Adaptive Permanence:
A Structural Response to Energetic Vulnerability

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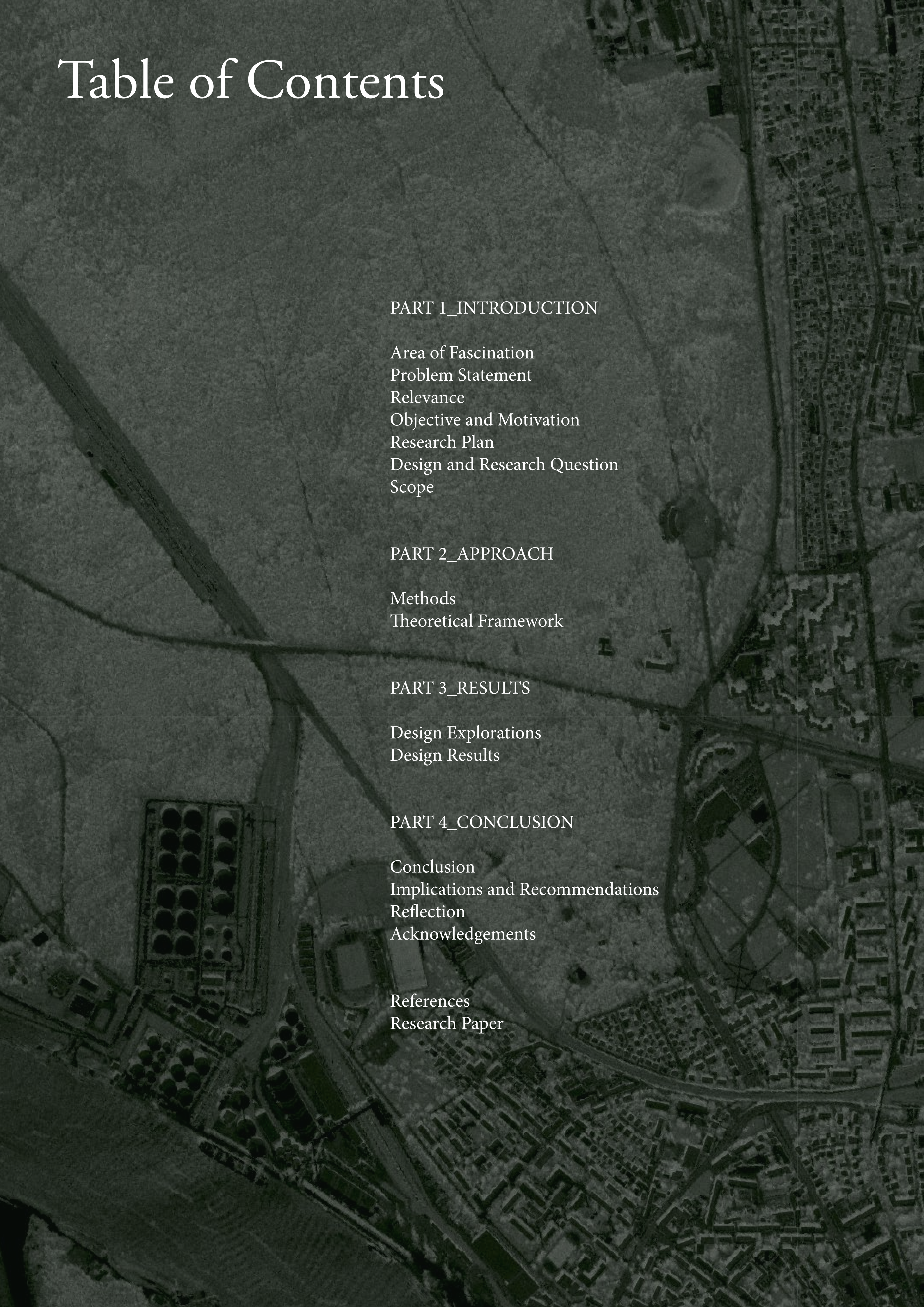

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Part 1_Introduction

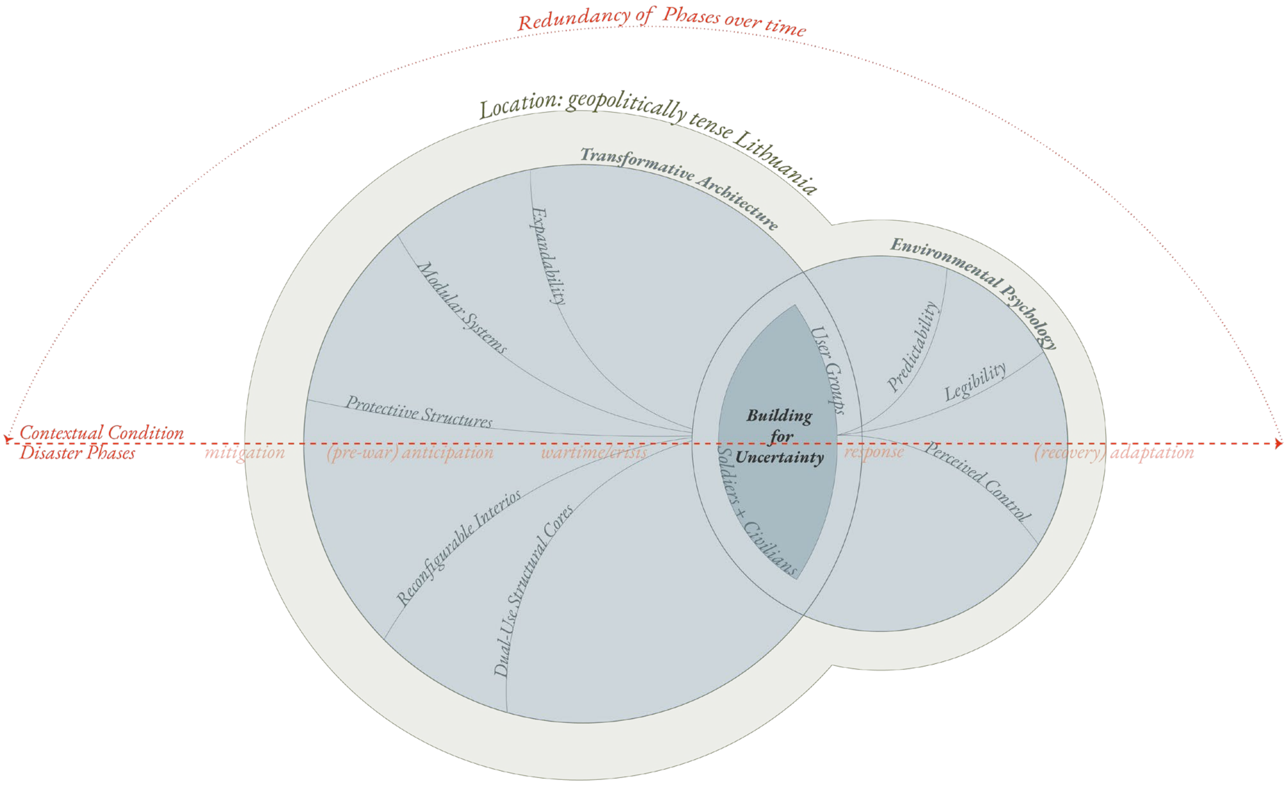


Figure 1: Relationships between Areas of Interest

Area of Fascination

Before I started my architectural education, I served for two years in the federal armed forces of Germany. There, I completed officer training, which has allowed me to gain a deep understanding of how people who work in extremely demanding professions make use of their environment, and I could also witness how these people are shaped by the structures they inhabit.

Looking back at this time, I notice how these military infrastructures also shaped my behaviour and influenced how I encountered my everyday life. I could not choose to live there, as it was part of my job. Working in the same place as one lives truly influences the mental state of a person in the long run. Of course, this is not only to be understood in a positive or negative way, but a complex relationship of the extreme that can be observed.

Looking back now, with a sharpened understanding of the built environment, combined with my personal experience in the army, I am excited but also nervous to engage with the following graduation thesis, located in the contemporary, geopolitically tense context of Lithuania.

The topic of increasing defensive infrastructure and investing tremendous sums of money into this industry in order to maintain the current political order in Europe and abroad is a highly controversial one, and there is a lot of doubt present about how to make the right decisions, if such even exist. Therefore, the EXTREME Graduation Studio, asking for a design for a new military base in Lithuania, is also a topic that is discussed a lot and partially a sensitive matter.

It also feels deeply personal to me as it touches directly on two areas of my life that have shaped me a lot and have made me the aspiring architect I am today. Through this graduation project, I hope to propose a way to mitigate the sensitivities of both realities -military and civilian.

I am eager to learn more about both, with the sharp and analytical view of a researcher, and look forward to exploring ways to design for a positive and delightful future despite potential conflicts.

Problem Statement

War is a spatial condition, one which can be seen occurring throughout human history.
As a result, it directly influences the ways we perceive, organize, and shape the built and unbuilt environment (Schoonderbeek & Shoshan, 2017). The temporal quality makes war not only political, but also fundamentally spatial. It is a phenomenon which affects landscapes, communities, and environments and has disrupted the lives of people repeatedly throughout history. Military structures have always been carefully placed in strategic locations to generate geographical advantages or to ensure smooth communication and supply for troops.
Because of this dependency, civilian grids and infrastructure are extremely important factors to consider in relation to the planning of new military structures, as they not only have to protect them, but also because they act as high-value strategic assets.

Especially in modern times, the operations and civilian life rely enormously on high-energy supplies, though many energy facilities still run on vulnerable, fossil sources, instead of renewable ones.

Although there are a lot of efforts initiated in recent years to switch to more sustainable energy sources, the increasing geopolitical tensions in Europe tend to shift the focus from sustainability to more defense-driven projects and investments.

This poses a contrast, given that modern combat relies heavily on huge demands of unfailing energy supply to function, but also requires independent energy sources to ensure self-sufficiency. Prioritizing only one or the other, therefore, creates a greater risk of a system collapse in case of an emergency.

Therefore, not only must communities continuously adapt to ever-changing circumstances (vesco et. Al....) but also the energy grid must become resilient and reliable enough to facilitate this.

The profound impact of war and its phases, therefore, directly influences architecture and ties it to energy, as architecture actively responds to conflict and its phases through a variety of processes. Architecture has the potential to facilitate and reinforce necessities such as infrastructure and fortifications, but also the repair and processing of the effects of traumatic events associated with experiences of war. Using tools such as spatial organization, light, materiality, and enclosure, architecture can influence the feelings of the people who use such spaces, as an "emotional subject" (Grabowska, 2017).

However, military bases and bunkers across Europe have not been designed to deal with the dynamic and recurring nature of conflict.

Usually, military-related structures are built for isolated states of conflict: anticipating conflict, active conflict, or post-conflict. As a result, these buildings perform extremely efficiently for their temporary purpose but are difficult to adapt or reuse using traditional methods (Sanna et al.)and can be associated with cultural importance and historical trauma, which complicates new uses post-conflict. Thus, they are often abandoned, become obsolete, and contribute to spatial fragmentation and architectural waste. With the advancement of war, technologies become more specialized, increasing the technical demands on military architecture. This further challenges the reuse capacity of military buildings (Ebejer et al., 2023).
This results in a challenge to create architectures that are not designed to fail and that can facilitate change and future-oriented energy supplies at the same time. There is a need for militarized structures to be designed to support the reality of the long-term character of conflict and beyond.

Figure 2: Fuel Tanks, Port of Klaipėda

Relevance

This research is written in the context of a rapidly changing global order, where world powers are in a state of transition, violence quickly expands, and unprecedented international extreme events are being witnessed with unprecedented frequency. Since architecture is inseparable from this state of tension between permanence and urgency, it is shaped by demands resulting from geopolitical circumstances, political intentions, collective fears, and technological advances.

Thus, the question can no longer be how long military architecture protects territory, but how it adapts, transforms, and carries meaning across ever-changing, unpredictable environments.

As civilian populations live inside and alongside military infrastructure that was built in anticipation of conflict, transformative architecture in the context of conflict, war, and peace becomes a societal necessity.
As civilian energy grids are not only relevant for the daily operability of civilian life, but constitute critical military targets, the challenge emerges to no longer consider architecture and energy and separate systems, but as an interdependent entity.

This creates an entanglement between architecture and energy that is shaped by military ambitions, geopolitical instability, and societal demands of resilience and forms the central investigation of this research.

Objective and Motivation

In the face of growing geopolitical uncertainty, I believe that architecture can contribute to more stability for the individual if it is designed to operate and remain relevant across crisis phases of anticipation/conflict/adaptation after conflict. Such a structure must provide physical shelter and a minimum of physical comfort, and also must take the psychological stability of its users into account. The objective of this thesis is to design a structure that can be seen as a toolbox that can be used and adapted according to the user‘s needs:
The anticipation phase structure is placed in one specific/strategic location, able to respond to sudden changes in the environment. The structure for the conflict phase needs to provide safety and shelter without diminishing operability. The adaptation phase asks for the reconstruction of settlements, critical infrastructure, and sanitary facilities.

The following research question is a direct derivation of the problem statement, my area of fascination, and the current geopolitical developments, which serve as the context of this research.

By studying the specifics of conflicts and by looking into war-related architectures of the past, I aim to develop a structure that can serve as an example of how architecture can fit into a complex environment, both geographically and politically.
By analysing the specific site of intervention and its energy potentials, I aim to offer a perspective on how energy self-sufficient architecture can also be a step towards conflict-phase resilience.

Research Plan

This research plan proposes a systematic design strategy that includes a variation of perspectives.

First, I conduct a theoretical literature review, which is used to write a research paper on my initial main interest in the assignment to create a new military base in Lithuania for the Dutch NATO forces. This forms the theoretical backbone of my work.

Subsequently, I undertake contextual research that results from a combination of my findings from the field trip to Lithuania and the analysis of the local conditions, resulting in the selection of a specific site for the final intervention.

The work concludes with a design brief, informing the final thesis project.

In order to ensure that a geopolitically, culturally, and contextually sensitive design can emerge, the subsequent phase involves extensive use of models and various types of drawings and diagrams to explore different options.

All these steps ultimately lead to the final design project:
A military base for the Dutch NATO forces in Lithuania that is both energetically self-sufficient and adaptable to geopolitical change.

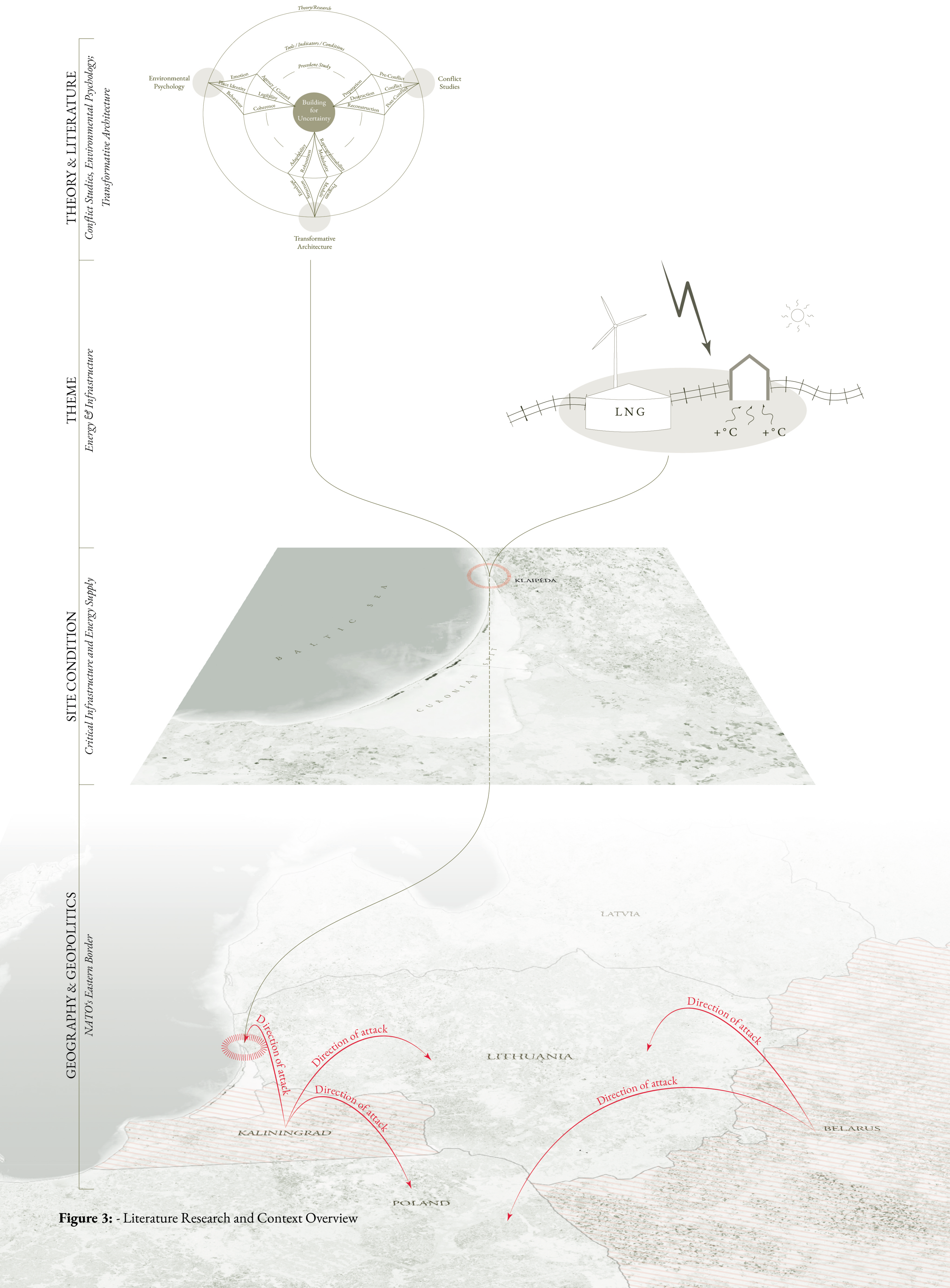


Figure 3: - Literature Research and Context Overview

Design and Research Question

Main Question

How can transformative architecture integrate energy generation and spatial adaptability to enhance civilian resilience across shifting conditions of anticipation, conflict, and reconstruction?

To answer this question, literature about peace and conflict studies, transformative architectural strategies, and environmental psychology is studied.

Transformative Architecture Strategies
(1) ***What architectural strategies enable buildings to transform across different phases of conflict?***

Then, the findings are tested on a selection of historical military architecture systems.

Historical Precedents
(2) ***What lessons can historical and contemporary war-related architecture provide for designing transformative architecture across conflict phases?***

The theoretical research concludes with design requirements and principles that inform the design brief for the graduation project. After that, contextual research is conducted about the conditions of Lithuania to determine a site. Simultaneously, energy poetentials of the site are evaluated and analysed.

Energy and Architecture
(2) ***How can the integration of energy autonomy and adaptable architectural systems redefine the relationship between civilian infrastructure and military vulnerability?***

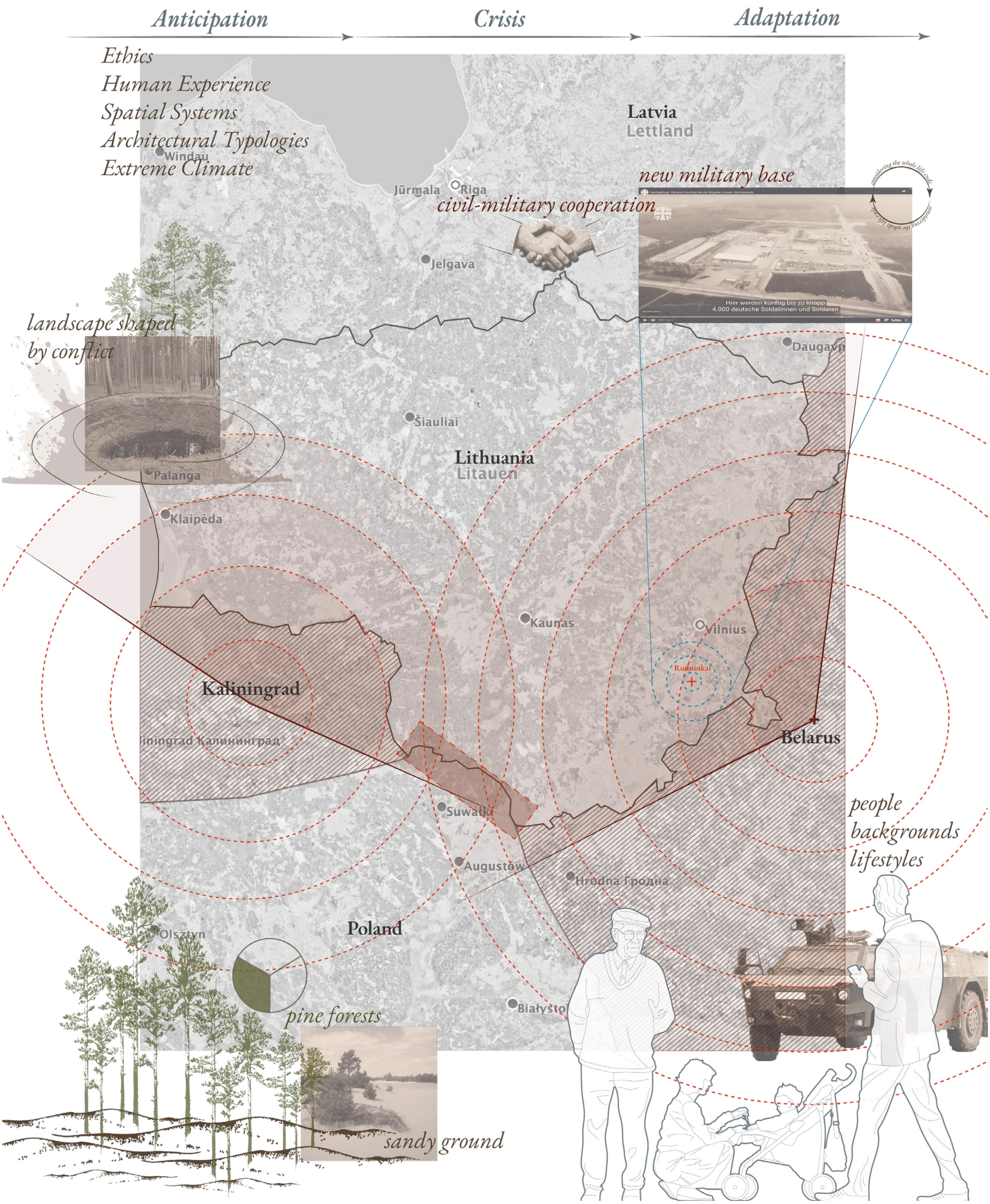


Figure 4: Lithuania in a geopolitical Context

Scope

Lithuania is a unique geopolitical location between Poland, Belarus, and Kaliningrad, which is of great relevance to NATO, given that it connects the Baltic States to the mainland of Europe. The Suwałki-gap, the narrow border area between Poland and Lithuania, is the only and most significant connection by land to the other NATO members. Therefore, Lithuania has been of special interest for defensive measures by NATO since the Russian invasion of Ukraine (Figure 4).
When it comes to defense, not only supply by land, but also infrastructure via ship, communication routes, and energy grids pose vulnerabilities to potential attacks and threats.

Lithuania shares roughly 15% of its border with the Russian exclave Kaliningrad, and the entire UNESCO-Heritage Landscape of the Curonian Spit, with the only access to the Baltic Sea being located on the Lithuanian side. located in this area, there is also the third largest city of Lithuania, Klaipėda (Figure 6). Klaipėda's port combines crucial energy infrastructure with well-interconnected infrastructure networks by rail and highway across Lithuania, Latvia, Estonia, and Poland. The LNG-Terminal in Klaipėda is the central pillar of energy security in the Baltic region and represents and secures independence, freedom (Figure 5). Therefore, the port of Klaipėda is of great political, economic, and historical significance, encapsulating the challenges of the current day, and thus is the focus area of the following work.

Figure 5: Weathervane of Port of Klaipėda: Symbol of uncompromising pursuit of freedom and independence (KN-Energies, https://knenergies.lt/en/terminal/klaipeda-lng-terminal/ , accessed May 25, 2026)

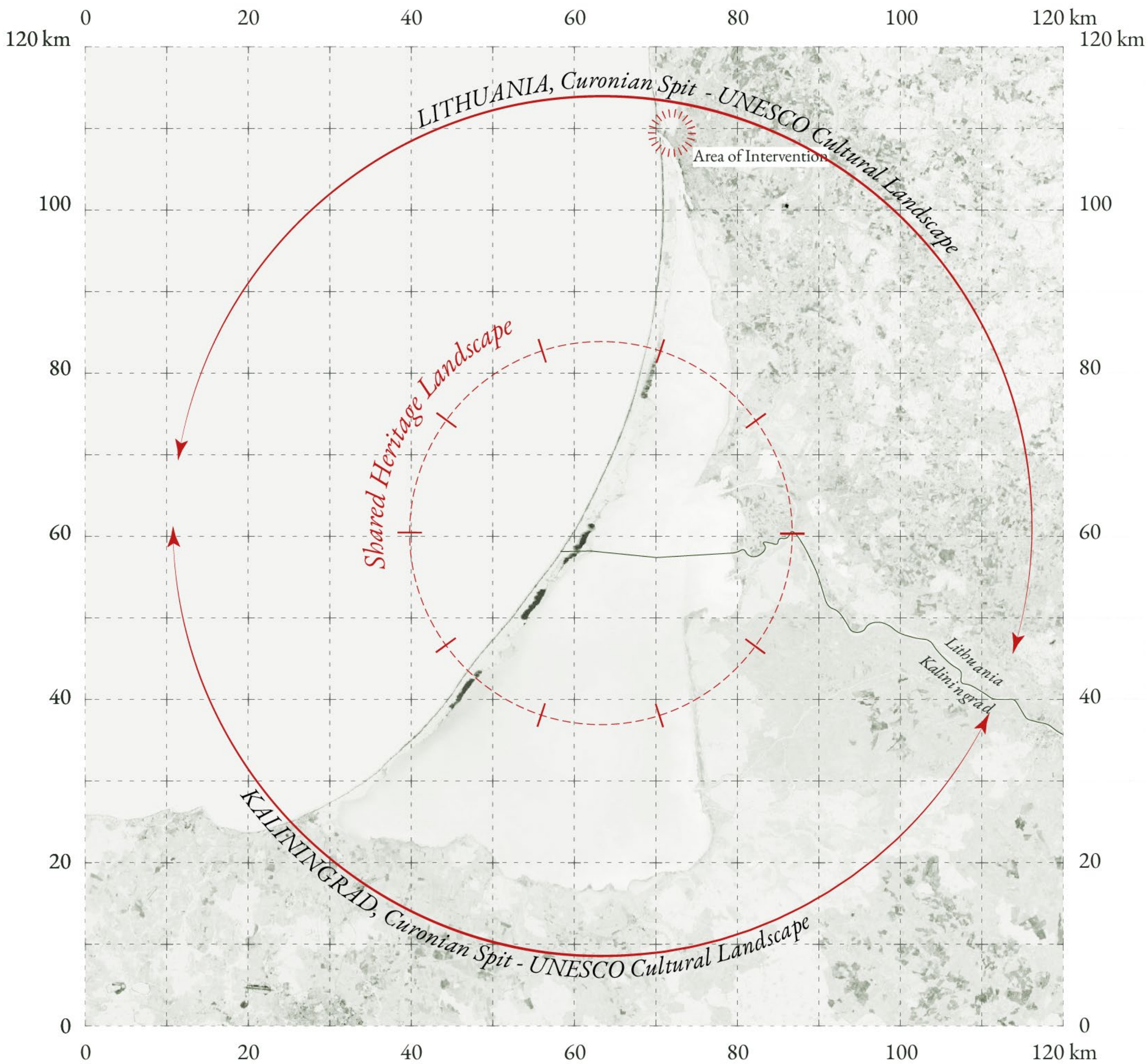


Figure 6: The Curonian Spit as a high-tension Zone

Although the Port of Klaipėda only imports LNG from European and international partners like Norway, Sweden, or the United States, the main source of energy still has to be imported and is not self-reliant. It requires a smoothly operating energy circulation and distribution system, which is already under heavy strain during the winter months, making it a weak spot in Lithuania's defensive strategy.

This is where I propose an architectural intervention that combines an energetically autonomous and functionally adaptable structure. A military base for Dutch troops that are deployed in immediate proximity to the port and a structure that can react and adapt to shifting conditions, which is embedded in a bigger scheme of supporting the energy transition of Lithuania away from fossil energy towards more sustainable and local energy potentials.

