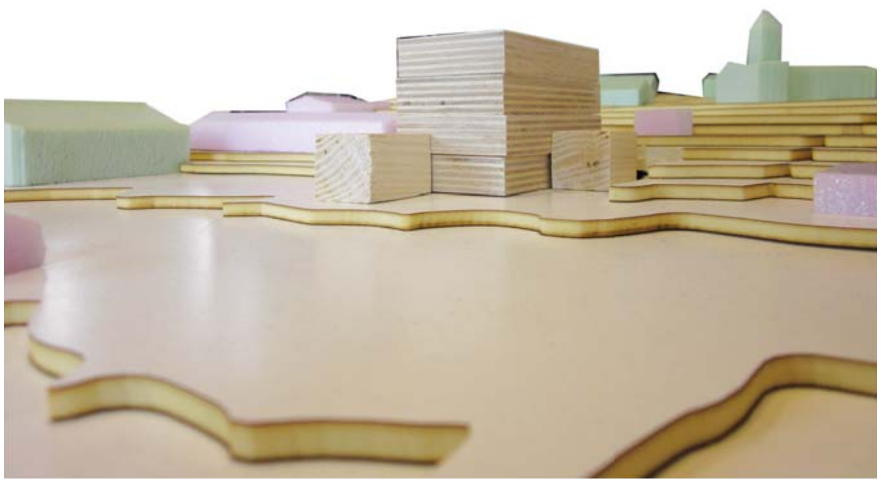
Ill. 87 Four floors. The volume matches the church in scale and attracts attention without dominating the site.

Volume studies showed that the building should match the larger volumes already existing. Following the design criterias it should attract attention but at the same time be a natural part of the site. The church and the warehouses both have a height of 8 meters. Tests are made with 1-4 floors of each 3 meters.
The sloping terrain has an influence on the way the building volume is experienced. There is a difference in terrain of four meters from east to west. This means that the eastern side will be 4 meters smaller than the western side.

Ill. 88



Ill. 89 The smaller volumes relates to the small sod houses sorrounding the building.



Volume studies also showed the need to work with both large and small scale building volumes. The mix of large dominant volumes at the harbour and the 2,5 m. sod houses adds a human scale to the site. This is important to consider in the further design. To make the building volume fit into the context as a natural part of the site it should match the already existing volumes. Both large and small.

INITIAL CONCEPT

The initial concept is a simple building volume protected from the external arctic climate by a glass layer with the exact same typology but scaled up. This extra glass skin detaches the house from the exterior by creating a semi outdoors environment with a climate warmer than the outside. The glass house offers the possibility for the users to actually grow plants. It adds a "green zone" to the town and let the children experience a three growing.
The two wind locks attached to west and northern sides and the building geometry itself reflects the typical elements from the Greenlandic building tradition, but in a new way that fits the needs of this specific site and function.

A wooden footbridge connected to the network of footbridges scattered around the town [chapter; Climbing the town] takes the movement of people through the greenhouse instead of around it. The greenhouse becomes a new public town space.
The footbridge follows the sloping terrain.

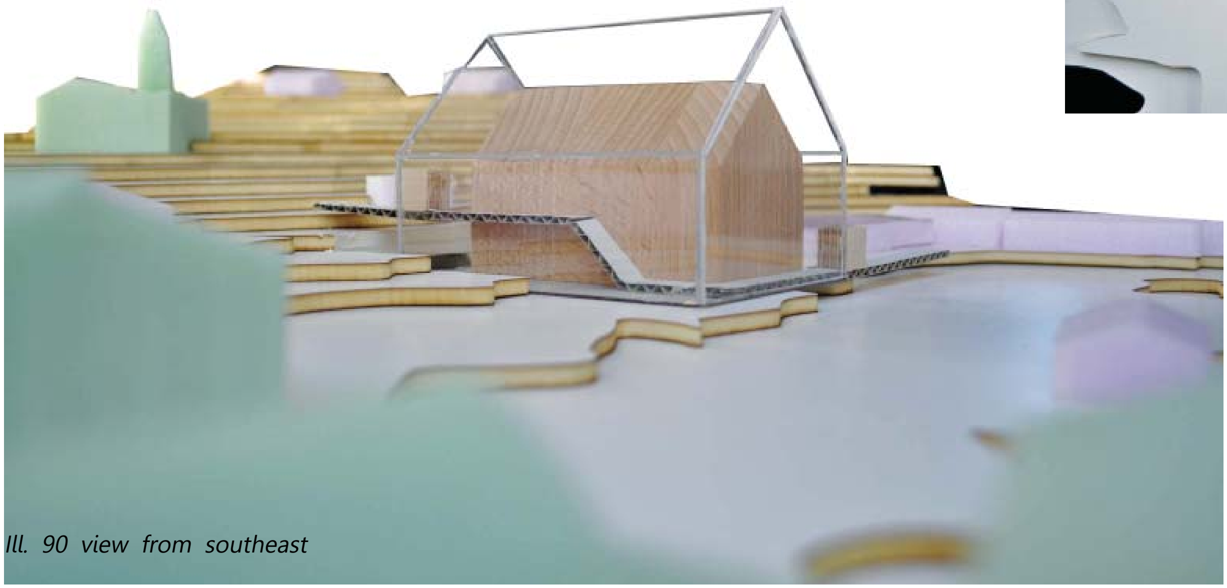
The shape of the building emphasizes the edge of the street following the east and south sides of the greenhouse.

The long side of the building faces south and the short side faces the wind direction. The compact and simple geometry keeps the linear thermal transmittance to a minimum.

In scale it matches the large warehouses and the church.

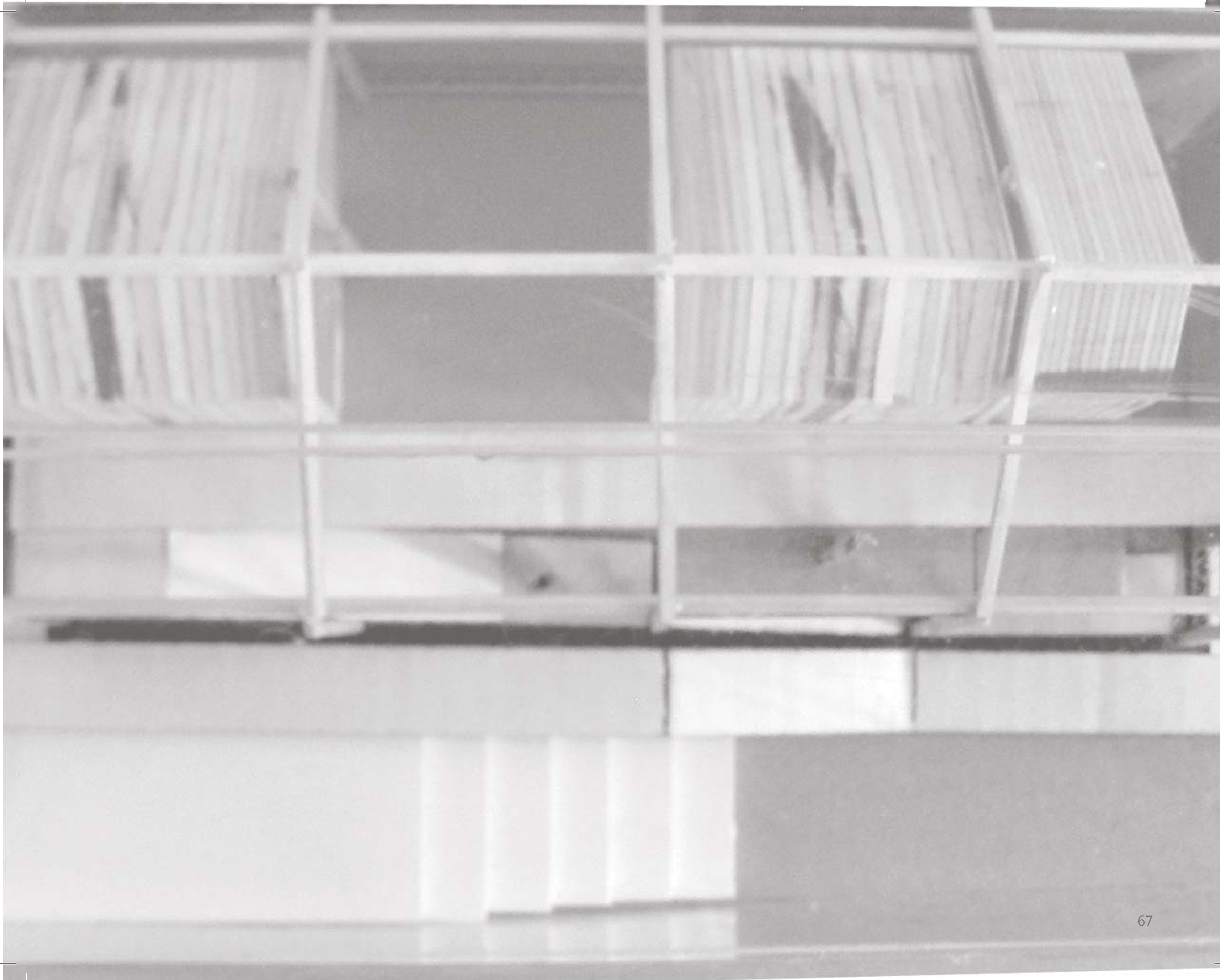
Ill. 91 view from northeast

Ill. 92 view from above



Ill. 90 view from southeast

DETAILING



THERMAL ANALYSIS 1

Virtual Environment has been used as a tool to find the window area and make decisions about surface orientation. A simplified model of the family centre with the properties listed is seen on ill. 93 This properties has been basis for the investigations made.

Looking into solar gain, energy consumption, heat loss through surfaces and overheating this tool has been helpful when making decisions.

Two different window types has been tested out. One with a low U-value to minimize heat loss through the windows and one with a high solar energy gain (g-value). The window type with a low U-value will let less heat out through the surface but will also let less solar heat in through the surface.
In the same way the type with a high g-value will let out more heat, but also let in more energy from the sun.

Testing these two types of windows shows how the energy consumption and indoor climate varies depending on solar gain and heat loss through the surface.

The following figures (Ill. 94-97) shows this variation. Different solutions to the distribution of window areas and orientations are tested out using the two different window types. The window types used have the following properties;

WINDOWS LOW U:

U: 0,7 W/M^{2}K

G: 0,5

LT: 0,67

WINDOWS HIGH G:

U: 1,11 W/M^{2}K

G: 0,62

LT: 0,8

IES VE MODEL PROPERTIES

Indoor temperatures 19^{o}C-23^{o}C
Internal gains people 90 W/pers (15 pers.), lighting: 1 W/m2
Infiltration 0.5 h-1
Natural ventilation when outside temperature is 19^{o}C-25^{o}C - 1 h-1
Mechanical ventilation on when CO2 level is more than 660 ppm, 3 h-1, Air temperature 19oC [appendice; Ventilation requirements]

