Master's thesis

NTNU
Norwegian University of Science and Technology
Faculty of Architecture and Design
Department of Architecture and Technology

Julie Nyland Nilsen

Nordlandsbua
Cabin in Nordlandsruta

Climate research and outer shell design

Master's thesis in MSc Sustainable Architecture
Supervisor: Pasi Aalto
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ABSTRACT

Shelter and protection against the weather are the earliest and primitive functions of a dwelling. Being a warm-blooded entity, a person needs shielding from the extreme wrath of the weather to survive and feel comfortable. 'A small, simple wooden cabin' depicts traditional narratives, norms, and ideals that cabin life is a simple, attentive, respectful way of life living within nature and getting away from modernity. Today, however, cabin development is forwarding towards several dense built-up cabins with the invasion of electricity, water and sewage, roads, and parking spaces into undisturbed nature. This sub-topic of the thesis Nordlandsbua, a cabin in Nordlandsruta, responds to how the built cabin should be adapted to the terrain. It reflects and analyses the climatic conditions and explores the conceptual form of the outer shell with the ambition for simplicity and encouragement for the reuse of material.

This sub-topic is split into three parts, with individual topics. The first two-part are the climatic and site portion of the thesis, and the second part is focused on the design of the shell. The design and the analysis of the climatic and terrain portion are performed through various climatic data sources and computable productions. This is done to depict the optional orientation based on site conditions, the influence of weather on material, finding the favourable site area and fundamental opinions, whilst advising other site adaptions for other areas along Nordlandsruta. Lastly, this sub-topic explores the outer shell in two simple forms, yet with different sizing variations.

With both parts and chapters, this thesis explores, identifies, advises and concludes on design solutions for Nordlandsbua based on climatic and site findings. Further, this thesis advises and seeks sustainable design forms and solutions to accommodate more visitors to the cabin and design for the longevity of the cabin by using the outer shell as a design implication.

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ABBREVIATIONS

CO_2	carbon dioxide
m^2	square meters
EPW	EnergyPlus Weather file
MET	Norwegian Meteorological Institute
NGU	Geological Survey of Norway

I. INTRODUCTION

BACKGROUND

CLIMATIC FOOTPRINT

The natural landscape in Norway is unique. The landscape is influenced and shaped by extensive coasts, soaring mountains, and immense forest and fauna arenas, where animals and plants can thrive and co-exist. The Norwegian people have always felt very connected and proud of this nature, an essential part of Norwegian identity, as the Norwegian cabin culture introduction chapter in the central thesis 'Nordlandsbua, cabin in Nordlandsruta". During the last decades, the development of cabins has increased. The pace of the development, the size and standards, and the form of the cabins have expanded. (Skjeggedal, Ericsson, Arnesen & Overvg, 2010). Building sustainably revolves in reality around simple principles and common sense – like the way we know and experience traditional building techniques. However, these traditional building techniques need to be interpreted in modern ways, with a basis of ecological knowledge, material, energy solutions, and techniques. (Butters, 2006)

Climate is an important environmental factor that architects and engineers need to consider when designing buildings (Graham, Berardi, Turnbull & McKaye, 2020). The carrying capacity of nature can be described as 'the ecological footprint'. All the resources affect human activity in this description, including buildings man has made for nature. (Butters, 2006). The level of emissions depends on many factors, including climate, land use patterns, density, lifestyle, and population. (Edwards, 2010)

BUILDING FOR A CHANGING CLIMATE

Climate change is a chain reaction resulting from the rise in average temperature. Due to this, the water stores in the icecaps and glaciers are melting, so the sea level rises. (Edwards, 2010). The amount of CO_2 determines the possibility of a four °C warmer Earth that human actions have delivered into the atmosphere and the sensitivity of the world's climate to greenhouse gases. (Smith, 2010). Although the term 'global warming' suggests even heating the planet, the reality is climate change and a great deal of regional instability. (Edwards, 2010).

With warmer temperatures, more vapour evaporation from the oceans, more moisture is available from rain (precipitation), and excess moisture in the air (clouds) contributes to shifting winds and weather patterns. (Smith, 2010).

CLIMATE CHANGE IN NORWAY

Climate change is due to an imbalance in the energy exchange between the earth and the external climate driver space, which has occurred at all times. Until a couple of hundred years ago, these were natural causes, but human activity increasingly affected energy exchange. According to the UN Panel on Climate Change, human activity is the leading cause of the observed increase in global temperature since 1950.

In addition to climate change caused by changes in external climate forces, energy exchange within the climate system can also lead to variation in weather patterns on earth. Such variations; - which are found naturally in the climate system, can have very different effects in different regions. Therefore, it is a challenge to distinguish them from the changes caused by external forces, and it is often uncertain how these variations are affected by global warming.

Norway is so far to the north that the country has a net loss of radiation to space. However, large-scale circulation in air and sea add energy in the meantime. Variations in these circulation patterns lead to variations in local weather conditions on time scales for several decades. Changes in these circular patterns will lead to changes in the regional climate in Norway.

This can be, for example, changes in the extent, intensity and trajectories of low migratory pressures or the event of changes in volume or heat content in the Norwegian Atlantic Ocean current.

CLIMATE-ADAPTIVE ARCHITECTURE

All built environment is affected by climate; a building needs to protect its interior against exterior climatic forces. (Dahl, 2010). So, what makes an environmentally friendly building? Climate adapted architecture is primarily found in traditional architecture. The climate's effect and toughness result in a more characteristically and divergent architectural form. (Dahl, 2010) Different arguments regarding environmentally friendly architecture, traditional buildings based on down-to-earth experience, others highlight newer ecological architecture, based on environmental thinking, which concludes to new forms and resource-efficient construction (Butters, 2006). However, faults can be found in both arguments. There is a pure blind belief in traditional building solutions and, on the other hand, originality just for originality. In terms of newer ecological buildings, technical facades and strange angles correlate to the designer's fault in making the building look environmentally technically original, more than common sense (Butters, 2006).

At this time, climatic adaption is synonymous with energy reduction and CO_2 savings. Therefore, contemporary architectural discourse is more focused on sustainability regarding minimising energy consumption than ensuring optimum utilisation of and adaption to the outdoor climate. This is a narrow response to energy-related design and completely ignores the potential of great attention to climate architecture. (Dahl, 2010). Environmentally-friendly construction is, in the end, only a matter of duration and quality. (Butters, 2006)

SCOPE & METHODOLOGY

SCOPE

This sub-thesis aims to understand the climatic challenges that the site location is facing now and interpret and design for the climatic strain in the future. This refers to the façade and fundamental decisions made for Nordlandsbua, the design of the outer shell will act as a protection cocoon over the cabin.

Intension using the climate and geology information about the site location gives an overview of the design and material options for façade and foundational opinions. In addition, other options and adaption for the foundation will be given to ground the cabin in the best possible way in other locations around Nordlandsruta if Nordlandsbua is being rebuilt.

One of the intentions for the outer shell is to design a simple timber frame structure, giving options of size and expansion possibilities. In addition, succeeding intentions are designed to reuse and recycle materials. Therefore, it is heavily encouraged to be constructed using recycled materials or as much natural material as possible.

METHODOLOGY

The research topic in this sub-thesis is climate exploration for the Tjoarvihytta site location and how the new cabin Nordlandsruta can be adapted into the site and other site locations along Nordlandsruta. Further, this thesis explores and advises on the design and structure of the outer shell.

The approach to climatic data and geology collection happened through four stages.

1. Collecting climatic information from weather-related websites like yr.no and storm.no

2. Using Norsk Klima service centre to locate and compare windroses similar to the site location based on terrain and assumed wind direction.

3. Find the closest EPW locations to the site and use programs like Climate consultant and Grasshopper to produce different results for comparison and assumption.

4. Collecting geology and terrain information from Saltdal Municipality maps and ngu.no (Norwegian geological survey)

These results affected the location advice for the cabin, orientation and foundation options.

The design decisions for the outer shell followed closely with the design of Nordlandsbua. The design further evolved when researching weather-exposed architecture. The final design gives design options for different sizes and needs, exploring simple yet effective forms.

II. SITE & CONTEXT

TJOARVIHYTTA

SALTDAL MUNICIPALITY

Saltdal is a municipality in Nordland County. The municipality is located around Saltdalsfjorden, which forms the innermost part of Skjerstadfjorden, and includes Saltdalen with Saltdalselva included. The municipality extends southward the watershed against Ranelva by Stødi on Saltfjellet. Towards the east, the municipality harbours mountain areas bordering Sweden, and in this areaEvensdalen and Junkerdalen intersect eastwards from Saltdalen. (Thorsnær & Engerengen, 2022)

FIGURE 1. photo by Bjarne J Aronsen "Coarvihytta"

EXISTING CABIN

The existing DNT cabin (fig. 1) is located in the Sulitjelma mountains, 600 above sea level, in Saltdal municipality. Tjoarvihytta/Coarvihytta, as it is called, is located roughly 11 km from the Sulitjelma ski cabin. The cabin consists of an older and a newer part, the older part initially being a sheep barn in timber but moved to Saltdalen in 1936. The cabin was the first shared cabin owned by Sulitjelma and Omgna Turistforening. The oldest part of the cabin is predominantly used by hikers and can house up to 9 people, whilst the newer part has a hall fitted with a kitchen and used for events mostly. (Turistforening, n.d)

The area is used both winter and summer as it is a pretty easy skiing route, with mostly a readymade skiing trail in the wintertime and a popular spot in the summer. The area is excellent for those who like fishing and berry picking. As the site borders Junkerdalen, the area is known to have domestic reindeer herds around, making the area delicate. (Turistforening, n.d)

ACCESS

During the summer, the cabin is accessible by car or by hiking. However, when the roads are closed due to snow, the best access approach is skiing from Skihytta. There are usually tracks along the road to Balvatnet/ Bálljávrre. The cabin is located around 2 km from Balvatnet, as shown in figure 5

FIGURE 2. photo by Per Roger Lauritzen "sommer ved hytta"