Part 2_Approach

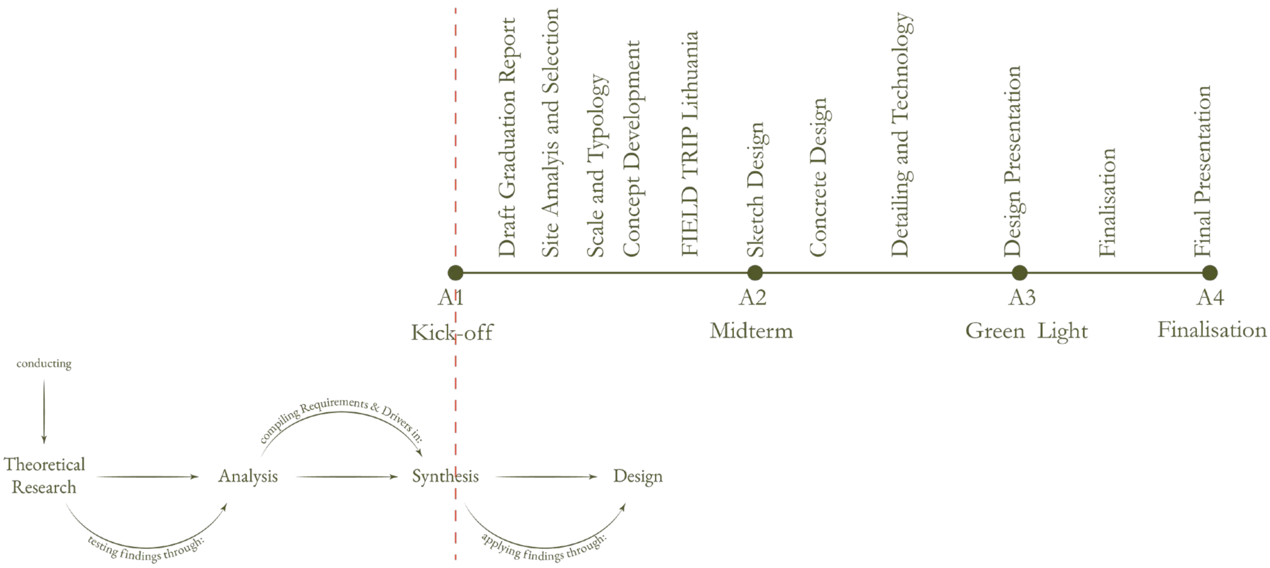


Figure 7: Graduation Plan

Methods

This graduation project is developed through four main steps: research, analysis, contextualisation, and application, resulting in an architectural design.
A preliminary literature study is done, focusing on transformative architectural strategies that enable a building to remain relevant throughout conflict phases. Therefore, the research defines first what conflict stages are and how they are characterized in spatial and functional terms to elaborate its architectural implications. Environmental psychology is briefly explained and serves as a lens to measure and contextualize the conflict phases. Psychological stability is framed as the main goal to achieve and provide through architectural means for conflict-prone environments.
Subsequently, the architectural strategies regarding their transformative properties are explored. This concludes the main part of the theoretical literature research. As a result of the conducted research, design parameters are developed that are used for the analysis.

In the analysis part, the findings and strategies are applied to real-life historical and contemporary architecture with a focus on military structures, as those are of focal interest for the graduation project.

It concludes with a synthesis of the findings, providing a framework and guidelines to inform the graduation project brief.

Finally, the theoretical research is supplemented with a contextual research of Lithuania and its energy potentials, specifically tailored to Klaipėda, leading to the development of a site-specific project.

The project will be developed in the following temporal segments, shown in the graph on the right.

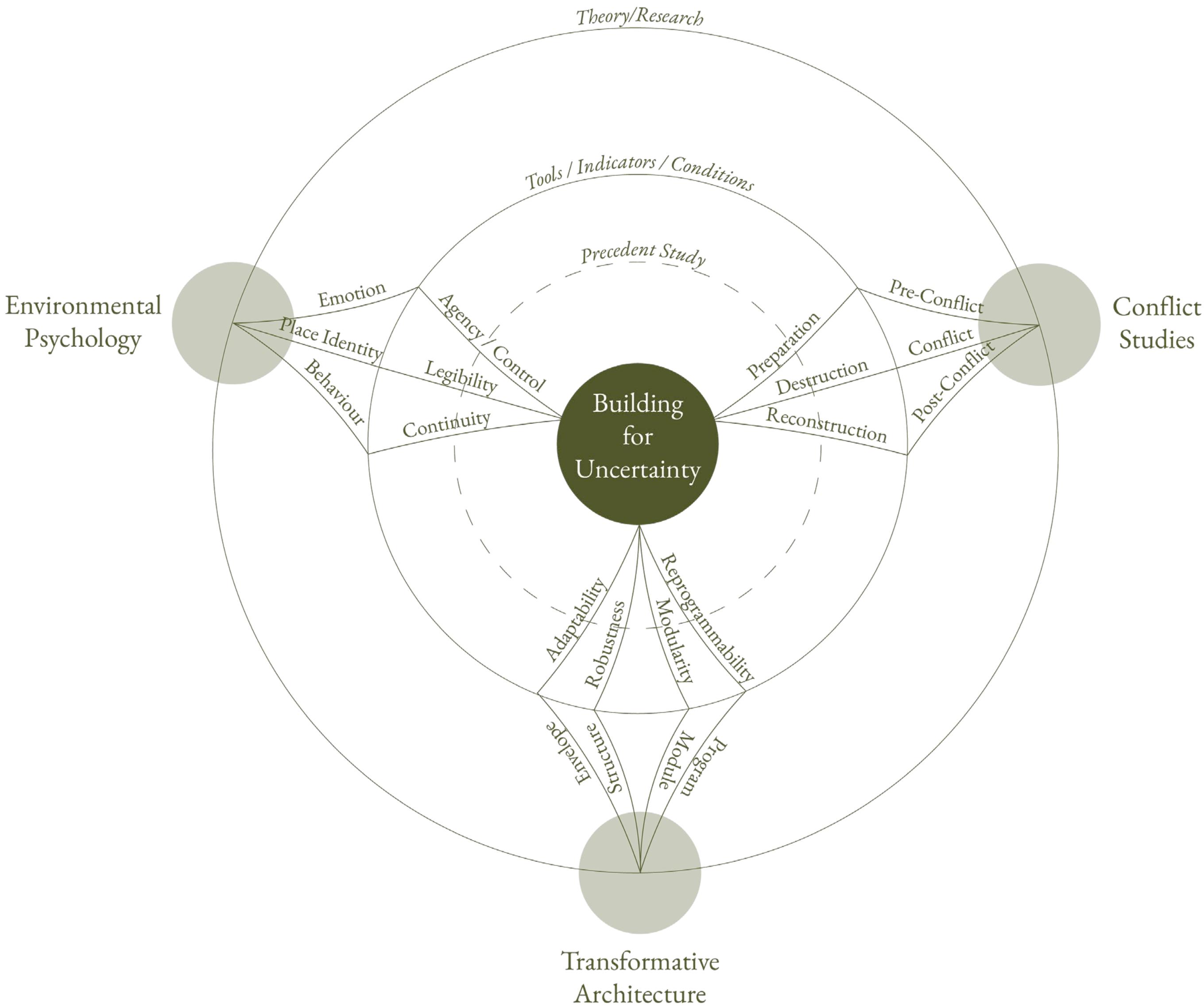


Figure 8: Literature Research Approach - Theory

Theoretical Framework

Literature Research

Temporality of Conflict

Conflict is not a singular, short-term event but a spatial process and part of a circular system of phases as conflict occurs and disappears over time. It can be divided into three main phases: pre-conflict, conflict, and post-conflict (United Nations. Crisis Environments Training Initiative & UN. Disaster Management Training Programme, 1998). All of the phases influence the spatial and functional requirements of the built environments and impose unique threats to the maintenance of psychological stability. Therefore, architecture can be understood as a temporal infrastructure that needs to transform in accordance with the conflict phases and the requirements they impose (Vesco et al., 2025).

For the pre-conflict phase, continuity of meaning and identity is under threat. For the conflict phase, the threat is at its highest level for the legibility of spatial orders, as destruction and restricted access are dominant. For the post-conflict phase, special attention has to be paid to continuity as the focus tasks are reconstruction, reconciliation, and rebuilding the destroyed environment.

Transformative Architecture

Transformative architecture can be understood as a mechanism or tool of the built environment to address changing conflict phases through adaptation (Askar et al., 2021). It holds the capacity to maintain psychological stability and meaning through applying specific architectural strategies, depending on the stage of conflict and external stressors. The key Mechanisms that are identified are: Reprogrammability, applied on a building and room-scale. It refers to the idea of open layouts, movable partitions, and independent services that support continuity. The second strategy explores the concept of modularity on a building and unit scale, emphasizing the potential it holds to mitigate during conflict phases and providing a high level of legibility due to its efficient and clear organization. Thirdly, Adaptability on a room/unit scale performs especially well in terms of coherence, because thresholds are controlled, but adjustable, mixed

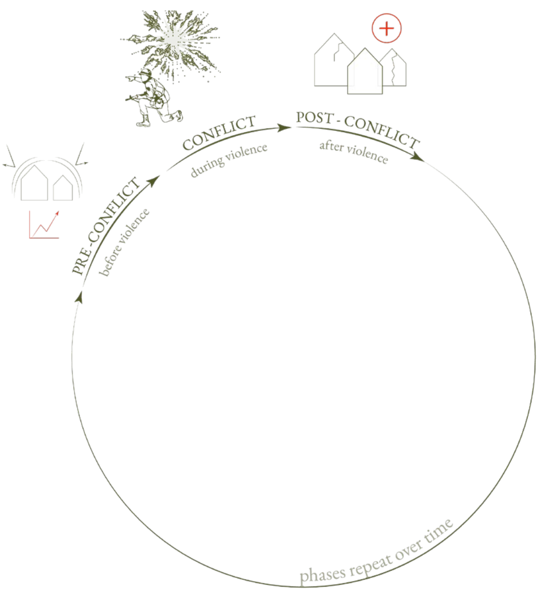


Figure 9: Conflict Phases

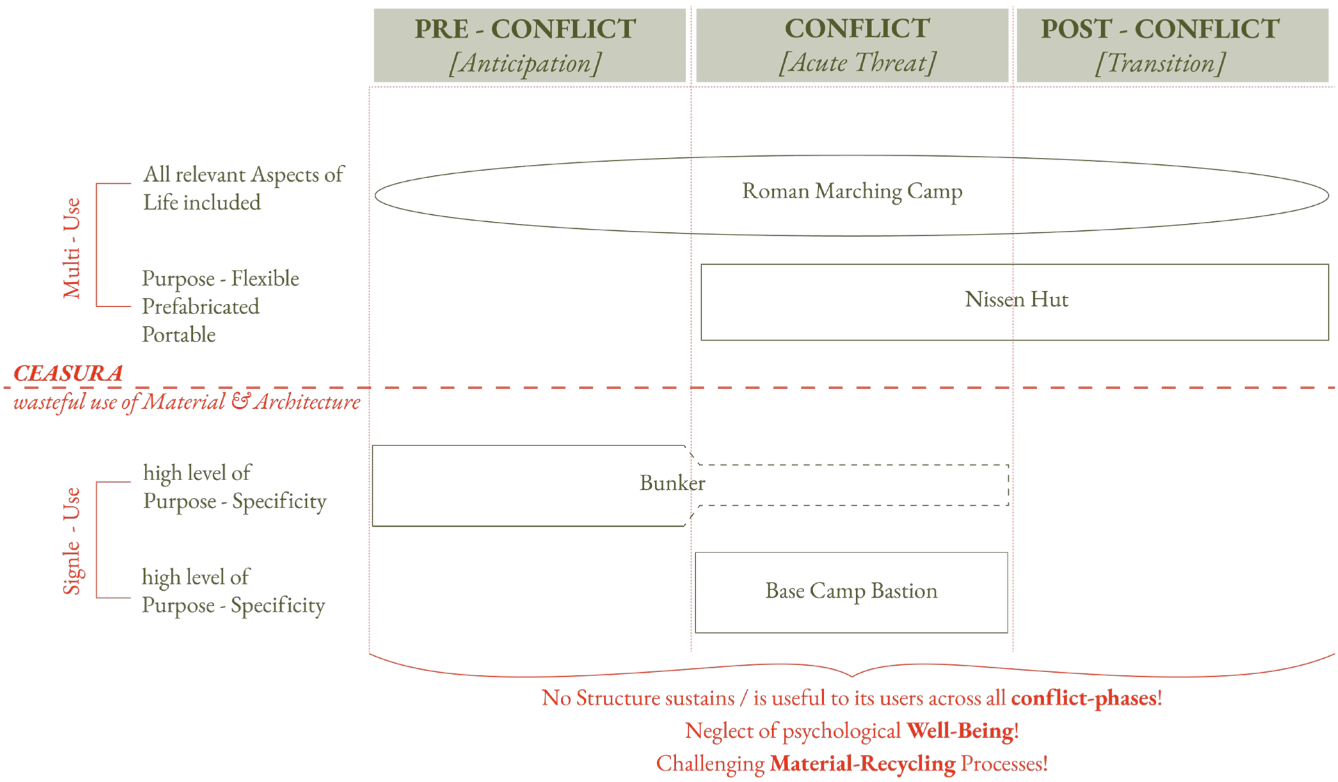


Figure 10: Results Precedent Analysis

uses are possible, and parallels can easily coexist. Structural robustness on a structure/envelope scale is the last strategy that is explored. It enables survival across phases and relies on mass and redundancy as a means to achieve this. Each of the presented strategies works best when combined. This makes transformative architecture very suitable as a frame to mitigate the challenges imposed by varying conflict phases, as the strategies complement each other and perform well under very different circumstances, making the structure as a whole system resilient.

Precedents

Precedent studies provide cross-case insights into structural, spatial, and functional, as well as psychological performance in conflict situations. They point out that the success of architecture in conflict environments correlates with clear modular order, strong but simple structures, and also highlight how a building's performance is limited in such a sequence of phases when reprogrammability is absent. Furthermore, psychological stability is at its highest in conflict phases of the past when spatial order remains readable and everyday functions can return to structures. Finally, the most resilient structures from the previous study combine robust cores and structures with flexibility and incorporate the possibility of modular growth.

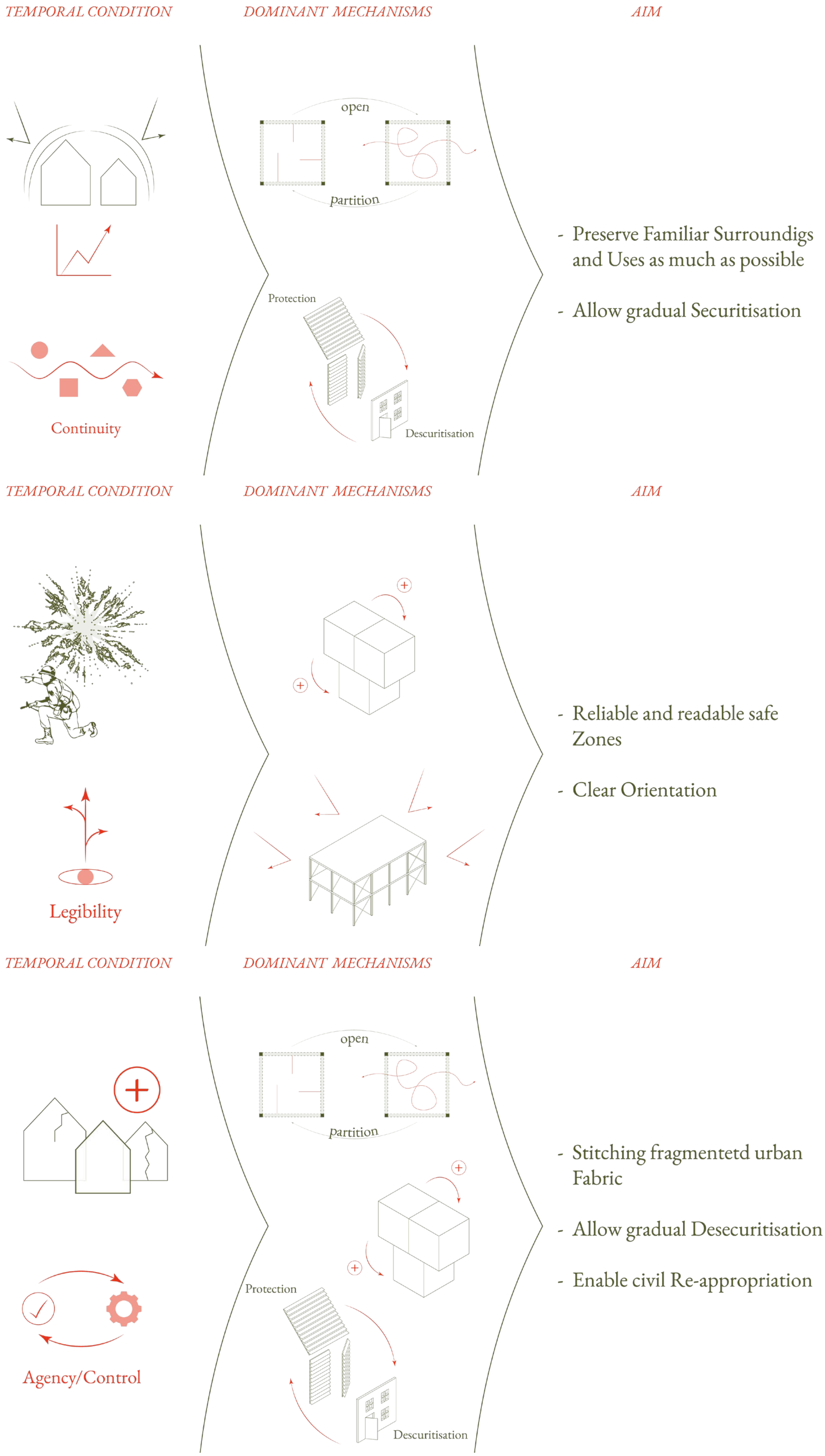


Figure 11: Design Matrix Phase-specific (top to bottom: pre conflict, during conflict, post conflict)

The Design must be phase-responsive and is most successful when multiple architectural strategies are combined:

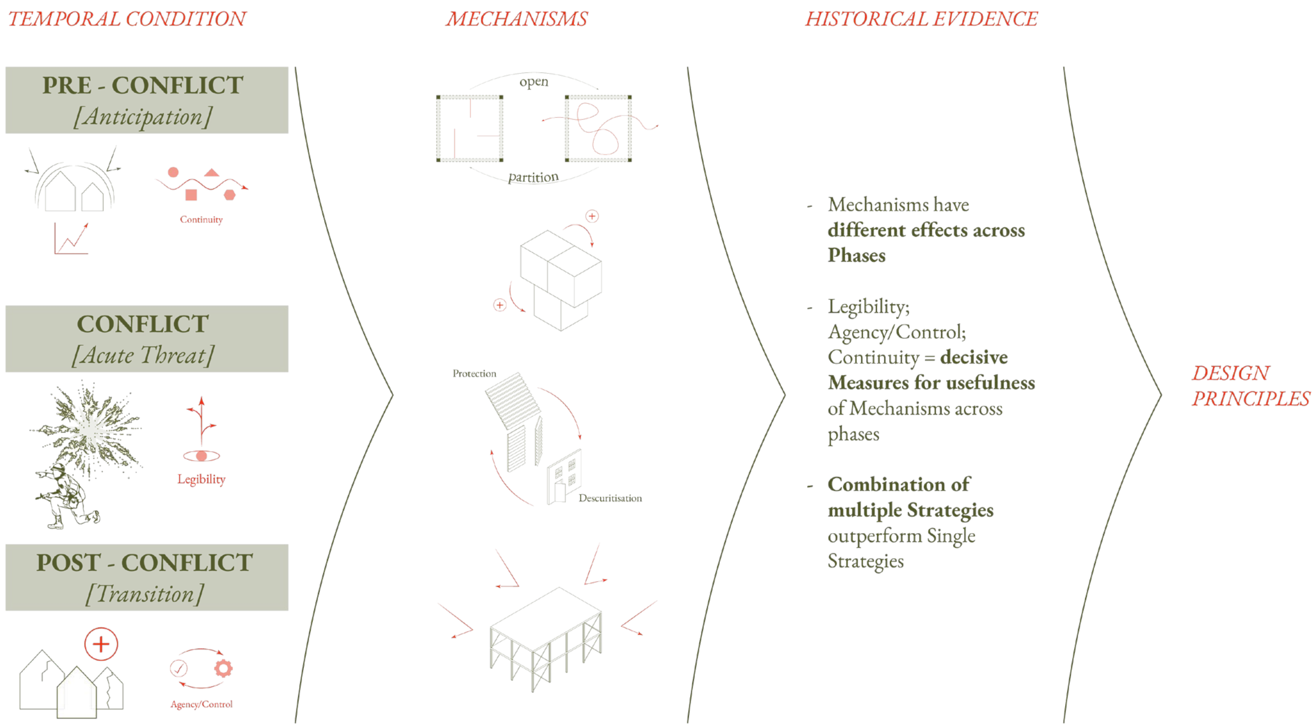


Figure 12: Design Matrix across Phases

Figure 13: Relevant Infrastructure, Risk Zones, Energy Potentials

Geographical Context

The systemic scale of the project shows how the complex environmental and man-made context around the port and how energy systems are intertwined with daily life. While the main import, processing, and distribution facilities are close to water bodies, they are closely connected to the inland by railways, highways, and smaller paths. This thesis makes use of those connections to create a bigger master plan to support a long-term energy transition. This ambition is rooted in the Green Port: hydrogen production and refuelling stations project, which aims to modernize and expand the port and focus more on hydrogen energy storage in the future. Furthermore, the investments intend to provide logistical support for military vessels as well, making the port a crucial military operator (Nadja Skopljak, OFFSHORE ENERGY, 2026, accessed May 25, 2026). Subsequently, energy is not only seen as a thematic guide for this thesis, but as a spatial frame that structures the built environment and future development of the region. The bigger scheme of technical innovation is taken into account while still ensuring robust energy supply methods within the system.

Scale: Urban

Considering the systemic dimension of the project, the urban scale turns inward, focusing on the logic within a military site. A microgrid-thinking is applied, showing how small fragments on an urban level fit into the bigger picture while still remaining self-sufficient to avoid a „single point of failure“. While energy supply on the bigger sclae connects large distances and parties, the components of this system must remain operational and function independently. They follow their own inner logics, while still feeding the bigger system. As the analysis concluded, risks and threats around the port vary depending on proximity. Therefore, the uses have to be tailored to the specificities of each zone (Figure 14).

The northern edge of Klaipėda not only accommodates energy-related facilities but also borders a large pine forest of recreational value, with park areas and an existing Lithuanian military base.

A university campus and a mixture of student housing and residential areas border this forest and the coastal edges of Klaipėda

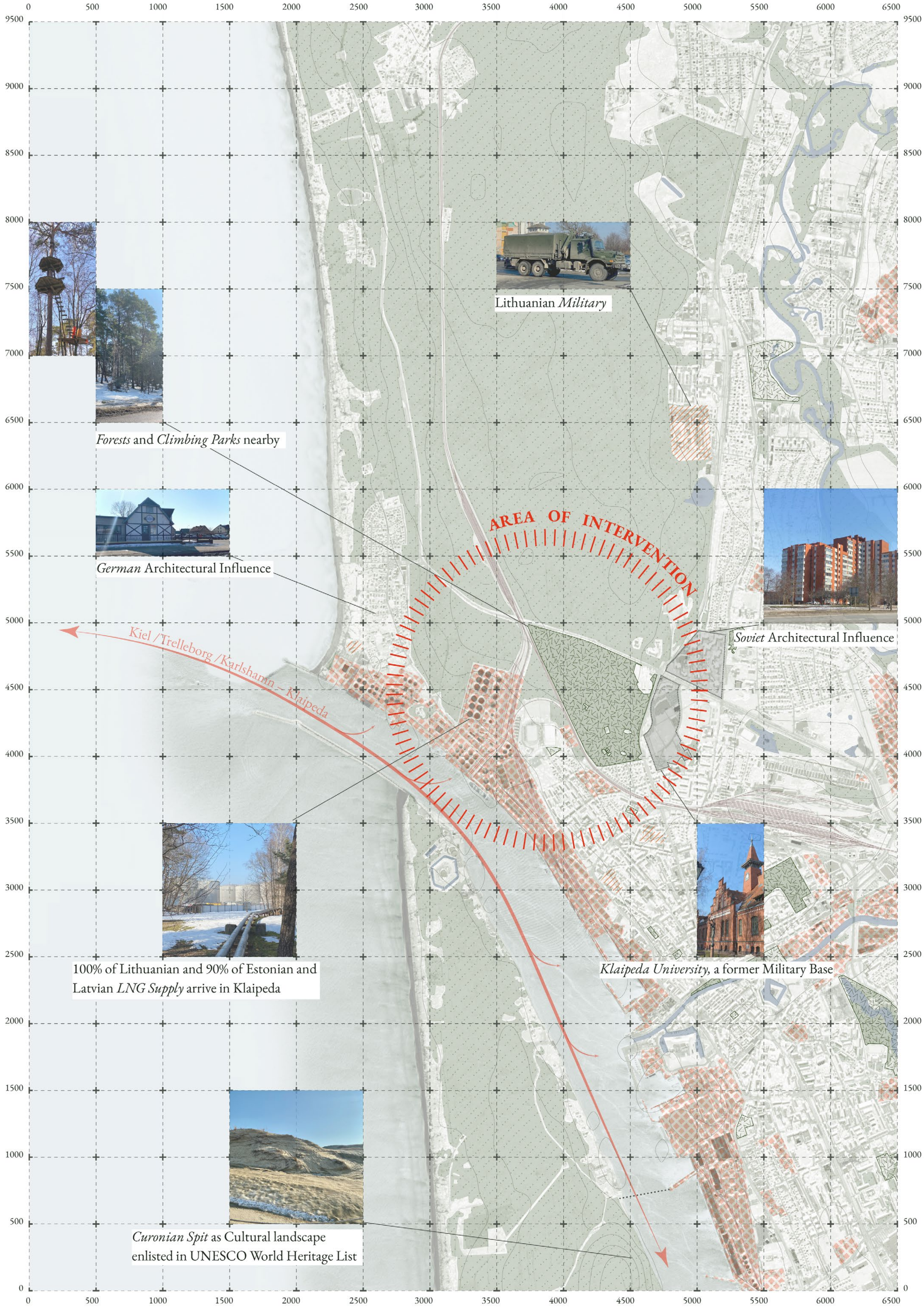


Figure 14: The Site - The Port of Klaipeda

(Figure 15). The combination of the university‘s research facilities, the large forest area, and the port‘s energy infrastructure supports the development of a future-oriented masterplan that focuses on collaboration between civilian and military parties working towards an energy transition. By creating a master plan that focuses on three key zones, a smooth integration of military and civilian structures can be achieved.

Scale: Building

The building represents the smallest unit across the scales of the systematic logic it is embedded in. It mitigates between infrastructure and supply chains, confidentiality levels, and civilian and military entities. It combines the complexities of its geopolitical environment and offers an approach to navigating it through changing conditions.

Architectural components like thresholds, envelopes, verticality, and materiality become tools that can communicate, control, and adapt over time. Therefore, precedents that explore how buildings not only facilitate energy generation but also become the source and storage itself are studied. Concepts like Baumschlager Eberle‘s 2226 serve as guiding references, because they treat architectural mass itself as defining themes in terms of energetic efficiency, longevity, and potentials of reducing technical vulnerability (Baumschlager Eberle 2025, https://www.2226.eu/prinzip/ accessed May 24, 2026).

Part 3_Results

Figure 15: Top: Facade study, Bottom: Phase explorations of a military site (from left to right: pre-conflict, conflict, post-conflict)

Design Explorations

Working Models

A spatial program was created to define the operational and architectural frame, which was translated into a military base that included all necessary elements of a base. This site was then transformed across changing crisis-phases using working models. This informed which buildings might be subject to changes and which buildings are significant across phases within the base and context of the bigger system. The following questions were of particular interest:

- *How do the changes interact with their surroundings?*
- *How does each building relate to the inside and the outside of the base?*
- *What needs to change and what can stay the same?*
- *How and which functions change across phases?*
- *How does each iteration contribute to the energy transition?*

Furthermore, a facade study was conducted exploring what a building in high-risk contexts must encounter. This was a direct embodiment of the design matrix requirements of the previous theoretical research and led to key insights on what aspects of the design need special care and informed which structures have potential for further elaboration.