Walls
U: 0,2 W/m2K

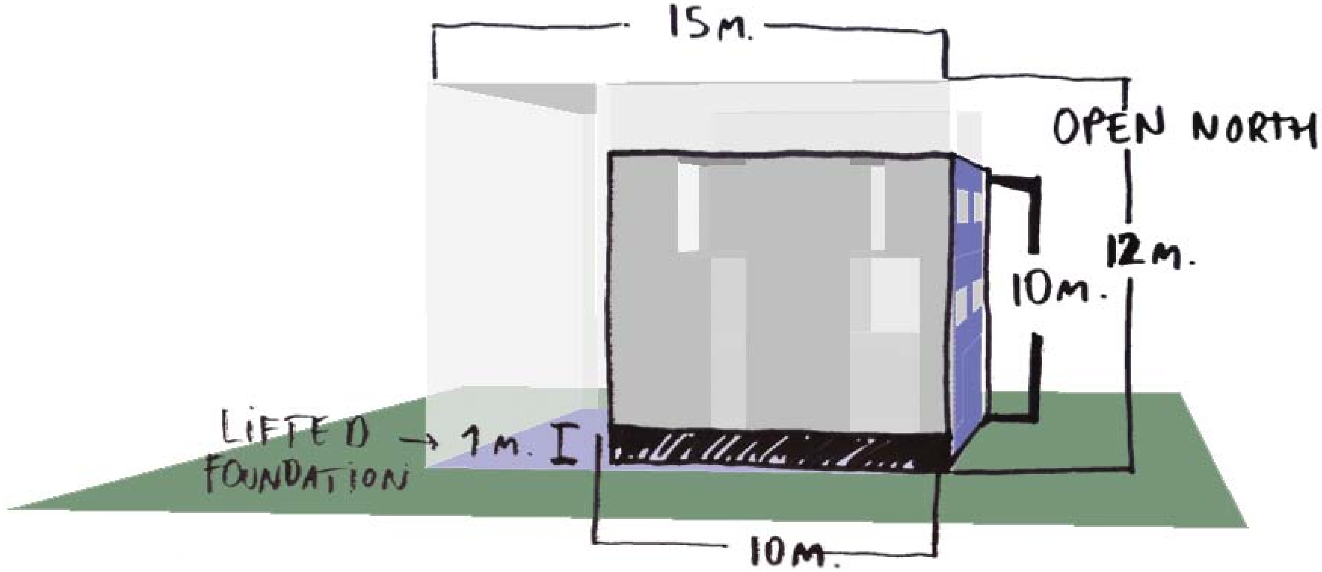
Roof
U: 0,08 W/m2K

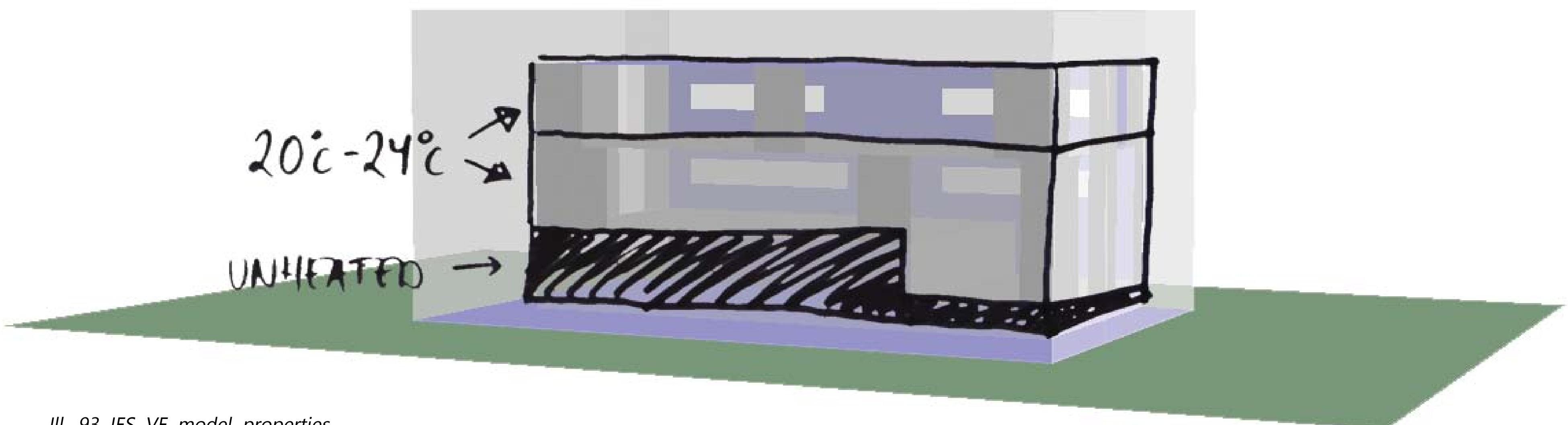
Floor to ground or basement
U: 0,08 W/m2K

SOURCE OF ERROR

The model created in IES VE is a simplification of the building volume. This simplification is made to make it easier to change and to work with. Also at this stage in the process the building design is not yet settled so an approximation is necessary - though it has the consequence of being imprecise.
One source of error could be that the model has flat roof. Compared to a sloping roof it has a larger heat loss as the roof is flat (the transmission coefficient is higher).
Also it has more surfaces because the sloping roof becomes the walls.

Another source of error is the weather file as described in the program (see chapter, Weather file data). As the climate is a bit colder in Uummannaq the results are not precise.





Ill. 93 IES VE model properties

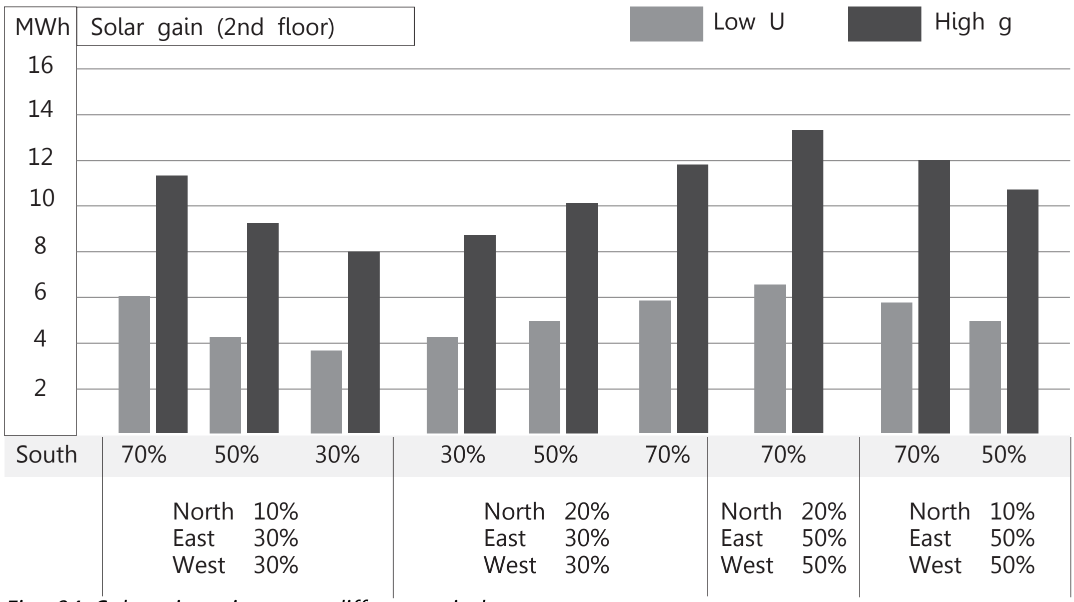


Fig. 94 Solargain using two different windowtypes

Figure 94, shows how the windowtype with a high g-value recieve much more energy from the sun than the type with a low U-value.

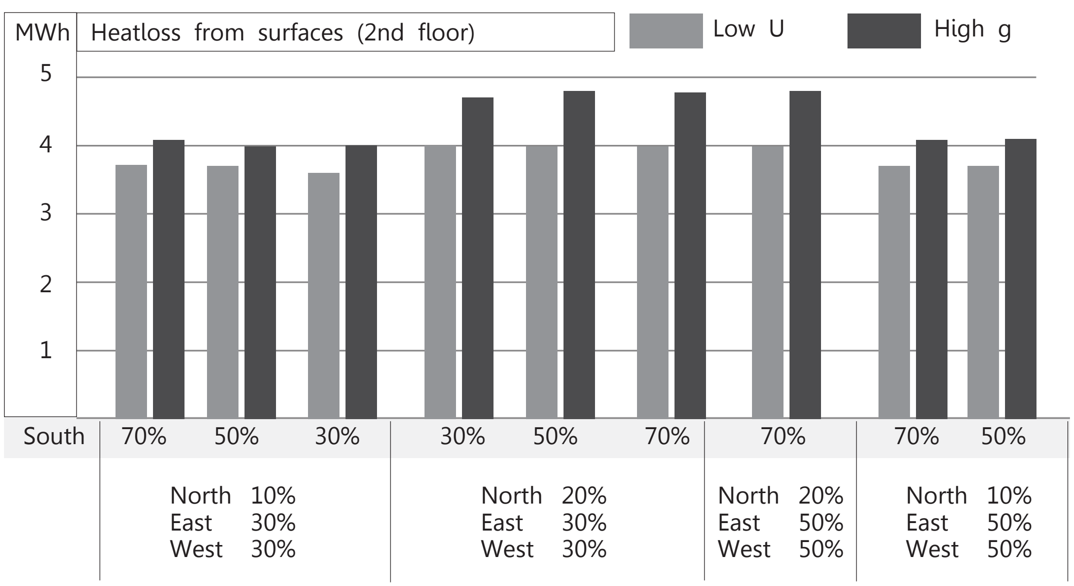


Fig. 95. Heatloss from surface using two different windowtypes

Figure 95 shows how the heat loss from the surface follows the amount of window area and that the type of window with high g-value also has more heatloss.
The most important issue to read form this figure is that the heat loss mainly follows the window area to north. When looking at the results with a north window area of 10% the heat loss is quite similar even though the east, west and south window areas are changing.
The reason for this can be that the north facade is open and therefore the exterior surface temperatures are lower.
The surfaces covered by the greenhouse therefore has a lower heatloss.

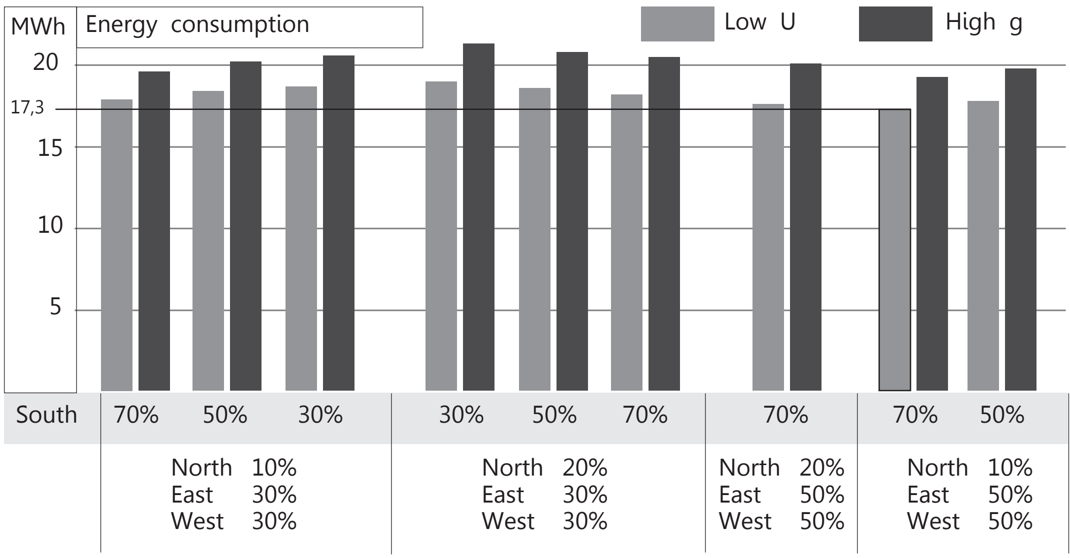


Fig. 96. Overall energy consumption using two different windowtypes

Figure 96 shows that the energy consumption generally increases when using the window type with a high g-value. Even though the windows make better use of the solar heat, they also lose more heat from inside.

The energy consumption shows to be lowest when having small window area to the north.
The best result is the second last bar having the distribution as follows; north: 10%, East and West: 50%, South: 70%.
These window areas shows to have the best distribution according to solar gain and heat loss.

This figure though only takes into account the energy consumption and not the quality of the indoor climate (hours of overheating).

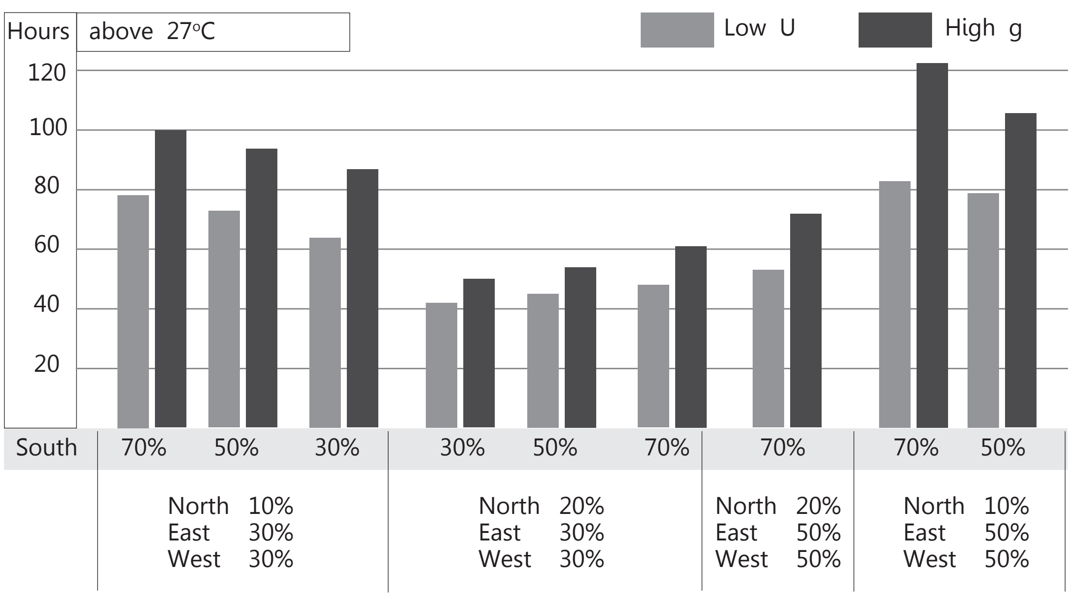


Fig. 97. Overall energy consumption using two different windowtypes

This figure shows the amount of hours above 27 °C. Following the standards in DS 474 (See room-program) the maximum amount of temperatures above 27ºC should be 25 hours.
To reach this level, shading must be added to the roofwindows and to the southturned windows in the greenhouse.
When shading is added, the solargain will decrease and therefore the energy consumption will increase. Thus, three factors must be considered when choosing the window areas.

-Dependence of solargain to keep the energy consumption low.

-Amount of overtemperatures before shading is added to the model.