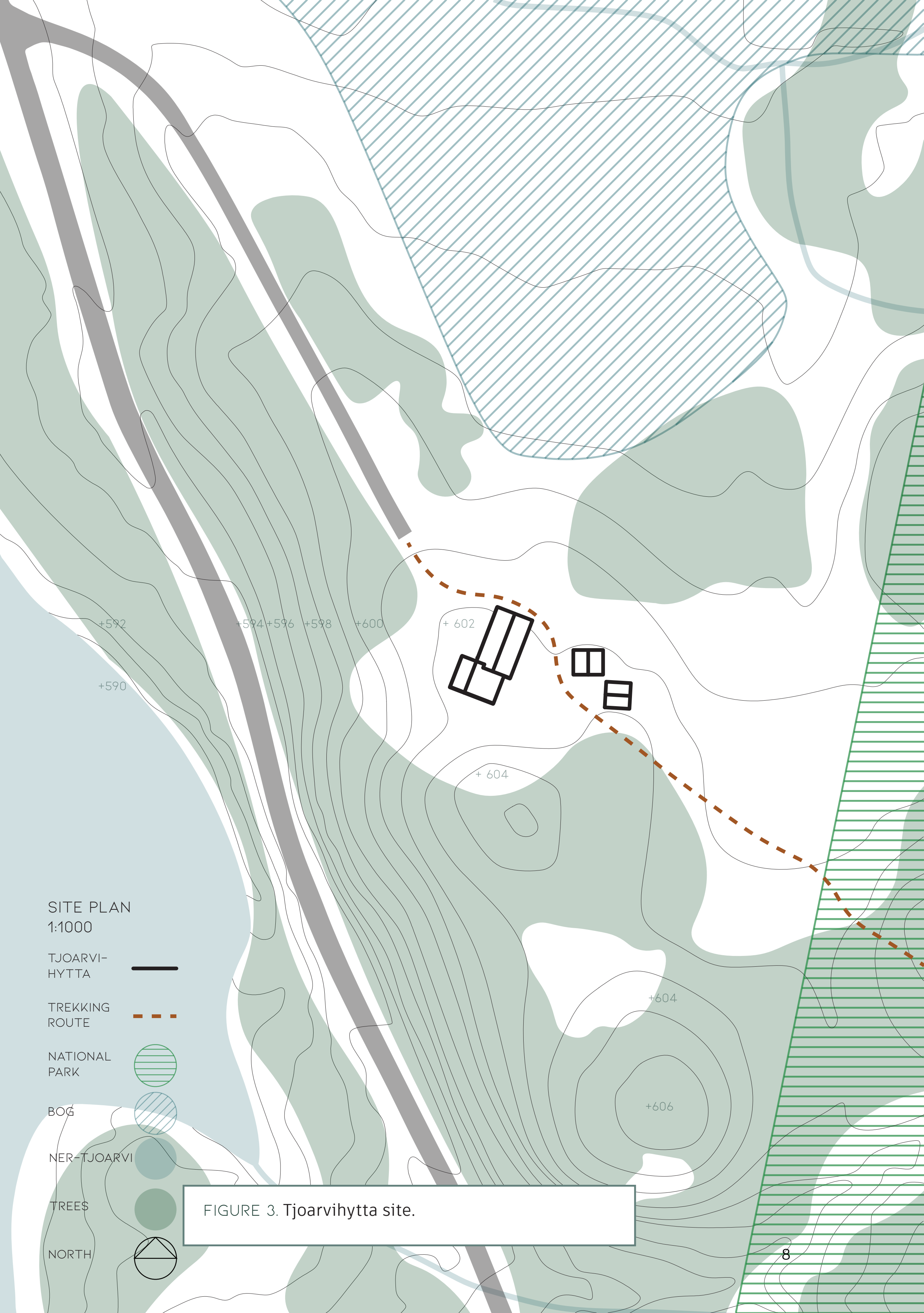


FIGURE 3. Tjoarvihytta site.

SALTDAL MUNICIPALITY

NATURE AND GEOLOGY

Saltdal municipality mainly consists of round and calm shaped mountain areas and dense pine forests in the plains and hills. The municipality highest mountain can be found in the east, measuring 1768 meters above sea level; the top of the mountain borders Sweden. (Thorsnær & Engerengen, 2022)

The bedrock in Saltdalen belongs to the Caledonian mountain range. In the south, the landscape consists of granite and granite gneiss, in the north is mostly mica shale (glimmerskifter), east is fylitt, calcareous rock such as marble and lime silicate shale (kalksilikatskifter) west in the valley. In addition, there are several limestone caves in this area. The cabin will be located north of Saltdalen, and the geology is mica slates, bogs and birch trees. (Thorsnær & Engerengen, 2022)

Nordland county mostly has a coastal climate, but this does not apply to Saltdal. As a result of the municipality being “protected” by mountains, the climate is dominated by a stable, dry inland climate. It involves cool winters and hot summers. (Thorsnær & Engerengen, 2022). Saltdal municipality borders Fauske in the north, Bodø in the northwest, Beiarn in the west, Rana in the south and Arjeplog municipality in Sweden in the east. The town of Rognan is an administrative centre in Saltdal municipality.

JUNKERDALEN

The site borders Junkerdalen. Junkerdalen National Park spans from Junkerdalen in the south to the mountains south of Sulitjelma, in Fauske municipality in the north. The Junkerdalen River, which borders the national park in the southwest, is protected as a nature reserve. In addition, part of this national park is protected as a nature reserve due to birdlife, and Gåsvatnet, Østerdalen and parts of Saltfjellet are protected as landscape protection areas. (Thorsnær & Engerengen, 2022)

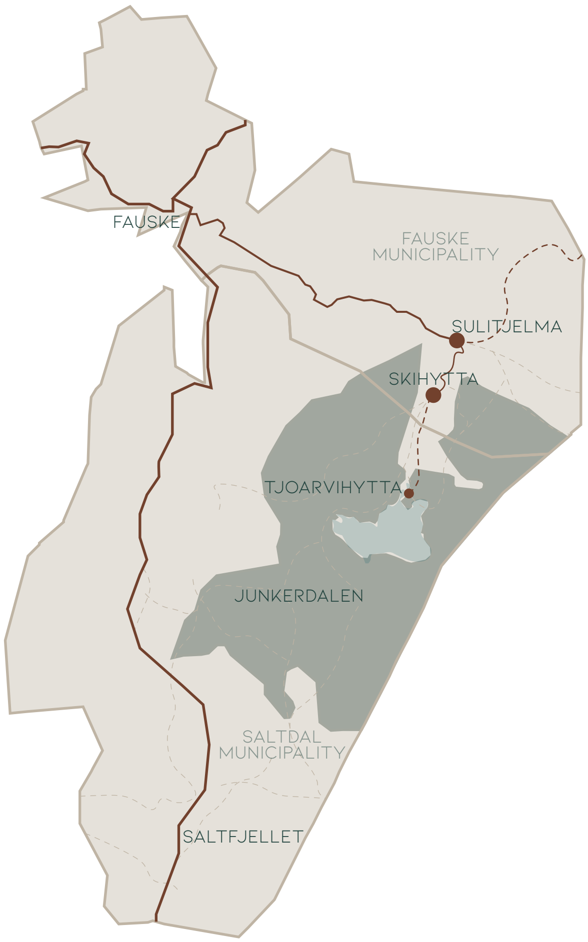


FIGURE 4. Junkerdalen

FIGURE 5. **Access**

III. CLIMATE ANALYSIS

CLIMATE NORDLAND

The climate in Nordland county is characterized by a relatively mild and rainy coast, while the inner valley areas have low annual precipitation and low temperatures in the winter. This weather pattern is not expected to change significantly at the end of 2100. In winter, low polar pressures can cause rapid wind growth and heavy snowfall in the outer regions of the county. (klimaservicesenter, 2022) A likely increase in uncertain climatic information within 2100 can be read in the next column—information taken from klimaservicesenter (2022).

Sun, temperature, wind and precipitation are the most critical factors that affect the climatic conditions in a building. The wind dramatically affects Sensed temperature; the wind is the driving force behind heavy rain and snow. Therefore, wind and radiate solar energy are the most important climatic factors in planning climate-adapted buildings.

Therefore, it is essential to determine which climatic load has the most significant consequences between wind and snowdrift. This is due to the difference in adaption strategies of the climatic strain. When the wind controls climate adaptation, one must strive to reduce the wind as much as possible. On the other hand, if there is also a lot of drift snow in the area, the snow will settle as snowdrift in the lesions and create problems. All the information above is retrieved from Byggforsk (2005).

Various simulation tools and climatic data websites were used to examine the climate in this part of the sub-thesis. There is no specific climatic data for the cabin's exact location. The closest weather stations and accessible EPWs with similar locations and elevations were chosen.

PROBABLE INCREASE

EXTREME RAINFALL

Episodes of heavy rainfall are expected to increase significantly in both intensity and frequency. This will also lead to more surface water

FLOOD RAIN

More and larger rain floods are expected, and in smaller streams and rivers, an increase in floodwater flow is expected.

LANDSLIDES, FLOODS AND MUDSLIDES

Increased danger due to increased rainfall..

STORM SURGE

As a result of sea-level rise, storm surge levels are expected to increase.

MOST LIKELY INCREASE

DROUGHT

Despite more summer precipitation, higher temperatures and increased evaporation can increase drought risk in the summer.

ICE

Shorter icing season, more frequent winter ice drifts, and ice drifts higher up in the watercourses than today.

AVALANCHE

It will rain more often on snow-covered surfaces with a warmer and wetter climate. This can reduce the risk of dry avalanches and increase the risk of wet avalanches in avalanche-prone areas.

QUICK CLEY LANDSLIDE

Increased erosion resulting from increased flooding in rivers and streams can trigger more quick clay landslides.

UNCERTAIN

STRONG WIND

Likely little change

ROCKFALL AND LANDSLIDE

More frequent episodes of heavy rainfall may increase the frequency of these types of landslides, but mainly for minor rockfall events.

MOUNTAIN SLIDES

It is not expected that climate change will significantly increase the risk of landslides.

TEMPERATURE FUTURE ASSUMPTIONS

According to klimaservicesenter (2022) for Nordland County, the temperature is estimated to increase roughly by 5.0 °C at the end of the century in Nordland. The most significant temperature increase will happen during the winter at 5.0 °C. In comparison, the summer has an estimated increase of 4.5 °C, and the growing season in the county will increase by 1 to 3 months. However, this is mainly in the outer coastal areas. In the wintertime, the days with shallow temperatures will be rarer.

Two different weather data collection platforms were used to understand the annual average temperature for the site location.

The first platform was Yr.no, as they archive their weather data information from Storstillas weather station. This is the closest weather station to the site, approximately 2 km away.

Based on results from yr.no temperature statistics from 2021, as seen in figure 7. the results show an average temperature below -11.2 °C ± in the winter months of November until April, and an average of +13.1 °C and over in May until October. Despite having the closest weather station to the site, yr.no only had statistics based on the year and no average temperatures combined weather data collection spanning over the years.