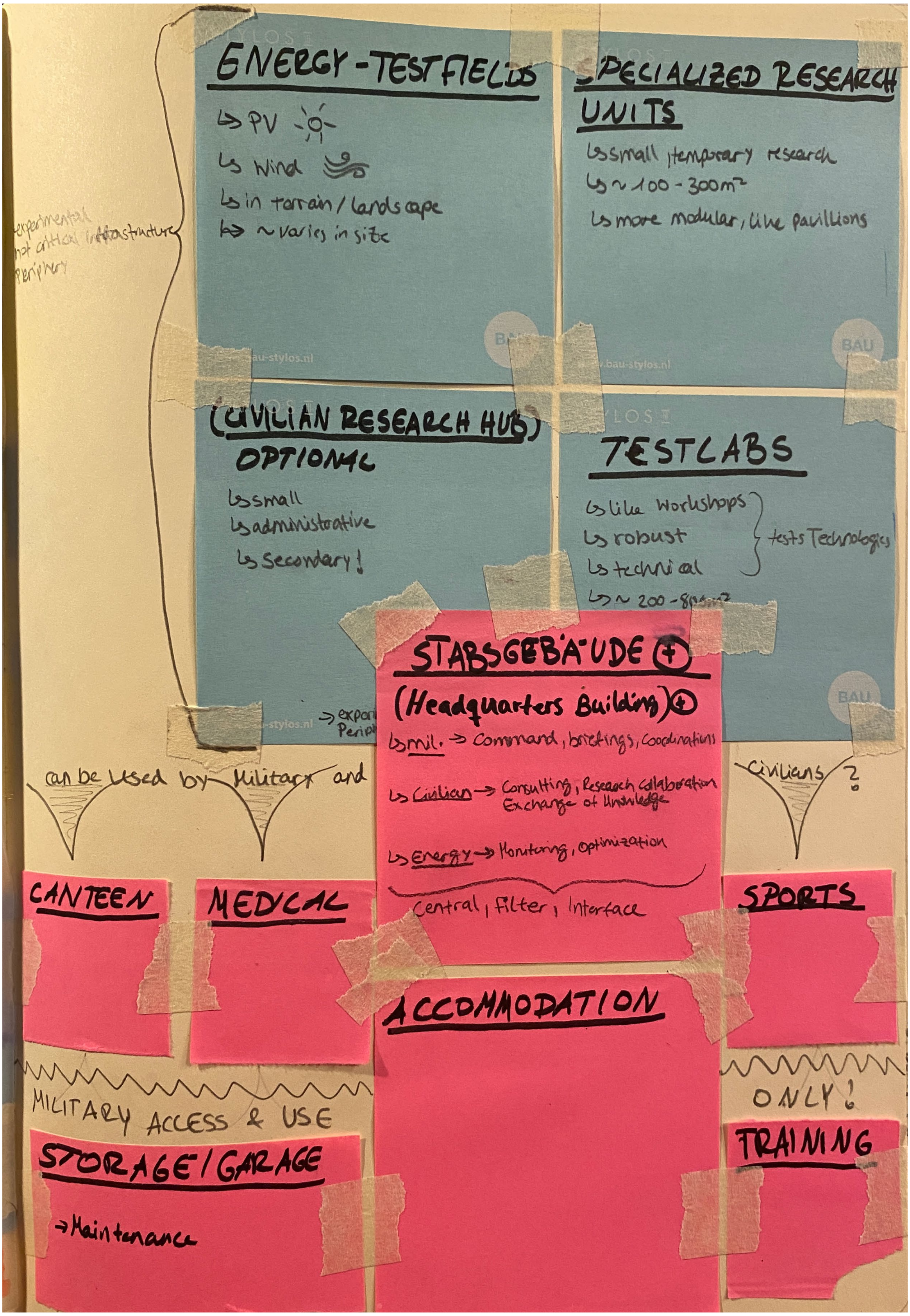


Figure 16: Spatial logic of the military base and relationship to civilian activities

Relationships

After that, the spatial program of the military base was organized to showcase how structures relate to each other and what their specific functions and qualities are. This helped identify the facility for architectural elaboration and solidifying the military base's role in the broader scheme of contributing to a sustainable energy transition and future-proof urban development.

Primus inter Pares

The headquarters building of the base is the subject of further elaboration as it navigates collaborations between civilian and military activities and is well-suited as a controlling and transforming entity. The headquarters building takes a leading role of the military base, but the other structures of the base do not rely on it to remain operational. The main building serves as a mediator, thereby becoming a filter, the heart of collaboration in times of peace, and at the same time, the threshold between two extreme states of reality.

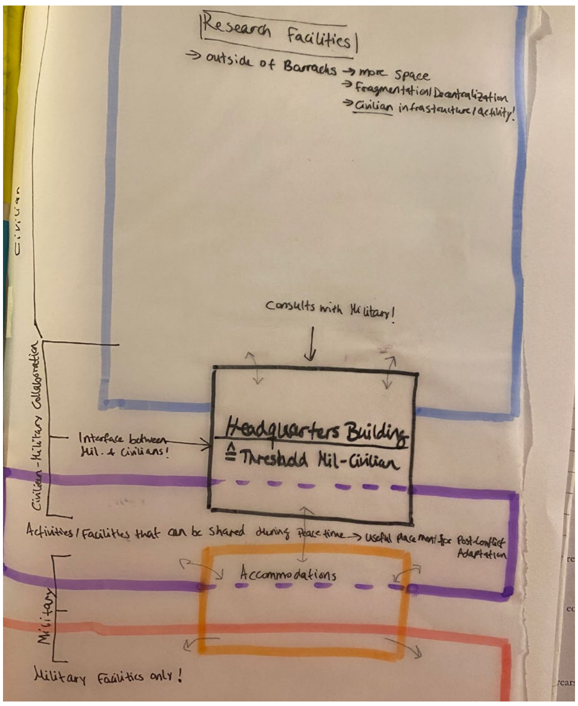
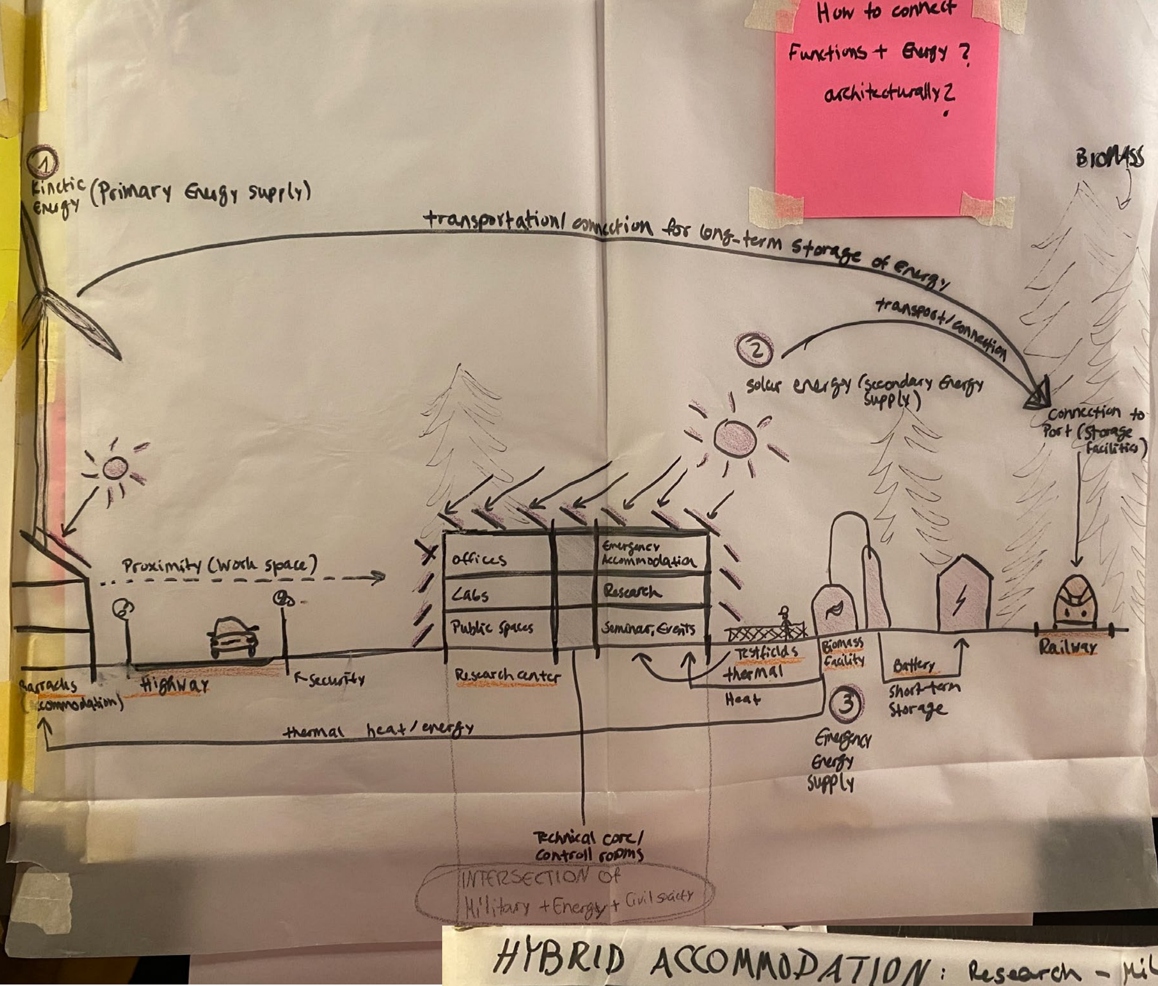


Figure 17: Zones of the military base and its connections



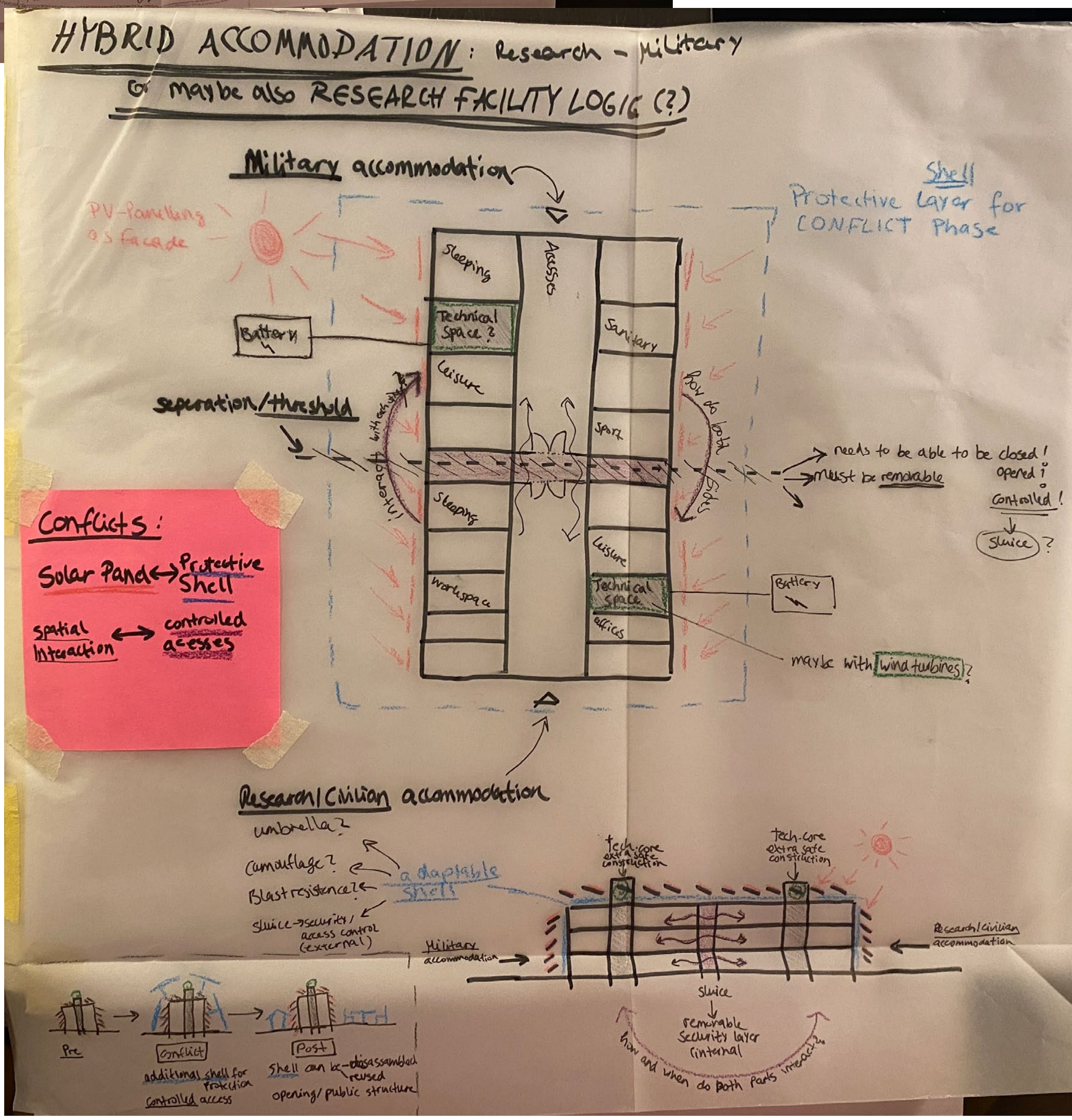


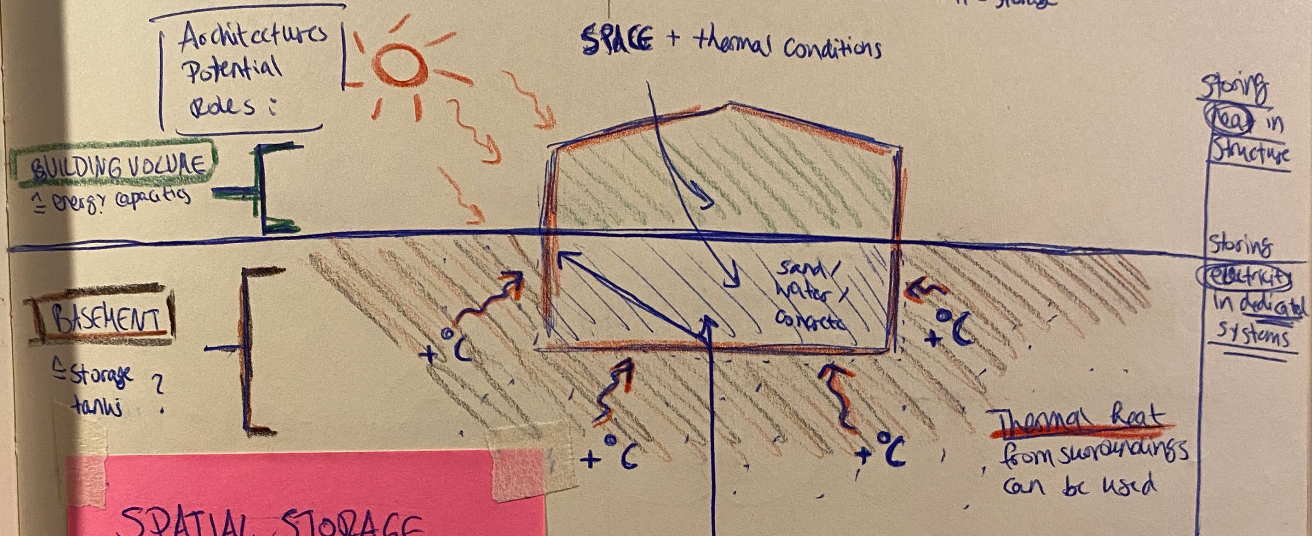
Figure 18: Energy explorations of the Headquarters building

Thermal Energy Storage

Electrical Energy Storage

- Structural Batteries
  - ↳ carbon fibres
  - ↳ Composite materials } load bearing materials

- Redox-Flow Batteries
  - ↳ liquid electrolytes stored in tanks
  - → Volume = energy capacity
  - → Basement = Storage



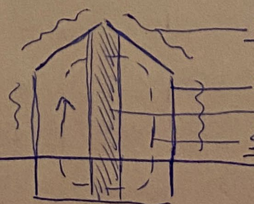
SPATIAL STORAGE
works great

ELECTRICAL STORAGE
is difficult / needs additional systems

Thermal Mass !
- ↳ STRUCTURAL RESILIENCE (Phases: Pre-Con-Post)
- (+)
- ↳ HEAT generation + storage (harsh climate esp. during winter)
  - ↳ day / night - Rhythm
  - ↳ Geothermal heat

STRUCTURE + SYSTEMS ⟶ create ENERGY ECOSYSTEM

Working with solar, wind, geothermal } energy generation



thermal storage = building mass (passive)

electrical storage = spatial integration
↳ battery ?

Figure 19: Masterplan 1:10 000

Design Results

Masterplan

Energy networks are complex and often vulnerable systems. Not only do they generate power, but they also engage in storing it (either temporarily or over extended periods of time) and distribute it to the users. Transforming existing energy networks, therefore, requires a multi-scalar approach.

The design of the military base close to the port of Klaipėda is therefore embedded into a masterplan that respects the necessary actions for a successful energy transition. Derived from the existing context of the site, with the Klaipėda University and residential areas in immediate proximity to the LNG port, the master plan contributes to an energy transition by facilitating research in the field of renewable energies. Klaipėda has great potential for such energy sources as wind, due to its coastal location and biomass, since the northern part of the city is surrounded by pine forests. Therefore, a variety of research facilities must be accommodated. Furthermore, the existing energy infrastructure at the port also creates risks, as it is considered a high-value target and because disruptions bear the potential to result in disasters. This leads to a design that is structured within three main safety zones that represent the circumferences of the dangerous impact. Within each zone, functions take place that are suitable for each risk zone. The zones also visualize the interrelated scales: The systemic, the urban, and the building scale.

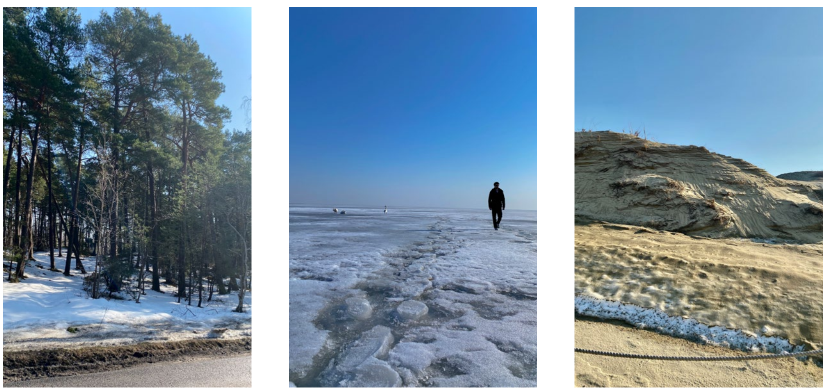


Figure 20: Landscape of the Site

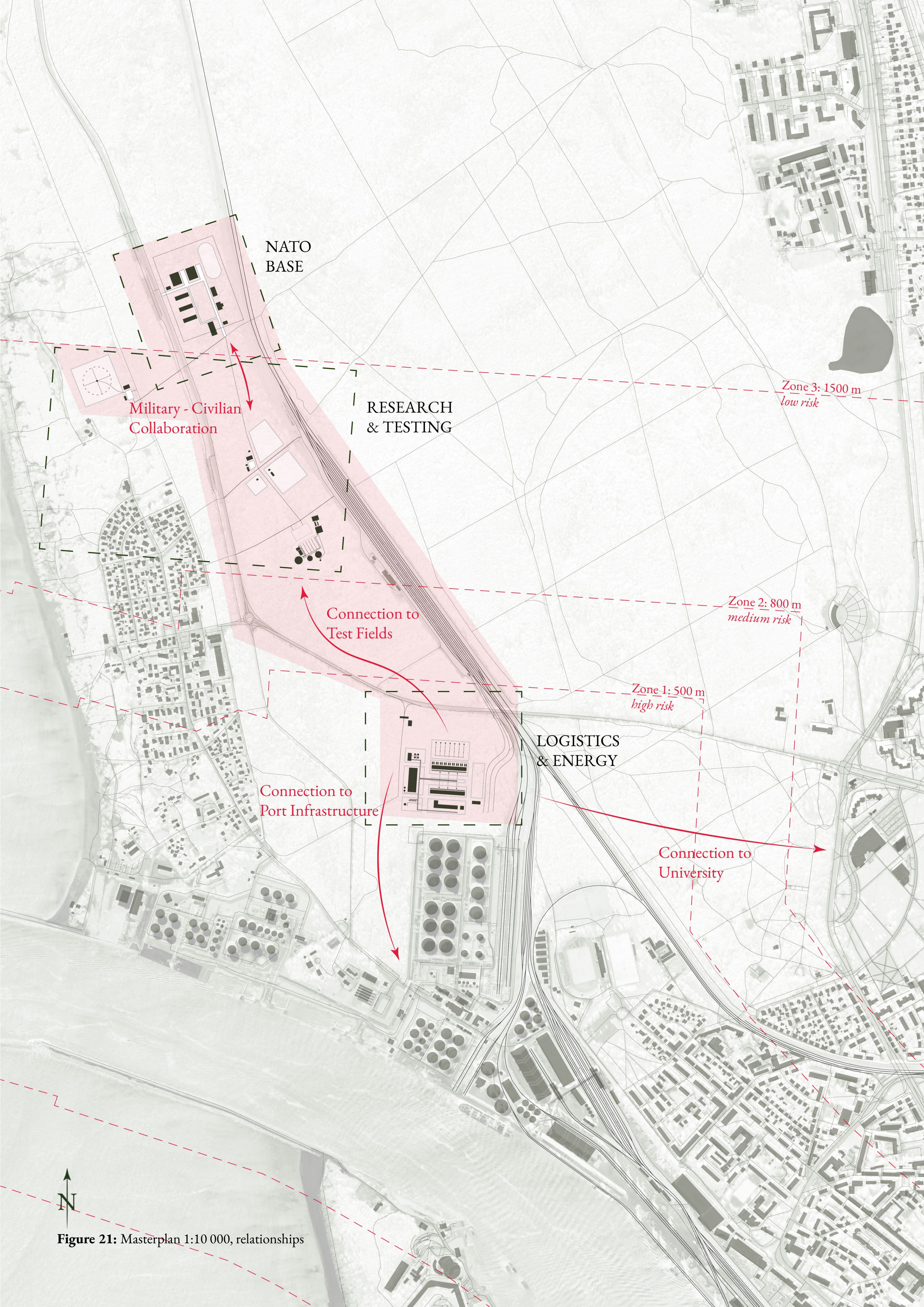


Figure 21: Masterplan 1:10 000, relationships

Hydrogen storage facilities are located right in the port, since they are directly related to current port activities of processing, storing, and distributing energy. This is also part of the investments that were granted in April 2026 the renew and expand the port infrastructure.

In the second zone, the medium-risk zone, test fields for various types of renewable energy are located. Such activities require space; however, the exact amount can vary a lot depending on the source. Since this zone focuses primarily on research and testing, potential disruptions or attacks do not affect the operability of the future system.

The military base is located in the third zone, the low-risk zone. Military operations react at short notice. It requires a good infrastructural system with alternative routes and accesses. However, the base must also remain functional, especially in case of an emergency at the port. This makes a positioning of the military site between the highway and the railway and with immediate access to the port and the Lithuanian military base, an ideal location, resulting in a system that creates a meaningful future during peace times while also preparing for emergency scenarios.

It becomes an Interface in which close collaboration takes place without requiring codependency between the components.

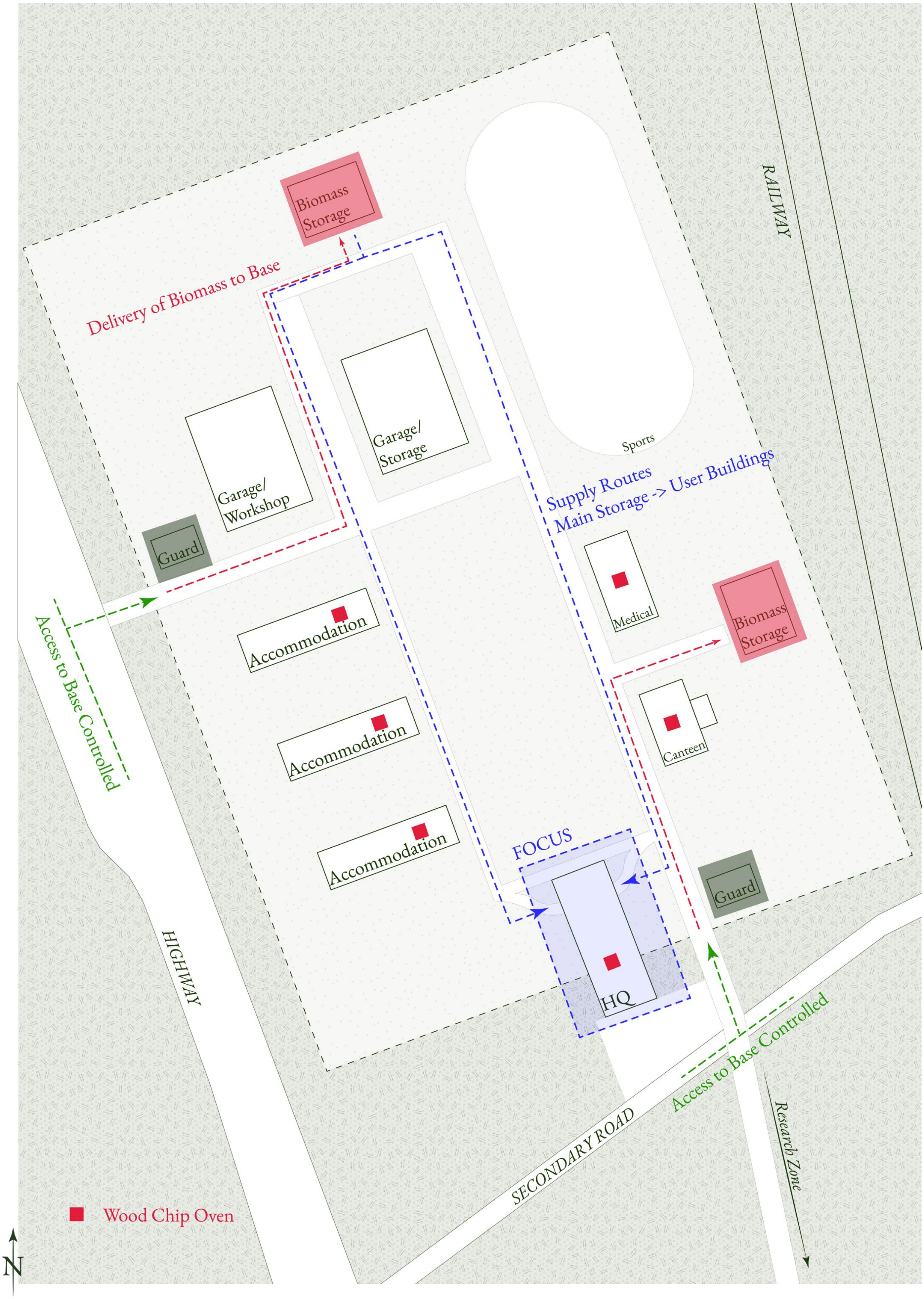
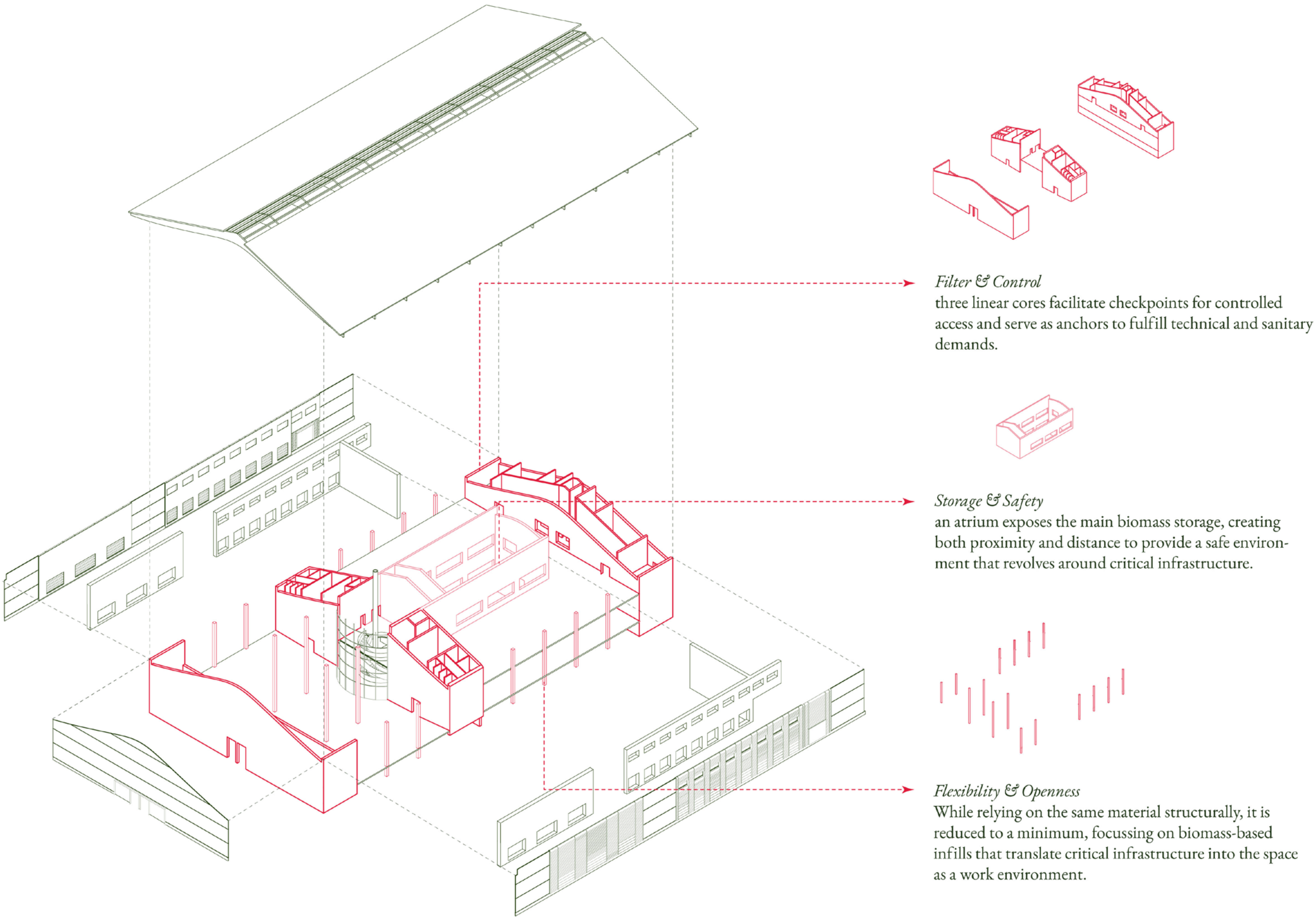


Figure 22: Site Plan 1: 500, internal circulation and logistics

Military Base

The base follows a clear internal logistical and functional logic. It can be organized into three main categories of use that are related but structured to enable smooth workflows: Maintenance, garages, and workshops related to the daily work in the base on the outskirts to avoid noise pollution and easy circulation without disrupting other workflows in the base.
Adjacent to that are the catering and support facilities: The canteen, the medical center, and sports facilities, which can tolerate moderate amounts of noise pollution, which bridge the logistical part of the base with the administrative areas.
Accommodations and the headquarters building at the southern edge of the base allow for easy access.
The design reflects a typical layout of a military compound, incorporating all standard functions, regardless of the military discipline.