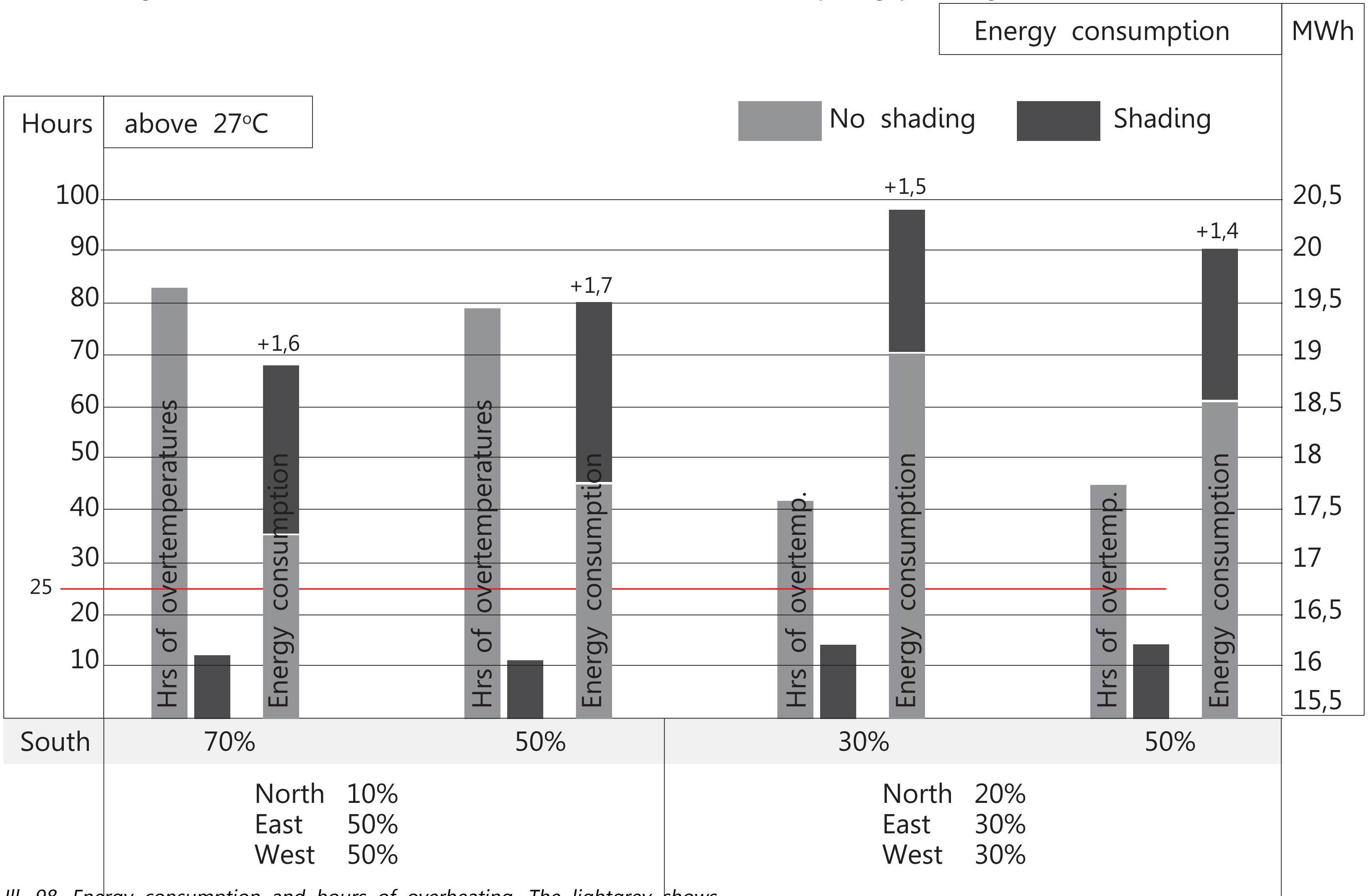
-Energy consumption before shading is added to the model.

THERMAL ANALYSIS 2

Four different options are chosen, to test out the results when adding external shading devices on the glasshouse. The shadings are put on both the roof and south, east and west windows with the following properties:

Shading on from 1st may - 1st October
Lower shading device when incident radiation > 300 W/m²

Figure 98 shows the effect of adding shading devices to the greenhouse. It is clear that the examples with more opening area to south, west and east have more extra energy consumption. The reason for this is that these examples loose more solar gain (see figure 94 solar gain).
The results show that the best solution is the first bar, which has the opening percentage N:10, E:50, W:50, S:70.



Ill. 98. Energy consumption and hours of overheating. The lightgrey shows the result without shading and the dark shows results with shading added to the model.

THERMAL CLIMATE IN THE GREENHOUSE

The risk of condensation in the greenhouse should also be considered. This could have a great impact on the solargain and also reduce the transparency. This especially becomes problematic if the condensation freezes and becomes ice.

Condensation appears when warm air is cooled down on a cold surface. An example is the windows with only one layer of glass. The glass is cooled by the external air while then cooling down the warm air on the interior side.

New low-energy windows have a very low U-value and therefore condensation an the inside of the window mostly appears in dwellings with insufficient ventilation.
On the contrary, these windows can have condensation on the outside mostly in the mornings where the glass surface temperatures increase slower than the air temperature outside.

A solution to prevent this is to ventilate the greenhouse well. Also because the plants evaporate and increase the relative humidity in the greenhouse.
Another solution could be to heat up the greenhouse to frost free. This solution is tested in IES VE and shows an increased energy consumption. Illustration 99 show how the increase in energy consumption mainly lies in the wintermonth.

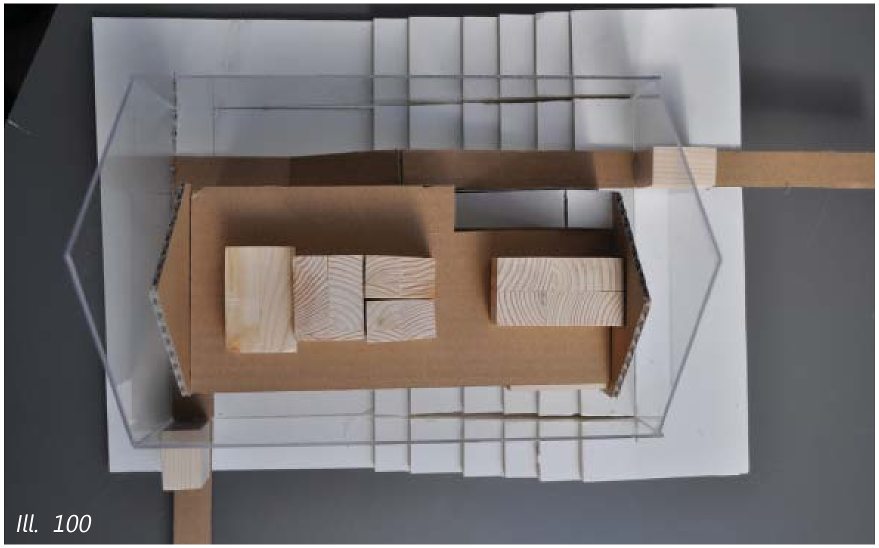
The left column shows the energy consumption with frostfree greenhouse and the right column is an unheated greenhouse.
The increase is 1 MWh (1000 kWh pr year).

	Room heating plant sens. load (MWh)	Room heating plant sens. load (MWh)
	varme i drivhus med varme.aps	varme i drivhus.aps
Date		
Jan 01-31	3.5368	3.0462
Feb 01-28	4.8509	4.5587
Mar 01-31	5.2432	5.1072
Apr 01-30	3.0842	3.0842
May 01-31	0.6786	0.6786
Jun 01-30	0.1641	0.1641
Jul 01-31	0.0056	0.0056
Aug 01-31	0.0303	0.0303
Sep 01-30	0.2788	0.2788
Oct 01-31	0.8653	0.8653
Nov 01-30	2.0247	2.0273
Dec 01-30	2.6142	2.4438
Summed total	23.3767	22.2900

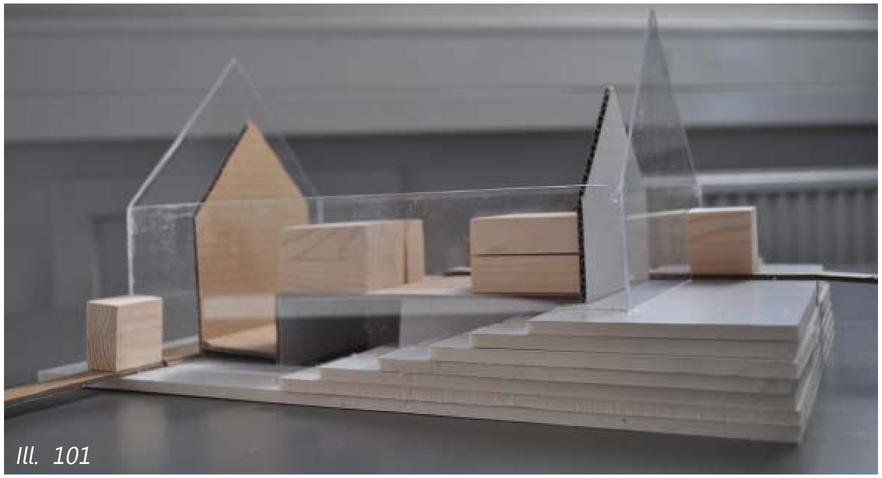
Ill. 99 Energy consumption comparing the difference between keeping the greenhouse unheated and frostfree.

SPATIAL ORGANISATION

The flow in the building and the room organization has been developed using physical models and sketching. Focus has been on the different characteristics of the three areas listed in the program; the community space, the social space and the private space. These three spaces should provide different atmospheres and spatial experiences. Room height and window openings play an important role, but also the organization of the functions in general.
The issue of flexibility has also been considered. Thus the spaces should follow a grid laid out by the construction.



