MASTER THESIS | Architecture

Fig. 1.
Building,
own photo

EFTERKLANG

Transformation of Kjellerupsgade School

TITLE PAGE

AALBORG UNIVERSITY

DEPARTMENT OF ARCHITECTURE, DESIGN & MEDIA TECHNOLOGY

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ABSTRACT

This thesis explores the architectural transformation of Kjellerupsgade School in Aalborg. The project investigates how the existing building structure, spatial qualities, and daylight conditions can inform the development of flexible and diverse housing while preserving the building's architectural and historical qualities.

Rather than applying a predetermined housing concept, the design process evolved through studies of the existing structure, circulation, and spatial conditions of the former school. Early investigations revealed potentials for open and adaptable dwelling structures, where the relationship between spatial framework, flexibility, and user appropriation became central to the project.

Daylight analysis, energy optimisation, and Life Cycle Assessment were integrated throughout the design process and informed decisions regarding preservation, material use, and energy performance.

The project demonstrates how transformation and reuse can reduce climate impact while creating adaptable housing environments rooted in the existing building structure.

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CHAPTER
01

PRELIMINARY

CONTENT

Acknowledgement
Reading guide
Introduction
Research question

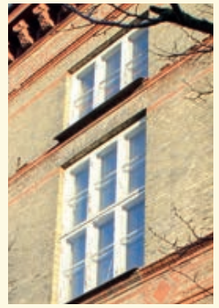


Fig. 2.
Building,
own photo

This section establishes the foundation of the project. It presents the acknowledgements, outlines how the report is structured through a reading guide, introduces the overall context and motivation of the study, the project case and defines the research question that guides the investigation. Together, these elements clarify the purpose, scope, and framework of the project and support the reader in understanding the following analyses and design work.

ACKNOWLEDGEMENT

A special thanks to main supervisor Michael Lauring and technical supervisor Kai Kanafani for their support and guidance throughout the project.

Thanks also to Aalborg Municipality for the opportunity to visit the project case building multiple times, as well as for an insightful meeting on their urban development plans, where the idea for the project first emerged.

READING GUIDE

How to navigate this thesis

This report is structured around a method, where research and design development take place in parallel and continuously inform each other throughout the process. Although the report is presented linear, the actual working process has been iterative.

The report begins with a theoretical framing, analyses, and related design implications. The collected knowledge is then processed and applied directly in the ongoing development of the project. Based on these findings, the different insights are integrated into the design process and synthesis, where analytical insights and design decisions are combined into the final design proposal.

Purpose statement

Throughout the report, each analytical, theoretical, or methodological component is introduced by a purpose statement, clarifying its role in guiding the design process and narrowing the project framework toward the final proposal.

Design implications

Throughout the report, design implications are presented after a group of analyses, marked consistently with the blue heading “Design Implications”. Here the most important findings are summed up and shown in how they can be used directly in the design. This part links the analyses to the design process and shows what is taken forward and built on in the next stages.

INTRODUCTION

Motivation

The motivation for the project is to explore how existing buildings, which today stand vacant or underused, can be given new life through architectural transformation. These buildings often carry strong spatial, material and historical qualities that no longer fulfill their original function. Rather than allowing such buildings to remain empty or be replaced by new construction, the project explores their potential as frameworks for contemporary forms of dwellings. The project focuses on how these structures can be adapted and reused in a way that both preserves their architectural value and introduces new spatial and functional relevance.

A dialogue with Aalborg Municipality identified the former school on Kjellerupsgade as a potential case for transformation, as the building currently stands vacant and holds potential for a new use. The project is therefore based on the transformation of the school, which occupies a prominent position in the city (fig. 3). Its central location, close to a range of everyday functions, makes it a particularly relevant case. The vacancy of such a large building in a central location raises questions about how existing buildings can be used more actively in relation to housing demand and the sustainable use of resources.

Fig. 3.
Map of Aalborg,
1:10.000

BUILDING SPECIFICATIONS

ADDRESS | Kjellerupsgade 16 & 18

OWNER | Aalborg Municipality

YEAR OF CONSTRUCTION | 1901

FOOTPRINT | 645 m²

GROSS FLOOR AREA | 3.185 m²

BASEMENT| 645 m²

STOREYS | 4 storeys
(incl. attic, excl. basement)

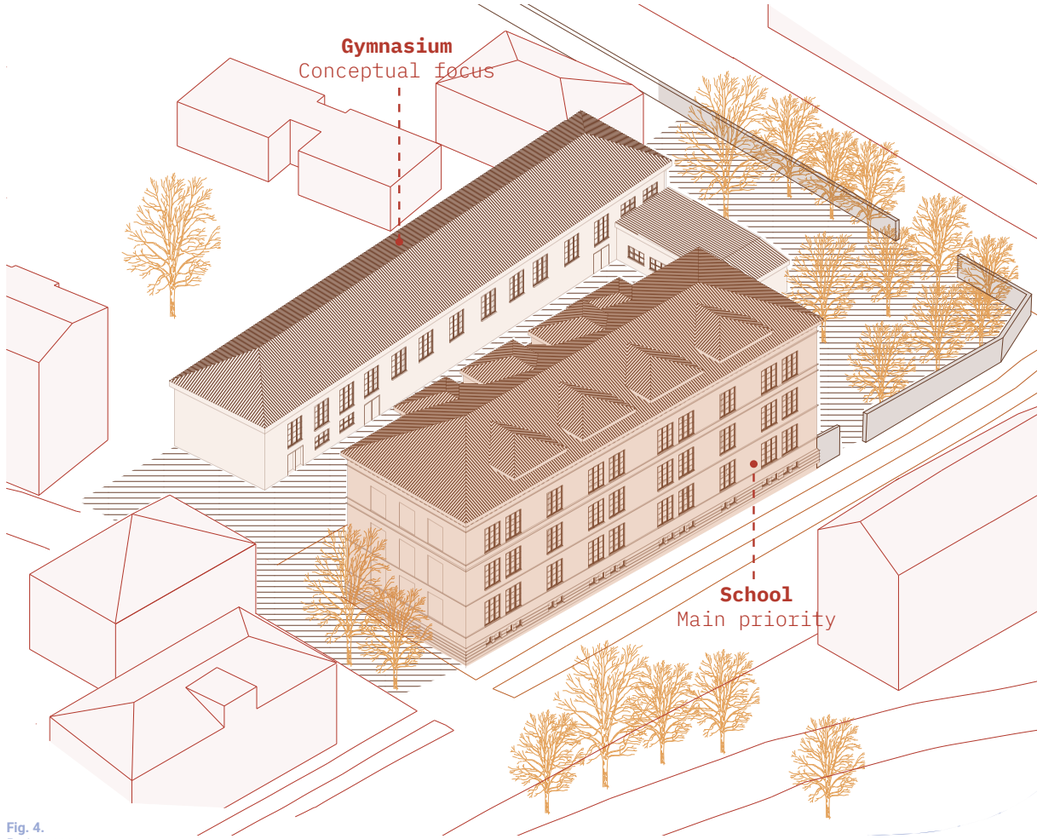


Fig. 4.
Project case

Project case

This thesis investigates how a former institutional building can be transformed into contemporary housing typologies.

Originally constructed in 1901, Kjellerupsgade School is characterised by deep floor plans, generous ceiling heights, and a clear symmetrical composition. Its load-bearing brick structure, repetitive window rhythm, and substantial multi-storey volume present both challenges and architectural potential. These qualities form the basis of the transformation strategy.

The project primarily focuses on the main school building, while the former gymnasium is addressed on a conceptual level (fig 4). As the municipality prepares the property for sale with potential residential use, the project is grounded in a realistic and current context.

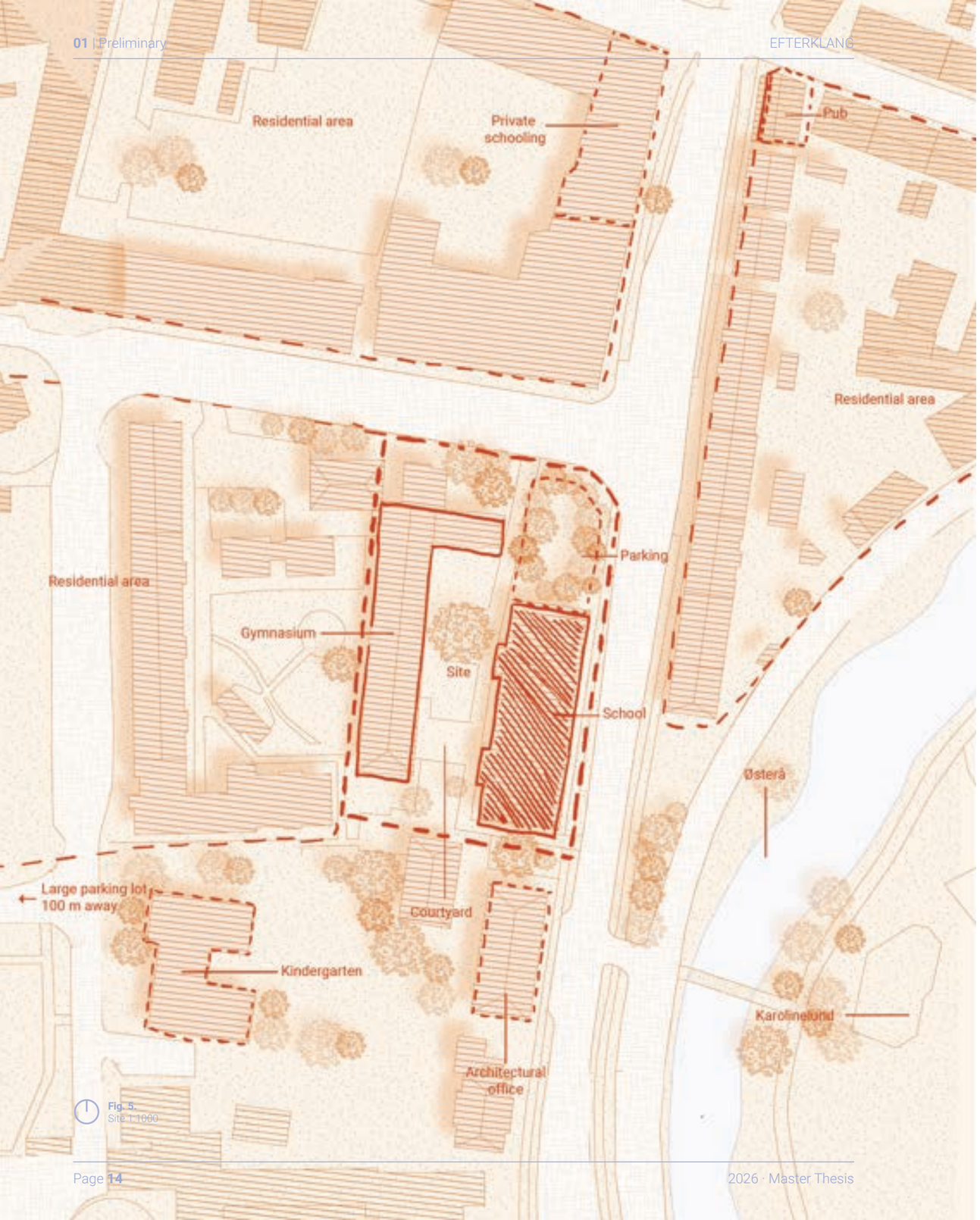


Fig. 5.
Site 1:1000

RESEARCH QUESTION

How can the existing building mass of **Kjellerupsgade School** in Aalborg be transformed into a **sustainable and diverse** residential development that preserves its **architectural and historical qualities**, while utilizing the inherent **daylight conditions** to inform spatial organisation, improve **energy performance**, and enable flexible and varied dwelling typologies?

CHAPTER
02

METHOD OLOGICAL FRAME WORK

CONTENT

Methodological approach

Transformation process

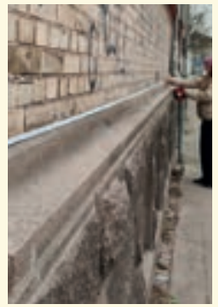


Fig. 6.
Building, own photo

The following section is divided into two parts, each highlighting an aspect of the project's methodology. The first part explains the general approach and guiding principles behind the process, while the second part focuses on the transformation project itself, outlining the method for investigative work to understand the existing building.

METHODOLOGICAL APPROACH

The Integrated Design Process

This thesis is developed through the *Integrated Design Process* formulated by Mary-Ann Knudstrup, Professor Emeritus and architect MAA. The method structures the project through phases of problem formulation, analysis, sketching, synthesis, and presentation, while emphasising the importance of iteration between the phases (Knudstrup, 2004).

In this project, the methodology has been adapted to support the transformation of an existing building. Unlike more conventional design processes, transformation projects do not allow all parameters, users, or spatial potentials to be fully defined from the beginning. Instead, the project has required a continuous investigation of the existing building, where new insights into spatial qualities, structural logic, and architectural character have emerged throughout the process.

This has resulted in a working method where analysis and design development take place simultaneously. Through ongoing building studies, spatial investigations and housing studies, the understanding of the existing structure has gradually deepened, allowing the design to develop on the building's own premises. Sketching, diagramming, and modelling have therefore functioned not only as representation tools, but as investigative methods to uncover architectural potentials within the existing framework.

By moving iteratively between analysis and design, the project aims to ensure that the final proposal is rooted in the inherent qualities of the building, allowing the transformation strategy to emerge from an informed understanding of the existing architecture rather than being imposed upon it.

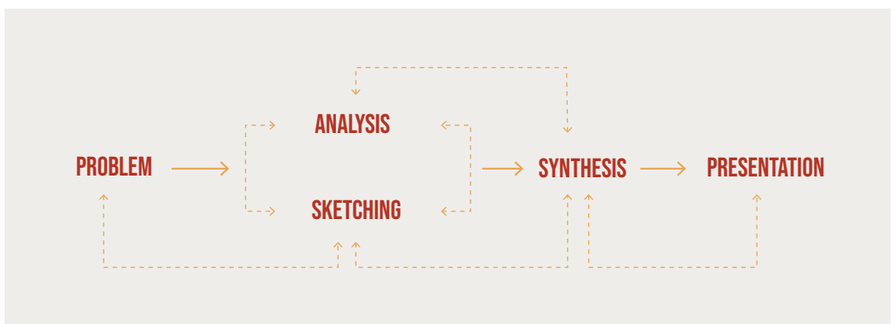


Fig. 7.
The Integrated Design Process

Fig. 8.
Project approach

TRANSFORMATION PROCESS

Initial research of the existing building structure

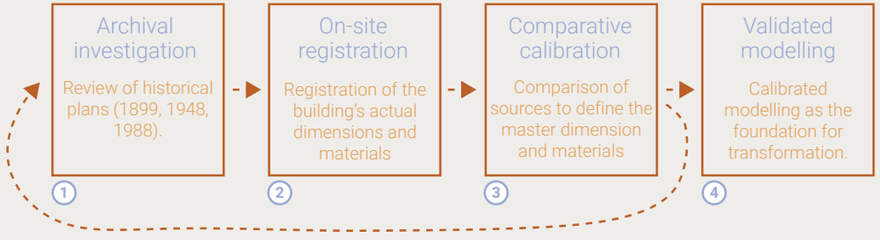
In a transformation project such as this, a significant part of the work lies in establishing a reliable foundation. Before proposing new transformation strategies, it is essential to gain a precise understanding of the existing building, its dimensions, materials, and historical development. The early phase of the project therefore focused on collecting and verifying archival drawing material alongside on-site measurements in order to develop a credible Building Integrated Model.

Original drawings dating back to 1899 were studied and systematically compared with later drawings and field measurements. Through this process, a consistent master dimension was established, forming the basis for all subsequent drawings and digital modelling.

This methodological approach ensures that the project operates from the building's actual constructed dimensions rather than solely from original drawings, providing a realistic and reliable framework for further design development.

In parallel, investigations into the building's construction were carried out to clarify wall constructions and materiality. This included identifying layers and structural build-ups in order to understand the building, how the building performs in relation to energy use. Together, this work establishes the foundation necessary for making informed transformation decisions with a focus on energy optimisation.

Fig. 9.
Measurements at site



CHAPTER
03

THEORETICAL FRAMEWORK

CONTENT

Housing between structure and use
Transformation as a sustainable strategy
Dialogue with the existing building
Life Cycle Assessment as a design tool

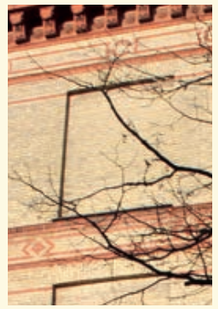


Fig. 10.
Building,
own photo

The following section establishes the theoretical base that informs and supports the project. Rather than defining a fixed housing typology or predetermined solution, the framework provides a conceptual foundation for reflecting on contemporary living, transformation, and sustainability in architecture.

HOUSING BETWEEN STRUCTURE AND USE

Architecture and everyday use

Purpose

This theoretical framework establishes housing as a relation between spatial structure and use. It is used to understand how different degrees of control and openness in space can support different ways of inhabiting a building, and it forms the basis for the following design work.

Introduction

This section is based on an understanding of housing not as a fixed and finished object, but as something that emerges through the relation between building and use. The focus is therefore not only on architectural design, but also on how housing is used, adapted, and changed over time.

The theoretical framework is based on N.J. Habraken, Dutch architect and theorist, and his Supports: An Alternative to Mass Housing, as interpreted by Shepard, and Jonathan Hill, British architect and theorist, and his Actions of Architecture: Architects and Creative Users. Both criticise standardised housing production, where users often have limited influence on their own dwelling.

Habraken, as discussed by Shepard, understands housing as a system divided into a fixed structure (support) and an adaptable part (infill), where inhabitants are given the possibility to shape their own dwelling over time. Hill, on the other hand, sees architecture as something that is only completed through use, where users can act as passive, reactive, or creatively transformative agents. (Shepard, 2023; Hill, 2003)

Across both theories, housing is understood as something shaped both by physical frameworks and by the ways people act within them. This forms the basis for an analysis of how housing can accommodate different degrees of control and freedom in relation to the user.

Fig. 11. Support and infill

The building provides a stable support, while internal spatial organisation can change over time.

Habraken: Support and infill

N.J. Habraken's Supports: *An Alternative to Mass Housing* develops a critique of post-war mass housing, where dwellings are produced as complete and standardised units with little or no influence from the inhabitants. According to Habraken, this approach reduces the user to a passive role and creates a clear separation between those who design housing and those who live in it. (Shepard, 2023)

As an alternative, he proposes that housing should be understood as a system made up of two levels: support and infill. The support refers to the permanent structural and infrastructural framework of a building. It is designed as a collective and long-term structure that can accommodate many different households over time. The support is not a finished dwelling, but a framework that makes housing possible. (Shepard, 2023)

The infill, on the other hand, refers to the elements that are controlled by the user. This includes internal partitions, room organisation, and functional layout. The key idea is that these parts can change over time in response to the needs of the inhabitants, without altering the main structural system of the building. (Shepard, 2023)

A central point in Habraken's thinking is that housing should be seen as a shared process between system and user. Instead of delivering a finished product, architecture should provide a framework that allows inhabitants to take part in shaping their own living environment (Shepard, 2023). This shifts housing from being a fixed object to something that can develop over time alongside its users.

Habraken's approach also has a broader social dimension, as it redistributes decision-making power in housing production (Shepard, 2023). Rather than concentrating control with architects and developers, it introduces the idea that inhabitants should have real influence over the form and organisation of their dwellings.

Hill: Use and the creative user

Jonathan Hill argues that architecture is not completed through design alone, but continues to be produced through use. He challenges the idea that buildings can be fully controlled by the architect, and instead understands architecture as something that changes through everyday actions and interpretations. (Hill, 2003)

A central point in Hill's work is that users actively participate in shaping architecture, even when this is not planned or controlled by the architect.

Hill describes three types of users: passive, reactive, and creative (fig. 12) (Hill, 2003). The passive user follows intended functions without changing them, while the reactive user adapts within existing spatial limits. The creative user, however, changes or reimagines space in ways that can change both function and meaning.

Importantly, these categories are not fixed. Hill emphasises that the same building, and even the same user, can move between these modes depending on situation and context. (Hill, 2003) Use is therefore not stable, but constantly shifting.

He further develops this through different forms of user creativity, including mental, bodily, physical, constructional, and conceptual actions (fig. 13). These describe how users can modify or change architecture in both subtle and direct ways, from changing meaning to physically transforming space (Hill, 2003).

Overall, Hill (2003) reframes architecture as an open system where meaning is not fixed by design, but produced through use. This positions the user as an active participant in the ongoing construction of architecture.

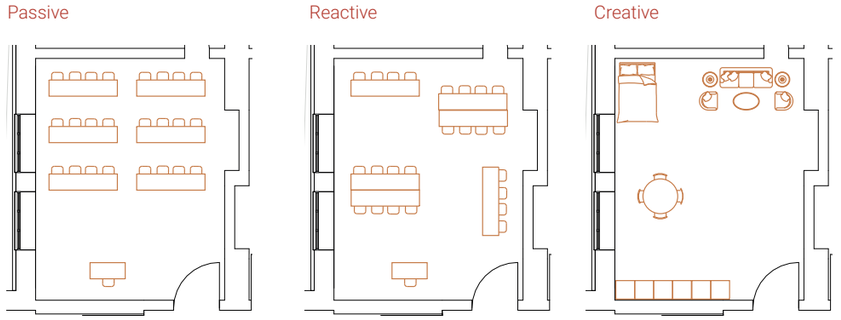


Fig. 12.
Use and the creative user

Use is not fixed but ranges from passive to creative, often overlapping within the same space.

Mental creativity: A resident sees the living room as a workspace during the day and a relaxing space at night.

Bodily creativity: A person uses the kitchen counter as a standing desk or sits on the floor instead of the sofa.

Physical creativity: Furniture is rearranged to create more open space or a new layout in the apartment.

Constructional creativity: A tenant adds a temporary shelf, curtain divider, or builds a small loft bed structure.

Conceptual creativity: A bedroom is reinterpreted as a studio, guest room, or shared multifunctional space without changing its structure.

Fig. 13.
Use and the creative user

Linking Habraken and Hill

Both Habraken and Hill address the same fundamental problem: How to understand housing and architecture beyond the idea of a finished, controlled product. Instead, they both frame architecture as something that depends on how it is used, changed, and occupied over time, even if they approach this from different angles.

Habraken's theory of support and infill focuses on the structural organisation of housing systems, where a permanent framework (support) enables users to actively shape their own dwellings through adaptable internal elements (infill). Habraken's main contribution is not only technical, but also social.

Hill, on the other hand, focuses on use as the site where architecture is completed and transformed. He argues that buildings cannot be fully controlled by design, since users continuously reinterpret and reshape space through different forms of action. This means that architecture is always open-ended and dependent on situated use.

Habraken describes how architecture can be structured to allow change over time through its physical organisation (support/infill), while Hill describes how change actually occurs in practice.

Habraken's model should not be seen as a fixed system, but as a framework where housing is continuously shaped through the relation between structure and user (Shepard, 2023). This is not only about flexibility in design, but about an ongoing interaction between building and use. This connects to Hill, who argues that use cannot be fully controlled by design. Even carefully planned spaces are always reinterpreted and changed in practice. Together, Habraken focuses on how architecture can allow change, while Hill shows that change always happens through use.

Together, the two theories establish a framework where housing is understood as a combination of spatial structure and lived use. Neither design or use is dominant; instead, architecture emerges in the interaction between the two over time.

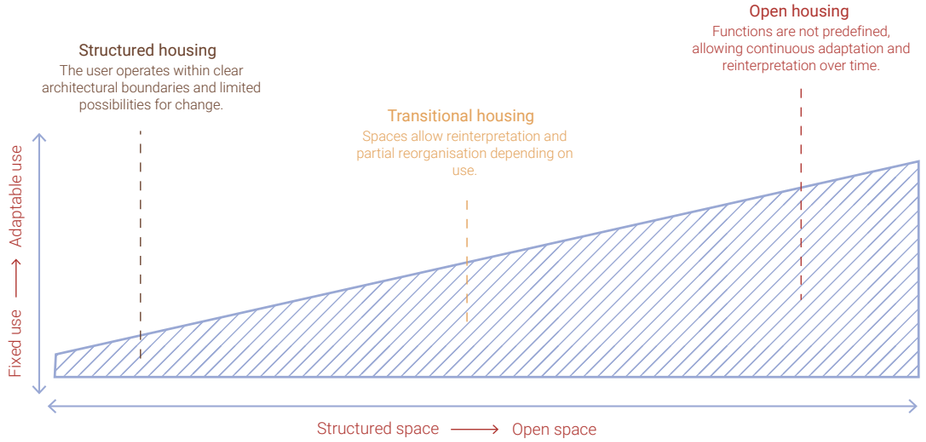


Fig. 14.
Structured vs. open space

From theory to spatial strategy

Based on Habraken and Hill, housing in this project is understood as a gradient between different degrees of structure and openness. On one side are more structured spatial zones, where layout and functions are partly defined through architectural elements. On the other side are more open and flexible spaces, where use is less determined and more open to interpretation (fig. 14).

Following Habraken, these differences can be understood through variations in the level of "support" in the building structure, where some parts of the architecture provide clearer spatial guidance than others. In relation to Hill, these spatial conditions also shape how users can act, ranging from more guided use to more open and creative forms of appropriation. Different degrees of support therefore enable different types of use, without fully determining them.

The transformation of the existing school is used as a testing ground for this spectrum, where different spatial situations are explored in order to examine how varying levels of structure influence possible ways of inhabiting the building.

TRANSFORMATION AS A SUSTAINABLE STRATEGY

Shaping new layers within existing structures

Purpose

This section examines how the transformation of existing buildings can reduce environmental impact compared to new construction, with a focus on CO_2 emissions, Life Cycle Assessments, and material use.

Climate and Sustainability

The approach to transforming existing buildings is directly linked to sustainability, as building lifespans, material use, and functional quality have a major impact on climate and resource consumption. Today, climate and sustainability play a decisive role in transformation projects. The building sector accounts for about 40% of Denmark's total energy consumption, mainly because many older buildings have not been energy-optimized since their initial construction (Indenrigs- og Boligministeriet, 2021). There is therefore great potential to reduce energy use and CO_2 emissions through targeted renovation and transformation rather than demolition and new construction. The strategy emphasizes the importance of using Life Cycle Assessments (LCA) and conscious material choices as tools to document and minimize the building's climate footprint (Indenrigs- og Boligministeriet, 2021).

The project focuses on the transformation of the school and compares its climate impact with the limit of new construction, examining how each performs in a LCA, the regulatory limit, from BR18, for new multi-storey buildings is 6.1 kg CO_2-eq/m²/year. (Social- og Boligstyrelsen, BR18, §297–298)

By focusing on the existing building stock, the need for newly produced construction materials can be reduced, waste minimized, and resources used more efficiently. When combined with energy efficiency measures, material reuse, and carefully planned interventions, transformation contributes both to CO_2 reduction and to a more sustainable use of building lifespans, while also preserving their social and cultural value.

Fig. 15.
Photo: Karner, Aalborg Stadsarkiv

The existing structure as the starting point for transformation — the building's long-term layer framing new possibilities.

DIALOGUE WITH THE EXISTING BUILDING

The building as design driver

Purpose

This section presents a theoretical framework for understanding transformation as a process of working with an existing building rather than imposing something new onto it. Instead of treating adaptive reuse as the insertion of a new programme into a neutral container, this project approaches the former school building as an active participant in the design process.

The aim is to investigate what kinds of housing the building is suited for, based on its structure, proportions and spatial organisation.

Buildings change over time

Stewart Brand, american futurist and writer, describes in *´How Buildings Learn´* (Brand, 1994), buildings as systems made up of layers that change at different speeds. He identifies six layers: Site, Structure, Skin, Services, Space Plan and Stuff – known as the "shearing layers of change" (fig. 16).