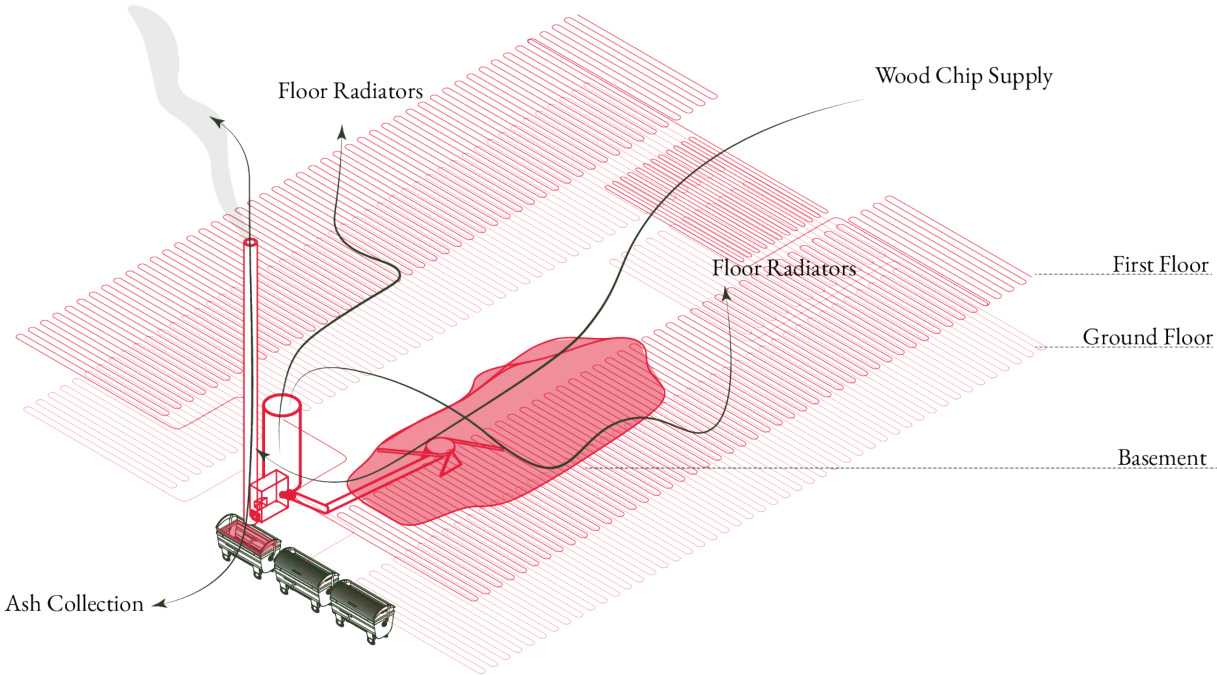


Figure 23, 24: Top: internal logic Headqaurters Building, bottom: Energy System within the building

The Building
Headquarters Building of a Military Base

To stabilize energy grids and contribute to sustainable developments, it is essential that the base has its own independent energy supply. It requires a stable and reliable supply and must function regardless of the weather conditions. Biomass in the shape of wood chips is a suitable source as it is abundant in Lithuania and is deeply rooted in the local culture. Additionally, wood chip ovens are robust systems, easy to maintain, and environmentally friendly to use. To ensure a sufficient supply of biomass and to avoid a „single point of failure“, the barracks contain multiple wood-chip storage facilities, and each building that requires heating is equipped with its own wood-chip oven, resulting in an internal energy microgrid.

Typically, the headquarters building serves communicative and administrative purposes. In this scenario, it acts as an interface between the military compound and the civilian community it collaborates with. Therefore, this building represents the core mission of the military compound in the context of Klaipėda:

A threshold and a mediator between civilian and military parties.
A catalyst for research and collaboration.
An advocate for a sustainable energy future despite geopolitical challenges.

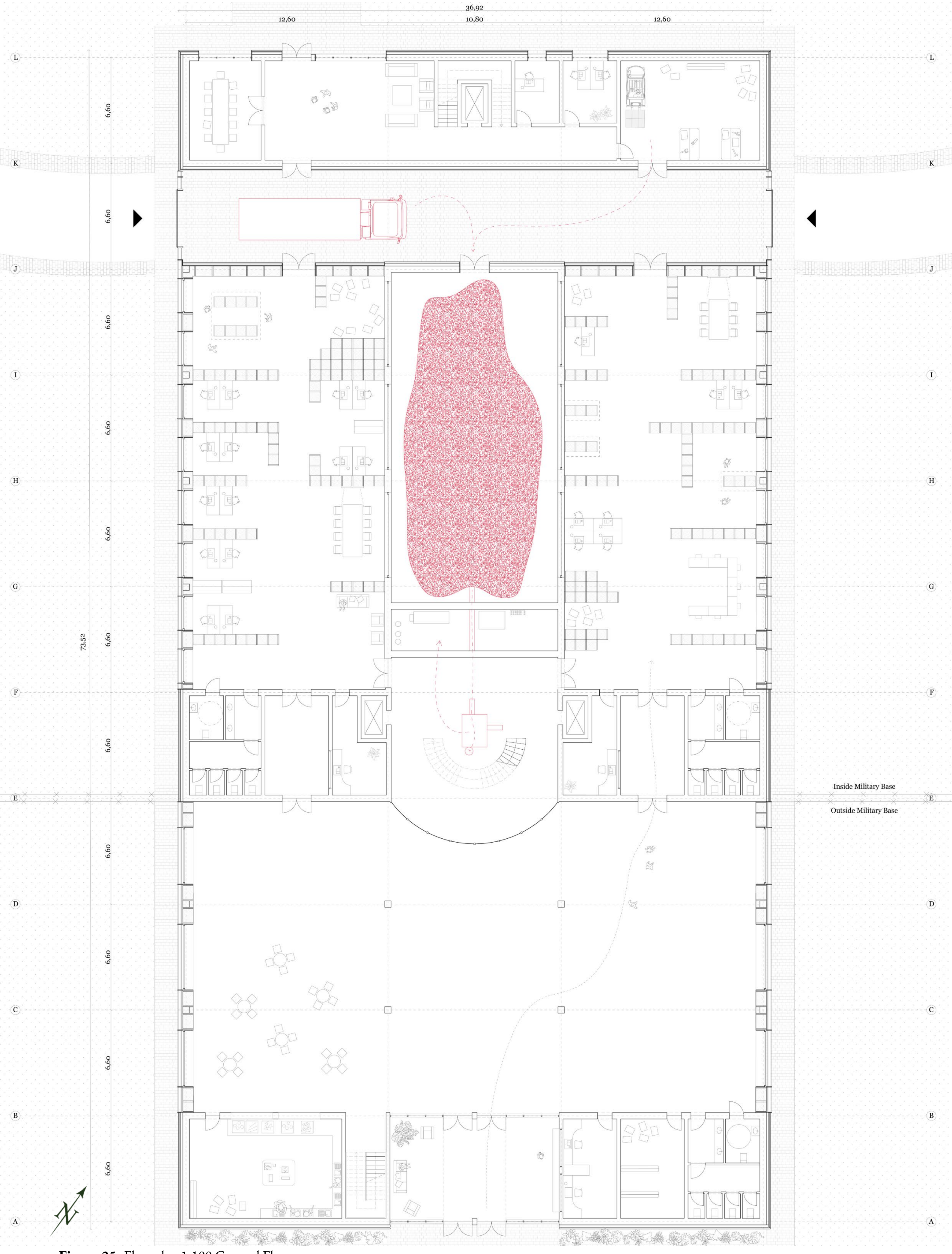


Figure 25: Floorplan 1:100 Ground Floor

The Building
Ground Floor

The building is placed on the border of the military site and thus becomes the threshold between military and civilian society itself. It is a linear structure that is characterized by two main spaces, which are framed by three dense incisions.
Each incision acts as a control point, filtering accessibility depending on confidentiality. The part reaching out of the military compound is a public space. It is widely accessible to civilians and represents the mission of the project to contribute to a sustainable energy future.

The second incision allows access for civilians and military staff who specifically work toward innovative technologies. The military plays a consulting role in this area. It is a space for hybrid activities. As the building runs solely on energy generated by wood-chip burners, this technology is made visible and can be experienced in this space, especially. The structure accommodates its own wood-chip storage that gets processed internally. The wood chip oven is located in the heart of the building: encapsulated between two sides of the incision while remaining visible. Not only the result of energy, but the process of its generation and the storage capacity become visible.

A supply road enables direct access to the storage unit and supplies the storage in the atrium with biomass and separates the military core on the ground floor from the hybrid area.

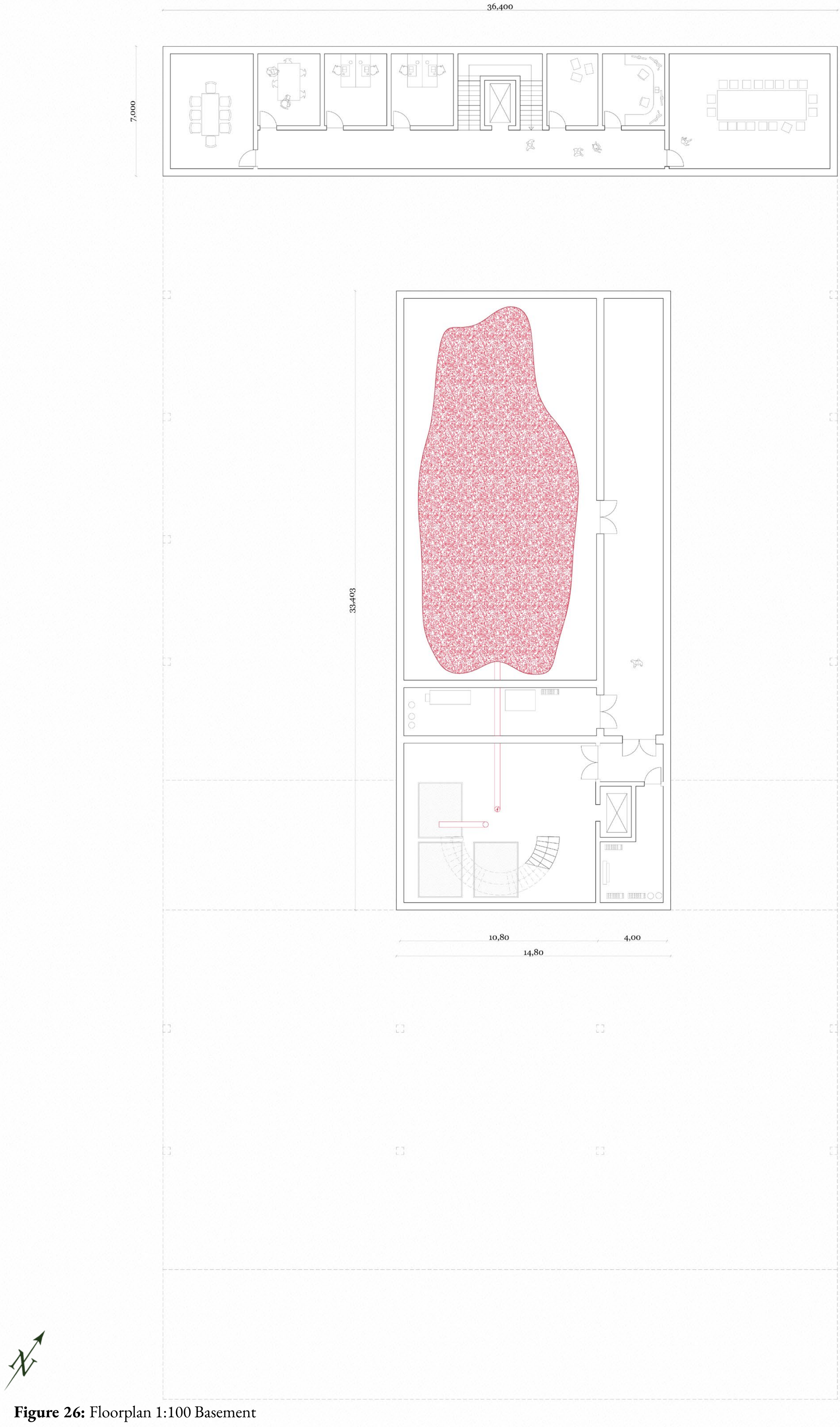


Figure 26: Floorplan 1:100 Basement

The Building Basement

The basements accommodate the rest of the technical facilities of the building. The biomass storage also reaches this part. It connects all floors both in purpose and use.

There are also protected work and rooms to ensure operability in cases of increased alertness. This part is not directly connected to the biomass storage, reducing the risks of fires.

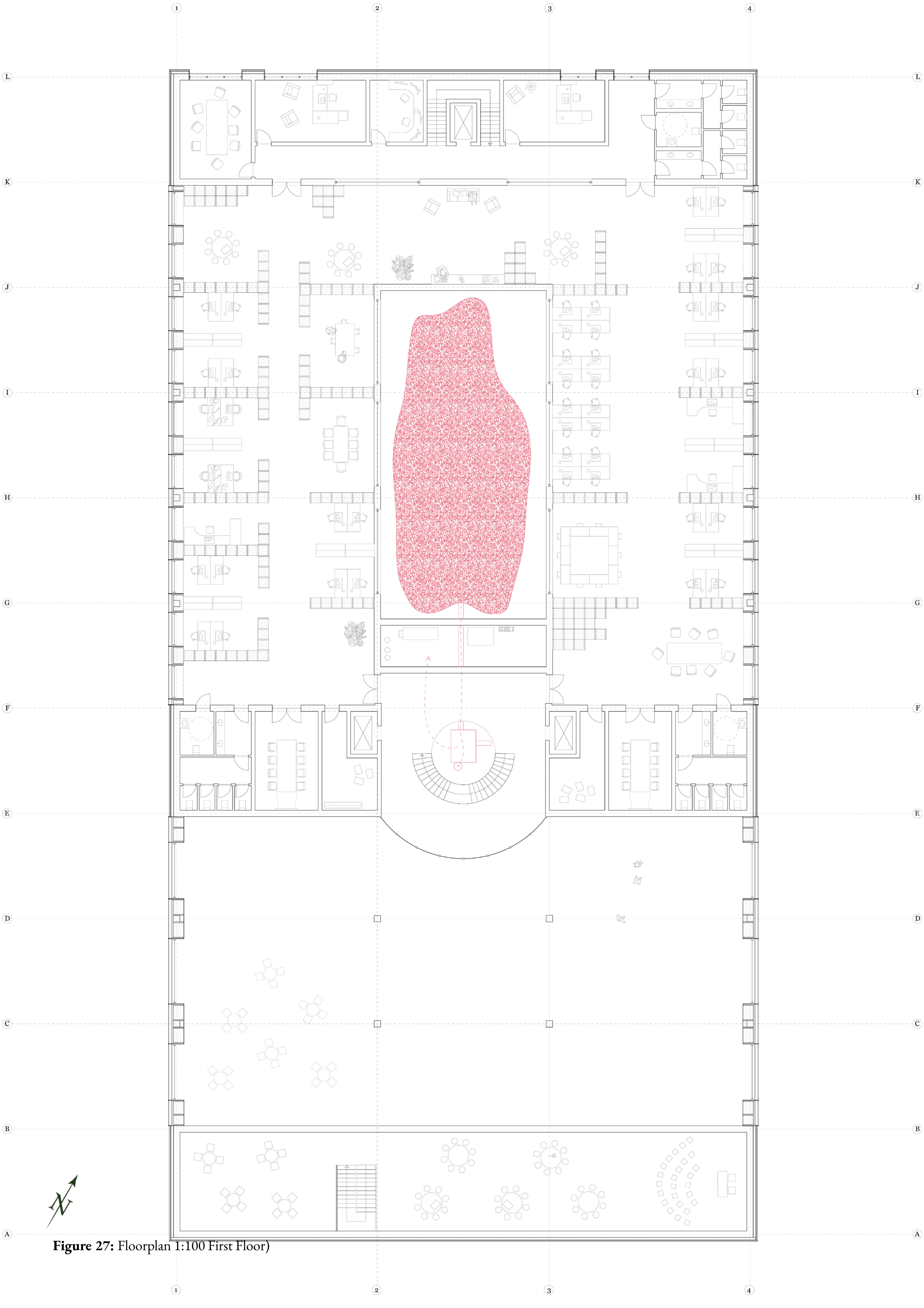


Figure 27: Floorplan 1:100 First Floor)

The Building
First Floor

The upper floor accommodates administrative and communicative purposes. It is the most protected area, and in order to reach it, one has to pass two control points on the ground floor.
This space remains accessible for authorized staff via the middle and the military core.

Figure 28: Foyer

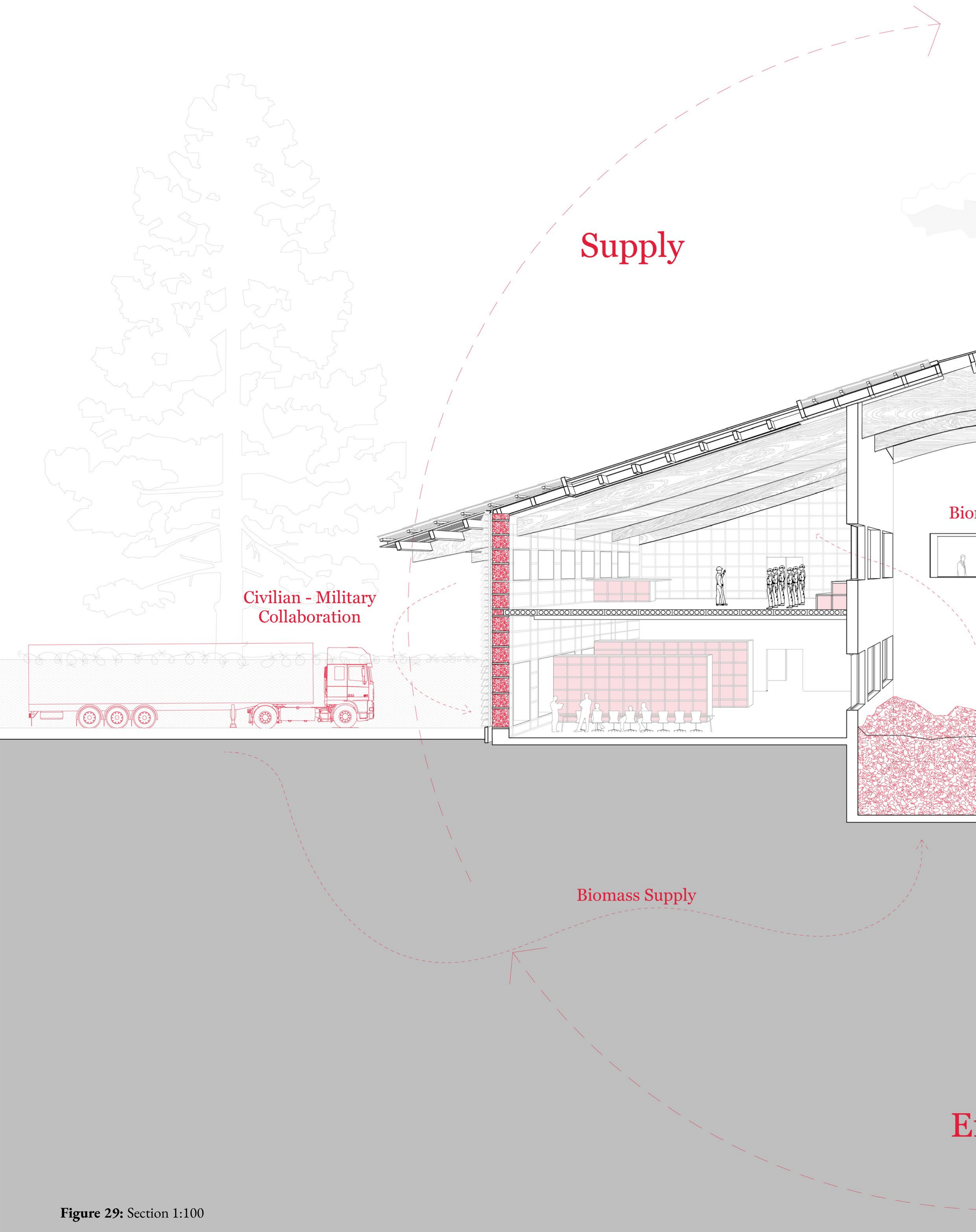
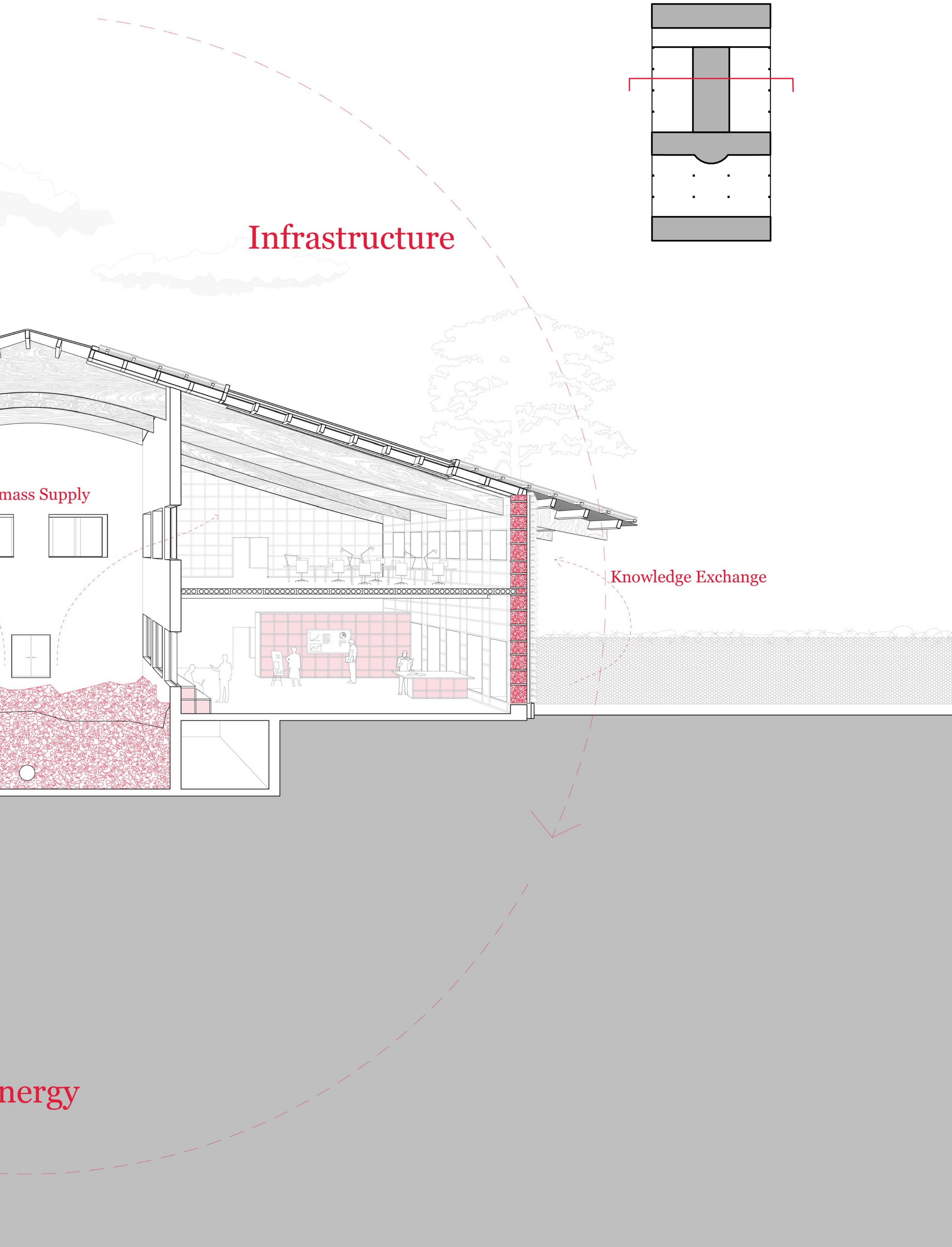
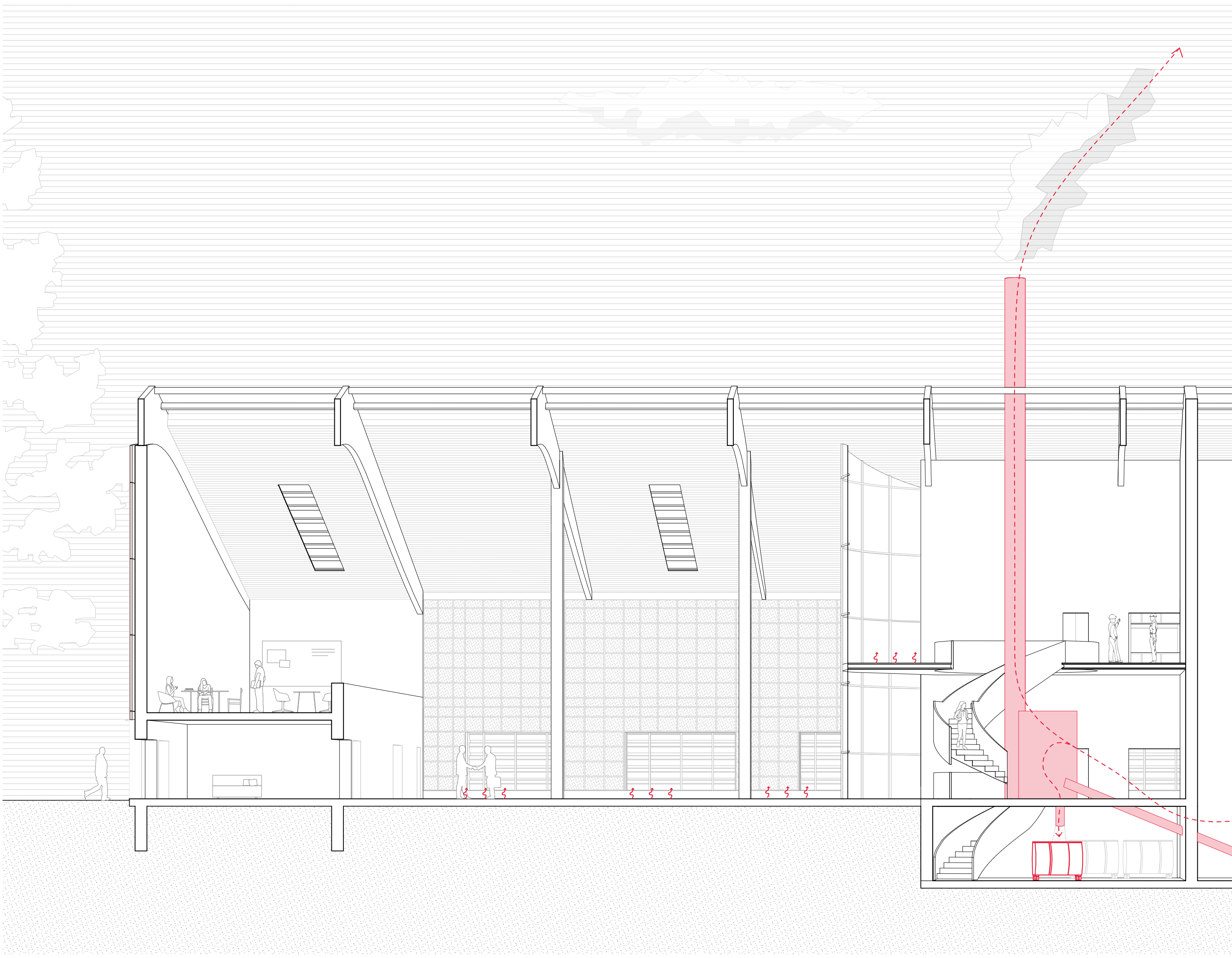