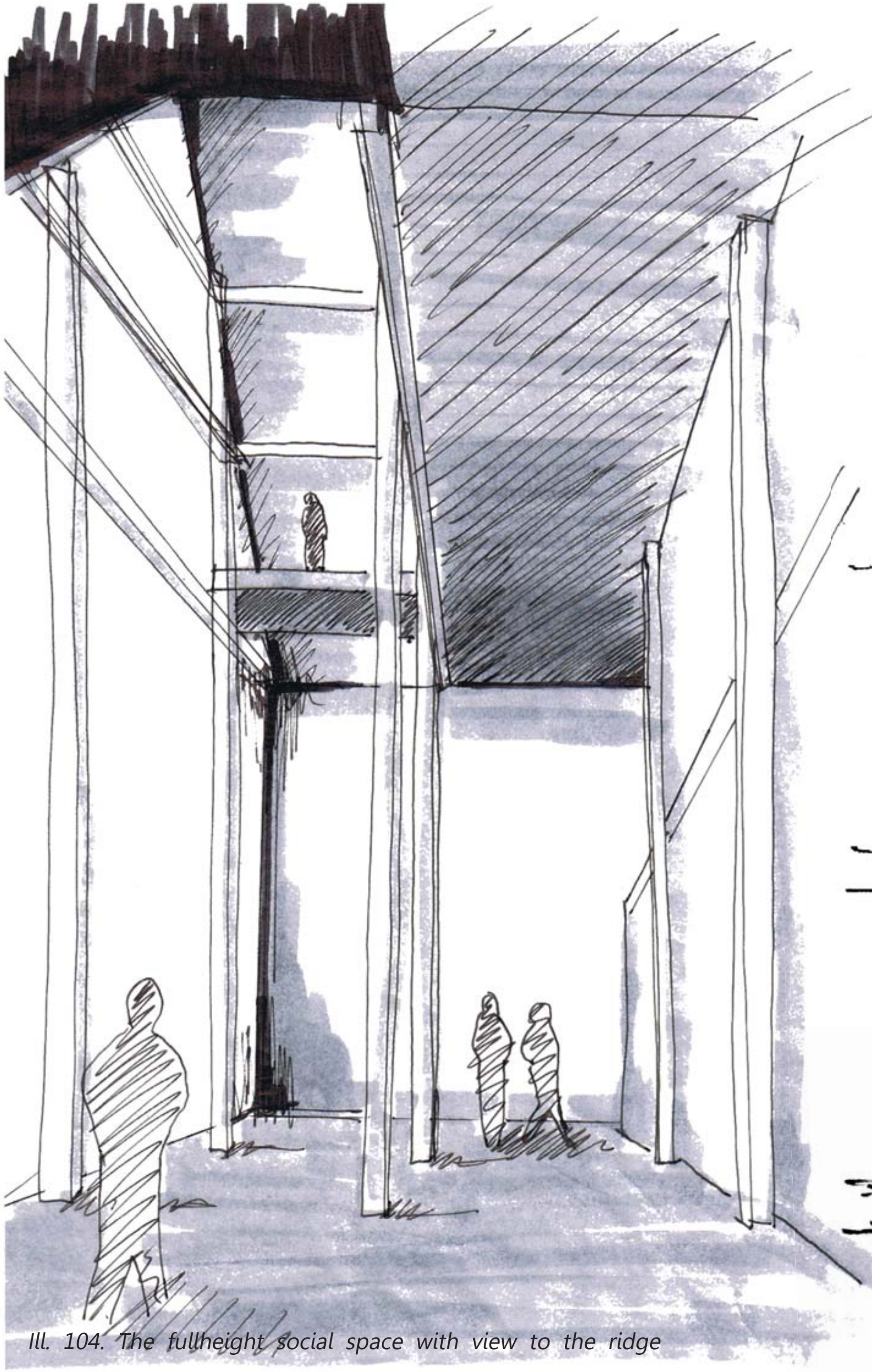
Ill. 100



Ill. 101

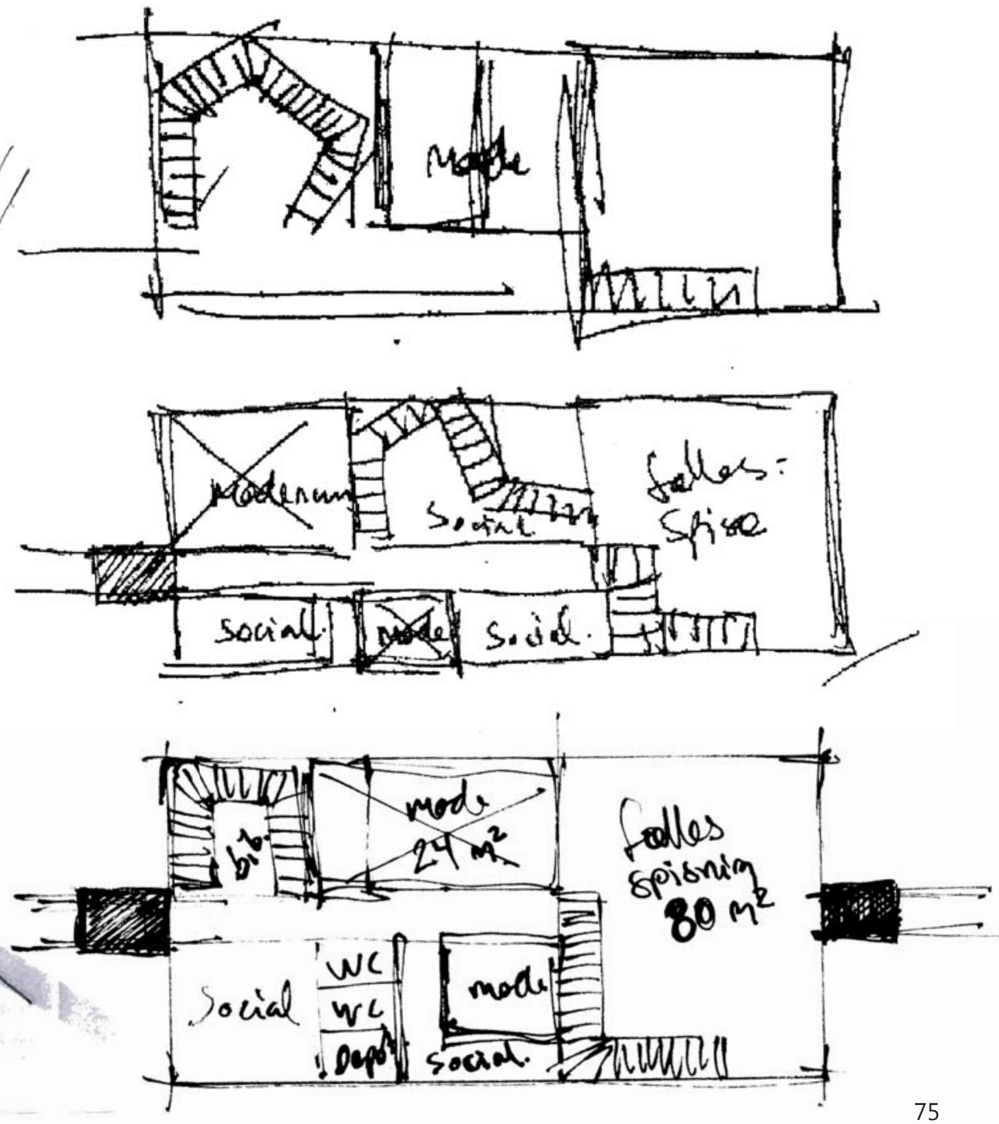
Ill 102. The sloping landscape merges with the building. The flow through the house becomes a natural part of the site.

Ill. 103. "Airholes" in the interior opens up to the outside and makes the indoor activities more visible from outside. The double high rooms makes the space more social.

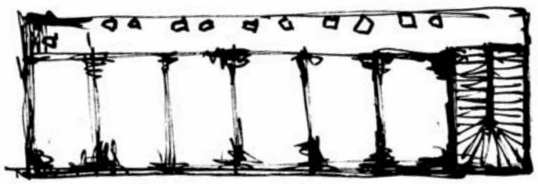


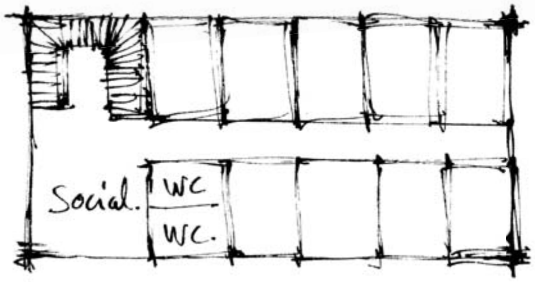
Ill. 104. The fullheight social space with view to the ridge

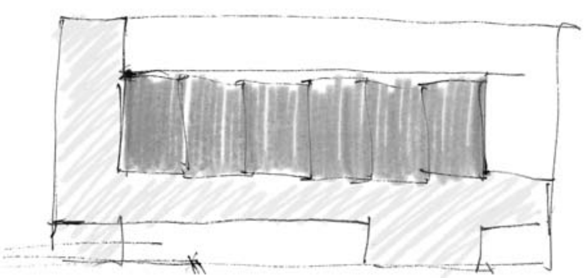
The social space can easily be part of the circulation space to make more use of the square metres and make the functions merge more fluently. On the sketches it is seen how the staircase becomes a social space. Placing the circulation spaces also decides where and how the boundary between private and public is laid out. Placing the circulation close to the south facade makes most sense as this facade has more window area [chapter; Thermal analysis]. Working with double high rooms gives a more open and public atmosphere.

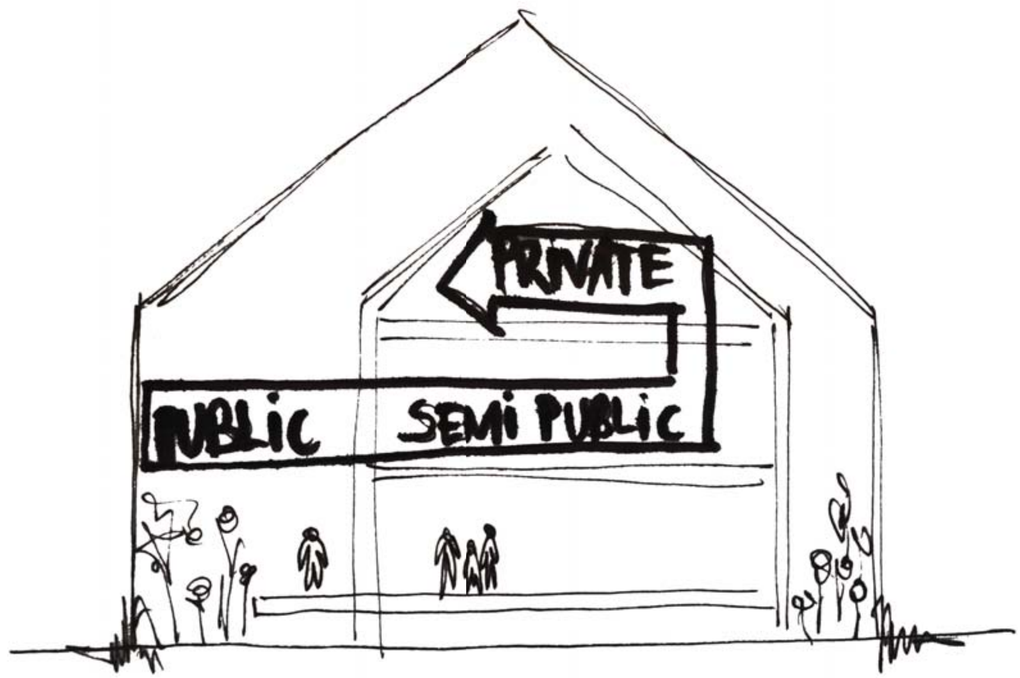


The sketches show how the division of private and public spaces are also considered in section. The lowest floor are the more public. The facades are also more public as the windows expose people to the outside.

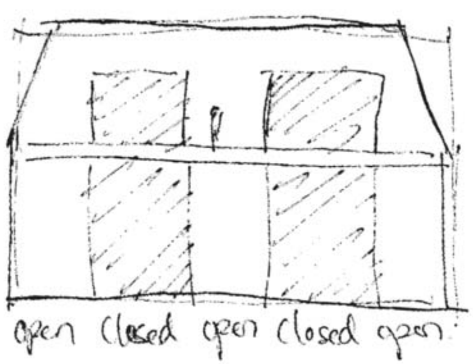


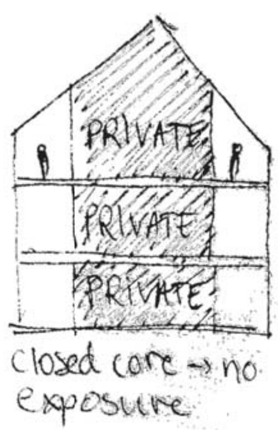


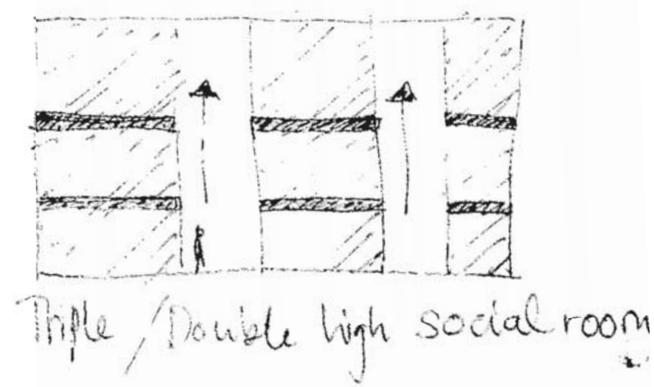


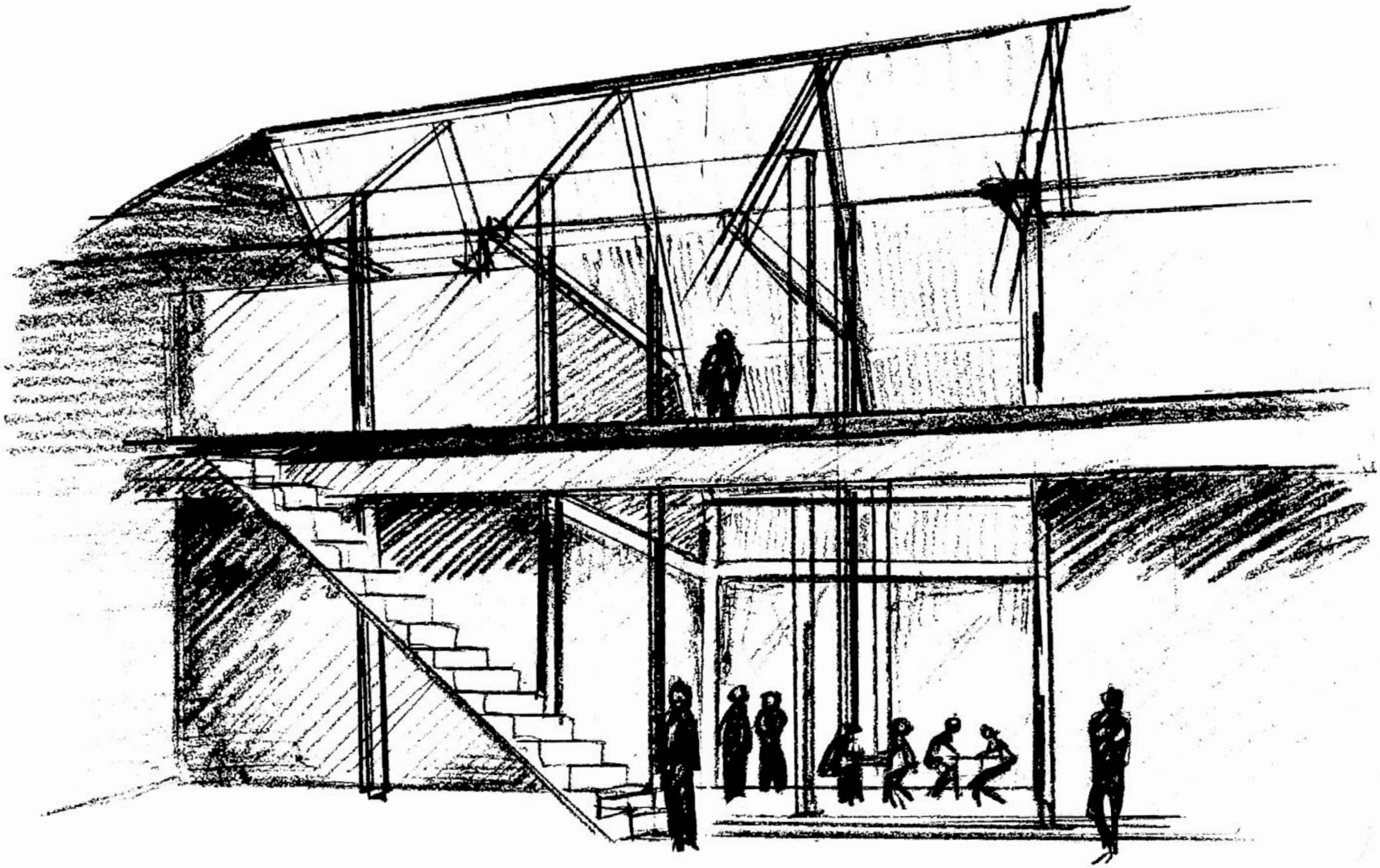


Ill. 104 The division between private and public spaces seen in section









Ill. 105. The public with visual connection to the upper floors

MATERIALS

Ill. 106 Sod house

Ill. 108 The local church

Ill. 107 The hospital. Wooden construction like most buildings in Uummannaq

When choosing materials many things must be considered.
As described in the program [Chapter; Materials] there are three main types of constructions to choose from; concrete, metal and wood. The scheme [Ill. 29] shows the different properties of the three types of materials.