The slower layers, especially site and structure, last the longest. The faster layers, such as layout and installations, change more often. Brand summarises this clearly:

"The slow parts are in charge" *(Brand, 1994, p.17)*

This idea is important in transformation projects. The structural system, load-bearing walls, proportions and relationship to the city define the building's long-term character. These elements should not be ignored or heavily altered without reason. Instead, they form the starting point for new design decisions.

Transformation therefore means understanding which parts of the building can change easily and which parts should remain stable.

Reading the building

Writers on adaptive reuse stress the importance of carefully analysing the existing building before defining a new programme (Douet, 2013; Plevoets & Van Cleempoel, 2019). This "reading" of the building includes:

- Understanding the structural system
- Identifying spatial rhythm and repetition
- Analysing light conditions and ceiling heights
- Recognising which walls are load-bearing
- Mapping circulation and access

Reading is not only technical documentation. It is a way of understanding what the building is capable of supporting.

Instead of asking, How can we fit housing into this building? the project asks:

What kind of housing does this building naturally lend itself to?

This shift in question changes the role of the architect. The design process becomes an investigation of suitability rather than an act of imposition.

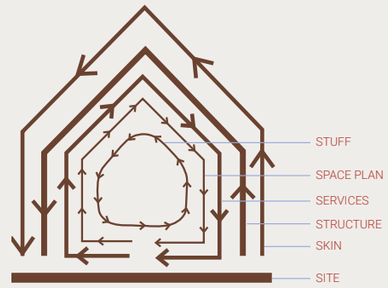


Fig. 16.
Shearing layers of change
by Steward Brand

SITE

The building's geographical setting and its legally defined lot. Extremely stable; expected to last centuries.

STRUCTURE

The foundation and load-bearing elements that give the building its stability. Expensive and difficult to change; lifespan 30–300 years.

SKIN

The exterior surfaces like walls, roof, and facade. Updated periodically to maintain protection and appearance; lifespan 20–30 years.

SERVICES

Mechanical and electrical systems (plumbing, wiring, HVAC, elevators). Require regular replacement; lifespan 7–15 years.

SPACE PLAN

Interior layout of walls, floors, and doors. Adaptable to new uses; lifespan 3–30 years.

STUFF

Furniture, appliances, and moveable items. Flexible and frequently replaced; lifespan days to months. (Brand, 1994)

Suitability and potential

Recent discussions in architectural practice argue that reuse should be prioritised over new construction, not only for environmental reasons but also because existing buildings contain spatial qualities that cannot easily be recreated (Malterre-Barthes, 2025; Betsky, 2024).

Working within existing constraints can generate more specific and meaningful architecture. A fixed structural rhythm can define apartment width. Large classroom windows can ensure good daylight for dwellings. Generous ceiling heights may allow variation in section. Existing staircases can organise housing clusters.

In this way, spatial constraints become design opportunities.Housing typology therefore does not come first. It develops from the building's structure and scale.

Application to the this project

The former school building in Aalborg has several defining characteristics:

- A robust load-bearing structure
- Repetitive classroom modules
- Strong facade rhythm
- Generous ceiling heights
- A corridor-based circulation system

Within Brand's framework, the structure represents a slow and durable layer. It carries the building's identity and should remain legible after transformation. The primary changes therefore take place within the space plan and services layers.

Entering into dialogue with the building means:

1. Keeping the structural rhythm visible rather than breaking it down.
2. Letting former classroom dimensions influence apartment sizes.
3. Using existing staircases and corridors to structure residential organisations. (Brand, 1994)

The housing types are therefore not decided in advance. They emerge through analysis and testing of what fits within the building's proportions, depth and structural system.
The building does not dictate a single solution, but it defines a range of realistic and meaningful possibilities. The final residential typologies are the result of this negotiation.

Transformation is thus understood as a continuation of the building's life – not as a replacement of it.

LIFE CYCLE ASSESSMENT AS A DESIGN TOOL

Project application

Purpose

The purpose of this section is to position Life Cycle Assessment (LCA) as an integrated methodological tool within the transformation of the former school.

Rather than applying LCA as a final compliance calculation, the method is introduced as a design-support framework informing architectural decisions related to preservation, material strategy and environmental impact.

This section therefore outlines the theoretical foundation of LCA and clarifies how it is integrated within the project.

What is Life Cycle Assessment?

Life Cycle Assessment (LCA) is a systematic method for evaluating the environmental impacts associated with a product or building throughout its entire life cycle (Hauschild, Rosenbaum and Olsen, 2018) (fig. 17).

Within the Danish building context, LCA is structured according to the danish building regulations (Social- og Boligstyrelsen, BR18, §297–298), which defines a modular system covering production, construction, use, end-of-life and benefits beyond the system boundary, shown in figure 18.

The methodology consists of four interconnected phases:

- Goal and scope definition
- Inventory analysis
- Impact assessment
- Interpretation

These phases are iterative and inform one another throughout the process. As described by Hauschild, Rosenbaum and Olsen, adjustments in scope or assumptions may occur as results are interpreted and refined.

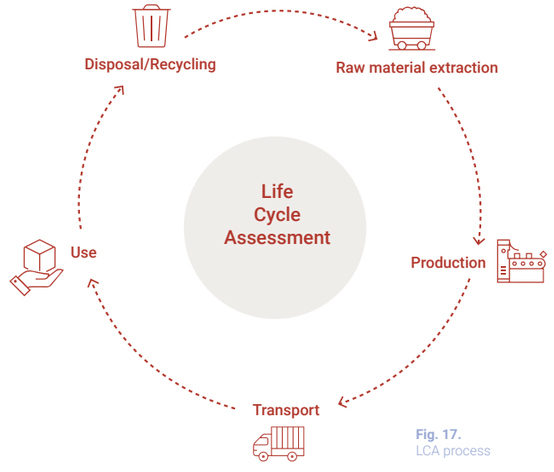


Fig. 17.
LCA process

Fig. 18.
LCA phases

Why use LCA in this project?

The transformation of an existing building involves decisions that are both qualitative and quantitative. While architectural value, spatial quality and preservation potential are essential parameters, environmental impact must also be addressed.

LCA is applied in this thesis to make the environmental consequences of design decisions explicit.

In particular, the method supports evaluation of:

- Preservation versus replacement of structural elements
- Addition of new housing units
- Material strategies for envelope upgrades and surfaces

The method therefore operates alongside architectural valuation methods, forming a holistic approach that addresses both measurable and immeasurable parameters.

Importantly, LCA is understood as a decision-support tool, not a prescriptive answer.

Goal and Scope of the assessment

Goal

The goal of the LCA in this project is to reduce the environmental impact of primary building components in the transformation project through comparative calculations.

The assessment balances operational energy (B6) and embodied impacts to inform strategic design decisions.

Scope

The assessment focuses on selected life cycle modules, it includes all life cycle modules required by the Danish Building Regulations (Social- og Boligstyrelsen, BR18, §297–298), except Module D:

- **A1–A3:** Product stage
- **A4–A5:** transport and construction process
- **C3–C4:** End-of-life
- **B4:** Replacements
- **B6:** Operational energy (final calculation)

Module D is not included because there is uncertainty about future reuse and recycling scenarios. Even though it is part of the building regulations to include Module D, it is chosen not to include it due to these uncertainties.

Preserved existing elements are treated as zero-impact and excluded from A1–A3. Newly added materials are fully accounted for. Generic data from Appendix 2, Table 7 of the Danish Building Regulations (Social- og Boligstyrelsen, BR18, §297–298) is used for the calculations.

CHAPTER
04

SITE

CONTENT

Contextual framework

Microclimate

Access and boundaries

Fig. 19.
Building,
own photo

This section examines the building's site. As a long-lasting layer that changes only slowly over time, it provides a stable framework for the building. Analysing the site's conditions, historical context and its relationship to the surroundings helps clarify the opportunities and constraints that inform the transformation.

CONTEXTUAL FRAMEWORK

Historic timeline

Purpose

This historic analysis aims to examine the functional development of Kjellerupgade School from its establishment to its current state. By tracing changes in use and ownership, it provides the historical context which is necessary to understand the building's condition and its potential.

Fig. 21.
Aalborg Stadsarkiv

1901

Primary school established

A brick building was constructed to accommodate a primary school (Bendix, 1936).

1901-1930

Fig. 23.
Aalborg Stadsarkiv

School as a social center

The school served as a social gathering place for the working-class neighborhood. It was an important meeting point for children and families in the community (Aalborg Kommune, 1999).

1930s

1935

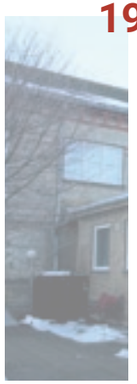


Fig. 24.
Own photo

Gymnasium was added

An additional building volume was constructed to house another gymnasium, so that boys and girls each had their own (Bendix, 1936).

Mid-1970s

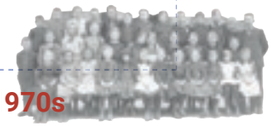


Fig. 22.
Photo: A. C. Larsen, Aalborg Stadsarkiv

From the mid 1970s the school only offered education up to 6th grade (Os fra det gamle Ø-gadekvarter 9000 Aalborg, 2024).

Fig. 20.
Photo: Karner, Aalborg Stadsarkiv

1992

School reforms

Public schools focused on hygiene and physical education. Students learned about cleanliness and took part in regular gymnastics (Gjerløff, 2019).

School closure

The school stopped operating as a public school (Os fra det gamle Ø-gadekvarter 9000 Aalborg, 2024).

Fig. 25.
Own photo

1992

´Det hem´lige teater´ takes over the gymnasium

Det hem´lige teater moves into the gymnasium, transforming them into a theater space (Det Hem'lige Teater, n.d.).

2000

Transferred to cultural use

Fig. 27.
Own photo

The building discontinued its function as a public school and was later occupied by AOF and FOF, accommodating evening education, workshops, and community-based activities (Brauer, 2018).

2019

Reacquired by Aalborg Municipality

Ownership returned to the municipality (Brauer, 2018).

Fig. 26.
Own photo

2026

Opening for transformation

Det hem´lige teater is moving its location. This leaves the project case open for transformation.

Fig. 29.
Own sketch

Future

A sustainable residential community

2024

Fig. 28.
Own photo

Building turns empty

Future of the building formally addressed in municipal planning (ByensEjendom, 2023).

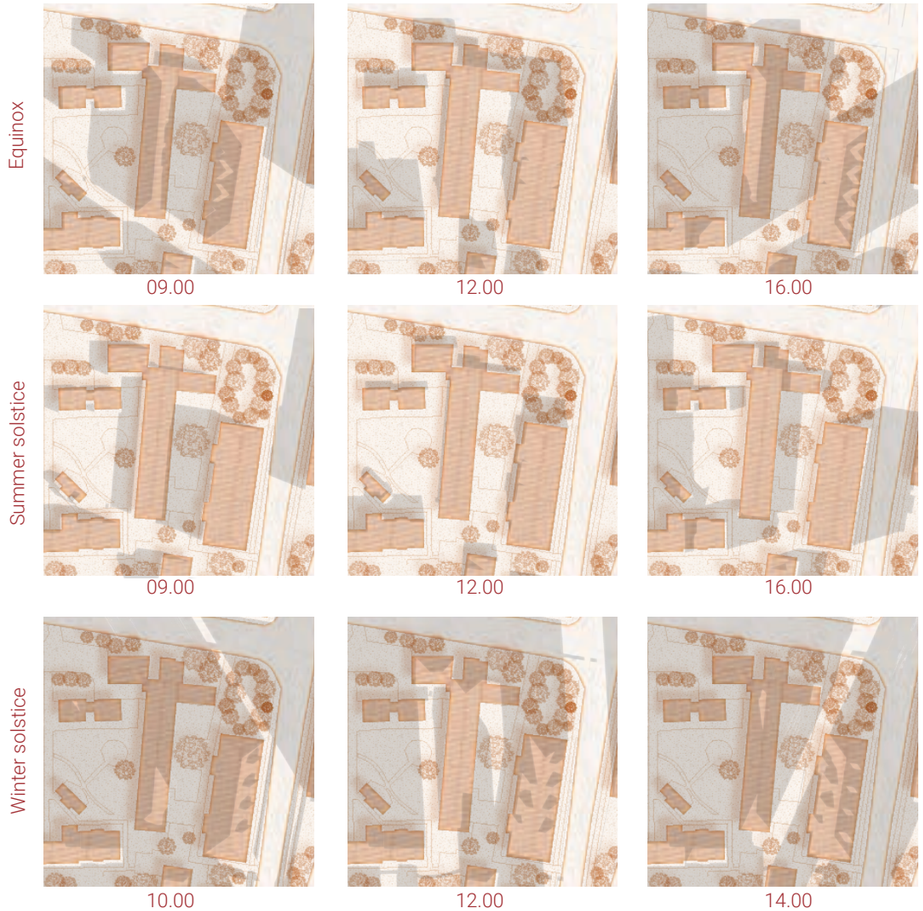
MICROCLIMATE

Purpose

The existing microclimatic conditions of the site are investigated to form the basis for organising the outdoor areas. The microclimatic conditions are analysed with focus on sun and shadow conditions, wind exposure, and noise levels.

Based on the noise and wind analyses presented in appendix 1, together with the sun and shadow analysis shown in figure 30, a synthesis drawing has been developed to summarise the key findings (fig. 31).

Fig. 30.
Sun/shadow analysis



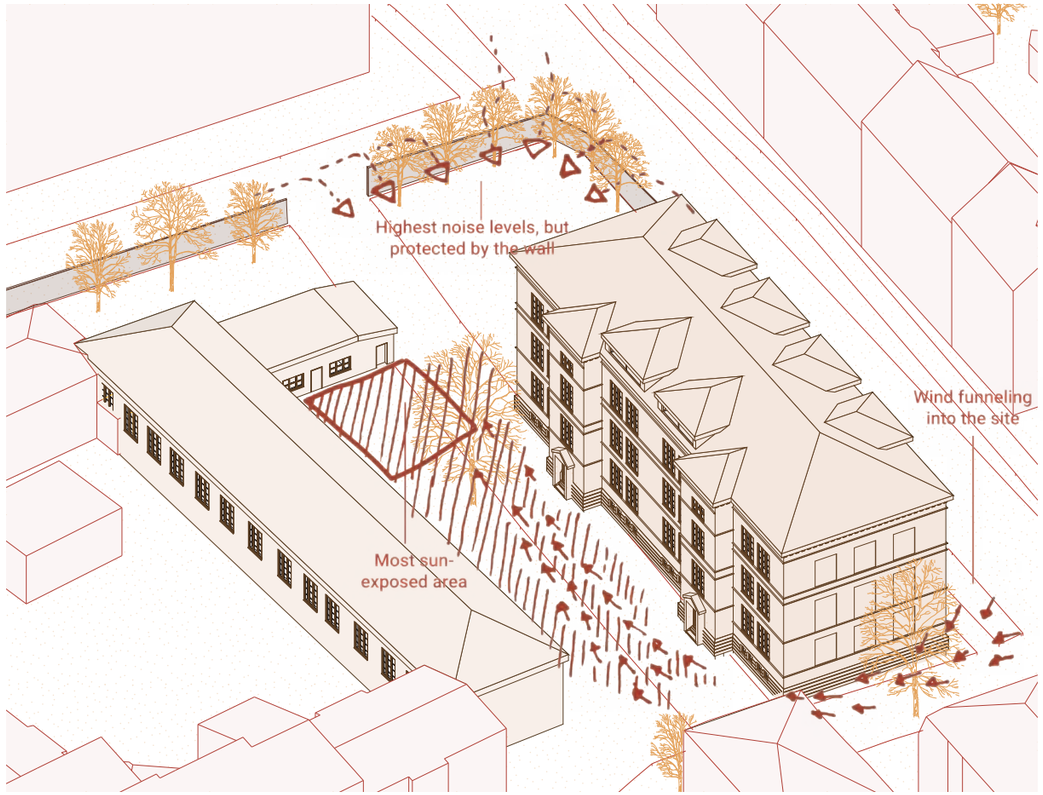


Fig. 31.
Microclimate translation

Solar analysis of the outdoor spaces shows that the courtyard receives afternoon sunlight in several areas, particularly between noon and 4 PM (fig. 30). This is beneficial, as the outdoor spaces are expected to be used primarily during the afternoon and evening when transformed into housing. The winter solstice has different time schedules due to later sunrises and earlier sunsets, resulting in fewer daylight hours during the winter period.

The courtyard is also affected by frequent winds, with the southern part of the site being less comfortable. The area with the greatest sun exposure also benefits from more favourable wind conditions, making it suitable for outdoor stay and seating, while other areas are more optimal for strolling.

Noise from the Kjellerupsgade is most noticeable in the north-eastern areas, although the wall surrounding the site provides some protection, while other parts remain relatively quiet, creating varied conditions for outdoor activities and social interaction.

Fig. 32.
Own photos

Street view of the school building along Kjellerupsgade, showing the southeast access point

The parking area in the northeast corner, framed by existing trees and accessed from the wide northern entrance

The existing wall enclosing the site, defining the former schoolyard edge

External access to the basement from the courtyard

Paths running along the facade, connecting the different parts of the site

The courtyard space enclosed by the surrounding buildings

View towards Karolinelund, with vehicle access from the southeast corner

A small area behind the gymnasium with bicycle parking and a shed

ACCESS AND BOUNDARIES

Site registrations

The purpose of this analysis is to examine the site's existing boundaries and access points, and how it relates to its surrounding context. As the site undergoes a change in function, understanding these current conditions is important as a starting point for the site's transformation.

Porpuse

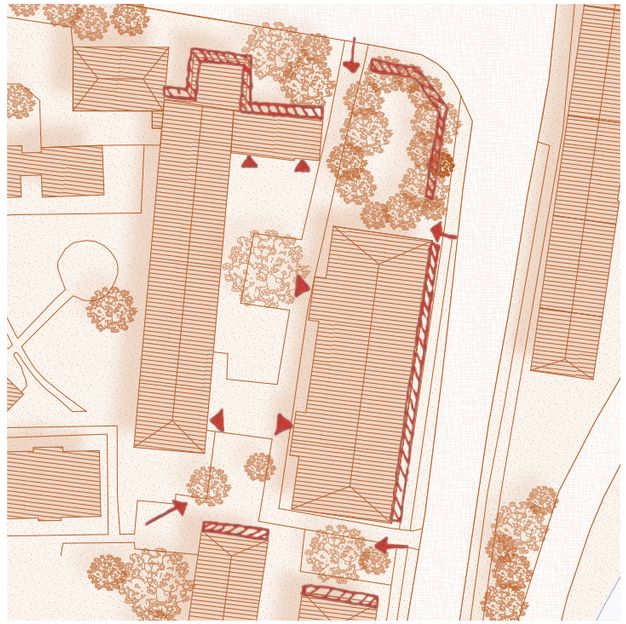


Fig. 33.
Access and boundaries currently 1:1000

The site currently reads as enclosed, with the northeastern corner blocked by a wall. All building entrances are accessed from the courtyard, giving the school a withdrawn and closed-off appearance along Kjellerupsgade. As a result, the site is primarily visited with a specific purpose, despite having formal access from all directions. This enclosed character limits casual pass-through or spontaneous use, as the courtyard is experienced mainly as an internal space for the school rather than a publicly engaging area.

DESIGN IMPLICATIONS

Urban zoning

based on:
MICROCLIMATE + ACCESS AND BOUNDARIES

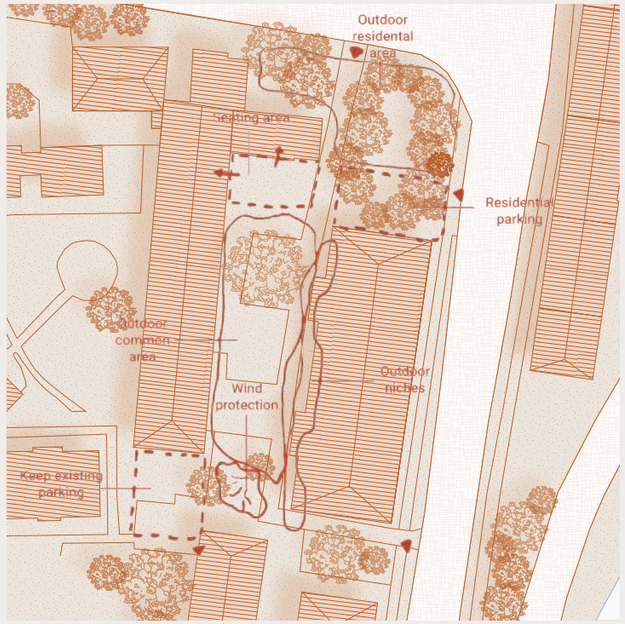


Fig. 34.
Design translation 1:1000

Based on the previous analyses, new outdoor zones are defined to translate the findings into spatial design strategies. The main interventions focus on creating a more pleasant courtyard that supports everyday stays and social interaction between future residents. This is done by introducing wind protection and semi-private niches for seating and informal use. The corner by the gymnasium volume is also identified as a suitable place for staying, as it is both sheltered and highly exposed to the sun. At the same time, the proposal reduces the amount of hard paving in favour of more planting and green areas, creating a softer and more inviting courtyard environment.

CHAPTER 05

STRUCTURE

CONTENT

Load-bearing structure

Fig. 35.
Building,
own photo

This section examines the building's structure. As a slow and long-lasting layer, it defines the building's fundamental logic and stability. Analysing the structural system helps clarify what can be changed and what should be preserved, allowing the structural rhythm to guide the transformation.

(Original drawings (WebLager, Aalborg Municipality) formes the basis for the analyses and are actively used through annotation and sketching to understand and interpret the existing building.)

LOAD-BEARING STRUCTURE

Brick masonry wall

The building's structural system is based on load-bearing masonry walls combined with floor slabs and timber beams supporting the roof. The exterior walls are made of solid brick and act as the main load-bearing elements, carrying loads from the floors and roof down to the foundation.

The floor slabs and roof beams distribute loads and transfer them to the load-bearing and stabilising walls. A central load-bearing wall also contributes to the overall stability of the structure.

Overall, the system creates a clear structure, where the walls carry the main loads, while the floors and roof span between them and help distribute forces throughout the building.

- Stabilising
- Load-bearing
- Load-bearing & stabilising

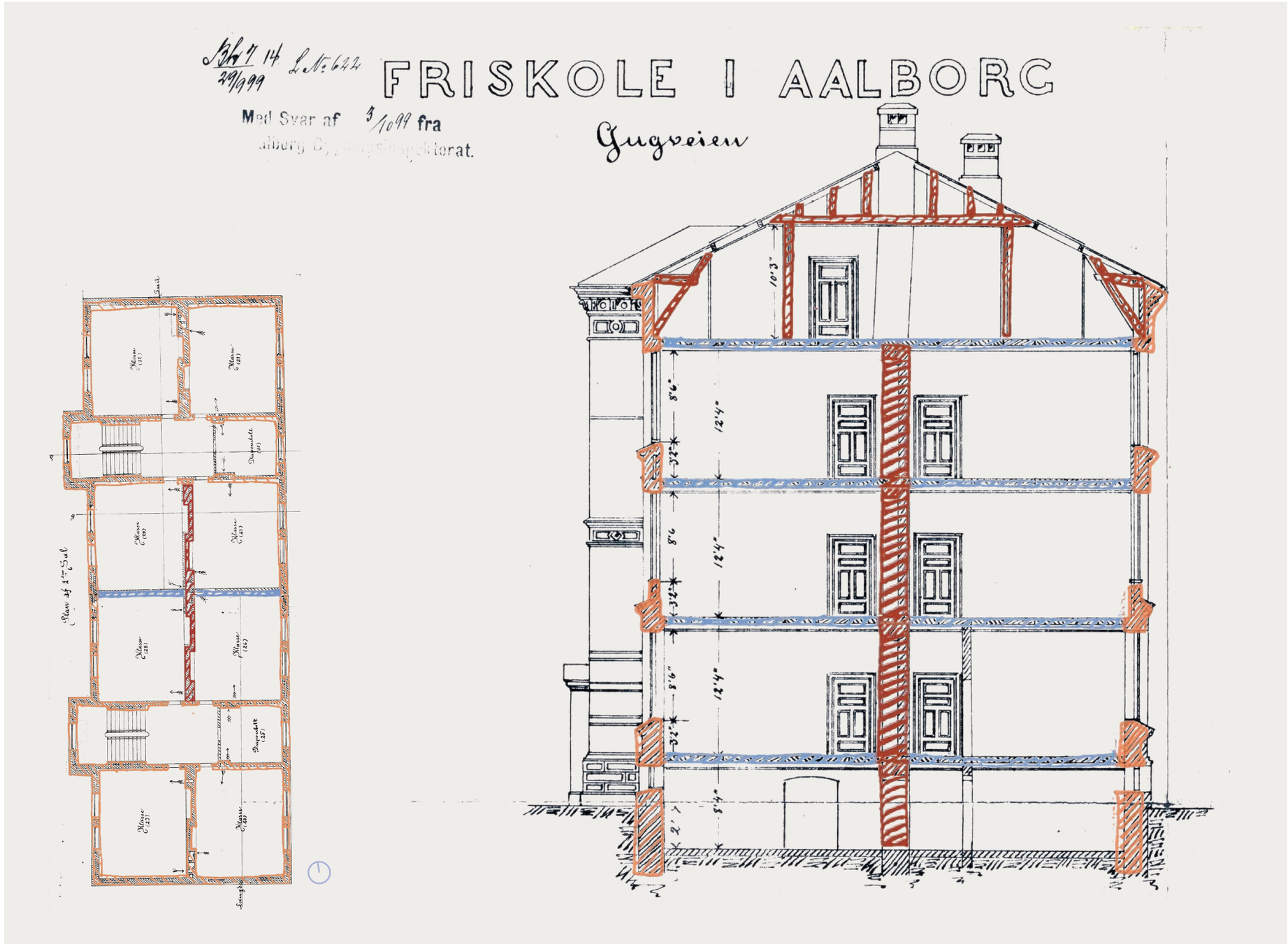


Fig. 36.
Structures

CHAPTER
06

SPACE PLAN

CONTENT

Building analysis | School
Building analysis | Gymnasium
Daylight conditions

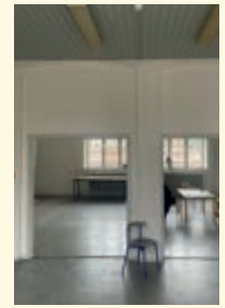


Fig. 37.
Building,
own photo

This section examines the building's space plan. As a more adaptable layer, it analyses how spaces are organised and used over time through their spatial rhythm, light conditions, ceiling heights and circulation patterns. Understanding this layer helps clarify how new layouts can be developed in response to the existing structure.

(Original drawings (WebLager, Aalborg Municipality) formes the basis for the analyses and are actively used through annotation and sketching to understand and interpret the existing building.)

BUILDING ANALYSIS | SCHOOL

Spatial organisation and character

This section presents an analysis of the original drawings of the building's plans and sections, focusing on spatial organisation, dimensions, symmetry, and architectural characteristics. It also includes an analysis of the building in its current state, including later additions and alterations. The aim is to understand the underlying ideas, intentions, and qualities of the original design, providing a foundation for further development while respecting and preserving its character.

Porpuse

The analysis of the original drawings reveals a strong spatial structure with a clear symmetry and order in both plan and section. This clear structure appears as a key quality of the building, where the relationship between spaces is consistent and easy to read (fig. 38 & 39). This is the structure that the project aims to preserve.

