SUB-STATION

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regaining awareness of the *subordinate*

UTSIRA

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ABSTRACT

This architectural thesis investigates the relationship between technology, human and nature in the establishment of a land based substation on the small island society of Utsira. Being more than just a subordinate component in the energy production and supply network; regaining awareness. In this thesis, we explore the substation's potential for generating acceptance and interest for renewable energy production.
The thesis is twofold. Rooted in a historical perspective it is, at one hand, an exploration of the value we as a society place in infrastructure. It calls for a new attention to such typology that reflects the values of tomorrow; transparency in production and modesty in consumption.
On the other hand, it explores the concept of impermanence within construction. The energy production of tomorrow is unknown, and the built scene should accommodate such changes. We explore how materials can be utilised with minimal processing and reuse as resources in its natural state by the next generation.
A deep understanding of raw materials and reuse of resources lies within the building heritage of Utsira. Stone has been a predominant material, and its traditions will be carried on in the establishment of a new cultural chapter. Contemporary technology allows for a higher level of precision in production to accommodate the technical demands of a high-voltage station. Creating the baseline for an architecture that embraces both its past and its future.
Through Life Cycle Assessment, the building's Climatic Potential, Social Potential and Reuse Potential has been presented. The final design presents a building with a halve CO2-eq. for a cradle-to-gate scenario as compared to the functional equivalent, and when including its reuse potential, in a cradle-to-cradle scenario, the substation has a negative GWP score. This whilst also embracing the Substations potential for generating social values

1. Utsira


4 Utsira, NO 20/02/2023

20/02/23

Off to sea
Waves head high
Seasick thoughts drifting by
Island life starting now

Empty town
Twisted eyes
Loneliness creeping in
Take me home!

Soaked feet still no one to see
Stones, grass, stones, grass -
and the sea
Nothing here, no one alive?
Nature is king - let us survive

The war in Ukraine and an energy crisis coloured the calendar year of 2022. Inflation and higher costs of living became an integral part of the conversation. It became the year in which energy-price-spotting became a competitive sport, and where we did laundry in the middle of the night. The energy in Norway has previously been as good as free, so having to consider the source of electricity sent shock waves through Norwegian society.

Only 20% of the global energy production derives from renewable sources, and one of the UN's Global Goals is *Affordable and Clean Energy* by 2030. To reach that goal, investments in renewable energy solutions must be made (UNDP, s.d.). Norway wants to shift its off-shore competencies from oil and gas, and partake in the renewable adventure (Ministry of Petroleum and Energy, 2016). The Norwegian Ministry of Petroleum and Energy has announced two areas open for offshore wind-projects in order to develop and increase the production of renewable energy (Olje- og energidepartementet, 2023).

One of the two areas, *Utsira Nord*, is situated 7 km from the west coast of the small island, Utsira (Olje- og energidepartementet, 2023). In addition to the 1010 square kilometres floating wind farm, a high-voltage substation will be built on the east coast of the island. This architectural thesis investigates the relationship between technology, human and nature in the establishment of a land based substation on the small island society of Utsira. Being more than just a subordinate component in the energy production and supply network; *regaining awareness*. In this thesis, we explore the substation's potential for generating acceptance and interest for renewable energy production.

THE FUTURE OF ARCHITECTURE AND ENGINEERING

But is a substation worthy of an architectural thesis?

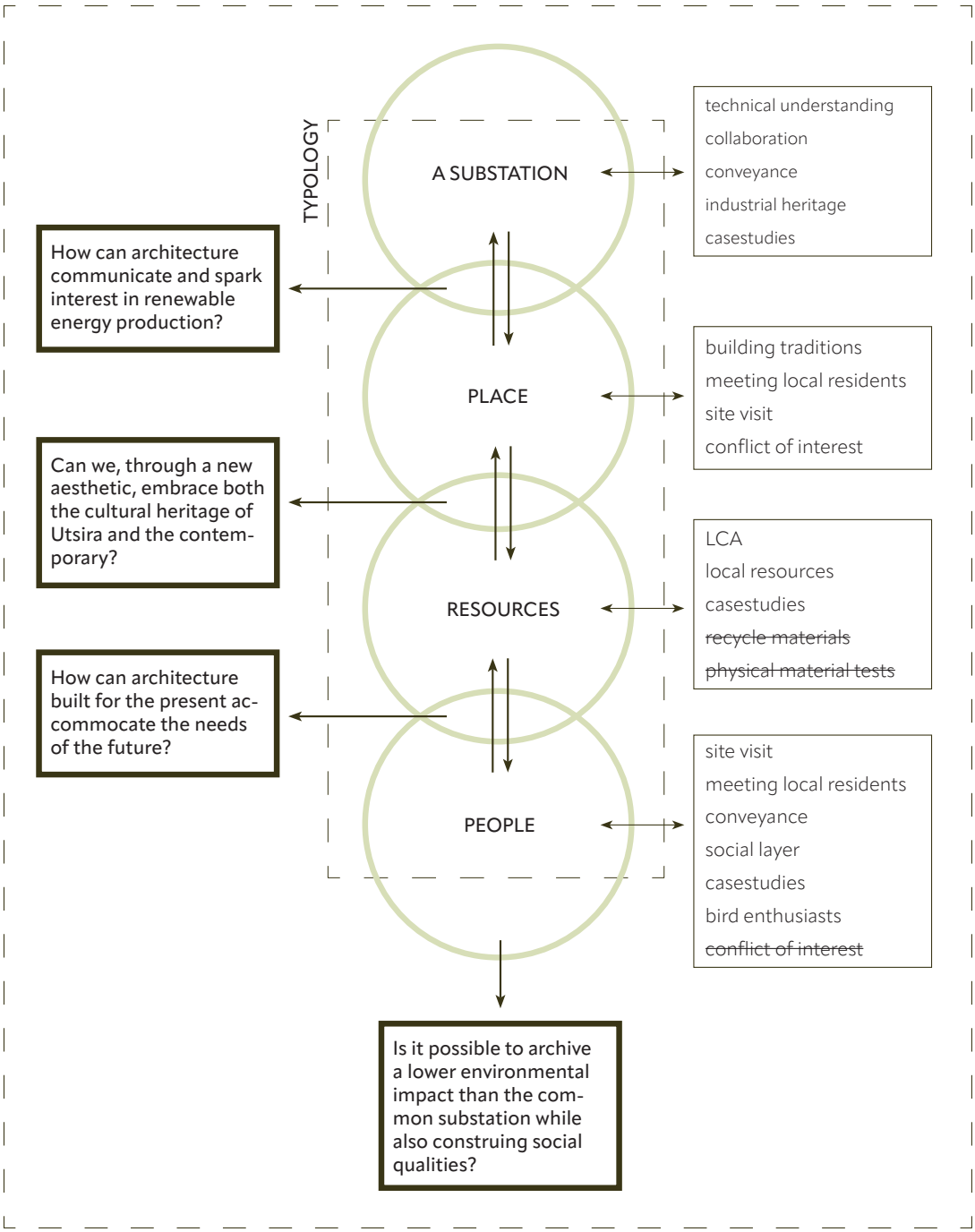
The climate crisis calls for a shift in the building industry. Contemporary architecture is dominated by time and controlled by economics, leaving limited space for architectural quality. We must resist conventional building practice, and rethink our role, in order to change the direction of the profession. The building industry accounts for 39% of the world's carbon emission (Adams, Burrows and Richardson, 2019). The future demands a generation of professionals with an activistic approach, who insists on a more sensible use of resources.

A new building practice comes with a new aesthetic. *Perhaps an aesthetic returning to a simplicity and honesty of construction?* An aesthetic where technical and functional solutions are an integral part of the architectural expression. We should use our interdisciplinary knowledge within architecture and engineering to emphasise materials and connections; making it easier to disassemble the building components after they have served their initial purpose.

Our infrastructure changes to accommodate a renewable demand, and this sensibility should be extended to entail all structures of the built environment. Substations have an important role in supplying renewable energy. Today's substations are typically introverted concrete structures, making their functionality hard to understand. We believe that a higher level of transparency creates awareness, and enables us, as consumers, to take a more critical position in the production and consumption of our energy.

The substation will have a major impact on the landscape and population of Utsira, and the building will symbolise a new chapter in their long and rich cultural heritage. There is a risk that the substation will appear an alien in the landscape and be a sign of exploitation to the local community. The substation could also appear inviting and allow people to partake in the wind adventure. The substation will be built to supply the growing demand of renewable energy and it should be done with consideration to the environment, nature, and community. We think the time has come for architects and engineers to interfere with the infrastructure of our societies.

SUBSTATION regaining awarenes of the subordinate



This architectural thesis is best read with a lens of climate anxiety, as this has been the state of mind of the authors in the creation of this project. Facing the practicing world of architecture, this project has been an attempt in navigating, and defining ourselves within, the different approaches of *'sustainable development'.*

Throughout our studies we've been introduced to various approaches, and our aim as architectural-engineers has been to merge the technical knowledge of the built environment with the experienced. This interdisciplinary approach, allows us to understand several viewpoints, and consider aspects beyond the realm of our field. The navigation in, and development of, such knowledge is at Aalborg University referred to as the Integrated Design Process (IDP) (Knudstrup, 2004). It consists of five phases; *problem, analysis, sketching, synthesis* and *presentation*. It is not a linear process, but one where one moves in design loops in between the phases all the way through the process.

Contradictory to other semester projects, the master project also presented the task of defining the framework or the problem of the assignment. Thus, we found it necessary to look beyond the integrated design process, as this takes its offspring in a problem. Bryan Lawson writes of the problem and solution space, and the interconnection of the two:

> *'Since neither finding problems nor producing solutions can be seen as predominantly logical activities we must expect the design process to demand the highest levels of creative thinking.'* – Bryan Lawson (Lawson, 2005; page 124)

The task of designing a Substation presented itself as an unfamiliar one to us. Therefore, a flexible design process was of importance, and the problem solution space allowed us to continuously move between the two in the moulding of the assignment.

Previously the interdisciplinarity of our study has existed within the walls of the University. However, this project was rooted in a future development of wind power. We were lucky to gain insight from the potential developer Deep Wind Offshore, and from Utsira Municipality, which presented us with a great interdisciplinary knowledge, and an extensive list of interests. True to the essence of the architect engineer, we opened up broad for input in the starting phase, whereafter we synthesised it to four major focal points of the assignment, which we continuously moved between in the process:

1. Understanding the technical equipment
2. Understanding the spirit of place
3. Understanding the impact of building materials
4. Understanding the societal tendencies

This has made the baseline for the four chapters of the report, namely; *1. A Substation, 2. Utsira, 3. Resources* and *4. People*. Whereas, the first and third had an intuitively quantitative approach, where the aim was to understand the magnitude, the technical requirements, and the environmental impact of a typical building, the two remainder were given a phenomenological approach. Phenomenology, as described by Christian Norberg-Schulz, speaks of the importance of understanding place and context in order to create a built environment of importance to society (Lund, 2008). This is done through experiences, thus field studies and conversations with stakeholders have played a vital role in the shaping of this process.

As stated before, this thesis has been an investigation of an ecological approach to architecture, where we've continuously moved between focusing on designing for longevity and for disassembly. Aiming for a low carbon footprint, whilst also being aware of the importance of establishing architectural quality, has called for the establishment of an assessment tool that considers both impacts. Thus, we have calculated a Global Warming Potential (GWP) for different design solutions and upheld it with its social values as presented through collagework. Allowing the quantitative and qualitative to remain in their respective fields, but creating a common language for them.

5. Design process


Copenhagen, DK
22/03/2023


BEL - T 132

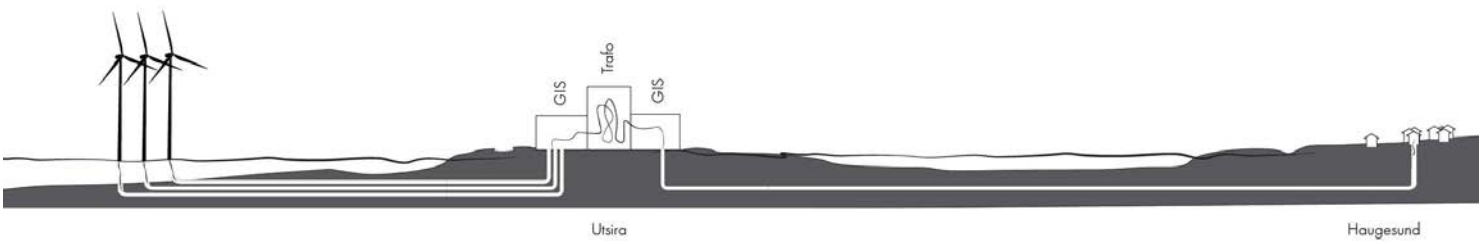

Arctic Circle
Sweden
Norway
Utsira Nord
Utsira
Denmark

On June 12 2020 the Norwegian state declared, as mentioned, two areas in the North Sea open for offshore wind projects. Contrary to usual practice, the field is delegated on qualitative criteria, and will be split amongst three developers. The aim; to redirect and develop Norwegian off-shore competencies in meeting with the green transition (Olje- og energidepartementet, 2023). In which case, the project may be a forerunner of new possibilities at sea for an otherwise oil dominant field.
Utsira Nord, with its 1010 square kilometres, is one of the areas open for development. The initial field is of 1500 MW (1.5 GW). The future capacity may be up to 6000 MW (6 GW), however the timeline is still uncertain (Offshore Wind Design AS, s.d.).
It is chosen by the Norwegian State due to its relatively low conflicts with fishing routes and wildlife (Olje- og energidepartementet, 2020). Utsira Nord is situated 7 km west of the island Utsira. Despite having no say in the matter, Utsira Municipality sees a great potential in the development, hoping that the project will provide local jobs (Utsira Municipality B, s.d.).
One of the developers presenting their proposal is the local firm Deep Wind Offshore in collaboration with french EDF Renewables. Their aim is to involve as many local operators as possible in the establishment, to strengthen its ripple effects. They see a potential in establishing a land based Substation on Utsira, which will be the face of the wind adventure.
If all three developers deem this the best solution, the capacity of the Substation may be expanded. If so, the architecture should be able to expand accordingly.

10. Utsira and Utsira Nord

HOW CAN ARCHITECTURE COMMUNICATE AND SPARK INTEREST IN RENEWABLE ENERGY PRODUCTION?

Making the production of our vital energy accessible and easily understandable through honest and transparent architecture. The main notion being a smarter and more sustainable use of our common resources.


GIS
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Utsira
Haugesund

A substation is a peek into the infrastructure that everyday provides us with the basic necessities of life. Where does one's water come from, where is the electricity in one's outlet produced? These are questions one rarely stops and considers, but which is of great importance in maintaining the quality of life one's gotten so used to today. In fact, universal access to affordable and clean water and energy are two of the UN's Global Goals (UNDP, s.d.).

Energy production is advancing, and becoming more and more efficient. Whether it be solar, hydro or wind, the means of transporting this harvested goods remains somewhat the same. A network of cables is either dug deep into the ground, submerged under water or flies high in the air to connect power plantations to the consumers. In order to minimise the energy loss over longer distances, Alternating Currents are transformed to Direct Currents, and the voltage is shifted up. This is the task of a Substation.

Typically, a substation is located as close to the production site as possible. The building cost of an off-shore station is significantly higher than its land based alternative. Due to Utsira's relatively close proximity to the production site, the Island presents itself as the optimal location for a substation according to the developer Deep Wind Offshore.

11. A substation

To emphasise the significance of the substation in Norwegian history, one needs to take a look back in time to understand its origin and heritage.
In the early beginnings of the energy production in Norway the substations have been proud imprints and reflections of its time and technological progress. A superior building typology. In conjunction with the technological development and the discovery of oil in 1967 (Regjeringen.no, 2021) the substations have thus been pushed aside to be subordinate.
The importance of it has though been resparked in connection to the energy crises in 2022.
The significance of industrial heritage is an important part of our cultural and social identity, traditions and aesthetic (Douet, 2016), therefore the substation can not be dismissed as something subordinate.

12.

1900

13.

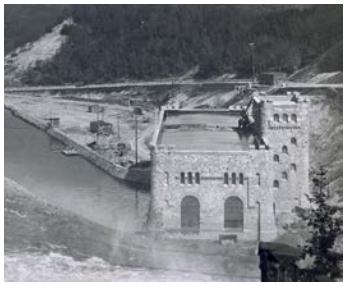
1907

14.

1912

15.

1914



16.

1914

17.

1919

18.

1932

19.

13

Hammeren substation, Maridalen Oslo

Photographer: Nynäs, H.M (2012)

14.

Dalsfos substation Kragerøvassdraget

Photographer: Nynäs, H.M (2009)

15

Tinfos II substation Notodden

Photographer: Storheil, S. (2017)

16.

Nedre Leirfoss substation

Photographer: NVE (1910)

17.

Såheim substation Rjukan

Photographer: Storheil, S. (2016)

2018

22.

Ekofisk oil Platform

1967

A new era of the substation?

2023

Ukrainian war and energy crisis

2022

1966

20.

1993

21.

18.

Rånåsfoss substation
Rånåsfoss

Photographer:
Eide, U. (2022)

19.

Skjerka substation
Åseral

Photographer:
Storheil, S. (2016)

20

Røldal substation
Røldal

Photographer:
Riibe, S. (2009)

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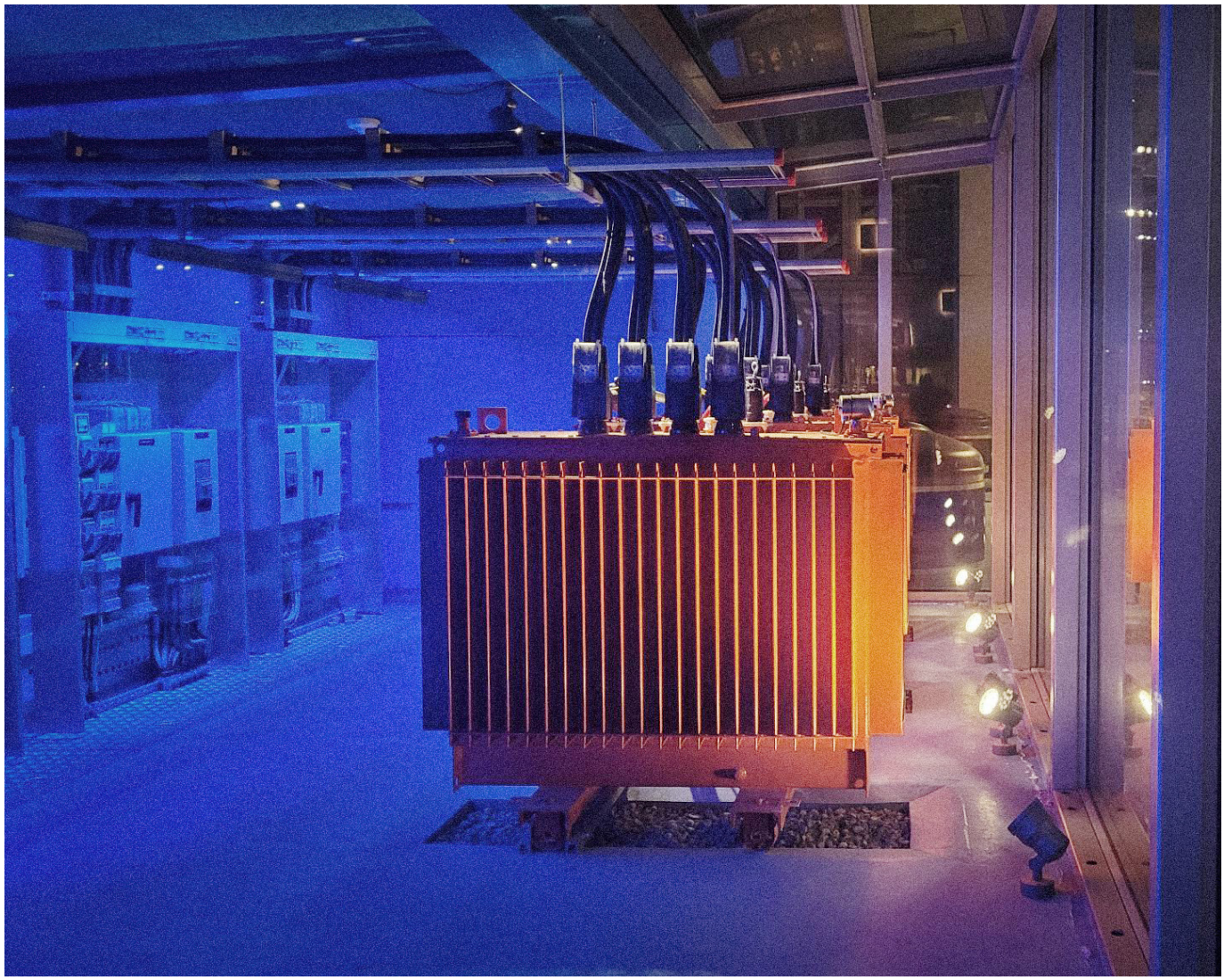
Svartisen substation
Meløy

Photographer:
Sissel Riibe, S. (2009)

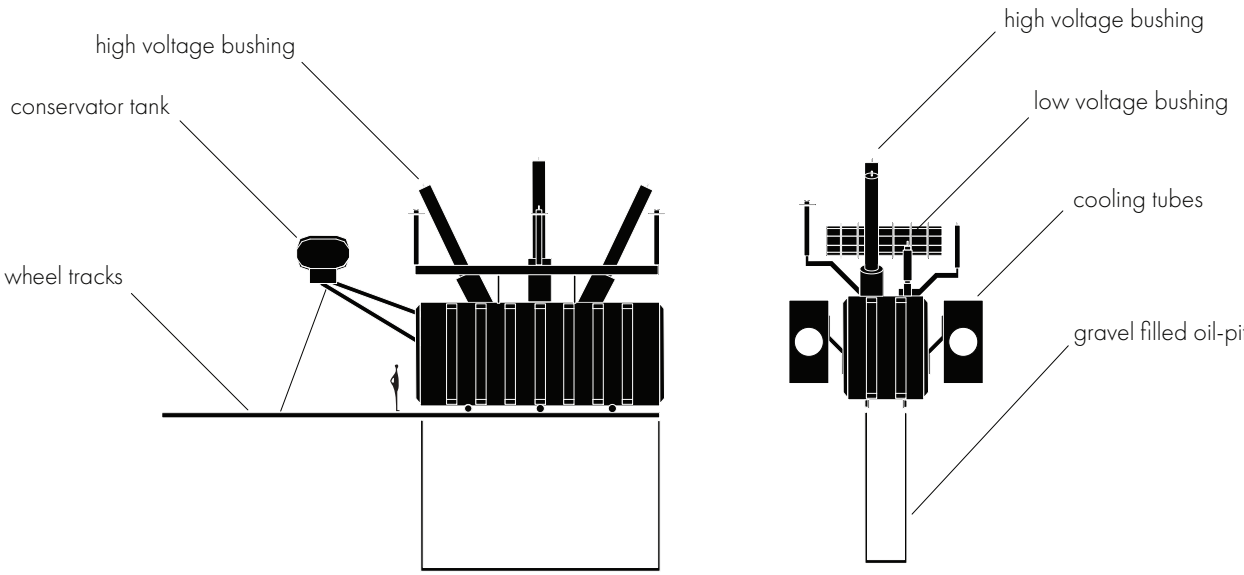
22.

Energy plant
Aarhus Ø

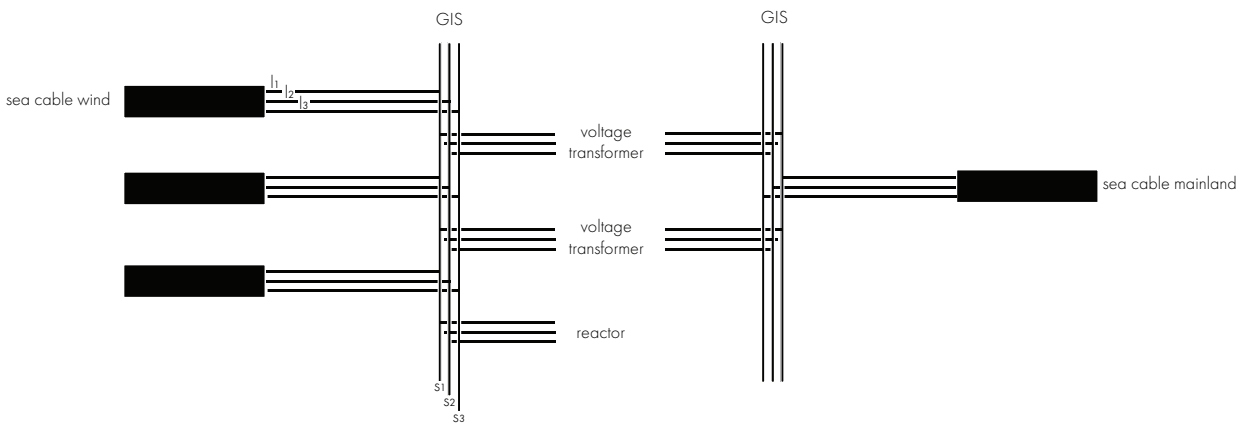


When high-voltage current is nearing its consumer, the need for a substation once again arises. This time to reduce the voltage, as the alternative would be a fateful one.
At Teglgårds Plads in Aalborg we find a substation that ceases to be subordinate in its expression and clearly distinguishes itself from the 70.000 other Danish ones (Rønningsbakk, 2017). Instead of hiding it exposes its function to interested people passing by. In doing so, it becomes a physical ode to Nordkraft's power producing past. For the knower of electrical supply, one can tell that the three transformers link the medium- and low-voltage distribution network, supplying Nordkraft with electricity without electrocuting its user. For the rest of us, its appeal lies in its colours and lighting. Neither provides insight into its purpose.

23. Exposed substation at Teglgårds Plads in Aalborg


high voltage bushing
conservator tank
wheel tracks
high voltage bushing
low voltage bushing
cooling tubes
gravel filled oil-pit

24.


GIS
GIS
sea cable wind
l1
l2
l3
voltage transformer
voltage transformer
reactor
sea cable mainland
S1
S2
S3

25.

GIS - GAS INSULATED SWITCHGEAR

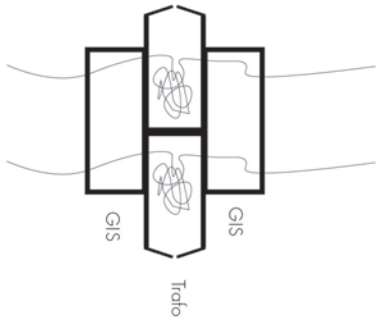
The energy produced by eight turbines are connected and transported to the Substation through a sea cable. Here, they are split up in their electrical phases L1, L2 and L3 (see illu. 25). As electricity is prone to jump between phases and cause overload, each phase needs to be insulated. This may either be done with air, which requires a lot of space, or it can be done with gas filled tubes (Drange, 2023). The latter is more reliable. The main function of the GIS is to act as a circuit breaker in the case of overload, which may cause fire, or if maintenance is needed on the lines. The phases are connected on a busbar s1, s2 and s3 allowing for the continued operation of the station in case of maintenance.

VOLTAGE TRANSFORMER

The transformer is the main technical component of the substation, which switches the voltage from 132 kV to 220 kV - thus minimising the losses. In doing so it produces a substantial amount of heat, and needs to be cooled down to avoid fire and explosion. A circuit of oil flows through it for this purpose, and passes through both the warm core and cooling tubes. This heat exchange can either be done by the use of air or water. Air takes up substantial more space, but water needs several other components to function, such as a water pump and purifier (Drange, 2023). This makes it more prone to failure, but also allows for utilising the hot water. A gravel filled pit is placed underneath the transformer (see illu. 24), to collect the oil in case of spilling - protecting the electrical components from potential fire. Fire protection between the two transformers is of utter importance, for the continued operation and supply of electricity. Acquiring a new transformer may take up to a year and is a costly procedure (Hjelme et al., 2022).

OTHER TECHNICAL EQUIPMENT

Several other technical equipment are needed to ensure a smooth operation. A reactor is connected to the line to stabilise the current, and is in its expression similar to a smaller transformer. As the operation is digitised and controlled from afar, a voltage transformer is also needed in the control room for nominal voltage, as well as a back-up generator and manual switches for redundancy.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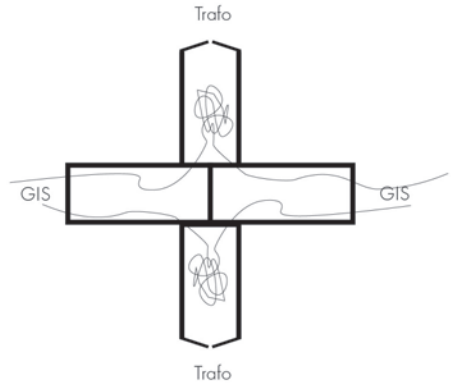
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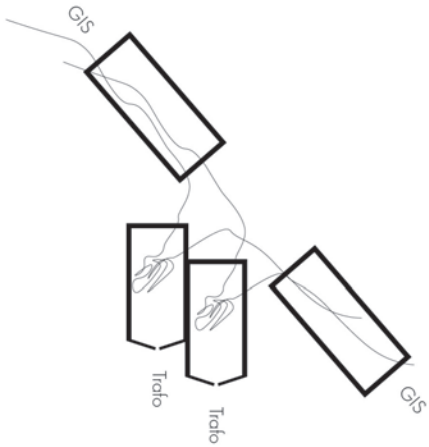
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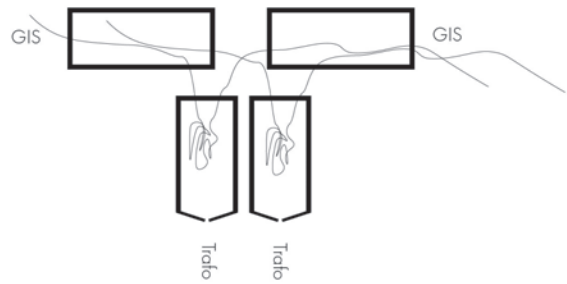
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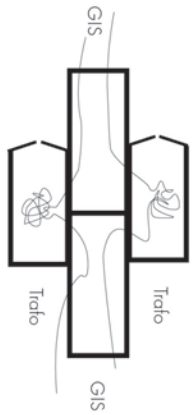
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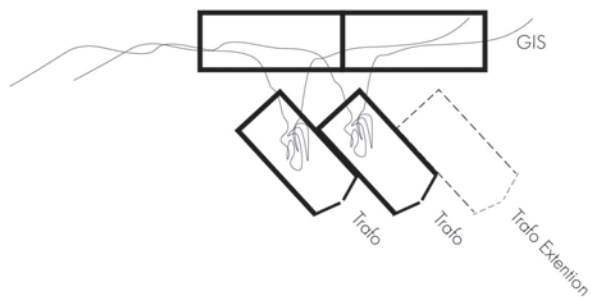
GIS
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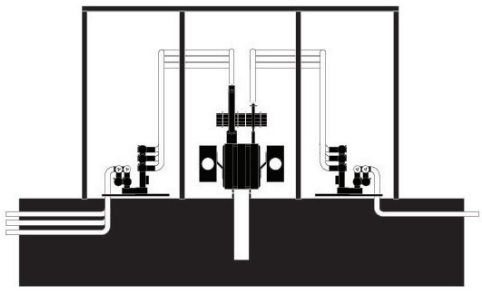
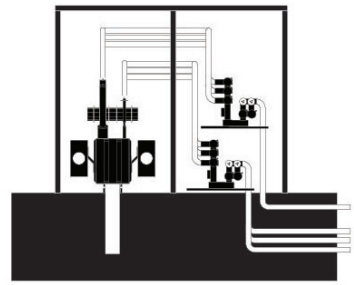
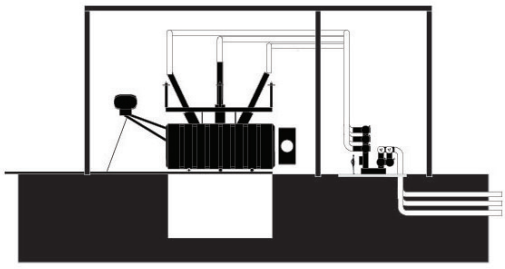
Trafo Extention

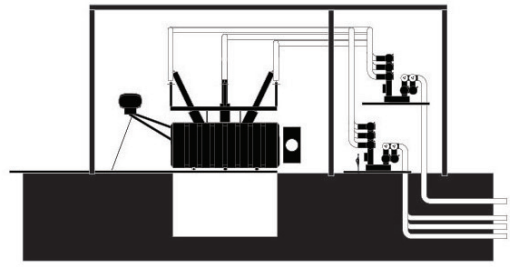
The produced energy from the wind farm enters the GIS with 132kV, where the electrical flow is collected on a busbar. From there it flows through either transformer before uniting on another busbar with 220kV. The most compact solution would be to place GIS central with transformers on either side. However, it creates an introverted building with little regard to transparency of processes. If all three wind-farm operators were to assemble the production line at Utsira, the structural principle should be able to accompany such a need. Therefore, an additive principle is preferred.

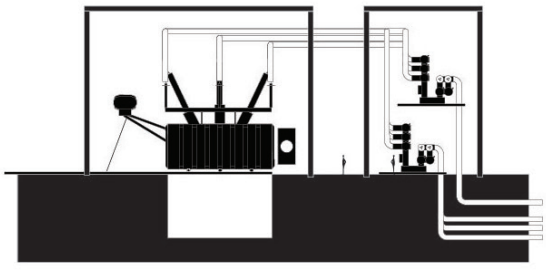
26.