The surrounding buildings are mainly wood constructions. It has low thermal conductivity and is a well known material concerning the construction methods [UFC, 2004].
Larger buildings in Uummannaq are sometimes constructed using concrete or steel, but as it is more expensive than building with wood it is only a few cases.
The town church from 1935 constructed using wood and granite from the local quarry.

Another issue is the architectural expression of the materials both inside and outside. As written in the design criterias it is important that the family house expresses a safe and homely atmosphere, but at the same time it should also keep the flow and movement on the site and be a natural meeting point.
The materials should therfore express these two contrasting atmo-spheres. The safe and stabile but also the more open and public.

Ill 109. Zumthors thermal baths in Vals has a strong and robust character. The choice of natural stone used consistently in the entire building volume, gives a solid, grounded and confident expression.

Ill 110. The work of SANAA uses transparency to express openess and to integrate the exterior into the interior. The 21st century museum of contemporary arts in Kanazawa has multiple entrances open for everyone and placed in a public park, it becomes part of the public space. Some of the artwork is visible from the outside and the small courtyards and skylights keep the visitor connected to the outside continously.

Working with heavy and solid materials together with transparent can create this duality in the architectural expression. The heavy and safe part and the transparent and public part.

The thermal properties of a material is also important the take into account. Wood works quite well in the arctic because of the low conductivity. But it does not store the heat very well.
In comparison, concrete and stone has a much higher thermal mass.

To test out the thermal performance of different materials, IES VE is used, changing the materials used in walls and roof. The model has the window area South: 70%, East/West: 50% and North.10%.

Output Analysis Help

	Room heating plant sens. load (MWh)	Room heating plant sens. load (MWh)
	10 50 50 70 louvres wood.aps	10 50 50 70 louvres stone.aps
Date		
Jan 01-31	2.9310	2.9617
Feb 01-28	2.2876	2.2449
Mar 01-31	1.6636	1.4857
Apr 01-30	0.7476	0.5201
May 01-31	0.0739	0.0027
Jun 01-30	0.0010	0.0000
Jul 01-31	0.0000	0.0000
Aug 01-31	0.0009	0.0000
Sep 01-30	0.0543	0.0008
Oct 01-31	0.4755	0.2476
Nov 01-30	1.3624	1.2593
Dec 01-30	2.3881	2.4045
Summed total	11.9858	11.1273

Ill 111, thermal storage lowers the energy consumption

The two examples are walls with respectively concrete and wood walls, floors and roofs. Both have the same amount of insulation. The concrete have 10 cm on both sides of the insulation.

The results show that the concrete wall has a reduction in the energy consumption of 800 kWh pr year.

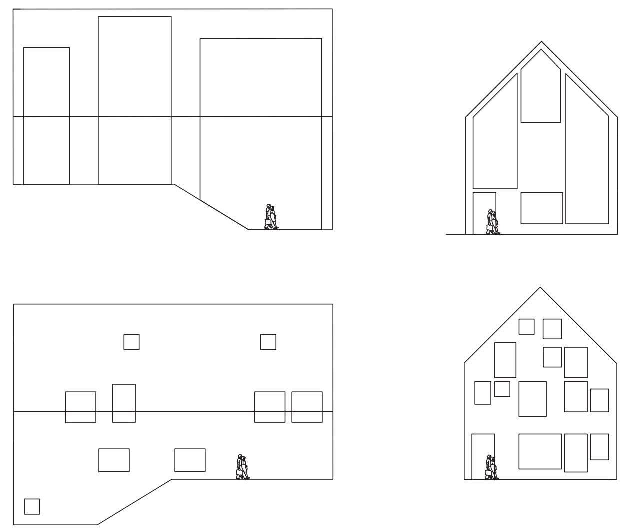
FACADES

Ill. 112. Facades from Uummannaq

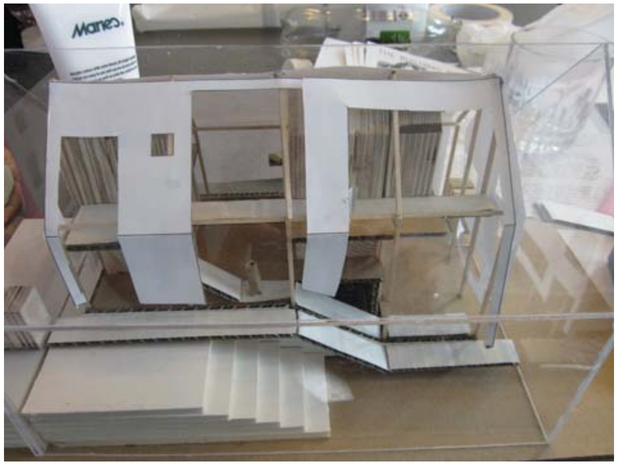
To keep the heat loss low, most houses in the arctic have small window openings. These openings all have a specific purpose. Therefore every home is different. The overall shape is general but the details like for example window openings are different.

Ill. 113. Warehouse on the harbour

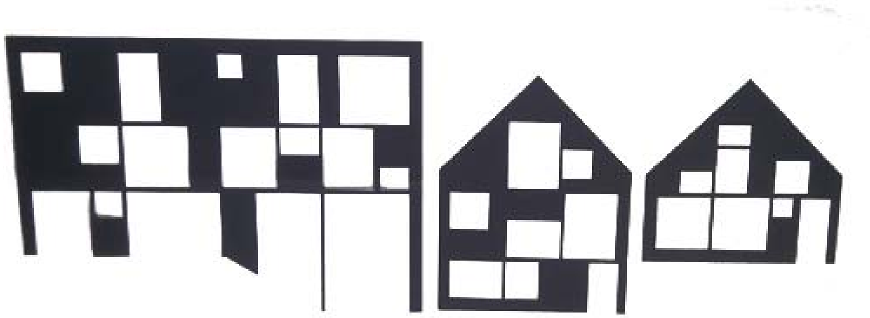
The large warehouse at the harbour saves heat by closing off the windows using shutters when the building is not in use.



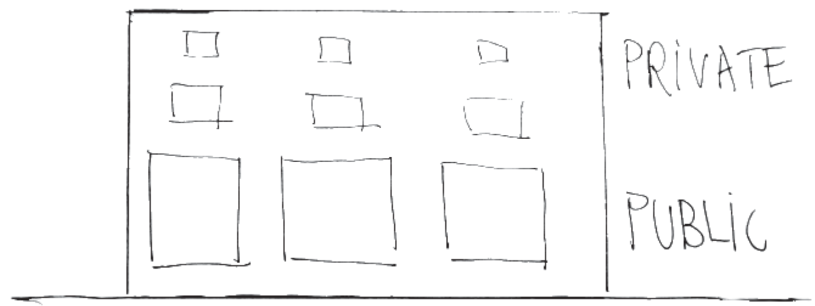
Ill. 114. Testing out the facade expression of different concepts. The upper right drawing shows an example of windows emphasizing the building shape. The upper left roughly peels of the facade to reveal the interior.
The two lower drawings show the concept of rectangular windows placed in a random pattern.



Ill. 115-16 Testing facades in model



Ill. 117



Ill. 118

Based on the IES VE investigations described in chapter; Thermal analysis 1 and 2, different facade proposals have been evaluated. The main concern was to create a facade which relates to the context while also following the interior spatial organisation and the overall concept.

One idea shown on ill 114 (upper right) was to make openings emphasize the shape of the building. This proposal dissociate the facades from the surrounding facades.

The seemingly random placement of the windows in the proposal on ill 114 (lowest) gives more coherency with the context though still in a way that complies with the calculations made on the optimal opening areas made in chapter; Thermal analysis 2.

The idea shown in ill 115-16 is further developed in model to see how the facades work with the interior an also to see the result as a three-dimensional whole expression.

The windows expose the life inside the building. Therefore, the windows sizes must reflect the life and the functions inside. The principle drawing (ill 118) describes how the openings are placed according to the interior room organization.

VERIFICATION

THE PROCESS

As described earlier in the chapter; Weather file it has been difficult to find a weatherfile from the position and a level of incorrection must be expected.

The results from IES VE shows an exceptionally low energy consumption. Though the weatherfile used is from a warmer climate it still seems incredibly low.

Usually when working on a project, the 24-hour average and the monthly average spreadsheets are used for early envestigations on energy consumption and overheating hours.
But as these spreadsheet does not supply the weather in Greenland, the early envestigations is made using IES VE which is a much more complex and detailed program. This makes the process more complex and therefore has more sources of error.

In the final verification Be10 showed a much higher energyuse than IES VE but still keeping lower than the building regulations [chapter; Saving energy in an arctic climate].

In this chapter only the results from Be10 is described as this program uses a weatherfile from Uummannaq.

BE10

The final data and results from Be10 can be found in Appendice: Be10. It shows an energy consumption of 150 kWh/m^2.
The Greenlandic building regulations for energy consumption [Saving energy in the arctic climate] sets the following demands for other buildings than dwellings;

98 kWh/m^2 pr. year plus 91 kWh/m^2 pr. year divided by number of storeys and plus 4444 kWh pr. year divided by the built area (footprint of heated area).

In this case the requirements are 168 kWh/m^2.

The decreased energy consumption achieved having the building enclosed in the greenhouse (b-coefficient) is the following;

With the greenhouse (b=0,7) = 150 kWh/m^2
Without the greenhouse (b=1) = 218 kWh/m^2

This means that the calculation made in IES VE [Chapter; Testing the concept] is correct as the difference in both cases are 30 % lower enregy use.

SUMMARY

The introduction to this report describes the importance of the visit in Uummannaq. The program describes this visit and all the envestigations made, both on the building tradition but also on the mentality and atmosphere of the towns people.
This very contextual approach has been followed by a more theoretical analysis of arctic building technologies. As a theoretical background, the term Complex ordinariness, has been studied.
Several projects within the same field of interest has been studied and used in the process. These projects represents examples of room organization, relation to site and climate and energysaving principles.
The program is summarized in the designcriterias listing the most important elements in the design.

The process describes how the listed parameters and criterias from the program are shaped into an architectonic whole.
Starting from an understanding of the site characteristic the following process had a strong concept to work from.
Working with both technical tools like IES VE (virtual environment), as well as drawings and models makes the project an integrated whole where the energy consumption is thought into the project already from concept sketching.
Spatial organisation, materials and facade detailing has been developed also following the criterias set up for each different room according to the atmosphere program.

In the detailing phase IES VE is used for calculating on the optimal solution of facades in relation to energy use and hours of overheating.
Throughout the process the designcriterias are evaluated and corrected to keep the focus at all times through the entire project.

The presentation report is the result of this long process and presents an integrated project where energysaving principles follow architectural principles strongly related to the cultural and physical context.

REFLECTION

This chapter is a conclusion an reflection upon the final result of the project "Illu Naasulik [house with plants] - growing families".

RELATION TO CONTEXT
The point of departure for this project has very much been the studytrip and the emphirical envestigations made. Also the studies made on the local building tradition have been a solid ground from which to build this project.
Therfore it is natural to reflect on the result of this. Does these analysis show in the final project? And should a building always be contextual and fit into a specific context?

The building reflects the very contextual approach in the process. First of all the physical relations to the site. It was very important to understand the site before designing. The basic concept of the project is directly inherited from the site charactristics. The flow, the public exposure, the view towards east and the sloping terrain.

Another issue is the mental context. Talking to people in Uummannaq I got an understanding of what is important for these people. When first arriving to Greenland completely astonished with the nature and climate, I saw Greenland in a completely different way than the people living there for several generations. This culture of isolated communities is so different from anything in our danish culture.
Building a beautyfull family treatment centre and place it in the midle of the town would most likely not be a succes. As this community is so small the house must be accepted by the town before anyone would set a foot inside. Therefore, to avoid stigmatisation of families in treatment, the house must become a natural and accepted element in the mentalilty of people. The house must communicate possitive energy to be a succes in this town.

Reflecting on the theoretical background the building follows this architectural approach in means of being a very contextual reinterpretation of element from the building tradition. Taking out elements like typology, materials, windlocks, windowopenings and putting them into a new use, makes people more aware of these elements.
When looking at the same surroundings every day people tend to forget the importance of these surroundings. Sometimes an outsider is more able to see the characteristics of a place than the people living there.
The projects described in chapter; Complex ordinariness, stand out from the context. They work with familiar elements but when looking closer they are very different and customized for its specific function.
This project stands out from the context first of all by using elements in a different way. The windows are in the same way placed in an irregular pattern though in this project they cover more than half of the south facade. A distortion of the well known and typical. Alos the windlocks are faliar elements in the greenlandic home. In this project the windlocks are connected to a transparent glass house. In this way they are emphasized and their function is made visible.
In general the building stands out by being covered with a protective layer of glass and filled with plants. As there are no trees in Greenland this house is going to be quite a change in the town picture. Therefore it is evident to raise the question; How contextual should a building be?
This project walks on this limit. The contextual approach has been a governing direction in the process, but it was also necessary to add something new to this place. To leave
Greenland is a country in change. The climate is changing rapidly and the whole structure of society is doing the same.
Therefore I wanted the project to take a stand and give a comment to the future perspectives.
What if Greenland really becomes green? They could grow their own plants and vegetables and be selfsufficient. Already now, South Greenland has big fields of vegetables and grow fruits in large industrial greenhouses.
It is a time of change and the greenalandic have to follow.