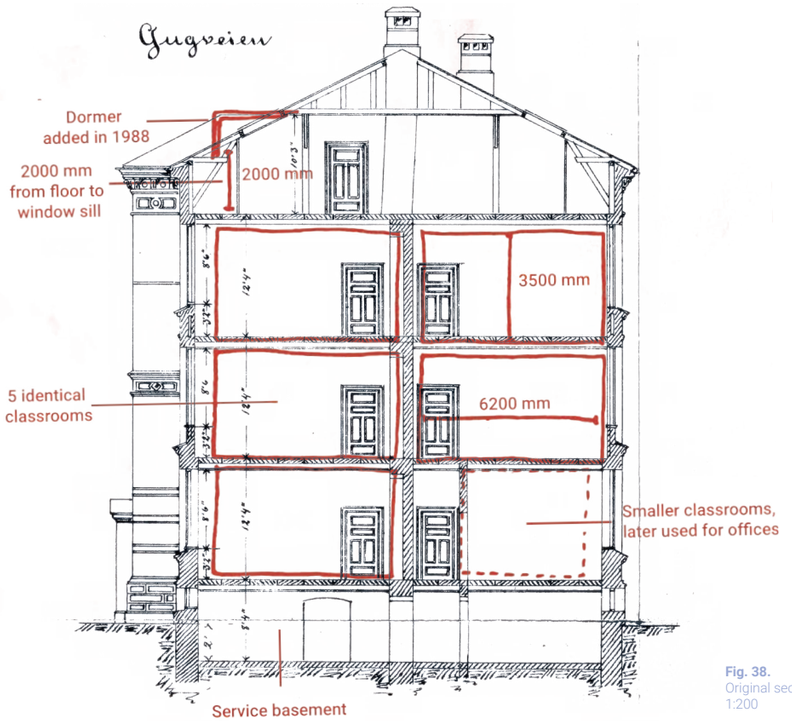


Fig. 38.
Original section
1:200

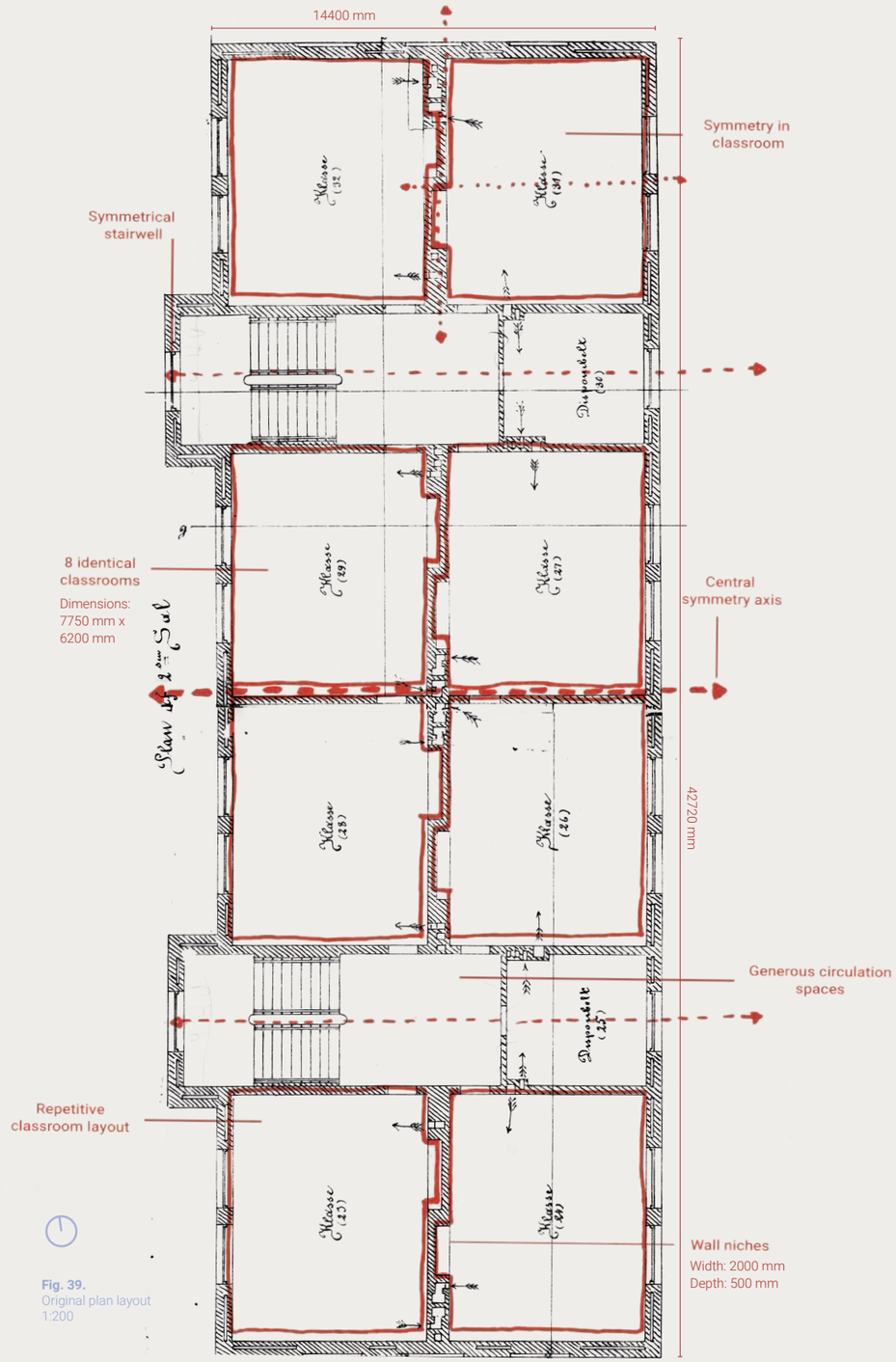


Fig. 39.
Original plan layout
1:200

Current spatial organisation

The later additions, on the other hand, appear less consistent and in several places break with the original structural clarity. These additions partly compromise the overall spatial logic and coherence of the building. The project therefore points towards a need to simplify or rework these elements in order to restore and clarify the original architectural whole.

The current floor plan of 1st floor, including later additions, is shown in figure 41. Selected additions are further illustrated in the photos beneath (fig. 40), while the remaining existing floor plans are presented in appendix 2.

Fig. 40.
Own photos of additions

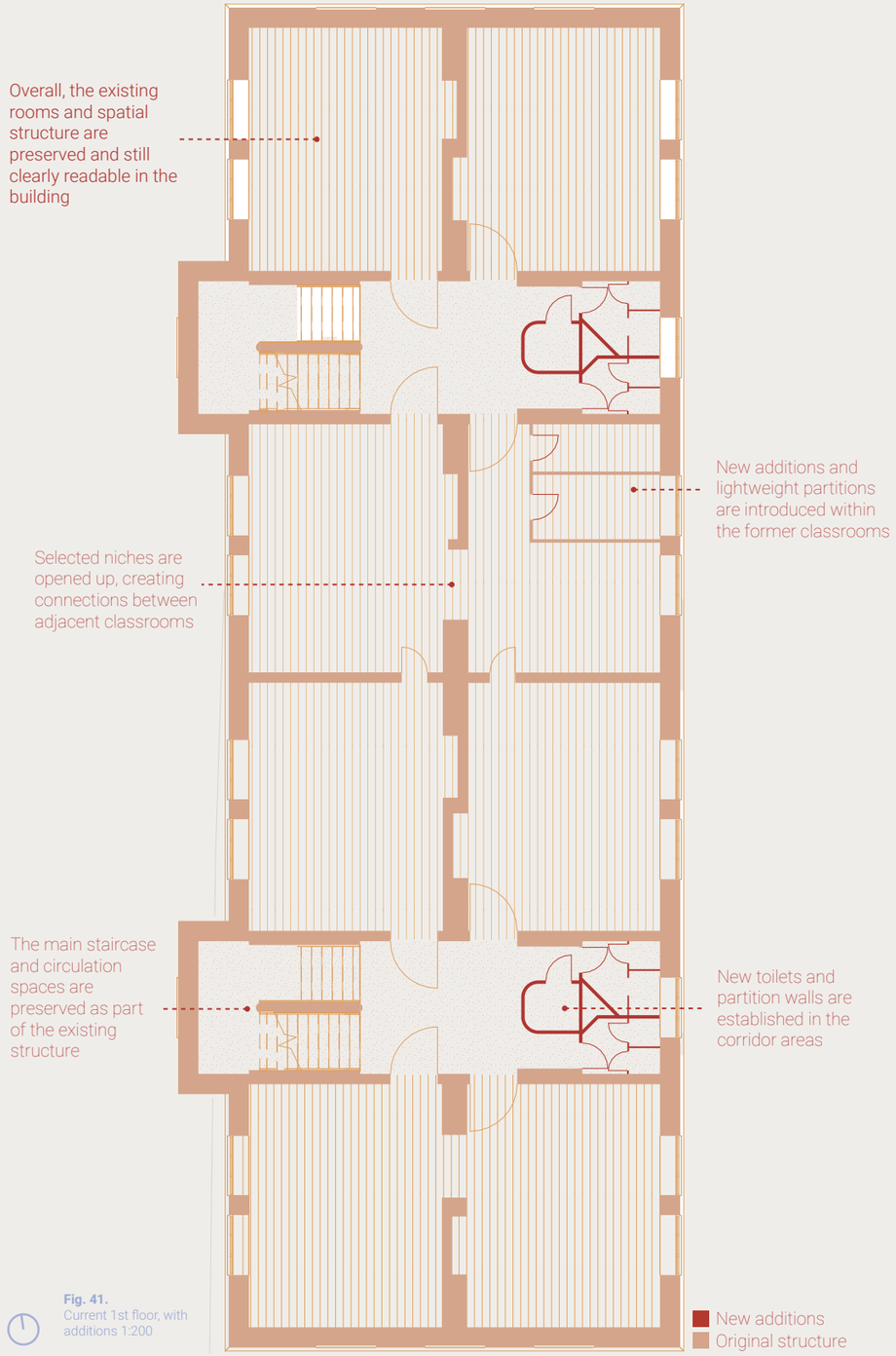


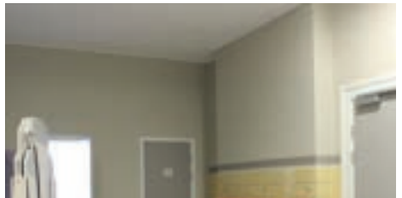
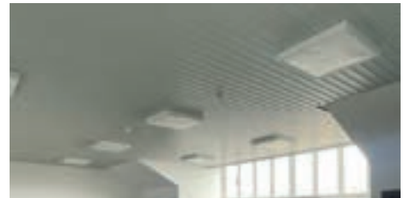
Fig. 41.
Current 1st floor, with additions 1:200

Classrooms, niches and basement

Fig. 42.
Own photos of the school building as it is today

Circulation space

Top floor

DESIGN IMPLICATIONS

Transformation of the school

based on:

BUILDING ANALYSIS | SCHOOL + STRUCTURE

Based on the analysis of the school's plans, sections and structure, various concepts for transformation have been explored.

Based on the analysis, the considerations shown in figure 43 are carried forward into the design process as potential solutions for the transformation into housing. Due to the floor-to-window height on the top floor, it is not suitable for residential use in its current state. Therefore, the transformation of this level and the roof design is explored, aiming to create housing on this floor that offers some other qualities than the rest of the building.

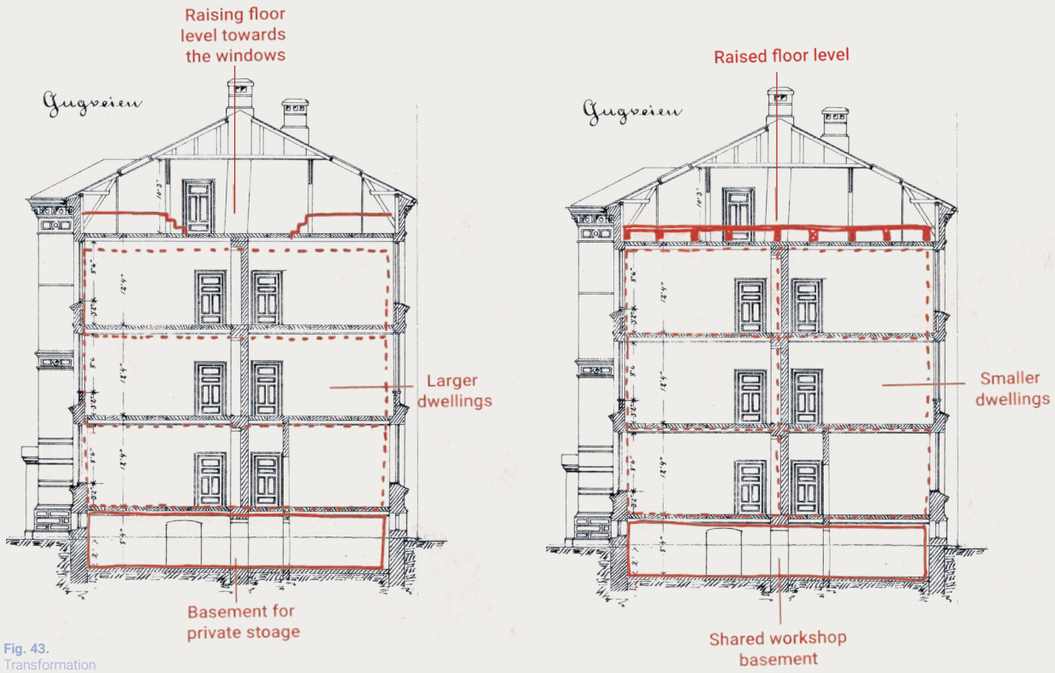


Fig. 43.
Transformation principles in section

Fig. 44.
Floor plan organisation

Focusing on the floor plan, the building presents a clear structural framework that is intended to be preserved, allowing it to inform and guide the organisation of housing units within the existing structure. Three main principles for the organisation of the units is shown in figure 44, and they will form the basis for the further design.

BUILDING ANALYSIS | GYMNASIUM

Spatial organisation and spatial character

Purpose

This section presents an analysis of the original drawings of the former gymnasium, focusing on spatial qualities, dimensions, and organisational principles. The aim is to understand the inherent spatial characteristics and intentions of the building through the historical drawings, providing a basis for exploring its transformation potential and future use.

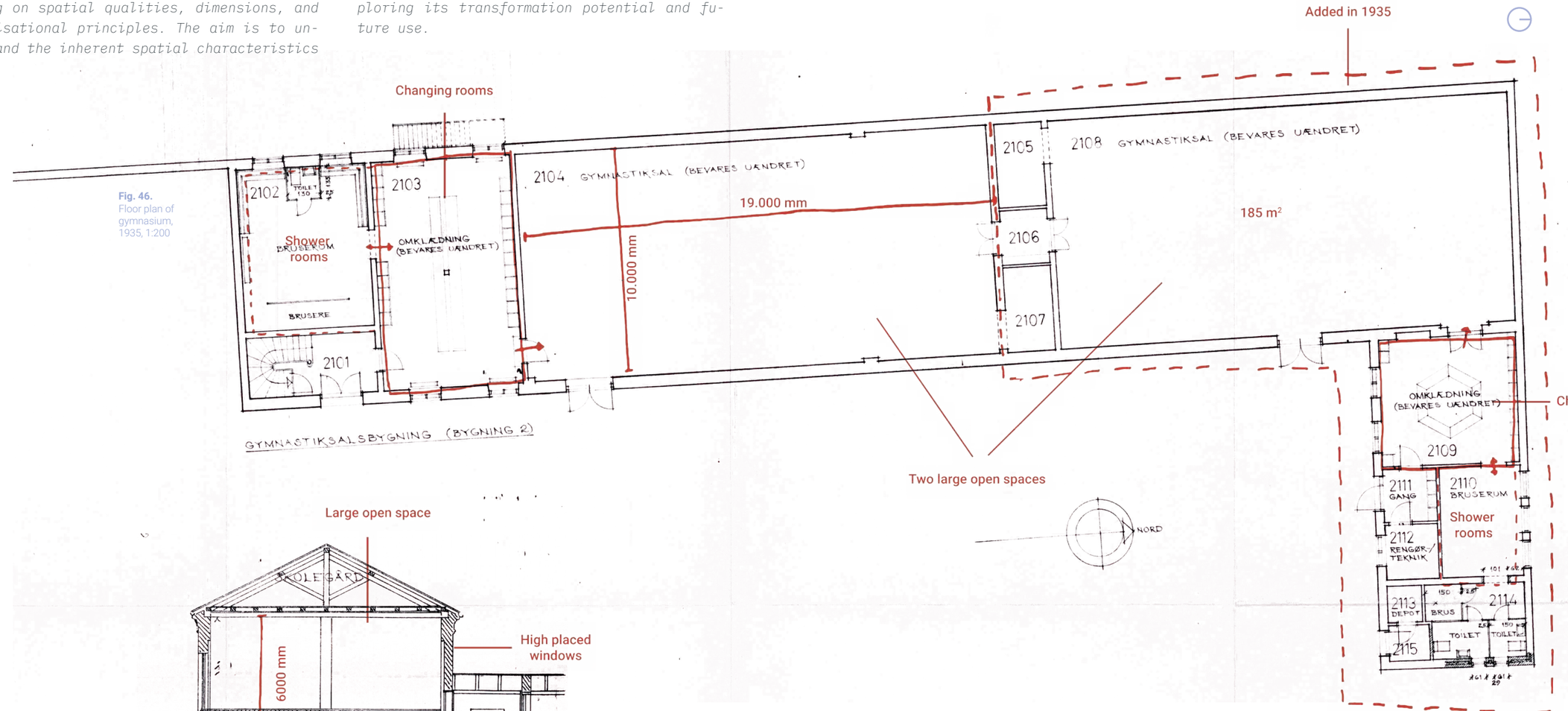


Fig. 46.
Floor plan of gymnasium, 1935, 1:200

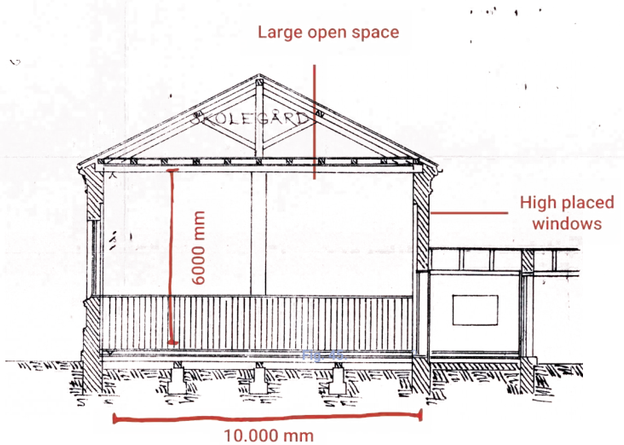


Fig. 47.
Section of gymnasium, 1935, 1:200

One of the old gymnasium converted into an theatre

One of the changing rooms for the gymnasium

Fig. 48.
Own photos of gymnasium as it is today

Existing high-level windows in the double-height space, originally from the former gymnasium, are now blacked out for theatre use

Entrance area with low-level windows and two floors

DESIGN IMPLICATIONS

Transformation of the gymnasium

based on:
BUILDING ANALYSIS | GYMNASIUM

Based on the analysis of the gymnasium plan and section, various concepts for transformation have been explored. The investigations focus on engaging with the existing qualities of the building, while building upon them to accommodate new functions and spatial possibilities.

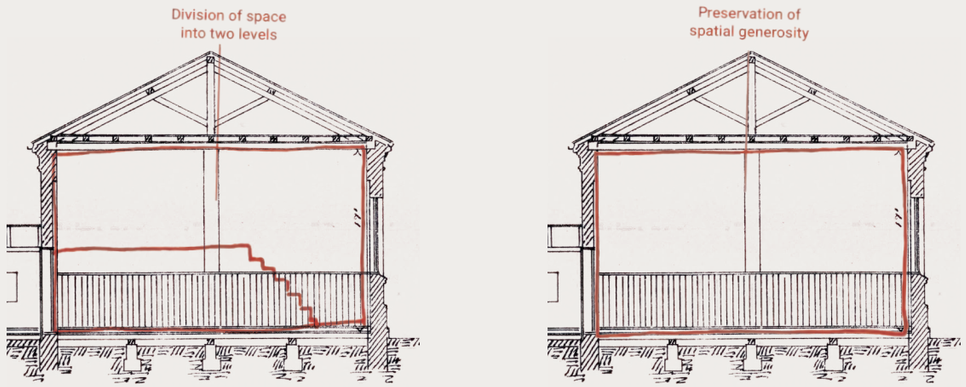


Fig. 49.
Transformation principles

The transformation of the building can take different directions, depending on the level of intervention, use scenarios and changes to the form and expression. Its generous spatial qualities allow for a range of commercial uses, including offices, cultural programs, or sports facilities. At the same time, the building's context and scale also support the possibility of row housing, though this would require a more extensive transformation.

Fig. 50.
Transformation principles

DAYLIGHT CONDITIONS

Illuminance analysis

Porpuse

Daylight conditions in the school are analyzed to understand the existing spatial qualities and the distribution of natural light. This provides a basis for evaluating the potential of the former classrooms for residential use, grounded in the current daylight conditions.

Daylight analysis

The daylight analysis has been made with focus on *Spatial Daylight Autonomy (sDA)* and *Usefull Daylight Illuminance (UDI)*, carried out in *Climate Studio* through *Rhino*. The analysis is used as a design tool to look at how daylight is distributed in the classrooms, and how different architectural choices affect light levels in the rooms.

In order to compare the result with the daylight requirement in BR18, which states that the indoor illuminance from daylight must be 300 lux or more for at least half of the daylight hours in at least 50% of the room's area, the sDA analysis is used. UDI is additional used, to describe the percentage of time that a point in space reports an illuminance level within the four ranges:

Failing: Less than 100 lux
Supplemental: Between 100 and 300 lux
Autonomous: Between 300 and 3000 lux
Excessive: Above 3000 lux

Existing daylight conditions

Results:
UDIa: 54,6%
sDA: 80,2%

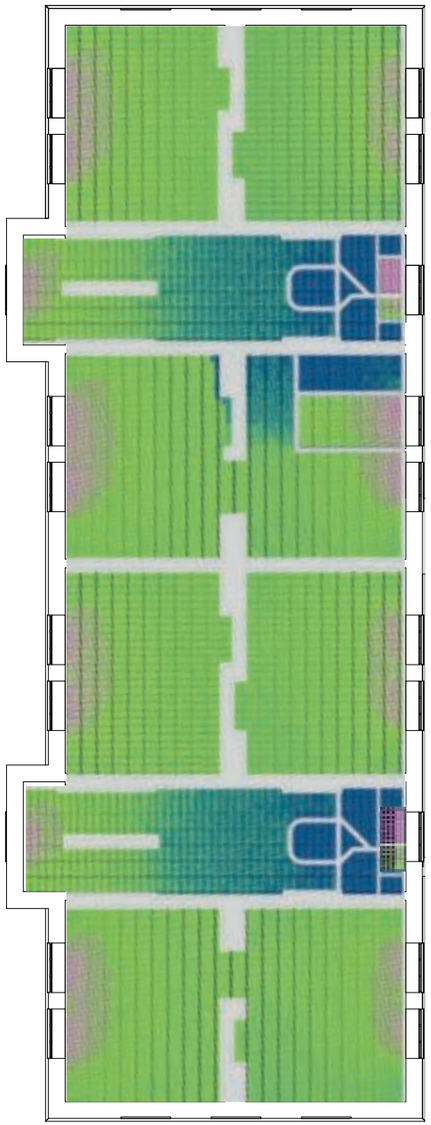


Fig. 51.
UDI analysis
1st floor

DESIGN IMPLICATIONS

Daylight in dwellings

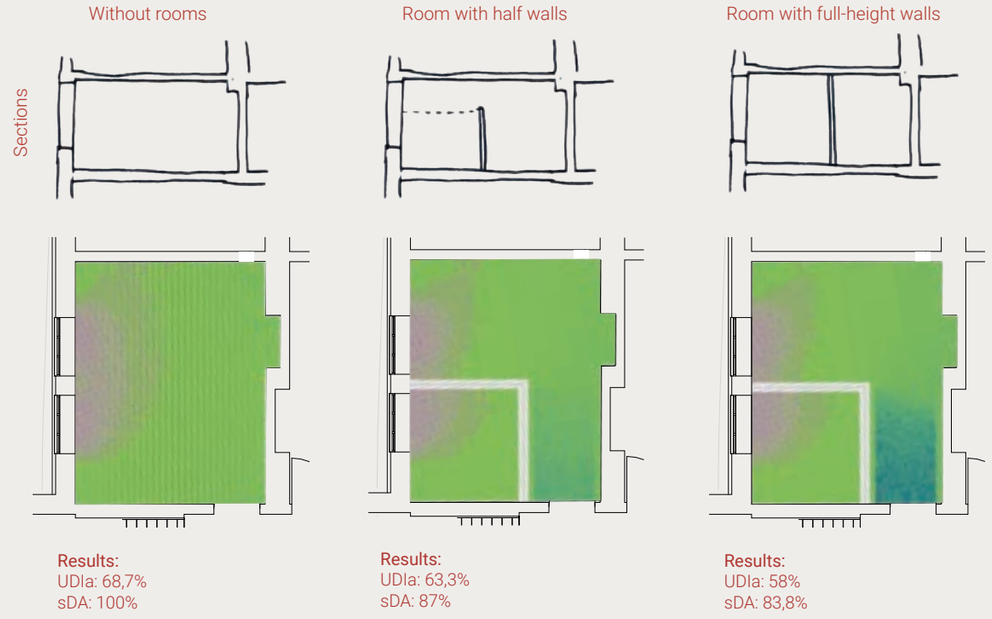
based on:
DAYLIGHT CONDITIONS

In the transformation from classroom to residential use, the existing framework provides a limited facade access in each dwelling. This creates a need to carefully consider how a dwelling can be organised within these constraints.

Several spatial principles have therefore been investigated to understand how each principle affects daylight conditions.

The introduction of full-height partition walls, as typically found in conventional housing layouts, has been found to negatively impact daylight penetration significantly. In particular, the deeper areas of the space are highly affected, receiving reduced daylight levels.

As a result, the project explores more open spatial configurations, including the use of partial-height partitions. These allow for a degree of spatial division while still enabling daylight to penetrate deeper into the space.



Results:
UDIa: 68,7%
sDA: 100%

Results:
UDIa: 63,3%
sDA: 87%

Results:
UDIa: 58%
sDA: 83,8%

Fig. 52.
UDI analysis
1st floor

CHAPTER
07

SKIN

CONTENT

Building expression
Understanding the skin
Window study
Identifying thermal bridges
Energy performance
Materiality

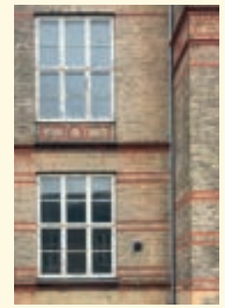


Fig. 53.
Building,
own photo

This section examines the building's skin. As a more adaptable layer, it defines the building's exterior expression and environmental performance. Analysing the facade, wall construction, windows, thermal bridges, materials and energy use helps clarify how the envelope can be modified to support the transformation while preserving the building's character.

(Original drawings (WebLager, Aalborg Municipality) formes the basis for the analyses and are actively used through annotation and sketching to understand and interpret the existing building.)

BUILDING EXPRESSION

Facades

Porpuse

This section examines the facade to understand how its architectural expression interacts with the surrounding context and to identify elements worthy of preservation.

The building's current form is formal and symmetrical, with a closed facade facing the street, offering no direct access (fig. 54). Reflecting its original function as a school, entry is provided from the courtyard. The remaining of the existing facades are included in appendix 3.