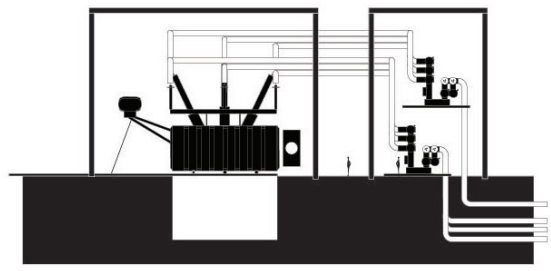


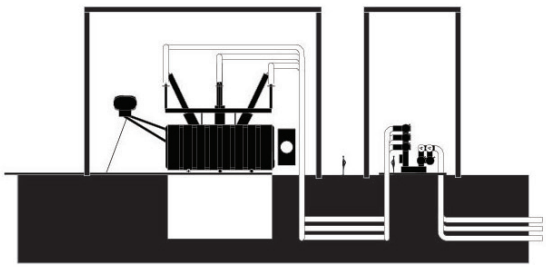


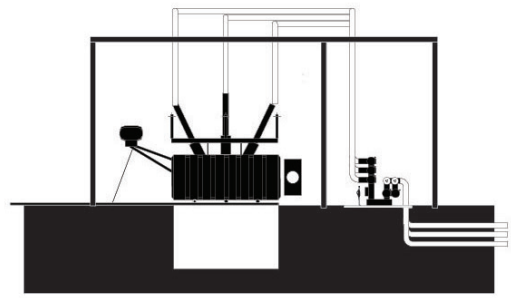






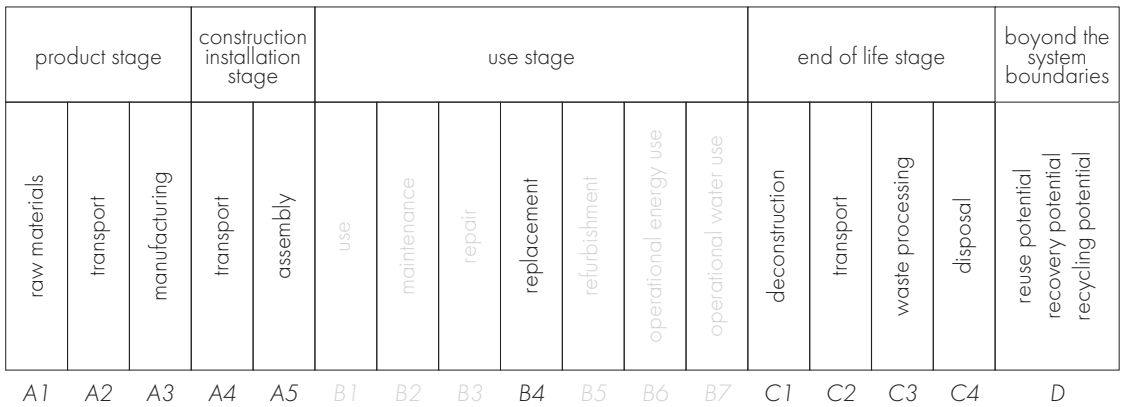






Each Voltage Transformer will be connected, through three tubes to the busbars of either GIS hall. The character in which they are connected may be an expression of the relationship between the functions. This presents a potential of displaying its functions to the public if the buildings are separated in several volumes. Commonly it is done by digging the tubes into the ground, but could also be done through Gas Insulated Tubes in the day. The latter visualises the purpose of the building, and could aid in justifying its presence.

27.



28. The Life Cycle Assessment is divided into 5 stages and 17 modules
The grey marked modules are considered irrelevant

The substation is an essential part in producing and distributing renewable energy from the coming floating wind farm. An initial Life Cycle Assessment of the substation has been carried out for the typical substation, or the Functional Equivalent, to identify and map its environmaental impact. Through the design process, material choices are compared to those of the Functional Equivalent.
The environmental impact is divided into stages and modules shown in illustration 28. This division makes it possible to study the environmental impact in details.
The volume of the assessment is based upon a feasibility study which has been carried out for establishing a land-based substation on the east coast of Utsira. The specification of the volumes is presented in a room program on the following page (Hjelme et al., 2022).

Material specifications
For safety reasons and continued operation if failure, the materials used should be able to withstand fire and explosions. The Norwegian Water Resources and Energy Directorate has presented some building materials that upholds the safety measures of high-voltage stations, and they state, that it can be constructed within the mountain, or as a shell construction from either 10 mm steel or 20 cm double reinforced concrete - or an alternative material with the same level of safety (NVE, 2012).
The functional equivalent is mainly made of reinforced concrete elements. The specification of the materials and amounts can be studied in appendix A. The analysis presupposes dock construction and instalment of technical components and will only focus on the shell construction around the technical equipment.

Reference study period
The assessment is carried out for a 60-year period, which is the assumed lifespan of technical equipment as well as the norm for calculating the environmental impact of buildings in Norway. As the material properties demand durable solutions, the building components are probable to outlive their functions. Therefore, the potential of reusing elements becomes interesting. The D module is thus weighed in the determination of the final design, as sustainability shouldn't be assessed in an isolated system, but also consider its effects on other systems - as the goal is to maintain the ecosystem as a whole. Thus, one shouldn't consider buildings as static elements we surround ourselves with, but as a circular concept that evolves and takes shape alongside our needs.
In regard to the lifespan of a building its architectural quality is important:

> *'In every circumstance it would be considered a waste of resources if a building is poorly constructed, failed and/or ugly. A building's collective quality is what justifies the use of the resources , whether it be a garden shed from recycled materials or a grand construction of conventional materials' - Anne Beim, Lena Larsen og Natalie Mossin (Beim, Larsen and Mossin 2002; page 13) (own translation)*

> *'Under alle omstændigheder vil der altid være tale om spild af ressourcer, hvis et byggeri er dårligt udført, mislykket og/eller grimt. Byggeriets samlede kvalitet er derfor altid det, der retfærdiggør ressourceudskrivningen, hvad enten der er tale om et haveskur af genbrugsmaterialer eller en stor bebyggelse af konventionelle materialer' - Anne Beim, Lena Larsen og Natalie Mossin (Beim, Larsen and Mossin 2002; page 13)*

Impact parameter: Global Warming Potential
The main environmental indicator for this calculation will be the Global Warming Potential (GWP). Seing the prominent climatic crisis of today. Both a cradle-to-gate, and a cradle-to-cradle, perspective will be assessed, as the building is merely a component in a larger circular system, and potential beyond the system will affect the GWP globally.

Impact parameter: Social Quality
When creating a structure, a potential of creating a space for humans and ecosystem arise. Such qualities are more difficult to quantify, and in the process of doing so its quality is reduced. Therefore, we aim to articulate such qualities through the medium of collages.

Goal
The aim of the analysis is to create a Final Design Proposal with a lower Global Warming Potential than the Functional Equivalent, while also creating the baseline for Social Qualities.

Room	Amount	Description	L	B	H
			[m]	[m]	[m]
Transformer	2	Transforms the electricity from 132kV to 220kV to limit the loss of electricity when transporting it to the mainland. When in operation, the system generates heat, and the oil in the transformer should be cooled down through an heat-exchange-system	25	8	13
Transformer cellar	2	If failure occur and oil is spilt from the transformer, a gravel-filled pit should collect the liquid	9	1,5	6
Reactor	1	Absorbs reactivepower generated in the electricity currents	25	8	13
GIS 132kV	1	Gas Insulated Switchgear. Three cables of 132kV each transports the electricity produced by eight floating wind turbines. If any of the turbines fail, and need reperation, the electricity current may here be shut down to allow for such repair	25	13	7
GIS 220kV	1	Gas Insulated Switchgear. Two cables of 220kV transport the electricity to the mainland	25	13	7
Cable entry room	2	The sea cables that transport the electricity enter the GIS through this room	50	13	7
Control room	1	Here one may oversee that the wind production operation is running smoothly. This may be shown to the public. There will also be fiberoptic cables connected to the GIS which only may be accessed by authorized personell	50	13	7
Storage	1	Storage of spare parts in case of system failure and need of reperation	20	10	8
Viewpoint	1	Public accessible viewpoint. A generous gesture from the substation to the society and hikers. Adding a social layer to an industrial building	-	-	-
Rest stop	1	Public accessible rest stop. A generous gesture from the substation to the society and hikers. Adding a social layer to an industrial building	-	-	-
Toilet	1	Public accessible toilet. A generous gesture from the substation to the society and hikers. Adding a social layer to an industrial building	-	-	-

Public access	Transperancy	Ground level	Extraordinary safety requirements (NVE, 2012)	Materials requirements (NVE, 2012)
		[masl]		
No	Yes	6	Walls REI 60 M Doors EI 60 Windows P5A / P6B	Min. 160 cm double reinforced concrete / min. 10 mm steel HB 200 or functional equivalent. The construction should as a min. withstand 2 kN/m2 from every direction
No	Yes	2	Walls REI 60 M Doors EI 60 Windows P5A / P6B	Min. 20 cm double reinforced concrete elements or functional equivalent
No	Yes	6	Walls REI 60 M Doors EI 60 Windows P5A / P6B	Min. 20 cm double reinforced concrete elements or functional equivalent
No	Yes	6	Walls REI 60 M Doors EI 60 Windows P5A / P6B	Min. 20 cm double reinforced concrete elements or functional equivalent
No	Yes	6	Walls REI 60 M Doors EI 60 Windows P5A / P6B	Min. 20 cm double reinforced concrete elements or functional equivalent
No	No	2	Walls REI 60 M Doors EI 60 Windows P5A / P6B	Min. 20 cm double reinforced concrete elements or functional equivalent
No	Yes	6	Walls REI 60 M Doors EI 60 Windows P5A / P6B	Min. 20 cm double reinforced concrete elements or functional equivalent
No	No	6	-	-
Yes	Yes	6	-	-
Yes	Yes	6	-	-
Yes	No	6	-	-


DANGER
High voltage

Social qualities

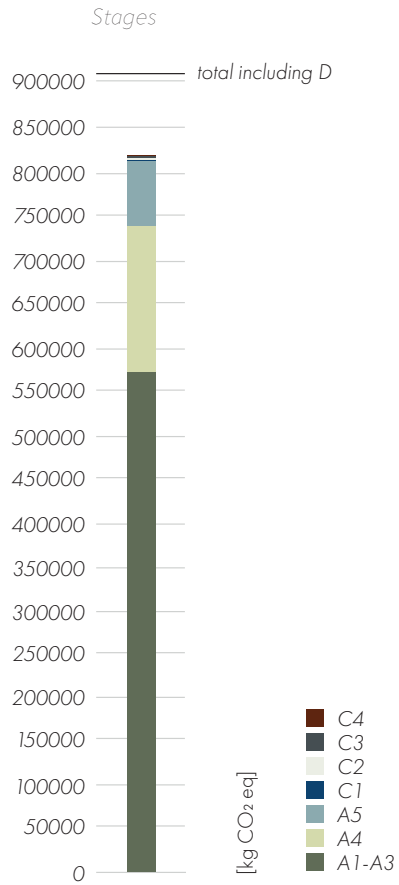
Illustration 29 visualise the functional equivalent, with its concrete walls and high fence. It appears dismissive to people passing by and is a visual polluter of Utsira's cultural landscape. The structure is a symbol of exploitation of nature and resources, for economical gain.

Global Warming Potential

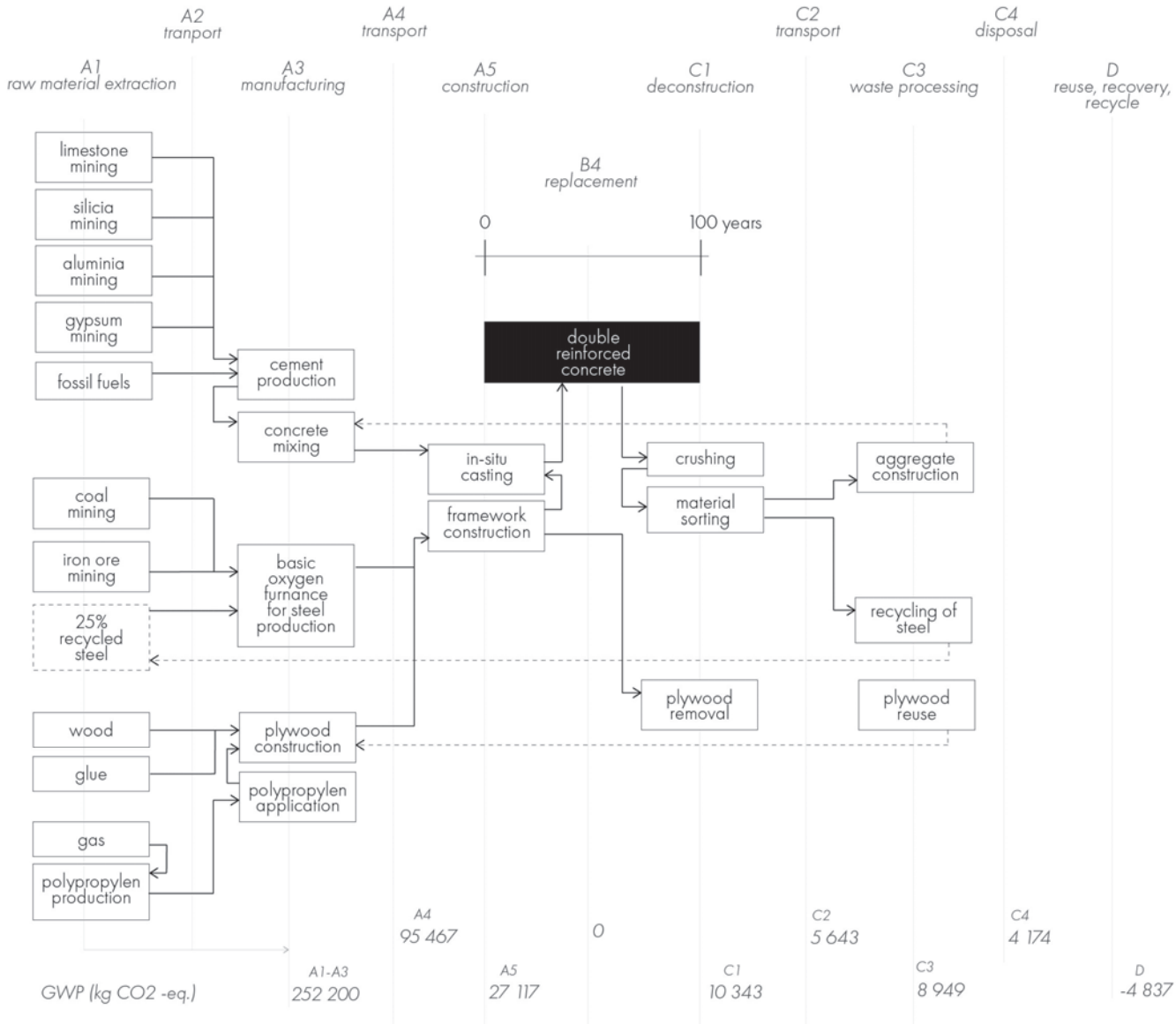
The chart shows the calculated Global Warming Potential (GWP) of the functional eqivalent devided into modules. The chart clearly identifies that the product stage contributes the most within the GWP score.

GWP (cradle to gate) 825797 kg CO_2 eq.
5,40 kg CO_2 eq. per m^2 per year

GWP (cradle to cradle) 914664 kg CO_2 eq.
5,98 kg CO_2 eq. per m^2 per year



29. A collage visualising the functional equivalent

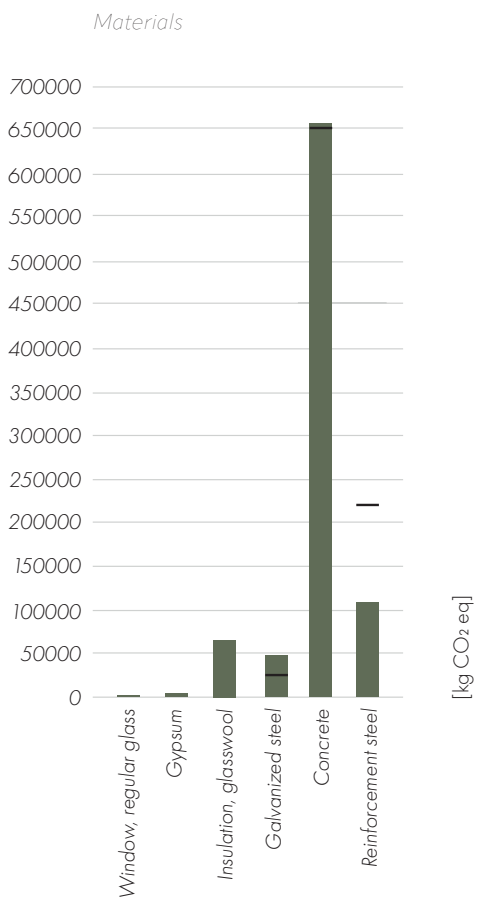


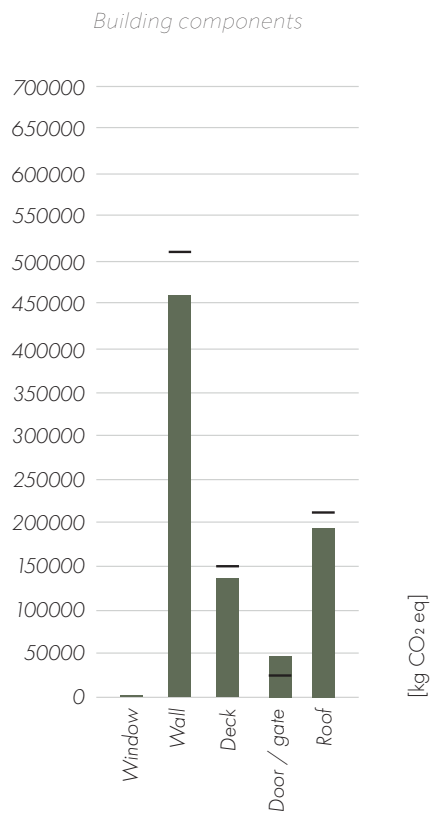
30. Mapping of processes and materials of double reinforced concrete

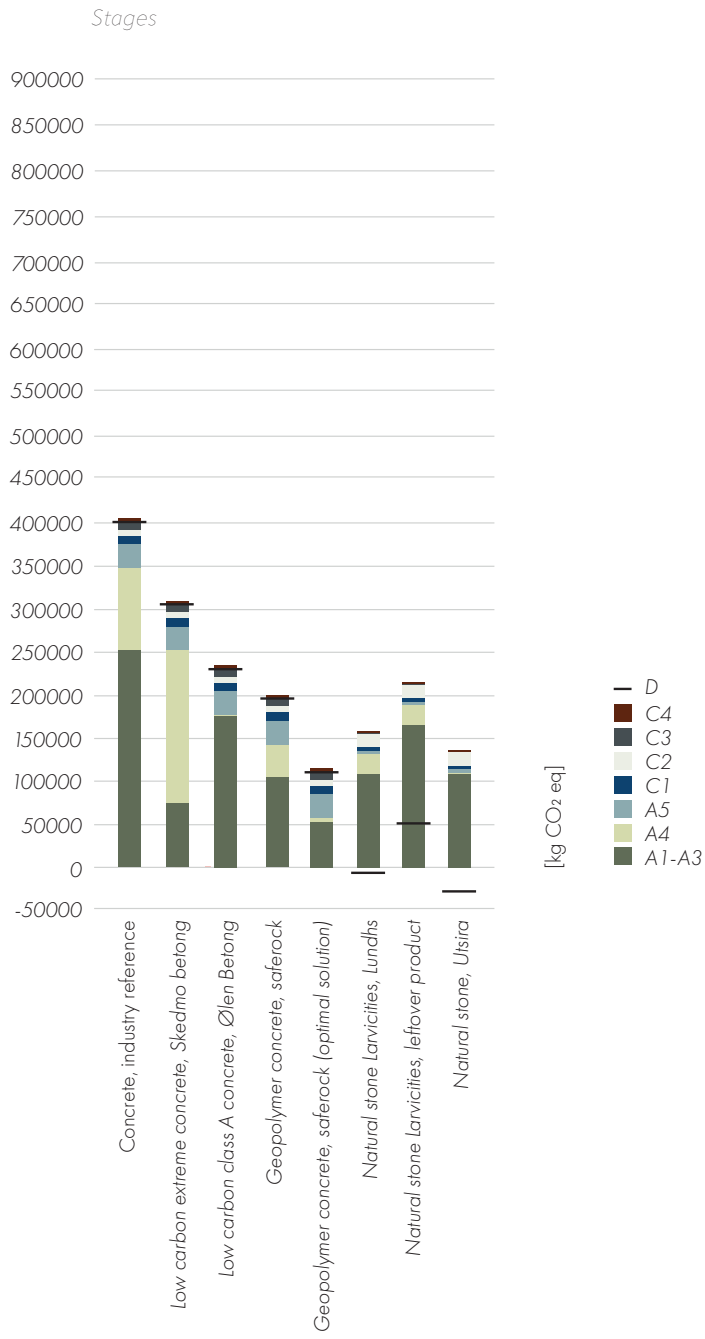
The chart below shows the calculated GWP score of the functional equivalent divided into materials and building components. The charts reveal concrete as the material with the highest environmental impact.

The stages going into producing reinforced concrete can be studied on illustration 30. Cement production requires high temperatures, and thus burning of fossil fuels. 40% of the emissions stem from this process, and the remainder 60% from naturally occurring reactions during processing (Carbon Smart Materials Pallette, s.d.). The best way of reducing such emissions is using less cement. Either by supplementing it with non-fossil fuel based cementitious alternatives or using larger sized aggregate. Reducing the cement amount could affect its curing time. Achieving the wished compressive strength would require a set environment and a controlled process.

The concrete is reinforced using steel bars as it lacks tensile strength. This ensures the stability of the elements as they are interconnected. Typically, it's done by inserting the steel through corrugated tubes and cast it afterwards with cement (Høg, 2018). However, when dismantling the elements again, its static properties are spoiled, and the elements can at best be crushed and reused for road filling. Alternatives to concrete is studied on the following page.






Stages
900000
850000
800000
750000
700000
650000
600000
550000
500000
450000
400000
350000
300000
250000
200000
150000
100000
50000
0
-50000
[kg CO2 eq]
D
C4
C3
C2
C1
A5
A4
A1-A3
Concrete, industry reference
Low carbon extreme concrete, Skedmo betong
Low carbon class A concrete, Ølen Betong
Geopolymer concrete, saferock
Geopolymer concrete, saferock (optimal solution)
Natural stone Larvicities, Lundhs
Natural stone Larvicities, leftover product
Natural stone, Utsira

Concrete production is a complex process consisting of several raw materials. The casting of such a component bind them together and make dismantling for reuse a complex process. Alternatives to concrete is investigated and presented in the lefthand chart.

At first, a set of substitute solutions are presented. The first two are low carbon cement solutions. Low carbon extreme is the industry reference of the best performing solution. However, this can only be achieved through planning and a controlled environment. The only valid Norwegian Environmental Product Declaration (EPD) is from Oslo, creating big emissions during transportation (A4). A local alternative with a poorer performing cement mix would actually be preferable according to its GWP.

A geopolymer concrete from Saferock is also investigated. This does not require high temperatures in production. However, it is still in research and the GWP score presented for it is based on an initial calculation made by the company in collaboration with the master student Simon Brekke (2022). Although, EPD's are preferable to compare results, innovative process should't be excluded on such basis.

The last material investigated is natural stone. With a thesis that a substation that can be built witin the mountain, can also be built of a stone shell construction.


33 Utsira, NO 21/02/2023

21/02/23

Fresh eyes, changing views
Sloping roads
First hellos
Not alone
New faces to see

Wind in our hair
Rain on our skin
Island life is yet not as grim

Warm smiles and inviting hands
Inspiring ideas without compromise said The great Utsira love

Wind, wind, wind is everywhere
Nature rules and words are poor
Utsira gives energy, Utsira takes energy, Utsira gives energy


Haugesund
Utsira
Stavanger

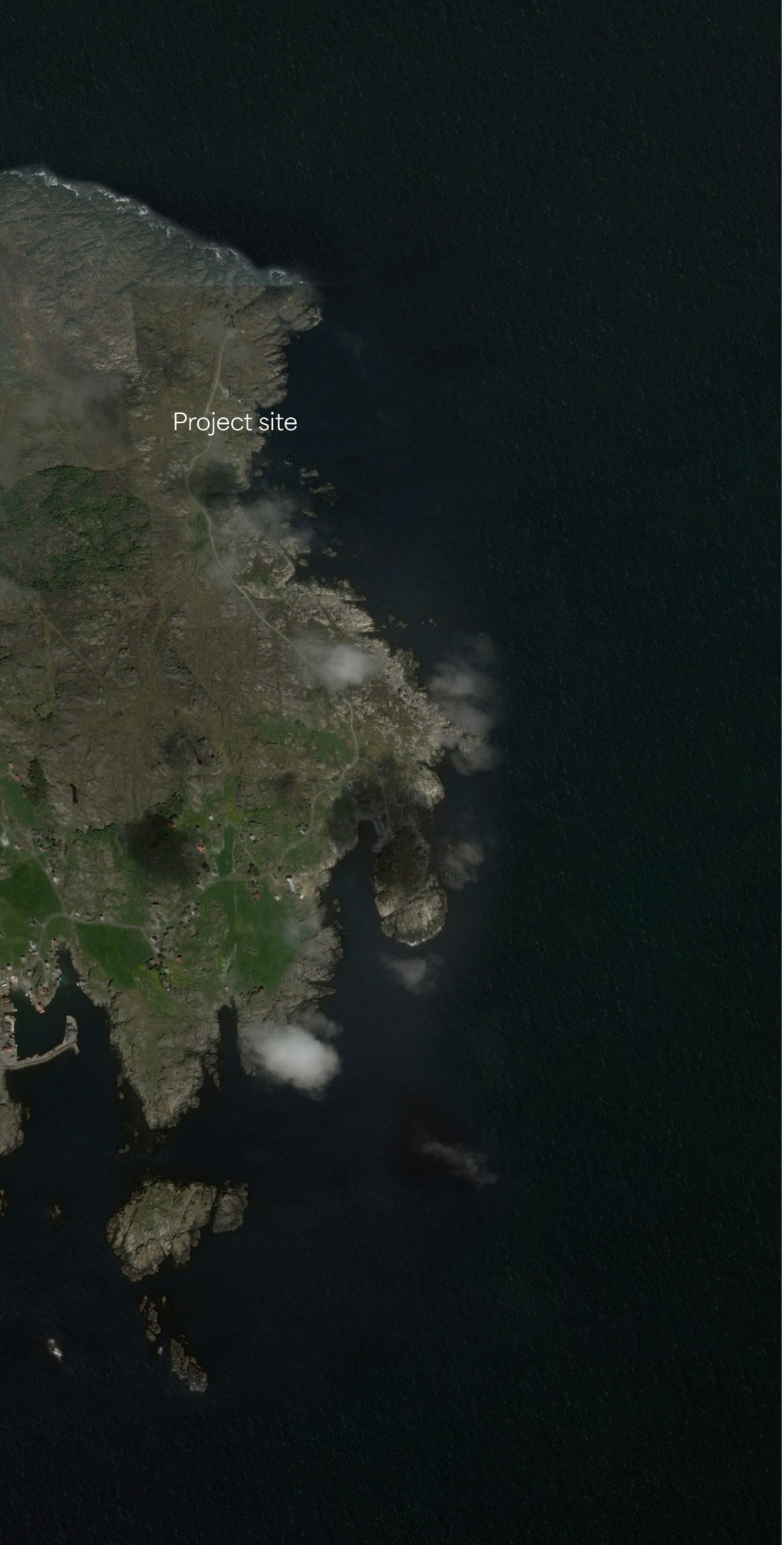
Utsira is Norway's smallest municipality, and is located 18 km off the west coast of Norway. Surrounded by the North Sea, it is only accessible by ferry; a 75 minutes long journey from the mainland. Here, people have lived on, and with, the sea for millennia. It has been inhabited since the migration period, and the landscape of raw rocks and little vegetation has remained the same, except for patches of sitka spruce that survives the harsh winds and salty air (Utsira Municipality A, s.d.).

The island is especially known for its raw coastal landscape and the 317 bird species that have passed by the island on their travels, which yearly attracts enthusiasts from far and near (Utsira Municipality A, s.d.).

Despite its slim population of only 193 inhabitants, Utsira is a complete society with all functional requirements. The island's community is very tight and has a big drive to take action to counteract its societal decay. The limited job opportunities on the island leave most people no other option than moving to the mainland (Utsira Municipality C, s.d.).

Utsira makes the perfect living lab for technology development within the green transition. *Utsira Provides Energy* is the slogan of the island. Being home to the world's first hydrogen producing wind turbine, the field of green energy development has become part of their identity (Utsira Municipality A, s.d.). The substation will be placed adjacent to the south of the hydrogen wind turbines on the west part of the island. Continuing the island's identity and movement of green energy production.

34. Utsira



35. *The island of Utsira. The access to the island and the majority of buildings is places on the central axis, leaving the east and west side more untoughed, raw and uninhabited*

A CULTURAL IDENTITY IN DEVELOPMENT

The development of Utsira Nord at Utsira makes the diverging forces of capitalism and culture evidently clear. Kenneth Frampton addressed this paradox within architecture, in his essay Towards a Critical Regionalism: Six Points for an Architecture of Resistance, already in 1983:

> *'...the ground in which the mytho-ethical nucleus of a society might take root has become eroded by the rapacity of development. Ever since the beginning of the Enlightenment, civilization has been primarily concerned with instrumental reason, while culture has addressed itself to the specifics of expression to the realisation of the being and the evolution of its collective psycho-social reality' - Kenneth Frampton (Frampton, 1987; page 17)*

As Utsira is gaining a new civilizational identity, one should consider its implications on its cultural identity, and the laters readiness to develop alongside the first. Society's willingness to embrace the Substation, and thus Utsira Nord, partly lies in the relationship between the new architectural expression and the existing building tradition. There lies a potential in studying the building heritage on the island, as well as the cultural values and tendencies for the future. The architecture of the

Substation should speak the language of the building heritage, whilst also telling the tale of development.

In doing so, one should not romanticise the vernacular architecture by mimicking its aesthetics, but indirectly apply elements to carry on the sense of place (Frampton, 1987). This may be derived from a structural principle, a potential within topography, or through the continuation of tactility. Tactility, or the bodily experience of place, of light and shadow, of cold and warmth, and of the urge to touch and interact, is given particular emphasis. An extensive site analysis has been carried out, with a phenomenological perspective, to comprehend the spirit of the place.

The importance of understanding the spirit of place or the genius loci was central in the works of Norwegian architect and theorist Christian Norberg-Schultz (Lund, 2008). He states that the role of the architect is to concretize the cultural values of society - using the built environment as medium to create a meaningful world. In the 60's he pointed out that culture had become manyfold and also included facets of industrialism (Lund, 2008). A line of thought of ever relevance today, as the green upheaval manifests itself as an integral part of our society.

CAN WE, THROUGH A NEW AESTHETIC, EMBRACE BOTH THE CULTURAL HERITAGE OF UTSIRA AND THE CONTEMPORARY?

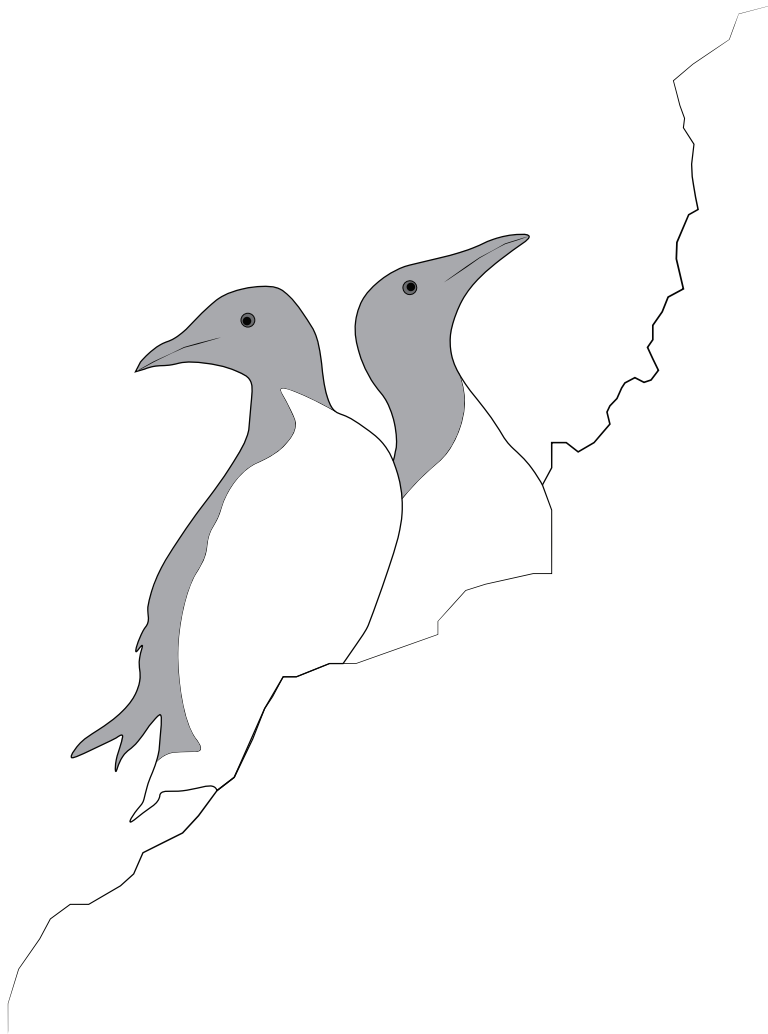
Creating a new architecture based on vernacular knowledge and contemporary processes.
Continuing the genius loci through a new medium.

The anticipation and thrill of embarking on the journey of a long boat ride towards a small island in the middle of the ocean was grand. Learning about the island from afar, we imagined meeting a cosy community and exceptional nature. When arriving on a windy, february morning, we soon realised that climate is in charge, and people live on its premises.

We arrived on a Sunday, to establish an impression of the place, before meeting with the municipality and developers the coming day. We spent the drizzly day on a drift, passing empty houses and rocky terrain. On our way to the site we met none. The sound of the wind and the waves filled the emptiness. We walked in silence, for our words became poor in meeting the majestic environment. We felt exposed, and vulnerable in the open scene. As if placed on the moon.

Painted red dots in the landscape guided our path back to civilization. Shoes were soaked, and soles were sore, as we reentered Utsira's central axis of settlement. Still, many houses were left empty, and stood in anticipation of their seasonal residents. The few we met were filled with warmth and smiles - welcoming to the intruders of their society. Soon we felt at ease. Despite the fact that the harsh winds marooned us out there.

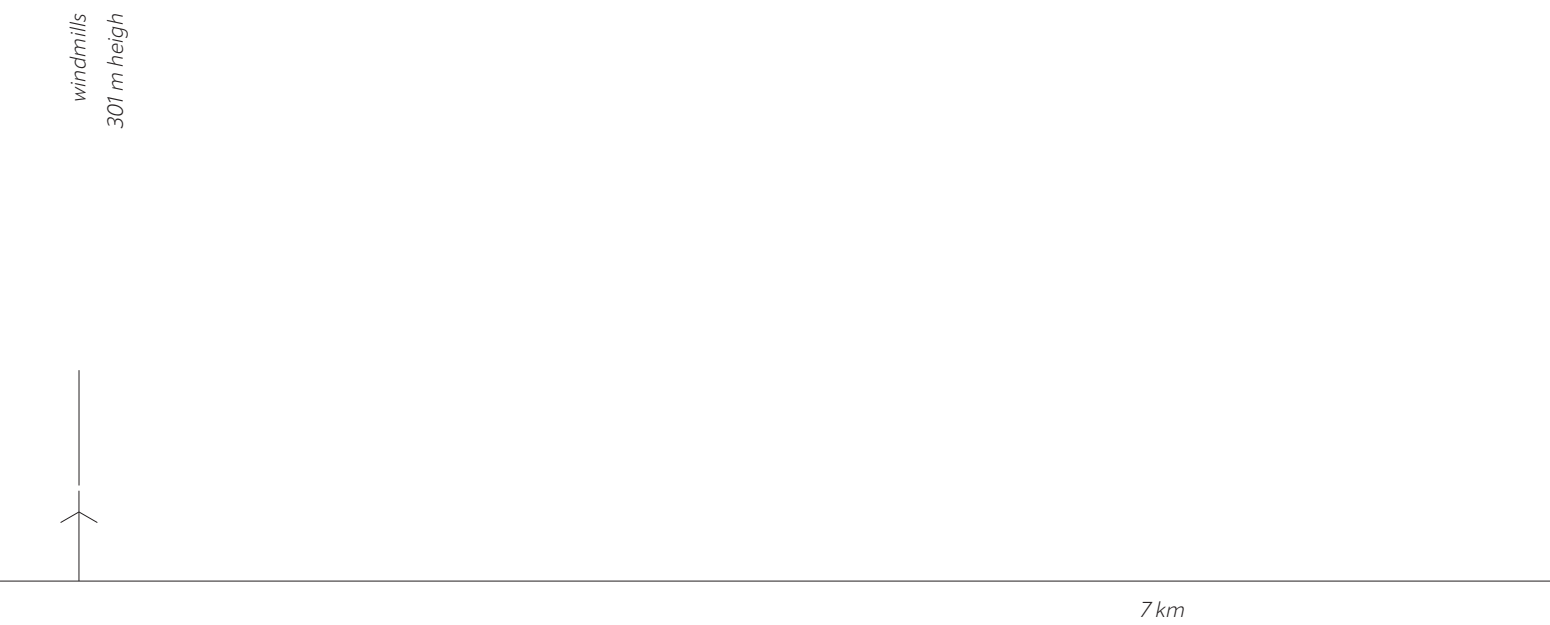
36. Utsiras harsh climate and nature. Empty views and raw materials.