THE FUTURE FAMILY HOUSE CONCEPT
The concept of this project can be used further as a concept for other family centres.
The well-known healing effect of green plants is a strong concept that goes well in combination with a green energy profile. The house opens up and welcomes the daylight as well as people. The normal energysaving house in the arctic has small window openings and very thick walls. The thermal concept of this project makes more use of the solarenegy as the heatloss from the surface is minimized and therefore allows larger windows.

APPENDICE

LIST OF ILLUSTRATIONS

REFERENCES

VENTILATION REQUIREMENTS

PROPOSAL FOR THE FAMILY CENTRE IN ILULISSAT

SECTION FROM THE PROGRAM FOR "VÆKSTHUSET"

BE10 - VERIFICATION

LIST OF ILLUSTRATIONS

PROGRAM AND PROCESS

PRESENTATION

WEBPAGES

WEB1:

http://slaederejsen.skolemedia.dk/materialer/2indsigt/historie/s2_groenlands_historie_resumeliste.htm

http://politiken.dk/indland/ECE737092/feststemt-groenland-indfoerer-selvstyre/

WEB2:

ftp://artekftp.byg.dtu.dk/Rapporter/2008/08-05/08-05.pdf

http://www.nanoq.gl/sitecore/content/Websites/nanoq/Emner/Landsstyre/Departementer/Departement_for_kultur/Forskning/Udgivelser/Inussuk%20-%20Arktisk%20Forskningsjournal/~/media/A803FB-7312374424B4C00D73702F7F39.ashx

www.tidsskriftetgronland.dk/archive/1973-1-Artikel03.pdf

www2.mst.dk/udgiv/publikationer/2002/87-7972-268-7/pdf/87-7944-987-5.pdf

WEB3:

www.dmi.dk/dmi/index/klima/virkninger_af_klimaaendringer/klimaaendringer_i_groenland.htm

http://climategreenland.gl/udfordringer_og_muligheder/landbrug/

www.bu.dk/pages/637.asp

http://politiken.dk/indland/ECE120881/taagede-udsigter-for-havets-kaemper/

WEB4:

www.arktiskcenter.gl/upload/centre/artek/billeder/proceedings%202005.pdf

http://bm.di.dk

http://ing.dk/artikel/109297-pivutaet-groenlandsk-lavenergihus-naar-ikke-egne-energimaal

WEB5:

http://da.wikipedia.org/wiki/Uummannaq

www.icecap.nu/index.asp?page=52&vpath=50|52|&docalc=yes&res=840

www.greenland.com/da/about-greenland

WEB6:

www.yr.no/place/Greenland/Qeqqata/Sisimiut/statistics.html

WEB7:
www.cancer.dk/Nyheder/nyhedsartikler/artikler/hejmdalaabning.ht

WEB8
www.tenu.gl/akk-files/akk-451.html

WEB9:
www.richardrogers.co.uk

BOOKS, PUBLICATIONS AND ARTICLES

Knudstrup, Mary-Ann, Pandoras boks, Aalborg universitets forlag, 2005
Strub, Harold, Bare poles - building in high lattitudes, Carleton Library Series, 1996
Rice, Elbert Floyd, Building in the North, University of Alska press, 2008
Beim, Anne, Økologi og arkitektonisk kvalitet, Arkitektskolens forlag, 2002
Krucker, Bruno, Complex ordinariness, GTA, 2002
Kristensen, Peter Thule, Kompleks almindelighed - Portræt af en aktuel arkitektur opfattelse, Oct. 2006
Pedersen, Hans, Det moderne Grønland, Miljøministeriet Miljøstøtte til Arktis, 2002
Andersen, John Selvbyggeri i Grønland
UFC, ARCTIC AND SUBARCTIC CONSTRUCTION, 2004
DS CEN CR 1752 - Indoor climate - Ventilation
BR06 - Greenland
DS 474 - Indoor climate

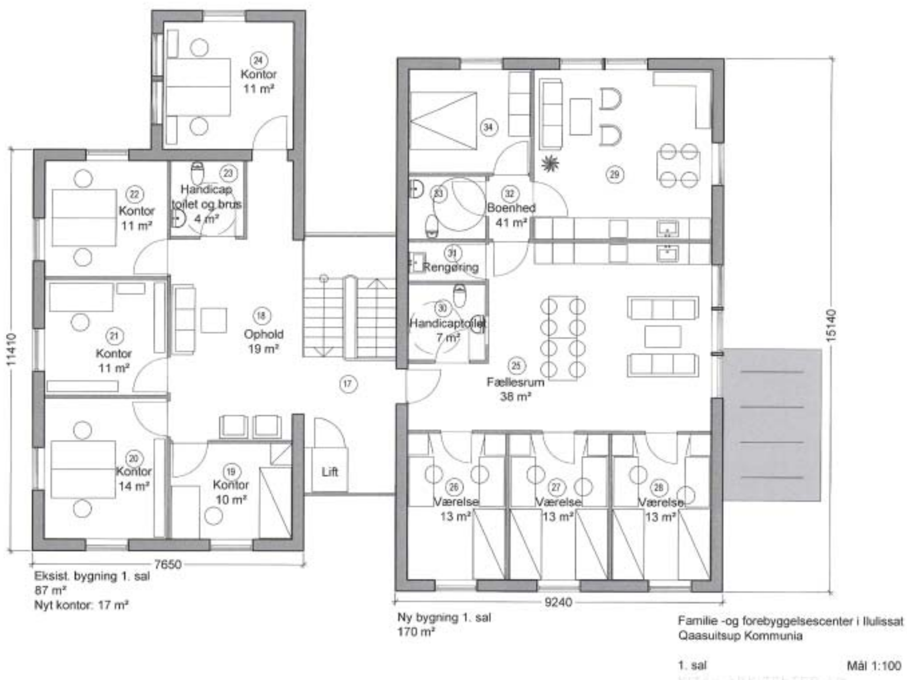
APPENDICE - VENTILATION REQUIREMENTS

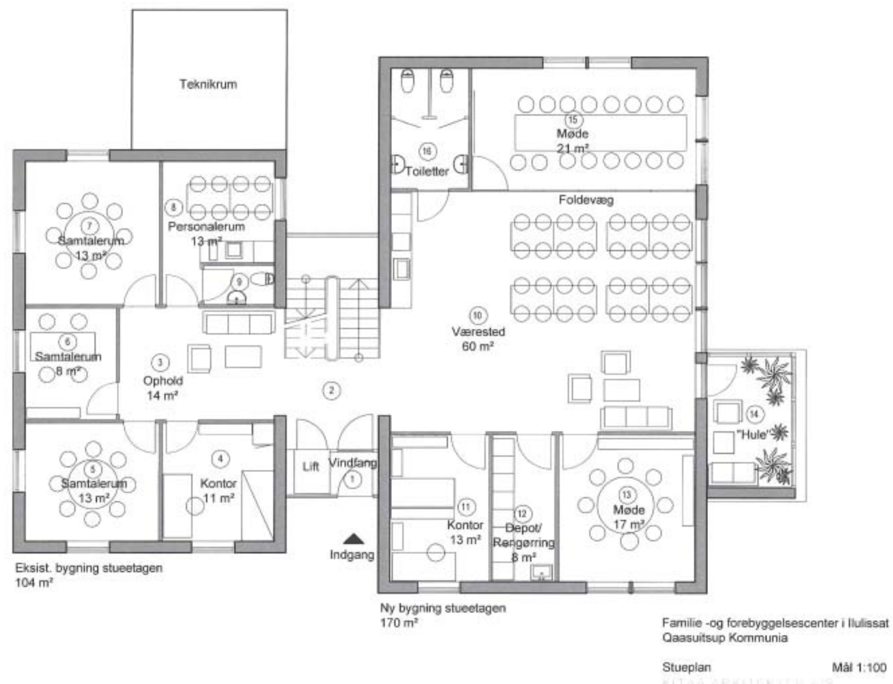
Comfort category	B
Building floor area	300 m^2
Building air volume (V)	1372,5 m^3
Occupants max	70 persons
Building regulations standards [CR 1752]	0,35 l/s pr m^2 x 300 m^2 = 105 l/s

	Symbol	Formula	Source	Result
Sensory pollution by occupants			[CR 1752 p. 26 – table A.6]	1 olf x 70 pers = 70 olf
Sensory pollution by building			[CR 1752 p. 27 – table A.8]	0,1 olf x 300 m2 = 30 olf
Sensory pollution total	G_c			70 + 30 = 100 olf
Desired Perceived indoor air quality – category B	$C_{c,I}$		[CR 1752 p. 23 – table A.5]	1,4 decipol
Perceived indoor air quality	$C_{c,0}$		[CR 1752 p. 27 –table A.9]	0 decipol
Ventilation rate required for comfort	Q_c	$Q_c=10x(G_c/C_{c,I} -C_{c,0})$	[CR 1752 p. 29 – table A.3]	714,3 l/s
Ventilation rate required for comfort (in m^3/h)	(l/s)x3600/1000			2571,5 m^3/h
Required air change according to sensory pollution		$(m^3/h)/m^3$		1,8 h^{-1}

CO2 load pr person l/h			[CR 1752 p. 26 - table A.6]	(19 l/h) x 70 = 1330 l/h
CO2 load pr person m^3/h	q	1330 l/h / 1000		1,33 m3/h
Outdoor concentration of CO2	c_i		[CR 1752 p. 24]	350 ppm = 0,00035 m^3/m^3
Maximum CO2 level – category B	c		[CR 1752 p. 24 - fig. A.8]	660 ppm = 0,00066 m^3/m^3
Required air change according to CO2 level	n	$c = (q/n \times V)+c_i$ $\rightarrow n = q/(c- c_i)xV$	[Grundlæggende klimateknik p. 29 – table 1.14]	3,1 h^{-1}

APPENDICE - PROPOSAL FOR THE FAMILY CENTRE IN ILULISSAT





APPENDICE - SECTION FROM THE PROGRAM OF "VÆKSTHUSET"

OPSUMMERING

Undersøgelser viser, at grønlandske børns alvorlige vanskeligheder kan relateres til familiers få eller manglende ressourcer i forhold til økonomi, beskæftigelse, uddannelse, omsorg og socialt netværk.
Disse forhold fordrer, at indsatsen på børne- og familieområdet intensiveres og rettes mod ressourcesvage familier, således at antallet af anbringelsessager og andre omfattende foranstaltninger mindskes.
Samtidig eksisterer en større gruppe af familier med middel ressourcer, som ifølge SFI's undersøgelse potentielt kan udvikle sig til en familie med svage ressourcer. Heraf formodes, at
børnenes trivsel tilsvarende vil forværres.
Dette med mindre, der iværksættes en målrettet indsats mod at styrke familiernes eksisterende ressourcer med henblik på at undgå en negativ udvikling.

Sammenfattende er det yderst relevant, at den forebyggende indsats intensiveres, således grønlandske børns og familiers trivsel sikres.
Dette indebærer et særligt fokus på at løse de faglige og logistiske udfordringer, der knytter sig til mindre byer og bygder.

En sådan indsats skal til forskel fra tidligere indsatser dokumenteres, så det på det socialfaglige forebyggende område bliver tydeligt, hvad der reelt virker.
Indsatsen skal kvalificeres gennem kompetenceudvikling af de aktuelt men også kommende ansatte på børne- og familieområdet. I denne sammenhæng anses det for væsentligt også at øge unges motivation for at uddanne sig. Der er i disse år stigning i ansøgningerne til uddannelser, også i Uummannaq, men det vurderes, at der mangler støtte og rådgivning til de unge inden uddannelsesstart, således færre giver op undervejs.

Den konkrete indsats skal ikke blot rette sig direkte mod familierne men også forældre og det samlede netværk omkring barnet. Børn, unge og forældre skal til enhver tid opleve, at de får hjælp, som er tilpasset deres aktuelle behov og muligheder.
Projekttitel

VÆKSTHUSET.
Navnet er en arbejdstitel; der skal inden realisering findes et grønlandsk navn
.
PROJEKTETS FORMÅL, MÅL OG SUCCESKRITERIER

Det overordnede formål for Væksthuset er at forebygge omsorgssvigt og mistrivsel blandt børnefamilier i Uummannaq og omegnsbygder.
Herved forstås, at børn og familier støttes og rådgives, inden eventuelle vanskeligheder måtte udvikle sig til omsorgssvigt, og inden sociale foranstaltninger må iværksættes fra de sociale myndigheders side. Med dette formål kan det forventes, at det høje antal af anbringelsessager over en længere periode vil falde.
Væksthusets øvrige formål er som udviklingsprojekt at skabe innovative og holdbare løsninger, som også kan danne præcedens i øvrige grønlandske byer. Bl.a. derfor vil projektet i evalueringssammenhæng blive fulgt tæt under hele projektperioden (se afsnit om evaluering).

Projektets formål opnås gennem en række mål:

At skabe et til enhver tid appellerende og stimulerende tilbud for børn og forældre

Faglig udvikling af medarbejdere og frivillige

Opkvalificering af kommunens personale på børne- og familieområdet

At koordinere og fremme samarbejde med kommunen

Tidlig afdækning af problemer i familier

Tidlig rådgivning og støtte til familier

SUCCESKRITERIER

Succeskriterierne for Væksthuset knytter sig til hhv. målgruppen, øvrige aktører og projektet som helhed.