Figure 29: Section 1:100



Infrastructure
mass Supply
Knowledge Exchange
nergy



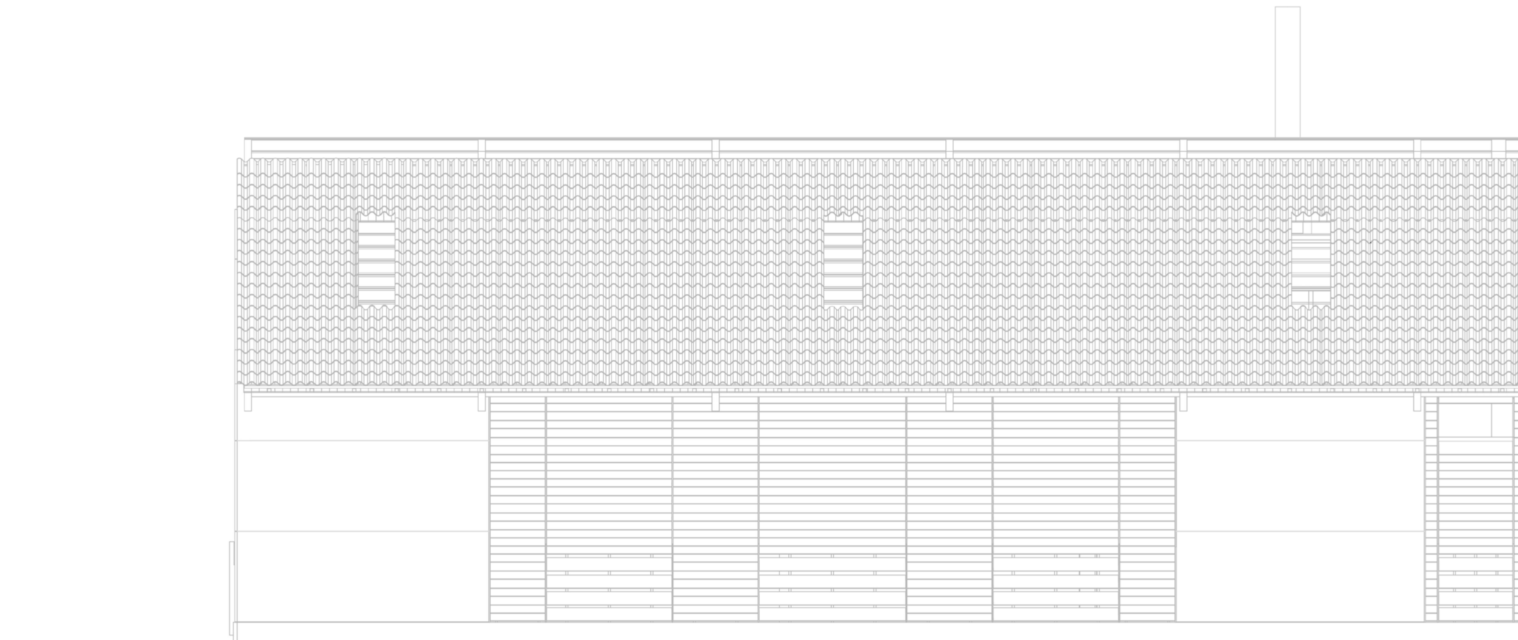
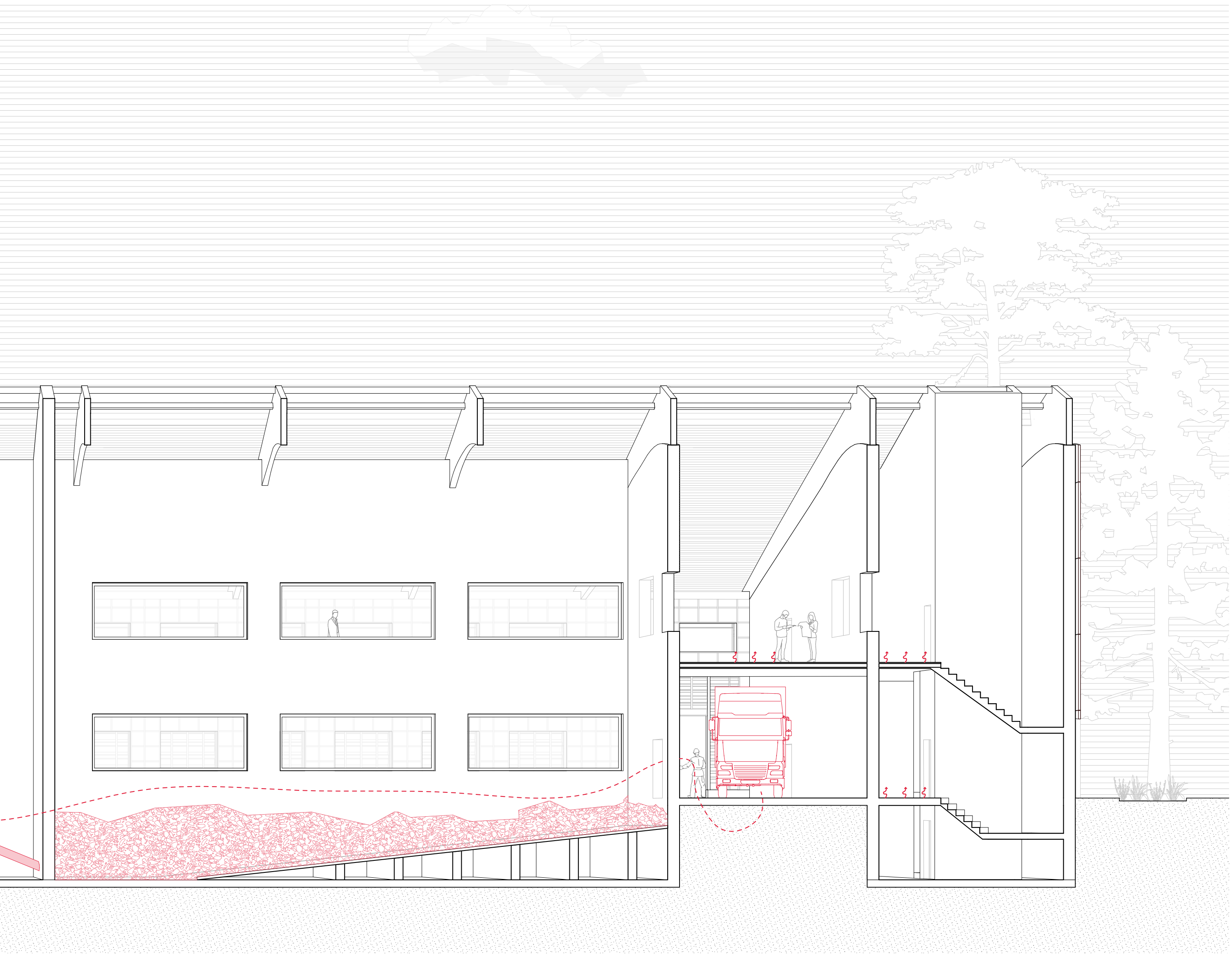


Figure 30, 31: Elevation Side and Section, 1:100



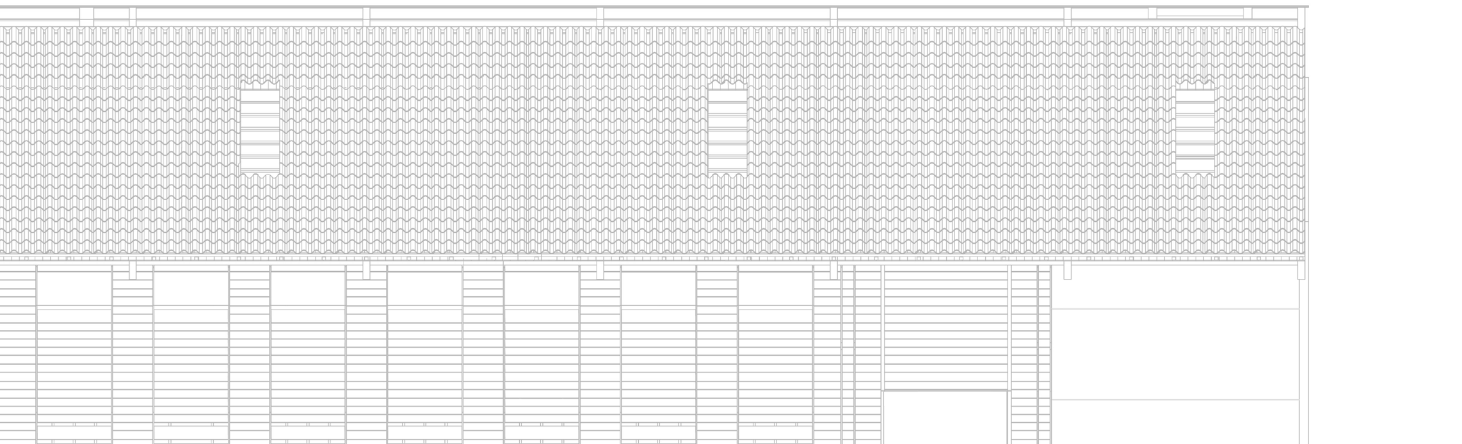


Figure 32: Exterior Visualization

The Building Materialisation and Construction

Because the building is both a protective and introverted structure, but also invites innovation, exchange, and collaboration, it positions itself within a spectrum of societal and spatial tension.
It embodies the ambiguities of its context, which is expressed through the construction and materialisation.

Solid construction techniques ensure protection and controlled accessibility. Collaboration areas are made of lightweight wooden skeleton structures. This duality translates to the choice of materials: Control areas utilize precast reinforced concrete elements with a rear-ventilated facade and wood fibre insulation. All components can be dismantled and reassembled without producing more waste. The open areas are made of a wooden skeleton structure with wide window spaces. These areas are mainly insulated with a thick wood-chip layer that plugs into the shelf-like walls. The insulation layer is also exposed to the inside, manifesting architecture as energy storage.
Partition walls are constructed using the same logic of plug-in shelving units, adding to this idea and allowing for easy adaptation and transformation of the spaces according to user needs.

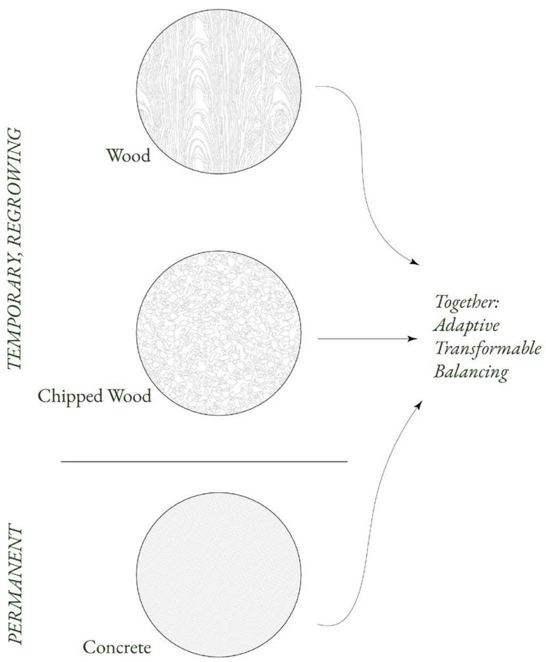


Figure 33: Material Choice

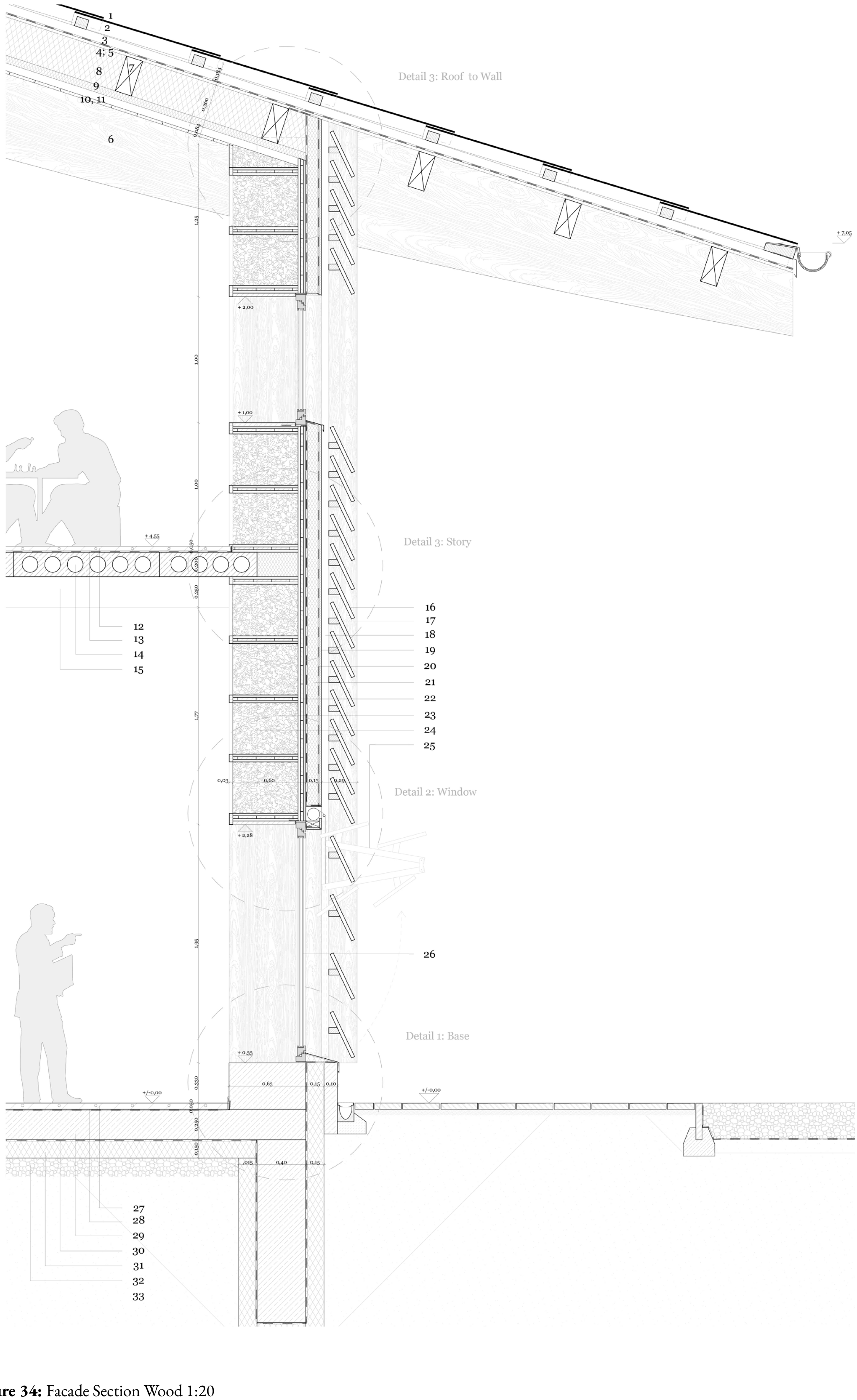
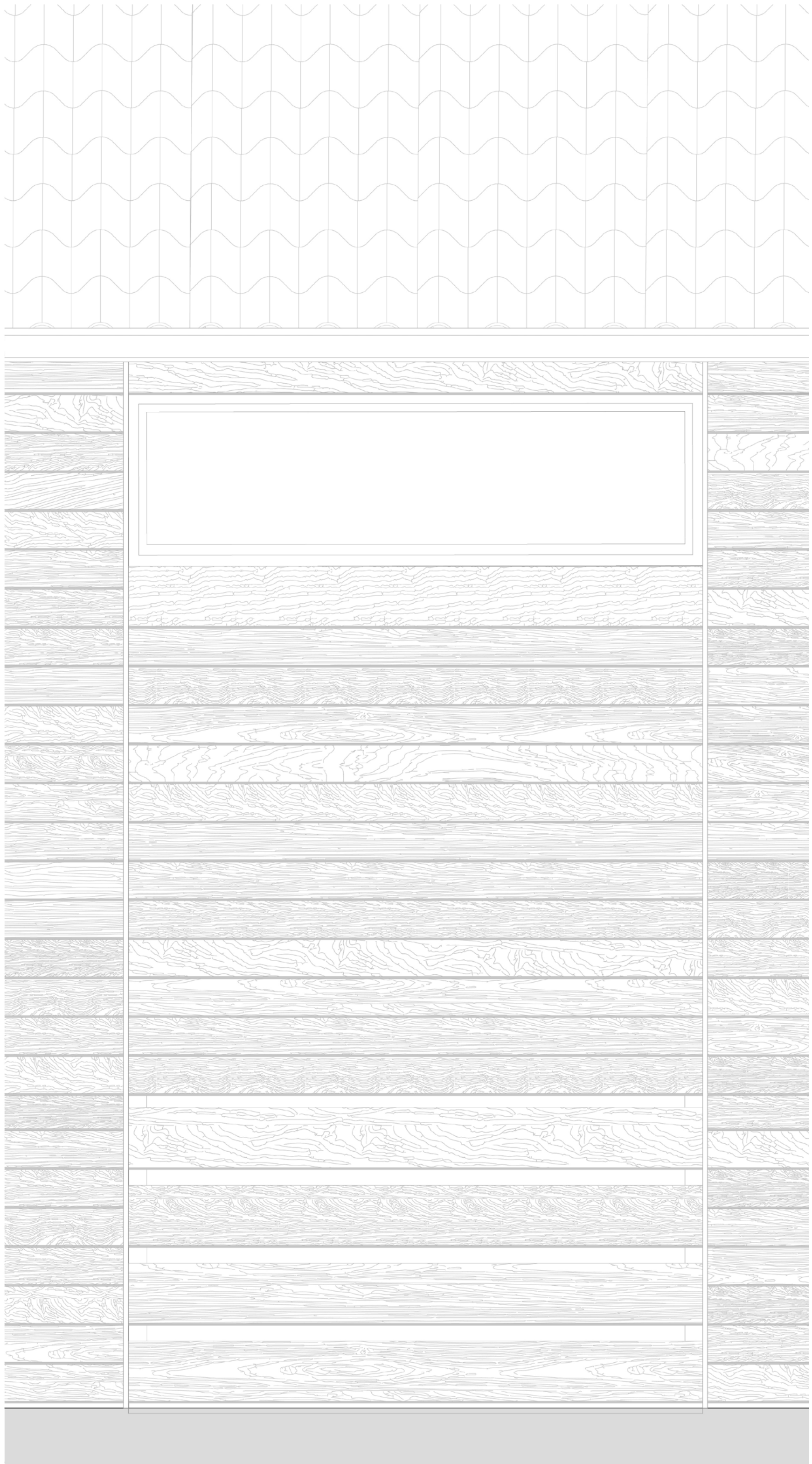


Figure 34: Facade Section Wood 1:20



Roof

1 Corrugated fibre cement sheet
2 Battens, pine, 80 mm x 60 mm
3 Counter-battens, pine, 80 mm x 60 mm
4 Vapor barrier
5 Sheating, pine, 24 mm
6 Glue-laminated timber beam, pine, 200 mm
7 Purlin, pine, 140 mm x 300 mm
8 Insulation between rafters, wood fiber, 300 mm
9 Counter-battens, pine with under-rafter insulation, wood fiber,
10 80 mm x 60 mm
11 Interior cladding, pine, 30 mm

Storey

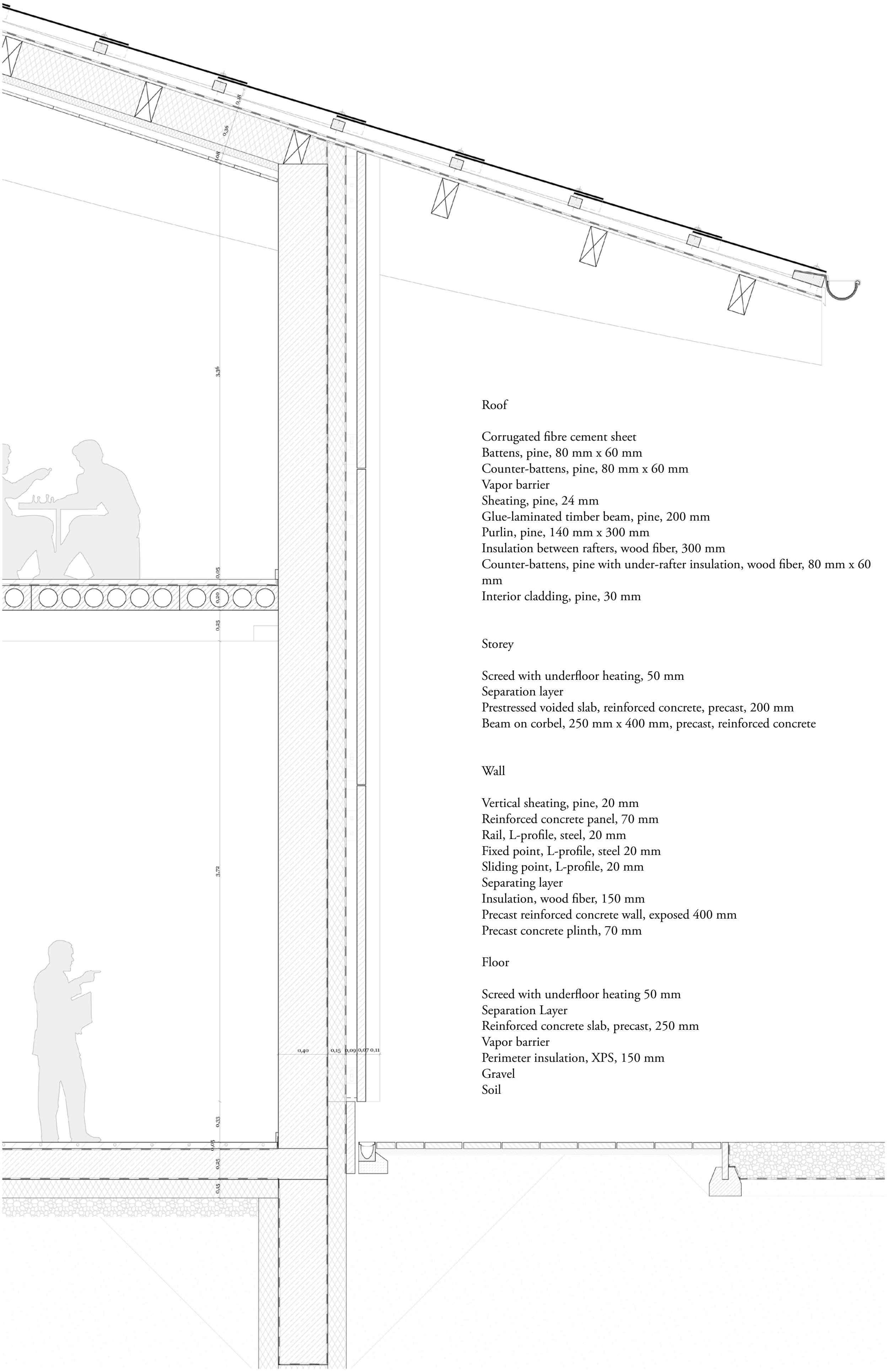
12 Screed with underfloor heating, 50 mm
13 Separation layer
14 Prestressed voided slab, reinforced concrete, precast, 200 mm
15 Beam on corbel, 250 mm x 400 mm, precast, reinforced concrete

Wall

16 Sheating, pine, 20 mm
17 Counter-battens, pine, 60 mm x 60 mm
18 Battens, pine 60 mm x 60 mm
19 Cladding, pine, 20 mm
20 Vapor Barrier
21 Insulation, wood fibre, 100 mm
22 glue-laminated timber shelving, pine, 63 mm
23 Loose-fill insulation in a wire-mesh box, wood-chip, 600 mm
24 Precast reinforced concrete column 400 mm x 400 mm
25 Vertical folding shading system
26 Window, double-glazed

Floor

27 Screed with underfloor heating 50 mm
28 Separation Layer
29 Reinforced concrete slab, precast, 250 mm
30 Vapor barrier
31 Perimeter insulation, XPS, 150 mm
32 Gravel
33 Soil



Roof

Corrugated fibre cement sheet
Battens, pine, 80 mm x 60 mm
Counter-battens, pine, 80 mm x 60 mm
Vapor barrier
Sheating, pine, 24 mm
Glue-laminated timber beam, pine, 200 mm
Purlin, pine, 140 mm x 300 mm
Insulation between rafters, wood fiber, 300 mm
Counter-battens, pine with under-rafter insulation, wood fiber, 80 mm x 60 mm
Interior cladding, pine, 30 mm

Storey

Screed with underfloor heating, 50 mm
Separation layer
Prestressed voided slab, reinforced concrete, precast, 200 mm
Beam on corbel, 250 mm x 400 mm, precast, reinforced concrete

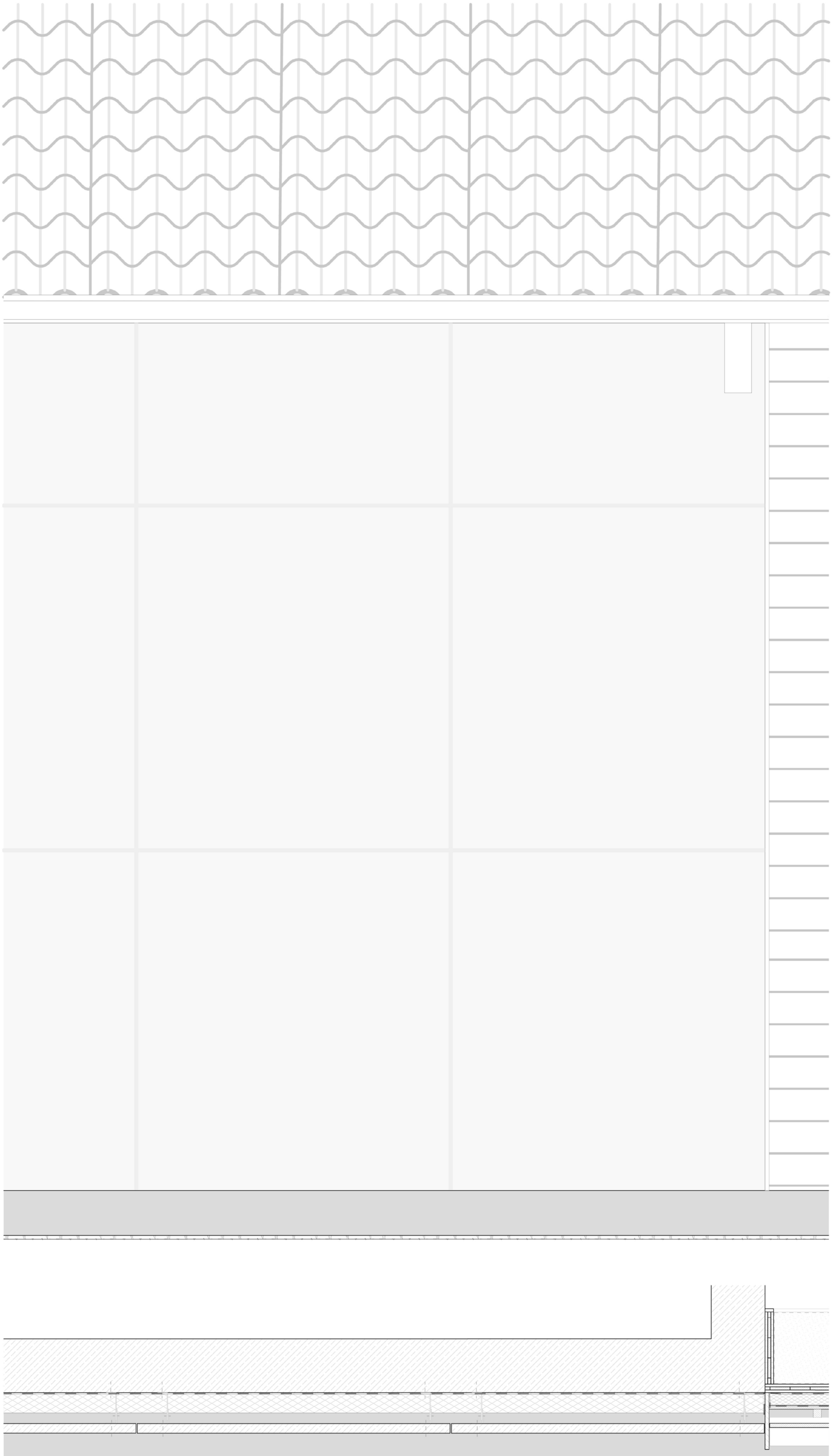
Wall

Vertical sheating, pine, 20 mm
Reinforced concrete panel, 70 mm
Rail, L-profile, steel, 20 mm
Fixed point, L-profile, steel 20 mm
Sliding point, L-profile, 20 mm
Separating layer
Insulation, wood fiber, 150 mm
Precast reinforced concrete wall, exposed 400 mm
Precast concrete plinth, 70 mm