The island of Utsira is Norway's bird paradise (Utsira Municipality A, s.d.) and every year it attracts not only rare birds but also a lot of bird enthusiasts, looking to discover more species. Most of the birds are using the island as a resting spot on their travels but some also stay all year (Grimsby, 2023). In relation to the project of Utsira Nord and its impact on the birdlife of the island, the bird enthusiasts seem optimistic after thorough investigations were made, dismissing risks of interference (Grimsby, 2023).

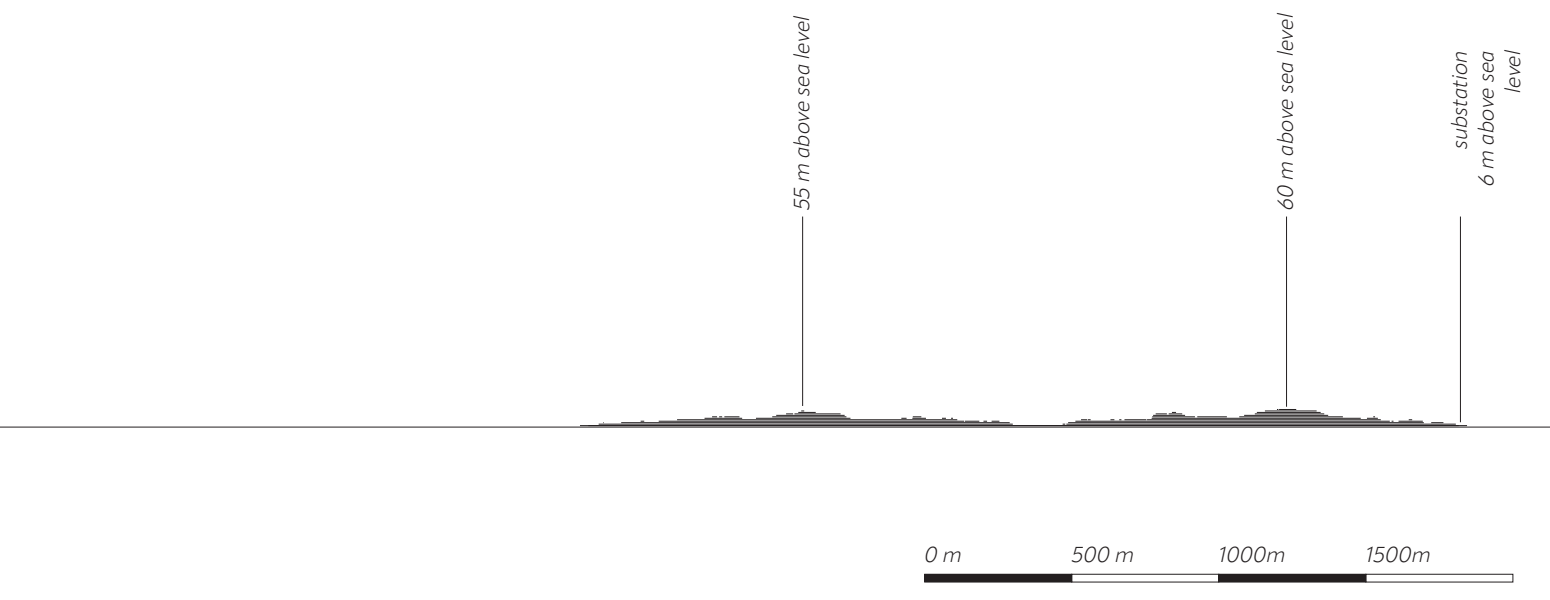
We see a potential in incorporating birdlife into the project of the substation, as some of the visiting bird species use the island not only to visit but also to breed (Grimsby, 2023). The raw landscape, cliffs and sea present hereby great breeding opportunities for some bird species such as the Common guillemot (Norsk Polarinstitutt, s.d.).

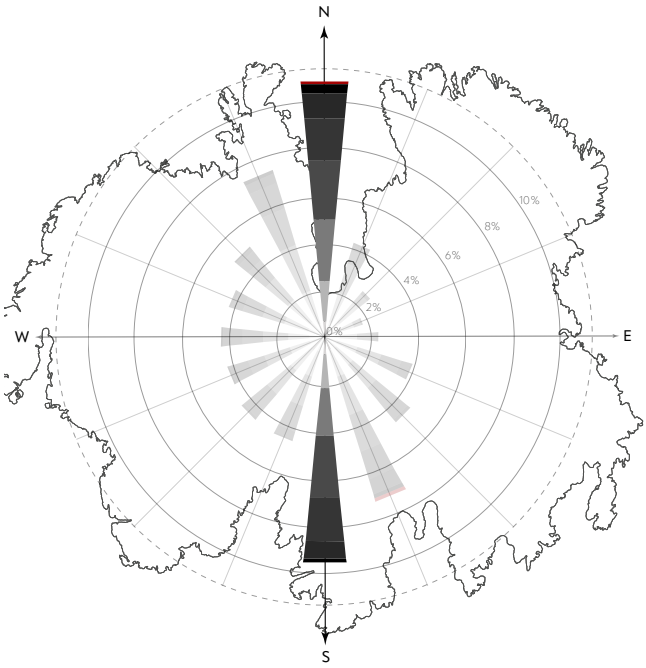
The substation could as such create space for the island's birdlife. Connected to making space for nature, the bird community would partake in the substation as well, uniting nature, human and technology.


windmills
301 m heigh
7 km

A section through Utsira communicates the island's intertwinement in Utsira Nord. The wind farm is located 7 km from the west coast of the island, and the substation is situated on the east coast facing the mainland.

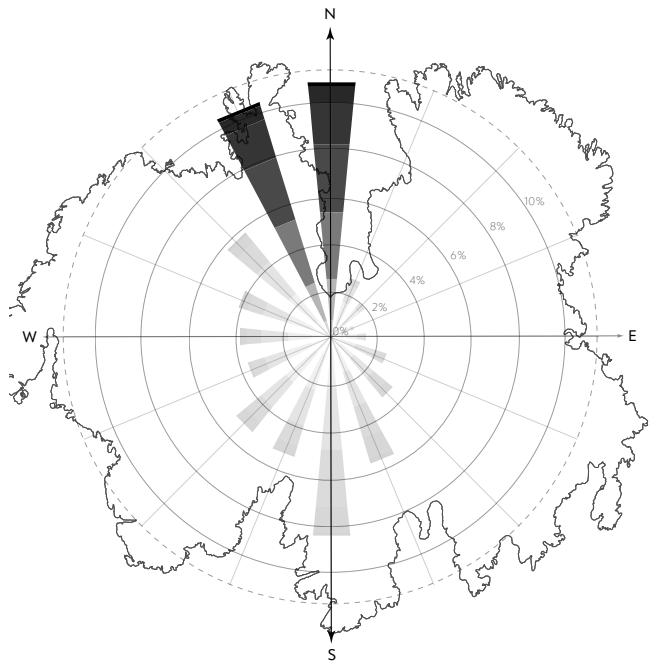
The section reveals the unique landscape of the island consisting of a rise on each side of the flat centre. It is not possible to see the wind farm from the Substation even if people are allowed to walk on top of the buildings. The connection between the windfarm and the substation should be communicated in another way.





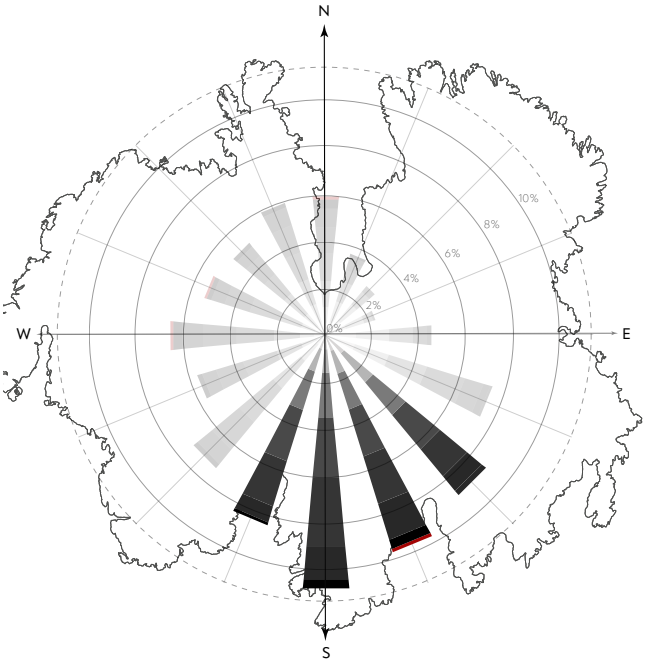
Spring is mainly subjected to strong northern winds, while also southern winds are interfering.

37.



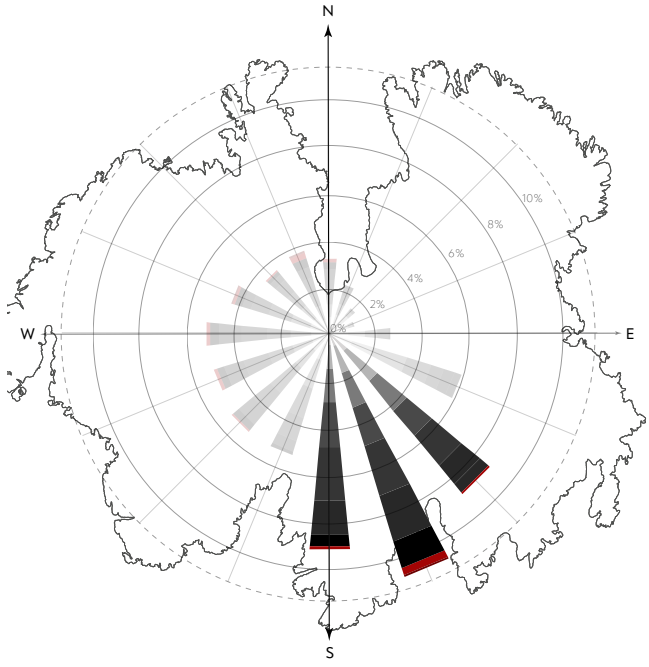
In summer Utsira is mainly exposed to winds from the North and North West.

38.



Autumn is characterised by strong southern winds, which marks a shift as weather gets colder.

39.



The wind in winter is mainlyfrom South and South East

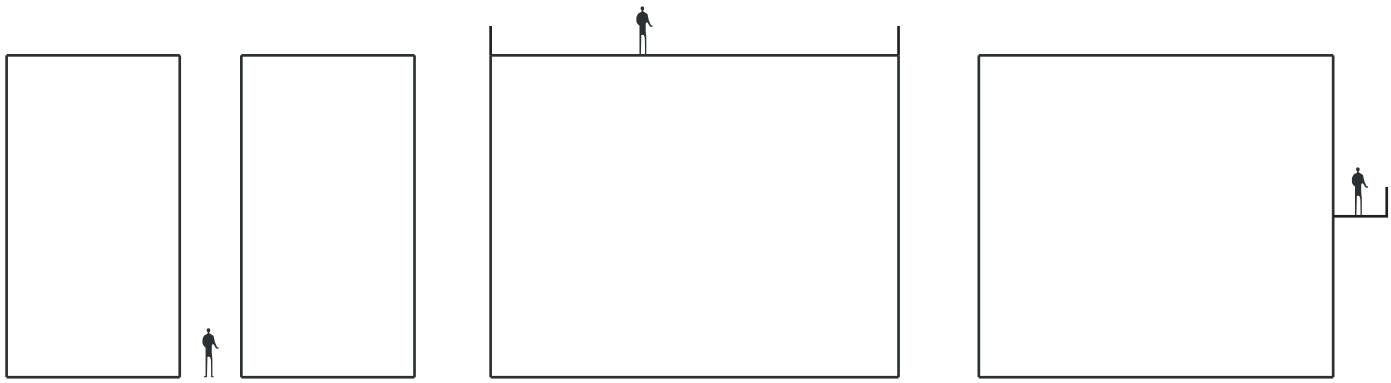
40.

Det finnes ikke dårlig vær, bare dårlig klær

There's no such thing as bad weather, only bad apparel

To understand Utsira, the nature and population, it is essential to understand the climatic conditions. Utsira is located in the North Sea exposed to the salty wind reflected on the landscape and building traditions.
The harsh climate on Utsira does not prevent the locals from venturing outside. They dress according to the weather, and they know where to find a shielded spot in the landscape for a break.

Wind is the focal point for Utsira Nord. The wind farm is located in the North Sea in order to utilise the strong wind to produce renewable energy. It is essential to shield from wind to create a gentle microclimate for people to take a break, but there is also a potential of emphasising it and exposing people to its power.
Utsira is primarily exposed to wind from north and south, and there is a potential in intensifying the wind, experienced by the user, in these directions.

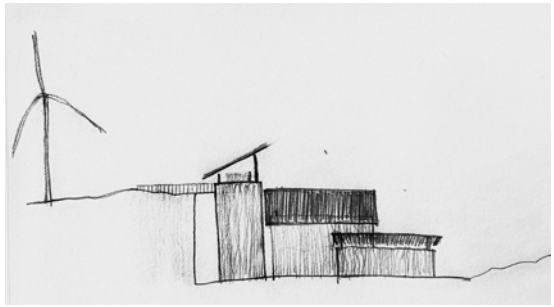


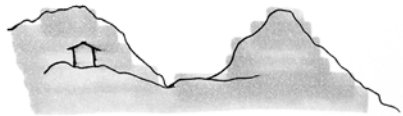
41.

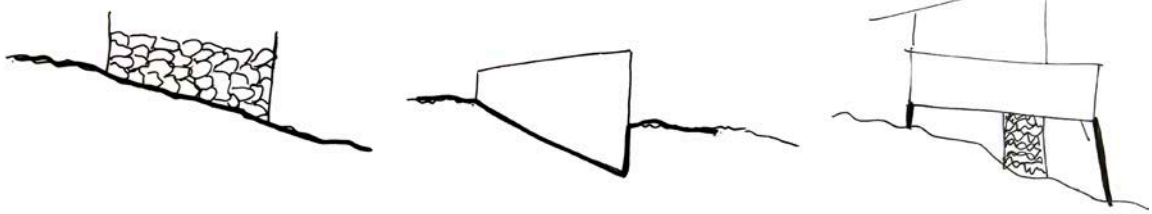
There is no visual connection between the wind farm and the substation. The omnipresent wind has a potential in representing the wind farm and the force of nature. Different ways of exposing people to the power of wind have been tested throughout the design process.

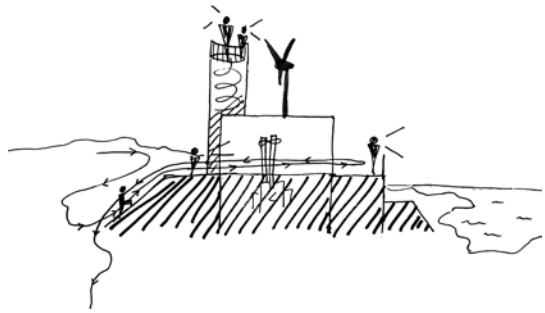
People could get access to the roof of the heigh building volumes, elevated from the landscape, exposed to the wind from every direction. They could also just get exposed from the main direction of the wind as a referral to the knowledge gained from investigating macroclimate. The wind could also be accelerated in between the building volumes in the creation of a wind tunnel.

42. Studies on how the visitor can get exposed to the wind, to experience natures forces.





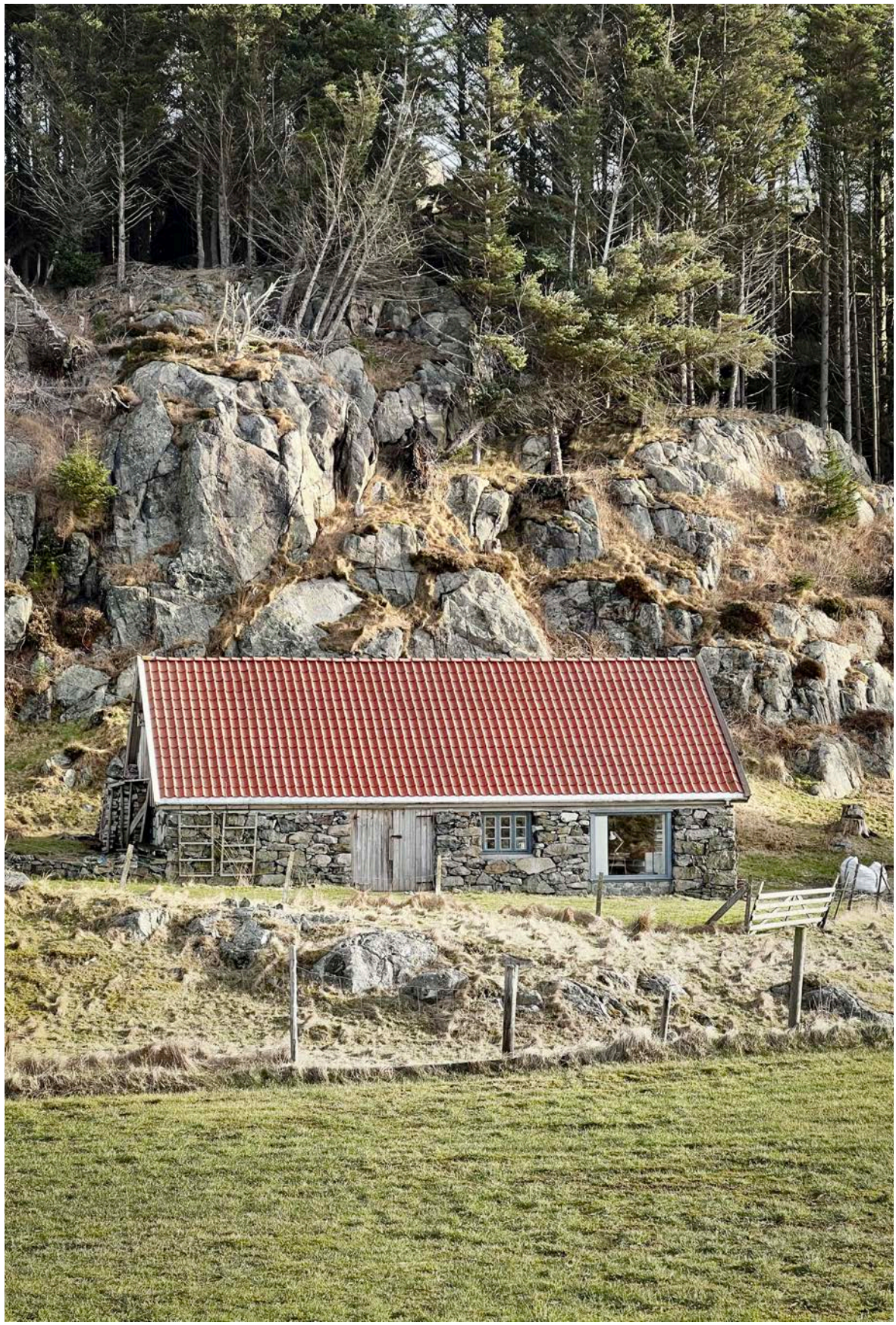




43.

The project is placed on a site that naturally lowered into nature in the middle part and enclosed on the north and east side through rock hills. These preconditions of the site give the potential to either blend into nature or stand out.
Historically substations were placed visible and proud into the landscape while the majority of substations now are hidden into mountain sites in Norway.

Having a site in an open landscape with no direct adjacent buildings the substation does not need to try and do much to stand out and in contrast to its context.
Instead of working towards one of the named possibilities, a connection of the two is preferred. Using nature not to hide but connecting to it while also standing out. Nature can hereby naturally support and emphasise the building's purpose of conveyance, energy production and use.



'Hvis ikkje det rusta på Utsira, så rusta det ikkje'

Utsira has a rich cultural heritage with cultural monuments dating back to the 16th century. The island was in 2022 distinguished as one of Norway's 51 cultural landscapes of agriculture, a token of the efforts to preserve cultural monuments within the society (Grimsby and Eek, 2022). The local building traditions at the island reveal a deep understanding of material properties developed through generations. A local building tradition shaped by the natural forces characterised by functionality. A cultural development is taking place on Utsira. The island wants to be a showcase for new sustainable energy solutions and a development of the society's cultural heritage for centuries is happening (Morisbak, 2021). It is however important to understand and respect the building tradition at the island and understand the force of nature.

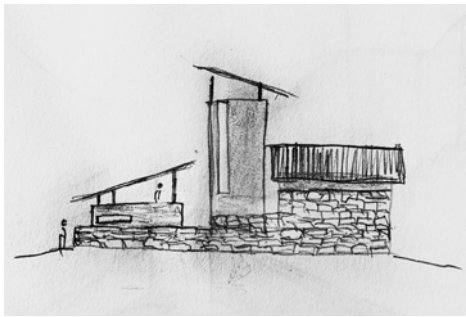
Its remote location has limited the selection of building materials. Therefore, the built environment consists largely of stone and driftwood. At Utsira there is a tradition of building *'grind'* constructions, a building tradition that stands in the shadow of *'stav'* and *'laft'* constructions' (Grimsby and Eek, 2022). What all of these construction methods have in common is their ability to be disassembled, moved and rebuilt at a new location. A sustainable and highly relevant building method, today named design for disassembly.

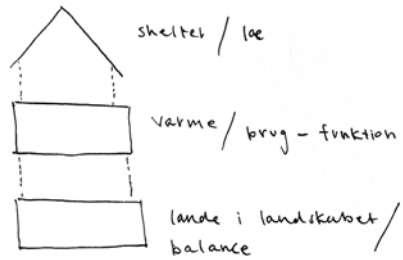
The majority of the building mass is placed in the central axis of the island, in a valley between the rocky landscape on the west and east hand side. The buildings are shaped with slated gable roofs, and oriented towards north-south due to wind. The grey slates on the gabled roof blends in with the landscape, hiding between rocks.

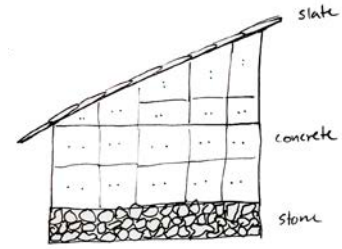
The grind construction is placed on a base of stone that almost grows from the landscape, providing balance on the rugged landscape. A natural element with strong properties. The stone base does not need any maintenance, and can endure the harsh climate. The stone base remains as a memento of past settlements (Grimsby and Eek, 2022).

The facades are cladded with wood, formatted to the stone base - reflecting the hierarchy between them. The wood cladding protects against rain and allows wind to blow through and ventilate the construction

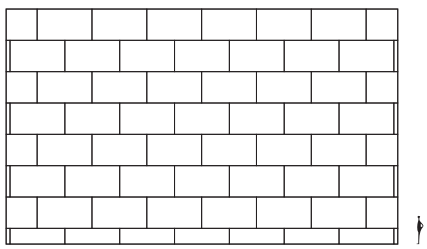
44. Old shed converted to a winter residence.

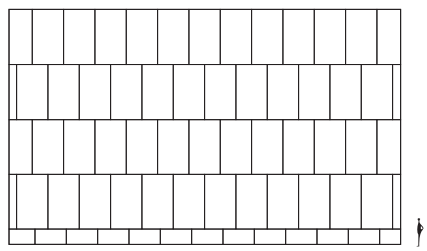


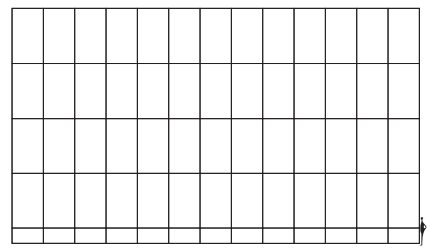

shelter / læ
varme / brug - funktion
lande i landskabet / balance


slate
concrete
stone

45.



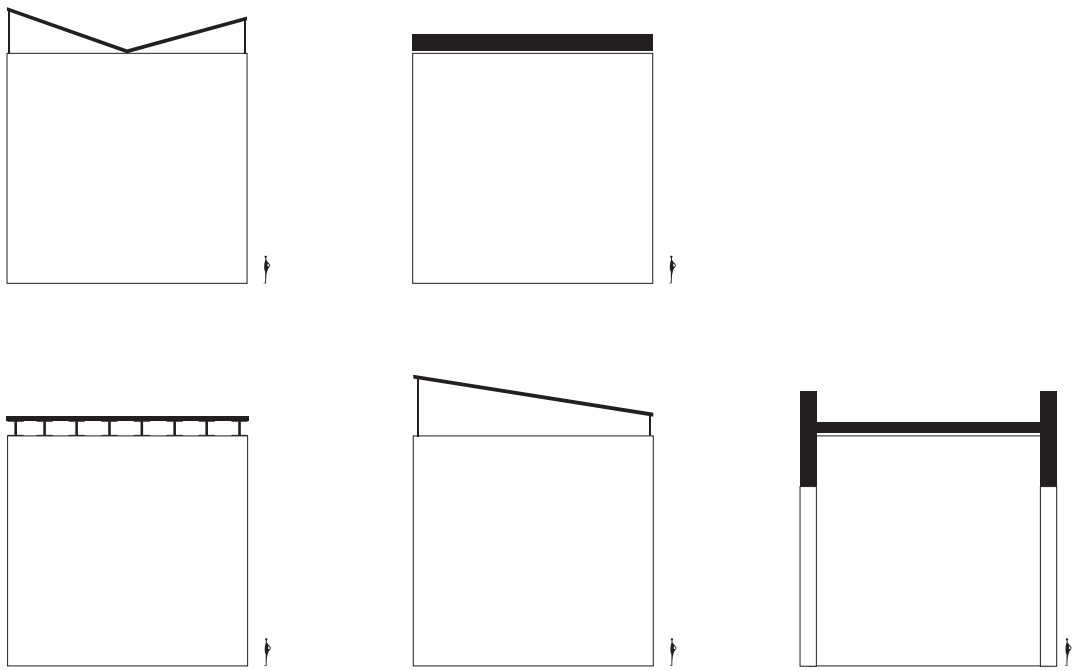




46.

The island's vernacular architecture is characterised by the use of natural materials building houses in 3 divisions, stone, wood and slate. We see a potential in transferring the historical building approach towards the substations volume. Breaking the scale of it down through divisioning the building would hereby benefit the visitors human scale.

We do not merely want to copy what has been done, also regarding the need of building with heavier materials than wood as body of the building in terms of safety requirements. The vision is to connect to the past and reinterpret it. But how much can we change without losing the connection to the past? Investigations of sizing building elements and divisioning the facade into two instead of three are done. Connecting not only to Utsiras building tradition but also industrial buildings design.



47.

Supporting the considerations on the facade divisions, a number of studies regarding the roof of the building were made. Investigations show that minimal changes create very varying expressions. The substation's roofing vision is that it should support the reinterpretation of the historical building practice and help facilitate a lighter expression and coherent design.

The tale of Utsira, is of people who have built their environment from material at hand. Through generations, they have developed knowledge of climate and resources, and built accordingly. Through minimal processing, raw materials are utilised as building blocks.

This understanding of application of resources should be brought forward in creating a new built environment on the island. Instead of discarding it in the face of modern building materials, one should rather develop it using contemporary technology.

The little vegetation and raw rock landscape of the island, resulted in an introduction of Sitka Spruce in the latter half of the 20th century. A fast growing and resilient species (Eek, 2017). Sitka is today considered an invasive species, and efforts are being made for its removal. Both stone and wood present themselves as viable materials for construction.

Water and wind have been considered important resources throughout history. The population has lived off the sea for millennia (Utsira Municipality A, s.d.), and the world's first hydrogen windmill was located on the island.It seems that wind will continue to play an important role in the future.

53.

TRADITIONAL MATERIALS, NEW TECHNOLOGY

The local building traditions reveal a deep understanding of available resources and their potential appliances as building materials. The municipality and population on Utsira are wary of the cultural heritage embedded in the building stock of the island, and there is a persistent focus on preserving with respect for the history. Visiting Utsira presented a local building tradition that has been refined through generations, and gave an insight into materials and construction methods that are able to withstand the harsh climate of the island (Beim and Madsen, 2015).

Local available materials are no longer a limitation for the architectural design process. The building industry is industrialised, digitised, and not least globalised. The number of materials and their processing are endless. Materials are getting extracted in one part of the world and processed in another. The building process and elements are growing continuously more complex, where the users are distanced from the construction process. A potential lies within tectonics to regain this connection.

> *'The tectonic remains to us today as a potential means for distilling play between material, craftwork and gravity [...]. We may speak here of the presentation of a structural poetic rather than the re-presentation of a facade.' - Kenneth Frampton, (Frampton, 1987; page 28)*

Rethinking the way we build, and construct is an ongoing process with a risk of forgetting the valuable knowledge of a local building tradition. A circular mindset is not a new concept, but used to be an integral part of construction practice at a time where material cost was high and building cost low.

> *'When the potentials of the construction are exposed they can form the platform for the future use and the further development of the building.' – Ulrik Stylsvig Madsen (Beim and Madsen 2015; page 150)*

Modern technology can be used as a potential to solve a contemporary problem within the building industry. The complexity makes it difficult to disassemble industrially produced building components and thereby hard to reuse them in a proper and sustainable way. Taking a cue from the past may allow for a simpler construction method that may meet the standards of today by the use of modern technology.

HOW CAN ARCHITECTURE BUILT FOR THE PRESENT ACCOMMODATE THE NEEDS OF THE FUTURE?

In the establishment of a new building, its construction material should be regarded as a mere loan of resources. An exploration of impermanence and intuitive disassembly.

Sitka spruce was introduced on Utsira between 1960 and 1970. The species grows naturally on the Pacific Coast of North America where it thrives in the rough climate (Teknologisk Institut, s.d.). Sitka spruce is a quickly growing tree that is considered invasive on Utsira, as it threatens the island's natural species. The municipality and the local community want to exterminate the species on the island. The trees are used as firewood on Utsira (Eek, 2017).

The trees have a greater potential than being used as firewood. Sitka spruce is normally used for timber and paper (Teknologisk Institut, s.d.). Unfortunately, the cost of transporting it to the mainland for processing outweighs the potential. It is not possible to use the trees for constructing the substation due to technical requirements, but the material could be used for concrete framework if the substation were to be built of cast-in-situ concrete.

Two examples on how to work with framework not only as casting form for construction, but used further as tactile expression of a substation and its facade were found.
Nyborggade Transformerstation, or Svanemøllen, is a 132 kV substation built in 1966-68. The architect, Hans Christian Hansen, has attributed the facade a keen sense of detailing. However, the cladding is not merely ornamentation, but in fact an essential part of its construction. The cladding holds tar paper and insulation batts in place, in which the concrete was cast against. The inner formwork was thereafter removed as it no longer served a purpose (Seier, 2019).

Another project in which the formwork has become an integral part of the architectural expression is Peter Zumthor's Bruder Klaus Field Chapel built in 2007. Here, the tactility is attributed to the inner facade. A wigwam of 112 tree trunks was established, whereafter 24 layers of concrete were casted against an outer formwork - creating a rammed effect. Later, a low-temperature fire was started inside of the building, allowing for charring of the tree trunks and their release from the concrete cast. The 112 concave columns have a charred finish - expressing several facets of its construction (Schwartz, 2016).

58. View upon the substation from the street

59.

Test with Sitka Sprouce as casting form for concrete. The Sitka is removed when the concrete has set and leaves the surface with its bark texture.

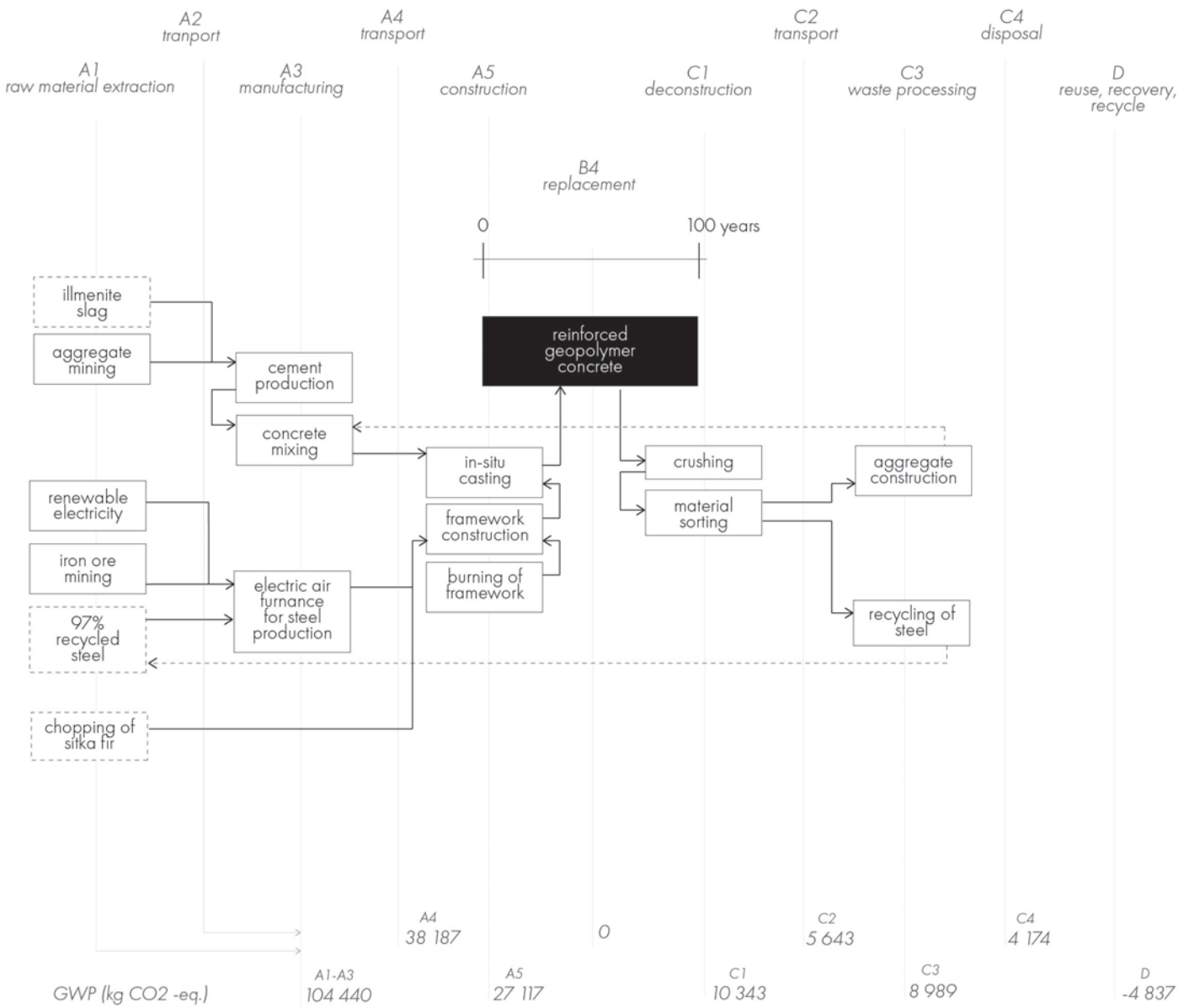
60.