The second source of information for temperature is an EPW file used with Climate Consultant. The location for the EPW is Merkenes, roughly 615 meters above the sea, located in Sweden, roughly 35 km away from the site. The average low temperature was below -10 °C from November until March. Average of +2.5 °C and over from April until October.

Based on these data sets, one can determine that the weather inland is cold in the wintertime; this will be further discussed later in the thesis.

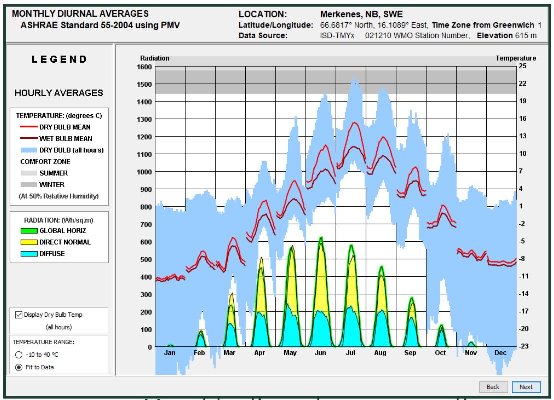


FIGURE 6. Monthly diurnal averages, climate consultant

FIGURE 7. Temperature graph from YR, 2021

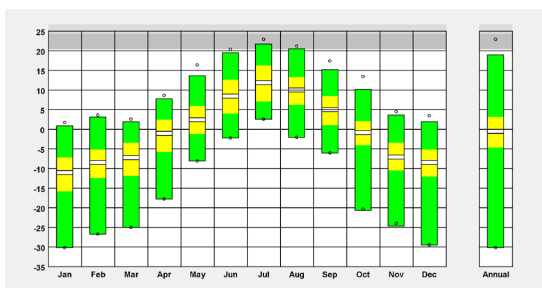


FIGURE 8. Average temperature, Merkenes. From climate consultant

SUN

The windows are located to the southwest to provide maximum light entry and energy-saving benefits in heating the building during the daytime. The beds are located on the east/north wall and will not be disturbed by the midnight sun when it hits any facades.

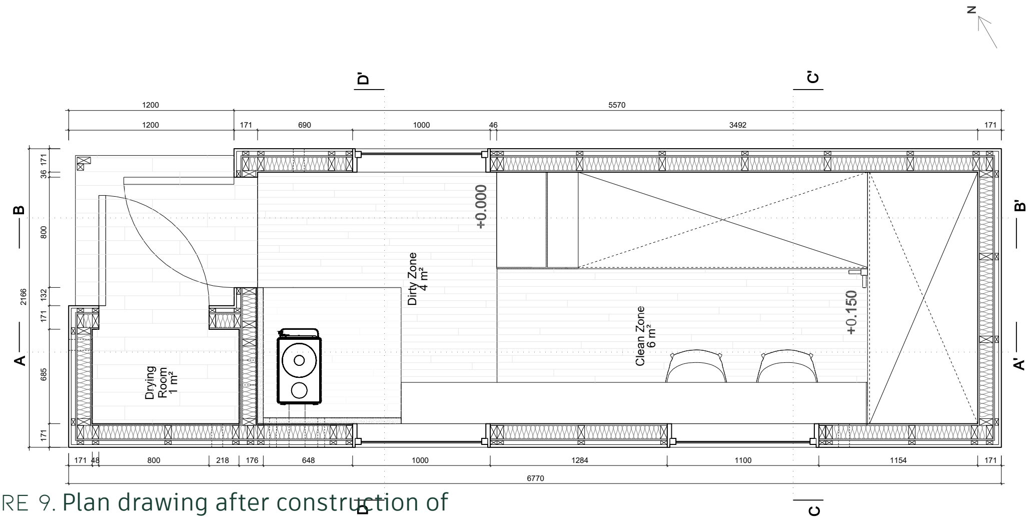


FIGURE 9. Plan drawing after construction of the cabin

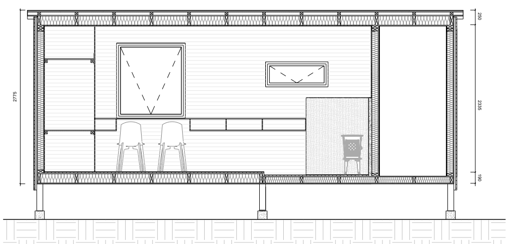


FIGURE 10. Section of the built cabin

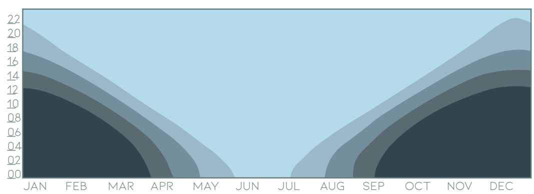


FIGURE 12. Daylight/night lenght

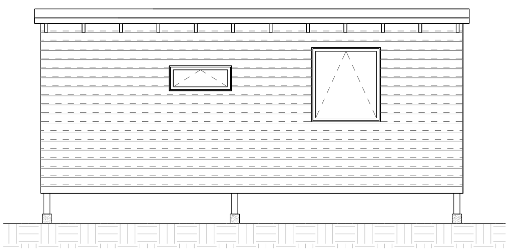


FIGURE 11. South/east facade

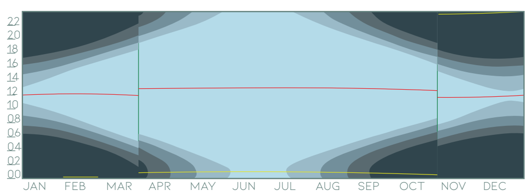


FIGURE 13. sunrise/dawn rise

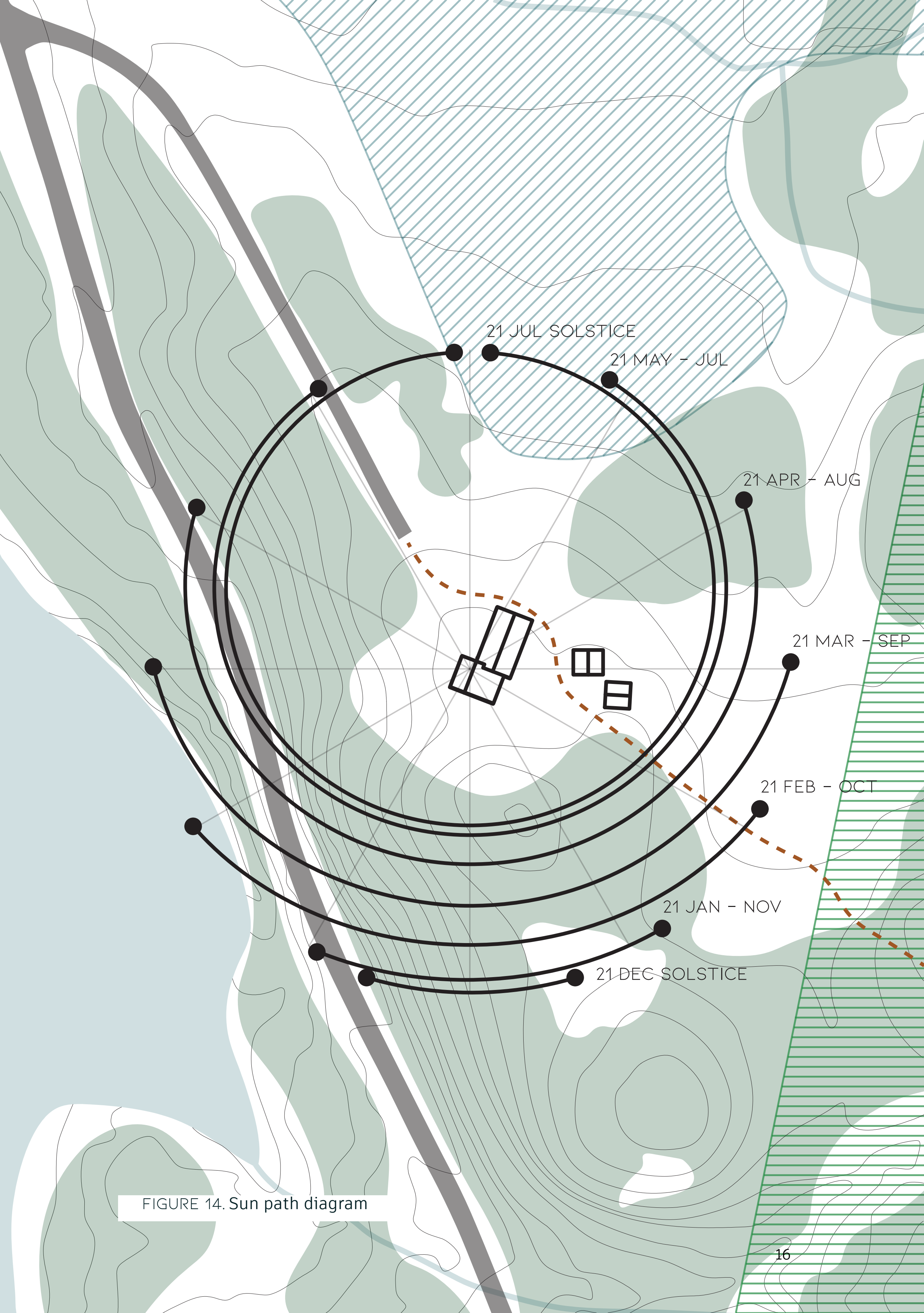


FIGURE 14. Sun path diagram

WIND

FUTURE ASSUMPTIONS

As stated in klimaservicesenter (2022), the climate models show little to no change in average wind conditions in this century, but the uncertainty in wind projections is excellent. However, the most crucial act for municipalities is that the knowledge of local wind conditions is included in the planning.

WIND STRESS ON THE CABIN

Buildings and other vertical surfaces, usually in the wind direction, slow down the wind, which must deviate away, somewhat sideways, above and below the building. This causes vortices and suctions winds in the transition to the leeward side. The wind stresses on and around the building increase with the height of the building. The height of the building should harmonize with the topography and vegetation in the area.

In the case of the site location, trees on the side of the cabin will lessen the wind and reduce the vortex formation on the leeward side.

During the conference on 31 May 2022, The local hiking outdoor enthusiast stressed the amount of wind in the area, which is the most crucial climatic strain on the building. The 'Nordlandsbua, cabin along Nordlandsruta' common thesis can read more on this. The local hiking outdoor enthusiast stressed the amount of wind in the area, which is the most crucial climatic strain on the building.