MÅLGRUPPEN

At Væksthusets målgruppe opnår større trivsel og livsglæde

At antallet af anbringelsessager og behovet for andre omfattende foranstaltninger falder Jf. FN's Børnekonvention om barnets rettigheder, som betragtes som god omsorg for barnet.
Se i øvrigt Christensen 2009: kap. 3-4

At flere unge påbegynder og gennemfører en uddannelse

Medarbejdere, fagpersoner og frivillige:

At medarbejdere, fagpersoner og frivillige erhverver sig viden og kompetencer, som de kan bruge i deres arbejdsliv og samfundsengagement i øvrigt At lokale fagpersoner føler sig bedre rustet til at varetage deres opgaver

At det tværfaglige samarbejde styrkes

Væksthuset:

At der efter første projektår bliver udviklet en plan for inddragelse af bygderne

At alle projektaktiviteter gennemføres inden for de første to projektår

At der udarbejdes en projektplan for projektår 3 og 4 på baggrund afmidtvejsevalueringen

At der i løbet af projektår 3 og 4 udarbejdes en implementerbar plan for kommunens eventuelle overtagelse af Væksthuset

At der ved projektets afslutning er udviklet en Væksthus-model, som kan implementeres i andre grønlandske byer.

AFGRÆNSNING
Væksthuset tilbyder primære og sekundære forebyggelsestiltag, dvs. henholdsvis oplysende og rådgivende, men overlader de tertiære tiltag, dvs. de behandlende, til kommunen.

Denne afgrænsning er væsentlig i forhold til at definere Væksthusets aktiviteter men også i forhold til kommunen og i særlig grad familierne.
Væksthuset samarbejder i vid udstrækning med kommunen, men det skal til enhver tid være tydeligt for alle parter, at der juridisk er en skarp adskillelse mellem Væksthuset og de kommunale myndigheder. I socialt arbejde eksisterer, uagtet lovgivningen, til alle tider et potentielt dilemma mellem tavshedspligt og underretningspligt.
Dette er særlig vigtigt i et lille samfund. Medarbejdere og frivillige vil blive klædt på til at håndtere dette dilemma. Derudover skal familierne orienteres om lovgivningen og deres rettigheder i øvrigt (se afsnit om pædagogisk tilgang for nærmere uddybning).

TIDSPERIODE
Projektet forløber samlet set over 4½ år, heraf er det første halve år en opstarts- og etableringsfase, hvor bygningen istandsættes og indrettes, og medarbejdere ansættes.
En detaljeret tidsplan for projektår 1 og 2 fremgår af bilag x. Med ønske om at udvikle projektaktiviteterne ud fra lokale behov, vil detaljeret tidsplan for projektår 3 og 4 blive udarbejdet
på baggrund af midtvejsevalueringen, som foretages i slutningen af projektår 2.

Opstartsfase
August 2010 – december 2010 Etablering af fysiske rammer og ansættelse af fire lokale fuldtidsmedarbejdere

Projektår 1 og 2
Januar 2011 – december 2012 Gennemførsel af projektaktiviteter
Efterår 2012 Midtvejsevaluering

Projektår 3 og 4
Januar 2013 – december 2014 Ny projektplan iværksættes
Udvikle og gennemføre projektaktiviteter
Løbende samarbejde med henblik på Væksthusets lokale forankring

Efterår 2014 Slutevaluering
Forankrings- og afslutningsfase

Januar 2015 FGB og UNICEF forventes at træde ud af samarbejdet

Februar 2015 Præsentere Væksthus-modellen og indgå dialog med Selvstyret, kommuner og øvrige relevante aktører

PROJEKTSTRATEGI
For at sikre Væksthusets formål og mål iværksættes en række på forhånd skitserede projektaktiviteter. Det er hensigten, at disse skal afprøves og om nødvendigt videreudvikles, så aktiviteterne fungerer optimalt i den lokale kontekst.
Den høje grad af inddragelse af børnefamilierne, fagpersoner og frivillige samt ønsket om at tilgodese de lokale behov fordrer stor fleksibilitet. Derfor er de fleste projektaktiviteter at betragte som rammer, aktørerne skal fylde ud.
Det er forventningen, at nye projektaktiviteter vil opstå undervejs som et resultat af høstede erfaringer og midtvejsevalueringen.

De fleste projektaktiviteter har børn og forældre som målgruppe, men inddrager lokale fagpersoner og frivillige i løsningen af disse. Nogle af projektaktiviteterne har derfor fagpersoner og frivillige som den primære målgruppe for at sikre en opkvalificering med henblik på at tilgodese forebyggelsen af omsorgssvigt og mistrivsel blandt børnefamilier. Denne tilførsel af ny viden og flere redskaber kvalificerer netværkets muligheder for at støtte op om den forebyggende og tværfaglige indsats ikke kun under projektperioden men også på langt sigt.

For at sikre den forebyggende indsats yderligere anses det som altafgørende, at Væksthuset samarbejder med kommunen, både på overordnet men også på projektaktivitets niveau.
Samarbejdet prioriteres derfor højt. På formelt plan betyder det, at der vil være repræsentanter fra kommunen i Væksthusets styregruppe, og at der etableres en følgegruppe med repræsentanter fra relevante samarbejdspartnere. Dette vil blive yderligere behandlet i senere afsnit.

De konkrete projektaktiviteter inddeler sig efter følgende temaer.
Familieaktiviteter
Forældreaktiviteter
Ungeaktiviteter
Mentorprojekt

Projektlederforløb
Sommerferieaktiviteter
Opkvalificering af personale
Webprojekt

Det bemærkes, at alle projektaktiviteter, ligesom Væksthuset, inden realisering skal have grønlandske navne.

Projektaktiviteterne gennemføres efter følgende progressionslinje:

Formidle – skabe kendskab og engagement 1

Afdække – opspore lokale behov og ønsker 1

Iværksætte – iværksætte og gennemføre projektaktiviteter 1-2

Evaluere – udvikle og justere projektaktiviteter 2

Forankre – gennemføre og implementere justerede projektaktiviteter

Dokumentere – sammenfatte og udvikle modelprojekt 4

APPENDICE - BE10, VERIFICATION

MODELDATA

Climate: Greenland - Uummannaq

væksthuset 1	
BBR-no	
Owner	
Address	

Comment	
The building	
Building type	Multy-story house
Rotation	0,0 deg
Area of heated floor	300,0 m²
Heat capacity	80,0 Wh/K m²
Normal usage time	168 hours/week
Usage time, start at - end at, time	0 - 24
Calculation rules	
Calculation rules	BR: Actual conditions
Suplement to energy frame	0,0 kWh/m² år
Heat supply and cooling	
Basic heat supply	District heating
Electric panels	No
Wood stoves, gas radiators etc.	No
Solar heating plant	No
Heat pumps	No
Solar cells	No
Wind mills	No
Mechanical cooling	No

Room temperatures, set points	
Heating	20,0 °C
Wanted	23,0 °C
Natural ventilation	24,0 °C
Mechanical cooling	25,0 °C
Heating store	15,0 °C
Dimensioning temperatures	
Room temp.	20,0 °C
Outdoor temp.	-12,0 °C
Room temp. store	15,0 °C

External walls, roofs and floors

Building component	Area (m²)	U (W/m²K)	b	Dim.Inside (C)	Dim.Outside (C)
	0,0	0,00	1,000		
syd 200 m2	60,0	0,20	0,700		
nord 200 m2	180,0	0,20	1,000		
øst 104 m2	52,0	0,20	0,700		
vest 104 m2	52,0	0,20	0,700		
	0,0	0,00	0,000		
Ialt	344,0	-	-	-	-

Foundations etc.

Building component	l (m)	Loss (W/mK)	b	Dim.Inside (C)	Dim.Outside (C)
fundament	58,0	0,13	0,700		
vinduer	306,8	0,03	0,700		
Ialt	364,8	-	-	-	-

Windows and outer doors

Building component	Number	Orient	Inclination	Area (m²)	U (W/m²K)	b	Ff (-)	g (-)	Shading	Fc (-)	Dim.Inside (C)	Dim.Outside (C)
syd	1	s	90,0	140,0	0,70	0,700	0,80	0,63		1,00		
nord	1	n	90,0	20,0	0,70	1,000	0,80	0,63		1,00		
øst	1	ø	90,0	52,0	0,70	0,700	0,80	0,63		1,00		
vest	1	v	90,0	52,0	0,70	0,700	0,80	0,63		1,00		
Ialt	4	-	-	264,0	-	-	-	-	-	-	-	-

Shading

Description	Horizon (°)	Eaves (°)	Left (°)	Right (°)	Window opening (%)
Default	15	0	0	0	10

Unheated room: New unheated room	
Gross area	180,0 m²
Ventilation	2,6 l/s m²
b	0,97

Transmission loss from building

Building component	Area (m²)	U (W/m²K)
gulv	180,0	0,10
	0,0	0,00
	0,0	0,00
	0,0	0,00
	0,0	0,00

Transmission loss to surroundings		
Building component	Area (m²)	U (W/m²K)
gulv	180,0	0,10
øst	9,0	0,20
vest	9,0	0,20
syd	23,0	0,20
nord	23,0	0,20

Ventilation													
Zone	Area (m²)	Fo, -	qm (l/s m²), Winter	n vgv (-)	ti (° C)	El-HC	qn (l/s m²), Winter	qi,n (l/s m²), Winter	SEL (kJ/m³)	qm,s (l/s m²), Summer	qn,s (l/s m²), Summer	qm,n (l/s m²), Night	qn,n (l/s m²), Night
	300,0	1,00	1,20	0,75	18,0	No	0,00	0,00	0,8	0,00	1,80	0,00	0,00

Internal heat supply				
Zone	Area (m²)	Persons (W/m²)	App. (W/m²)	App,night (W/m²)
msk	300	4,0	6,0	0,0

Lighting											
Zone	Area (m²)	General (W/m²)	General (W/m²)	Lighting (lux)	DF (%)	Control (U, M, A, K)	Fo (-)	Work (W/m²)	Other (W/m²)	Stand-by (W/m²)	Night (W/m²)
lys	300,0	2,0	5,0	200	3,00	K	1,00	1,0	1,0	0,0	0,0

Other el. consumption	
Outdoor lighting	0,0 W
Spec. apparatus, during service	0,0 W
Spec. apparatus, always	0,0 W

Basement car parkings etc.											
Zone	Area (m²)	General (W/m²)	General (W/m²)	Lighting (lux)	DF (%)	Control (U, M, A, K)	Fo (-)	Work (W/m²)	Other (W/m²)	Stand-by (W/m²)	Night (W/m²)

Mechanical cooling	
Description	Mechanical cooling
Share of floor area	0
El-demand	0,00 kWh-el/kWh-cool
Heat-demand	0,00 kWh-heat/kWh-cool
Load factor	1,2
Heat capacity phase shift (cooling)	0 Wh/m²
Increase factor	1,50
Documentation	

Heat distribution plant

Composition and temperature		
Supply pipe temperature	70,0 °C	
Return pipe temperature	40,0 °C	
Type of plant	1-string	Anlægstype

Pumps				
Pump type	Description	Number	Pnom	Fp
Combi-pump (const. during heating season)	pumpe	1	75,0 W	0,60

Heating pipes					
Pipe lengths in supply and return	l (m)	Loss (W/mK)	b	Outdoor comp (J/N)	Unused summer (J/N)
	0,0	0,00	0,000	N	J

Domestic hot water	
Description	Domestic hot water
Hot-water consumption, average for the building	100,0 litre/year per m² of floor area
Domestic hot water temp.	55,0 °C

Water heaters

Electric water heater	
Description	Electric water heater
Share of DHW in separate el. water heaters	0,5
Heat loss from hot-water tank	1,0 W/K
Temp. factor for setup room	0,30

Gas water heater	
Description	Gas water heater
Share of DHW in separate gas water heaters	0,0
Heat loss from hot-water tank	0,0 W/K
Efficiency	0,0
Pilot flame	0,0 W
Temp. factor for setup room	0,00

District heat exchanger	
Description	New district heating exchanger
Nominal effect	30,0 kW
Heat loss	1,2 W/K
DHW heating through exchanger	Yes
Exchanger temperature, min	0,0 °C
Temp. factor for setup room	0,00
Automatics, stand-by	8,0 W

Other room heating	
Direct el for room heating	
Description	Suplemental direct room heating
Share of floor area	0,0
Wood stoves, gas radiators etc.	
Description	
Share of floor area	0,0
Efficiency	0,4
Air flow requirement	0,1 m³/s

Solar heating plant		
Description		New solar heating plant
Type		Domestic hot water
Solar collector		
Area 0,0 m²	Start 0,8	-
Coefficient of heat loss a1 3,5 W/m²K	Coefficient of heat loss a2 0,0 W/m²K	Anglefactor 0,9
Orientation	Slope 0,0 °	-
Horizon 10,0 °	Left 0,0 °	Right 0,0 °
Solar collector pipe		
Length 0,0 m	Heat loss 0,00 W/mK	Circuit 0,8
Electricity		
Pump in solar collector circuit 50,0 W		Automatics, stand-by 5,0 W