Test with Sitka Sprouce as casting form for concrete. The Sitka is left in place to then be burnt when the concrete has set to leave its burnt texture as mark. Unfortunately the experiment did not go to plan, as the concrete would break when temperatures rise too high while burning the Sitka.

61.

On the third test, the Sitka Sprouce is again used as mould for the concrete. It is left in place and treated with yogurt and moss to fast forward its decomposition process. The goal of this experiment is to create a facade will change its expression over time.

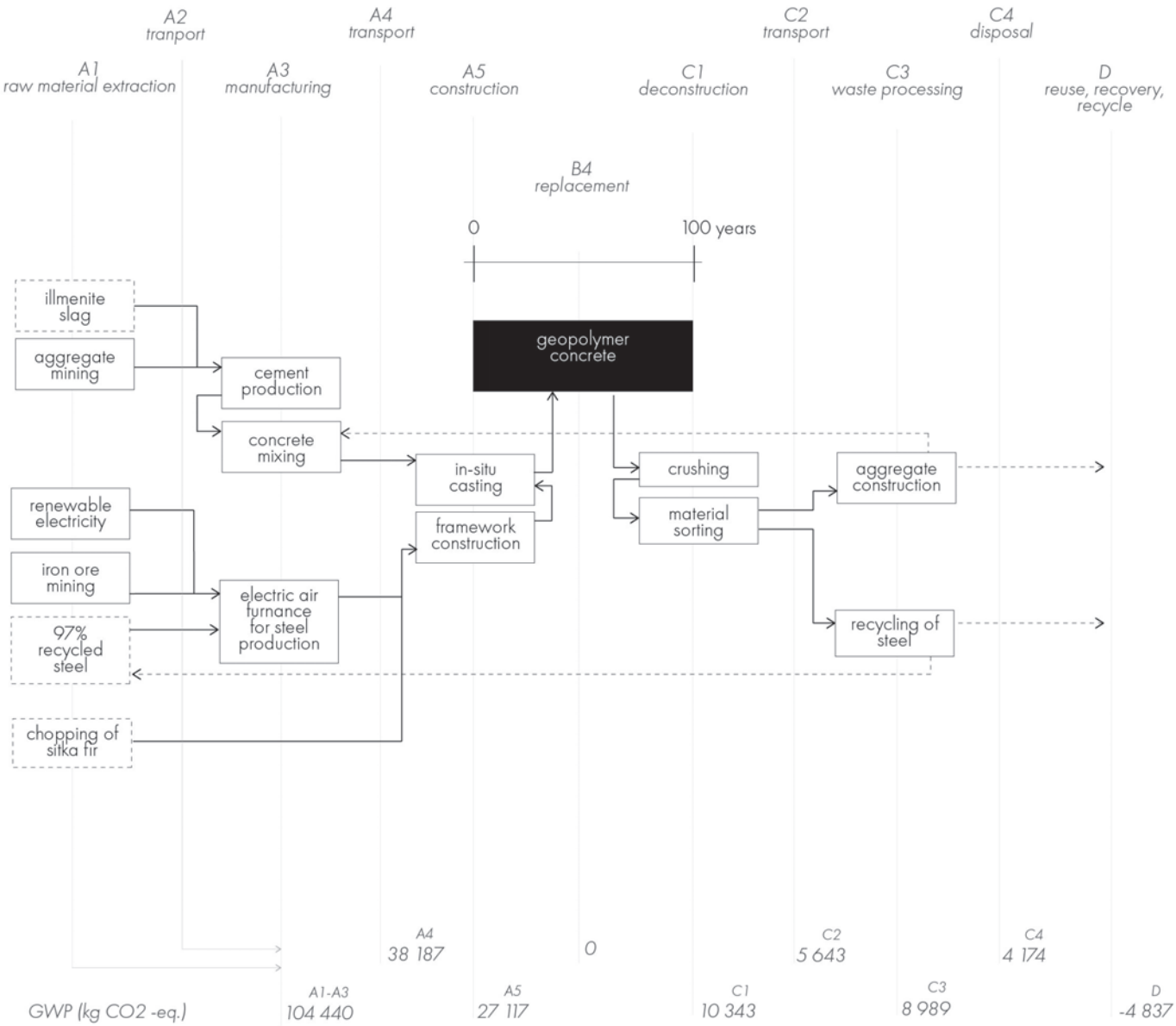
When building in concrete elements, the tactility of the building is often left unprocessed.
To obtain a more sensory experience for the user the surface of the concrete is processed through framework utilising sitka spruce. Three different expressions where tested, leaving the concrete either with imprints of the sitka spruce bark, charred or left to patinate over time. Each giving the visitor a different experience and possibility of interaction with it.
Taking inspiration in Zumthor's approach of construction in the Bruder Klaus Field Chapel, we had to conclude that the outcome in the investigations failed and the discharge of CO2 of the burnt Sitka spruce would go against the sustainable thought throughout the project.
On the other hand letting the formwork of Sitka stay in place and decay over time would open up the possibility for the user to interact with the facade. The building and facade would through this approach change over time in tactility and expression. Creating a space for insects to live.



62. Mapping of processes and materials of reinforced geopolymer concrete

The local community may partake in the establishment of the new structure. The building will have a tactile element shaped by the trunks of the Sitka fir. Being a memento of Utsiras return to its cultural landscape. Additional energy is needed for the burneing, which releases carbon

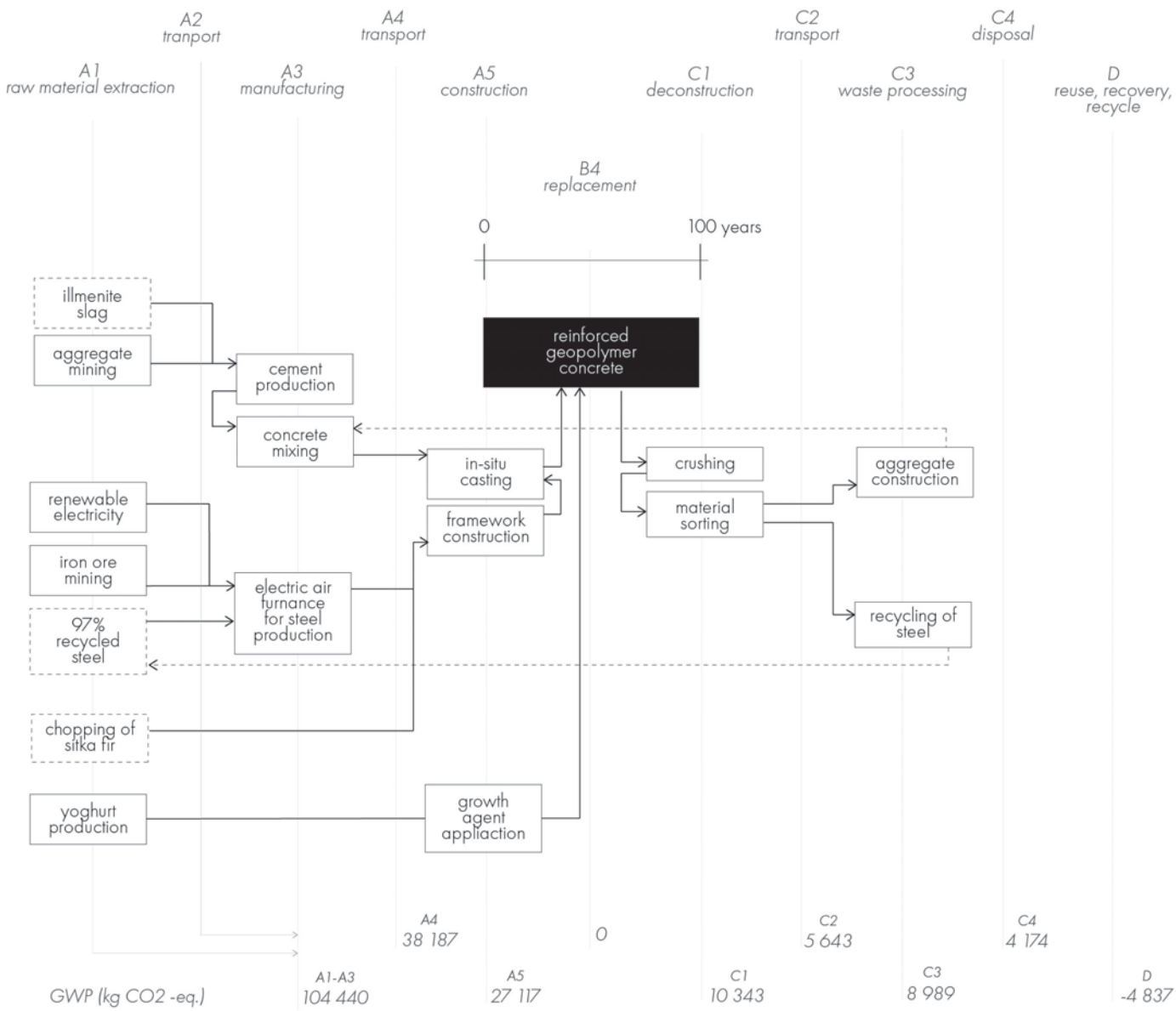
63. A collage showing burnt formwork



64. Mapping of processes and materials of reinforced geopolymer concrete

Instead of burning the wood, the Sitka formwork is left to decay. The building will change its appearance over the course of its lifespan. The wooden beam may be the host of insects or animals. The building may be a continuation of the natural ecosystem.

65. A collage showing formwork left as facade expression



66. Mapping of processes and materials of reinforced geopolymer concrete

To speed up the decay process, the building is treated with yoghurt and moss. The building will take on several colors thorough its lifespan. From the brown of the Sitka bark, to a bright lime green of moss, and to the eventual dark color of geopolymer concrete. The green color will be a contrast to the surrounding soft blue/grey surrounding tones, but being part of the natural pallette, not alienated.

67. A collage showing formwork left as facade expression

1 *Sirevåg*
Lundhs, Anorthosite

2 *Larvik*
Rocks of Norway, Larvikite
Lundhs, Larvikite

3 *Dovre*
Dovreskifer, Shale

4 *Sørli*
Liskifer, Shale

5 *Fauske*
Norwegian Rose, Marble

There is a long tradition of building with stone as one of the only available building materials on Utsira. Stone is technically still a locally available material, but if the substation should be built of stone, the material would be extracted from one of the many established quarries around Norway. The map illustrates some of the quarries in Norway. Common for the companies is their ability to extract and deliver larger blocks of stone. The quarries extract different types of stone, with different properties, nuances and tactility.

The rock of Utsira consists primarily of quartz diorite, tonalite, trondhjemite, mangeritt, gabbro, gneiss and amphibolite (NGU, s.d.). The nuance of the landscape differs according to the weather, but a general description of the nuance of the stone is warm grey.

Several processes go into producing a stone block. First holes are drilled vertically and horizontally, then a diamond wire connected to an electric engine is inserted to saw a block from the mountain. The blocks extracted are approximately 10 x 15 x 2 m and have a weight of around 100 tonnes. The blocks are formed after determining the use of the block, varying in size from 2 to 40 tonnes (Lundhs, s.d.). The surface of the blocks can get a wealth of different finishes.

Quarrying has a negative environmental reputation, as the process of extracting can destroy habitats and pollute waterways, even though stone has a considerably lower environmental impact than concrete and steel. Concrete partially consists of stone, but has a 40% reduced strength compared to a massive stone block of the same size. Stone does not need to be maintained, has a nearly infinite lifespan, and the block can be reused after the building's end of lifetime (Miles, 2022).

68. A selection of quarries in Norway

The 15 Clerkenwell Close is a six-story mixed use building designed by GROUPWORK and Amin Tahar. The Building explores stone as structural load bearing material. Giving an outlook on how to construct with stone and the architectural expression it creates. A clear intention was set on not only to use stone as a clip on material to concrete columns but use it as a load bearing column instead (WEBB YATES ENGINEERS, s.d.).

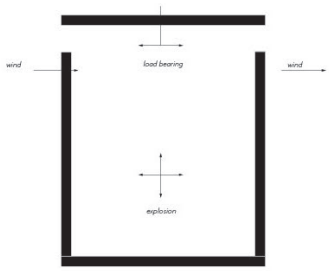
The architectural studio decided to use less time on manufacturing and polishing the stone used in the project, instead it has been left mostly as it came from the quarry. Meaning the stone elements display their natural rough edges, visible drilling pattern and slightly more worked edges that are smooth (WEBB YATES ENGINEERS, s.d.). Through working with the processes visible on the material used, the architecture emphasises the aesthetic value of the material.

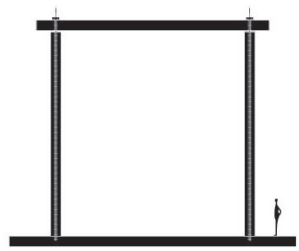
The heavy and rustic material naturally displays its strength (Miles, 2022) and through the iterative design process of GROUPWORK with the focus on material properties, the columns vary in size according to the load carried (WEBB YATES ENGINEERS, s.d.).

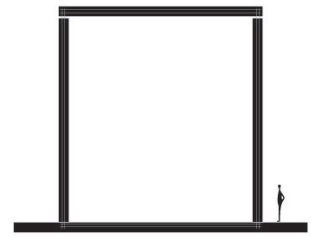
Building with stone is nothing new in the vocabulary of architectural heritage, and is largely spread not only throughout the history of Norway but many other countries.

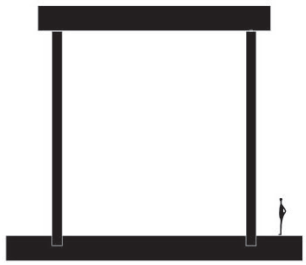
This project aims to re-inherit the possibilities and understanding of stone as building material and emphasise its aesthetics and structural qualities.

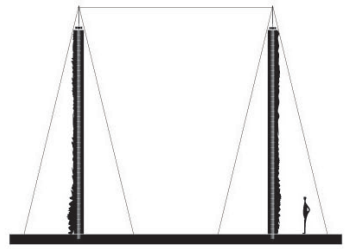
69. 15 Clerkenwell Close, designed by GROUPWORK and Webb Yates

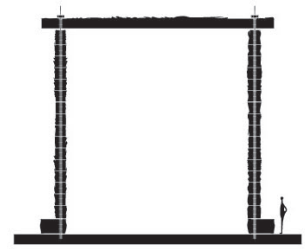

wind
load bearing
wind
explosion











'Stacking stones on top of each other to form walls is something man has always done. Whether it has been to get rid of the stones from the field or to create a protection against enemies or wild animals. Natural stone is a beautiful material that belongs in the Norwegian landscape, and dry masonry is a very resource-friendly and environmentally friendly building practice' - Norsk Bergindustri (Norsk Bergindustri, 2013; page 70) (own translation)

'Å stable steiner på hverandre til murer er noe mennesket alltid har gjort. Enten det har vært for å bli kvitt steinene fra åkeren eller for å skape et vern mot fiender eller ville dyr. Naturstein er et vakkert materiale som hører hjemme i det norske landskapet, og tørrmuring er en meget ressurs- og miljøvennlig byggeskikk' - Norsk Bergindustri (Norsk Bergindustri, 2013; page 70)

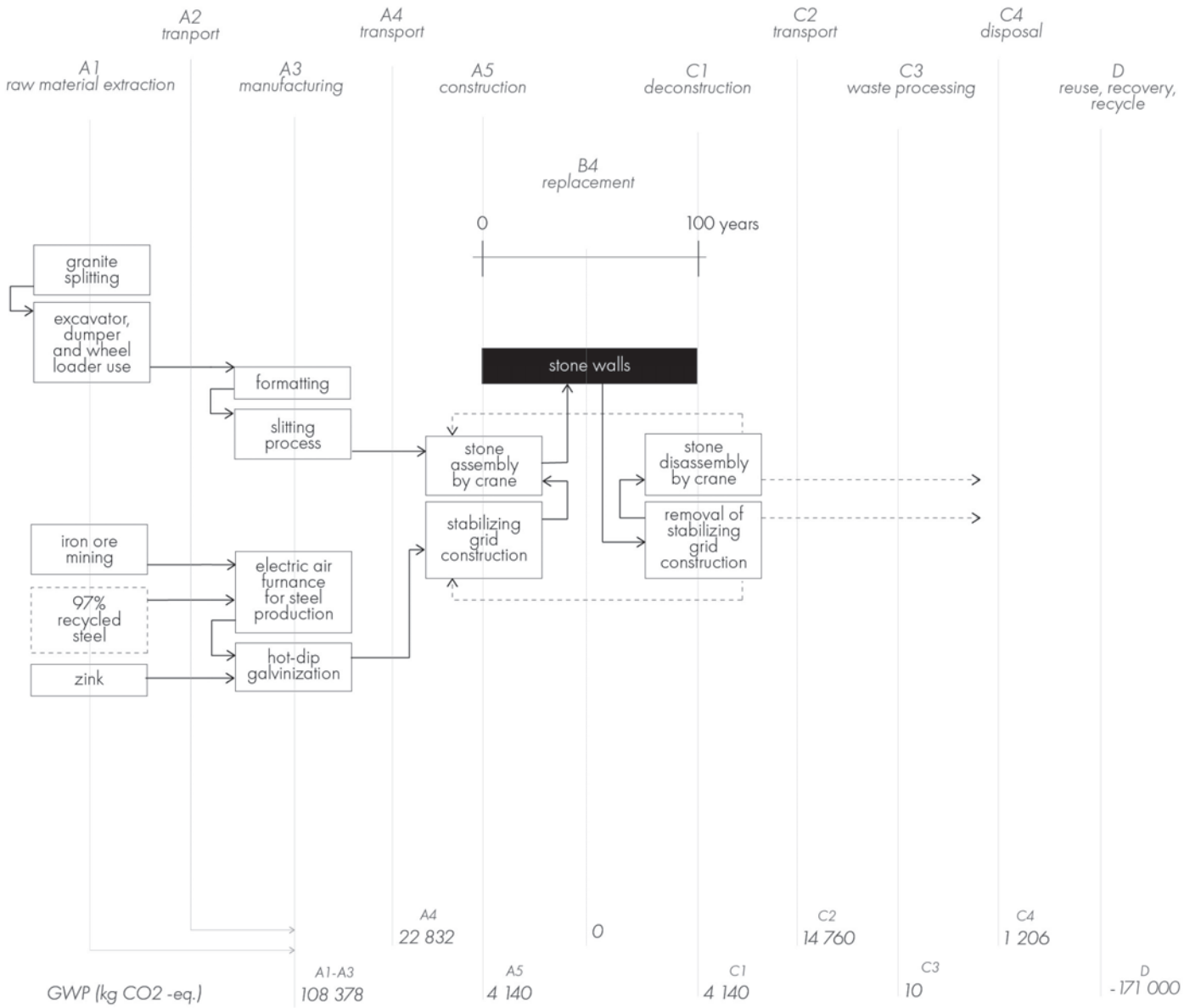
Although building with natural stone is a common practice in Norway, the substation and its construction needed investigations regarding its construction and assembly. Whether stacking stone without mortar, with mortar to receive stability, shaping joints with machinery or introducing steel into the construction are examined.

Stacking stone without mortar and archiving stability requires processing of the material. Removing drill holes and to receive tighter joints and cut so the joints of the stones create a slight inward slope are hereby important. The stability of the wall is improved when using larger stones and the largest are placed in the bottom. The tight horizontal joints and their large surface pressure can result in local peeling or crushing of the joints edges (Norsk Bergindustri, 2013).

Another investigation of construction was made by introducing steel as a stabilising element.

I-profiles that could be cut into the stone and steel wires that could be mounted where examined. The importance hereby is to use stainless or acid-resistant steel to counteract the risk of rust (Norsk Bergindustri, 2013). To achieve easy and intuitive assembly and disassembly of the construction cement mortar was ruled out.

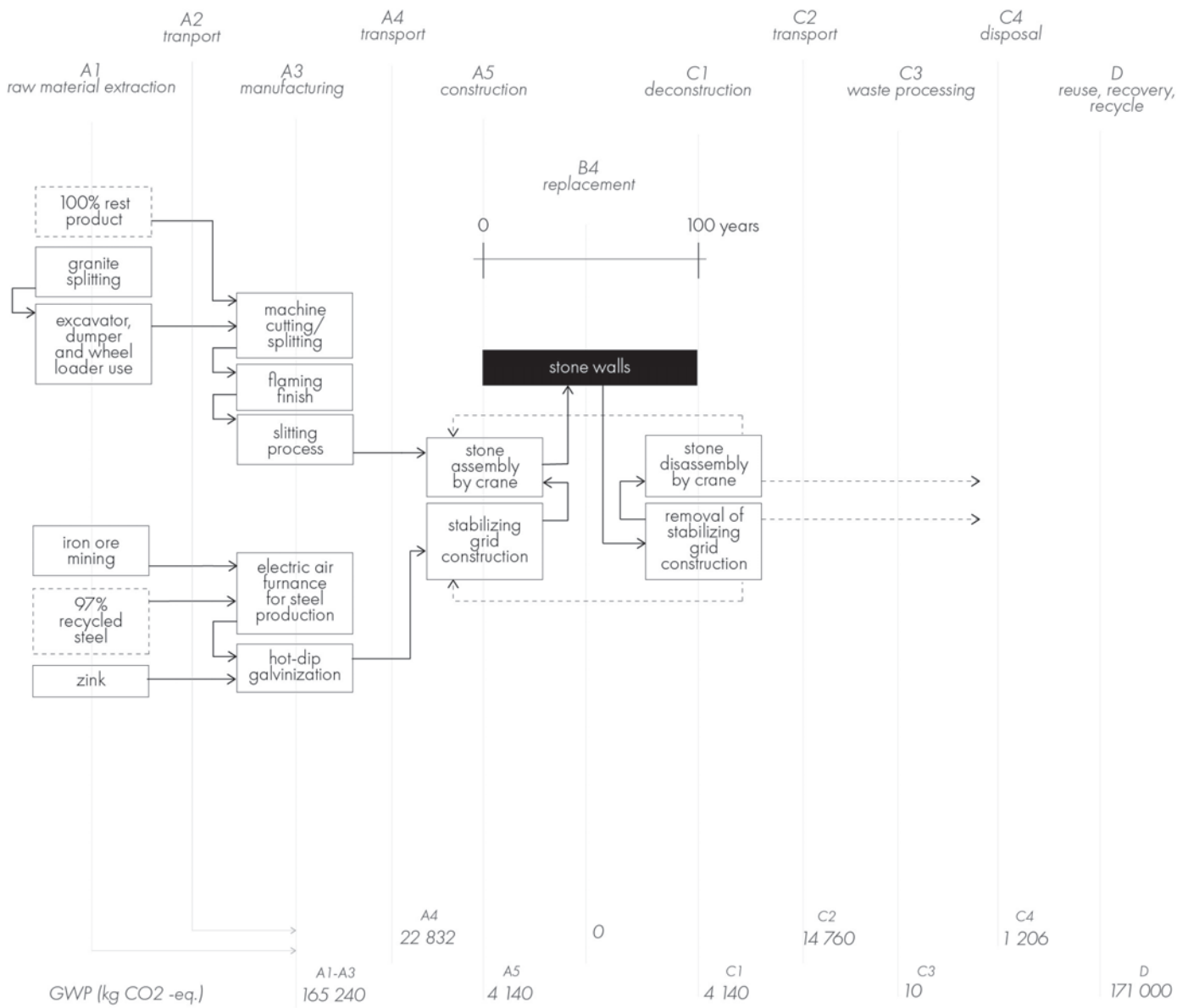
70.



71. Mapping of processes and materials of a stone wall made of blocks

Natural stone as facade. Drilling hole from the splitting process is visible on the facade, telling the story of the building's origin. The building is a continuation of the natural cliff landscape, but is in its vertical form a new element - allowing for natural rock climing by its users. The crane used to install the transformer may be utilized to lift the big blocks in place.

72. A collage visualising stone as building blocks

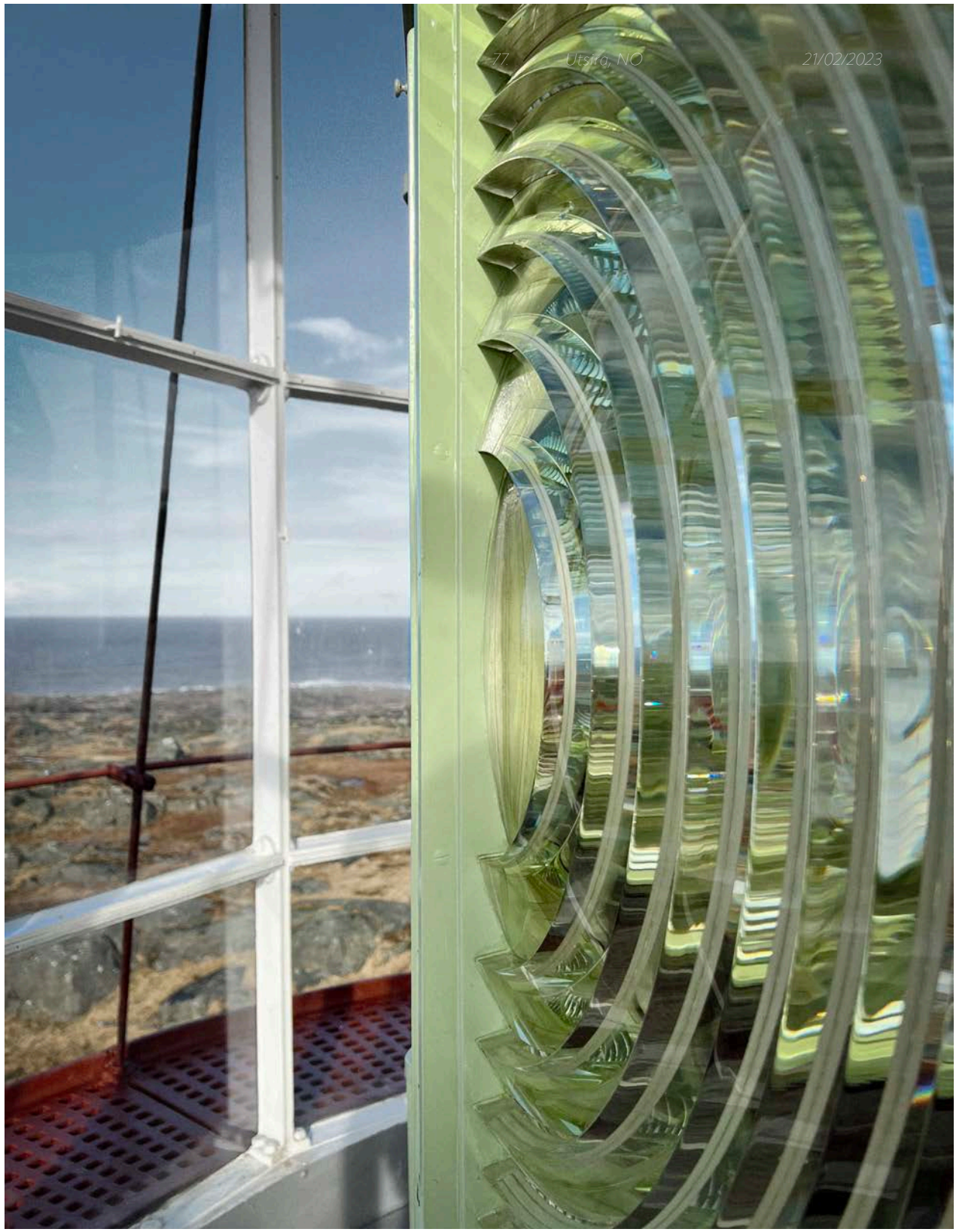


73. Mapping of processes and materials of a stone wall made of a part time waste product

Smaller stone elements as facade. Here, waste products from the mining process may be given new life. The dimensions of such product is more uncertain, and may need more formatting with new technology. Cement rises as the favorable option for ensuring stability despite its carbon heavy impact.

74. A collage visualising stone as building blocks


BALENCIAGA



77. Utsira, NO 21/02/2023

22/02/23

Sunshine smiles and happy to be
Out on tour to see houses at sea
Utsira gives energy

Childhood dreams coming true
Startet the lighthouse lika a Sirabu
Sun, no wind, sun

Warming rays of sunshine
Stories from years ago
Utsira is filled with history that no one
would know

Tired eyes
Memory filled
Bird's eye view
The sea is still

Sailing home
Up and down
The waves are taking ud back to town

The people of Utsira live intertwined with nature and its forces. They have a deep care for nature, and wish to preserve the identity of the landscape, which has remained nearly untouched since the Mitigation Period (Utsira Municipality A, s.d.).
Utsira Nord presents the society with both potentials and pitfalls. For a society in decay of population, the establishment of job opportunities is of utter importance for its continuation. Utsira Nord, and its ripple effects, introduces the potentials of several new industries. Utsira Municipality has high expectations, and aims for the establishments of 50 new jobs on the island (Hansen, 2023).
This is an ambitious number, but also a display of the sacrifice they make for the development. For their horizon will be plastered in wind turbines - spoiling their every sunset.
The Substation presents a potential for reconciliation. Where the locals may be invited to partake in the adventure. The architectural expression could either be the sign of unresolved conflict or it may be the offspring of acceptance, or perhaps even pride amongst the society.

CATALYS ARCHITECTURE

'A catalyst is a facilitating agent' (Kiib & Marling, 2014).

Hans Kiib and Gitte Marling claim that catalyst architecture initiates and accelerates behaviours as a result of, and in relation to, the built environment. It may facilitate meetings between people of different backgrounds, cultures and viewpoints - and initiate interest and conversation. Also, the building itself may be an agent for sparking interest and through architecture tell the tale of its origin and purpose.

The term is closely related to Leatherbarrow's performative architecture, which have sparked Kiib and Marling to develop two analytical concepts; internalised performance and external architecture-related performance (2014). Whereas, the first relates to one's subjective experience of the built environment, the latter is the built environment's ability to facilitate meetings between user groups; hereunder society and technology. So what means do we have as architects to ensure this? Kiib and Marling claim that this may be achieved through semiotic meanings and aesthetic effects (2014). However, such effects are highly site-specific and dependent on the cultural and historical context.

'[...] architecture that in its design and architectural effects either challenges our senses, our memory and recollections, or directly invites to a bodily interaction' - Ann Klingmann (Kiib and Marling 2014; page 32)

The building should in its programming offer spaces where meetings between technology and users may occur, and it's only successful if people feel invited and entitled to enter the building. In doing so we may seek inspiration in the term affordances. For the stature of a building determines how one interacts with it.

There is, however, a clear subjectiveness present in the meeting between the built environment and its viewer (Griffero, 2022). For, the experience may be quite different for an energy enthusiast, a bird enthusiast and wind protagonist. There is a fine balance in creating a place with transparency of production and creating a visitor centre for energy tourism. For the latter may be just that a place one visits and not one the Sirabu feel invited to use as their own.

79.

80.

Røldal portal station is situated on the border between nature and technology acting as a mediator between the two. Here, Geir Grung practised a reductant aesthetic, where ornamentation is stripped and beauty is found in the honest display of components and their structural and technical purpose (Palmstrøm, 2022).

During the 60's, the history of energy supply was written in Norway. A number of waterways were dammed up into reservoirs, and a total of nine hydroelectric power stations were established, all terminating at the Suldal lake in Nesflaten (Brandal, 2015). Despite the drastic impact on nature, the inhabitants of Røldal and Suldal remained positive of the development. It established a number of new jobs that allowed the otherwise depopulated valleys to remain (Brandal, 2015).

Geir Grung 1926-1989), member of CIAM (Les Congrès Internationaux d'Architecture Moderne) and PAGON (Progressive Arkitekters Gruppe Oslo), was commissioned to draw the portal buildings for Røldal and Nesflaten power stations. The innovative and optimistic spirit of the future was continued in the idiom of the two distinct buildings. They are both constructed from in-situ cast concrete, allowing for expressive forms that never before were seen in the built environment of Nesflaten or Røldal.

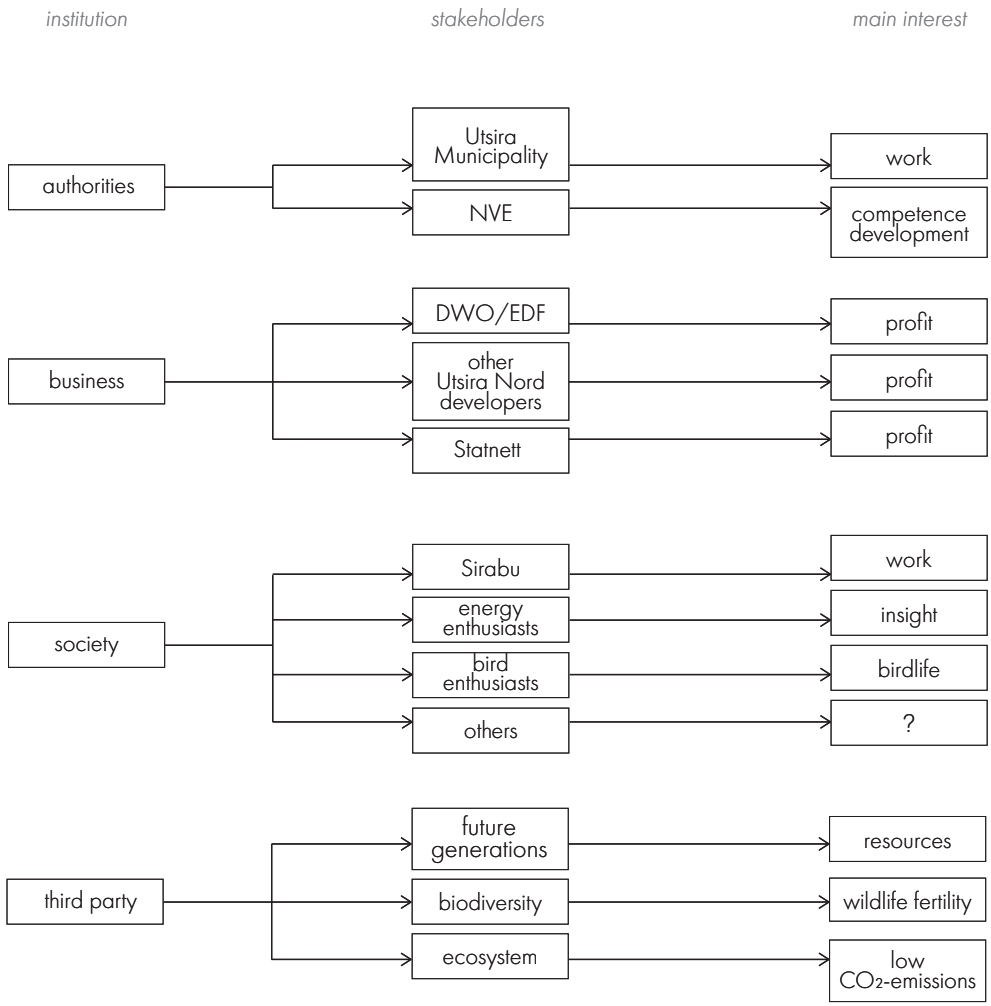
Pride was shown in the groundbreaking project and architecture at the time, and is still to this day. The hotel, which used to host energy fairs and lodge its participants, is today open to the public, and attracts tourists from far and near to partake in its history. The substation hereby creates a meeting between human and technology, sparking interest and interaction. Today, the daily operation at the portal building at Nesflaten is digitised and controlled from afar, but the interest in repurposing and utilising it remains (Lindseth, 2023).