The prevailing winter winds are southwest and northwest. Therefore, it has brought forth the final assumption of design rotation. As the dominant wind direction is SW and partly NW, one can assume that the wind blows the snow away from the entrance area. However, this is only an estimation as the wind rose data is collected from MET (Norwegian Meteorological Institute) of the weather station Lønsdal Station, located south of Tjoarvihytte, 36 km away. This station was chosen as it had assumed similar terrain formation, and the wind directions seemed to correspond to the landscape around Tjoarvihytta.

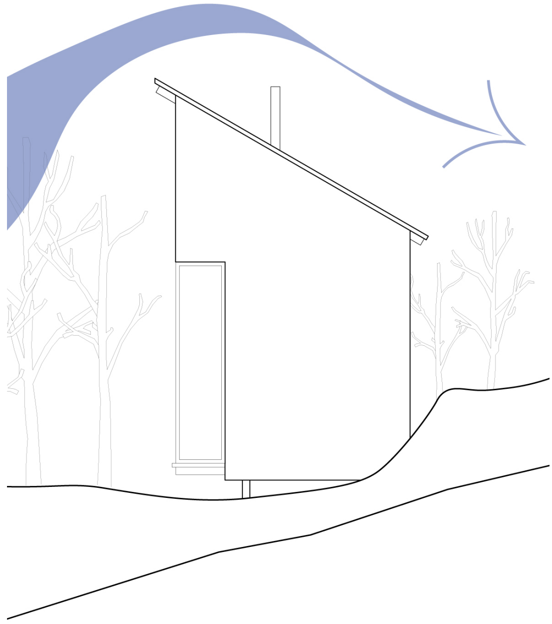


FIGURE 15. Wind and snow concept, prevailing winter wind flowing over the cabin.

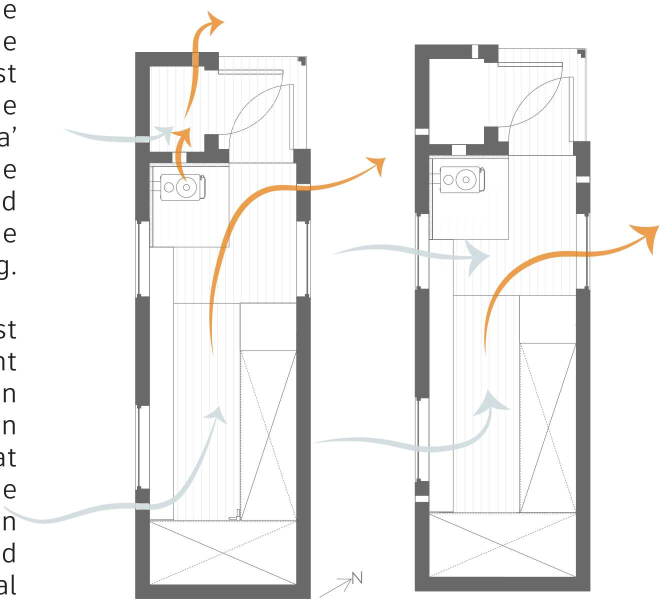


FIGURE 16. Vent and cross ventilation in the cabin

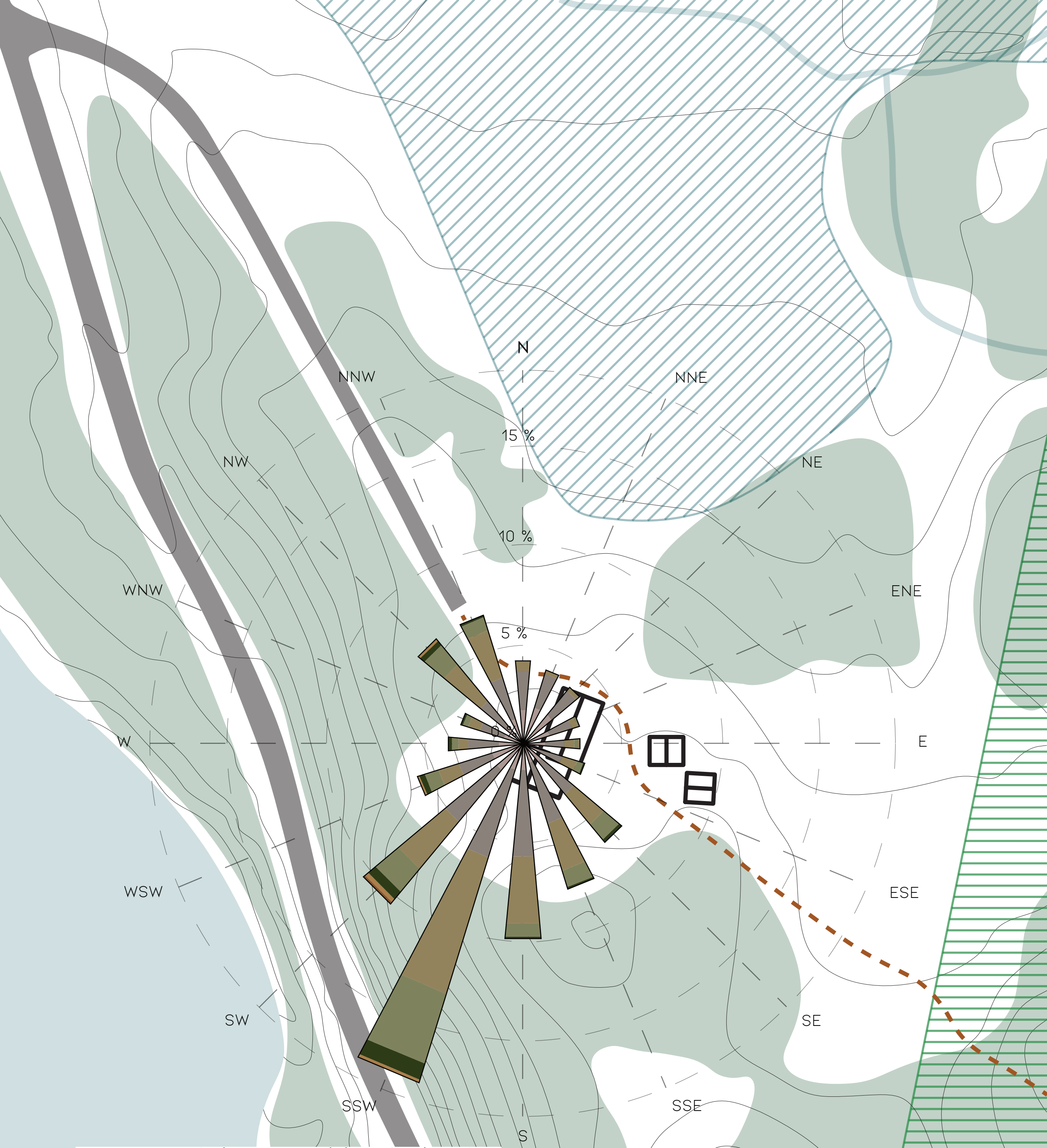


FIGURE 17. Wind rose, Lønsdal station location

FAINT WIND	(0,3 -1 ,5 M/S)	WEAK WIND	(1,6 – 3,3 M/S)
LIGHT BREEZE	(3,4 – 5,4 M/S)	SOFT BREEZE	(5,5 – 7,9 M/S)
FRESH BREEZE	(8,0 – 10,7 M/S)	SLIGHT STRONG WIND	(10,8 – 13,8 M/S)
STRONG WIND	(13,9 – 17,1 M/S)	STRONG WIND	(17,2 – 20,7 M/S)
LITTLE STORM	(20,8 – 24,4 M/S)	FULL STORM	(24,5 – 28,4 M/S)
STRONG STORM	(28,5 – 32,6 M/S)	HURRICANE	(> 32,6 M/S)

RAIN

According to klimaservicesenter (2022), the annual precipitation in Nordland is estimated to increase by approximately 20%. The precipitation change for the four seasons assumption is as follows:

- Winter: +10%
- Spring: + 5%
- Summer: + 30%
- Autumn: + 25%

Incidents of heavy rainfall are expected to increase significantly, both in terms of intensity and frequency in all seasons. The amount of precipitation for the days with heavy rainfall is expected to increase by approximately 20%.

The combination of rain and wind is defined as torrential rain. Heavy rain means that the rainwater hits vertical surfaces, such as the façade of a building, even though a roof extension protects the façade. More precipitation in the future will lead to a more significant rainfall load on the vertical surfaces. (miljødirektoratet, 2019). This has been taken into consideration when designing the facade. To increase the longevity of the cabin, the facade has a layer of Hunton wind barriers that can stand exposed to the elements for some time and keep the cabin dry as new cladding is being installed. As can be seen in figure 20.

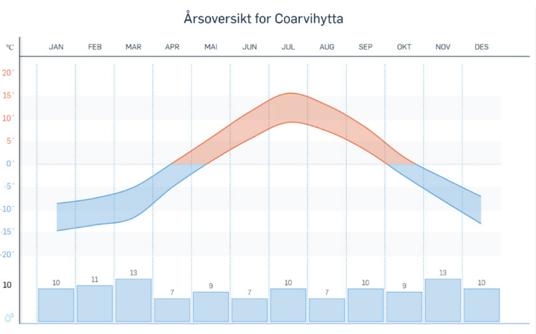


FIGURE 18. Yearly Temperature and percipitation. Graph taken from Storm.

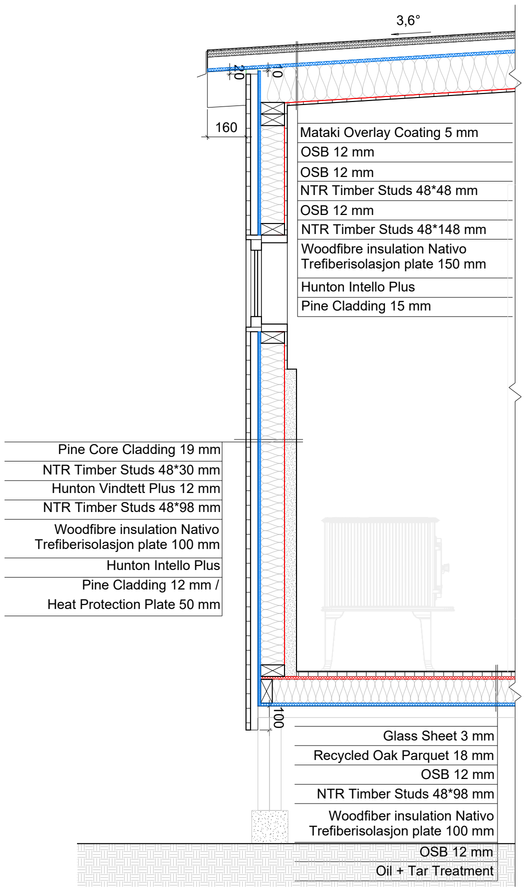


FIGURE 20. After build, final material and construction detail.