Floor

Screed with underfloor heating 50 mm
Separation Layer
Reinforced concrete slab, precast, 250 mm
Vapor barrier
Perimeter insulation, XPS, 150 mm
Gravel
Soil

Figure 35: Facade Section Concrete 1:20



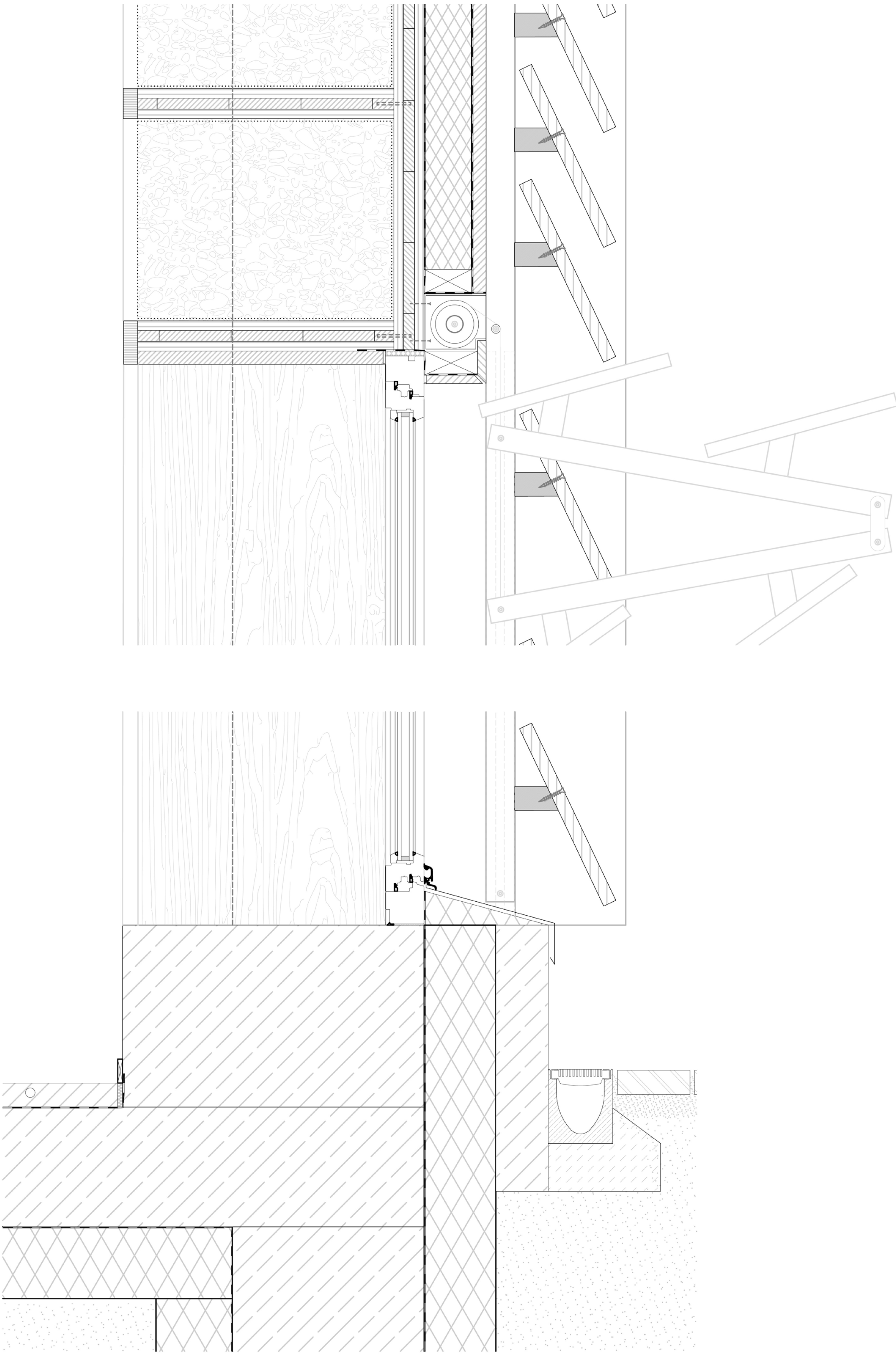


Figure 36: Detail 1:5 Window, Wood

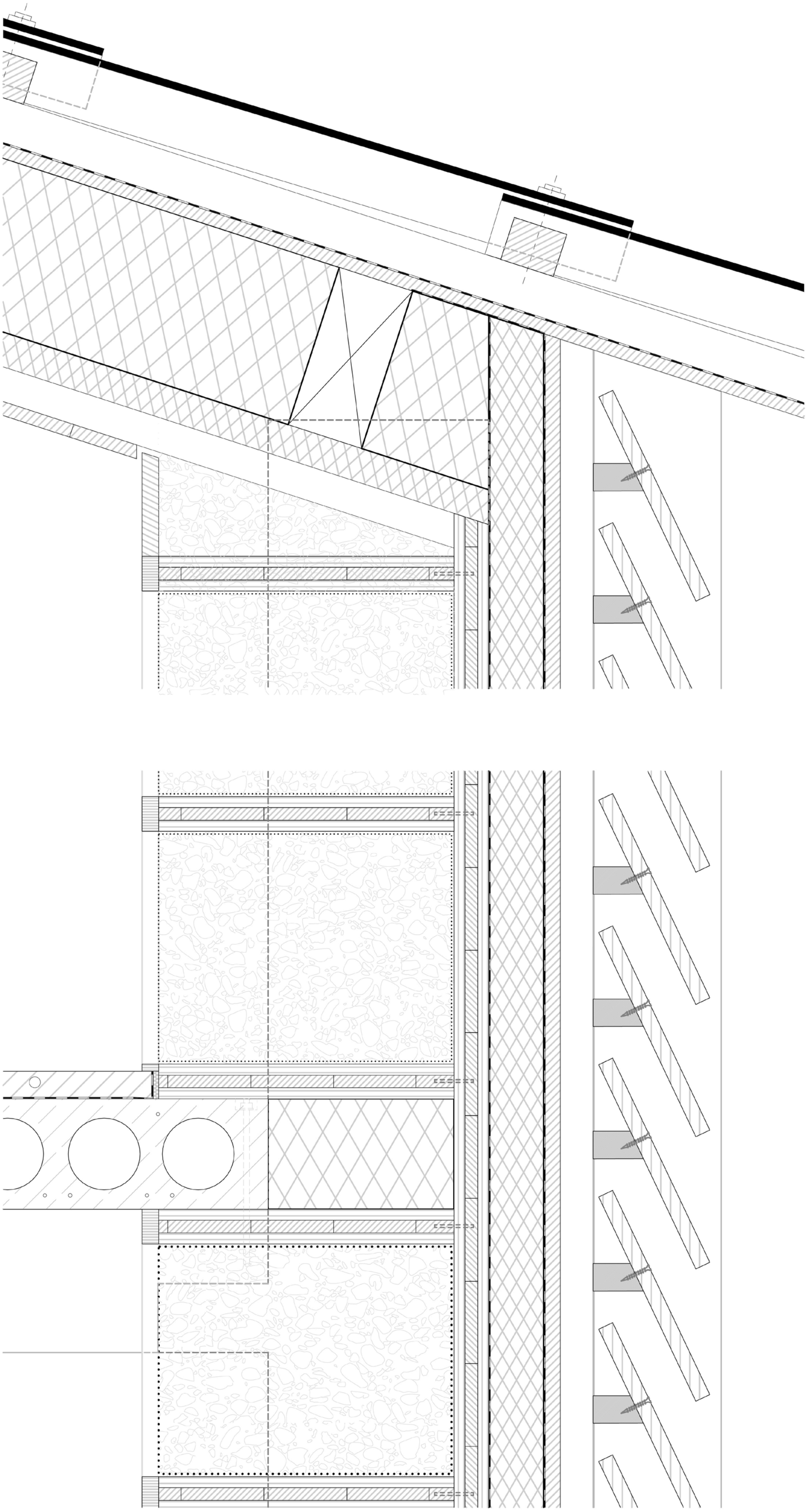


Figure 37: Detail 1:5 Story and Conncection Roof to Wall , Wood

Figure 38: Interior Visualisation and of Energy System

The Building Energy Scenarios Peace time and Emergency

In peacetime, the building runs on wood-chip-based energy supplied to the building and stored in the atrium storage. This can easily be refilled and enables comfortable temperatures during the winter months in all spaces.
In case of emergency and extended periods of stress, comfortable room climates are reduced to a minimum: the longer this period persists, the more drastic are the cuts on which spaces are prioritized in terms of thermal comfort until only the military core gets continuously warm. Supply chains are expected to be interrupted and unreliable. Therefore, the wooden parts of the building can gradually be dismantled and burned.

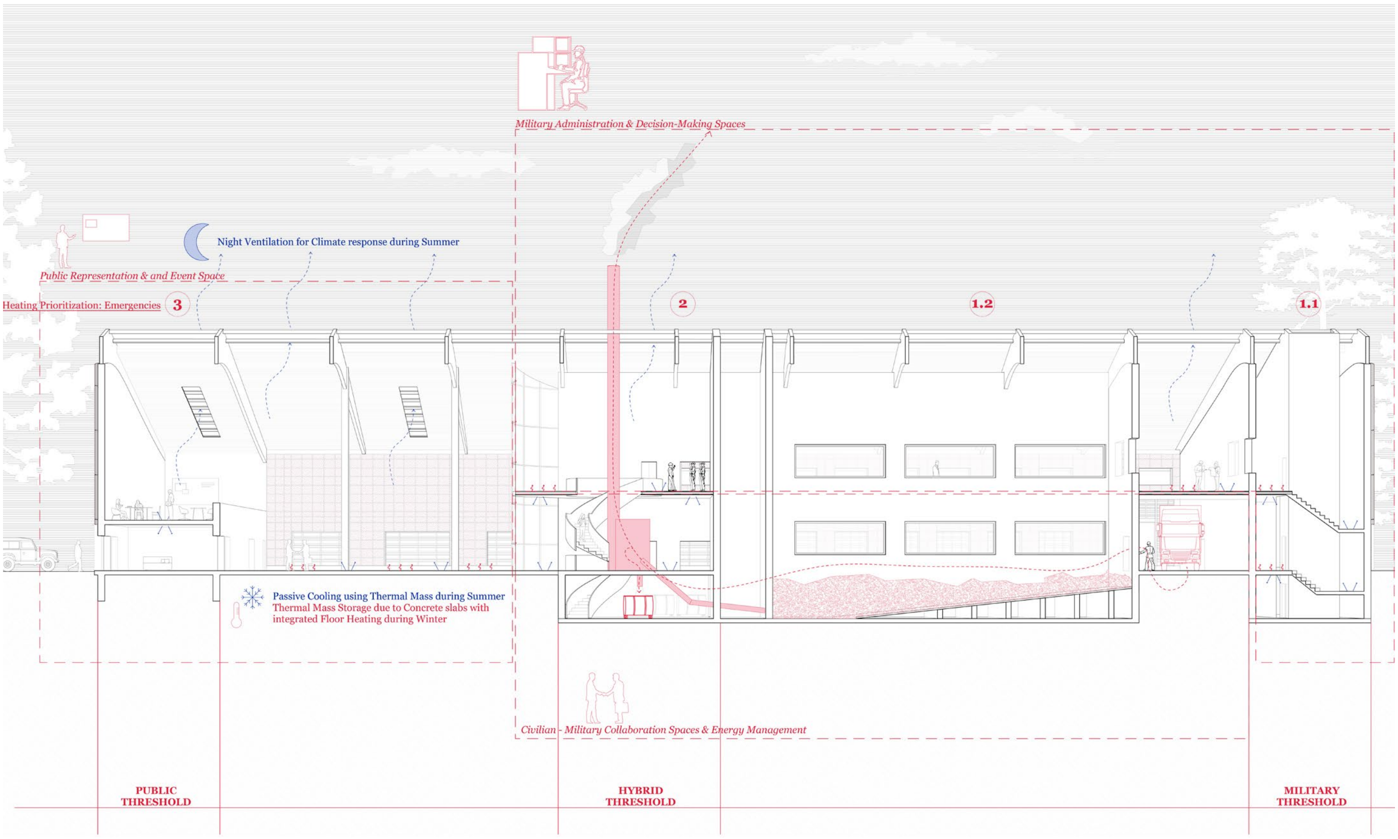
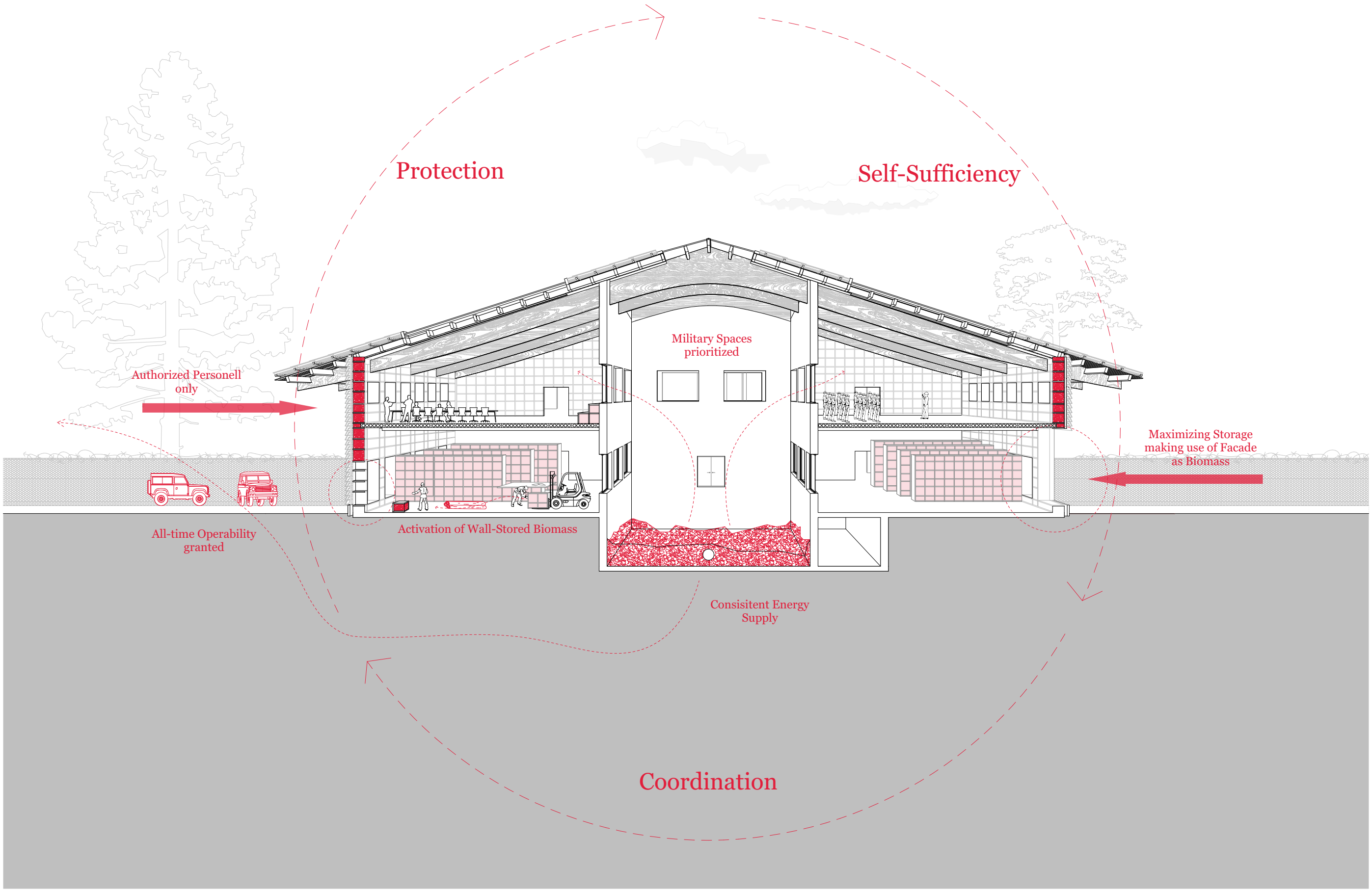


Figure 39: Relationship Energy System and Zoning according to use



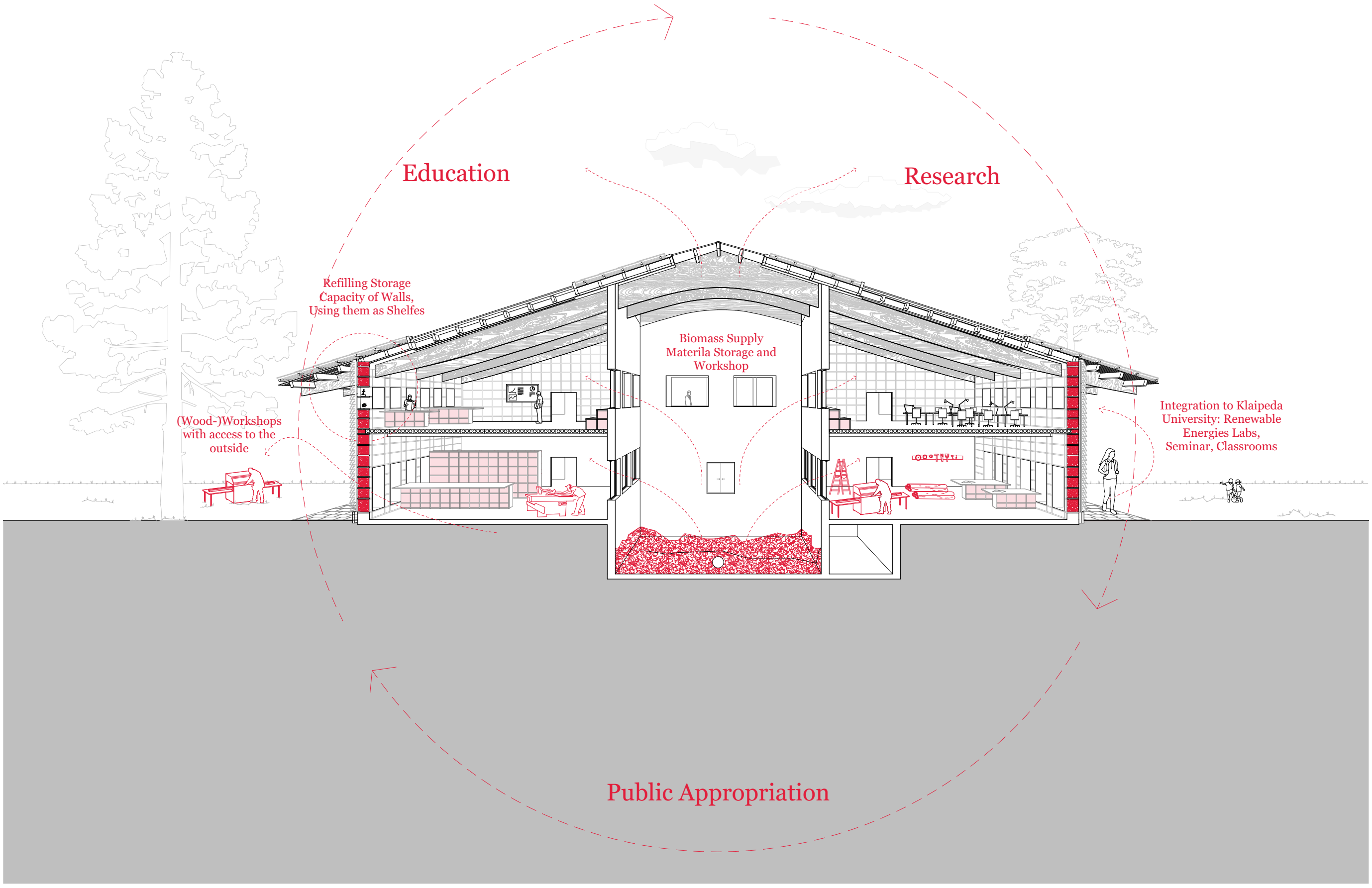


Figure 40: Conflict-Phase Adaptation top: Conflict, bottom: Post-Conflict, right: Pre-Conflict

The Building
Phase-Specific Adaptations

Pre-Conflict

The base, including the headquarters building, is planned and constructed as a response to increased alertness. Therefore, the building itself is a structure of anticipation. During the pre-conflict phase, the focus lies on preparing for a crisis by activating all storage capacities and expanding them where possible. Collaborative research on renewable energy and resilience training is a key activity taking place. The structure is used to its full capacity.

Conflict

During the conflict phase, it turns inward, hardens thresholds to the outside of the military compound, and prioritizes the military areas in terms of energy supply. The public spaces are used as an extended biomass storage space and are inaccessible to the public.

Post-Conflict

Assuming that the building used large parts of its wall-stored biomass, a reconstruction phase follows. It replenishes its energy storage and gives up its military use to not only generate energy but also to support the reconstruction of the surrounding area by providing energy and materials.
Furthermore, a civilian repurposing of the building in line with the energy transition is possible, for example, as a wood processing facility and workshop space affiliated with the Klaipėda University.

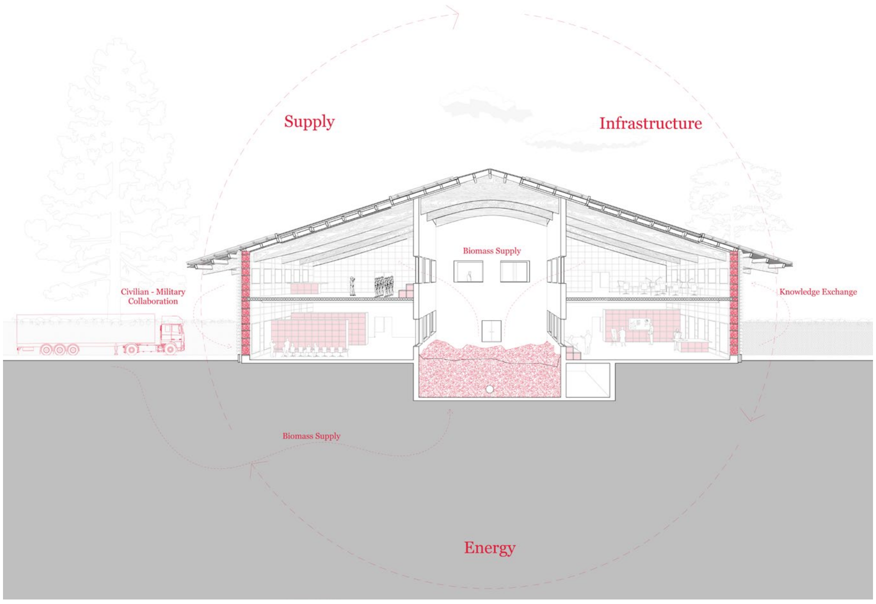


Figure 41: Conflict-Phase Adaptation Foyer left: Conflict, right: Post-Conflict

Part 4_Conclusion and Discussion

Conclusion

The work conducted in this research explored how architecture can react to complex geopolitical contexts by not only focusing on one state but also by anticipating a crisis. It represents itself as an example that, although a structure can respond highly specifically to a certain condition, it does not imply that it cannot transform drastically and still remain relevant over time.
The final design demonstrates how a military base can function as a mitigating entity between military, technical innovation, civilian benefit, and become infrastructure itself without becoming a vulnerable target on a system level.

Energy infrastructure is not merely a temporary military necessity. Sustainable energy is also not only a luxury for peace-time scenarios. It is a need that must be considered no matter the geopolitical circumstances and must be viewed as a long-term spatial foundation that promotes sustainable and resilient development as it transitions between military and civilian uses.

The subsequent areas of tension, such as inside and outside, openness and secrecy, security and vulnerability, form the basis that gives the building meaning and a strong frame of action.
Changes do not occur in a uniform manner, but rather in differentiation dependent on the context. While some components remain stable, such as the cores, others are highly adaptable depending on the user groups.
The result is a building that can be extremely specialized without ever becoming obsolete.

The project directly addresses the main research question by proposing an adaptive structure, which is an energy generator, energy storage, and military-civilian collaboration infrastructure. It proves how architecture can transform throughout vastly changing external conditions. This principle is scalable, with the building being the smallest fragment of the energy system. Similar principles thus apply for the military compound as a whole, and the energy transition masterplan in the long run, as energy is a consistent need in urban development that needs continuous modernization and transformation.

Furthermore, the thesis demonstrates the significance of approaching climate-related challenges on an interdisciplinary level. None of the presented challenges can be solved solely at a building scale; instead, it takes constant collaboration and united efforts on different scales and across fields of expertise to create meaningful structures. Users give buildings a purpose. The purpose creates needs that must be met. The challenges that appear are usually multi-dimensional.

Therefore, the thesis concludes that architecture can provide the meeting ground and catalyst for exchange and discourse that enables the necessary actions by the users. It acts as a mediator between infrastructure, society, and unstable environments. It is a spatial response to energetic vulnerability, providing the space for transformation and progress.

Implications

The relevance of this project exceeds the specific site conditions of Klaipėda‘s port. It portrays a very specific way of dealing with architecture and primarily focuses on one type of energy generation. The chances and challenges around critical energy infrastructure are not one that is unique to Klaipėda. Instead, energy is generated and distributed over wide spanning distances and tightly interwoven networks. Each position of such a network has the potential to be explored on and cared about on an architectural level and beyond.

A key quality of this design is its collaborative and multi-scalar attitude. It enables a perspective on architecture that goes beyond spatial considerations but is aware of its limitations and challenges. Because of that, the project could act as a starting point for an even larger systematic approach that considers multiple energy nodes and illustrates how they relate to each other.

The project is also not merely related to its military and geopolitical context, but can be translated to other contexts that have ambitions for a sustainable, energetic future. This project was compiled in the geopolitically tense context of Lithuania and dealt with this on an energetic level. The energetic implications of this project, however, can be used and further developed and tested in completely different contexts, adding to the innovative capacity of architecture in this realm, by focusing on other renewable energy sources that can result in different but complementary findings to this topic.

Reflection

Personal Process

This graduation project started from a very open approach. We were given three different geographical contexts, which we could choose: Syria, Namibia, and Lithuania. Each of them presented different challenges and conditions. What initially inspired me to work within the context of Lithuania was my personal background. Before starting my architectural education, I served for two years in the Federal Armed Forces of Germany, where I was trained to be a Reserve Officer. During my time in the military, I became very familiar with military rationales and the reality of the life of a soldier. I also personally know a lot of soldiers who were deployed to Lithuania during and after my time in the military and had access to their personal experiences in a military base within NATO.

This gave me valuable insights and perspectives into the internal logic and priorities for military operations abroad, which informed my decision to work in this context.
To me, this graduation project combines both my educational and professional paths in a way that also challenged me and pushed me to explore new fields of expertise. For me, this was found in choosing to focus this project on energy systems. My previous education provided me with background information that allowed me to step into a side of architecture that I was not very comfortable with before.