The quality of the buildings should be attributed to its adaption to context - both historical, cultural and physical. The 60's were characterised by a optimism for the future and of technology, Røldal portal station manages to capture this societal and architectural movement by telling a tale of technological development through materiality and architectural expression. The scene has since changed greatly. It was followed by a conflict between nature and energy production, where the substations were hidden away and built into mountains. The start of this decade has reintroduced the typology to the day, but in an economy-efficient concrete suit. With today's societal interest in 'sustainability', a demand has risen for transparency of production, branded by the capitalists as 'energy-tourism'.

We believe the time has come to treat the typology with some more affection, where pride and optimism may yet again arise from the production. A pride and acceptance extended to all members of society, not merely the ones with economic means to buy a slot on a guided tour. The substation should regain the users attention and invite interactions and create an acceptance that can last through time.

IS IT POSSIBLE TO ACHIEVE A LOWER ENVIRONMENTAL IMPACT THAN THE COMMON SUBSTATION WHILE ALSO CONSTRUING SOCIAL QUALITIES?

The substation should have an inviting character to allow people to partake in the wind adventure.


institution
stakeholders
main interest
authorities
Utsira Municipality
NVE
work
competence development
business
DWO/EDF
other Utsira Nord developers
Statnett
profit
profit
profit
society
Sirabu
energy enthusiasts
bird enthusiasts
others
work
insight
birdlife
?
third party
future generations
biodiversity
ecosystem
resources
wildlife fertility
low CO_2-emissions

Upon our arrival to Utsira, we were expecting a conflict between the bird enthusiasts on the island and the wind farm developers. A meeting with the stakeholders revealed as follows.

22nd of February 2023

We were invited to partake in a meeting between the developers and the municipality, where interests and co-existence were discussed. Deep Wind Offshore had brought with them Asplan Viak who were engaged to assess the impact of the project on society, nature and ecosystems, and Harald Østensjø who had assessed the impacts on fishing routes. It was pointed out that no obvious conflict would arise, as both fishing routes and bird migratory routes mostly diverge the area. However, information on how life at sea is affected is still lacking, and the project presents itself as an opportunity for researching such effects for future references.

An extensive group from Utsira Municipality was present, among them mayor Marte Eide Klovning, municipal director May Britt Jensen, head of environment and agriculture Atle Grimsby, business developer Grete Møgster, head of economy Rune Solevåg and assistant councillor Arnstein Eek.

A surprising outtake of the meeting was the keen interest from both the municipality's side as well as the developers for public support in matters of aligned interests. For in fact, neither stakeholder is responsible for the decision making. Instead the authority lies with the Norwegian government, wherein Utsira was chosen as host for the wind farm due to its relatively small conflict with fishery and wildlife.

The government will allocate the building concession based on qualitative terms in which GWP, waste management, co-existence, and development of local competencies will be weighted (Olje- og energidepartementet, 2023). The two categories sustainability and positive local ripple effects each account for 10 percent of the allocation. However, it's not specified whether local refers to Utsira, Haugalandet, Vestlandet or Norway in relation to Europe's development of wind power.

To account for the complexity of interests, and relationships of power, a stakeholder mapping has been carried out.

81. Diagram of the different stakeholders and their interests.

stakeholders

Utsira Municipality

NVE

'research facilities would be obvious'

'Utsira could use a co-working space'

DWO/EDF

other Utsira Nord developers

Statnett

'visitor centor'

'how about utilising the heat generated from the substation for a sea pool?'

'a climbing wall for the childrens in school'

'energy tourism'

Sirabu

energy enthusiasts

bird enthusiasts

others

'museum'

'the east coast of the island could use a spot for watching birds'

future generations

biodiversity

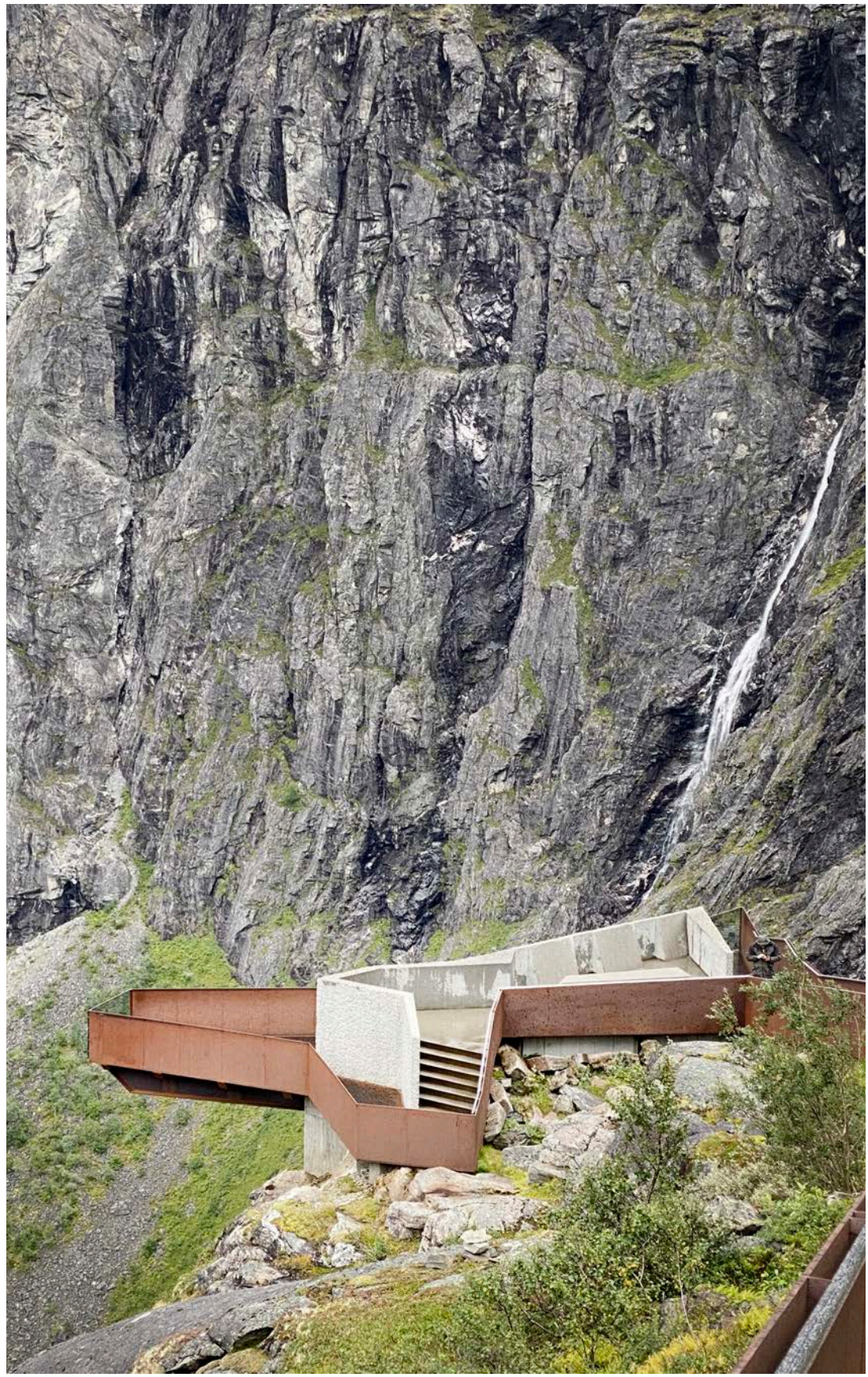
ecosystem

'Utsira could use a hotel with own bath'

The reason why people should have interest in visiting such a place has filled a great deal of the process. Rooted in conversations with the municipality, the developers and the Sirabu, several options came to mind. Sea pool, sauna, climbing wall, co-working space and bird-watching tower were options to accommodate the Sirabu and to attract the interest of others. A research facility for the co-existence of biodiversity and wind farm, or the potential of establishing new industry, were options to accommodate the needs of the municipality and the developers. A visitor centre would aid in communicating the function of the station. However, it must not create an economical barrier between the station and its visitor, which soon became a principle design parametre for the secondary function. Rather, it should be the task of architecture itself to communicate this.

The secondary function should not overshadow the primary, but simply complement it. Making the work with affordances even more important. For there should be no doubt that people are invited in.

82. Stakeholder mapping of wishes to supplementing function to the Substation



The Norwegian Scenic Routes are investigated to give an insight on how to add a social layer of interaction to the substation. The added layer should emphasise architecture, nature and technology without creating any economic barrier for the user. Complementing the substations primary function.
18 roads in Norway were selected in 1993 (Statens vegvesen B, s.d.) to become part of the Norwegian Scenic Routes. NPRA (Norwegian Public Roads Administration) is responsible for developing these routes (Statens vegvesen C, s.d.). The project started with the aim to promote Norway as a travel destination and is financed by the Norwegian Government who supports the Ministry of Transport and Communication through budgeting (Statens vegvesen B, s.d.).
The selected roads run along waterfalls, mountains, fjords and coasts, whomall display special natural qualities (Statens vegvesen C, s.d.).
More than 50 architects, designers, artists and landscape architects have created an experience along these roads (Statens vegvesen A, s.d.).
The principles of the desired architectural expression are described as:

> *'The architecture should facilitate the experience of nature, while also appearing as an attraction in its own right.'*
> *- Norwegian Scenic Routes (Statens vegvesen A, s.d.)*

Not only must the architecture answer these principles but also facilitate functions such as parking, views, rest, information, toilet facilities and waste management. Moreso must the designer ensure to choose materials in their structures that make de design last (Statens vegvesen B, s.d.).
Many of the stops and rest areas facilitate simple activities such as bird watching, landscape outlook, conveyance or hiking (Statens vegvesen B, s.d.). Through inviting gestures, positioning, architecture and the surrounding nature these activities thus lead the visitor to have an extraordinary experience.
One of these extraordinary experiences is the Troll's Road Plateau designed by Reiulf Ramstad Architects. The thoughtful choice of materials regarding the elements and small gestures in the design, help highlight nature, invite and increase the visitors' experience (Reiluf Ramstad Arkitekter, s.d.).
By designing the substation the focus should be on inviting the user to experience nature, architecture and the conveyance of the energy production. The Scenic Route experiences, their principles and functions, will serve as inspiration for the design of the substation on Utsira.

83. Trollstigen viewpoint


1


2


3


4

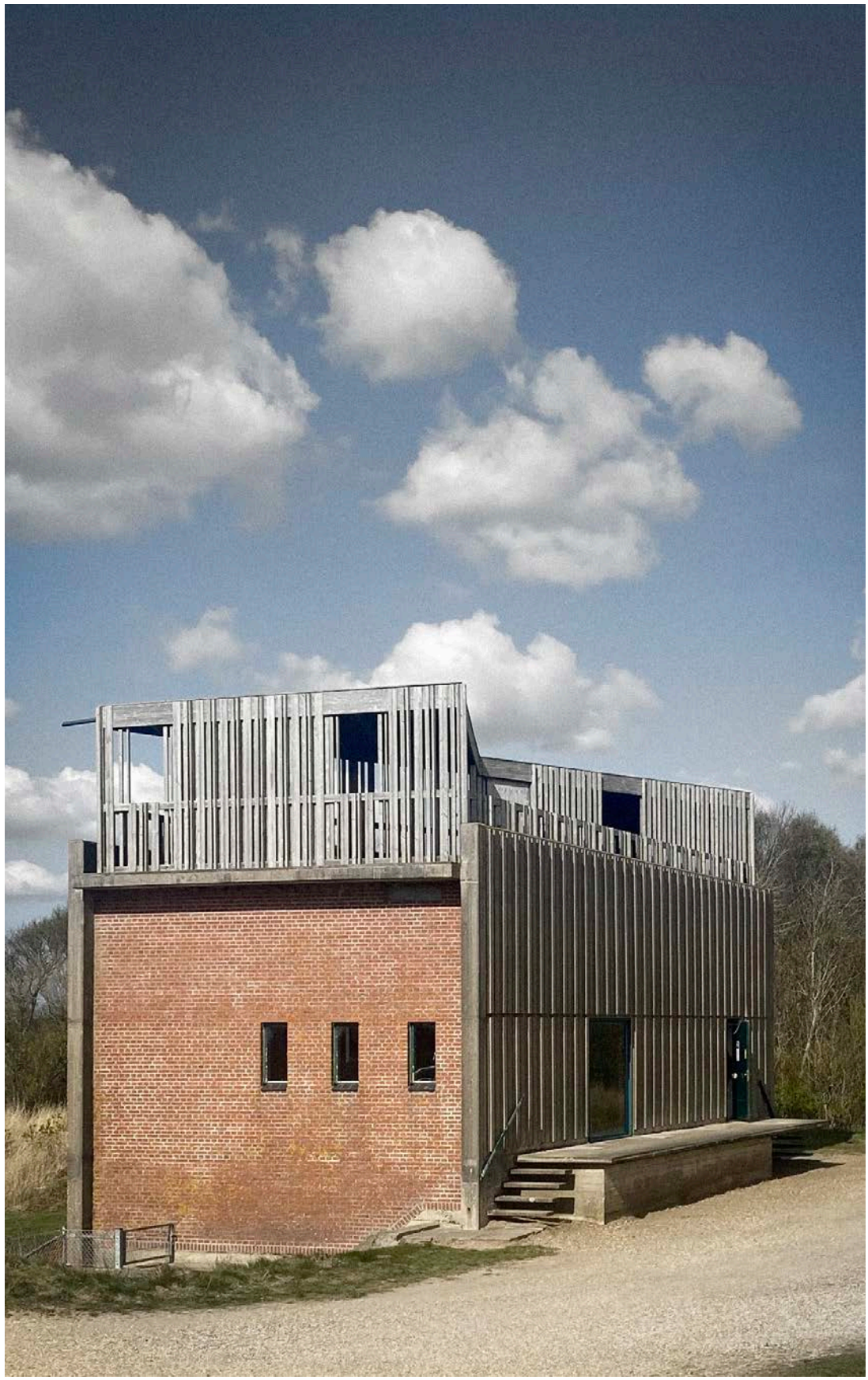

5


6

On a hiking trek through the rocky landscape from west Utsira towards east, the hydrogen wind turbines suddenly become visible like two foreign vertical elements in the landscape. The new substation is to be built on the plot south of the wind turbines. On the hiking trek, the plot gets alternately visible and hidden behind the landscape. The route goes briefly on the road, past the plot and further into the landscape.
The new substation will be another foreign element in the landscape along the hiking trek. It is important that the building does not turn its back on people passing by but instead arouses their interest and invites them towards the substation.

84. *The hiking trek and stops where pictures towards the site were taken.*

85. *Series of views, hiking towards the site.*



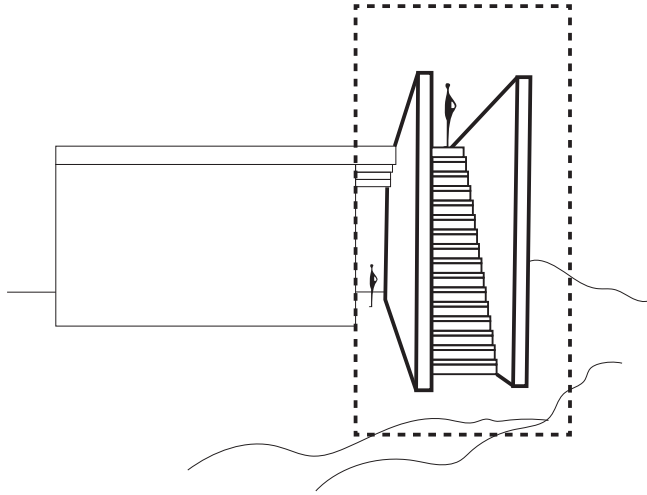
The Skjern River Pump Station designed and rebuilt by Johansen Skovsted Architects, has brought new life to the area (Johansen Skovsted Arkitekter, s.d.). The rebuilt pump station is accessible to all and has thereby no financial barrier. It invites visitors inside and lets them move through the storyline of the pump station. Throughout the flow indoor and outdoor viewpoints are implemented to highlight the landscape surrounding the station (Johansen Skovsted Arkitekter, s.d.). Through detailing, material choice, viewpoints and the conveyance of its function the station is able to create a close relationship between technology, architecture, nature and visitors.

The building is anchored into the motif of the pump station's original aesthetics and connection to its surroundings, thus strengthening the site's historical value (Johansen Skovsted Arkitekter, s.d.).

By implementing a social layer, rethinking but routing the design in the history of place one is able to create a multi-layered experience for its user.

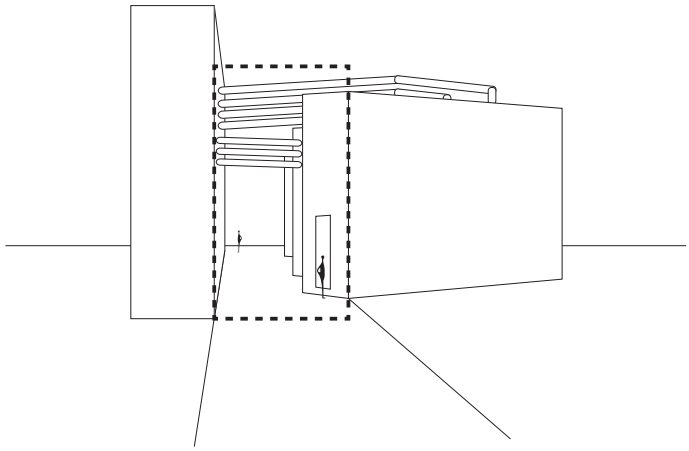
The design of the substation on Utsira will find attachment in these thoughts and be inspired by the accessibility, and flow through the building's conveyance of processes. Another aspect will be to connect to the surrounding place and reinterpret the building's historical roots.

86. The Skjern RIver Pump Station



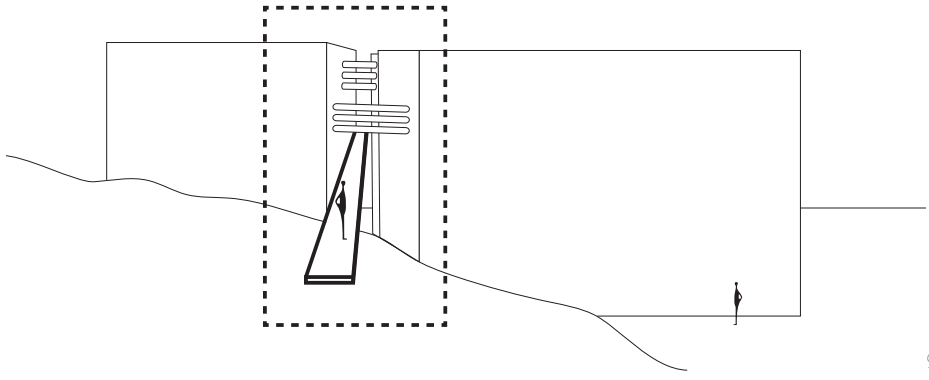
The staircaise

89.



The passage through the building volumes.

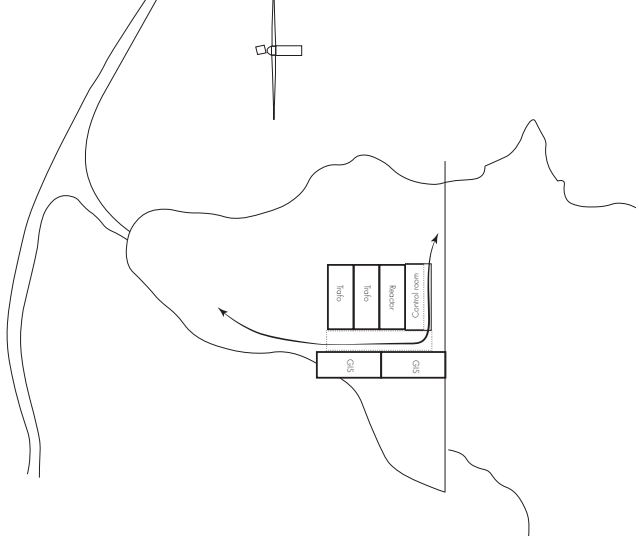
90.



The walkway

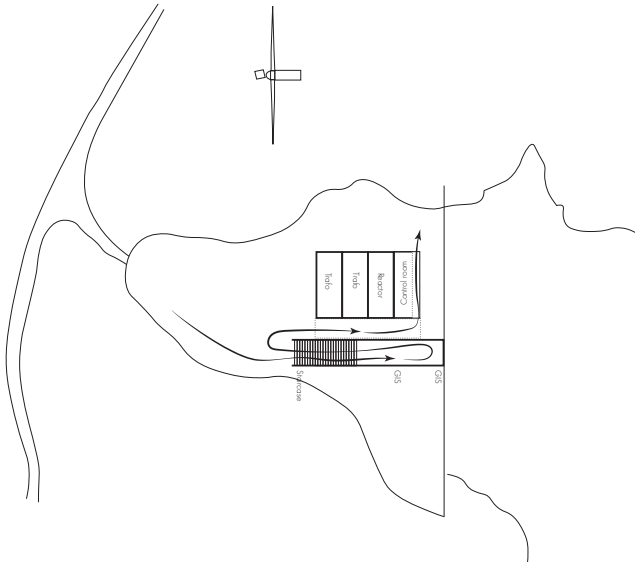
91.

The otherwise non-accessible industrial building typology of a substation will be made accessible in this project. Making it utmost important to radiate an inviting gestus when meeting the building and dismiss any doubt of the possibility of entering.
The building should be open and spark the visitors' interest to enter. Through the process of implementing transparency through windows, intuitive access ways in terms of stairs or a footbridge, the meeting and inviting effect of the building have been studied.
The staircase has the potential of drawing people to the site through its landmark appearance, yet is a gestus by itself taking away the focus of the building. Furthermore, the staircase is not inviting to all but may symbolise non accessibility for disabled visitors.
The footbridge on the other hand includes all and draws the visitor naturally in and through the site and architecture.



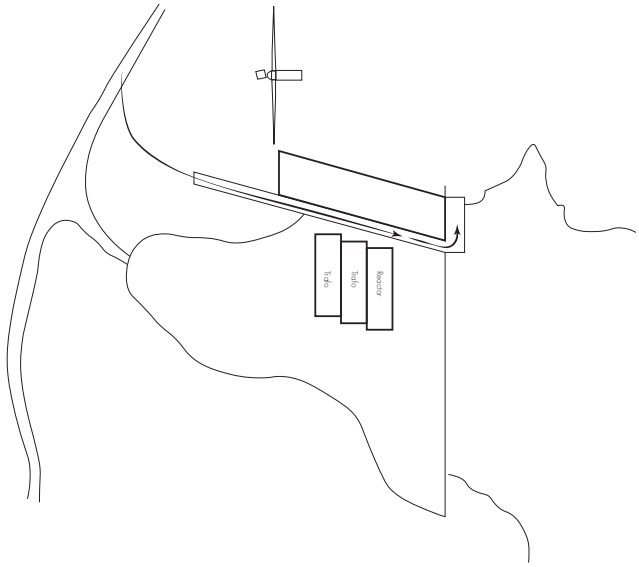
Flow investigation. The visitor is guided through the building volumes and control room out to the water.

92.



Flow investigation.
The staircaise captures the visitors attention and draws them in and up. Giving them an outlook from the top of the building.

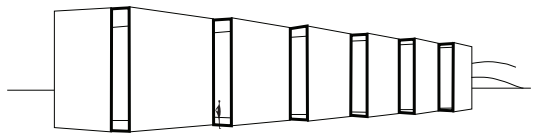
93.

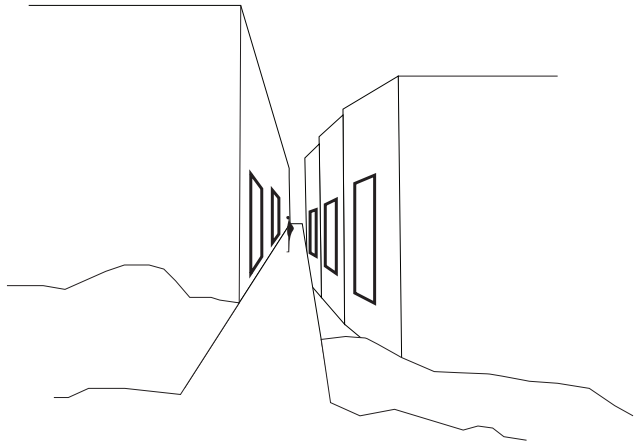


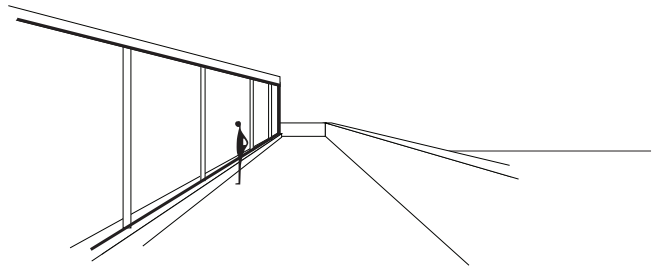
Flow investigation.
The walkway is an extention of the hiking route, drawing the visitor naturally in towards the building on the 1st floor level.

94.

Creating an inviting building also means to not only have an open expression towards the visitor, but also naturally lead them through the site.
Working with the aspect of conveying the processes the building holds, the flow and accessibility throughout the design and its different components are important. We came to the conclusion to place the transformer buildings one after the other in an intuitive system. Based on that we started investigating how visitors would move in relation to conveying the processes inside the building volumes. Starting on the floor level and guiding the visitor along and through the building, we wanted to add an extra layer of experience for them. Leading the visitor on top of the building through a staircase or footbridge to introduce the ultimate viewpoint.
To add to that experience we concluded that the viewpoint does not need to be as high, thus creating a more intuitive flow through the site and the different levels.

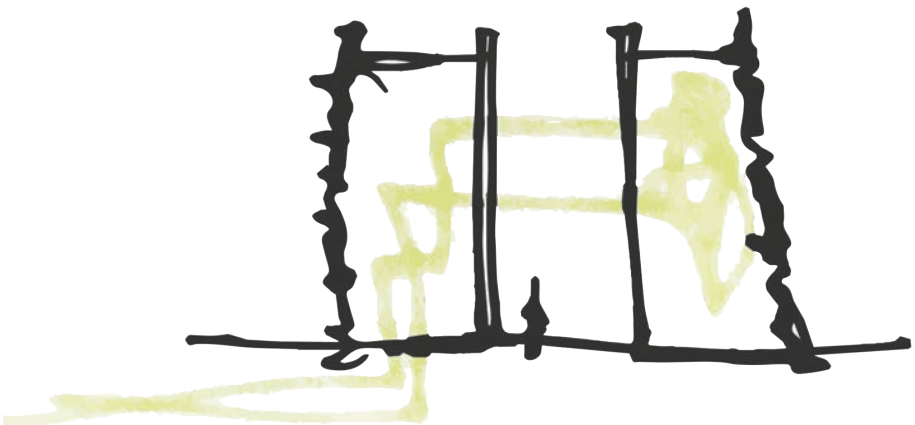






97.

Making the processes of the different components of the building visible and understandable, thereby creating interest and transparency in the green energy development is the leading parametre of the design.
To maintain the interest of the visitor, investigations were made of creating selected and small views inside the buildings, leading them through the design by talking to their curiosity.
Views from the floor level and from the top of the staircase and down to the transformer were investigated. Although the visitor gained insight on the processes the views did not give them an overview and intuitive understanding of the substation. This led us to investigate placing the pipework outside and create bigger and more qualitative views, so the visitor understands the different processes and their connection to each other.

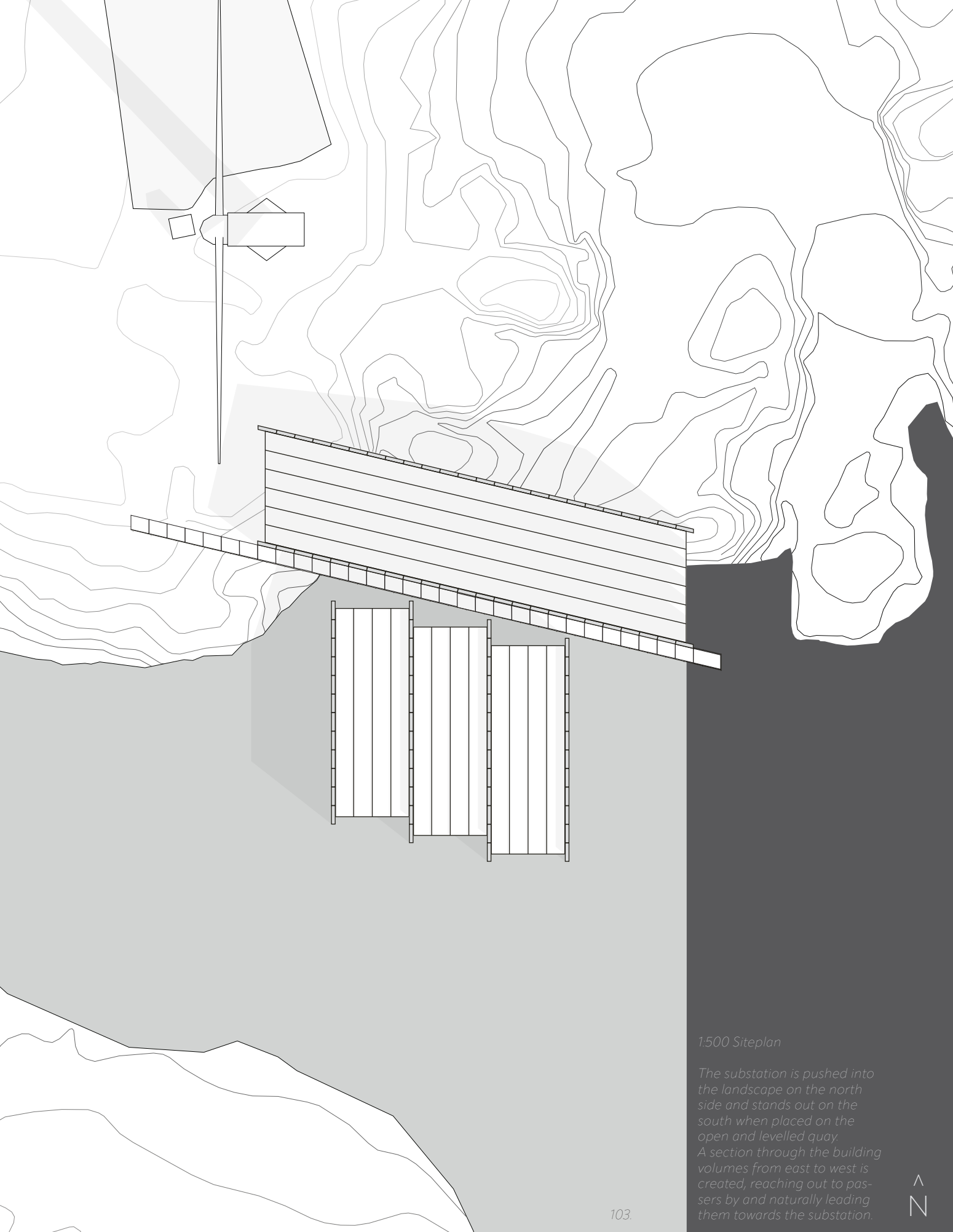


102. concept

A substation is located on the east coast of Utsira, but it is not like most substations. Behind rocks and undulating terrain the substation is placed as a vertical fell in the landscape. It is built from pure stone elements from a Norwegian quarry, interpreting the local building traditions and leaving a modest environmental impact.

A walkway extends from the landscape to the sea, in between the heavy, safety walls of the substation. Along the walkway between pipes and technical components, the architecture exhibits and communicates the production of renewable energy, by exposing its interior. At the end of the walkway when exiting the electrical system on display, the forces of nature are in focus.

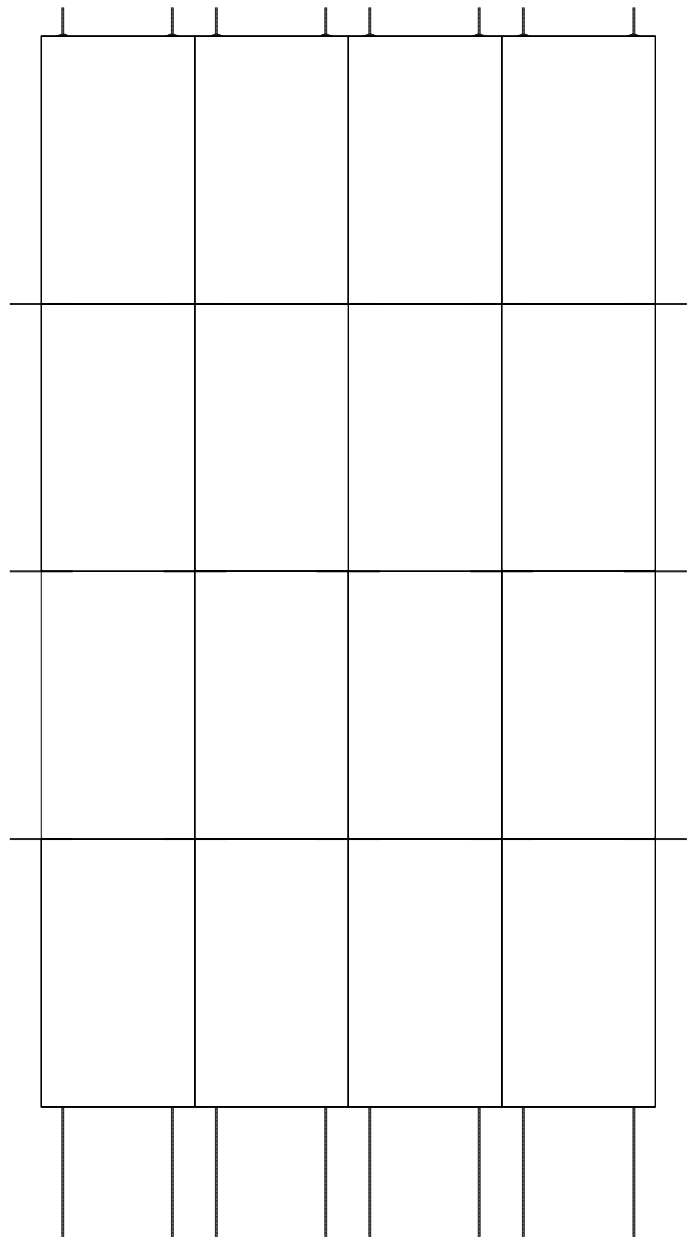
Hikers are invited to take a break in the extension of the control room, the heart of the substation. The substation is an attraction displaying the production of renewable energy and an invitation for a subtle break from the forces of nature. A table and a bench for people to enjoy their lunch, a sink to fill their bottle with water and a toilet. Nothing more and then back on the hike through the unique landscape of Utsira. Not only humans but likewise nature is part of the building's use. Therefore a wall dedicated to the many birds passing through or living on the island is created on the northern side. Giving them a place to rest, build nests or stop on their way. Creating a connection and coexistence between nature, technology and humans.