FIGURE 19. Percepitation 2021, Storstillas weather station.

SNOW

As stated in klimaservicesenter (2022), there will be a significant reduction in the amount of snow and the number of days with snow; it is estimated that there will be 3-4 months shorter snow season in the future. However, according to Miljødirektoratets climate models and estimations, there will still be some years of significant snowfall, even in the lowland areas. Due to the increase in temperature, more melting episodes as prune arrive. Higher mountain areas may have an increasing amount of snow until the middle of the century, but it is expected that smaller amounts of snow in these areas as well.

Snow has been one of the leading design drivers for choosing foundation types.

AVALANCHES

The risk of avalanches and landslides is firmly linked to local terrain conditions, but the weather is one of the most important triggering factors for landslides. Climate development could increase the frequency of landslides associated with rainfall/floods, snowfall, and melting snow in steep terrain. (klimaservicesenter, 2022). However, assuming based on the terrain steepness for this site, landslides are not common, neither has it been marked as a danger zone by NGU (Geological Survey of Norway)

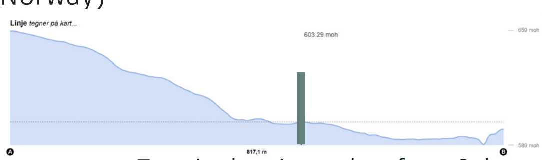


FIGURE 21. Terrain drawing, taken from Salten Municipality map

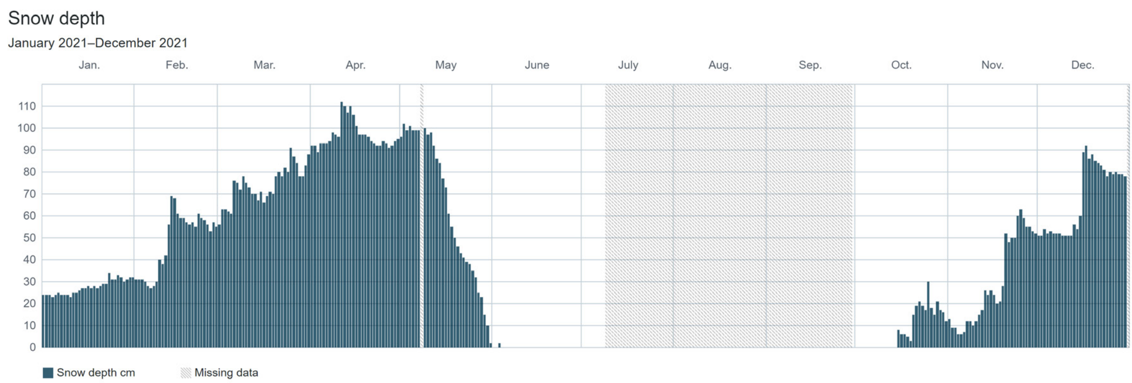


FIGURE 22. Snow depth 2021, Storstillas weather station. Taken from YR

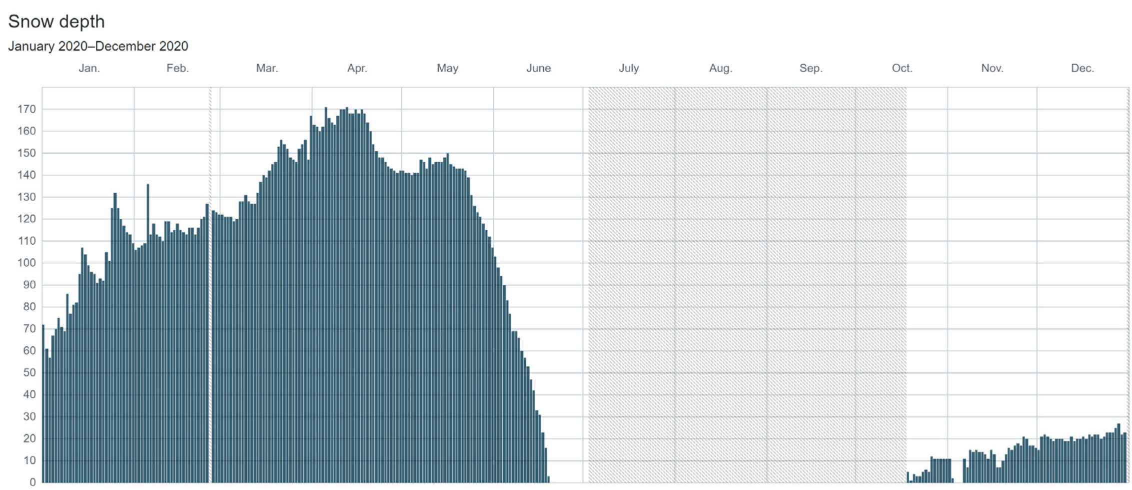


FIGURE 23. Snow depth 2020, Storstillas weather station. Taken from YR

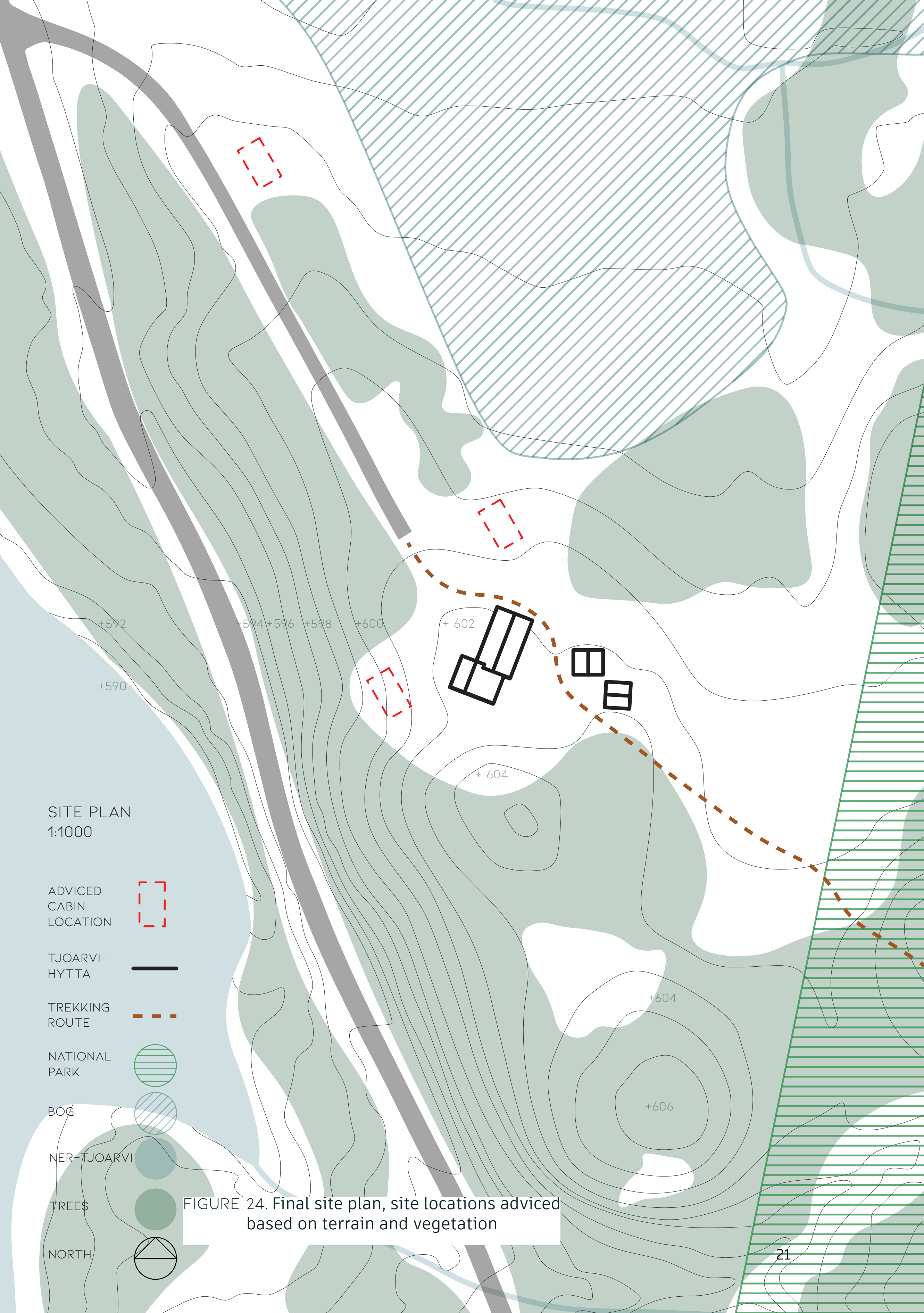


FIGURE 24. Final site plan, site locations adviced based on terrain and vegetation

IV. CONCEPT & FROM

BUILDING FORM

OUTER SHELL

It was a wish from the client to be able to accommodate more people during the summer months of the year. It was from this concept that the unheated outer shell proceeded to evolve. From an early stage in the design process of the cabin, it was explored to create the outer shell as a cacoon for the cabin. This solution would allow people to facilitate the roof of the cabin during the summer months yet work as a protective shield against the harsh elements. In addition, movable walls and wall elements would be advised to install to let the light through during the day whilst still facilitating the use of the shared space.

The central concept of the outer shell is that it can be changed and adapted according to where along Nordlandsruta it will be placed. This is concluded with how many people visit the area during the year. The shell works accordingly as a wood and equipment storage area and a social zone. Various sized and will be explored during this thesis, having flexibility, comfort and simplicity in mind.

SHAPE

According to Byggforsk (2005), buildings in weather-exposed places should have the most straightforward shape. If the complexity of the building increases, it will be more challenging to predict where snow showers will accumulate, and the possibility of snow piling up will decrease. However, it is essential to change the wind pattern around the building as small as possible.

As will be shown in the outer shell part later in this thesis. Some of the design options have a sloped roof, and after advice from Byggforsk (2005), sloped roof buildings should be placed with the highest wall against the wind. Due to this, the lesion becomes smaller, and the distance between the weather wall and the ceiling increases. It must be noted that high weather walls must withstand a significantly higher wind load than a low walls.

HEIGHT

The height of the building is essential for the speed of development of the sheltered zones. In zones sheltered from drift snow, the snowdrift has a lower development rate than if the supply of drift snow is more significant.