Constructed between in 1901, the building exemplifies the historicist approach common in Danish architecture of the period, where architects drew inspiration from earlier architectural styles to express structure and hierarchy. Features such as carefully arranged windows, detailed brick facades, and proportional compositions connect the building to its architectural tradition (DAC, 2023).

The following photographs on page 71 highlight the rich detailing and craftsmanship inherent in the existing structure, demonstrating the value of working with a historic building. These architectural details contribute to the building's character and are considered significant for preservation, ensuring that its expression, cultural history, and architectural integrity can be appreciated and extended into its renewed function for many years to come.

Fig. 54. Existing east facade

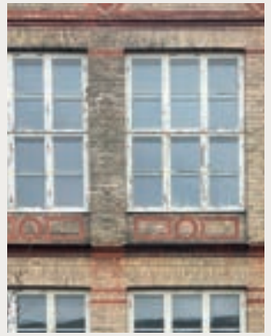
Facade detailing around windows

Cornice at the roof

Horizontal banding and decorative motifs

Detailed niches in the gables

Roofline and dormer



Window rhythm and alignment

Base material and plinth expression

Building entrance and facade hierarchy

Facade repetition and structural clarity

Fig. 55. Own photos

UNDERSTANDING THE SKIN

External wall

Porpuse

This analysis focuses on the exterior wall as an integrated architectural element combining structure, materiality, and environmental performance, informing the transformation.

The building envelope consists of solid brick masonry, 2 1/2 brick thick at ground level, reduced by half a brick on each upper floor as the structural load decreases. Internally finished with plaster and expressed externally as exposed brickwork.

As shown in Fig. 56, the construction reflects a building tradition from 1901, before dedicated insulation layers became standard in external wall construction. Its thermal behaviour is therefore largely shaped by solid masonry, wall thickness, and material mass.

Fig. 57 illustrates how the wall relates to the interior, revealing ceiling heights, window proportions, and deep window fenestrations caused by the wall's thickness. The air gap between the glasses improves thermal performance by reducing heat transfer.

Together, the diagrams show how the skin functions as a climatic barrier, while its thickness and materiality define the spatial character. These qualities form the basis for integrating interventions such as insulation and spatial reconfiguration without compromising the existing skin.

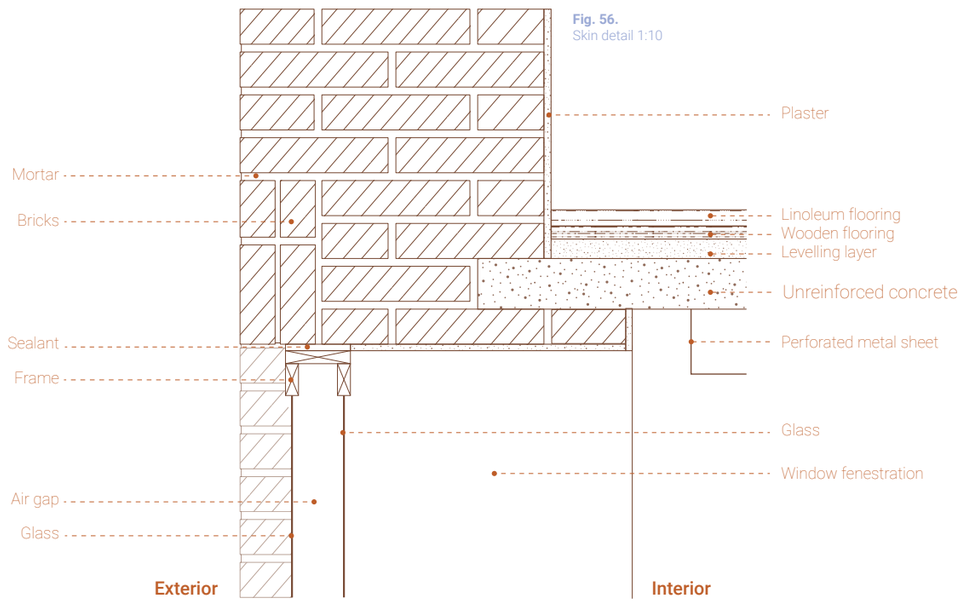


Fig. 56.
Skin detail 1:10

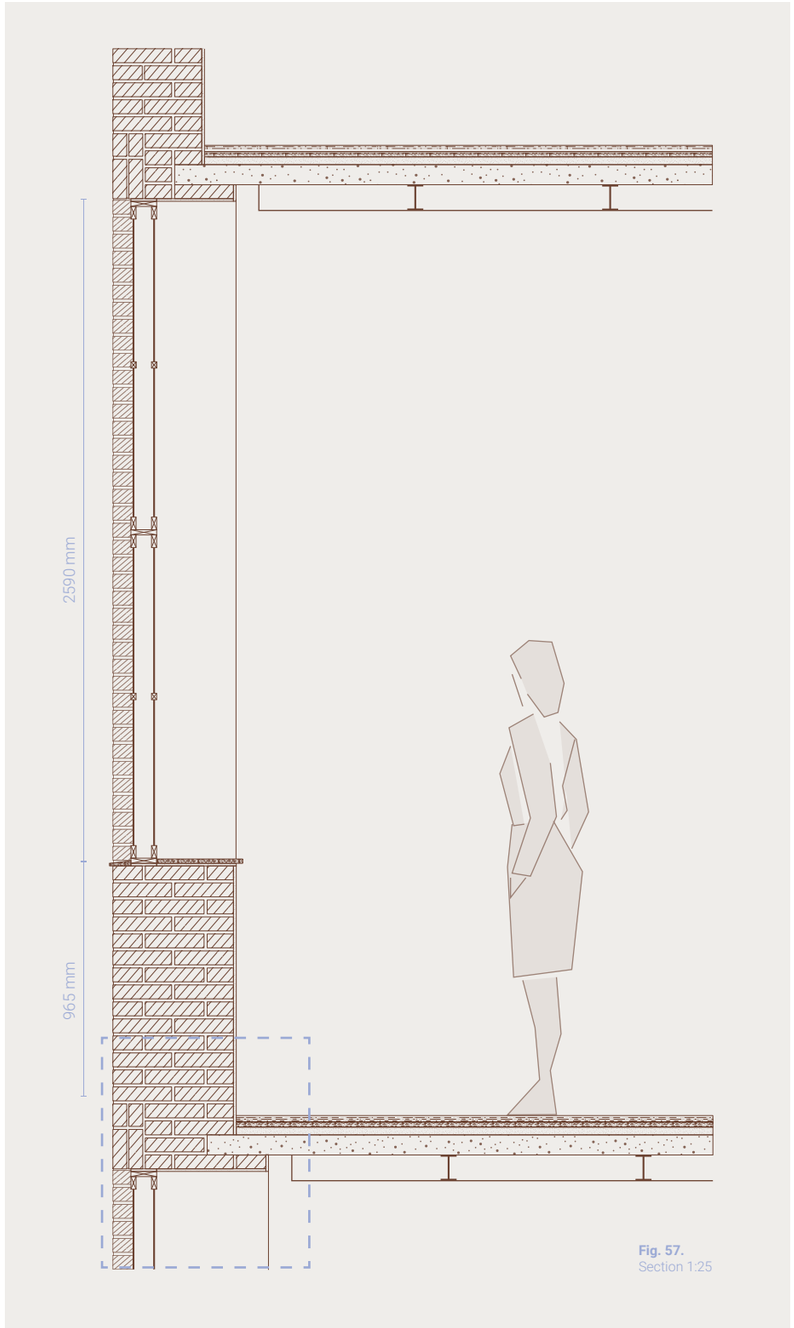
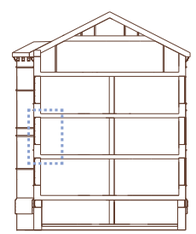
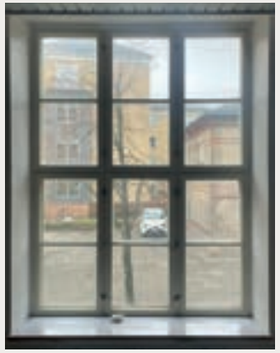


Fig. 57.
Section 1:25



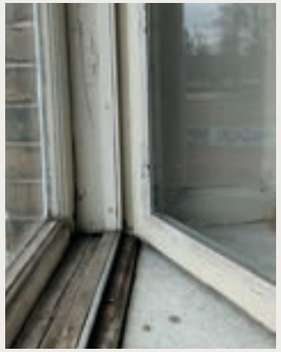


Timber window from inside with deep frame

Exterior window with regular grid of vertical and horizontal muntins

Timber frame with peeling exterior paint and visible joints

Original window handle for opening

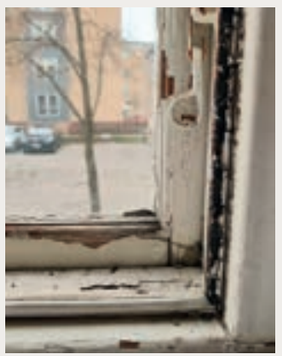


Corner detail showing frame, glazing and gap between the glass

Window grid forming a consistent pane subdivision

Interior sill with inclined surface and timber edge

Open inward-facing secondary glazing



Lower frame detail with worn timber, glazing and putty joints

Fig. 58. Own photos

WINDOW STUDY

Condition of the existing windows

Purpose

This section examines the existing windows, as they are important for both the building's expression and its performance. The aim is to assess their condition and potential for reuse.

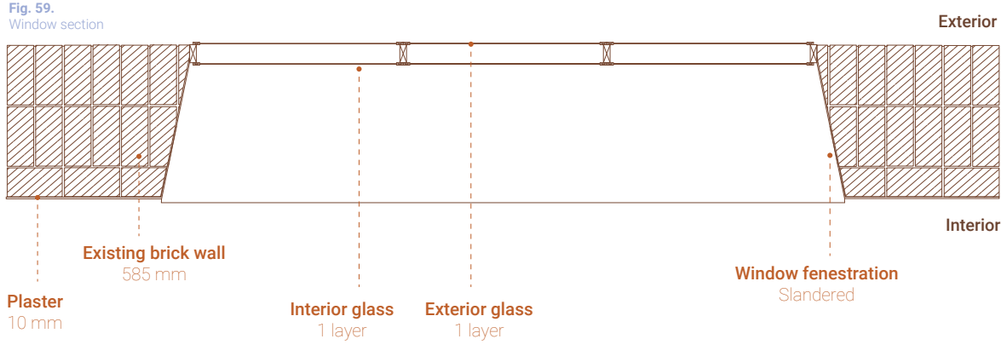
The windows consist of timber frames with subdivided panes and original fittings, which contribute to a consistent architectural character, as shown in the photographs on page 74. Signs of wear are visible, particularly in the exterior paint and lower parts of the frame, while the overall construction and detailing remain largely intact.

The section in figure 59 shows that the window is positioned close to the outerface of the wall, with the reveal opening towards the interior. This angled reveal allows more daylight into the room and is considered an architectural detail worth preserving.

Based on the observed condition, the windows appear suitable for repair rather than replacement. This conslusion is based on the assessment of window condition in appendix 4. Maintenance such as repainting and local repairs is therefore considered a relevant approach (Vadstrup, 2010).

The exterior windows are therefore retained to preserve the architectural and historical expression, while the existing secondary glazing on the interior side is considered for replacement with a more energy-efficient solution, if required based on further analysis of the building's energy performance.

Fig. 59.
Window section



IDENTIFYING THERMAL BRIDGES

Assessment of critical joints

Porpuse

The purpose of this section is to identify thermal bridges and areas of heat loss in the existing building as part of the transformation process. The analysis will be used in the further design process to improve the building envelope and reduce heat loss in the transformed proposal.

The analysis of the existing building has identified several areas of increased heat loss within the building envelope. The current wall construction contains no insulation, resulting in significant heat loss, and thermal bridges have been identified at connections between building elements.

Since detailed construction drawings are limited, the assessment is based on the visible structure and typical construction principles from the building's period (Danske Bygningsmodeller, n.d.).

Overall, these areas represent key points of heat loss in the existing condition and will be important focus areas in the further design development when improving the thermal performance of the building envelope.

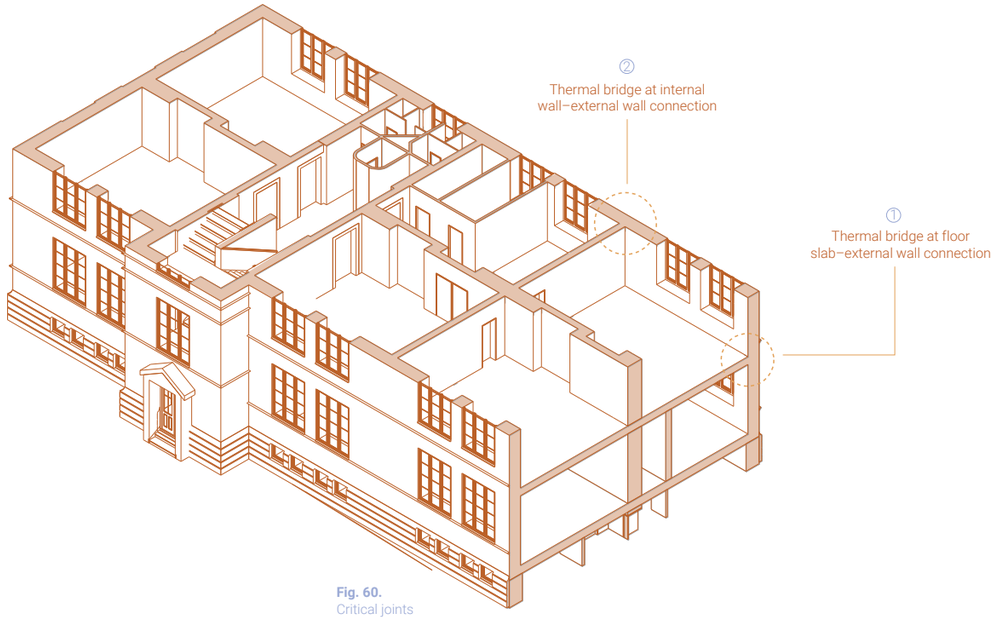


Fig. 60.
Critical joints

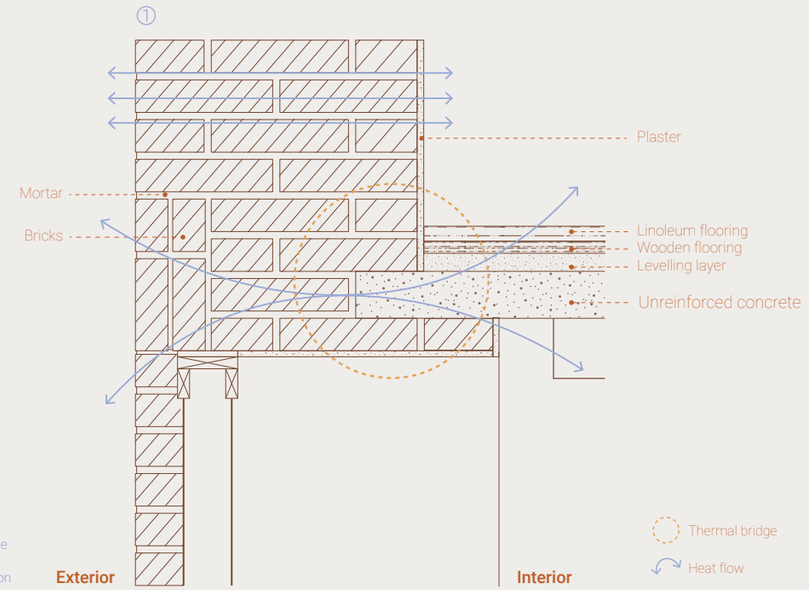


Fig. 61.
Thermal bridge detail of floor slab connection

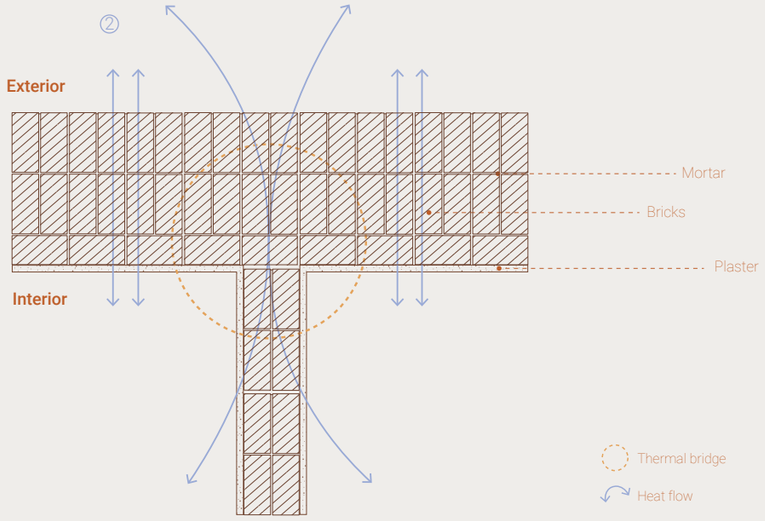


Fig. 62.
Thermal bridge detail of meeting between walls

ENERGY PERFORMANCE

Be18 analysis

Porpuse

This section evaluates the current energy performance of the building based on a Be18 calculation. The aim is to understand how the building performs in its existing state and how far it is from meeting current energy requirements.

The calculation is based on the existing construction elements, including external walls, roof, floor and windows (fig. 66), as well as the current heating supply and usage patterns. The building is assessed in its current state and used as a non-residential building (fig. 64).

The results show a relatively high energy demand, primarily caused by heat loss through the external walls and windows. This is further illustrated in the heat loss distribution (fig. 65), where external walls and windows account for the majority of the total heat loss. The high U-values of the existing constructions also reflect this condition (fig. 66).

Overall, the building does not meet the energy requirements for renovation class 2 in its current condition. This indicates a need for improvements to the building envelope, especially in relation to insulation and window performance. In a later phase, where the building is evaluated as housing, stricter energy requirements will apply (fig. 63). Be18 key numbers are documented in appendix 5.

The analysis forms the basis for identifying relevant energy improvements in the following design phase.

Fig. 63.
Renovation class 2

Renovation class 2 (Social- og Boligstyrelsen, BR18 § 280)

Energy frame for housing must not exceed:
70.7 kWh/m² per year

This table shows the energy frame requirements for renovation class 2 for housing. The energy frame defines the maximum allowed energy demand.

Fig. 64.
Be18 results - exisitng building

Be18 results - existing building

Be18 – Key results
- Heated floor area: **2690 m²**
- Heating supply: **District heating**
- Current use: **Non-residential (school)**
- Usage pattern: **40 hours/week (daytime)**

Energy demand:
- Total energy demand: **138,8 kWh/m²/year**

Energy frame (Renovation class 2):
- Limit: **95,7 kWh/m²/year**
- Result: **+43,1 kWh/m²/year above requirement**

This table shows the calculated energy performance of the building in its current use. Conversion to housing will reduce the allowed energy frame from 95,7 to approx. 70,7 kWh/m²/year.

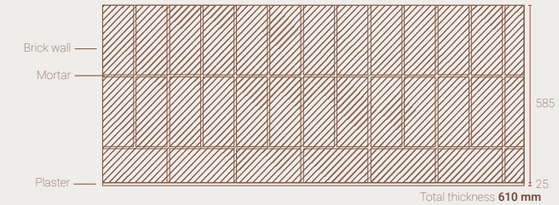
Fig. 65.
Heat loss distribution

Heat loss distribution
- External walls → **42.2 kW**
- Windows → **24,7 kW**
- Roof → **5.8 kW**
- Foundation → **5.1 kW**

Heat loss is primarily concentrated in external walls and windows.

Existing construction elements

External wall

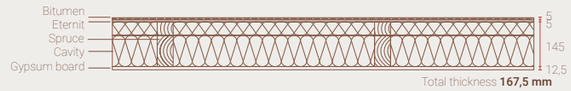


Solid brick wall with plaster

Thickness: **610 mm**
U-value: **0,9 W/m²K**

High thermal mass but low insulation

Roof

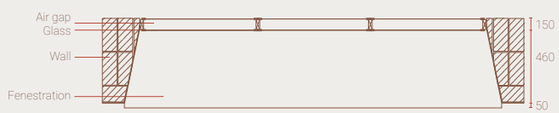


Timber structure with eternit and bitumen on top of that

Insulation: **100 mm**
U-value: **0,3 W/m²K**

Moderate performance

Window



Single glazing with secondary glazing

U-value: **~2,4 W/m²K** *(based on typical values for original windows with secondary glazing, Kampmann, 2002)*

Major source of heat loss

Foundation

Concrete slab

U-value: **0,8 W/m²K**

Contributes to heat loss

Fig. 66.
Existing construction elelments

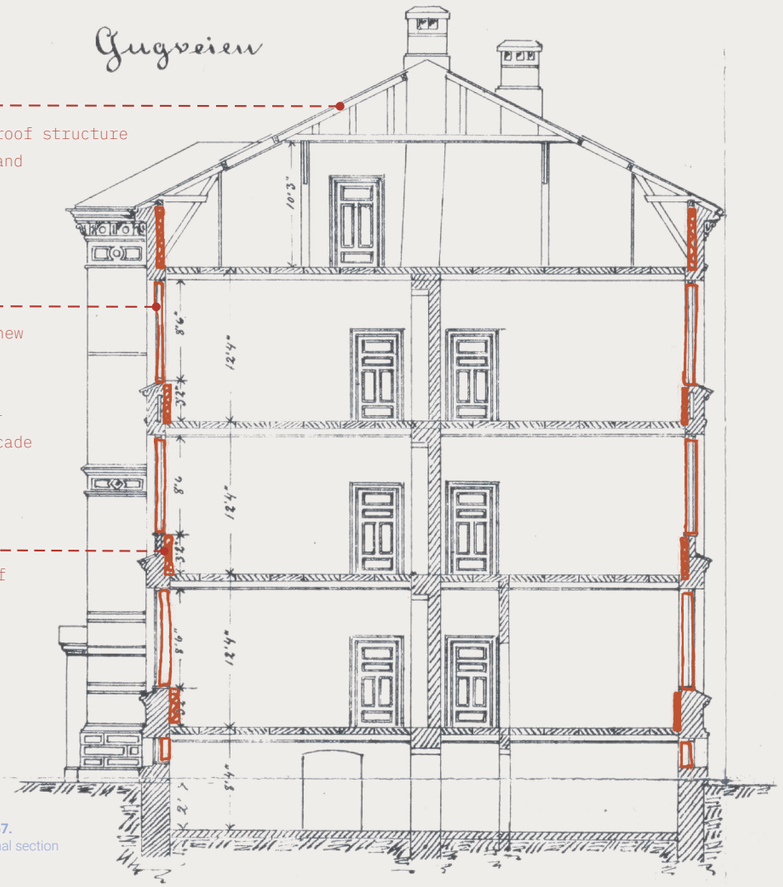
DESIGN IMPLICATIONS

based on:
BUILDING EXPRESSION + UNDERSTANDING THE SKIN + WINDOW STUDY + ENERGY PERFORMANCE + THERMAL BRIDGES

Energy optimisation principles

The energy strategy focuses on the building envelope, where the greatest potential for improvement has been identified.

Based on the previous analyses, the section translates these findings into a set of design principles that balance energy performance with preservation of the existing architectural qualities.



Roof
Reinsulation of the roof structure
→ improves thermal- and energy performance

Windows
Refurbished windows with new energyoptimized secondary glazing
→ improves thermal performance while preserving facade expression

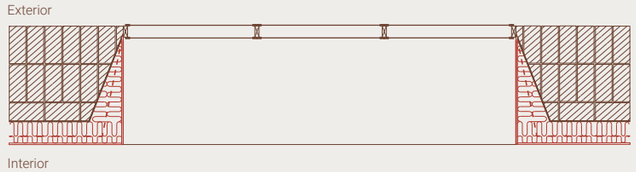
External walls
Internal insulation of external walls
→ targets the primary source of heat loss

Fig. 67.
Original section

Interventions are concentrated on external walls and windows, as these elements account for the majority of heat loss identified in the previous analysis.

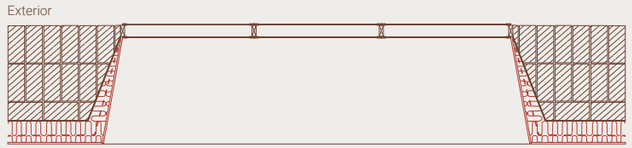
Window reveal detailing

Windows are identified as a major source of heat loss in the energy analysis. Interventions therefore focus on improving their thermal performance while preserving their architectural role.



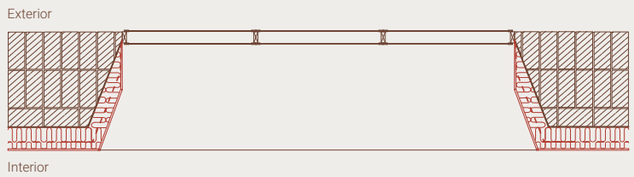
Straight reveal

Creates a straight reveal by extending insulation into the window opening.
Improves thermal continuity but alters the original geometry and reduces daylight penetration.



Reduced angled reveal

Maintains a partial angle while introducing insulation at the window edge.
Balances improved thermal performance with some preservation of the original spatial quality.



Preserved angled reveal

Retains the original angled reveal, preserving daylight conditions and spatial character.
Insulation is carefully detailed to minimise thermal bridges while maintaining the existing geometry.

Fig. 68.
Window reveal principles

The preserved angled reveal is selected for further development in the design process, as it maintains the architectural and spatial qualities identified in the window study while allowing for targeted thermal improvements.

MATERIALITY

Present in the building

Porpuse

The purpose of this section is to visually document the existing materials in the building. These images provide a reference for understanding the variety, condition, and character of the surfaces before analyzing their suitability and potential adaptation in the transformation to residential use.

The materials currently present in the building display a wide range of characteristics, finishes, and conditions (fig. 69). This variation reflects both the original construction and subsequent interventions and adjustments made throughout the building's lifespan. Differences in material type, wear, and visual expression illustrate the evolving functional and aesthetic requirements of the school over time, offering insight into which elements may be preserved, adapted, or replaced in the conversion to housing.

Fig. 69.
Existing materiality

DESIGN IMPLICATIONS

based on:
MATERIALITY

This section assesses the existing materials at Kjellerupsgade School. The aim is to guide decisions on preservation or adaptation for the school's transformation into housing.

		Material	Condition	Spatial quality	Heritage value	Approach
Classroom	Floor	*Linoleum*	*Worn*	*Soft, matte, slightly warm, but institutional*	*Low – standard school flooring, not character-giving*	*Replacement*
	Ceiling	*Acoustic metal ceiling*	*Fair*	*Cold, hard, technical*	*Low – functional, industrial, minimal aesthetic contribution*	*Adapt surface*
	Original wall	*Plastered brick*	*Fair*	*Smooth, matte, cool, low tactile depth*	*Low – uniform white surface, no original texture or character*	*Adapt surface*
	Partition wall	*Gypsum board*	*Poor*	*Flat, smooth, neutral, low spatial presence*	*Low – functional, temporary character*	*Remove*
Circulation space	Floor	*Terrazzo*	*Fair*	*Hard, cool, smooth*	*High – durable, tactile*	*Preserve*
	Ceiling	*Gypsum board*	*Fair*	*Smooth, matte, neutral, non-tactile*	*Low – plain, uniform surface with minimal architectural value*	*Adapt surface*
	Wall	*Tiles*	*Fair*	*Hard, glossy, cold, artificial*	*Medium – quirky, characteristic, adds visual interest*	*Preserve*

Fig. 70.
Material study

CHAPTER
08

VALU ATION

CONTENT

Functional diagram

Design drivers

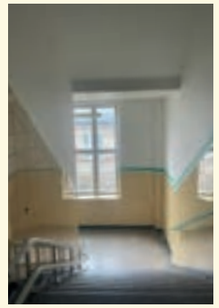


Fig. 71.
Building,
own photo

This section gathers key insights from the analyses to define the design drivers guiding the transformation. It establishes a strategy for preserving the building's values and highlights the building's potential, summarised in a functional diagram that illustrates how its spaces can be adapted for residential use.