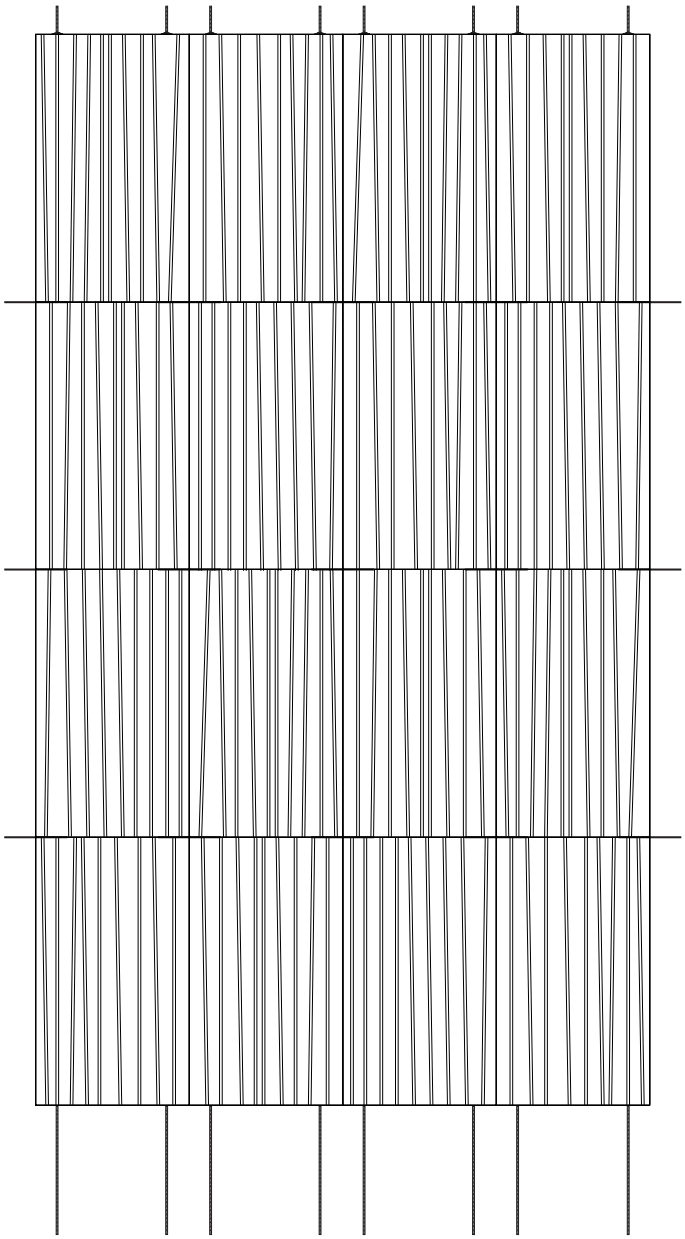


1:500 Siteplan

The substation is pushed into the landscape on the north side and stands out on the south when placed on the open and levelled quay.
A section through the building volumes from east to west is created, reaching out to passers by and naturally leading them towards the substation.

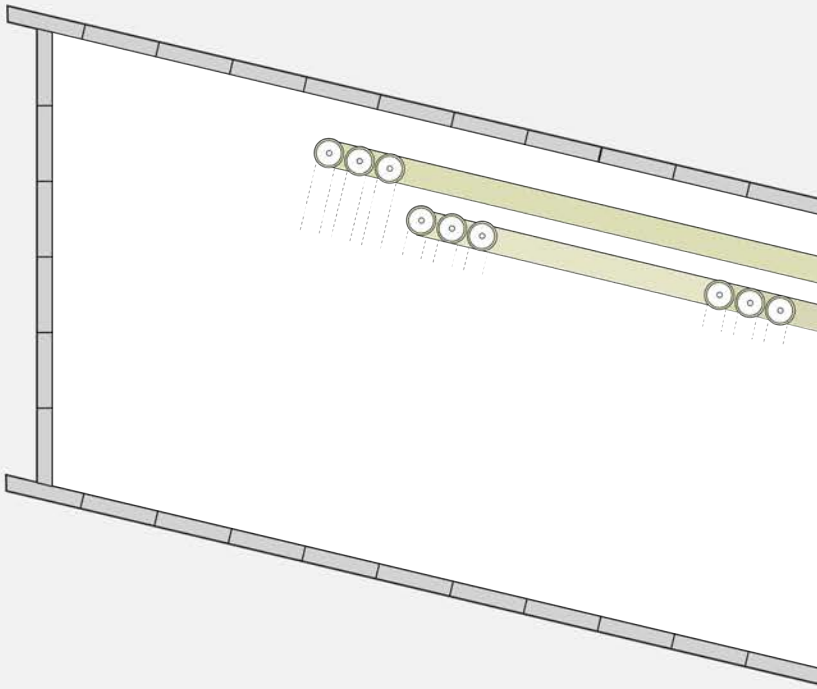
104. *Constructed in a system of vertical walls, the substation stands strong while also connecting itself to nature through materiality and placement. As if it would grow out of the rocky landscape itself.*

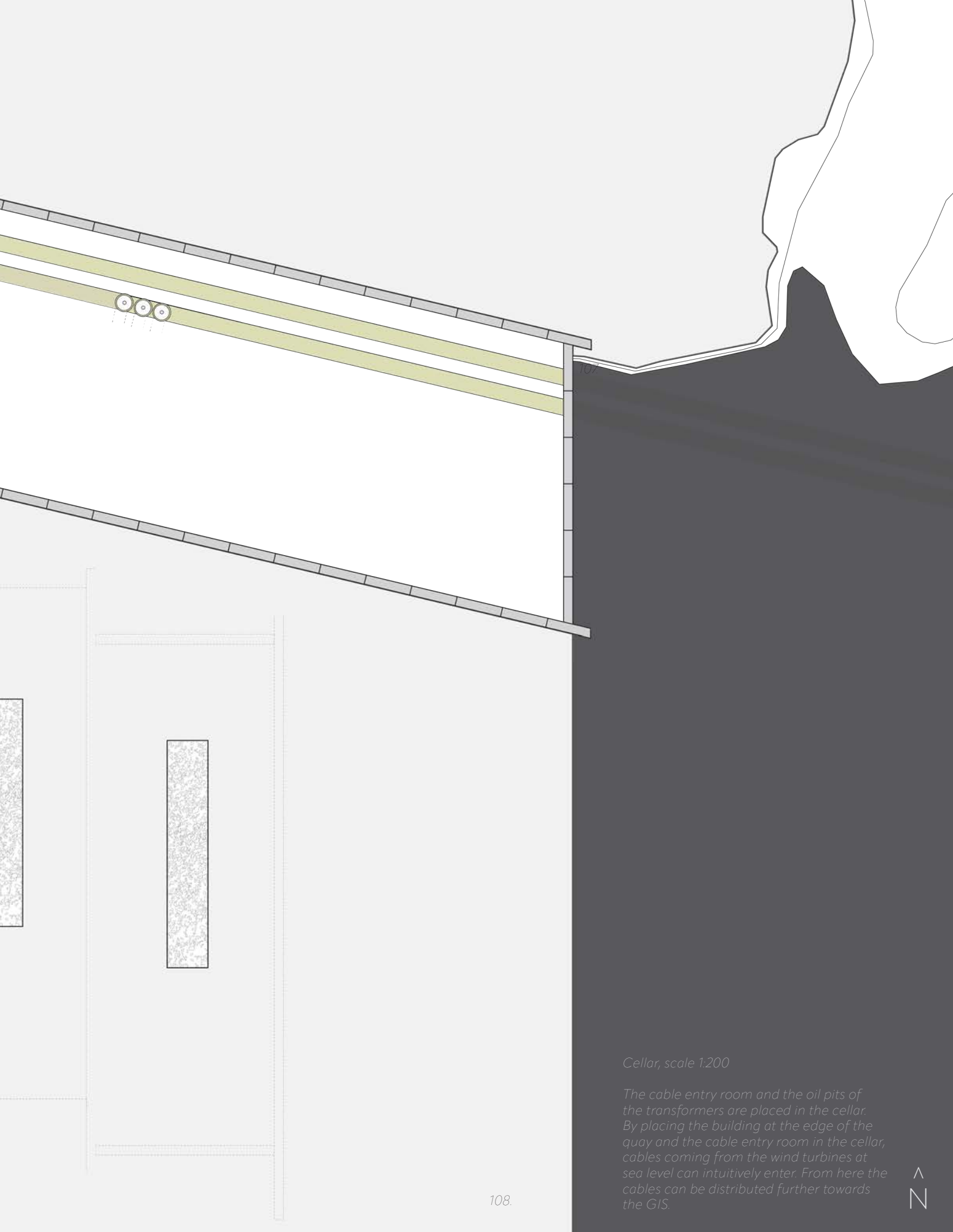




105.

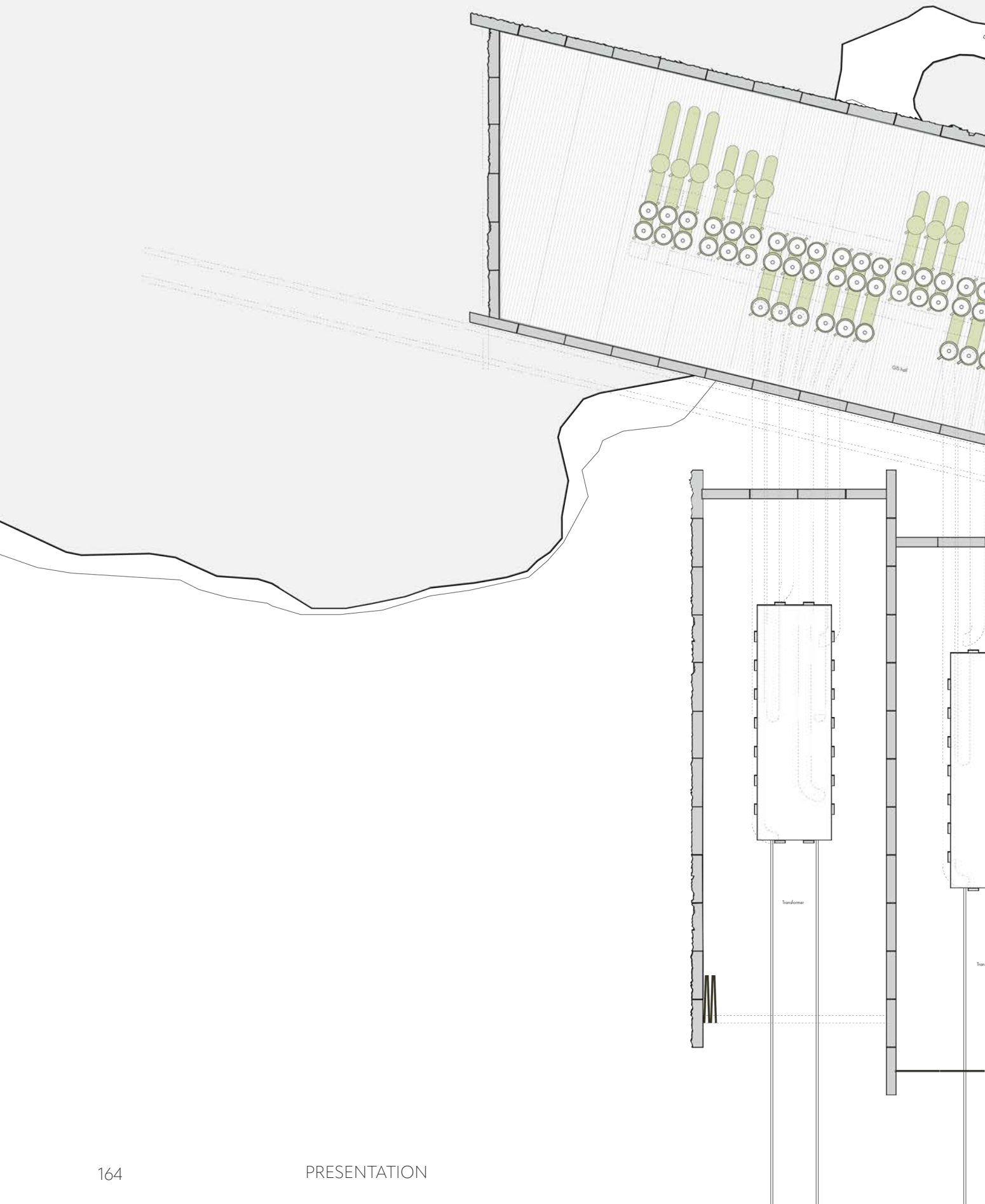
The substation works with two different types of tactility in its stone facade. The smooth and hammered one steps into the background, inside the passage through the buildings. Directing the visitors attention towards the renewable energy narrative. In contrast the raw tactile facades face to the outwards, emphasising Utsiras landscape and nature's forces.

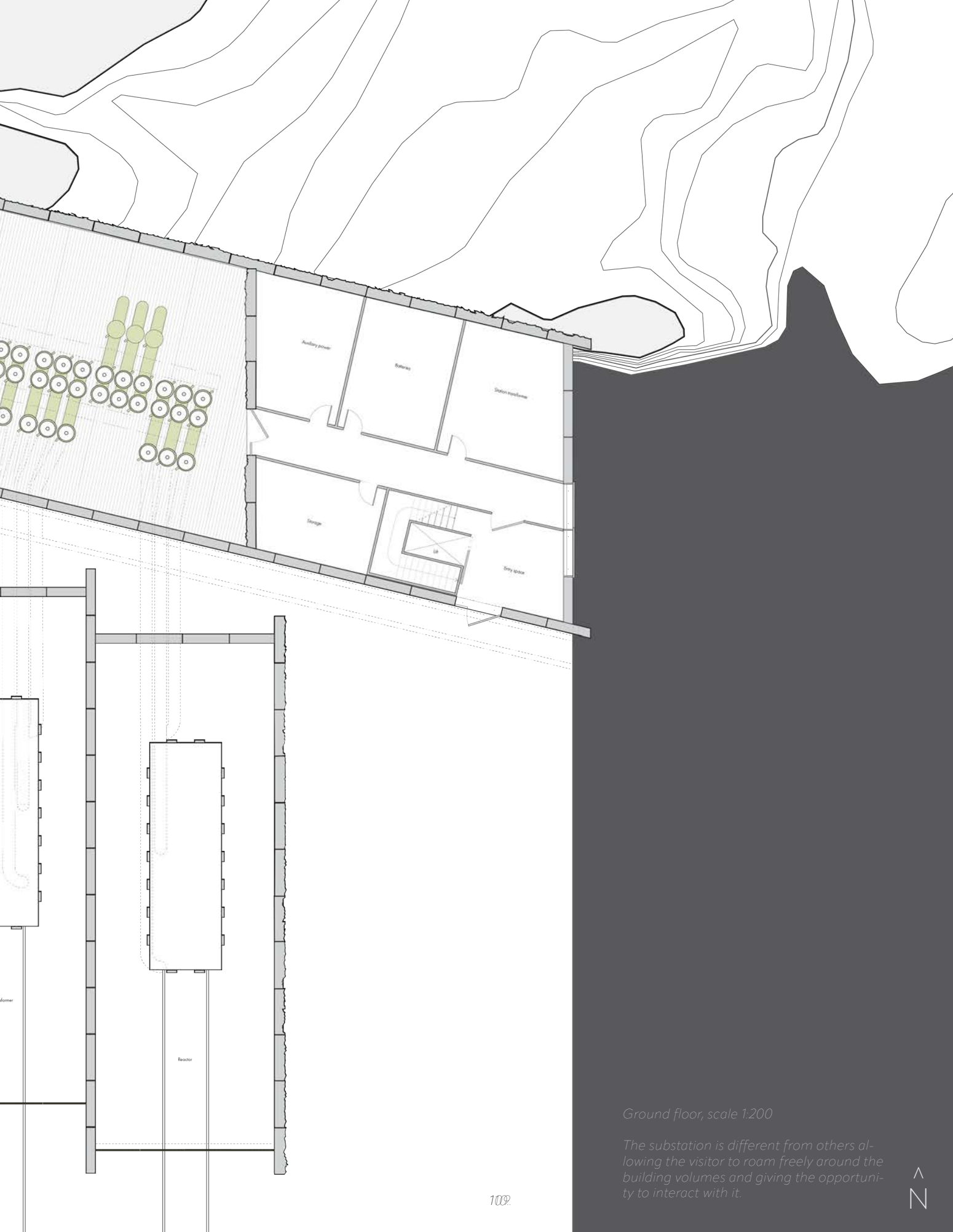




Cellar, scale 1:200

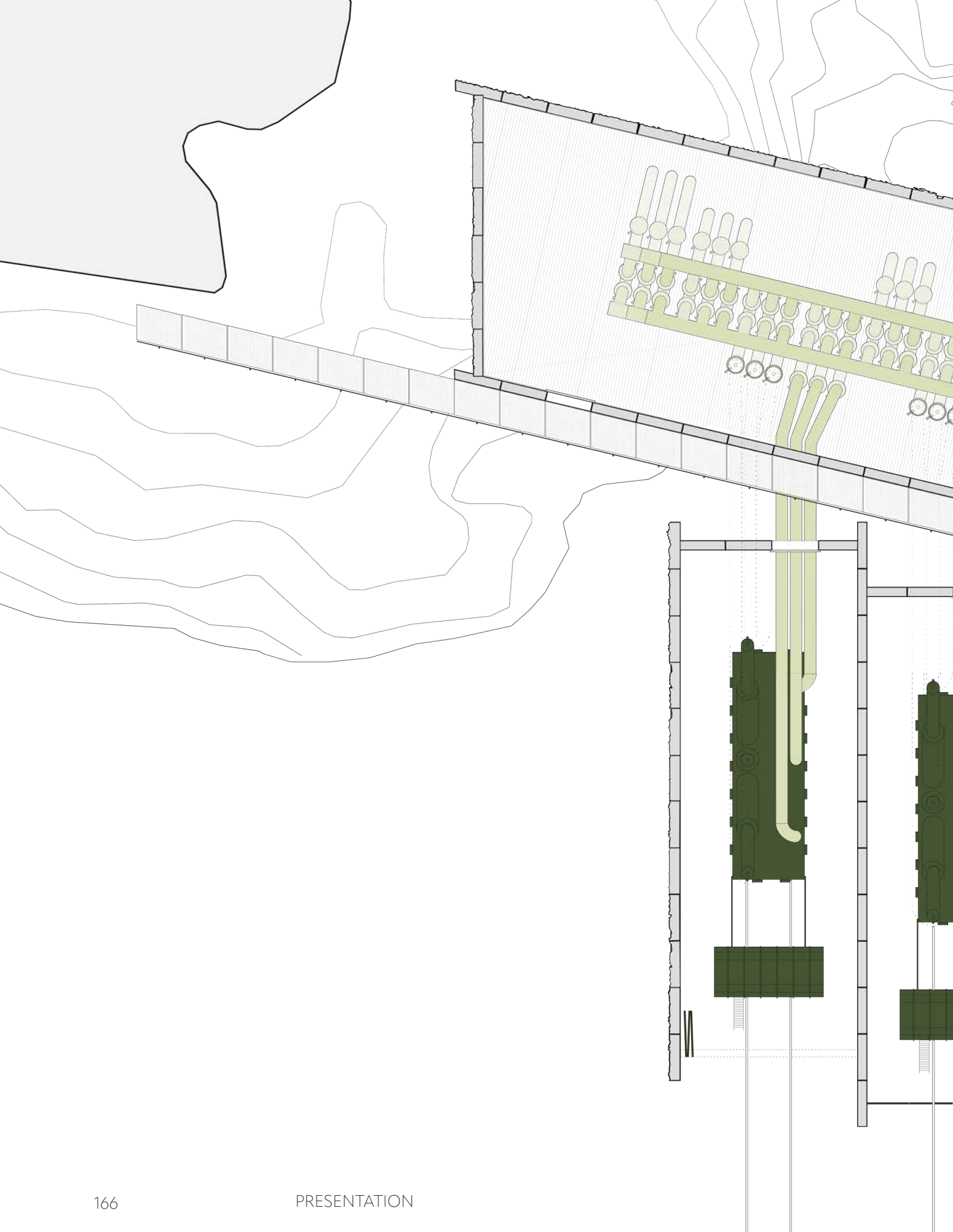
The cable entry room and the oil pits of the transformers are placed in the cellar. By placing the building at the edge of the quay and the cable entry room in the cellar, cables coming from the wind turbines at sea level can intuitively enter. From here the cables can be distributed further towards the GIS.

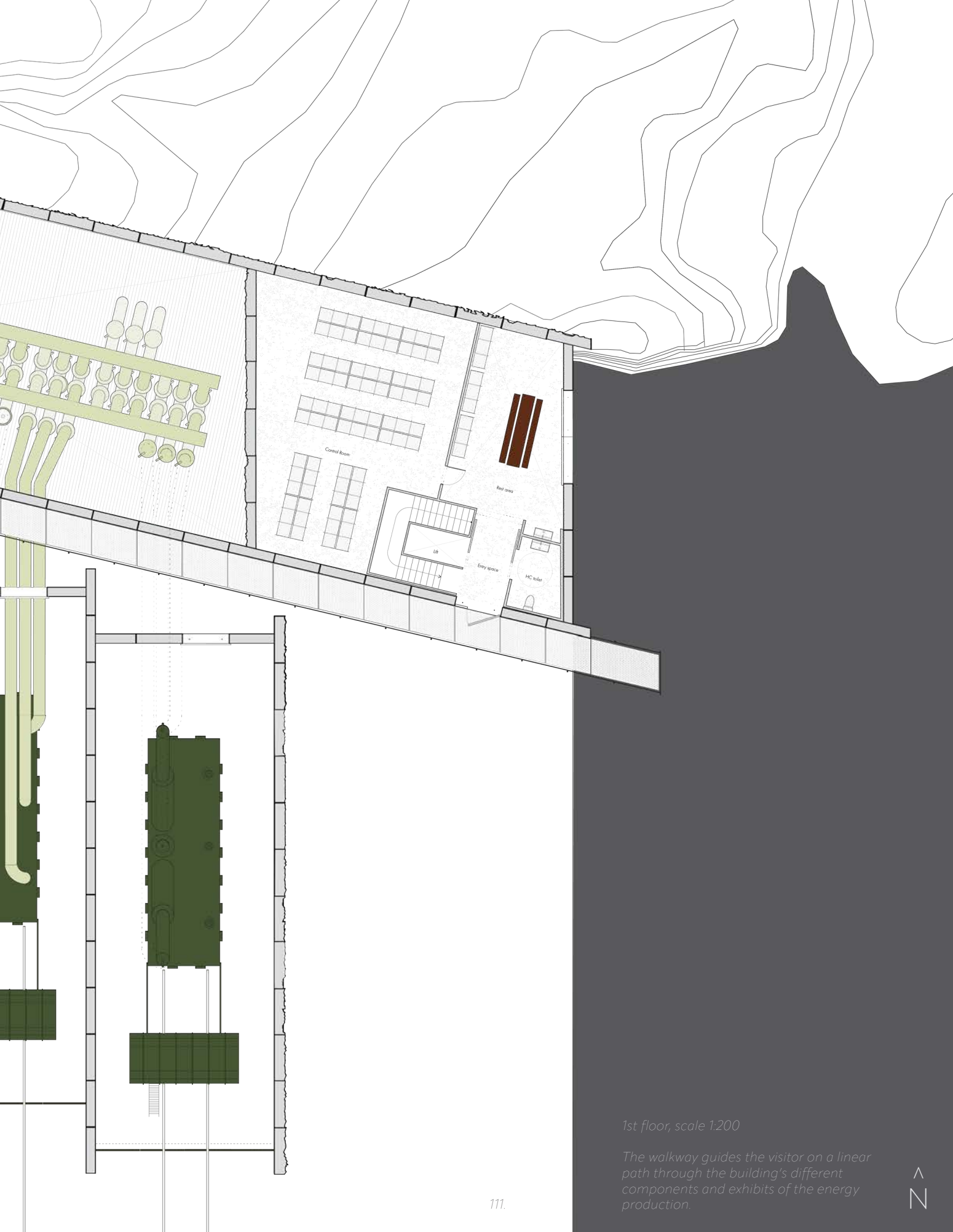

Transformer



Ground floor, scale 1:200

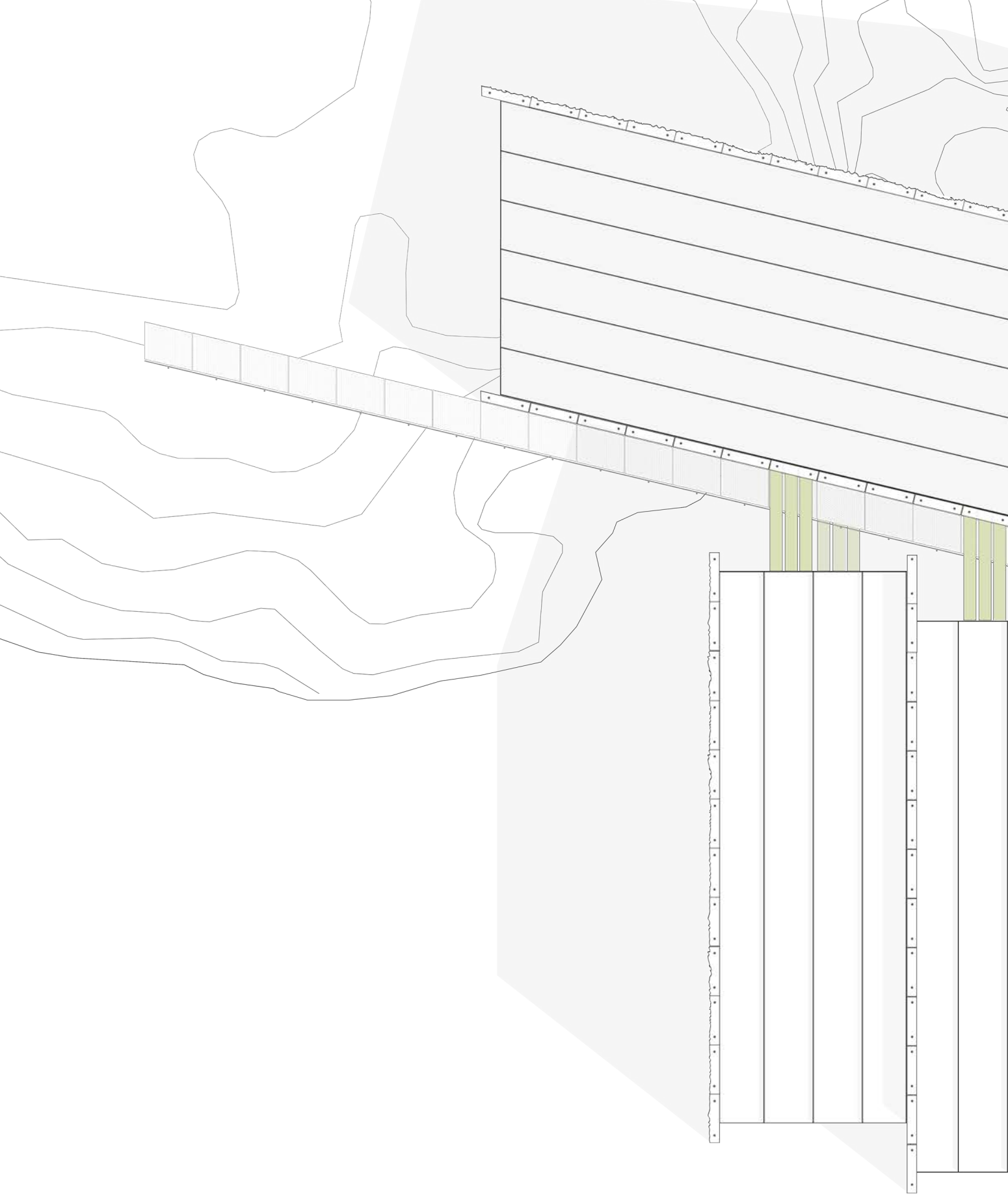
The substation is different from others allowing the visitor to roam freely around the building volumes and giving the opportunity to interact with it.

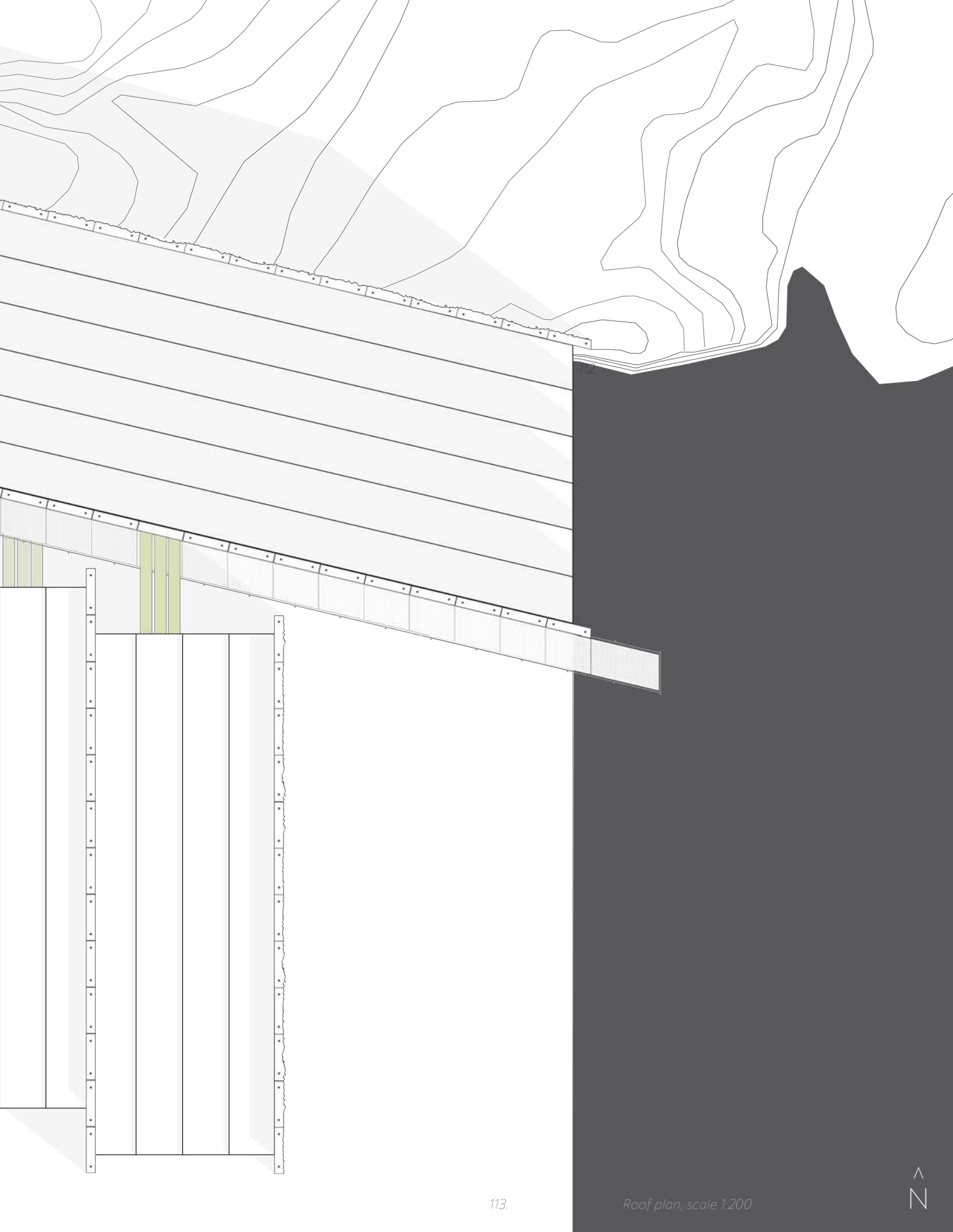




1st floor, scale 1:200

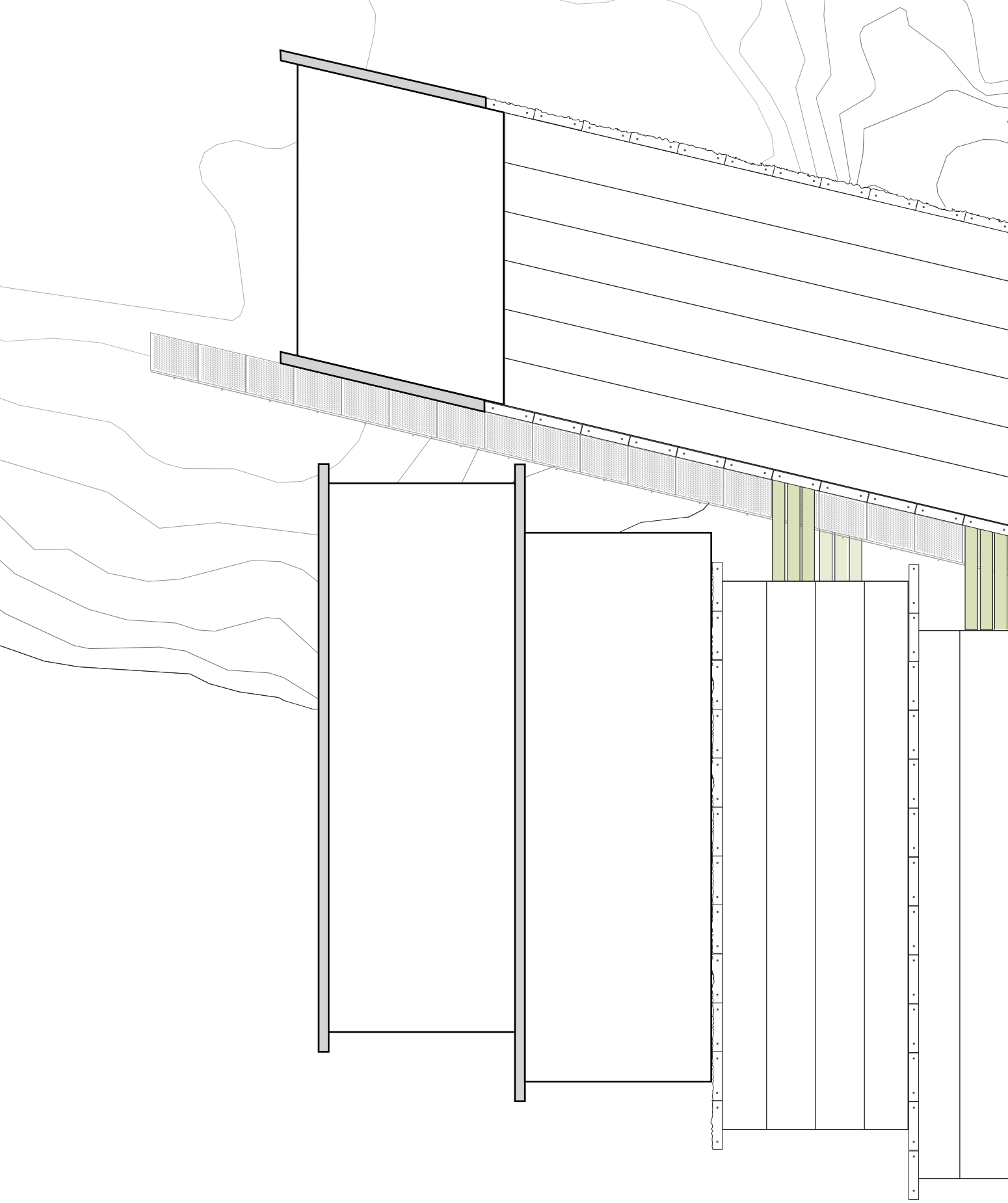
The walkway guides the visitor on a linear path through the building's different components and exhibits of the energy production.