FIGURE 25. Outer shell, concept roof shapes

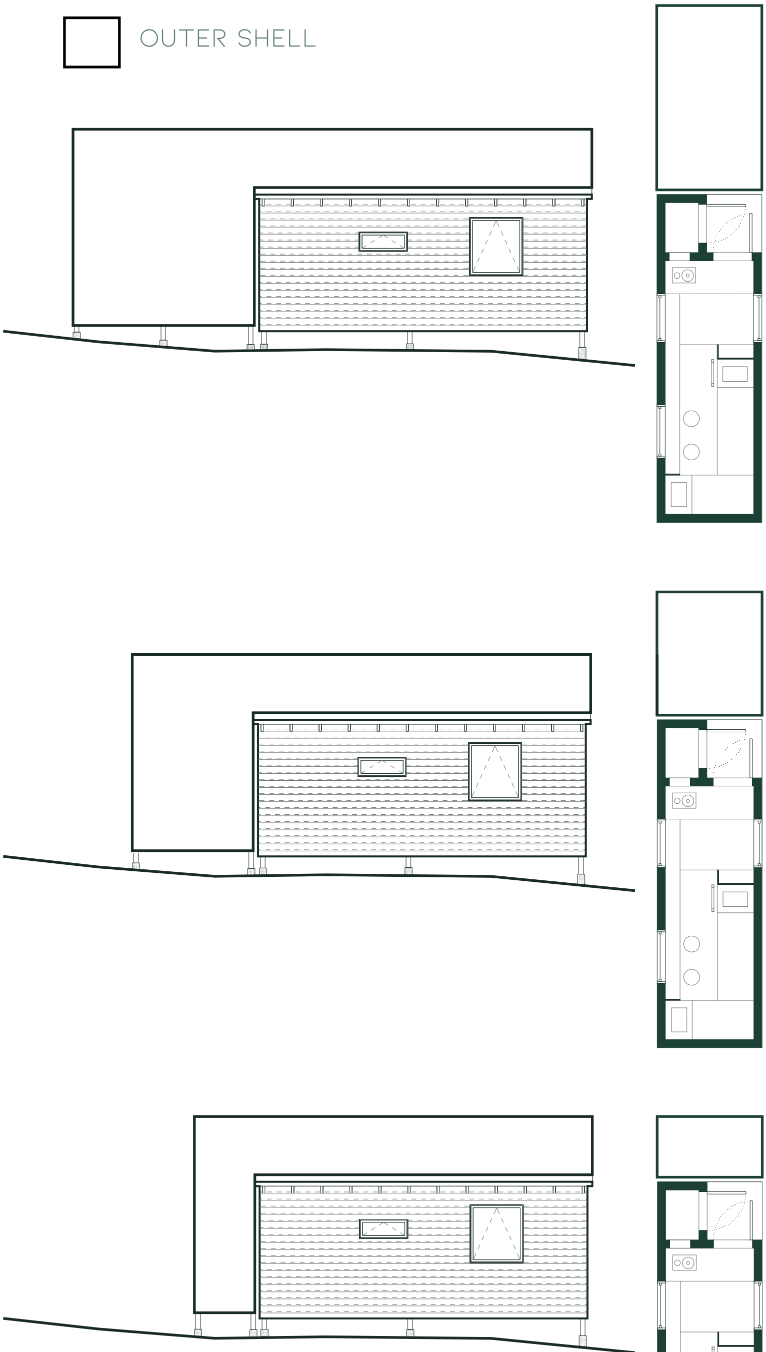


FIGURE 26. Outer shell, concept size area

ENTRANCE

The cold air entering the building through doors can cause condensation and significant heat loss. To prevent this, a windbreaker or vestibule is common in Norwegian buildings. This problem is solved through the outer shell; in this way, there is no direct passage between the indoor and the outdoor air, and heat loss is minimized.

The entrance should be relatively exposed to the wind, preferably near a corner, so as not to be blocked by the leeward snow gathering, although the wind forces can be strong here. In places where wind conditions are variable and there are several main wind directions, it may be appropriate to construct alternative entrances, according to Byggforsk (2005), as shown in the different design adaptations of the outer shell.

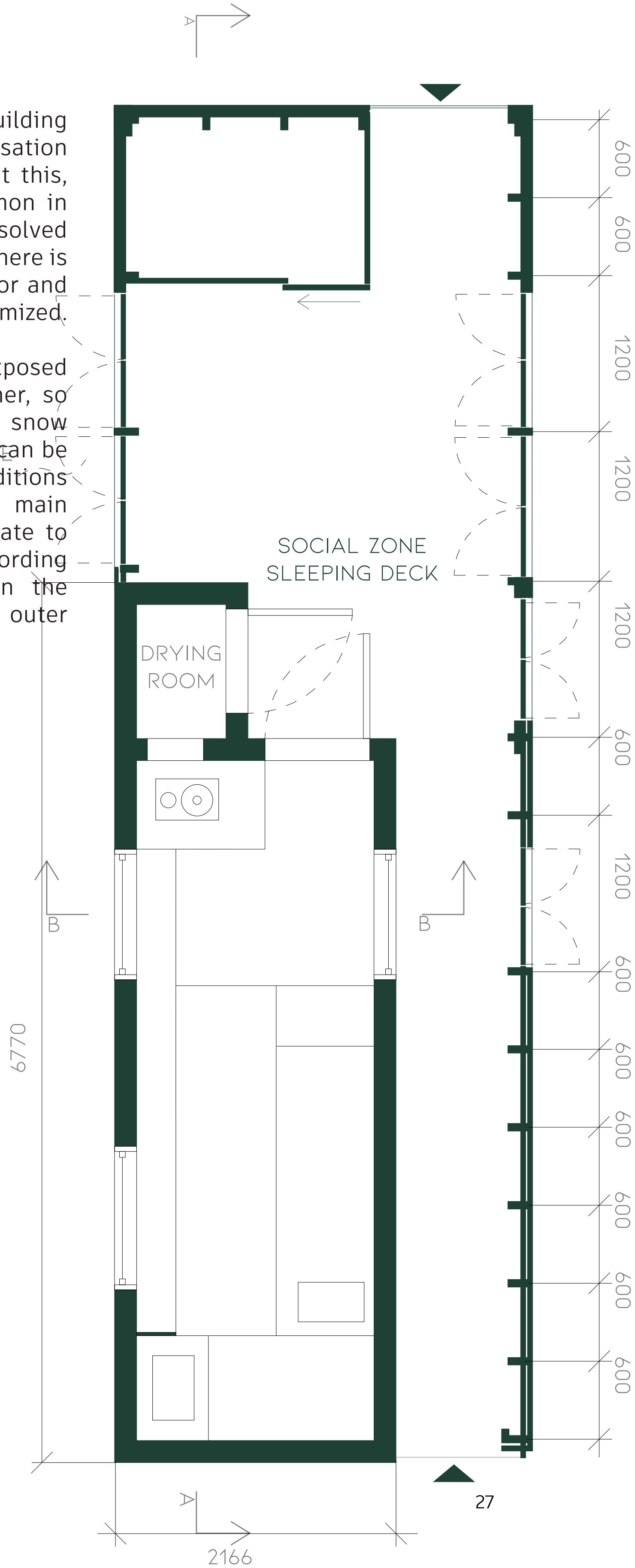


FIGURE 27. Cabin and outer shell

FOUNDATION

Foundation on pillars is not generally recommended because the foundation method gives several disadvantages, e.g., appearance, windproofing, and frost protection of water and drainage pipes. (Byggforsk, 2005). In the case of Nordlandsbua, these disadvantages are not a big issue, as the cabin footprint is 12 m^2 and easy to heat up, and the U-value of our floor areas are 0.37 and 0.26. Another issue we did not have to consider is the frost protection of pipes as this Cabin's sole heating source is a wood-burning stove and no other appliances. More on this can be read in the main thesis report and Sonja Morzyzki's thesis topic, 'Heating and firewood consumption analysis'. One of our arguments for having the Cabin on pillars is the amount of snow in the wintertime. Making the Cabin more accessible and preventing snow accumulation right up to the walls. Moreover, for repainting the tar on the bottom layer.

The wind current under the building will accelerate with this type of foundation, and a jet stream will form into the covered zones behind the building. Displaced downstream, direct contact with the building and the snow are avoided. (Byggforsk, 2005). The distance between the building and the terrain must, according to Byggforsk (2005), be a minimum of 1.3 m, and the airflow must not be blocked under the building.

The Cabin and the outer shell are adaptable. So different foundation solution types may be implemented into the other cabins that will be placed along Nordlandsruta.

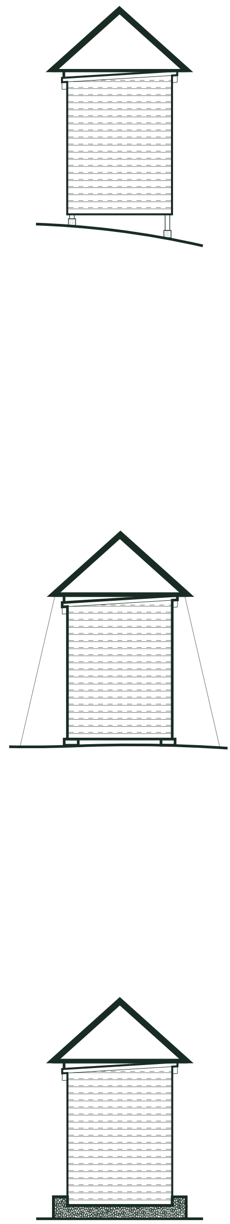


FIGURE 28. Foundation options, pillars, wires and grounded with rocks.

V. OUTER SHELL

CONSTRUCTION PRINCIPLE

The construction of the outer shell would happen on site. So after Nordlandsbua has been placed on-site, the cabin could be used to host the workers building the outer shell.

The material of choice is timber; this allows the shell to be constructed easily using the CC60 timber frame grid structure. In terms of cladding, reused or recycled materials are the material of choice, and design for disassembly is highly advised.