FUNCTIONAL DIAGRAM

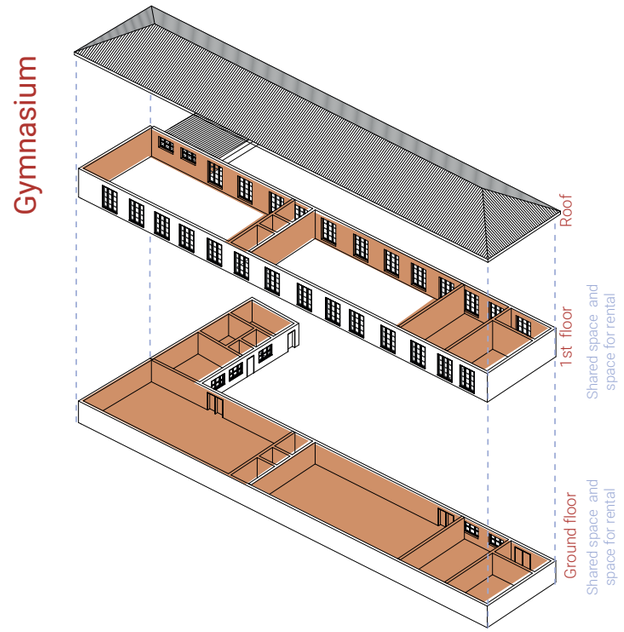
This section illustrates the spatial organisation and relationships between the functions and dwelling types on each floor through a combined diagram, showing how spaces are arranged and connected across the different levels based on previous analyses, sketches, and investigations (fig. 72).

The functional diagram has been developed continuously throughout the design process, alongside the ongoing work with the building. It is presented here to provide a background understanding of the direction in which the design process is moving.

The approach focuses on preserving the existing structure of the building and working with its spatial qualities. The intention is to establish apartments of different character, based on the building's existing rooms and spatial variations. In this way, the existing architecture is used as a starting point and helps shape the different dwelling types.

On the top floor, the aim is to create owner-occupied apartments with a different character and quality compared to the dwellings below, taking advantage of the building's position and spatial conditions at roof level.

In the former gymnasium, located opposite the school, the program is divided into shared functions for the residents of the apartments and areas for external rental use.



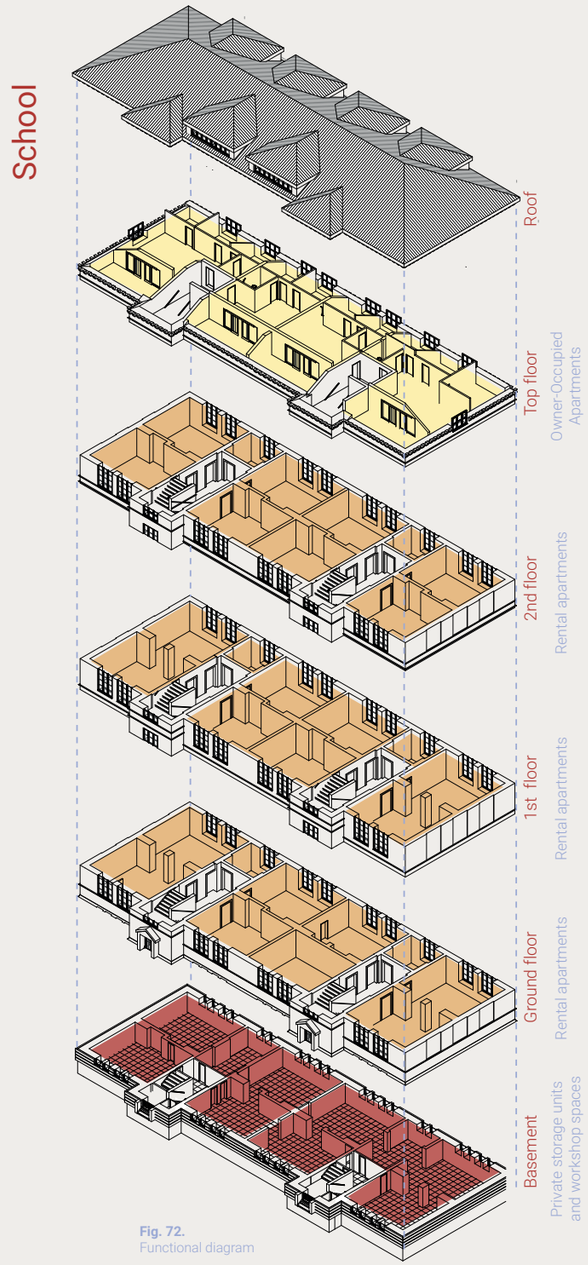


Fig. 72.
Functional diagram

DESIGN DRIVERS

Purpose

Based on the previous analyses and theory, the vision for the project is to transform Kjellerupsgade School into a sustainable and diverse residential framework where the existing building and its daylight conditions actively shape flexible dwelling typologies and new ways of living. The following design drivers are created to ensure this vision. They have been adjusted and developed along the way as new knowledge and insights were gained.

Fig. 73.
Facade

Fig. 74.
Window

Fig. 75.
Classroom

Fig. 76.
Details

Architectural Identity & Heritage

Maintain spatial character - preserve ceiling height, large window openings, sense of scale and spatiality that characterises the original teaching spaces

Retain the building's identity – respect architectural characteristics and historical identity

Material strategy - Introduce warmer materials to create a more domestic atmosphere, while preserving selected existing materials so the original institutional identity remains clearly readable

Daylight & Indoor Environment

Daylight optimisation – dwellings should be designed to maximise daylight and organise layouts so natural light reaches the primary living spaces, ensuring a comfortable indoor environment, while complying with Danish Building Regulations for daylight (sDA300/50%)

Energy performance and indoor climate - achieve renovation class 2 through internal insulation and window upgrades without altering the building's exterior character

LCA-informed design – use Life Cycle Assessment (LCA) as an investigative and supportive tool in the design process to evaluate and compare the climate impact of different design iterations

Functional & Spatial Efficiency

Functional efficiency through integrated design – ensure that design solutions support both usability and spatial efficiency by integrating functions into the architecture

Guided dwelling typologies – apartment layouts should respond to the former classroom modules, structural rhythm, and corridor organisation

Residential efficiency – target an 80% ratio of residential floor area relative to shared spaces to support affordability for the users

Courtyard environment – transform the former schoolyard into a pleasant and comfortable residential courtyard by prioritising sheltered, usable outdoor zones and support everyday stays and social interaction

Preserving Values

Selective subtraction - remove only elements that compromise function, spatial quality or environmental performance, such as later additions

Repair before replacement - prioritise repair and upgrading of existing elements, especially the original windows, retaining patina as part of the building's character

Minimal intervention – preserve long-lasting layers such as structure and skin

CHAPTER
09

PROCESS AND SYN THESIS

CONTENT

Space plan
Site
Skin

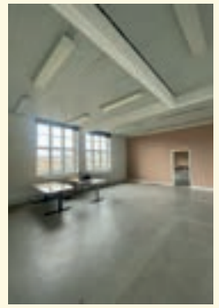


Fig. 77.
Building,
own photo

This section presents the design process as a synthesis of the analyses and the established design drivers. The work unfolds across the different layers – space plan, site and skin – showing how decisions around layout, materials, and performance have been shaped. The process has been iterative rather than linear, with insights from each layer informing and guiding the others throughout the design.

SPACE PLAN

Overall layout of the plan

Purpose

The purpose of this section is to investigate how the building's spatial layout can be re-organised into dwellings, based on the design translation developed in the design implications presented on page 58-59 and informed by the spatial analysis of the existing school structure.

From three conceptual approaches to subdividing the plan, three overall layout strategies are developed and applied across the residential floors (fig. 78-80). Each layout explores different ways of organising dwellings within the existing structural framework, balancing spatial qualities, daylight conditions, and user needs.

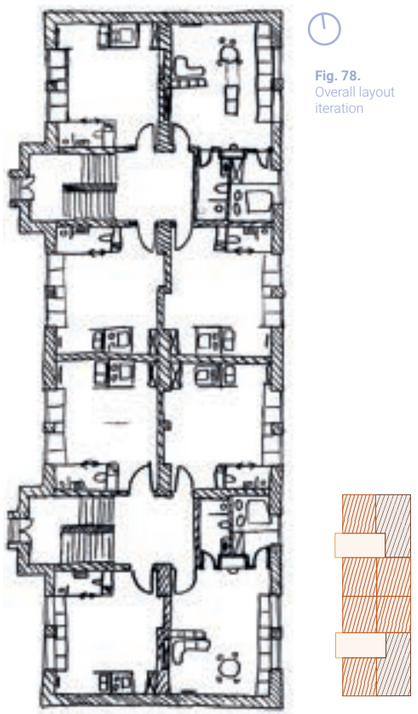


Fig. 78.
Overall layout iteration

Small dwellings

- 6 × 50 m² and 2 × 70 m² units
- Based on the original classroom organisation
- Dont use potential in gables for windows
- Primarily suited for couples and singles

Study evaluation

Together, the three strategies demonstrate different potentials within the existing structure. The third strategy is selected for further development, as it responds most directly to the building's inherent spatial logic while utilising the potential of having windows in the gable facades.

A key element is the inclusion of adaptable rooms positioned between dwellings. These rooms are not fixed to a specific unit but can be incorporated as needed, allowing a dwelling to expand. This supports changing needs—such as an additional child or temporary guests—without requiring permanent alterations to the structure.

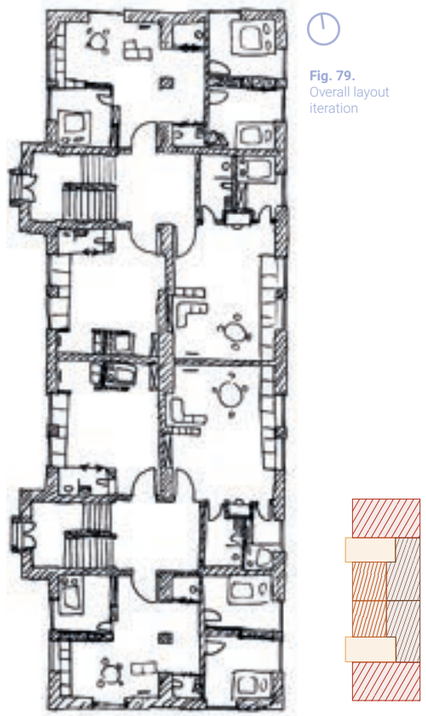


Fig. 79.
Overall layout iteration

Mixed dwelling sizes

- Variation from 50 m², 70 m² to 100 m²
- Utilises the building's spatial potential
- Activates gables for larger units with more rooms and daylight
- Accommodates a broader and mixed user group

Chosen variant

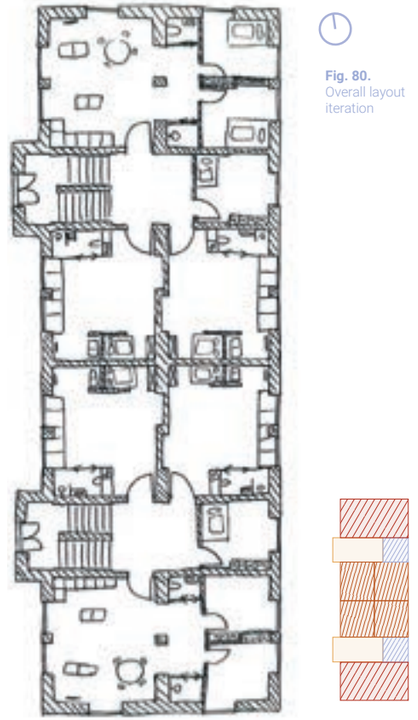


Fig. 80.
Overall layout iteration

Family dwellings & small units

- Combination of family units and smaller units
- Flexible organisation with adaptable rooms between dwellings
- Larger units placed in gables, smaller units centrally
- Supports coexistence of different user groups

Family apartment

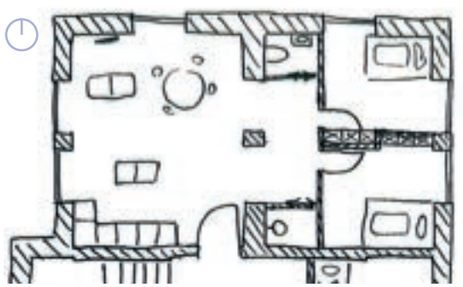
Purpose

The purpose of this section is to explore how different spatial configurations of the family apartment affect daylight and the quality of the living space.

The study compares two- and three-bedroom layouts, showing that a three-bedroom solution creates a more fragmented interior (fig. 81 & 82).

Two rooms

Fig. 81.
Two rooms

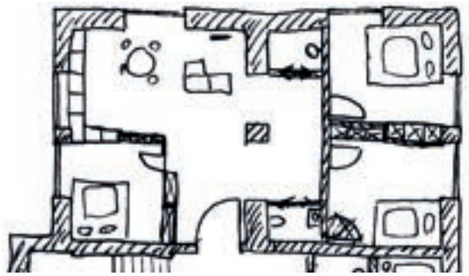


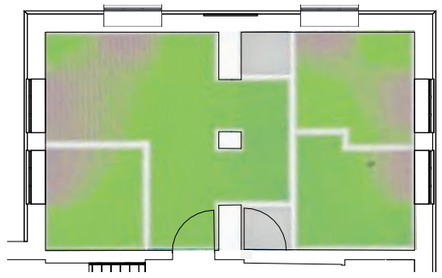
Results:
UDIa: 68,9%
sDA: 100%

Chosen variant

Three rooms

Fig. 82.
Three rooms





Results:
UDIa: 68,8%
sDA: 100%

100 300 3000 lux

Study evaluation

The two-bedroom configuration is selected, as it preserves the spatial integrity and openness of the living space (fig. 81). Introducing a third bedroom results in a more fragmented and darker interior, compromising the primary spatial quality of the apartment.

Rather than maximising the number of rooms within the unit, the design prioritises generosity in the shared living space. This decision is made in relation to the development of the shared room along the corridor, which allows for temporary expansion when needed.

The strategy therefore goes from a fixed program towards a more adaptable spatial framework, where quality and flexibility are prioritised over quantity.

Spatial scenarios of the intermediate space

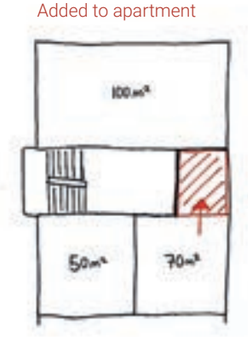
Purpose

This section explores different ways of activating the intermediate space located in front of the wide staircases between the apartments.

The area is relatively large and currently underutilised, mainly used for toilets, as shown in `Current spatial organisation` p. 55. The aim is to investigate how this space can be used more effectively and which functions are most appropriate in this location (fig. 83).

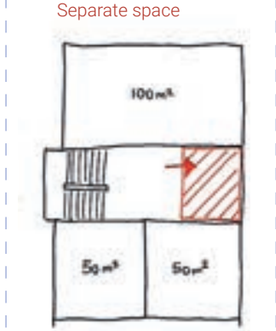
Spatial configurations

Added to apartment

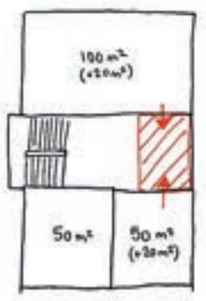


Chosen variant

Separate space



Can be added to both apartments



Shared between two apartments

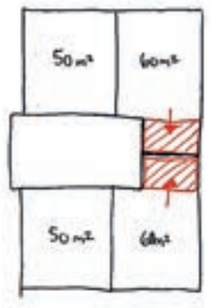
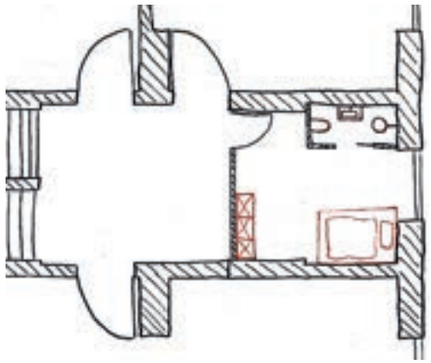
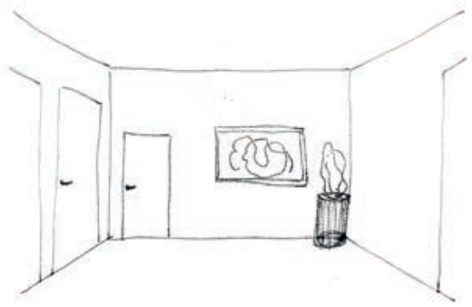


Fig. 83.
Scenarios of the intermidiate space

Detailing the seperate room

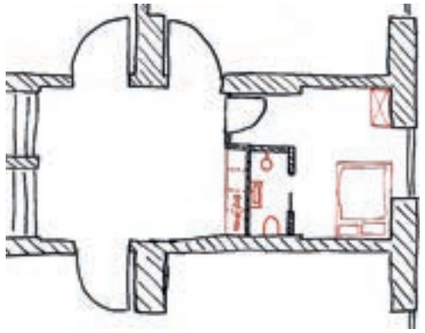
Guest and youth room





Chosen variant

Both room and laundry



Open laundry / shared space

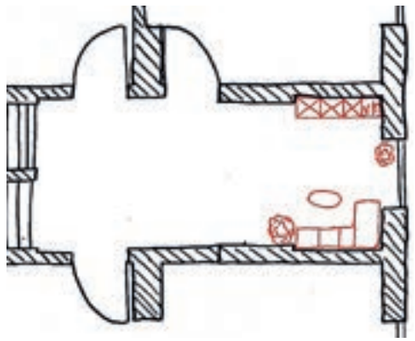


Fig. 84.
Detailings
seperate room

Placement in building

1st floor: laundry | Ground and 2nd floor: guest and youth room

Chosen variant

Both functions on each floor

Fig. 85.
Placement in building

Study evaluation

A separate room is selected (fig. 84), as it offers flexibility for the residents by allowing the apartments to be extended with an additional room if needed. With access from the corridor, it is easier to integrate without altering the existing apartments and can also function as a guest room.

At the same time, the space can accommodate a shared laundry facility for the three units on each floor in each end of the building (fig. 85), reducing the need for such functions within the apartments. Its location directly outside the entrance makes it convenient to use, while also activating the corridor as an extension of the home.

Initial study of the open-plan apartment

Purpose

The purpose of this section is to explore how the dwellings are developed in relation to the existing classroom structure while maintaining its key spatial qualities of height, light, and openness.

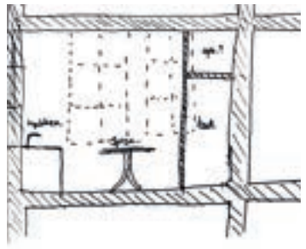
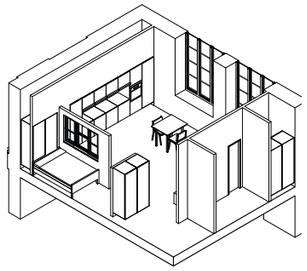
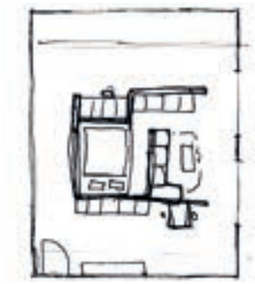
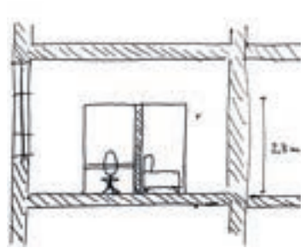
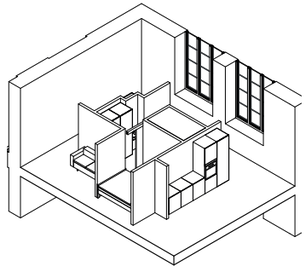
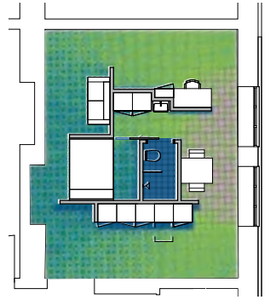
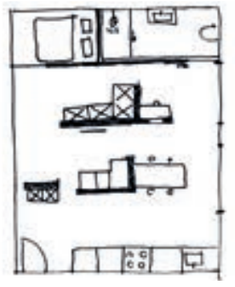
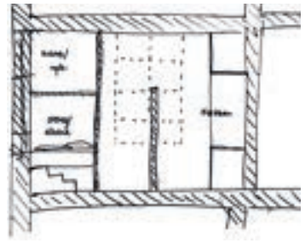
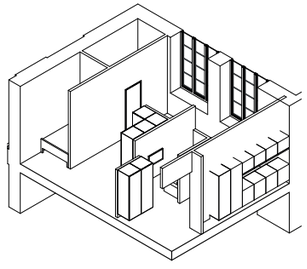
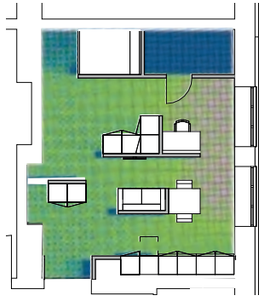
Across the overall layout strategies, smaller dwellings remain an important component. In these units, a key challenge is that daylight is limited to a single facade. Rather than subdividing the space and compromising the qualities, this study explores the open-plan apartment.

The intention has been to maintain a sense of generosity while allowing for individual use, prioritising flexibility.

Initial sketches explores approaches to organising within an open spatial framework, compared in the following (fig. 86).

Study evaluation

The strategy of organising functions along the wall was selected for further development. It responds directly to the design drivers by freeing the central floor area, maintaining openness, and allowing greater flexibility in use. It also ensures optimal access to daylight by keeping the space towards the facade unobstructed.

	Plan layout	Section	Isometric	Daylight conditions	Qualities	Limitations
Functions along the walls				Results: UDIa: 48,1% sDA: 64,8%	• Clear organisation along the wall • Preserves openness towards the windows • Good daylight distribution • Free space for individual use	• Limits usable wall surface • Encourages a more centralised furniture layout
Centered functions				 Results: UDIa: 30,6% sDA: 35,6%	• Respects the existing room by not touching the walls • Organises space through surrounding zones • Enables a higher degree of privacy	• Darker back areas • Reduces openness • Less intuitive layout • Limited free space • Fixed organisation
Wall elements				 Results: UDIa: 44,7% sDA: 45,2%	• Introduces floating zones within the space • Creates privacy and spatial shielding	• Occupies valuable space in the center • Reduces daylight • Limits flexibility • Decreases usable floor area

Chosen variant

Fig. 86.
Initial study of the open-plan apartment

Further development of functions along the wall

Purpose

The purpose of this section is to further develop the organisation with functions along the walls based on the previous study.

A series of iterations were developed to explore different spatial configurations. Selected examples are presented in figure 87, showing various ways of organising functions along the perimeter. This process helped identify layouts with the greatest spatial potential and usability.

To evaluate the proposals, a set of criteria was established:

1. **Flexibility** | degree of individualisation
2. **Zoning potential** | sleeping, living, dining, entrance
3. **Privacy** | possibility of placing the sleeping area towards the back

Study evaluation

Two proposals are chosen for further development. Both are grounded in the theories of Habraken and Hill, as they explore different degrees of openness and user influence within the dwelling. One approach is based on a more defined spatial organisation, while the other offers a more open *structure*, allowing for a higher degree of *constructive* and *conceptual creativity*.

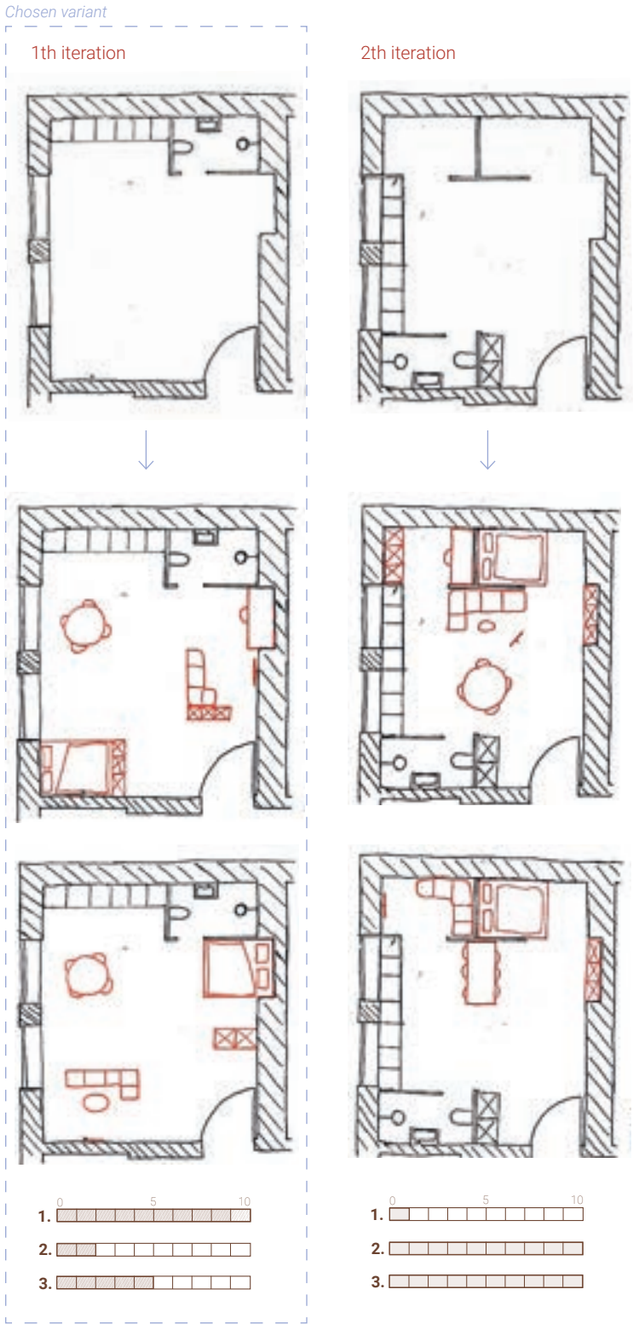
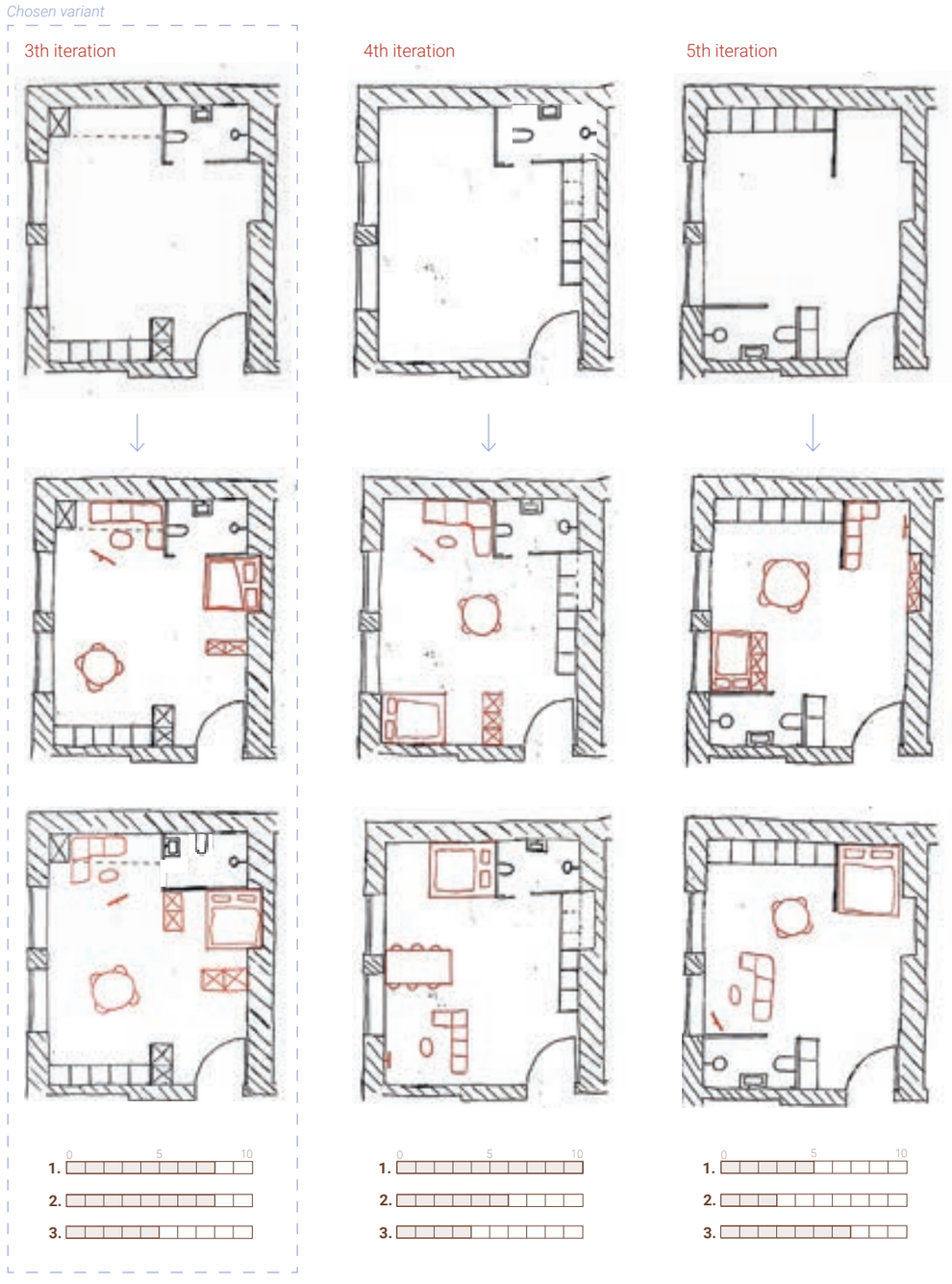


Fig. 87.
Development of functions along the wall



Material studies

Purpose

This section investigates how different materials, colours, and textures affect the perception and atmosphere of the space, in order to identify materials suitable for the transformation. A material matrix, supported by process renders and the materials Global Warmning Potential (appendix 6), is used to clarify the spatial qualities and experiential effects of the different material choices.