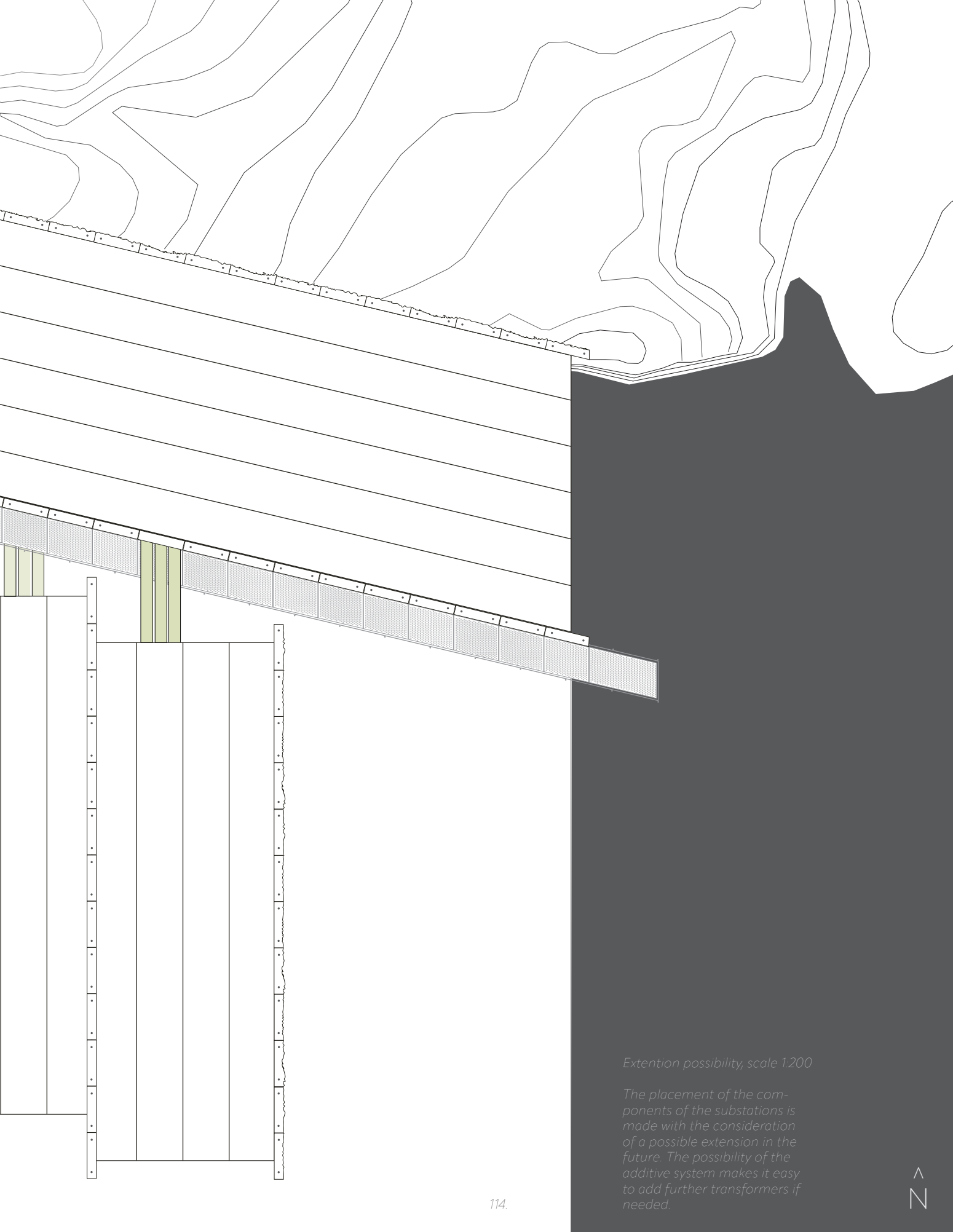




Roof plan, scale 1:200

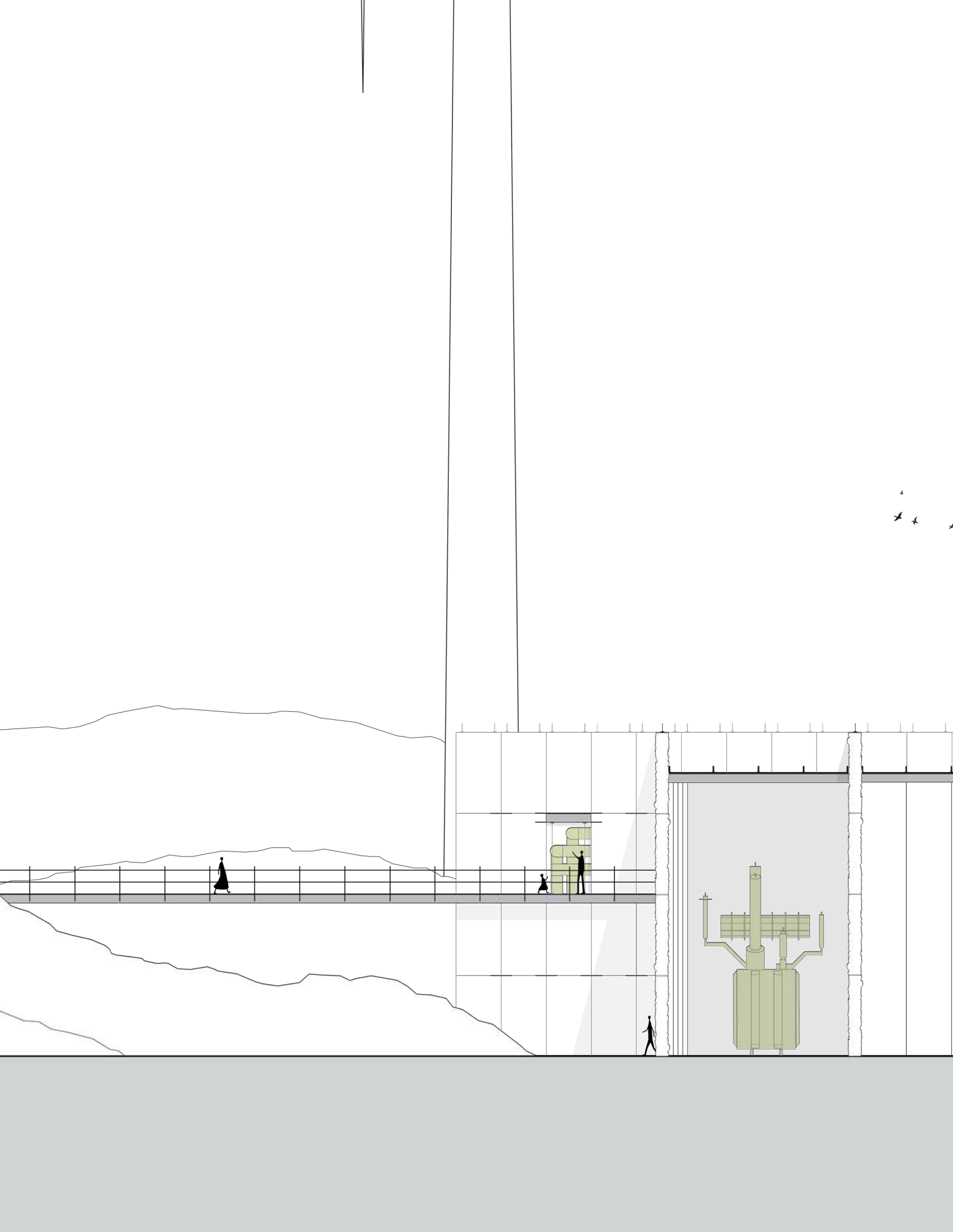
N

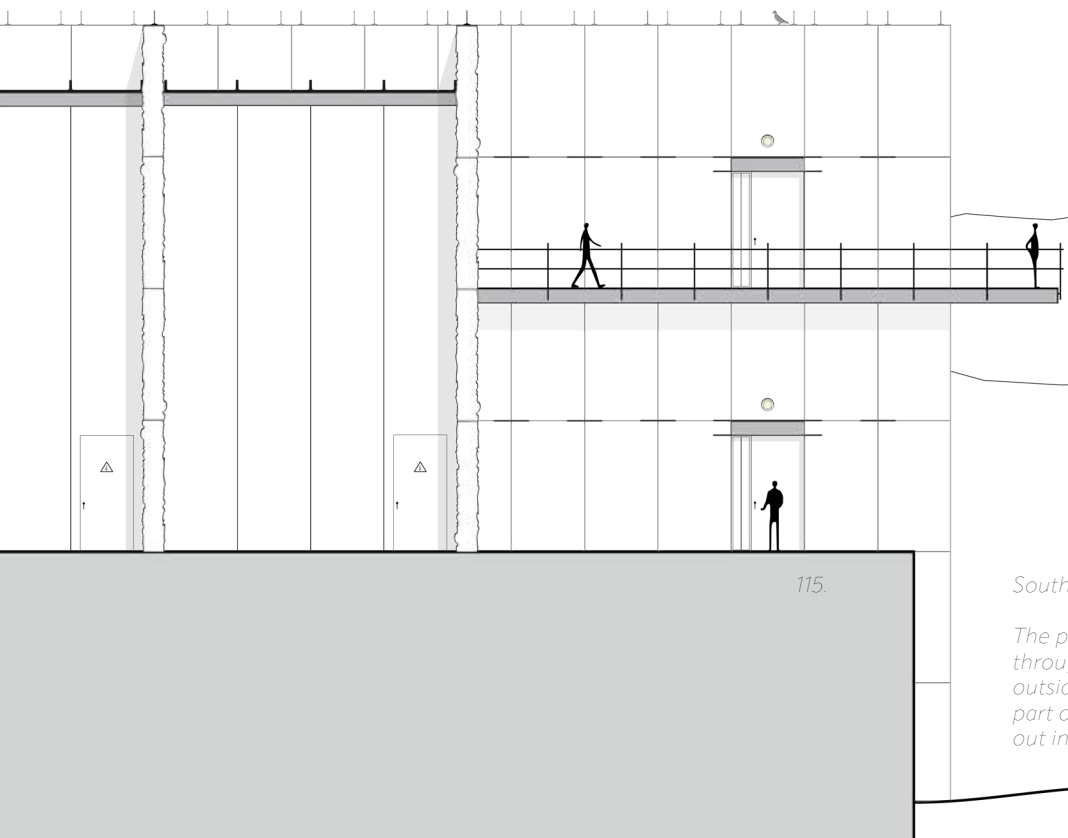




Extention possibility, scale 1:200

The placement of the components of the substations is made with the consideration of a possible extension in the future. The possibility of the additive system makes it easy to add further transformers if needed.





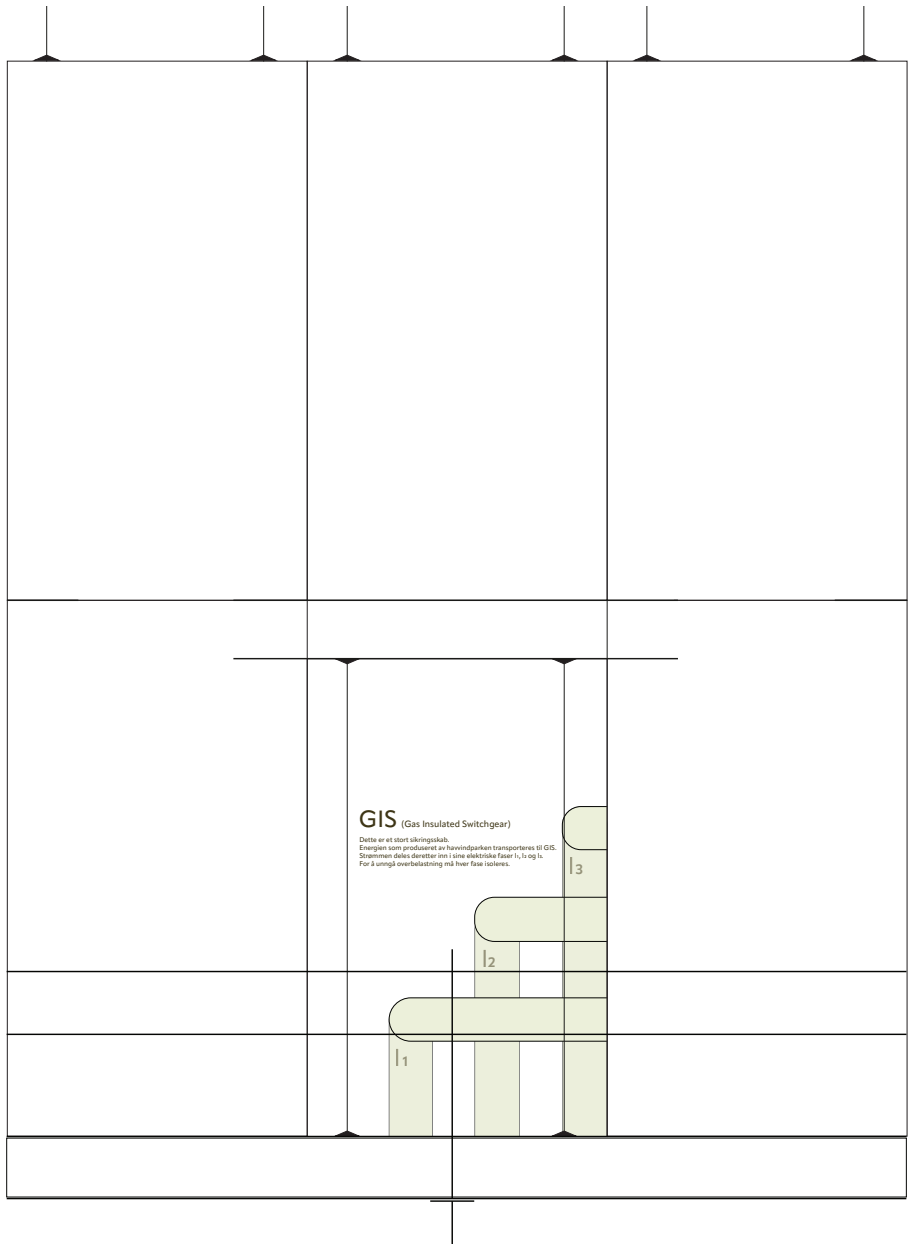
115.

South facade, scale 1:200

The passage leads the visitor through different phases from outside the system, to being part of the system and stepping out into nature's forces again.

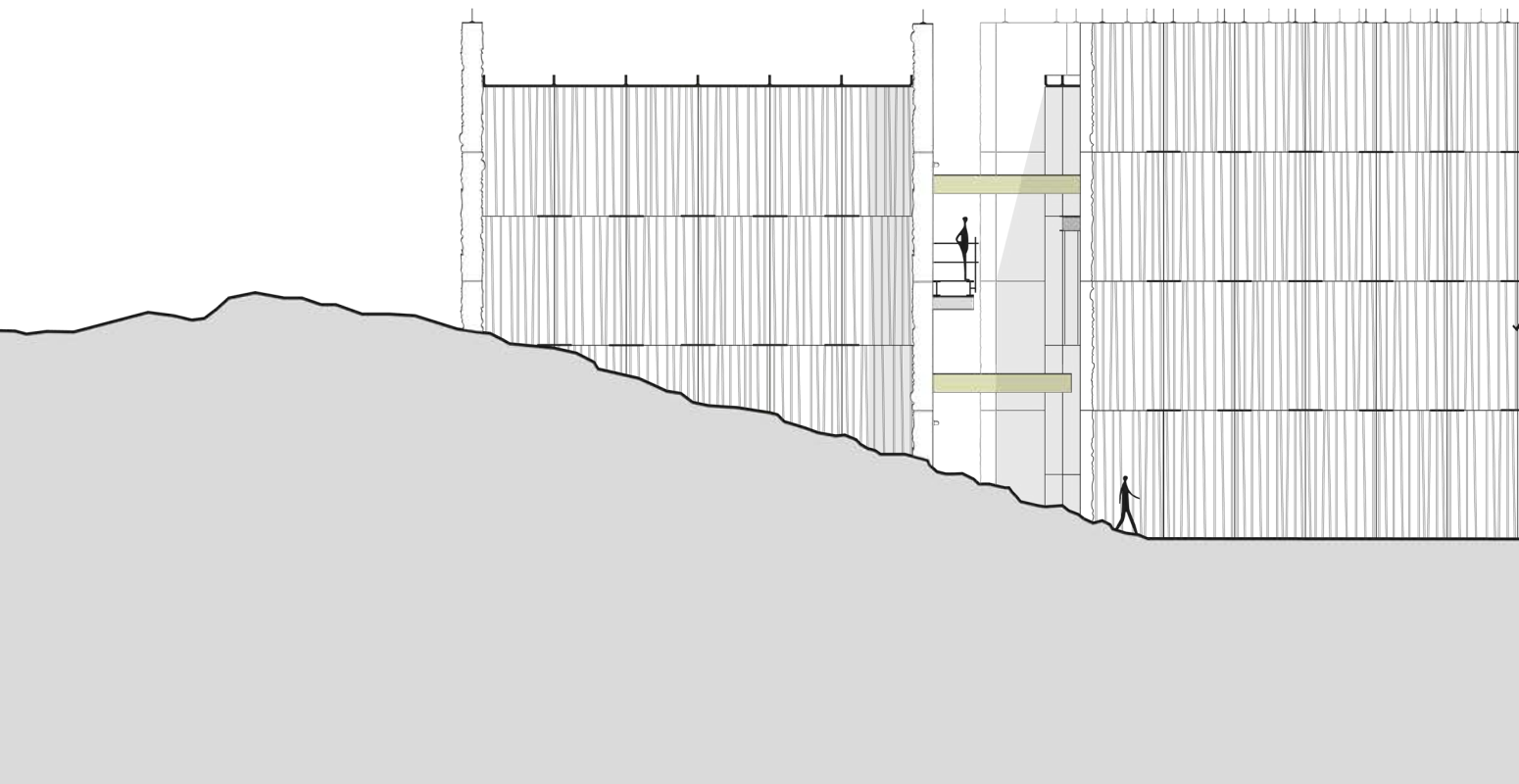
116.

The architecture guides the users attention through tactile differences in materials, colour coding, windows and flow towards the exhibited renewable energy production, communicating its purpose and processes.



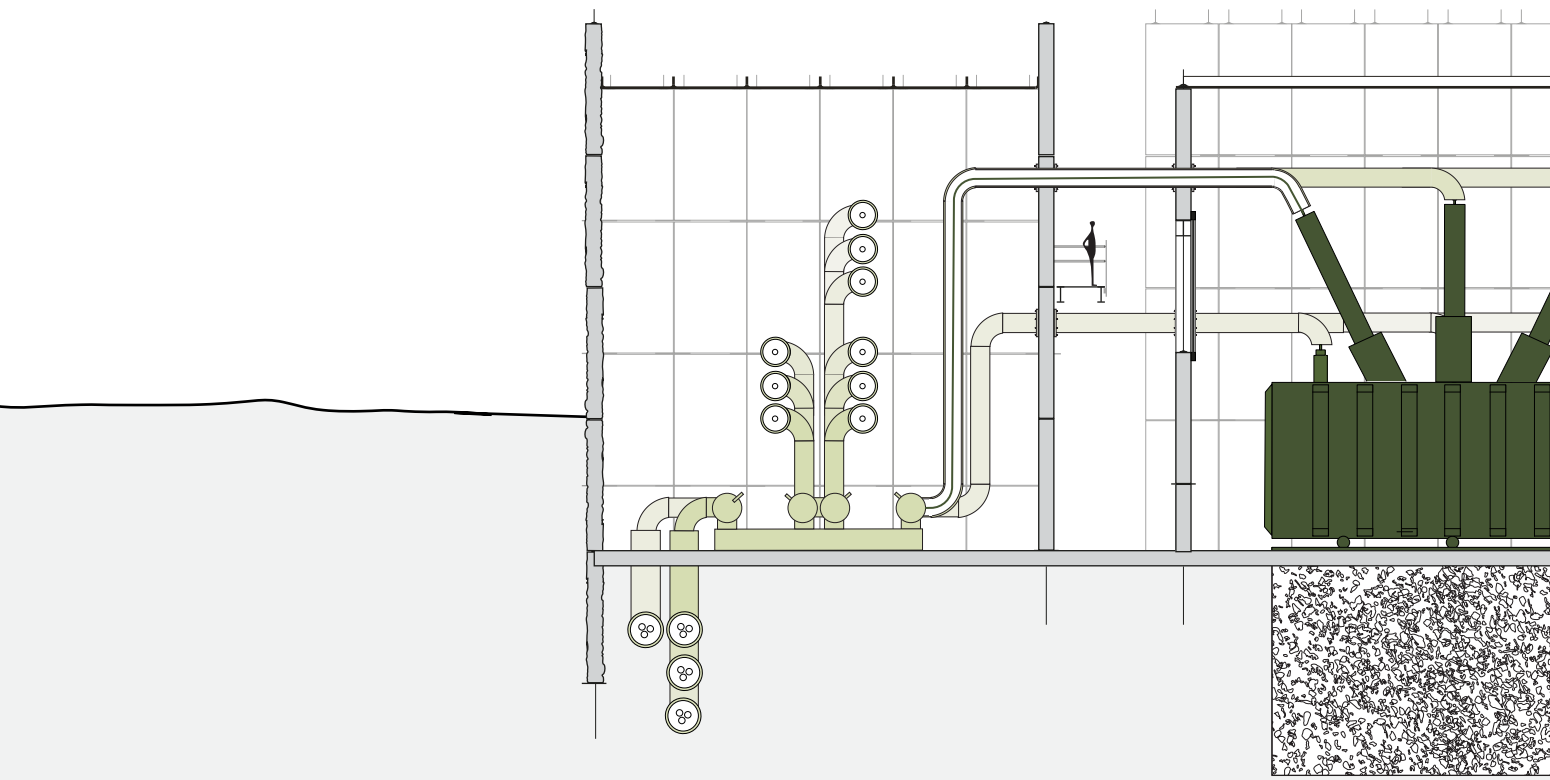
117.

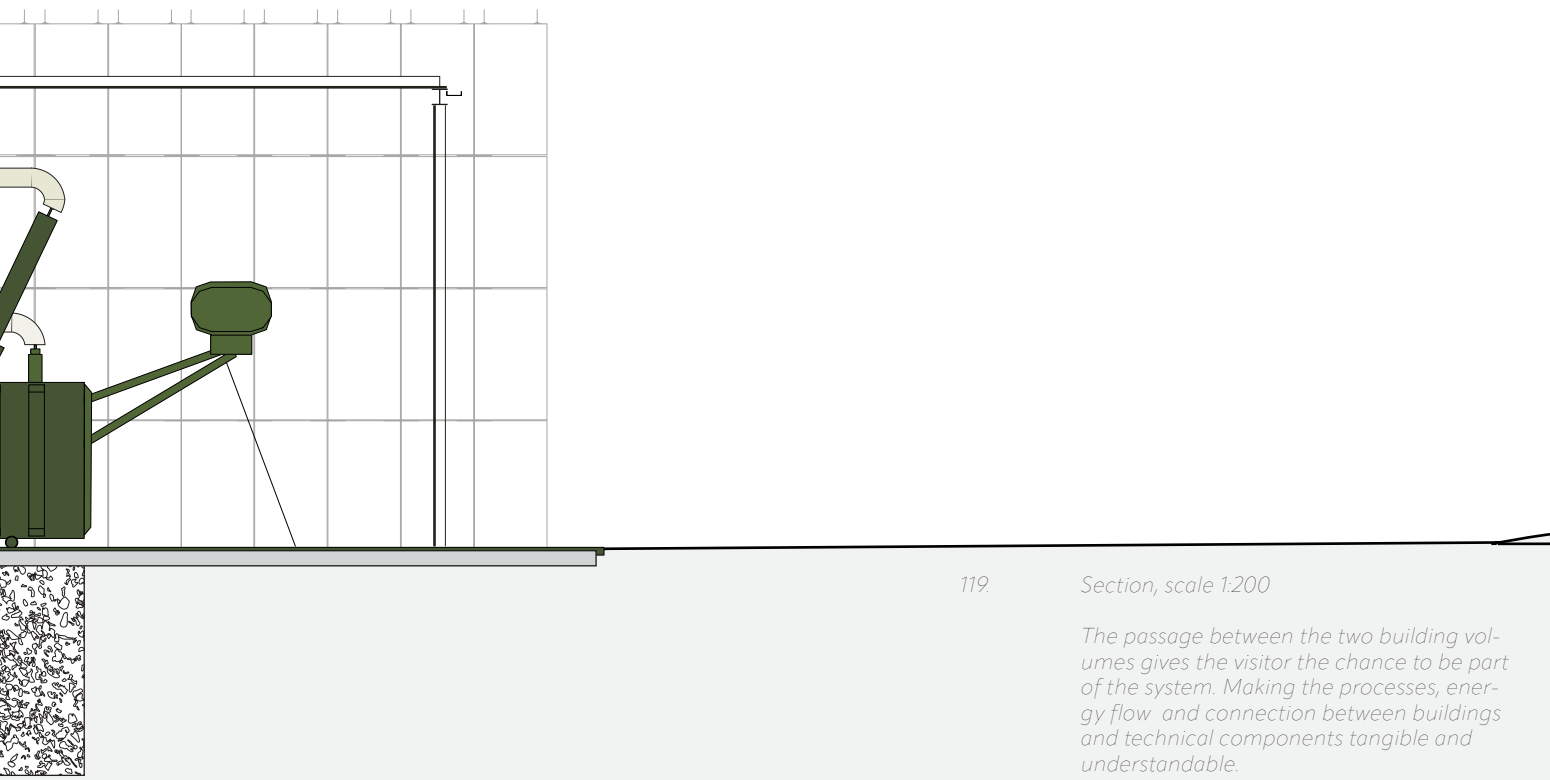
The substation works with two different forms for tactility in the stone facade. The smooth and hammered facade steps into the background directing the visitors attention towards the renewable energy narrative of the building. In contrast the raw tactile facade facing outwards emphasises Utsiras nature and its forces.



118. *West facade, scale 1:200*

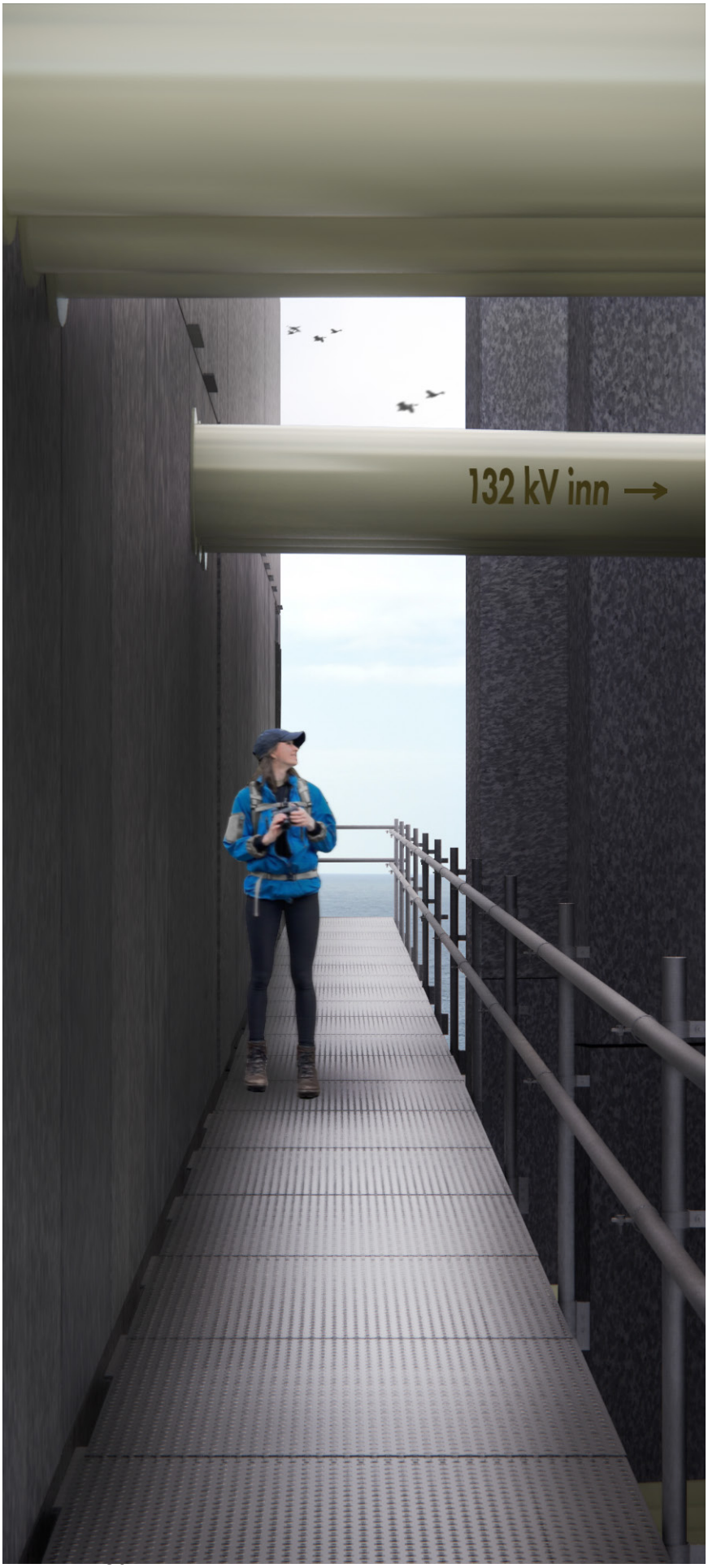
The visitor meets the massive building that opens up in the middle, giving them a hint of what lies within.



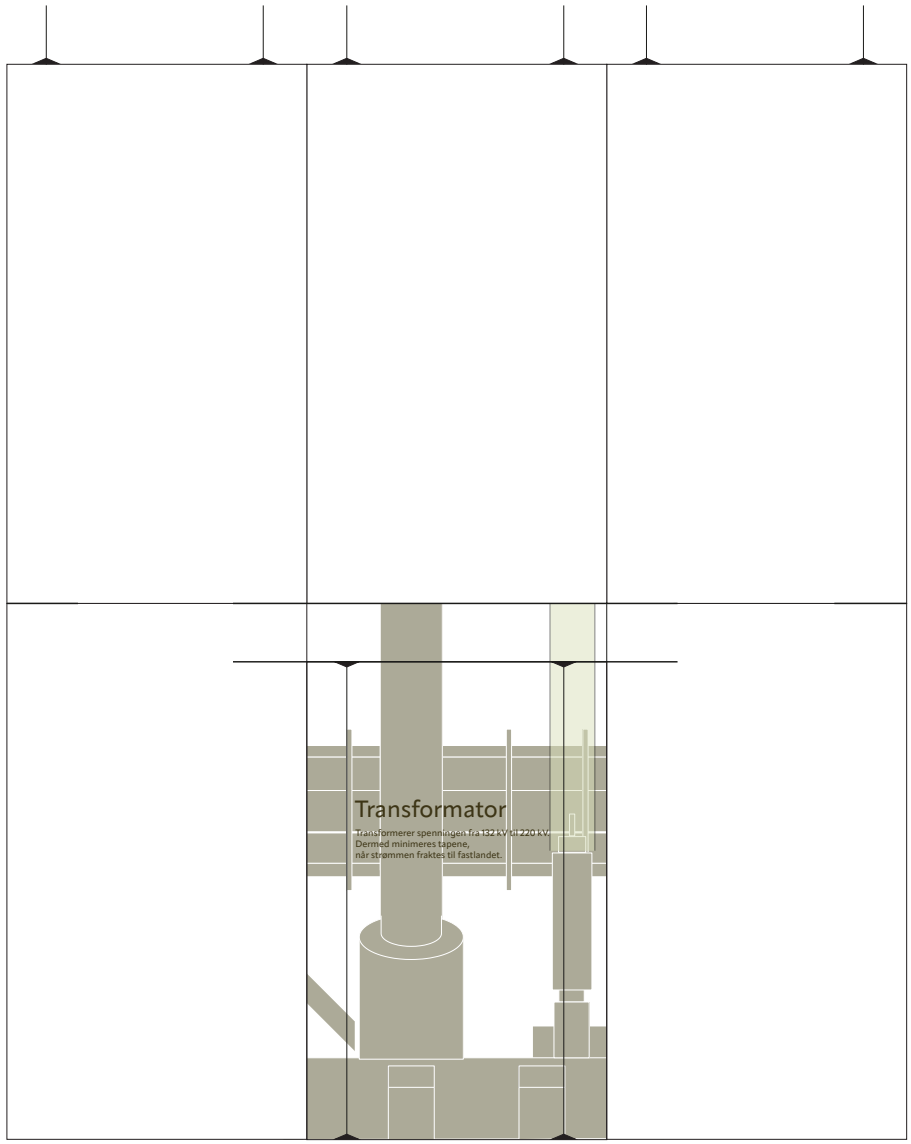


119. Section, scale 1:200

The passage between the two building volumes gives the visitor the chance to be part of the system. Making the processes, energy flow and connection between buildings and technical components tangible and understandable.