This experience also acts as a reminder that insights and knowledge across fields of expertise can only enrich one's perspectives and the development of a project, as it broadens the possibilities of how problems can be solved. It strengthened my belief that future-oriented design requires close inter-disciplinary collaboration. This is also proven through the many consultations and workshops that were organised by the graduation studio, which had a great impact on the development of the project, as it provided valuable insights from professionals in the field and related to peacekeeping.

Design/Research Methods, Tools, and Techniques

Throughout the development of this project, I made extensive use of exploring the design through sketching, researching, and compiling information and research in my notebook, which compiles my whole process. It was an important tool to collect all the data and keep me on track with the purpose and direction of the project. I often used it to double-check my strategy, explore and communicate ideas, and present and discuss them with my tutors. Furthermore, physical models helped a lot to understand mass and spatial relationships, which informed the final design significantly. Additionally, I used digital tools and architectural software to bring the project into a realistic and feasible shape.
Artificial Intelligence in the shape of ChatGPT was used for surface-level research, but was primarily used to reflect and conclude information and explore ideas. The information resulting from it demanded continuous cross-checking and verification and was not used to replace the design process itself but rather to give initial impulses and overviews that were then explored and checked in depth through my own research and consultations with my tutors.

Acknowledgements

I would like to express my sincere gratitude to my supervisors, Ingr. Freek Speksnijder and Prof. Dr. Ing Ulrich Knaack for their guidance, support, and valuable feedback throughout this graduation project. They guided and encouraged me throughout this exciting journey of writing and designing this thesis. Without their encouragement, continuous excitement, and engagement, this project would not have been realised and elaborated as it is now.

I wish to express my appreciation and special regards to those who supported the development of this project by providing their expertise from the professional field in architecture, the Dutch Ministry of Defense, and TNO, as their input and feedback profoundly shaped my creative and academic process. Without your engagement, this project would not have been possible.

Further, I would also like to thank my family and friends, who have continuously supported me and encouraged me during times of uncertainty and difficulty. I am grateful for the patience, numerous conversations over the phone, several dinners, lunch breaks, and weekend activities that kept me going through this process.

I am grateful to my peers for their companionship, encouragement, support, and fun I was able to experience in the EXTREME Graduation Studio.

Finally, I would like to thank all the people who have contributed to the completion of this thesis, directly or indirectly; their support has been greatly appreciated.

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Transformative Architecture:

Spatial Strategies across Conflict Phases in War-Affected Environments

by

Sophia Idalies Birgit Scheiwe (6303161)

Research Paper submitted in partial fulfillment of the requirements for the degree of Master of Science in Architecture, Urbanism, and Building Sciences

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List of Figures

Transformative Architecture: Spatial Strategies across Conflict Phases in War-Affected Environments

Keywords: Transformative Architecture, Crisis, Architecture for Conflict, Conflict Management, Conflict Architecture, Military Architecture, Environmental Psychology, Resilient Architecture, Conflict Impacts

Introduction

War as a Spatial Condition

War is a recurring and continuous phenomenon throughout human history. Though its intensity and character change over time, it has a direct impact on how the built and unbuilt environment is perceived, organized, and shaped by its inhabitants (Schoonderbeek & Shoshan, 2017). Thus, war is inherently spatial in nature, and not only a military or political phenomenon. It shapes landscapes, communities, and environments long before and long after violence takes place.

The cycle of anticipating conflict, experiencing conflict, and recovering from conflict-induced challenges has impacted the lives of humans repeatedly (United Nations. Crisis Environments Training Initiative & UN. Disaster Management Training Programme, 1998). It led people to relocate, changed natural and built environments, catalysed technological innovation, disrupted infrastructures and economies, and forced communities to continuously adapt to ever-changing circumstances (Vesco et al., 2025). In this context, architecture serves humans not only by providing shelter but also offers a framework for daily life and is influenced by the changing circumstances that are associated with conflict phases.

Problem Statement

Architecture can react to the changing conditions of conflicts by making buildings and infrastructure more protective and by providing space for return, repair, and processing of experienced events. Because of this, architecture can be understood as an "*emotional subject*" (Grabowska, 2017), as it can influence its inhabitants' mood through space, materiality, light, or enclosure. In a broader sense, it therefore has the power to mitigate uncertainties of (geo-) political realities. Despite this, much of modern architecture situated in such contexts, such as Cold War bunkers or military bases across Europe, is designed for conflict as a stable condition, neglecting its dynamic and recurring nature and its need to adapt to shifting circumstances. Typically, it is highly optimized for one specific moment of crisis: anticipation of conflict (defensive Infrastructure), active conflict (emergency or military facilities), or post-conflict recovery (refugee shelters) (Lahoud, 2010). Consequently, such structures perform well under the specific conditions they were designed for, but struggle to adapt or adjust to the changing social and political demands of post-conflict times. Conventional reuse or modification is often curtailed by factors such as restricting dimensions, limited accessibility, or inadequate ceiling heights (Sanna et al., 2025). Thus, they often become obsolete, abandoned, or irrelevant when circumstances shift, and add to spatial fragmentation and architectural waste. As modern war has advanced technologically, the demands for its architecture have also advanced, complicating its adaptability for changing circumstances in the future(Ebejer et al., 2023).

Subsequently, communities inherit environments that are designed for conflict or the anticipation of it. This kind of architecture is incapable of adapting to conditions of peace and can become hostile or unusable, failing to support the longer temporal reality of conflict evolution in the long run.

This research addresses this discrepancy by asking:

Research Question

How can transformative architecture be designed to adapt to the functional and spatial demands of pre-conflict, conflict, and post-conflict phases?

(A) Crisis Phases and Requirements
How can pre-conflict, conflict, and post-conflict phases be defined in terms of their environmental, functional, and operational requirements?

(B) Transformative Architecture Strategies
What architectural strategies enable buildings to transform across different phases of conflict?

(C) Historical Precedents
What lessons can historical and contemporary war-related architecture provide for designing transformative architecture across conflict phases?

Relevance

This research is conducted in the context of a rapidly changing world order. Political world powers which were once stable are now in a state of transition, where violence escalates more rapidly, and unprecedented, extreme events take place. Since architecture is tightly interwoven with this state of tension between permanence and urgency, it is shaped by geopolitical circumstances, political forces, collective fears, and technological advances. In reality, the question then becomes not how long military architecture can protect territory, but how it adapts, transforms, and how it carries meaning across ever-changing and unpredictable environments. Today, as civilian populations increasingly live inside and around military infrastructure that is built in anticipation of war, conflict, and peace, transformative architecture becomes a societal necessity.

Objective

This research tries to bridge studies with architectural transformation theory to develop a phase-based conceptual framework that can be used as a toolkit for future research and design work. Building on phase-specific requirements and transformative architecture strategies, newly built buildings can be relevant across all conflict-phases. Although the findings of this research are also applicable across conflict-prone contexts, they are developed in the context of contemporary European geopolitical tensions as the context for the subsequent graduation project.

Scope

The paper deals with architectural systems and buildings, not urban warfare or political strategy. It considers conflict phases as the temporal context with spatial impacts and focuses on the proximity of military and civilian users as the main user groups. By looking at a few historical and contemporary examples, the set of requirements and strategies developed is tested and used as a tool for measuring the effectiveness of the matrix.

Methodology

This work uses a qualitative, research-by-analysis approach by drawing upon theoretical reviews with analytical frameworks to evaluate comparative precedents.

First, the literature on conflict management is reviewed and contextualized with architecture studies and environmental psychology to define conflict phases and identify architectural requirements. Then, transformative architecture is explored as a concept for how architecture can react to changing conflict phases. Next, a selection of historic and contemporary precedents is analysed based on the criteria that were derived to evaluate their performance during the conflict phases. The concept of environmental psychology, specifically the aim of psychological stability, is used as a lens for assessing how a built environment maintains relevance over time, apart from functional and operational efficiency. To assess this, indicators of psychological stability for agency, continuity, and legibility are defined and discussed. Finally, the findings of the previous chapters are synthesised into a theoretical framework that serves as a matrix of criteria that can be used for subsequent architectural elaborations regarding architectural projects in geopolitically tense contexts.

Definition of Changing Conditions

As contexts shift depending on human activities, functional, spatial, and operational requirements also evolve and influence reactions of the built environment (Kamara et al., 2020). *Functional* needs describe the tasks that are required of a space. *Spatial* requirements relate to representing the program and layout that express functions of a building, and *operational* demands refer to the performance of the whole structure under changing conditions. In this paper, the term "changing conditions" refers to the time-dependent shifts in *spatial, functional, and operational* properties of a system or building, as well as the psychological impact those have on its users.

In accordance with the phases of pre-conflict, conflict, and post-conflict, for instance, the functional needs for a space can vary across phases from storage in anticipation of conflict, barracks for military personnel during conflict, and shelter for civilians after a conflict resolves. Concurrently with shifting functional demands, the spatial properties of a structure must facilitate these needs and operational continuity has to be ensured while also a minimum of psychological stability has to be provided.

Psychological Stability as a Lens

The way a building is perceived by a person can influence their mood, attention, and behaviour through attributes like spatial organization, materiality, light, or enclosure, making architecture an active psychological entity that impacts the comfort and well-being of its users (Vesco et al., 2025).

Taking this into account, this research uses psychological stability as described in environmental psychology as a design indicator. It aims to evaluate how architecture can mitigate uncertainty while providing a minimum of comfort and well-being (Weinberger et al., 2021).

The primary indicators to evaluate this are *agency and control*, *continuity*, and *legibility*. Although more indicators support psychological stability in environmental psychology, these three are the focal indicators for this research, as they directly relate to how space is organized, understood, and perceived, and respond to pressing challenges in environments of uncertainty, such as the loss of identity and the destruction of the familiar environment (Weinberger et al., 2022). While *control and agency* describe that users can make a space their own by making minor changes to it, *legibility* illustrates the ease with which users can understand and navigate their environment. *Continuity* describes a building's capacity to maintain its identity and meaning over time (Lewicka, 2011). To provide a minimum of psychological stability throughout turbulent and rapidly shifting times. All of the indicators mentioned need to be addressed and fulfilled throughout all conflict phases.

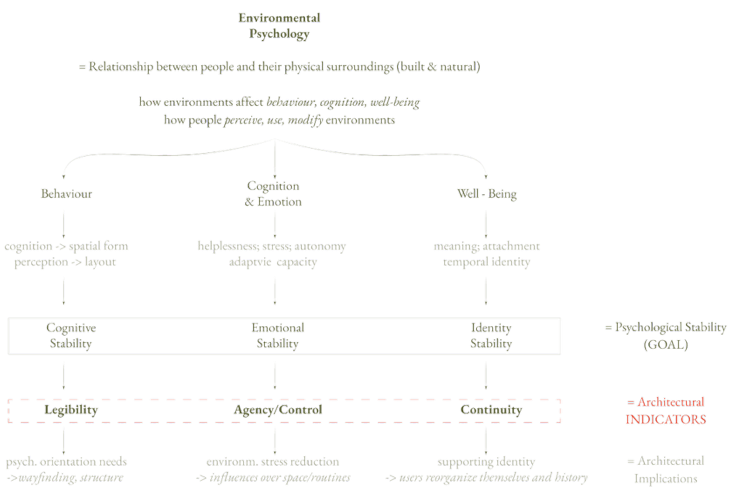


Figure 1: Environmental Psychology - Indicators

Figure 2: Life-Cycle of Conflicts

Discussion

(A) Crisis Phases and Requirements

How can pre-conflict, conflict, and post-conflict phases be defined in terms of their environmental, functional, and operational requirements?

Conflict Phase Requirements

The progression of extreme events can be seen from multiple perspectives, because their origins and effects impact not only climatic and environmental systems, but also humanitarian, social, and political domains. In this work, environments are studied that result from geopolitically tense contexts. Literature across conflict studies and resilience theories states that conflicts are processes that evolve through identifiable stages (Grech et al., 2010). They are inherently dynamic. Existing approaches in conflict studies propose frameworks that describe life-cycles of conflict ranging from three to nine phases (Allwood & Ahlsén, 2015). In order to identify distinct architectural requirements across conflict phases, this research will focus on a framework described by the United Nations, which elaborates on three main stages of conflict: Phase I: Before Violence; Phase II: During Violence; and Phase III: After Violence (United Nations. Crisis Environments Training Initiative & UN. Disaster Management Training Programme, 1998). Throughout this research, this is referenced as *pre-conflict:* the anticipation of crisis; *conflict*: the impact; and *post-conflict*: the recovery from crisis. It considers conflict-phases as a temporal design condition that shapes space, use, and human behaviour and experience of space. Continuity, coherence, and legibility serve as indicators of psychological stability and are evaluated across phases in relation to how space and function are perceived correspondingly.

Pre-Conflict

The period before a conflict or crisis manifests in a physical way, for instance, violence or a natural disaster, is already characterized by stress and worry about an uncertain future (Levin-Banchik, 2021). Although major impact violence has not taken place yet, tension is omnipresent, and measures in anticipation of a crisis are being put into place to prepare for a sudden shift in events (United Nations. Crisis Environments Training Initiative & UN. Disaster Management Training Programme, 1998).

Spatially, this is primarily expressed through the introduction of more and more civil-military dual-use environments. A special focus lies on defensive infrastructures, with surveillance and the separation of freely accessible and restricted areas being particularly relevant (Levin-Banchik, 2021). Programs that are often considered generic are now complemented with additional security features, and there is a constant tension. This tension manifests in a sustained state of readiness and in daily routines that respond to the change in the environment (Ciax & Runkel, 2024).

With clearer distinctions between accessible and inaccessible structure, the environment is especially legible and coherent for its users, although at the same time it is under strain as social division increases(Graham, 2011a). Especially notable is that despite routines, habits, and spatial patterns persisting, a feeling of fear overshadows it, translating into a threat to continuity as the course of the future is uncertain and perceived as threatening(Graham, 2011b).

These findings suggest that, for practical application, architectural interventions in this period need to take these concerns into account and must provide a sense of continuity and familiarity where possible, especially during times when so much feels out of control for users. This can be done, for instance, by using familiar patterns, materials, and spatial logics to avoid loss of identity and provide a sense of cultural and social continuity.

Conflict

The conflict phase is primarily characterized by violence and disruption. Once familiar and central spaces are damaged or destroyed (Zelli & Krause, 2025). As future events remain impossible to predict, a state of emergency prevails, and the focus lies on efficiency. This is driven by a centralized command system and strict security regime that operates under high pressure, leading to reduced user autonomy (Graham, 2011c). Monofunctional or specialized defensive structures are being prioritized. Temporary and semi-temporary fortifications, enclosures, and protected zones develop, which creates an imbalance between care for civilian and military structures, arising due to a state of emergency. As a result, everyday spatial connections break down (Schoonderbeek & Shoshan, 2017).

The destruction of the natural and built environment leads to disorientation and alienation, or becomes opaque to civilians, as only trained (military) personnel are capable of reading space. This highlights that during the conflict-phase, *legibility* is the most precarious psychological indicator, but it also indicates that *agency and control,* as well as *continuity,* are severely disrupted, as familiar spaces become inconsistent, disappear, or lose their identity and shared meaning.

Subsequently, for this phase, architecture can contribute to fostering more stable environments for people through providing protected spaces with structural and spatial clarity, as well as hierarchy to respond to the need for both privacy and community.

Post-Conflict

As major activities of violence end, questions regarding reconstruction, reorganization, and reconciliation arise (United Nations. Crisis Environments Training Initiative & UN. Disaster Management Training Programme, 1998). The overall sentiment continues to be dominated by a sense of unease and uncertainty. Many of the remaining spaces now carry memories of conflict and suffering. This phase is shaped by transitional efforts from emergency to civilian governance and ambiguous responsibility (K. E. Till, 2012). Old spaces must negotiate between the old and the new. Civilian life moves to the foreground, negotiating and progressively replacing and transforming military structures into civil architecture. During this phase, both temporarily repurposed and permanent structures coexist (Pullan, 2013).

Past spatial logics are being questioned and negotiated with a new focus on civil order. The creation of a *controlled* new spatial order presents itself as the main challenge to provide a psychologically stabilising setting that lasts, since competing past functions fragment the environment and complicate a shared order. Furthermore, rebuilding spatial logics across fragmented landscapes takes time and negotiation. Achieving this in a short period of time poses challenges (K. E. Till, 2012). But as new programs and pathways are introduced and familiar patterns and new shared uses are created, *legibility* improves again, and *continuity* returns.

On an architectural level, this phase especially asks for a multidimensional approach, as the past needs to be honoured while new uses need to be enabled (Zelli & Krause, 2025).

In Sum

Each of the conflict phases mentioned above creates a set of stressors on its users in terms of physical and psychological safety, and it is clear that at each of the phases, there is one dominant destabilizing indicator. Architecture is supposed to soften these stressors that result from the dynamic conditions of conflict. It must adapt to the specific conditions of each phase.

The following chapter explores four architectural strategies and mechanisms that can be helpful to mitigate such environments while at the same time considering user-specific needs.

(B) Transformative Architecture Strategies
What architectural strategies enable buildings to transform across different phases of conflict?

Transformative Architecture: Transformative Capacities of Architecture

Transformative architecture has the power to evolve over time and societal and environmental conditions (Askar et al., 2021). In the context of conflict, it can respond to the changing needs of pre-conflict, conflict, and post-conflict conditions. At the same time, it needs to be a human-centered design that has meaning to its inhabitants. Transformative architecture also supports the use of technology, addresses the needs for society to respond to it, and understands the needs of the users and the context in which they are situated (Fox, 2000).
The following chapter focuses on four key mechanisms that support this idea and then connects it to geopolitically tense environments. The mechanisms cover varying building scales, including structure, envelope, and interior space, and show how each strategy operates at spatial, physical, and psychological dimensions. Each mechanism is evaluated with respect to changing conditions during conflict and post-conflict recovery performance.

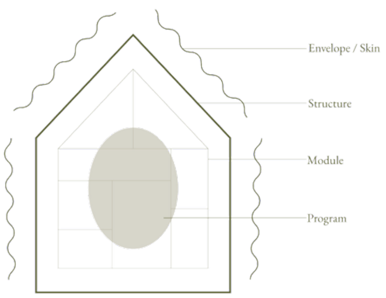


Figure 3: Transformative Architecture - Layers

Reprogrammability [room/building]

Definition and Scope
Reprogrammability in relation to space is the ability to facilitate multiple functions without structural intervention. Robert Kronenburg refers to such spaces as "multi-use-space[s][..]that can accommodate a wide range of functions" (Kronenburg, 2007). Allowing architecture to dynamically react to the changing requirements, resulting from pre-conflict, conflict, and post-

conflict stages, is an important property for continuous usability and the meaning of a building, which will be further elaborated in the following section.

Spatial Components

Kronenburg explains uses Multi-use spaces that are able to accommodate a variety of functions without significant adjustments imposed on the structure to explore the idea of reprogrammability (Kronenburg, 2007). For example, through the implementations of movable partitions and lightweight walls, flexible configurations and subdivisions of rooms can be achieved. However, to be suitable for multiple scenarios of use, the space asks for neutral proportions, with flexible ceiling heights. This can complicate considerations regarding interior climate requirements, technical services, light, and access, to name a few (Kronenburg, 2007). Since it is a direct translation of reprogrammability into space, it also carries some structural and functional challenges in terms of the interior elaboration.

To mitigate this, he also presents the concept of fluctuating space, "incorporating […]dedicated, functional spaces that address specific functions that need to be carried out there, but are also directly linked with more ambiguous territory" (Kronenburg, 2007), creating neutral space in between functionally specific spaces that allow for spontaneous and rapid expansion. This way, a building can be equipped with the correct servicing and furnishing without losing the flexibility of facilitating different uses (Kronenburg, 2007).

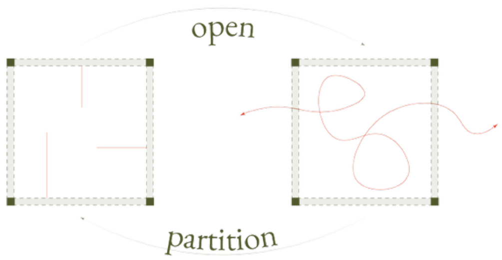


Figure 4: Reprogrammability - Scheme

Phase Relevance

Because the multi-use spaces are not tied to specific purposes or use but are meant to support a variety of functions, they can easily be transformed into conflict-phase-specific structures. Therefore, they perform very well in all phases from a spatial and functional perspective and are very well suited in terms of long-term spatial and resource-management needs (J. Till & Schneider, 2005). Fluctuating spaces, on the other hand, are able to respond well to changing conditions, because they can connect specification of uses and openness for expansion and adjustment through their interior layout and technical and structural setup (Kronenburg, 2007).

Psychological Impact

From a design perspective, this means that reprogrammable spaces as a whole have a high degree of orientation and therefore *legibility* to their users, because of their simplistic spatial organization. The ability to switch between functions also has a positive impact on the perceived *control* and personal impact users can take in a space. However, this spatial and functional flexibility also implies generic layouts that lack character and identity, resulting in a reduction of familiarity and emotional *continuity* related to architecture.

Design Considerations

While spaces can adjust, adapt, and shift in size through small interventions, multi-use spaces can appear bland and lack identity (Kronenburg, 2007). Reprogrammable spaces do not necessarily provide survival through structural protective systems and may also require more protection against threats in conflict-prone environments. Construction and materials could also cost more because more mass is required, and flexibility demands can also be high due to additional movable elements, and integration of independent service systems that may be difficult in some conflict phases (Kronenburg, 2007). Although they perform very well in terms of adjusting to functional user needs, it is advised to carefully integrate this mechanism with other strategies to also maintain *continuity* and relevance beyond times of uncertainty or conflict, and to ensure a basic level of physical protection.

The concept revolving fluctuating space, on the contrary, if planned with the intent to react to a set of anticipated scenarios, can be a very effective strategy to provide functional *continuity* and give the user a sense of control and personalisation due to its integrated buffer zones between function-specific spaces, and also remains *legible* because the core functional spaces do not change dramatically throughout shifting conflict stages (Kronenburg, 2007).

Modularity [unit/building]

Modular spatial systems in architecture were historically designed for portable or temporary structures and describe a compositionable, standardized construct. This construct consists of several units that can be extended or reduced by adding or subtracting units according to user-needs over time (Lawson et al., 2014). It is a systemic architectural approach that aims to react to shifting spatial demands by contracting and densifying while maintaining a previously set-up organizational logic, which is broken down into smaller, interdependent parts (Wallance, 2021). On a unit and building scale, this allows for rapid reaction to abrupt changes of the environment, because modules are often prefabricated, movable, and interchangeable units designed for quick assembly and deployment, making this architectural strategy very convenient for unpredictable contexts (Kronenburg, 2007).

Spatial Components

Modular systems are based on independent components that can be added to each other through interfaces. The Components are strictly separated from each other, and structure, services, infill, and enclosure are tailored to the specific needs and circumstances. Modular systems are also highly adaptable to rapid changes in conditions, as damaged or obsolete elements can be removed or replaced when necessary (Wallance, 2021).

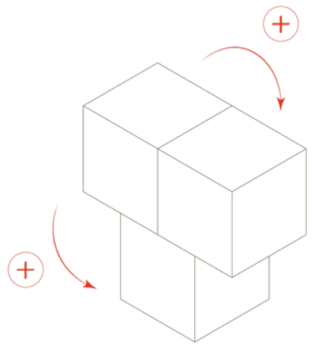


Figure 5: Modularity - Scheme

Phase Relevance

Modular Systems are already commonly used in military and crisis contexts due to their rapid-response abilities (Lawson et al., 2014). They perform well in providing multi-purpose spaces, and infrastructure, or even cheap long-term residential structures, to name a few possible adaptations across conflict phases (Kronenburg, 2007).

Psychological Impact

As a result, it is worth noting that especially the additive qualities of highly function-specific spaces can provide essential stabilizing effects in terms of *agency* in a space, *continuity* of identity, and *legibility* of the spatial logic in the space through changing conditions. Additionally, modular systems are often prefabricated, and it is difficult to adjust to the elements themselves. The structure is therefore to be handled carefully, especially in post-conflict environments.

Design Considerations

A high standardization of the architecture will likely lead to monotony if there are no variations, hierarchy, or other flexible architecture mechanisms applied. The need to prefabricate modules may lead to some technical and logistical challenges, not only in terms of storage, but also in terms of transportation, because the modules must be delivered to the places where they are needed. In addition to this problem, modular systems must have a tight alignment between their systems' structural, spatial, and service grids, not only during the construction of the modules, but also during their deployment and installation.

Adaptability [room/envelope]

Adaptability systems in the are the capacity of envelopes and thresholds of buildings to adapt to changing environmental, functional, and security conditions (Askar et al., 2021). The mechanism of adaptability within the context of external conflict management allows a building or structure to respond and regulate an escalation or de-escalating of the situation in an environment. This can be observed in spaces, buildings, and envelope thresholds and can affect the degree of openness, protection, and environmental comfort for their inhabitants (Kronenburg, 2007).

Spatial Components

The physical manifestation of adaptable envelopes can range from small-scale façade elements, such as shutters or screens, up to layered skin systems. Thresholds vary and can regulate the relationship between inside and outside. These thresholds can also incorporate small buffer zones or semi-public spaces, almost acting as an environmental control system that allows regulating light, ventilation, and external visibility, but also allows for a degree of physical protection from the environment and potential external impacts (Leatherbarrow & Mostafavi, 2002).

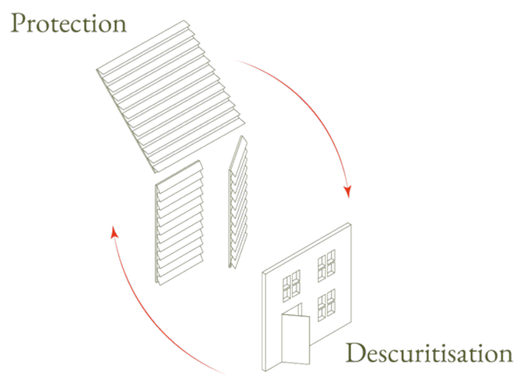


Figure 6: Adaptability - Example: Facade

Phase Relevance

The envelope of a building is a crucial flexibility component when it comes to environment- and function-responsive architecture (Kronenburg, 2008). Throughout the three stages of conflict, a building's skin can function as a permeable, transparent, and accessible social interface, but can also transform into a defensive, secured, and reinforced barrier from the outside world, providing protection and privacy (Leatherbarrow & Mostafavi, 2002). The envelope or the façade of a building is exposed to the environment and is therefore vulnerable and requires properties that enable repair and easy modification, especially during conflict. After conflict, gradual reopening and softening of thresholds support reintegration into civic use and everyday-life.

Psychological Impact

Envelopes or Facades represent a building's face. Therefore, clearly articulated boundaries help users to orient themselves even in chaotic environments, but also transport degrees of safety and control, contributing to psychological stability and *legibility* of organizational logics. *Coherent* spatial transitions between inside and outside can reinforce a spatial logic that also translates into the inside, or can do the contrary by disguising it (Leatherbarrow & Mostafavi, 2002). Due to its need for *continuous* modification or repair, it is possible to maintain familiarity and identity (Kronenburg, 2008). This will help preserve the importance of a building in times of conflict and peace, and to bring it to the desired new objectives and attributes.

Design Considerations

The findings above suggest that adaptive systems in envelopes, and are very promising in terms of technical advances, but can also be complex installations. Even though envelopes and façades can be adapted in times of conflict, they are also likely to be over-securitized so that they become less open and create problems for re-configuration after the end of conflicts. An important aspect to consider is the need to connect envelope adaptability to the structural system of the envelope to prevent it from failing or breaking down. It is advised to coordinate envelope adaptability with its underlying structural system to avoid vulnerability or collapse.

Structural Robustness [building/structure]

The use of mass and structurally robust systems as a basis for transformable structures is not a new phenomenon. In fact, it is a very commonly used architectural mechanism in relation to the design and construction of durable and adaptable buildings (Matheou et al., 2023). As structural resilience represents one of the key tasks a building has to fulfil, it must hold the capacity to accommodate and process external impact and damage over time, especially in contexts of conflict. Resilient and durable load-bearing structures must be able to accommodate changes in functional and spatial terms (Matheou et al., 2023). The structural robustness mechanism makes a distinction between structure and infill so that architecture can survive years of conflict and serve as a starting point for recovery instead of replacing it completely (Kronenburg, 2007).

Spatial Components

The transformative aspect targets a separation of structure and use and this and all-around range of functions can be used (Brand, 1995). Structures are durable and withstand a certain degree of damage. It is crucial to this mechanism to have a clear and even distribution of the load to achieve a maximum of stability. Usually, this creates clear structural grids that can accommodate a variety of spatial layouts in the building over time (Brand, 1995).