Wall and floor

The matrix in figure 88 examines the relationship between walls and floors, evaluating whether existing materials should be preserved or replaced. Focus is placed on creating a harmonious interplay between surface materials and creating a warm atmosphere going from school to home, and at the same time lowering the climate impact.

To preserve the spatial quality, light materials are used to reflect daylight and emphasize the proportions of the space. The existing wooden floor is therefore retained, sanded, and treated to achieve a light appearance while maintaining a warm tone. In this way, the floor contributes to the spatial experience while also reducing environmental impact by reusing the existing material.

Light walls enhance daylight and openness, while plywood integrates functions and defines zones. The red lye treatment preserves the wood grain and adds warmth and tactility.

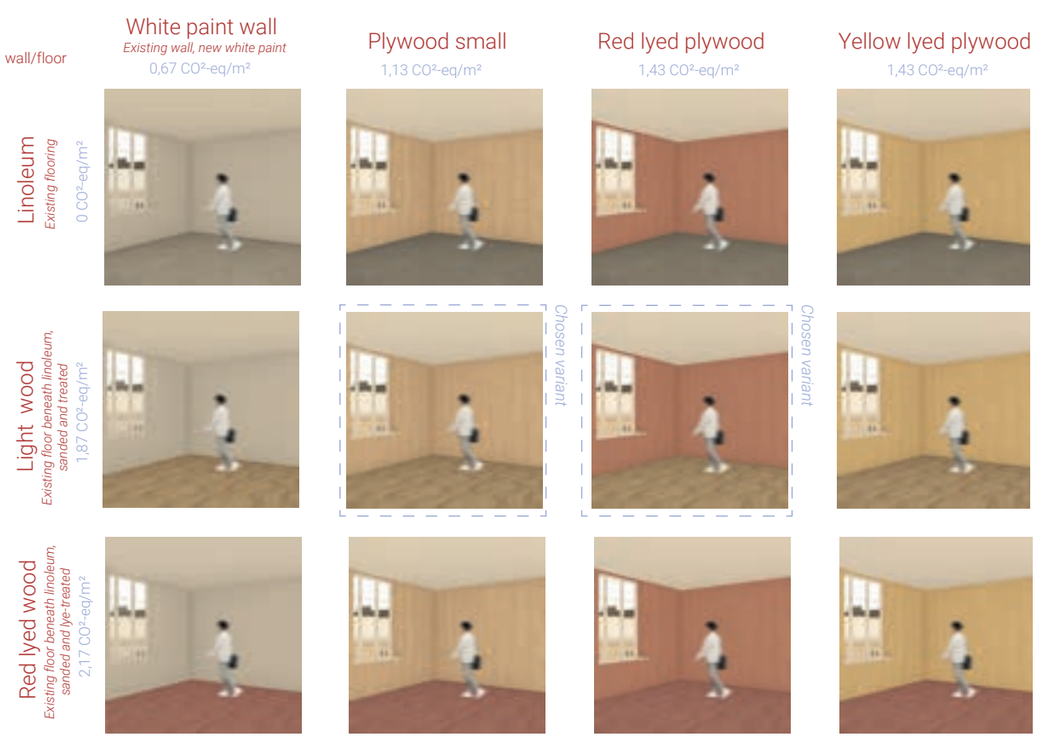


Fig. 88.
Material matrix wall/floor

Ceiling materiality

Purpose

The purpose of this section is to build on the analysis of walls and floors to define ceiling materials and finishes that complement the overall material palette and enhance the spatial experience (fig. 89).

The existing acoustic ceiling is chosen to retain and paint in a lighter colour to brighten the space while maintaining its acoustic properties.

By preserving the existing ceiling rather than replacing it, the solution also performs well in terms of LCA, as it reduces material consumption and avoids unnecessary demolition. At the same time, the retained acoustic qualities ensure a comfortable indoor sound environment, supporting the overall spatial experience of the apartments.

Fig. 89.
Material matrix
ceiling

Integrated functions

Purpose

The purpose of this section is to investigate material choices for functional elements such as kitchen and bathroom walls and built-in storage units, with an emphasis on coordination and integration with the surrounding surfaces (fig. 90).

The design continues the use of a combination of white painted surfaces and plywood treated with red lye, where the furniture elements are expressed in the warmer, red-toned material.

The red-treated surfaces are used in areas with niches and built-in functions, where a warmer material quality supports a more enclosed and tactile spatial character. The remaining wall surfaces are kept in white paint to maintain spatial clarity and enhance daylight reflection. The end wall, behind the integrated furniture is also executed in red-treated plywood, which visually unifies the built-in elements into a coherent functional wall.

Fig. 90.
Material matrix integrated functions

Fig. 91.
Material combination chosen

Study evaluation

The materials that will be further developed and implemented in the dwellings are shown in figure 91. The selection is based on findings from the material matrices and illustrates how the chosen materials, colours, and textures interact to create a coherent spatial experience and atmosphere.

Detailing furniture and materiality

Purpose

The purpose of this section is to investigate different configurations of the fixed elements within the apartments.

The study includes the kitchen, bathroom, and storage. The storage is designed as flexible units, allowing residents to rearrange cabinets according to their own needs. In this section, the principle is illustrated through an example of a possible configurations (fig. 92).

Study evaluation

The project continues to work with the principle of functional walls extending fully to the ceiling. This enhances the spatial experience while also making functional use of the existing ceiling height.

The principle are also applied in the family dwellings, where the kitchen elements similarly extend vertically.

In contrast to the other proposals, the elements with full height become an integrated part of the architecture rather than appearing as furniture placed within the space.

Above the bathroom, a loft is introduced and accessed by a small ladder, in order to utilise the vertical space and increase flexibility in the interior layout.

Bathroom / kitchen

Chosen variant

Bathroom / storage

Kitchen / entrance

Fig. 92. Detailing interior

Dwelling types and ownership structure

Purpose

This section defines how different apartment types and ownership structures are shaped through the organisation and development of the different dwelling typologies.

Through the design process, several different dwelling types have been developed and are defined in figure 93-96.

The lower floors are organised as rental apartments, as this increases accessibility and allows a wider range of residents to gain access to the housing.

The apartments on these floors vary in both size and organisation. Some are open and flexible in their layout, while others are more defined with functional zones or fixed room separation. This variation is based on differences in the spatial layout, where the niches are placed differently within the rooms.

The top floor differs by offering other spatial qualities, that point towards a different housing type, where a higher degree of individuality and privacy is emphasized. Therefore, this level is organised as owner-occupied apartments.

100 m² family apartment

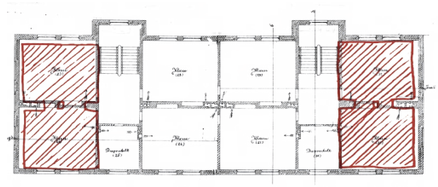


Fig. 93. Family apartment

Families with 1–2 children

Can support living for a small family constellation who wants to live near the city center

Top floor apartment

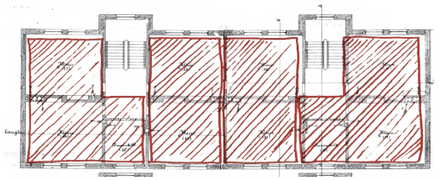


Fig. 95. Top floor apartment

Couples or small families seeking higher spatial quality and private outdoor space.

Suitable for households prioritising views, privacy, and more exclusive living conditions.

50 m² apartment

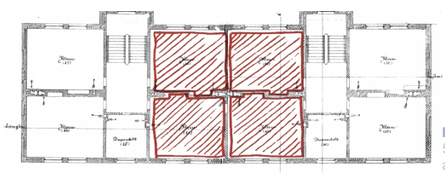


Fig. 94. 50 m² apartment

Young couples, older couples without children living at home, or individuals.

Open-plan apartment

Suitable for residents who prefer a more structured layout with predefined zones, offering clear spatial organisation for everyday use.

Structured apartment

Suitable for residents who prefer a flexible and open space, where the layout can be interpreted freely and adapted to personal ideas, furniture, or ways of living.

Guest/youth room

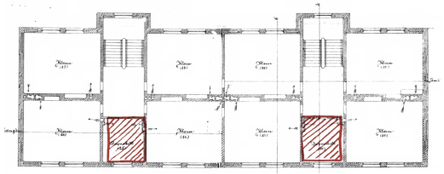


Fig. 96. Guest/youth room

Family members or visitors staying short-term

Can be used as a guest room or as an extension of dwelling, as a youth room

SITE

Courtyard studies

Purpose

This section is based on the corresponding design implications presented on page 45. The purpose is to investigate how the courtyard can support both arrival and everyday use, as well as how the project addresses practical needs such as parking, waste management, and wind conditions.

Among the explored options, two main iterations are shown in figure 97-100. One introduces a green core, defining the courtyard as a more enclosed and characterful space. The other places greenery along the facades, creating a greener edge and a more open, flexible central area for movement and use.

The second option is chosen due to its ability to create a shared central core which improve the everyday use of the courtyard.

Fig. 97.
Masterplan iteration

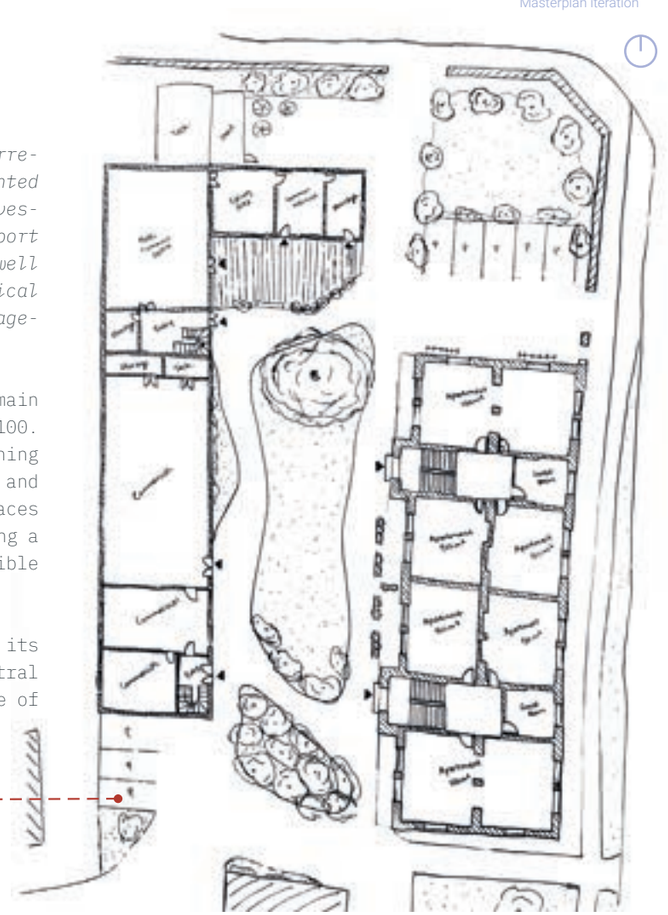


Fig. 98.
Context section

Fig. 99.
Masterplan iteration

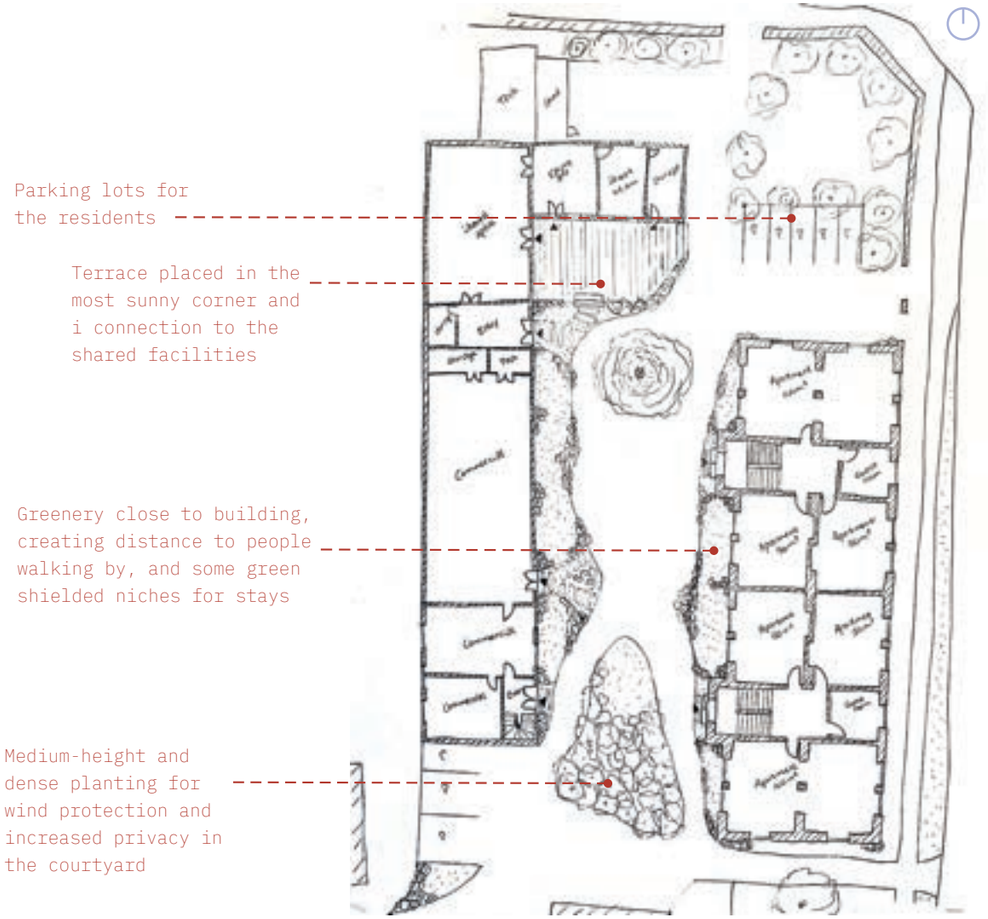


Fig. 100.
Context section

SKIN

Roof typologies and spatial experience

Purpose

This section is based on the corresponding design implications presented on page 58-59. The purpose is to examine how the top floor and roof can be adapted for residential use by developing design solutions and consider the environmental impact of these interventions. The study on figure 101 investigates how different roof typologies influence the spatial qualities of the top floor, both internally and externally, while maintaining respect for the existing building.

The three iterations explore different roof typologies, including the existing roof and two alternative proposals.

Further studies of the roof design are carried out based on the initial finding that a flat roof stands out too much in relation to the building. The flat roof option is therefore not developed further, as it appears too dominant in the overall expression.

Instead, the investigation continues with both the existing roof and a potential mansard roof. Although the mansard may appear more dominant in relation to the building's current character, it is still explored, due to its potential to significantly utilise the attic space.

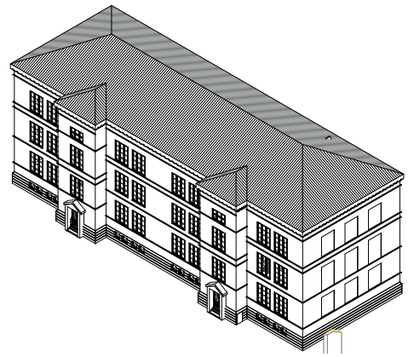
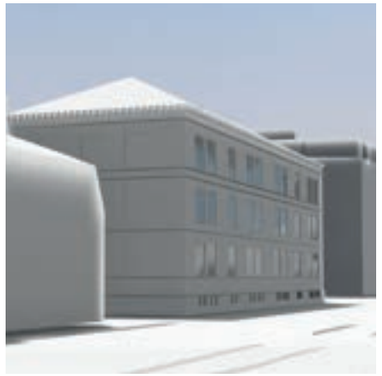
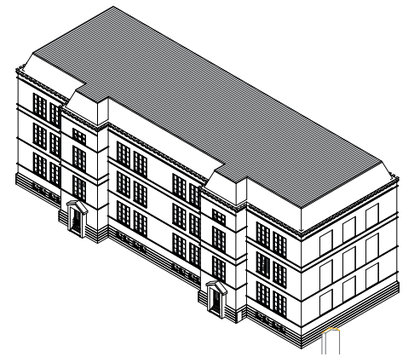
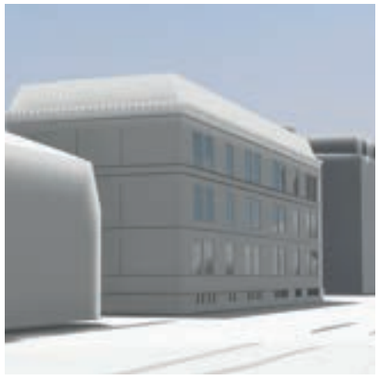
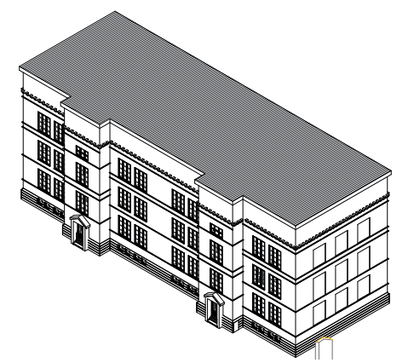
	Outside	Street view	Inside
Chosen variant Gable roof			
Chosen variant Mansard roof			
Flat roof			

Fig. 101.
Roof typologies

Cornice retention or removal

Purpose

This section investigates the possibility of preserving the existing roof by selectively interrupting the cornice to enable new openings and window positions. The focus is on whether such interventions can be justified in relation to the building's architectural expression. This study builds on the previous findings on page 112-113.

The building features a well-defined cornice at the base of the roof, which highlights the architectural detailing and clearly expresses the character of the building (fig. 102).

It is considered whether this cornice can be partially interrupted by lowering the windows, allowing them to function as emergency exits (fig. 103). This would improve the possibility of preserving the existing roof while still making the attic suitable for residential use.

The mansard roof option is considered due to the initial intention of not interrupting the cornice, as it is a strong and characteristic element of the building. However, balancing this with the existing roof typology, which is better suited to the building, a compromise is explored in the further studies where the roof is retained, while new dormers are introduced that slightly cut into the cornice.

This thereby gives three iterations that will be explored further in the next sections.

Fig. 102.
Cornice photos

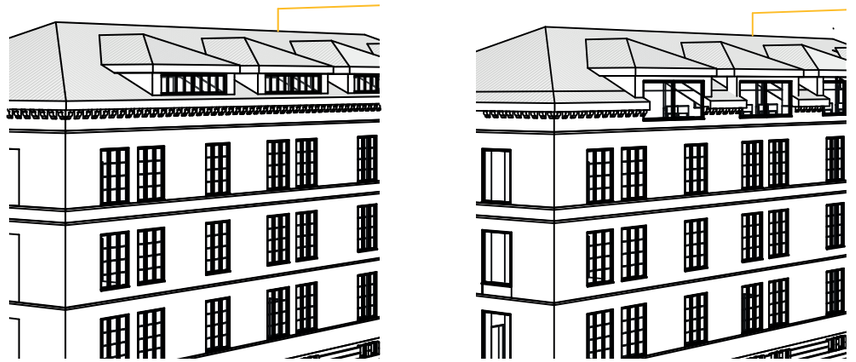


Fig. 103.
Cornice strategies

Gable roof

Mansard roof

No balcony

Smaller

Larger

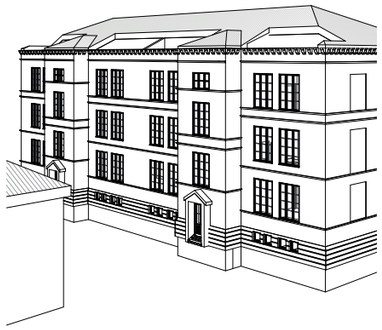


Fig. 104.
Balcony integration

Balcony integration

Purpose

This study explores how such interventions affect the roof's architectural expression, and compares the possibilities of integrating balconies within both the existing roof structure and a proposed mansard roof.

The intention for the top floor is to create residential units that offer a different spatial quality compared to the rest of the building. Being the top floor, it provides unique opportunities, including the possibility of integrating balconies without altering the existing facade.

Instead of adding balconies externally, which would disrupt the architectural expression, they can be integrated into the roof by opening up the roof surface. This allows for the creation of private, recessed balconies while preserving the original facade.

Based on this investigation, further development focuses on both small and larger balconies within the existing roof. This approach best preserves the character of the building while allowing for the creation of more exclusive and high-quality residential units.

Synthesis of proposals and climate impact

Purpose

This section compares three selected approaches to transforming the top floor into housing, based on the previous studies, and evaluates their qualities, including their impact on the climate.

The climate impact of the different proposals is shown in figure 105 (with detailed calculations in appendix 6), while figure 106 presents the functional and aesthetic considerations of each roof solution.

Based on these findings, the project continues with a focus on preserving the existing roof with new dormers.

A key priority is to respect the original architectural expression, even if this requires compromises in other aspects of the design.

The next phase focuses on further detailing, particularly in relation to material choices, interior design, and the design of new dormers.

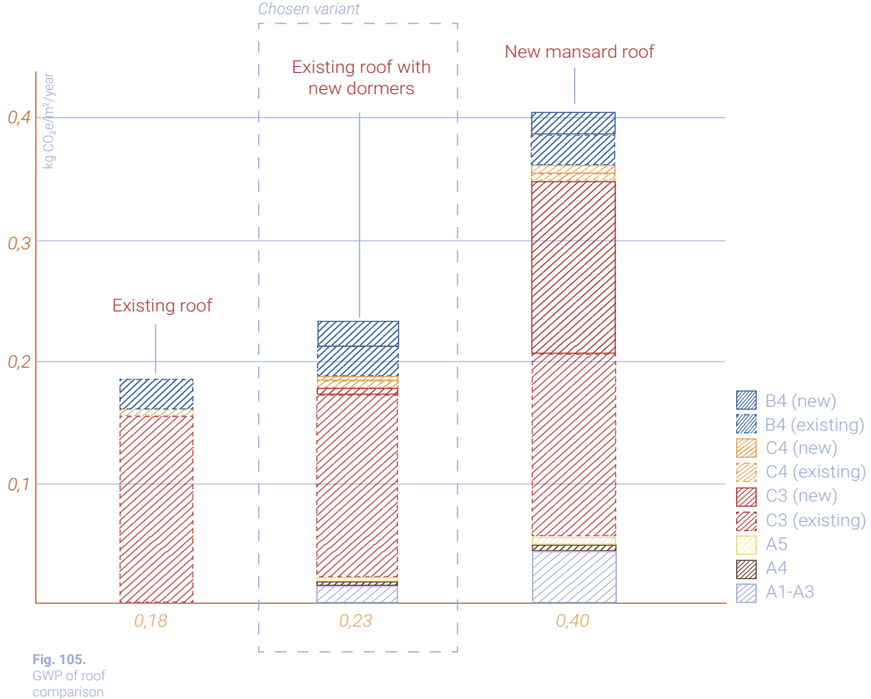
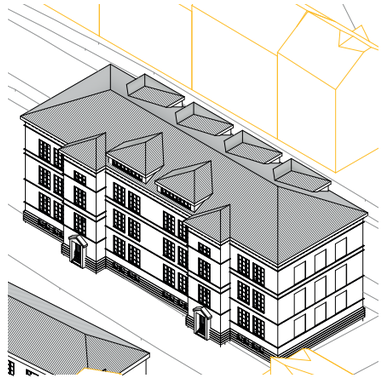


Fig. 105.
GWP of roof comparison

Existing roof



Function

- Creates multiple split levels within the apartments
- Results in lower ceiling heights
- Balconies are only possible for the two end apartments because of existing dormers
- Leads to less optimal layouts and spatial quality on the top floor

Aesthetics

- Preserves the existing roof
- Maintains the current architectural expression of the building

Existing roof with new dormers

Chosen variant

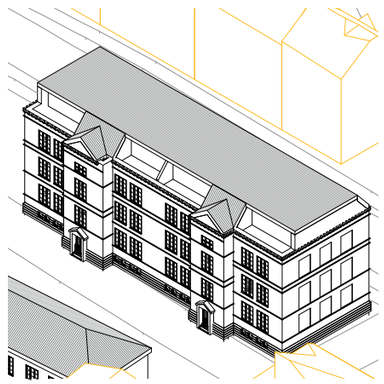
Function

- Reduces internal level changes within the apartments due to the possibility of lower dormers
- Makes balconies possible for all four apartments

Aesthetics

- Partly preserves the main form of the existing roof
- Removes later added dormers that are out of proportion with the building
- New window openings disturb the existing cornice line

New mansard roof



Function

- Makes balconies possible for all four apartments
- Allows for more efficient and functional layouts
- Allows for higher ceiling heights

Aesthetics

- Preserves the cornice as an architectural detail
- Introduces a new roof form that significantly changes the existing architectural expression

Fig. 106.
The three roof iterations

Organisational considerations

Purpose

This section examines how different roof solutions and typologies influence the layout and organisation of the apartments.

The sketches in figure 107–108 explore different approaches to organising the top floor as residential units. The studies compare solutions that either increase the total floor area and remove the need for internal stairs, or introduce split levels within the dwellings, ensuring that living spaces with fire escape requirements are placed accordingly. The proposal with a single internal floor level is selected, as it creates significantly more usable space.