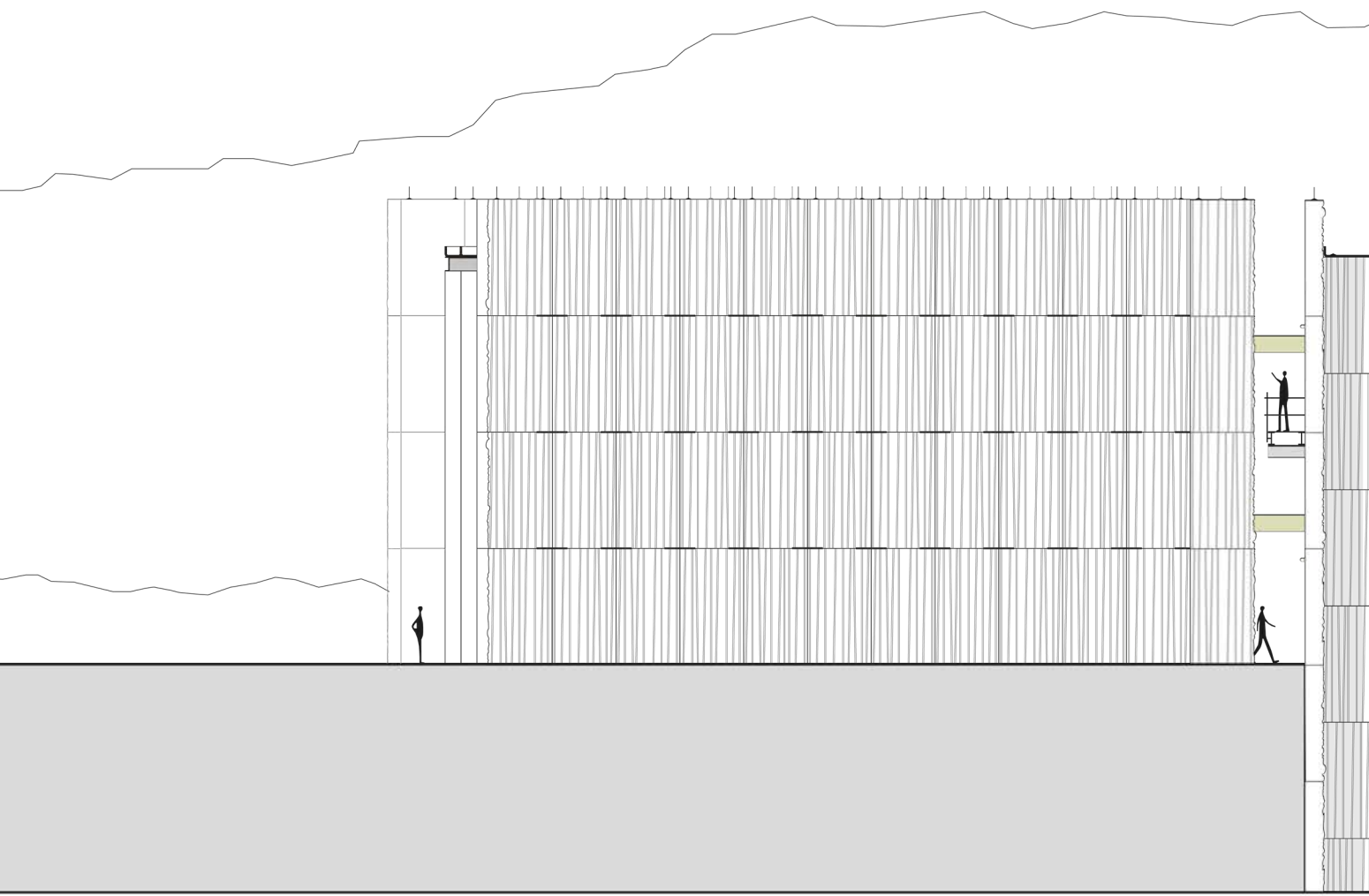


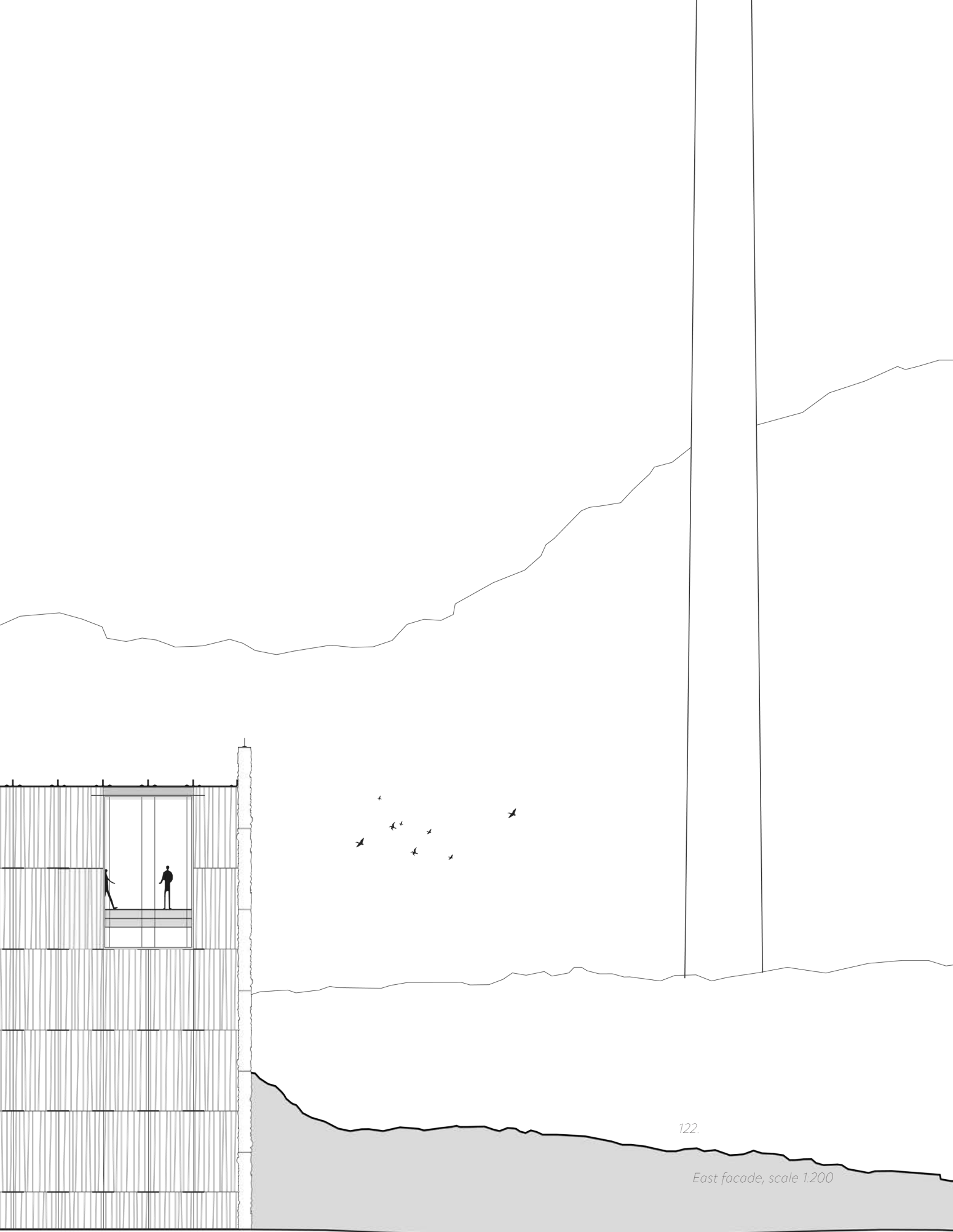
Entering the passage the technical components and exposed interior become exhibited in the flow of walking further towards the end. The visitor becomes part of the system while moving through it. Interconnecting human and technology.



121.

The windows placed to give insight towards the technical equipment help the visitor understand its function through informative texts.
It breaks the rhythm of the stone wall and replaces a stone element. The above stone elements are lifted through the column that rests on top of the window. The steel wires running through the stone elements are accentuated in the windows and make the construction tangible.

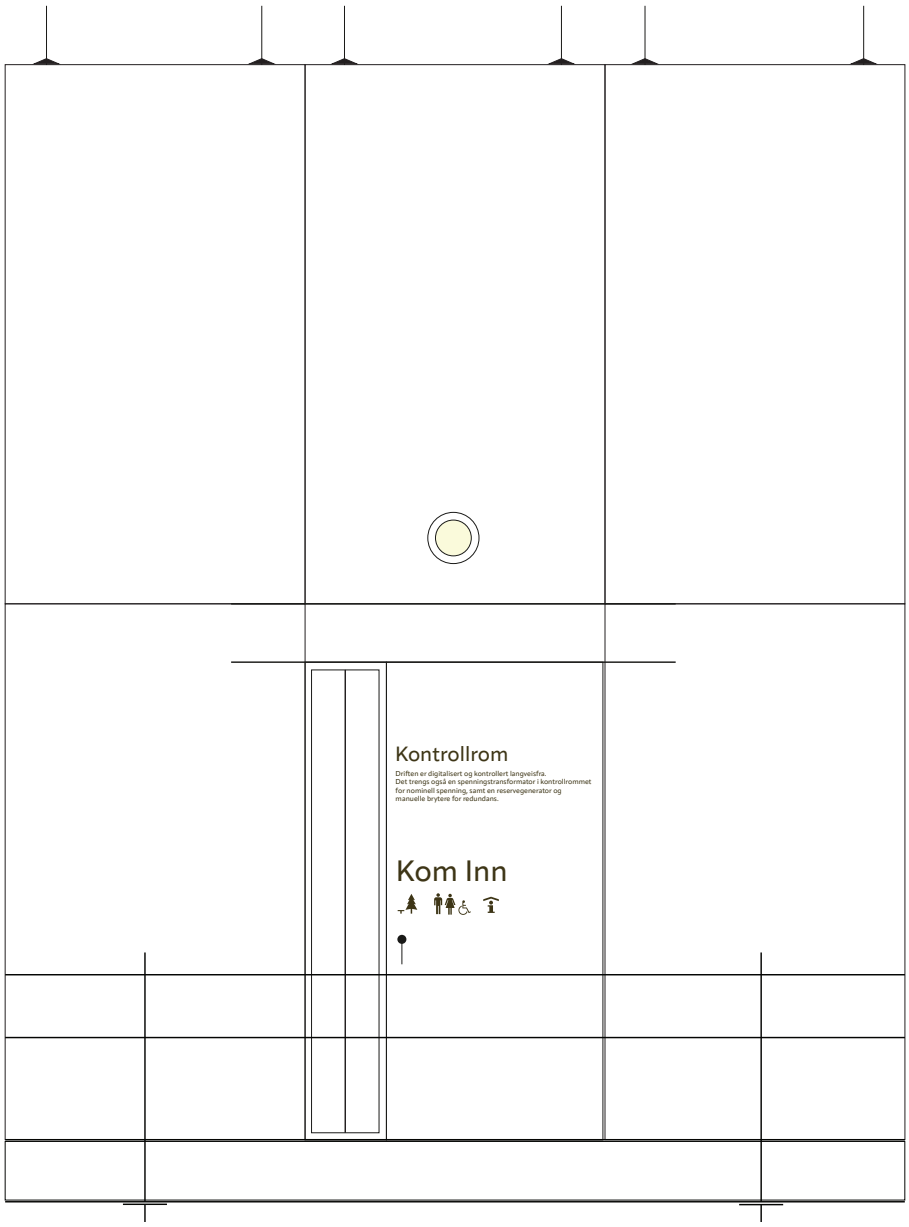




East facade, scale 1:200

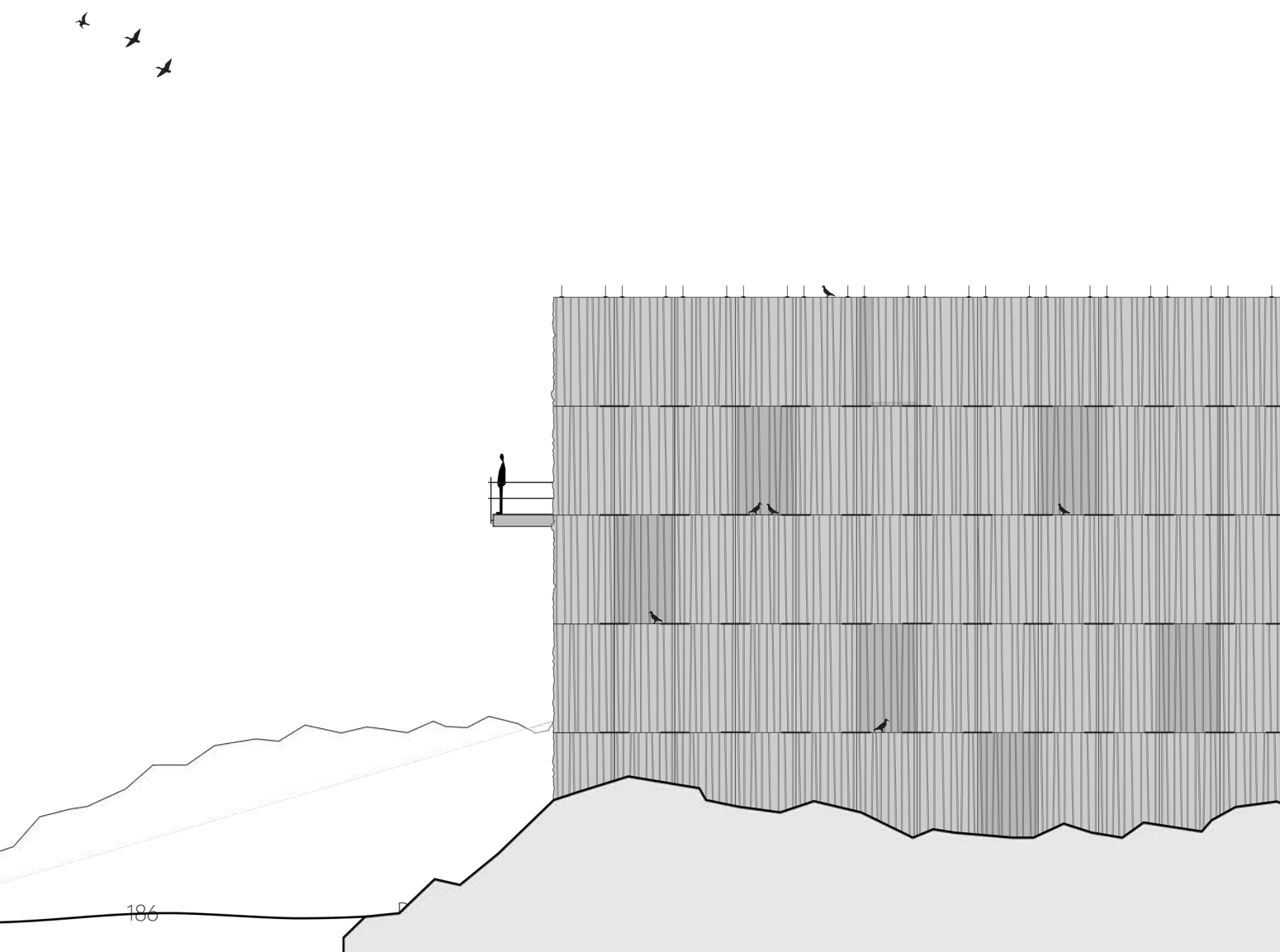
123.

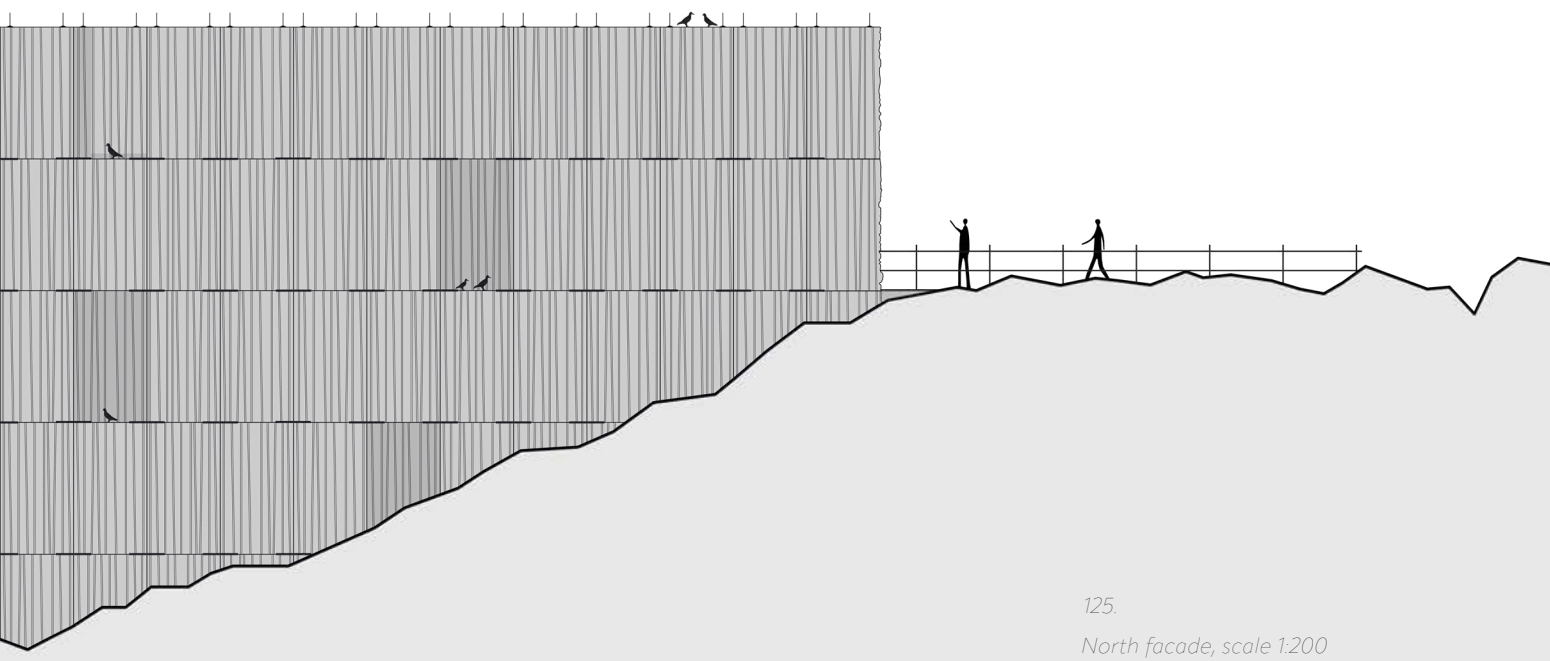
Exiting the system the visitor is able to step outside the building's sheltered passage and reconnects with nature. Totally exposed to all of nature's forces the visitor is met with an exhilarating experience.



124.

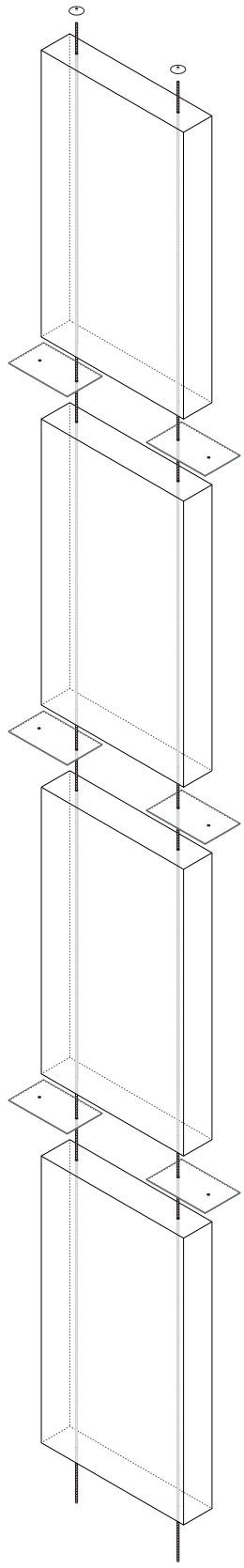
In order to avoid the visitors' doubt of the possibility of entering the building, the accessibility and functions are emphasised through writing. The door, like the window, breaks the rhythm of the facade structure and accentuates the steel wires of the construction.





125.

North facade, scale 1:200
The north facade is dedicated to Utsiras diversity of birds. Emphasising nature through tactility, materials and creating room for nature to grow and live alongside in connection with technology and humans.



126.

The construction system of the substation focuses on intuitive assembly such as disassembly. By the end of life stage, the individual parts of the building can be disassembled and without much processing be repurposed or reused.
The construction consists of stones stacked on top of each other connected through a steel wire, bolted into the ground and on top. Stability is created by introducing a steel plate that connects to the adjacent steel wire and row of stones.

Social qualities

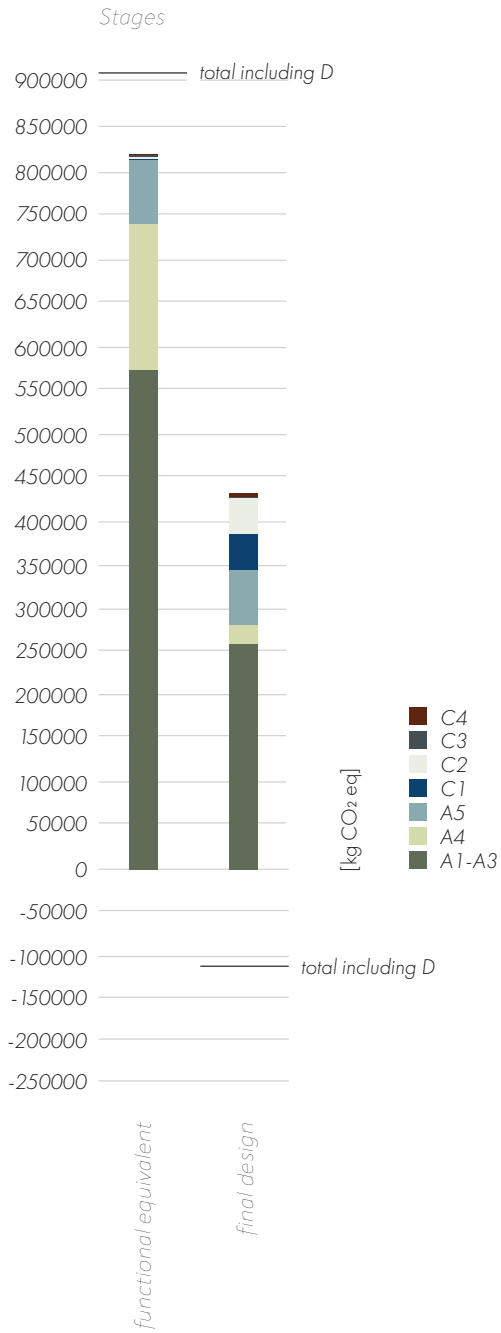
This initial study of the Substation of Utsira shows that it is possible to establish a Substation that achieves a lower GWP than its functional equivalent whilst also establishing social qualities. The final design invites bypassers to partake in the wind adventure, and offer public spaces to the local community to intake as their own. Instead of being an introverted structure surrounded by tall fences, it opens itself up, and allows people insight to its technical core. The outer side is left raw, and becomes a part of the surrounding cultural landscape - allowing for nature, ecosystem and humans to use the building as a part of the landscape.

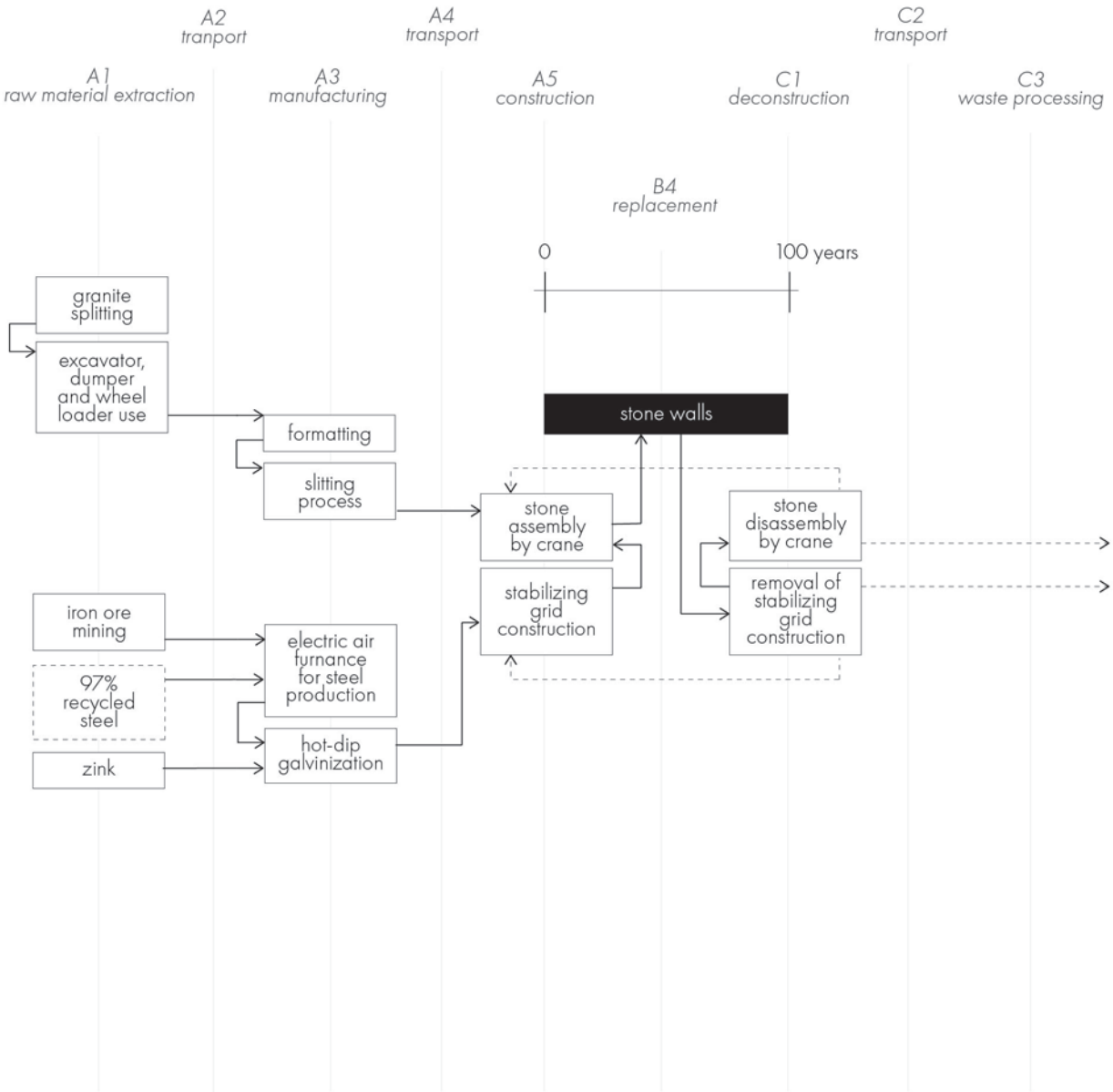
Global Warming potential

The Substation at Utsira has a substantial lower Global Warming Potential than the initial presented functional equivalent. This is because the concrete is substituted by natural stone blocks. Building with natural stone is nothing new, but ensuring stability of the stone blocks in this magnitude will demand further technical detailing. For the final design a wall thickness of 40 cm is presented - double the amount of concrete elements. It should be kept in mind that this is an explorative building approach, and the data origin is not solely based on Environmental Product Declarations (EPD), but also includes studies and composed values to best represent the hypothetical scenario. The details behind the calculations can be studiet in appendix A.

Stone is a material with a near infinite lifespan. It has the possibility of being used and reused numerous times. This is highlighted in the D-stage of the calculation, as the component could enter another system after its lifespan, by being a 'waste' product for this system, and hopefully replace a more conventional, carbon-heavy alternative. In such a case the rock bolts shouldn't be casted in with concrete but be assembled with the possibility of dismantling the elements again.

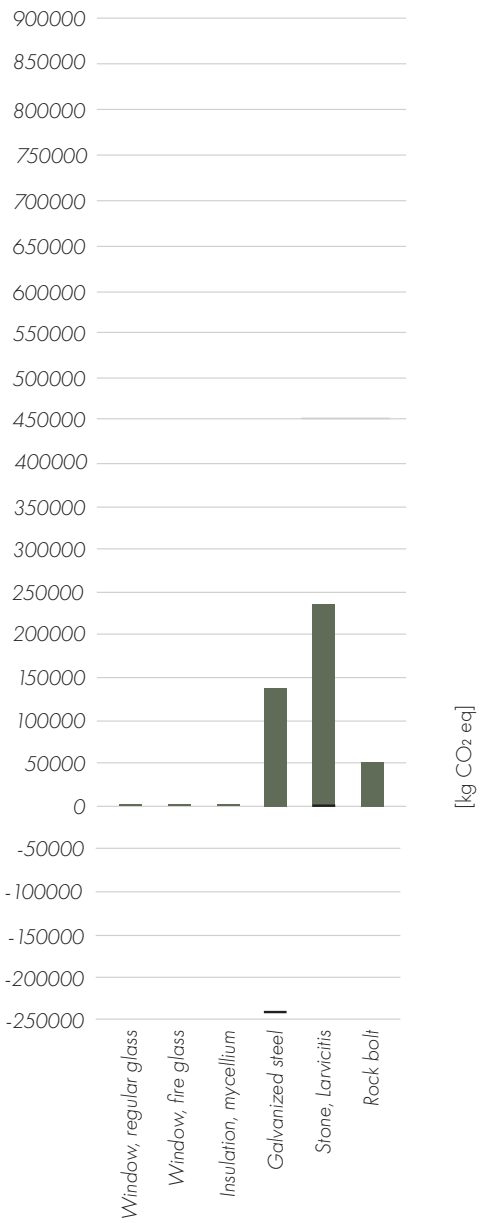
GWP (cradle to gate)	439185 kg CO_2 eq. 2,87 kg CO_2 eq. per m^2 per year
GWP (cradle to cradle)	-109244 kg CO_2 eq. -0,71 kg CO_2 eq. per m^2 per year



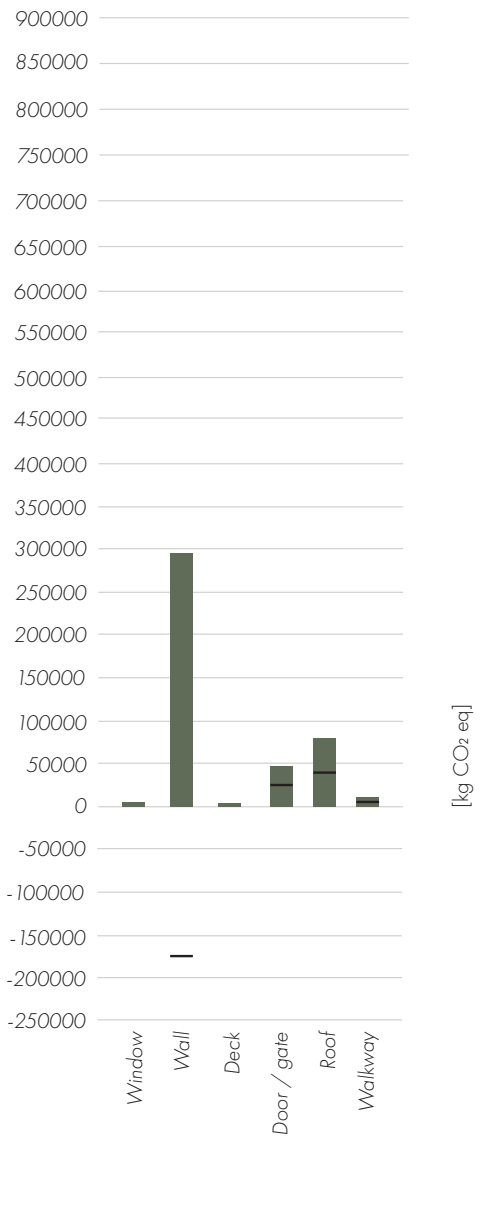


127. Mapping of processes and materials of a stone wall

Materials



Building components



This project may be read as a navigation of the term sustainability within architecture and the built environment. Throughout the project our stance on how one should approach this topic has changed numerous times and is still in discussion. There has been a constant pull between establishing meaningful architecture that may last for generations, and climate-anxiety where all forms of ornamenting were considered a waste of resources. The Substation is a proposal on uniting both considerations.

Design for Longevity or Design for Disassembly

Whether the building should be one of longevity or designed for disassembly has been a focal point for the design process. When investigating low impact wall types to concrete it was evident that a geopolymer solution would have the best GWP score. However, the act of casting presents a laborious task of disassembly and reuse of components. It is a process in which raw materials are bound together in a set state, and where the components in set state only allow for a singular lifespan. This leaves the designer an immense responsibility in creating a place that can afford a relationship with humans - both today and of the coming generations. For a building unworthy of recognition is one that will be torn down, and is in its essence, a waste of resources.

Thus arises the question of responsibility; is it the responsibility of the planners of tomorrow to use their knowledge and innovative technology to repurpose their built environment, or should we today build to accommodate such change? For the world is running out of raw material, and we shouldn't appropriate future resources without utter necessity. Rather, we should consider the built environment as a loan of resources for the given lifespan of a building, and allow for their return to the cycle without further processing.

Reinterpreting a Cultural Heritage

Typically high-voltage substations in Norway are hidden away by being built within the mountain, although they are descendants of prideful buildings . The Substation of Utsira is attempting to regain the awareness of the subordinate by reinterpreting its industrial and cultural heritage.

Stone presents itself as an optimal building material for the Substation. Both in regards to its material properties, but also as a continuation of the cultural heritage on the Island. The machinery already on site, allows for a construction process of larger elements than elsewhere. The quarrying of rocks may then be of minimal impact and processing - being used as a building component in its most natural state. Allowing the facade to be left exposed and natural tells the story of its becoming. It acts as a conversation starter between the Substation and the Sirabu. For, stone is a known material to them - one of few resources available on the island, and thus an integral part of their building heritage. The Substation hereby becomes a

part of the cultural identity of the place, and writes itself into the existing story instead of creating a new.
Despite consisting of known processes within the mining industry, building from stone blocks is an explorative approach. We wished to look beyond normal building practice as the future demands an innovative approach to resources, materials and their processing - and perhaps also their aesthetics. Though, there is at present a gap between design proposal and reality, which demands further investigations into the material properties and assembly process before we can finally assess its success.

An Inside Out Approach
The design of a substation in which the technique is at display is an inside out approach. We are facing a time where the expansion of the infrastructure of energy production will have a great impact on our built environment.The Substation reclaims its position of priority and pushes its old subordinate expression aside.
Towards a more conscious society - not taking for granted.

Tectonics and Detailing
The act of formgiving may seem subordinate to that of reducing its environmental footprint or of meeting the technical demands. This education revolves around merging the knowledge of the architect and the engineer in the creation of an integrated design. However, the process of working with the two is quite different. Where one can be quantified, creating value within the other is a more abstract task. The latter demands space for exploration and time - to mould into a shape that correlates with its environment. Even though we design for disassembly one can not write of the task of creating an aesthetic, and tactile, pleasing architecture.
Throughout our studies, we have learned to unite the thoughts and skillset of the architect and the engineer. Giving us advantages but also disadvantages in the field of architecture. The more knowledge we have gained throughout our studies, the more obstacles we face in relation to the creative process. Leading to more time spent on technical considerations and solutions that inform the creative process and vice versa.
However, it is a difficult balancing act as the projects become more complex when investigating all aspects of the building. Often this can lead to a drowning of the creative process in the technical aspects.
The advantage of interdisciplinary nature is that it helps us to challenge the current build environment and makes us able to take on new unexplored territories. Such as designing a substation that is able to embrace and unite technology, human and nature.
We leave the project with an itch to dig deeper into tectonics, detailing and more than ever unknown territories

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