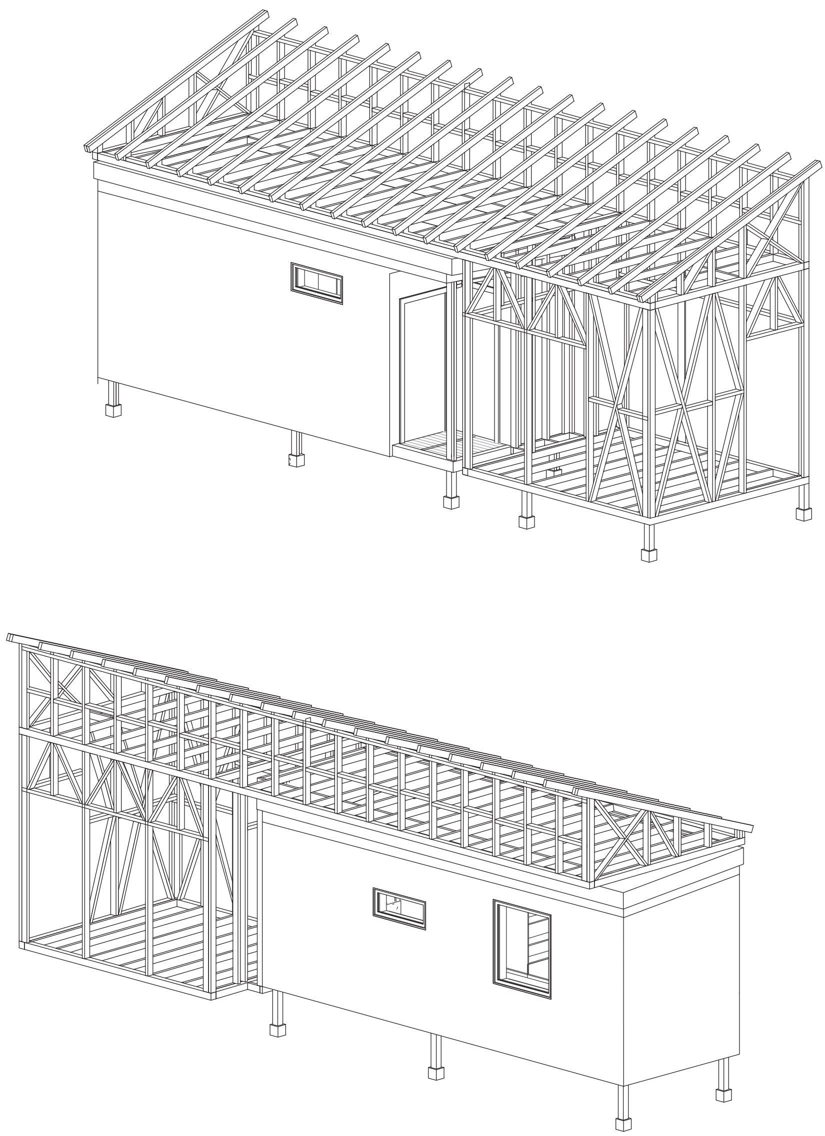


FIGURE 29. CC60 timber frame construction explored

ADAPTION 1

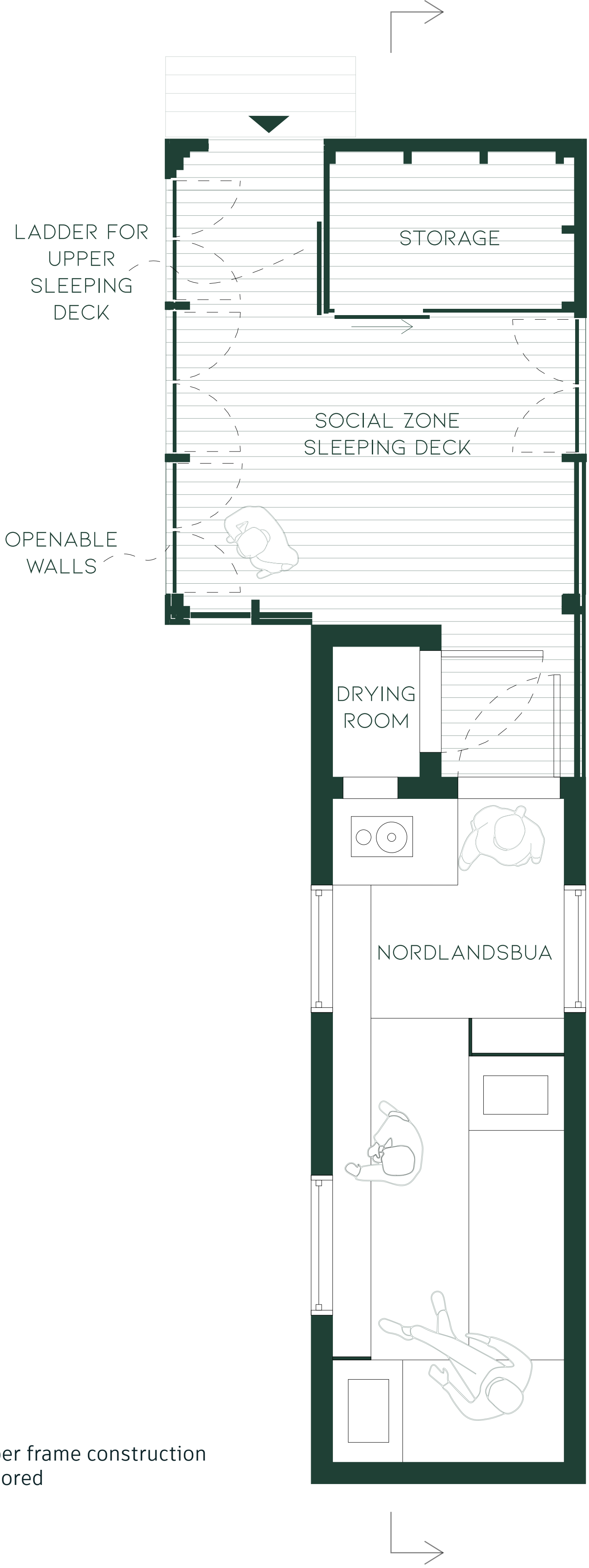


FIGURE 30. CC60 timber frame construction explored

ADAPTION 2

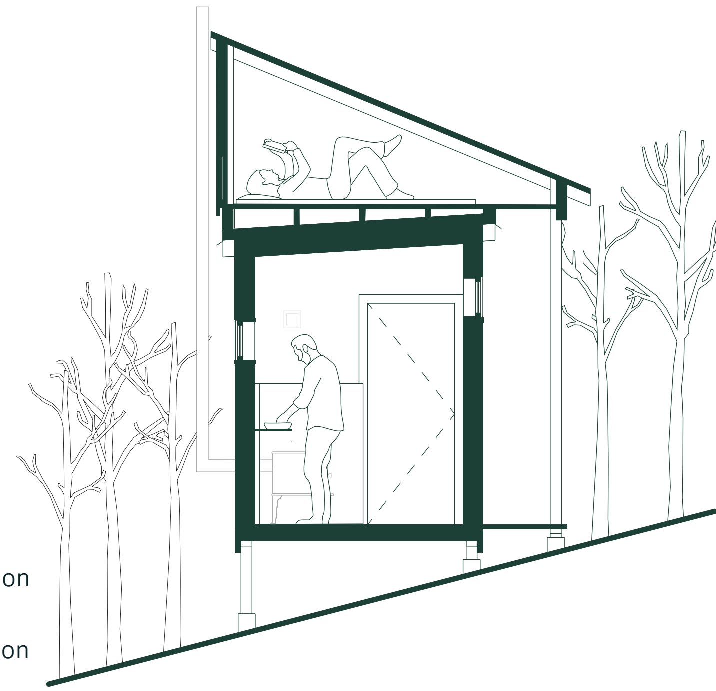
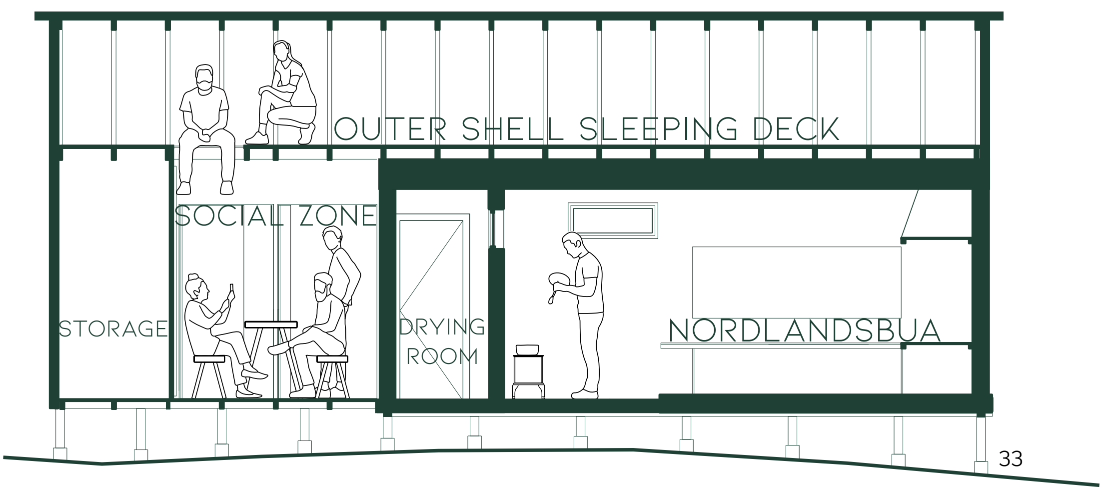