In fig. 109, different organisations and balconies are explored. The wider balcony is selected due to its more coherent spatial layout and improved potential for a larger, more generous balcony.

Chosen variant

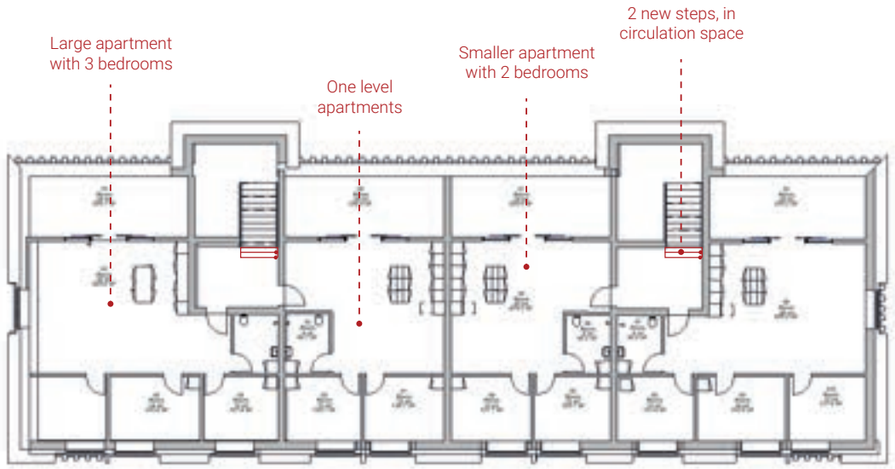


Fig. 107.
Top floor plan iteration with raised floor

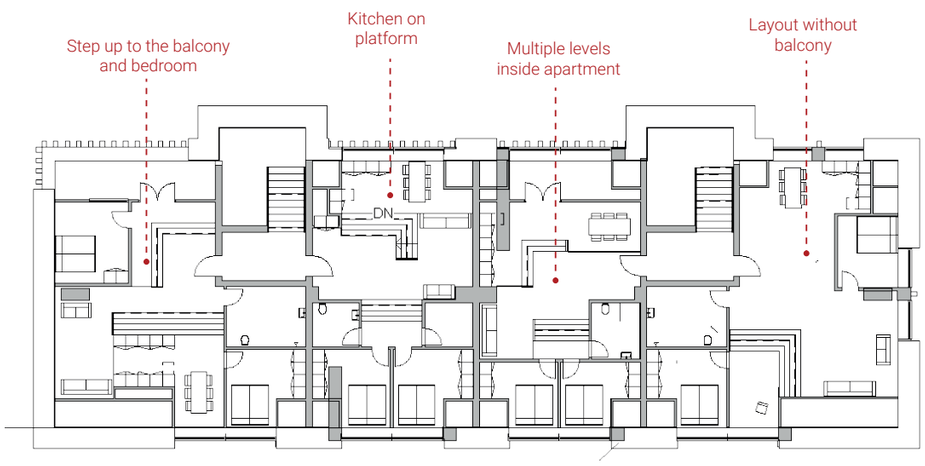


Fig. 108.
Top floor plan iteration with stairs

Chosen variant

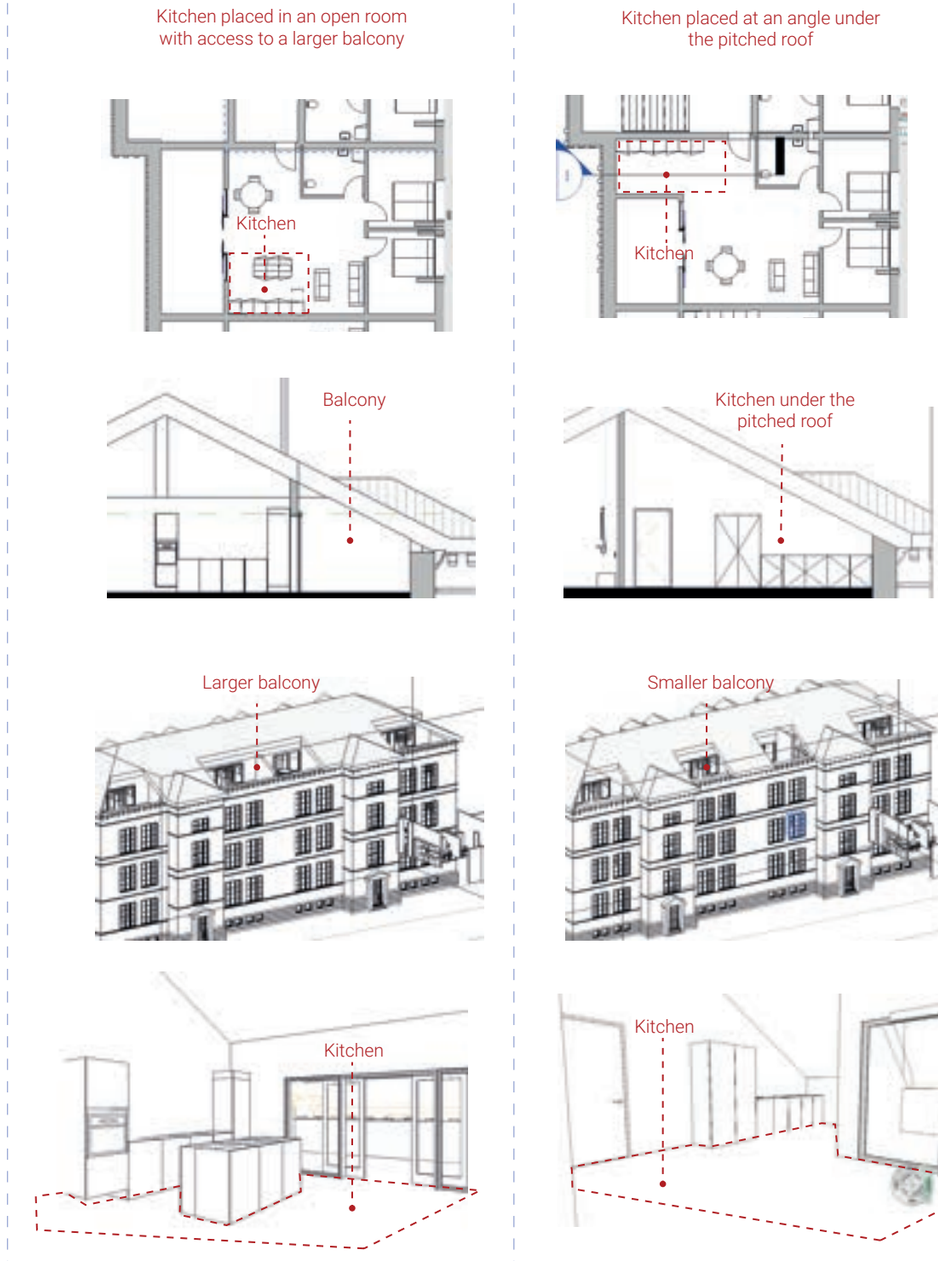


Fig. 109.
Top floor considerations about kitchen placement

Dormer typology

Purpose

The purpose of this section is to compare different design options for the new dormers roof profile in order to define their final form and expression.

The iterations focus on how the dormers relate to the existing building and roof. Therefore, the dormers shown in figure 110, are aligned with the existing window positions below in order to respect the original symmetry of the building. The gable roof dormers are further developed, as they align with the existing formal language of the building.

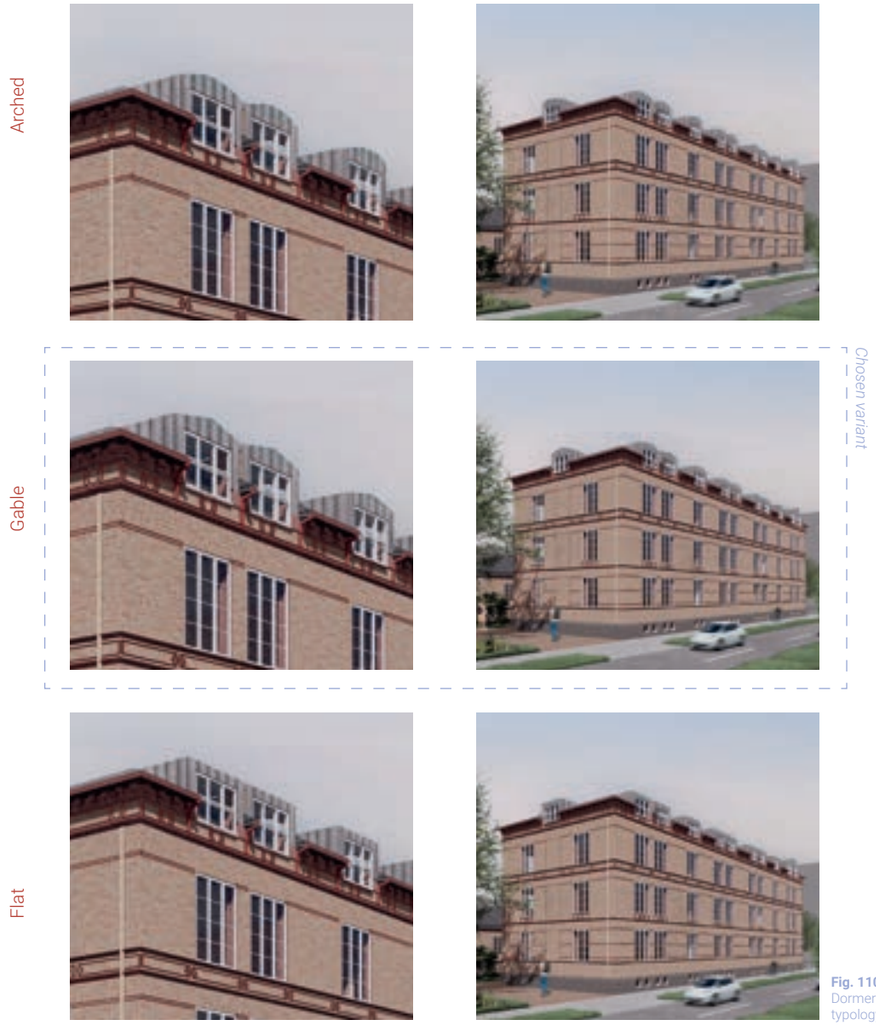


Fig. 110. Dormer typology

Materiality

Purpose

This section compares different material options for the cladding of the new dormers in order to determine the most suitable material strategy.

Based on the study in figure 111 steel dormers are selected, as they provide a lighter and less dominant expression. They integrate naturally into the building without standing out excessively, while still reads as a new architectural intervention.

Fig. 111. Dormer material color

Wall insulation strategies

Purpose

The purpose of this section is to explore and compare internal insulation strategies for improving the thermal performance of the external walls.

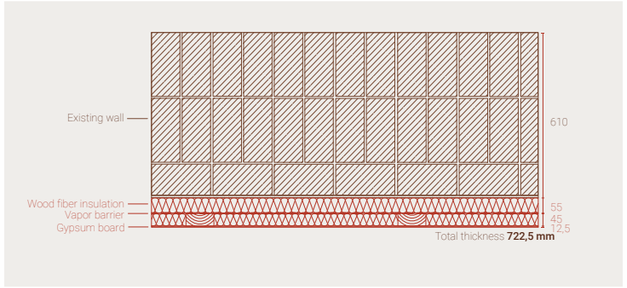


Fig. 113.
Wood fiber

Wood fiber

Vapour barrier required
More complex build-up

U-value: **0.14 W/m²K**

GWP: **0,09 CO_2-eq/m²/år**
(appendix 6)

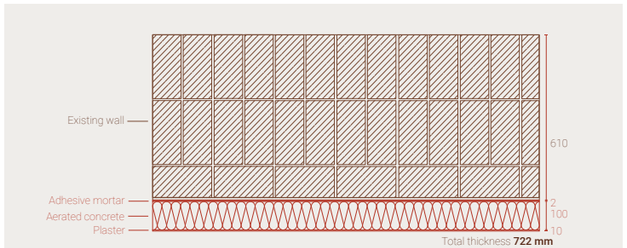


Fig. 112.
Aerated concrete

Aerated concrete

No vapour barrier required
Simple construction

U-value: **0,5 W/m²K**

GWP: **0,4 CO_2-eq/m²/år**
(appendix 6)

Two internal insulation strategies are explored to improve the thermal performance of the external walls.

The strategies differ in build-up, complexity and resulting U-values, directly influencing the requirements for window upgrades.

Lower wall performance, as the option with aerated concrete, increases the demand for higher-performing window solutions.

While high-performance wall with wood fiber insulation allows for moderate window improvements.

Window upgrade implications

Purpose

The purpose of this section is to examine how the choice of wall insulation directly affects the required thermal performance of the window upgrade. To meet the overall energy frame, different secondary glazing strategies are evaluated.

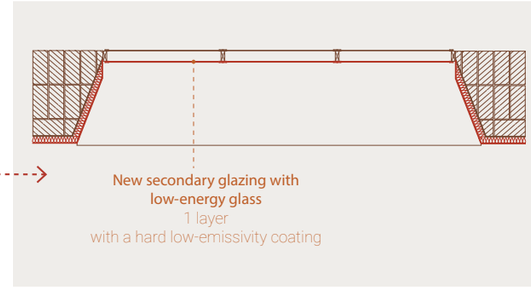


Fig. 114.
Low-energy secondary glazing

Standard secondary frame (energy glass)

U ≈ **1.7 W/m²K**
Less intervention
Preserves more of the original

Sufficient when combined with high-performance wall insulation.

Chosen variant

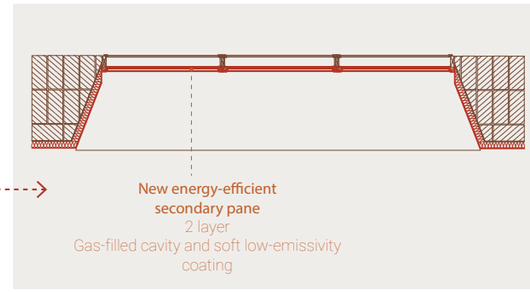


Fig. 115.
Energy-efficient secondary pane

Secondary energy glazing (double layer)

U ≈ **1.3 W/m²K**
Better performance
More intervention

Required when wall insulation performance is limited.

Study evaluation

Although the wood fiber insulation system provides a lower U-value and GWP, the aerated concrete solution is selected due to its simplicity, robustness and reduced moisture risk.

As a consequence, a higher-performance secondary glazing solution is required. The project therefore adopts a secondary energy glazing with a U-value of approximately 1.3 W/m²K *(based on values for secondary glazing, Kampmann, 2002)* to compensate for the lower wall insulation performance.

This demonstrates how material and construction choices directly influence detailing strategies and overall energy performance.

Be18 results - Transformation

Be18 – Key results
- Heated floor area: **2690 m²**
- Heating supply: **District heating**
- Use: **apartment building**
- Usage pattern: **168 hours/week**

Energy demand:
- Total energy demand: **69,9 kWh/m²/year**

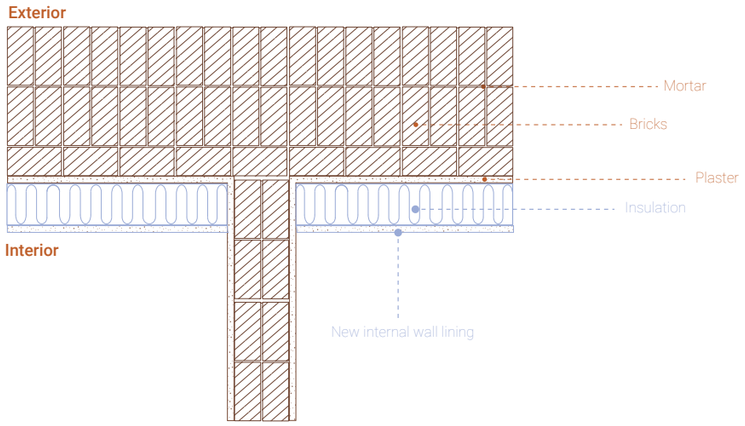
Energy frame (Renovation class 2):
- Limit: **70,7 kWh/m²/year**
- Result: **-0,8 kWh/m²/year**
  within requirement

Thermal bridges

Purpose

Based on the identified potential thermal bridges on page 76-77, this section explores different strategies for how these can be addressed in the design. Two main connections are examined: the connection between the inner wall and facade, and the connection between the floor slabs and the external wall.

For the inner wall and facade detail, a total correction strategy is applied (fig. 116). This is chosen because it is possible to separate the two construction elements by introducing a gap and insulation between them. By cutting the wall connection and ensuring that the inner and outer parts are no longer directly connected, the thermal bridge can be avoided.



Chosen variant

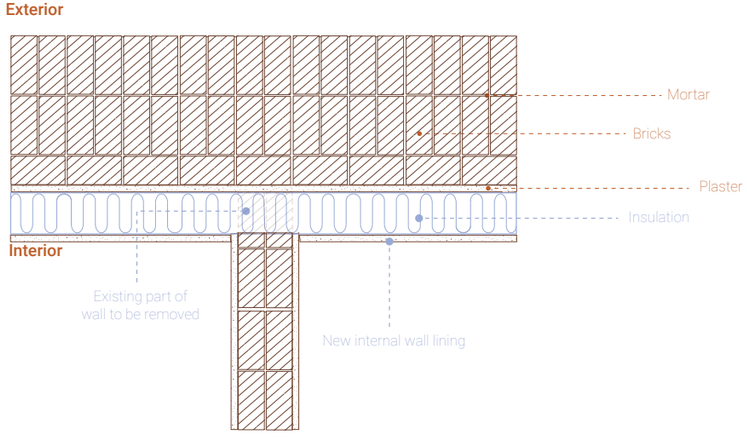
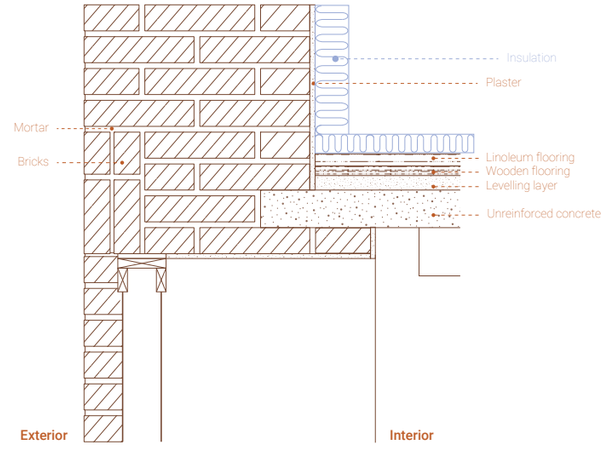


Fig. 116.
Thermal bridge strategies

For the floor and ceiling slab connection to the external wall, a partial correction strategy is used instead (fig. 117). In this case, a full separation and continuous insulation layer around both floor and ceiling would be a much more extensive intervention, both in terms of construction and material use. Therefore, a more limited solution is chosen, where heat loss through the wall surface is reduced. This approach does not avoid the thermal bridge, but prioritises a balance between improved thermal performance and material consumption.



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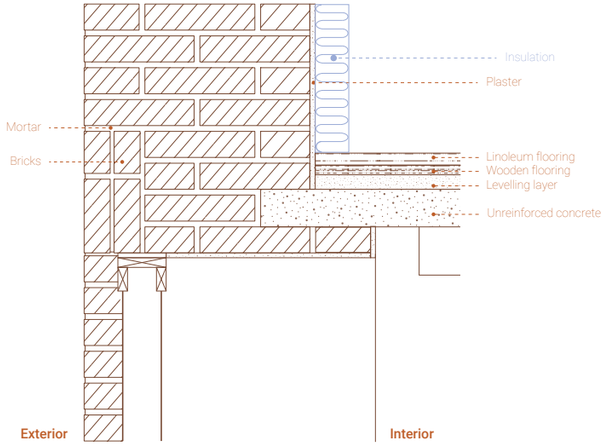


Fig. 117.
Thermal bridge strategies

Life Cycle Assessment

Purpose

This section summarizes all of the previous studies and compares total LCA calculations for the three scenarios: the existing building baseline, transformation into housing with few roof interventions and the transformation including a completely new roof (fig. 118).

Overall

The proposal with the lowest climate impact is the strategy where the existing roof is preserved and supplemented with new dormers, combined with new secondary glazing and additional insulation of the external walls. The energy improvement strategies reduce the overall climate impact in this case.

The proposal with a completely new roof also performs better than the existing building. However, the climate impact associated with constructing a new roof is significantly higher, but the lower energy use is lower, resulting in a total impact that exceeds the strategy based on preserving the existing roof.

The calculations behind this comparison are presented in appendix 6 and are based on updated emission factors from 2025, which are 57% (electricity) and 60% (heating) lower than those from 2023 (Social- og Boligstyrelsen, 2025, Emission factors, Table 1 & 3). Based on calculations carried out using Be18 and LCAbyg, it can be concluded that the updated emission factors have a significant influence on the overall results.

Study evaluation

Based on these findings the transformation strategy where the existing roof is preserved and new dormers are introduced are chosen. This decision is supported not only by the LCA results, but also by previous architectural studies of the roof and its relationship to the building's overall expression.

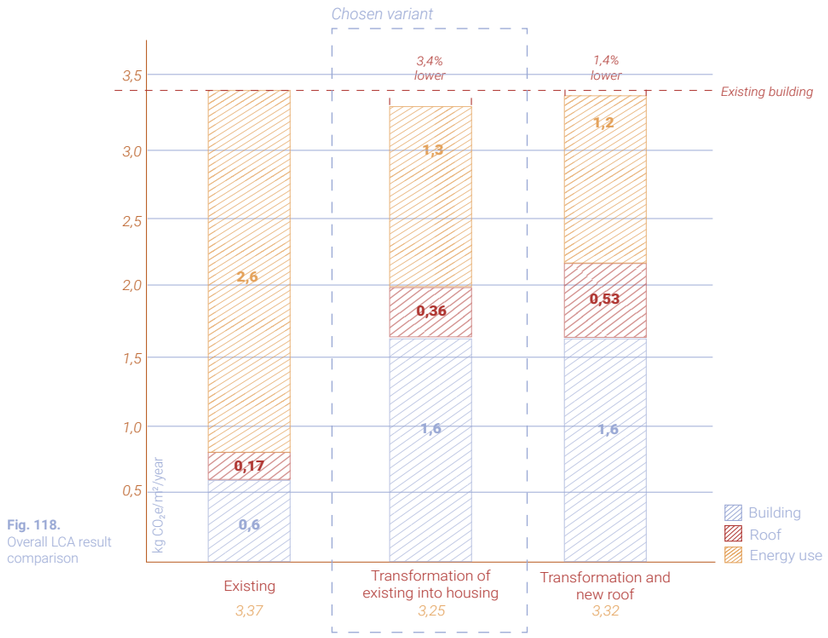


Fig. 118.
Overall LCA result comparison

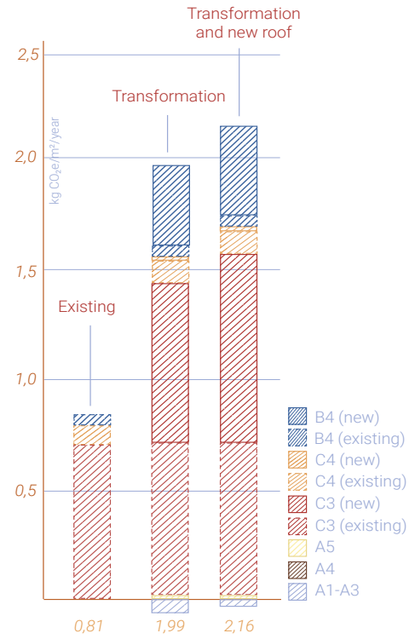


Fig. 119.
LCA modules

Modules

The distribution of climate impact across LCA modules is shown for all three scenarios. In the existing building, modules A1–A5 are zero, as no new construction processes or material production are included. In the transformation scenarios, these modules contribute to the total impact.

Across all three cases, module C3 (waste processing) represents the largest share of the climate impact.

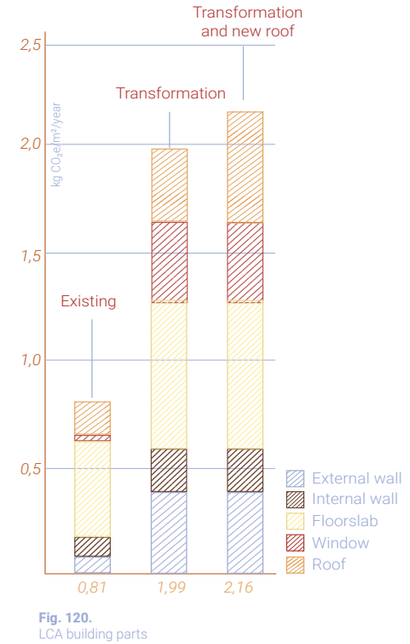


Fig. 120.
LCA building parts

Building parts

The breakdown by building elements shows how different parts contribute to the total climate impact. The two transformation strategies are largely similar, with the primary difference being the roof. The new roof significantly increases the impact compared to the preserved roof solution.

Compared to the existing building, the transformation scenarios show increased impact in elements such as added insulation of external walls, new internal partitions, maintenance, and new windows, as well as interventions in the roof structure.

CHAPTER
10

PRESEN TATION

CONTENT

Masterplan
Courtyard and context
Building expression
Room program
Skolen & Salen
Dwellings
Trygheden
Friheden
Muligheden
Mellemrummet & Vaskehjørnet
Top floor
Basement
Performance
Spatial organisation
Daylight
Salen

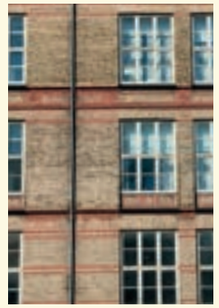


Fig. 121. Building, own photo

This section presents the final design proposal, *EFTERKLANG*. It brings together the developed material through drawings and visualisations, including plans, sections, facades, and renders. The material illustrates how the design responds to the existing building and translates the previous analyses into a coherent architectural proposal.

Fig. 122.
Masterplan
1:500

MASTERPLAN

Transformation of Kjellerupsgade School

The masterplan (fig. 122) transforms the former school into a cohesive residential environment, where infrastructure and spatial quality are balanced. Vehicular access and parking are placed in the corners of the site, while pedestrian movement is kept away from the facades, allowing the courtyard to function as a calm, shared space at a slower, more human scale.

Parking for commercial units and owner-occupied dwellings is provided, though reduced compared to the municipal parking norm for Aalborg Midtby of approximately one space per two dwellings (Aalborg Kommune, n.d.). Due to the limited site area, this reduction is intentional, prioritising generous outdoor spaces. Because not all parking is accommodated on site, the parking facility close by is taking into consideration as option for additional parking.

This is supported by extensive bicycle parking at ground level and in the basement with direct access.