RESULTFILE

Model: væksthuset be10	**SBi Beregningskerne 5, 10, 12, 5**												
Be06 results: væksthuset 1													
Climate data: Greenland - Uummannaq													
Total energy requirement													
MWh	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Heating	4,52	4,93	3,17	1,81	1,31	0,51	0,26	0,56	0,83	1,32	2,50	5,50	27,21
El. (factor 2,5)	0,63	0,56	0,35	0,19	0,14	0,09	0,11	0,15	0,25	0,47	0,61	0,63	4,19
Excess temperature in rooms	0,00	0,00	0,00	1,06	4,32	6,08	4,69	3,22	0,14	0,00	0,00	0,00	19,50
Total	5,15	5,49	3,52	3,06	5,77	6,67	5,06	3,93	1,22	1,78	3,12	6,14	50,90
kWh/m²	17,2	18,3	11,7	10,2	19,2	22,2	16,9	13,1	4,1	5,9	10,4	20,5	169,7
Heat requirement. External supply to building													
MWh	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Boiler/district heating	4,52	4,93	3,17	1,81	1,31	0,51	0,26	0,56	0,83	1,32	2,50	5,50	27,21
Gas radiators	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Gas water heaters	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Cooling	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Total	4,52	4,93	3,17	1,81	1,31	0,51	0,26	0,56	0,83	1,32	2,50	5,50	27,21
kWh/m²	15,1	16,4	10,6	6,0	4,4	1,7	0,9	1,9	2,8	4,4	8,3	18,3	90,7
El. requirement. External supply to building. Building service													
kWh	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Central heating plant	33	30	9	0	0	0	0	0	0	19	32	33	157
Domestic hot water	0	0	0	0	0	0	0	0	0	0	0	0	0
Ventilation plant	214	188	127	70	50	29	37	54	95	161	207	214	1447
Boiler/district heating	6	5	6	6	6	6	6	6	6	6	6	6	70
Heat pump	0	0	0	0	0	0	0	0	0	0	0	0	0
Solar heat	0	0	0	0	0	0	0	0	0	0	0	0	0
Room heating	0	0	0	0	0	0	0	0	0	0	0	0	0
Local el. water heaters	0	0	0	0	0	0	0	0	0	0	0	0	0
Cooling	0	0	0	0	0	0	0	0	0	0	0	0	0
Lighting	0	0	0	0	0	0	0	0	0	0	0	0	0
Total for building service	254	223	142	76	56	35	43	60	101	186	246	254	1674
kWh/m²	0,8	0,7	0,5	0,3	0,2	0,1	0,1	0,2	0,3	0,6	0,8	0,8	5,6
El. requirement. External supply to building. Other el. consumption													
kWh	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Other lighting	223	202	223	216	223	216	223	223	216	223	216	223	2628
Equipment	1339	1210	1339	1296	1339	1296	1339	1339	1296	1339	1296	1339	15768
Total for other	1562	1411	1562	1512	1562	1512	1562	1562	1512	1562	1512	1562	18396
kWh/m²	5,2	4,7	5,2	5,0	5,2	5,0	5,2	5,2	5,0	5,2	5,0	5,2	61,3
El. requirement. External supply to building. Total el. requirement													
kWh	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
The building	1816	1635	1704	1588	1618	1547	1605	1622	1613	1748	1758	1816	20070
Solar cell performance	0	0	0	0	0	0	0	0	0	0	0	0	0
Wind mill performance	0	0	0	0	0	0	0	0	0	0	0	0	0
Resulting el. requirement	254	223	142	76	56	35	43	60	101	186	246	254	1674
El. for heating	0	0	0	0	0	0	0	0	0	0	0	0	0
El. for other purpose than heating	254	223	142	76	56	35	43	60	101	186	246	254	1674
Room heating, Heating requirement													
MWh	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
In rooms	2,81	2,46	0,10	0,00	0,00	0,00	0,00	0,00	0,00	0,22	1,47	3,46	10,52
Heat coil	1,70	2,47	3,07	1,81	1,31	0,51	0,26	0,56	0,83	1,09	1,03	2,04	16,69
Pipe loss	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Total	4,52	4,93	3,17	1,81	1,31	0,51	0,26	0,56	0,83	1,32	2,50	5,50	27,21
Total, kWh/m²	15,1	16,4	10,6	6,0	4,4	1,7	0,9	1,9	2,8	4,4	8,3	18,3	90,7
Room heating, Fulfilment of heat requirement													
MWh	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Boiler/district heating	4,52	4,93	3,17	1,81	1,31	0,51	0,26	0,56	0,83	1,32	2,50	5,50	27,21
Solar heating plant	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Heat pump	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
El. heating of rooms	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
El-VF in ventilation plant	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Wood stoves	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

etc.													
Total	4,52	4,93	3,17	1,81	1,31	0,51	0,26	0,56	0,83	1,32	2,50	5,50	27,21
Domestic hot water, Hot-water requirement													
m³	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Total consumption	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Domestic hot water, Supply													
m³	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Central heating plant	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Local el. heaters	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Local gas heaters	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Total	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Domestic hot water, Heating requirement													
MWh	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Central water container	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Local el. heater	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Local gas heater	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Heating total	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Loss central water container	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Loss connection pipes for DHW	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Domestic hot water, pipe loss	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Loss local el. water heaters	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Loss local. gas water heaters	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Total loss	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Total	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
kWh/m²	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Domestic hot water, Fulfilment of heating requirement													
MWh	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Boiler/district heating	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Solar heating plant	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Heat pump	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
El. heating of central water container	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
El. tracing of DHW pipes	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Local el. water heaters	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Local gas heaters	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Total	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
El. requirement in heating plant													
kWh	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Direct room heating	0	0	0	0	0	0	0	0	0	0	0	0	0
Pumps	33	30	9	0	0	0	0	0	0	19	32	33	157
Total	33	30	9	0	0	0	0	0	0	19	32	33	157
kWh/m²	0,1	0,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,1	0,1	0,1	0,5
El. requirement in hot-water discharge plant													
kWh	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
El. heating of central water container	0	0	0	0	0	0	0	0	0	0	0	0	0
El. tracing of DHW pipes	0	0	0	0	0	0	0	0	0	0	0	0	0
Charging pump	0	0	0	0	0	0	0	0	0	0	0	0	0
Circulating pump	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0	0	0	0
kWh/m²	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
El. requirement in ventilation plant													
kWh	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Heat coils	0	0	0	0	0	0	0	0	0	0	0	0	0
Ventilators	214	188	127	70	50	29	37	54	95	161	207	214	1447
Total	214	188	127	70	50	29	37	54	95	161	207	214	1447
kWh/m²	0,7	0,6	0,4	0,2	0,2	0,1	0,1	0,2	0,3	0,5	0,7	0,7	4,8
Boiler/district heating exchanger, Heat													
MWh	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Performance	4,52	4,93	3,17	1,81	1,31	0,51	0,26	0,56	0,83	1,32	2,50	5,50	27,21
Consumption	4,54	4,96	3,20	1,83	1,33	0,51	0,27	0,57	0,84	1,33	2,52	5,53	27,44
Utilizable heat loss	0,02	0,03	0,04	0,02	0,02	0,01	0,01	0,01	0,01	0,02	0,01	0,03	0,23

Efficiency	99	99	99	99	99	98	98	98	99	99	99	100	99
Boiler/district heating exchanger, El. requirement													
kWh	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Burner, kWh	0	0	0	0	0	0	0	0	0	0	0	0	0
Automatics, kWh	6	5	6	6	6	6	6	6	6	6	6	6	70
Total	6	5	6	6	6	6	6	6	6	6	6	6	70
kWh/m²	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,2
Heat pump, Heat													
MWh	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Performance, Room heating	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Performance, DHW	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Total	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Contribution ratio, room heating	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	
Contribution ratio, DHW	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	
Heat pump, El. requirement													
kWh	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
El. requirement, room heating	0	0	0	0	0	0	0	0	0	0	0	0	0
El. requirement, stand-by room heating	0	0	0	0	0	0	0	0	0	0	0	0	0
El. requirement, DHW	0	0	0	0	0	0	0	0	0	0	0	0	0
El. requirement, stand-by DHW	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0	0	0	0
kWh/m²	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Solar heating plant, Heat													
MWh	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Performance, Room heating	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Performance, DHW	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Total	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Contribution ratio, room heating	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	
Contribution ratio, DHW	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	
Solar heating plant, El. requirement													
kWh	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Pump	0	0	0	0	0	0	0	0	0	0	0	0	0
Automatics	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0	0	0	0
kWh/m²	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
El. requirement for lighting. Included in the building's performance													
kWh	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
General during service life	980	817	837	739	710	664	701	746	780	884	928	1018	9806
General stand-by when not in service	0	0	0	0	0	0	0	0	0	0	0	0	0
Working lights in service life	223	202	223	216	223	216	223	223	216	223	216	223	2628
Total	1203	1019	1060	955	933	880	924	970	996	1107	1144	1242	12434
kWh/m²	4,0	3,4	3,5	3,2	3,1	2,9	3,1	3,2	3,3	3,7	3,8	4,1	41,4
El. requirement for lighting. Other lighting													
kWh	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
During service	223	202	223	216	223	216	223	223	216	223	216	223	2628
Night consumption	0	0	0	0	0	0	0	0	0	0	0	0	0
Basement car parkings	0	0	0	0	0	0	0	0	0	0	0	0	0
Outdoor lights	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	223	202	223	216	223	216	223	223	216	223	216	223	2628
kWh/m²	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	8,8
El. requirement for epuipment													
kWh	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Equipment	1339	1210	1339	1296	1339	1296	1339	1339	1296	1339	1296	1339	15768
Night consumption, equipment	0	0	0	0	0	0	0	0	0	0	0	0	0
Special equipment during service	0	0	0	0	0	0	0	0	0	0	0	0	0
Special equipment	0	0	0	0	0	0	0	0	0	0	0	0	0

always													
Total	1339	1210	1339	1296	1339	1296	1339	1339	1296	1339	1296	1339	15768
kWh/m²	4,5	4,0	4,5	4,3	4,5	4,3	4,5	4,5	4,3	4,5	4,3	4,5	52,6
Solar cells and wind mills													
kWh	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Total el. requirement	1593	1433	1481	1372	1395	1331	1382	1399	1397	1525	1542	1593	17442
Solar cells	0	0	0	0	0	0	0	0	0	0	0	0	0
Wind mills	0	0	0	0	0	0	0	0	0	0	0	0	0
Total performance	0	0	0	0	0	0	0	0	0	0	0	0	0
Balance	-1593	-1433	-1481	-1372	-1395	-1331	-1382	-1399	-1397	-1525	-1542	-1593	-17442
Surplus	0	0	0	0	0	0	0	0	0	0	0	0	0
Adjustment of performance	0	0	0	0	0	0	0	0	0	0	0	0	0
Solar cells, included	0	0	0	0	0	0	0	0	0	0	0	0	0
kWh/m²	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Wind mills, included	0	0	0	0	0	0	0	0	0	0	0	0	0
kWh/m²	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Net heating requirement in rooms													
MWh	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Heat loss	5,06	6,32	7,62	5,19	4,33	2,75	2,36	2,91	3,36	3,91	3,73	5,69	53,24
Incident solar radiation	0,02	1,93	7,96	10,04	11,58	11,33	8,79	7,68	4,77	2,09	0,14	0,01	66,35
Internal supplement	2,23	2,02	2,23	2,16	2,23	2,16	2,23	2,23	2,16	2,23	2,16	2,23	26,28
From pipes and water container	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Total supplement	2,25	3,95	10,20	12,20	13,81	13,49	11,02	9,92	6,93	4,32	2,30	2,24	92,63
Relative supplement	0,45	0,63	1,34	2,35	3,19	4,90	4,67	3,41	2,06	1,10	0,62	0,39	
Utilization factor	1,00	0,98	0,71	0,42	0,31	0,20	0,21	0,29	0,48	0,81	0,98	1,00	0,62
Part of month with heating	1,00	1,00	0,26	0,00	0,00	0,00	0,00	0,00	0,00	0,56	1,00	1,00	
Heating requirement	2,81	2,46	0,10	0,00	0,00	0,00	0,00	0,00	0,00	0,22	1,47	3,46	10,52
Heating in ventilating heat surface	1,70	2,47	3,07	1,81	1,31	0,51	0,26	0,56	0,83	1,09	1,03	2,04	16,69

Net. room heating	4,52	4,93	3,17	1,81	1,31	0,51	0,26	0,56	0,83	1,32	2,50	5,50	27,21
Total, kWh/m²	15,1	16,4	10,6	6,0	4,4	1,7	0,9	1,9	2,8	4,4	8,3	18,3	35,1
Solar shield, forced vent., night vent. and cooling													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Solar shield, red. factor	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	
Forcing, share	0,00	0,03	0,41	0,66	0,77	0,86	0,83	0,75	0,54	0,25	0,00	0,00	
Night ventilation, share	0,00	0,00	0,00	0,21	0,30	0,47	0,45	0,33	0,19	0,00	0,00	0,00	
Mechanical cooling, share	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	
Mean ventilation. Sum of natural and mechanical ventilation													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
m³/s	0,36	0,37	0,43	0,48	0,50	0,51	0,51	0,49	0,46	0,40	0,36	0,36	
l/s m²	1,20	1,22	1,44	1,60	1,66	1,72	1,70	1,65	1,53	1,35	1,20	1,20	
Share of time at 26,0 °C room temperature or above													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Time sha<re	0,00	0,00	0,00	0,18	0,25	0,40	0,38	0,27	0,10	0,00	0,00	0,00	0,13
Mechanical cooling, net													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
MWh	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
kWh/m²	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Total heat loss, W/m²													
Heat loss	28,8												
Ventilation without HRV in winter	46,5												
Total	75,3												
Ventilation with HRV in winter	11,6												
Total	40,5												