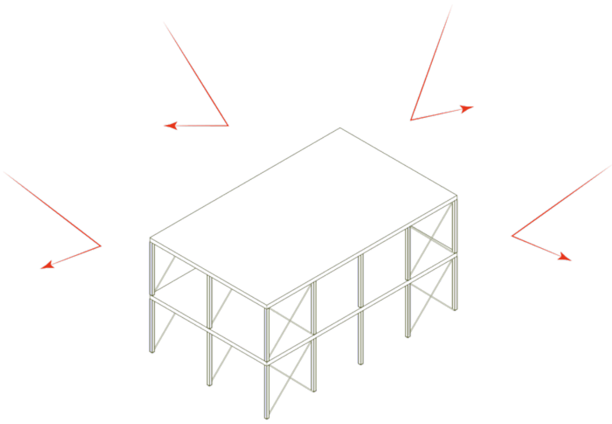


Figure 7: Structural Robustness - Scheme

Phase Relevance

The strategy of structural robustness allows for a high chance of durability and resilience, beneficial in conflict-prone contexts. Due to the strict distinction between structure and infill relevant functions, a high degree of operability and relevance for both civic and governmental uses can be guaranteed throughout periods of uncertainty (Brand, 1995). Even after damage, depending on the severity, the building can still be used or adapted thanks to its robust configuration (Schmidt, 2016).

Psychological Impact

Because of the clear logic that is applied to achieve structural robustness, the overall assembly and structure are very comprehensible. As the uses and tasks the building accommodates may drastically change during conflict, its meaning remains due to its structural consistency, which anchors changing programs within a stable and familiar program (Schmidt, 2016).

Design Considerations

Structural durability may also mean that one of the structures might remain in one place for an extended period of time, with a limited possibility of structural change, which requires a lot of material and structural maintenance. It is also a material-demanding process as it costs more for building and perhaps maintenance over the life cycle of a building. Structural robustness alone is not enough to ensure the safety of the structure, because the types of impacts and environmental conditions it must withstand evolve over time (Brand, 1995). Therefore, it is advised not to solely rely on the structural integrity of a building when it comes to designing for uncertain, hostile environments. Although the structure is a separate entity in the transformative architectural mechanism, it is important to consider potential spatial infills as they influence each other.

(C) Historical Precedents

What lessons can historical and contemporary war-related architecture provide for designing transformative architecture across conflict phases?

Historical Precedents

"The creative act may not introduce any new element at all, only put them together, in space and time, in a new way."
— Johan Galtung, 2000

The quote describes creativity less as an imaginative action than a reconfiguration. It expresses the use of existing tools and strategies to respond to the context in which it is placed. With respect to the pre-conflict, conflict, and post-conflict situations identified previously, this chapter investigates how well real historical structures operate in terms of function and spatial organization, in addition to what kind of strategies and mechanisms were used. It also reflects the psychological impact on the users. In the following, a short performance analysis of four selected historical and contemporary military structures is conducted. Because military structures must withstand uncertainty and conflict conditions tightly connected to their historical context, structures from different times in history were chosen. Moreover, the analysis highlights whether specific mechanisms helped or hindered psychological stability in real conflict contexts and throughout the phases. At the end of the study, the findings are compiled and compared in a matrix that highlights each structure's strengths and weaknesses to supplement a subsequently developed framework for transformative architectural strategies for conflict-prone contexts.

Roman Marching Camp - *Castra*

The ancient Roman legions used standardized fortifications during almost all their campaigns and were remarkably successful in doing so. In fact, many contemporary big cities have their origins in such fortifications. They were designed for rapid deployments and dismantling on the march, usually made out of simple and relatively lightweight materials like wood and leather. Since the camp had to be set up and taken down regularly and under circumstances in a hurry, it followed strict spatial rules and always used the same layout logic that could be adapted in size. It was designed like a typical Roman city with two main intersecting roads, a forum in the centre, and other uses such as accommodation, storage, and equipment around it.

The inhabitants of this structure were familiar with its organization, providing a sense of familiarity even in unknown territories. It also had a layer of protection in terms of trenches and walls as well as wide streets and pathways that were used as buffer zones, which added a level of protection without undermining legibility and coherence. After a campaign, many camps were dismantled, but also quite a lot grew into permanent settlements over time, and military and civilian uses and spaces became connected.

Therefore, the Roman *Castra* were very successful in terms of longevity: meaning remained over time, and the structures were well laid out for their inhabitants. The most important architectural strategies were modular systems, built based on clear grids and standard units, which provided predictable and legible layouts. But also structural robustness in areas like earthworks, walls, and later, more extensive fortifications, and reprogrammability were important. A Roman marching camp was like a regular Roman city, which could easily be adapted for and after conflict.

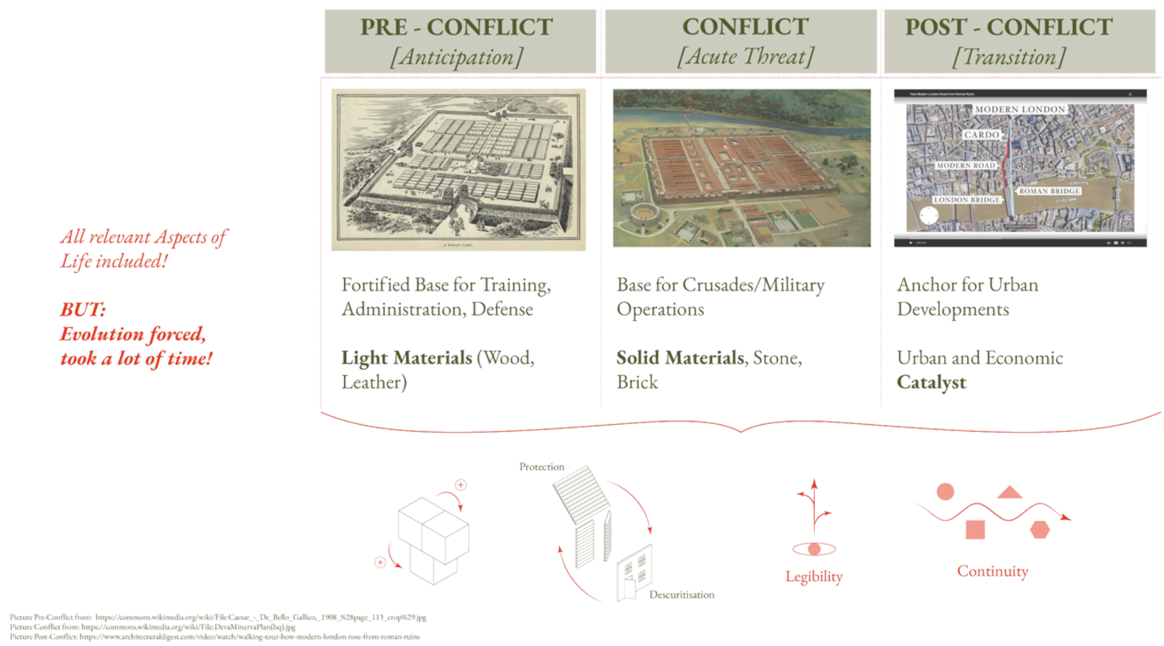


Figure 8: Roman Marching Camp (Castra) - Analysis

Nissen Hut

Nissen huts, designed by Peter Norman Nissen, were developed during the First World War and used as barracks, field hospitals, and storage, even during the Second World War. After the wars, they were often used as emergency accommodations, workshops, and community buildings. They were prefabricated, semi-cylindrical structures made of steel and were mass-produced as rapidly deployable and immediately usable building ensembles. While they used transformative architectural strategies like modularity and reprogrammability, many of the Nissen huts were dismantled or destroyed over time, as they were reminders of a violent past and did not recover from or adapt to this traumatic history. Thus, despite its highly flexible features, the Nissen hut was only relevant at the point of or shortly after war.

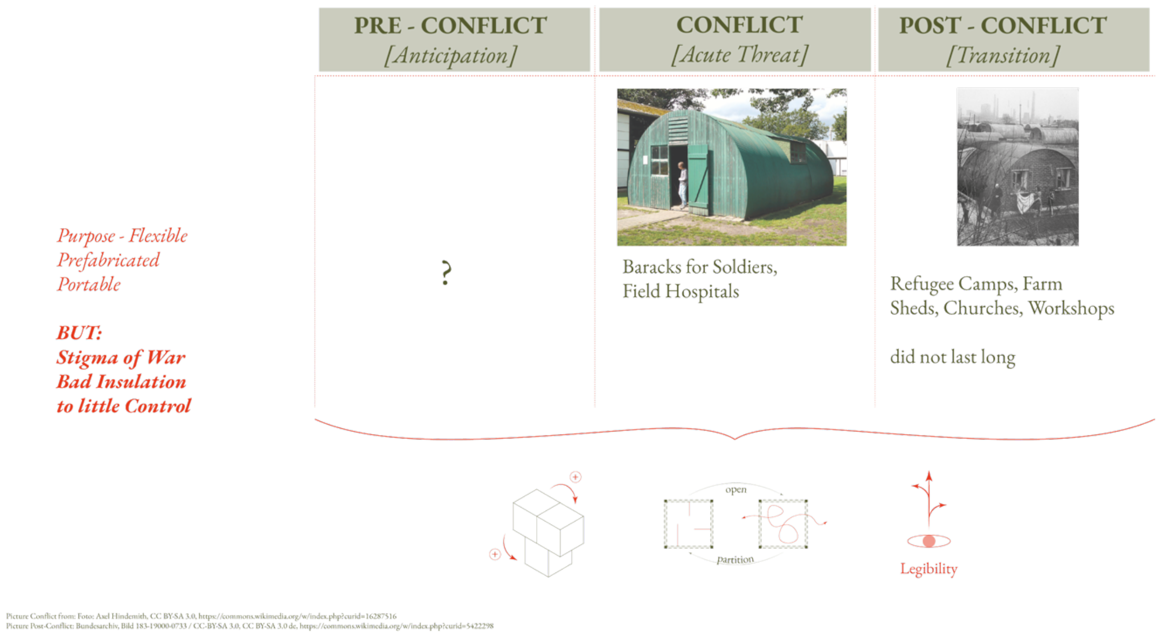
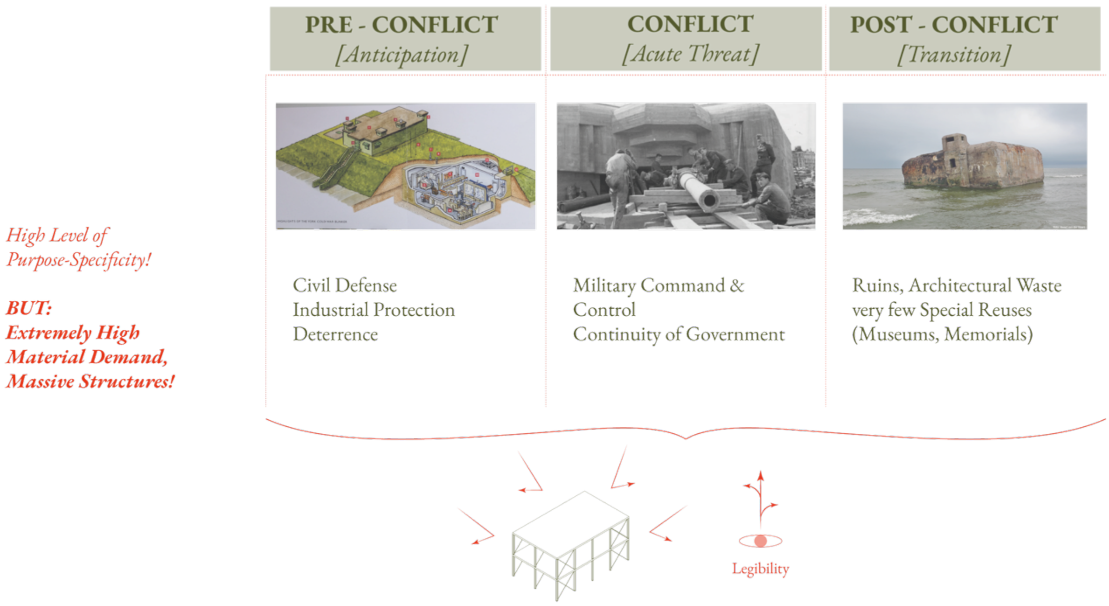


Figure 9: Nissenhut - Analysis

Cold War Bunker

Bunkers are spaces with extreme fortified properties, particularly the Cold War Bunkers, which were designed for survival from nuclear attack and shelter, and enable command for high-risk conflict scenarios. Typologies of Bunkers were developed in order to deter. They have an extremely strong protective envelope to provide effective shelter for their users during a potential event of conflict. As conflicts are resolved other than through an actual armed conflict, those structures lost their relevance and thus were decommissioned and essentially abandoned. Reprogramming them for other civil uses usually turns out to be a very challenging task, which is a direct result of their strong dedication to one use and the purpose of protection. To achieve this, it heavily relied on strategies like structural robustness. Bunkers rely on the idea of Mass; the envelope is reinforced, and the shells are thick and usually highly impermeable. Although they can also be considered to be a part of a modular system, the units are too rigid to be added immediately to each other. The concept of Reprogrammability can almost completely be eliminated for the reason that such bunkers were constructed for one purpose only and did not consider user experience values, which makes them easily become obsolete for peacetime adaptations.



Picture Pre-Conflict from: https://dubmanandstreylock.wordpress.com/2016/09/04/york-nuclear-bunker/
Picture Conflict from: Bundesarchiv, Bild 101I-294-1531-14 / Müller / CC-BY-SA 3.0, CC BY-SA 3.0 DE , via Wikimedia Commons.
Picture Post-Conflict: Annet van der Voort: https://www.marinemuseum.de/event/abendvortrag-von-dr-volker-jakob-the-wall-der-atlantikwall-eine-deutsche-monstrositaet-in-europa/

Figure 10: Cold War Bunker - Analysis

Camp Bastion

The modern examples of military-related architecture can be seen in Afghanistan, where Camp Bastion, a NATO base camp, was established from 2001 to 2020 to provide logistics facilities and central command hubs as well as barracks. It is a modular structure and continuously expanded throughout its life cycle. This could be achieved through the use of highly standardized units and their ability to reconfigure. Despite its flexibility, after its decommission, the structure of the camp was broken down and many parts were removed, and large parts were removed, although this was not intended.

Spatially, the camp consisted of container units and tents, which could be relocated and filled with various programs, ranging from housing to sanitary and logistic facilities. Its clear structure offered a high degree of legibility and coherence for the users, and the overall layout followed a repetitive and additive logic. However, the camp was never constructed to last but was meant to be removed. Therefore, it lacks continuity in meaning and identity post-conflict.

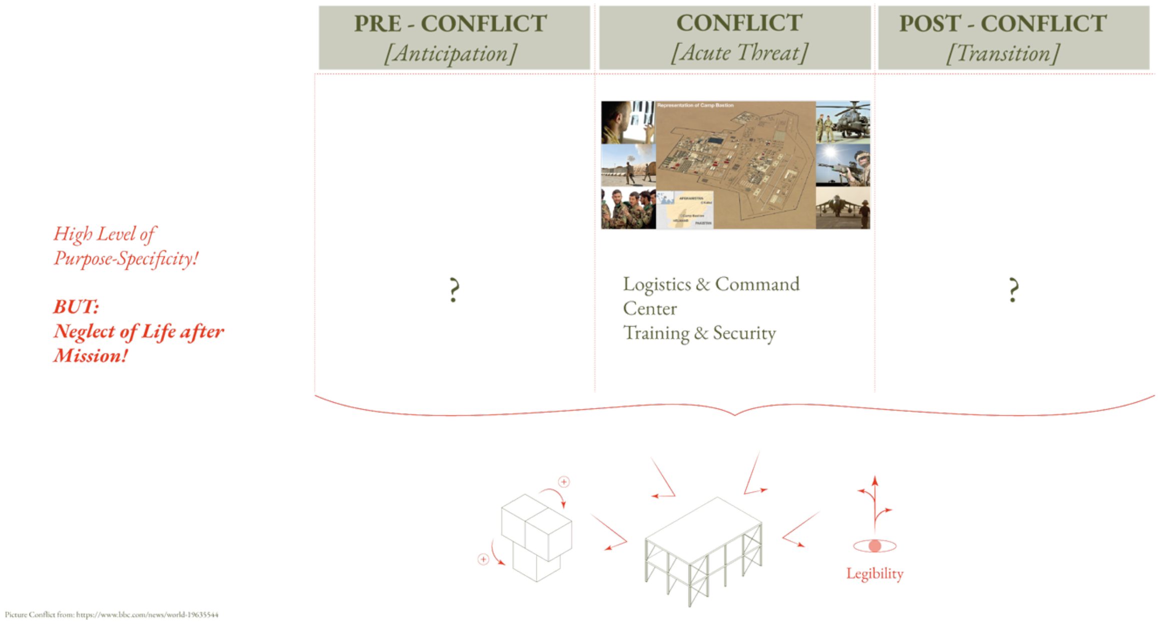


Figure 11: Camp Bastion - Analysis

In Sum

The comparison of the historical precedents shows that transformative capacity is less about form than a strategic organisation over time, as psychological stability is highly dependent on the alignment between architecture and the most important needs in each conflict phase. Modularity supports legibility in terms of consistent and repeatable spatial order, while reprogrammability enables continuity, which is particularly effective in the transition from military to civic use. Structural robustness is essential for survival, but does not hold up in post-conflict adaptation without being combined with other mechanisms.

The analysis demonstrates that spatial and functional performance are tightly connected: Structures and environments with clear hierarchies of layouts and identifiable patterns are more likely to provide experiences that support legibility, continuity, and coherence. The results of this research, in conjunction with the previous chaptersare used as the basis for the following synthesis in which the data and principles are used to create a conflict-phase-responsive design framework for the graduation project.

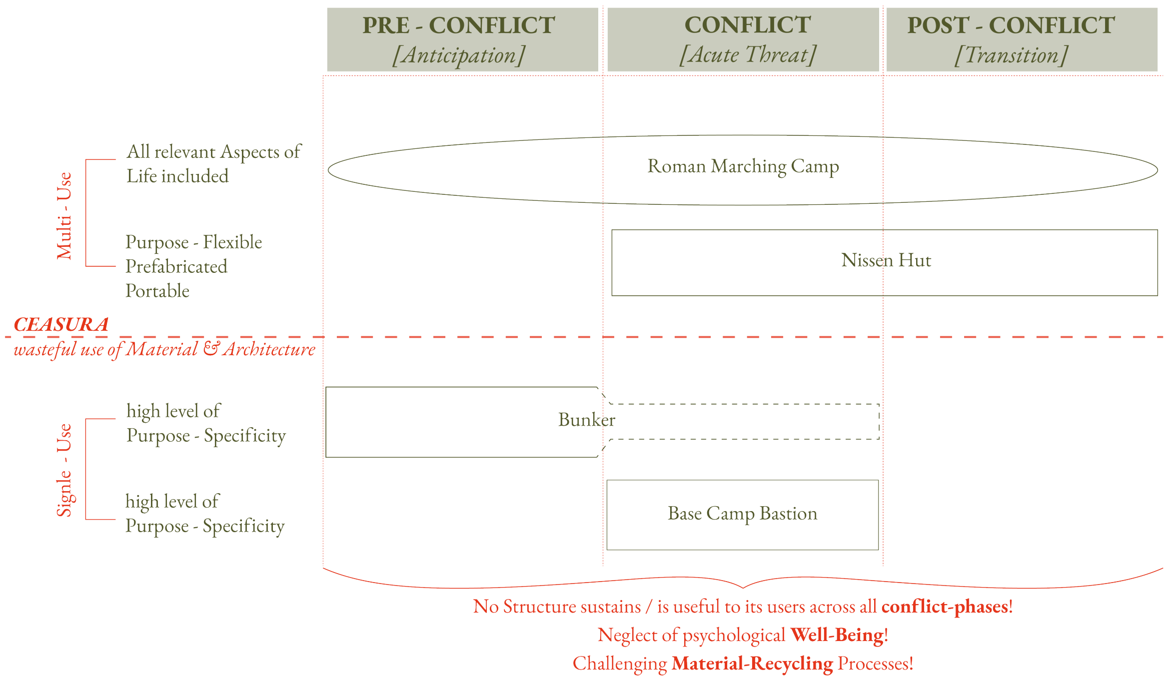


Figure 12: Comparison of historical Precedents

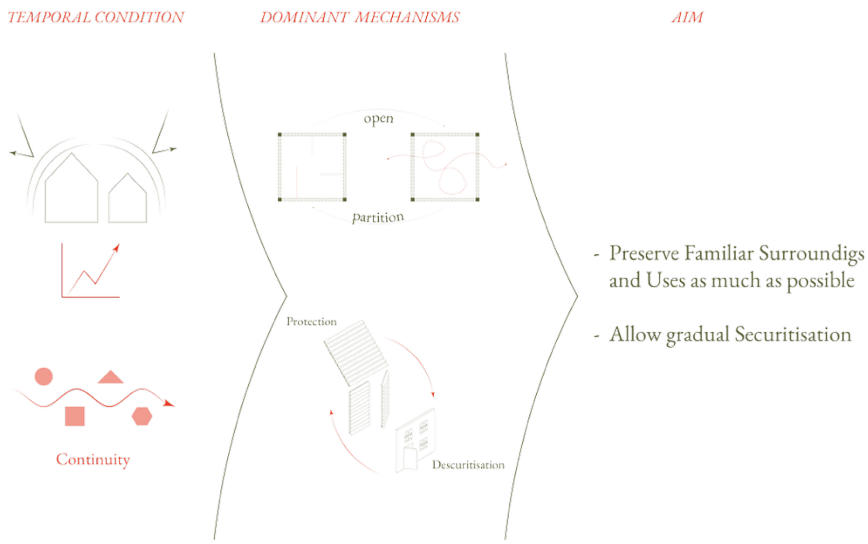


Figure 13: Design Matrix - Pre-Conflict

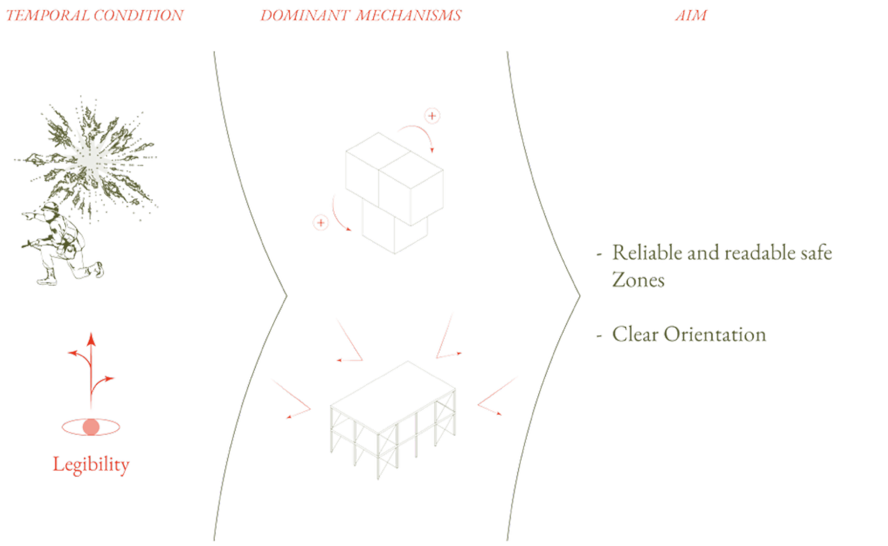


Figure 14: Design Matrix - Conflict

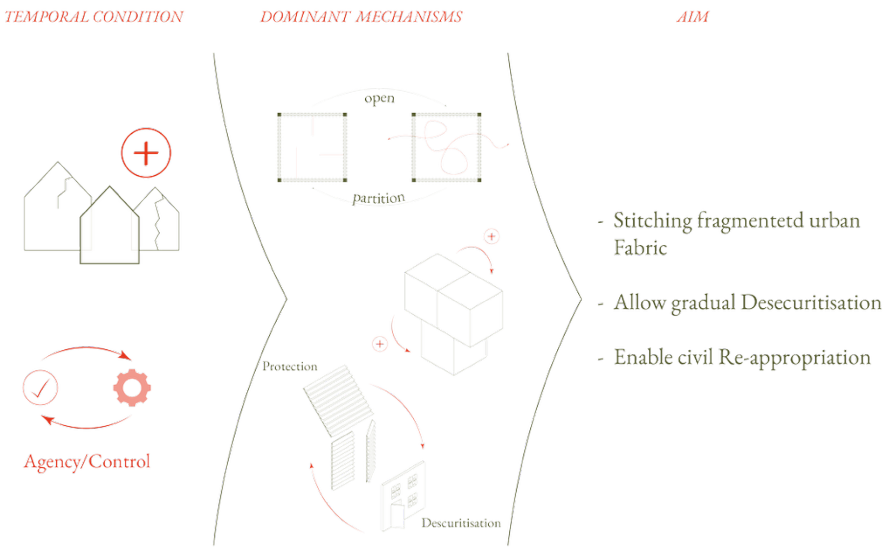


Figure 15: Design Matrix - Post-Conflict

Conclusion

The previous research and the knowledge of conflict-phases and transformative architectural approaches are used to create a design matrix that can be used in future designs in contexts of tension and uncertain futures.

The previous study shows very clearly that the use of only one mechanism has only short-term success in terms of architectural longevity and desired cross-phase stability. Conflict can be understood as a temporal condition with specific design implications for each phase. Each phase is dominated by one psychological need. The pre-conflict phase is characterized by actions of preparation for crisis, and fear plays a significant role in the user's everyday life. Therefore, there is a heightened need for continuity of identity. Architecturally, this can be met by making use of reprogrammable floor plans, specifically by using the concept of fluctuating space, as Kronenburg describes it (Kronenburg, 2007). The need for securitization can be fulfilled by adapting the skin, the envelope of a structure, accordingly.

Regarding the conflict phase, where a strong demand for legibility is caused by the destruction of the built and natural environment, modularity and robustness structures can provide clear orientation and protection, as well as reliable and readable safe zones created through architecture. As conflicts resolve, civil and military spaces need to be renegotiated. The post conflict phase revolves around reconstruction, reconciliationa and reorganization of both society and the space each party inhabits. In anticipation of possible future conflicts and challenges, buildings and environments have to be constructed in ways that enable future adjustments, changes, and adaptations. This phase mainly deals with descuritising the built environment, although it has to consider possible adaptations in terms of architecture for safety against possible future threats.

In order to accommodate the demands and requirements of each phase, architectural design is most successful when combining multiple transformation mechanisms at once. This way, not only are the spatial, operational, and functional needs met, but the structure also takes emotional and psychological needs into account, making it long-lasting and more future-proof as the buildings hold meaning and identity to communities and serve the users.

Therefore, the psychological indicators of continuity, legibility, and control/agency serve as valuable decisive measures to evalutate wether a mechanism can be successful in terms of conflict-resilience.

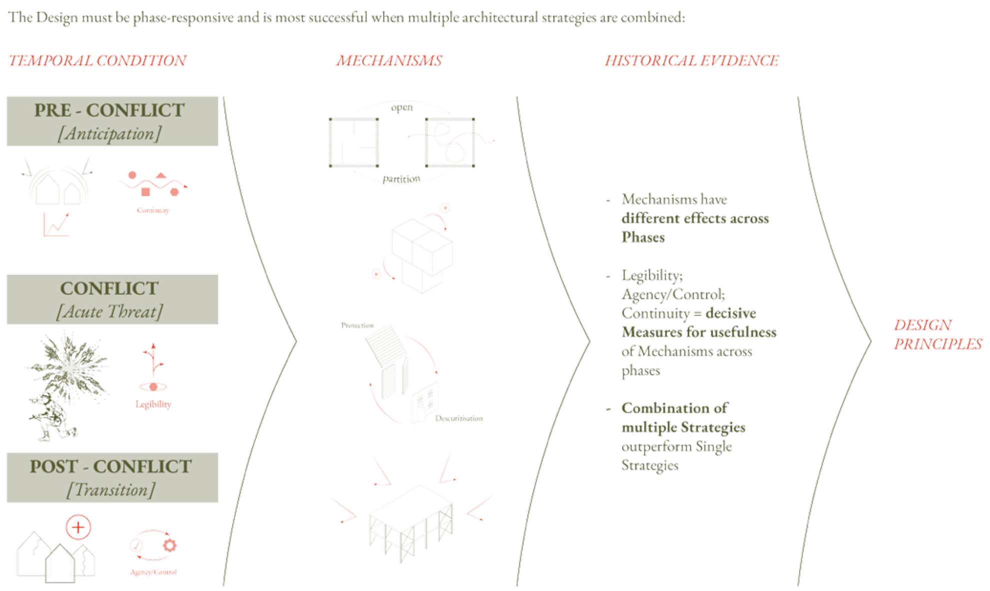


Figure 16: Design Matrix across all Phases

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