FIGURE 31. CC60 timber frame construction explored

FIGURE 32 CC60 timber frame construction explored



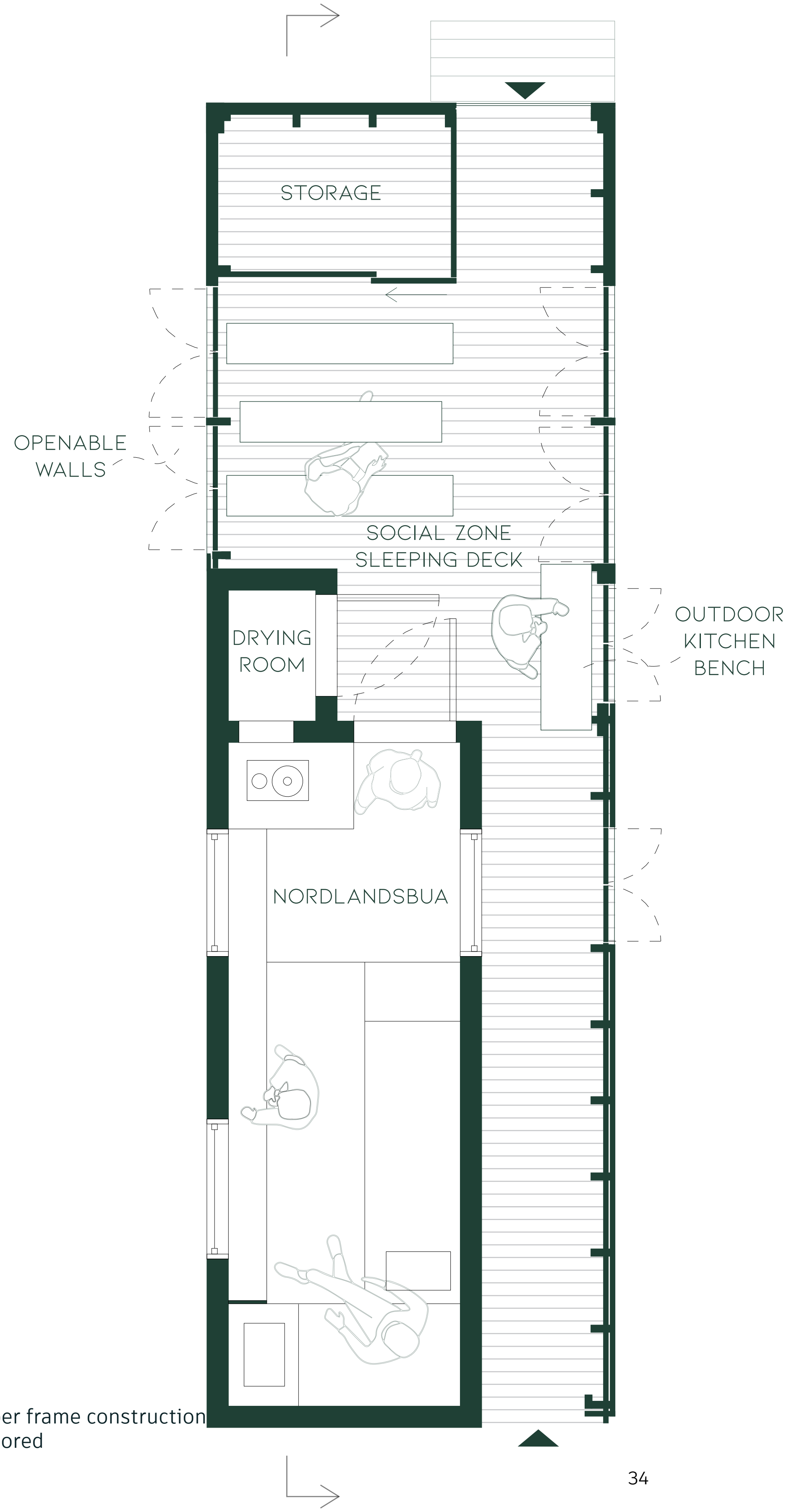


FIGURE 33. CC60 timber frame construction explored

ADAPTION 3

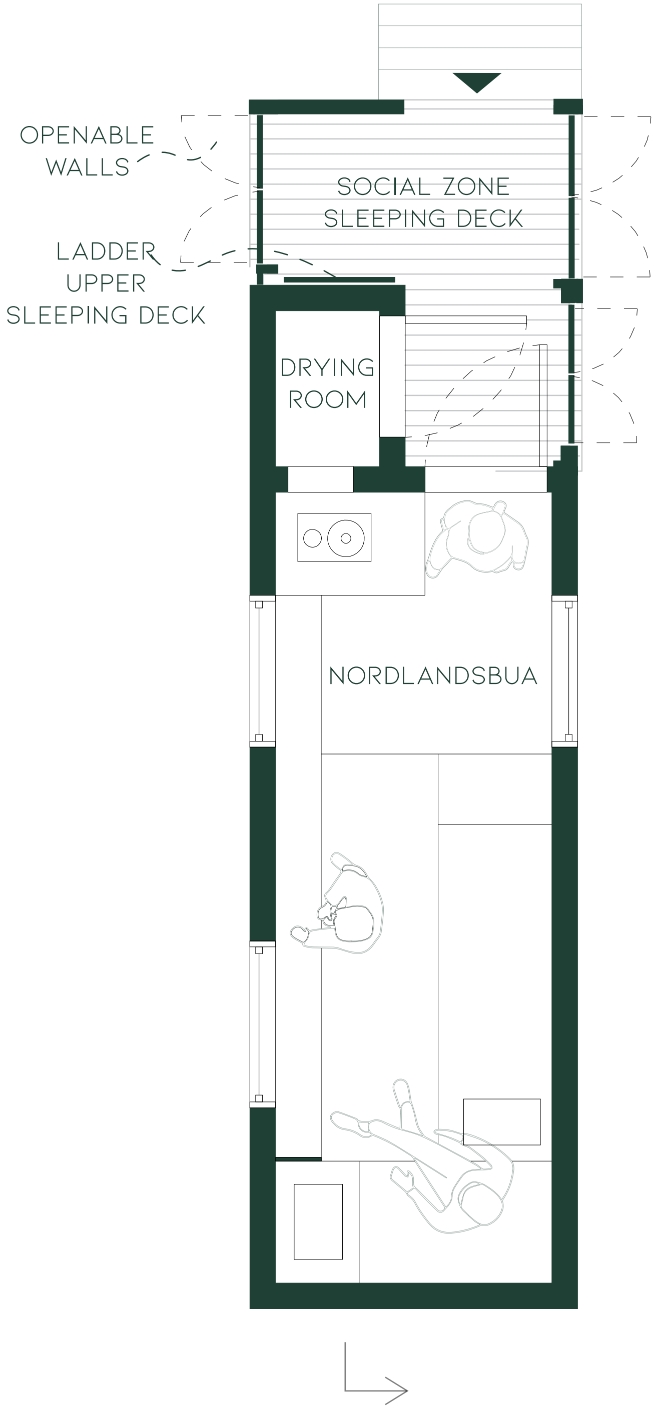


FIGURE 34. Adaption 3

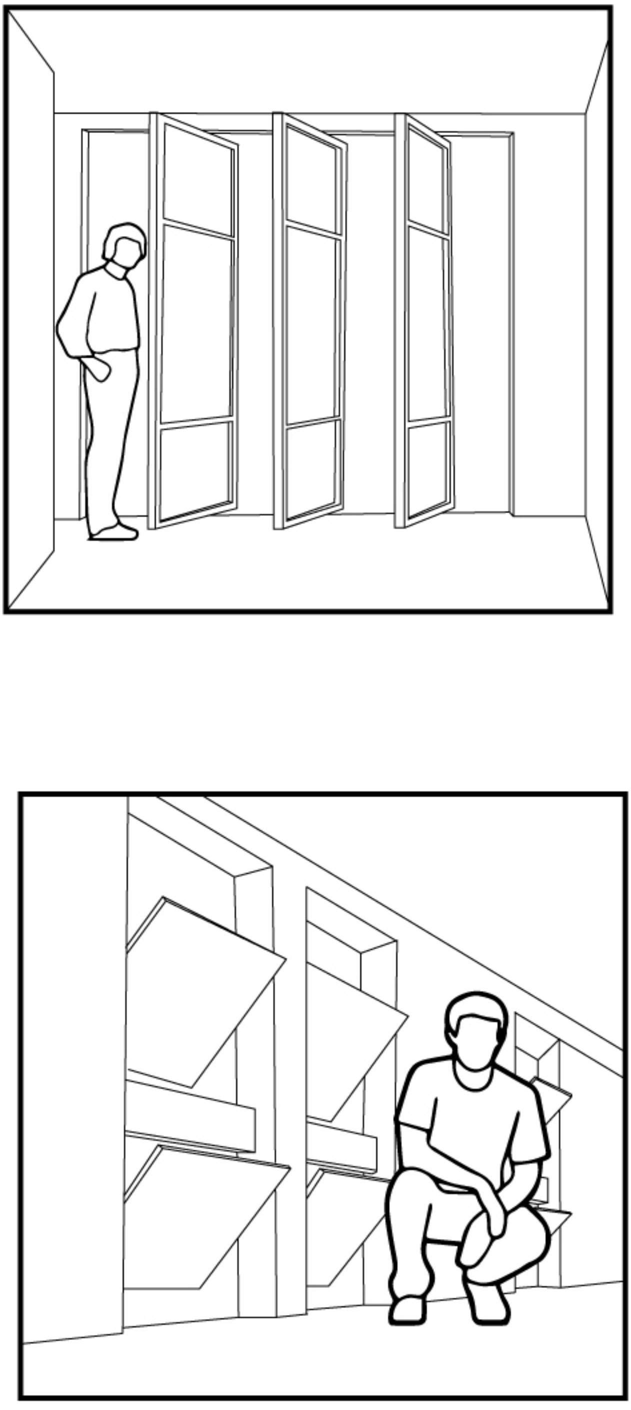


FIGURE 35. Movable walls

VI. CONCLUSION

CONCLUSION

The earliest and most basic functions of a house are shelter and weather protection. As a warm-blooded being, a person requires protection from the extremes of the weather to survive and feel comfortable. 'A modest, simple wooden cabin' depicts traditional narratives, conventions, and aspirations that cabin life is a simple, attentive, and respectful way of life spent in nature while escaping modernity. However, with the invasion of power, water and sewage, roads, and parking places into a new environment, cabin growth moves to multiple densely built-up cabins. This sub-topic of the thesis Nordlandsbua, a cabin in Nordlandsruta, addresses how the cabin should be built to fit the terrain. It examines the conceptual shape while reflecting on and analyzing the climatic conditions.

This sub-topic was divided into three areas within each set of topics. The first part of this thesis was set to site nature and geology to understand the terrain condition better. The second part was site analysis of Tjoarvihytte; this was done with a few different sources of weather data collection. However, some weather stations were closer than others, and these results are primarily assumptions and speculation. Thirdly, this thesis began to explore the concept and form of the outer shell and how it could be adapted to Nordlandsbua.

The information produced during the site information and site analysis data determined the advice given for the foundation due to snow and terrain conditions. The site analysis and climatic research concluded in orientation on-site and optimal form. These results were further implemented when designing the concept of the shell, foundation and outer shell sizing for other cabins that will be placed along Nordlandsruta.

Further, if this sub-thesis topic were repeated, the steps would have changed. Firstly, this would have successfully computed aerodynamic simulation in terms of wind analysis. This was attempted through Grasshopper with Eddy 3D and Butterfly plug-ins. However, due to inexperience and program faults, results were not produced as wished. Secondly, evolving the shell to its full design potential. This could quickly have been done by more exploration of structure and form and through inputs from experienced hikers who have visited Nordlandsruta to hear what they would like. Moreover lastly, going to the Tjoarvihytte site if the possibility arises to understand the terrain, area, and accessibility truly.

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