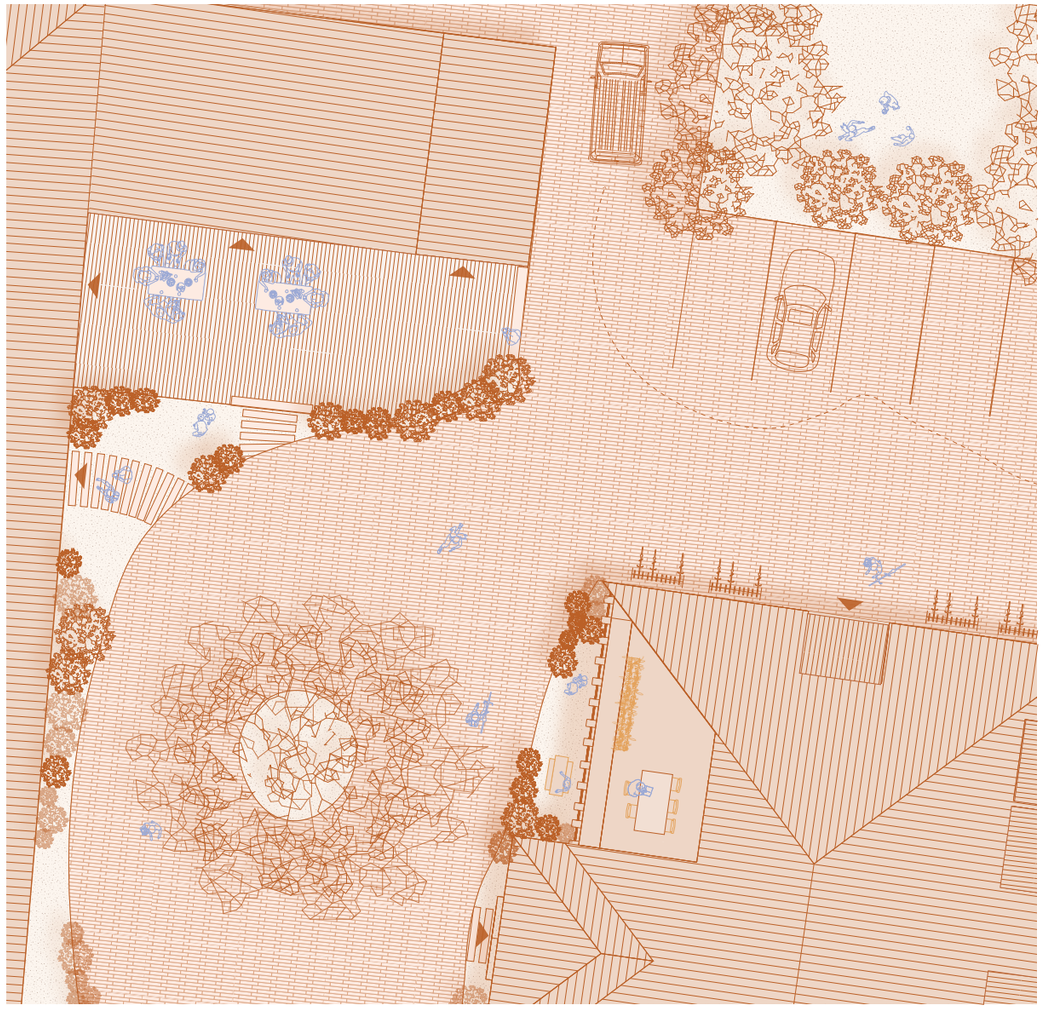
Waste is handled through integrated molok systems, ensuring efficient sorting within a cohesive urban design.

Fire access is provided via wide access routes from both the north and southeast, allowing emergency vehicles to enter, manoeuvre, and reach all parts of the building.

Green elements include a park-like area in the northeast corner and smaller planted niches along the facades, creating a transition from shared to semi-private space. The transformation is completed by new dormers and recessed roof terraces, adding a contemporary layer to the existing structure.

Masterplan cutout

Fig. 123.
Masterplan
1:200



Masterplan - Key data

Programme

22 dwellings
18 rental / 4 owner-occupied

Design strategy

Organic layout
Contrasts existing structure

Bicycle parking

70+ spaces
Outside + basement
Direct access

Waste

Molok system
On-site sorting

Parking

8 spaces on site
3 commercial / 5 residential
↓ reduced (req. ~11)
Parking facility 100 m west

Outdoor spaces

Shared courtyard
Semi-private niches
Park area (NE)
Terrace with shelter & sun
Planting belt (S)

Access and safety

Pedestrian courtyard
Vehicles at edges
Fire access from north and southeast

Surface and climate

Reduced hardscape
Green infiltration

Fig. 124.
Visualisation
from the street

These visualisations illustrate two key views of the projects urban environment.

From the street (fig. 124), the transformation appears more restrained. The existing architectural expression is preserved, while new dormers subtly introduce the residential programme into the roofscape.

From the courtyard (fig. 125), the space is shown as a shared, everyday environment. The central surface is defined by small-format paving in warm yellow tones, creating a tactile and accessible ground while reducing the overall scale. Planted niches along the facades form semi-private zones, while a south-facing planting belt—composed of hornbeam, yew, and ornamental grasses—provides wind protection and privacy.

Fig. 125.
Courtyard

COURTYARD AND CONTEXT

Relation between building volumes

Section AA (fig. 126) shows how *Salen* and *Skolen* enclose the courtyard, forming a sheltered space within the block. The existing structure defines a clear boundary towards the street, separating the courtyard from surrounding traffic.

Within this frame, the courtyard shifts from an open central surface to greener niches along the facades, creating a gradient from shared to more private space.

A shared terrace is placed in the north-west corner, where it benefits from both favourable sunlight conditions and increased privacy.

Fig. 126.
Context section
AA 1:200

Fig. 127.
South facade
1:200

BUILDING EXPRESSION

Facades

The design of the facades focuses on preserving the existing external appearance of the building. The facades contain a number of well-crafted architectural details, and it has been important to maintain this character throughout the transformation. The building is strongly defined by its symmetry, which is also carried through in the interventions.

In the gable facades (fig. 127-128), new windows are added within the existing niches. This approach maintains both the symmetry and the proportions of the original facade. The result is a continuation of the original architectural logic, where new elements are integrated without disrupting the overall expression.

Fig. 128.
North facade
1:200

On the facade drawings, the placement of the new gutters is also shown. A new strategy for the gutter placement has been made because of the new dormers, which break the roof line. Therefore, the gutter has been lowered and aligned with an existing facade detail to create a calmer facade without adding new disturbing lines. This solution also avoids long downpipes at every break in the roof edge. Instead, smaller pipes connect the roof edge to the main gutter, which is placed on the gable, keeping the street facade cleaner and allowing the facade details to stand out without being interrupted.

Fig. 129.
West facade 1:200

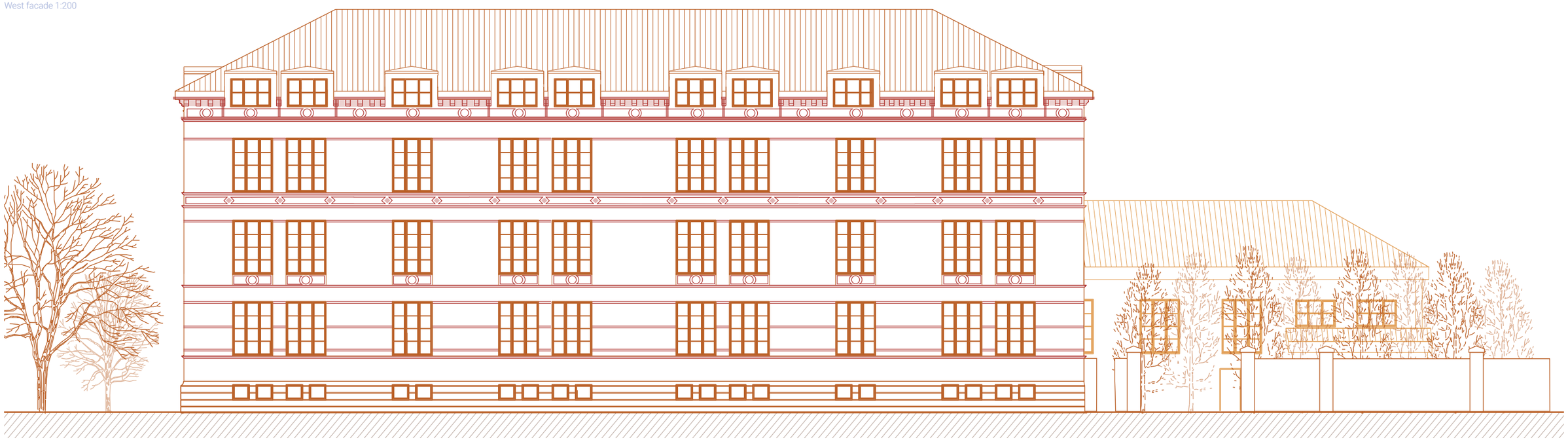


Fig. 130.
East facade 1:200

The long facades (fig. 129-130) are strongly defined by the large existing windows, which are an important part of the building's external expression. These windows are preserved, in order to maintain the original architectural character.

Compared to the existing dormers from 1988, the new ones are designed with reference to the building's proportions, rhythm, and symmetry. This ensures that the additions are aligned with the existing architectural language and support a coherent overall expression.

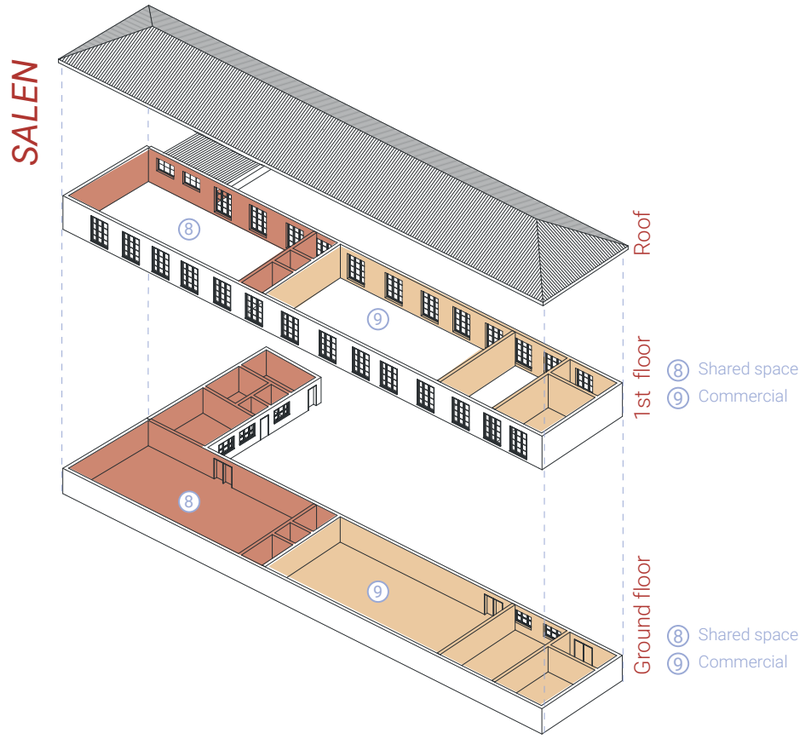
Fig. 131.
Isometric

ROOM PROGRAM

	Room type	Area m²	Amount of each room	Height Room height	Type (rent/own/shared)	Floor Level B / G / 1 / 2 / 3
Residential	Friheden	48	6	3500 mm	Rent	G / 1 / 2
	Muligheden	48	6	3500 mm	Rent	G / 1 / 2
	Trygheden	98	6	3500 mm	Rent	G / 1 / 2
	Mellemrummet	15	6	3500 mm	Rent	G / 1 / 2
	Udsigten 01	103	2	1400-4700 mm	Own	3
	Udsigten 02	130	2	1400-4700 mm	Own	3
Circ.	Circulation	227	-	-	Shared	B / G / 1 / 2 / 3
Basement	Bike parking	95	-	2300 mm	Shared	B
	Workspace	194	-	2300 mm	Shared	B
	Storage units	3	22	2300 mm	Rent / Own	B
	Tech.	29	2	2300 mm	-	B
Salen	Flexible space	140	1	18600 mm	Shared	G
	Entry	24	1	1400-4700 mm	Shared	G
	Eating area	45	1	2600 mm	Shared	G
	Kitchen	18	1	2600 mm	Shared	G
	Tech.	55	-	-	-	G
	Storage (shared)	27	-	-	Shared	G
	Storage (commercial)	30	-	-	Rent	G
	Commercial	420	-	2600, 3000, 18600 mm	Rent	G / 1

	Category type	Area m²
Total	Residential (incl. storage units and circulation area)	2013
	Shared space	543
	Shared area percentage (total area / shared)	*21%*

Fig. 132.
Room program



SKOLEN & SALEN

Exploded diagram

Skolen and *Salen*, is transformed from its original educational use. The existing structure forms the basis for the new organisation, where the spatial qualities of the former classrooms and larger rooms are maintained and reinterpreted as part of the concept.

The exploded diagram in figure 133 highlights how the transformation is carried out with respect for the existing architectural logic, while introducing new layers of residential functions. This creates a clear structure where circulation, shared spaces, and dwelling types are integrated into the original framework of the building, allowing the transformation to be read as an extension of the existing rather than a replacement.

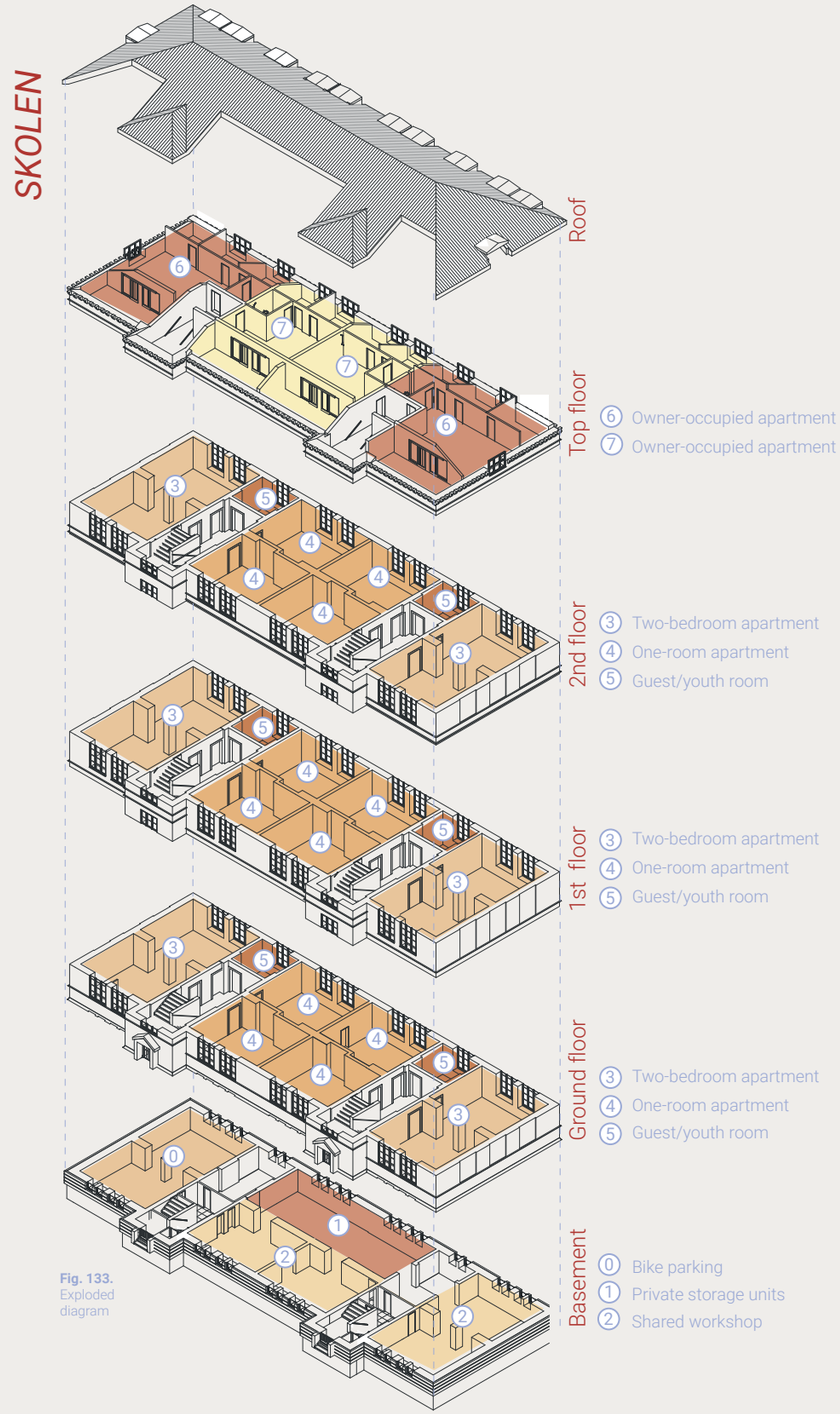


Fig. 133. Exploded diagram

DWELLINGS

Ground -, 1st - & 2nd floor

The ground floor plan of *Skolen (fig. 134)* establishes the overall spatial organisation, which is repeated on the first and second floor, while the rooftop level follows a different layout.

Four smaller apartments are placed centrally, while larger family units occupy each end, separated by a shared intermediate space.

The existing staircases are preserved and form the organisational core of the plan, providing clear access and a natural distribution of dwellings. The layout follows a symmetrical structure, where the plan mirrors itself around the central axis. This reflects the original organisational logic of the building, reinforcing its inherent architectural identity, as also expressed in the facades.

Fig. 134.
Ground floor
1:200

TRYGHEDEN

Rental | 98 m^2 | 2 bedroom apartment

Trygheden is organised around the qualities of the former classrooms. Towards the west, one classroom is kept as a single, open volume, creating a spacious living area with kitchen and living room, defined by generous daylight and a high ceiling (fig. 135).

Towards the east, the plan shifts into a more private zone with two bedrooms. Here, loft spaces are integrated above the bathroom and toilet, utilising the existing ceiling height of 3.5 metres for storage or additional playing areas (fig. 136).

The preserved structural walls create a natural transition between functions, forming a distribution zone that separates living and sleeping areas while maintaining the clarity of the original layout.

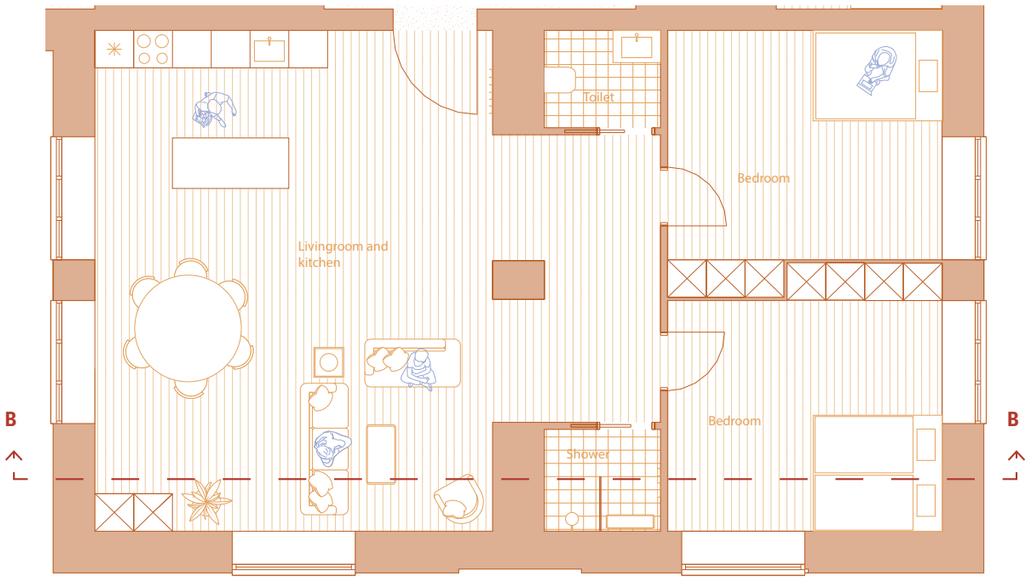


Fig. 135.
Floor plan
1:100

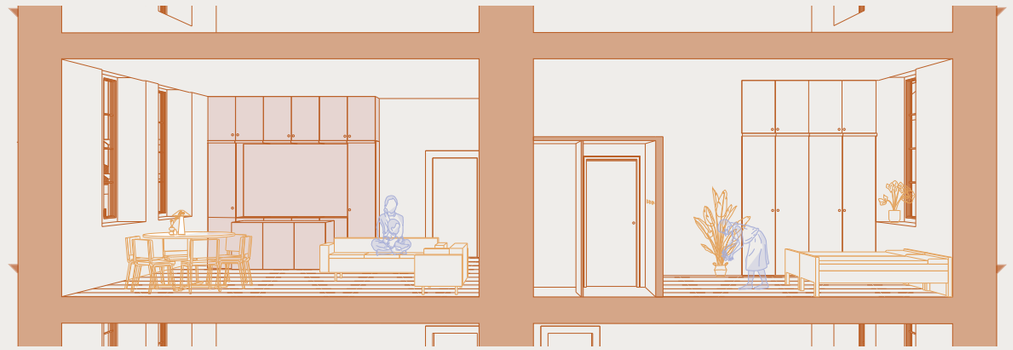


Fig. 136.
Section BB
1:100

Fig. 137.
Trygheden

FRIHEDEN

Rental | 48 m^2 | Studio apartment

Friheden is based on the idea of minimum predetermined structure, where the dwelling is kept as open as possible to allow for individual interpretation and use. This creates a spatial framework that can adapt to different lifestyles and changing needs over time, rather than defining a fixed way of living (fig. 138-140). The fixed elements, such as kitchen and bathroom, are compressed and placed along one wall, which frees up the rest of the space. This creates a large, open plan area that can be arranged according to the needs and preferences of the resident, whether related to everyday life, hobbies, or personal belongings. In this way, the resident becomes an active participant in shaping the atmosphere and function of the home through daily use and personal arrangement.

Fig. 138.
Friheden floor plan
1:100

Alternative arrangements

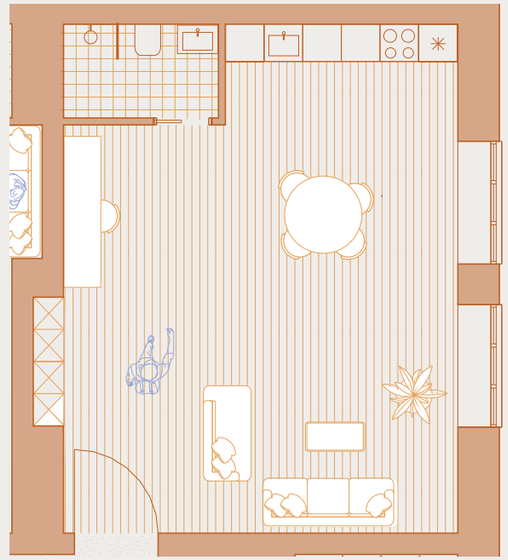


Fig. 140.
Alternative arrangement
1:100

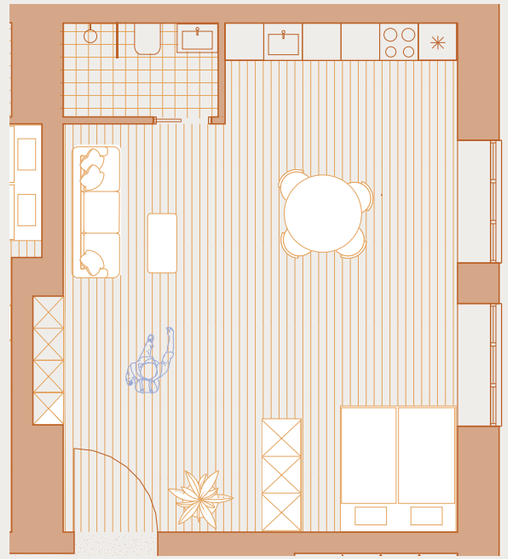


Fig. 139.
Alternative arrangement
1:100

With a ceiling height of 3.5 metres, the room also offers potential for vertical use. A loft placed above the bathroom creates a smaller, more defined zone within the otherwise open layout, which can be used either as a sleeping area or for additional storage (fig. 141).

Fig. 141.
Friheden section CC

Fig. 142.
Friheden

After the transformation, the former classroom has become a dwelling for those who value the character of the existing building: the generous ceiling height, the large original windows, and the spatial qualities that are rarely found in newly built apartments. In *Friheden*, the openness of the classroom is largely preserved, creating one continuous living space. Warmer surfaces and an integrated kitchen and bathroom wall introduce a more domestic atmosphere, giving the room a clearer organisation without compromising its original openness. In this way, the space is transformed from an institutional classroom into a home.

MULIGHEDEN

Rental | 48 m² | Studio apartment

Muligheden takes a different approach by working with spatial zoning and a more clearly defined layout by having integrated furniture designed to the space. The dwelling is organised into a sequence of areas with varying degrees of openness and privacy, creating a natural structure within the home. Rather than leaving the space entirely undefined, the arrangement suggests different ways of inhabiting the dwelling and supports a range of everyday activities. This creates a more articulated living environment, where movement, function, and atmosphere are shaped through the spatial composition itself (fig. 143-145).

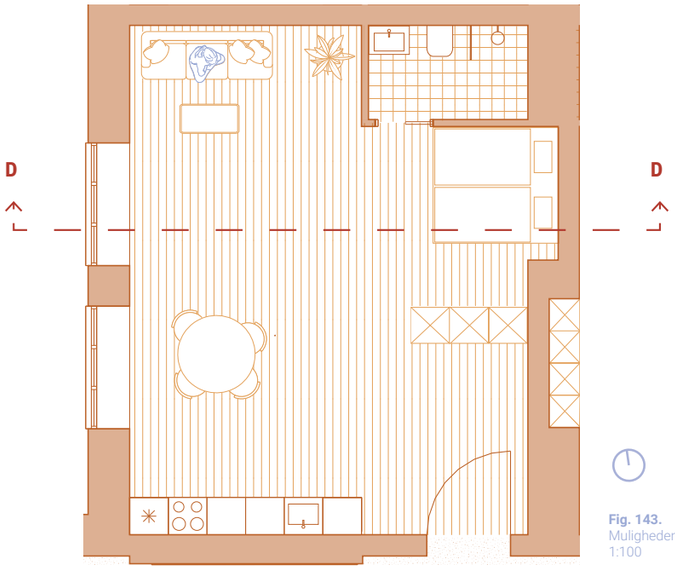


Fig. 143.
Muligheden floor plan
1:100

Alternative arrangements

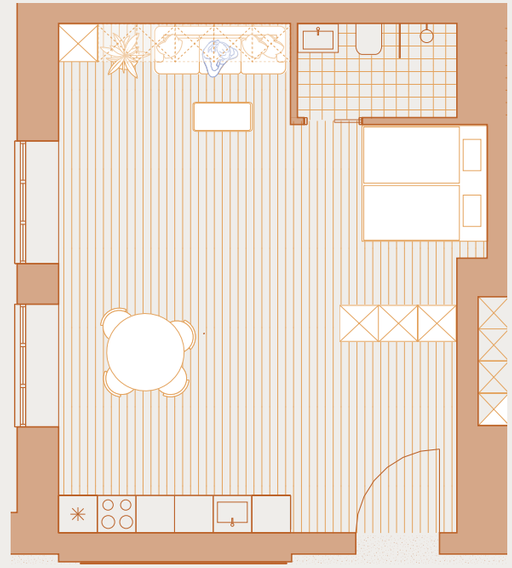


Fig. 145.
Alternative arrangement
1:100

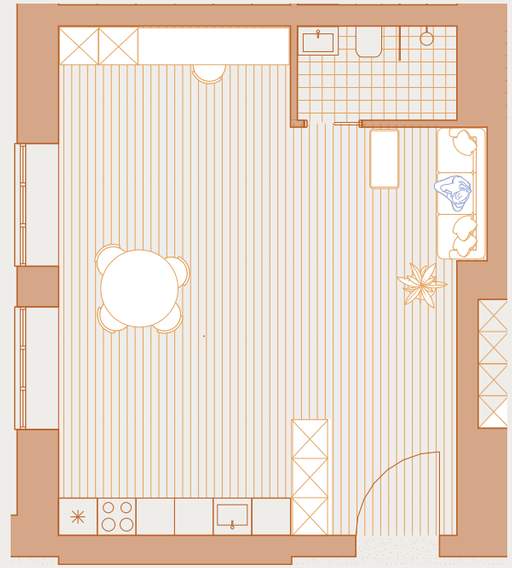
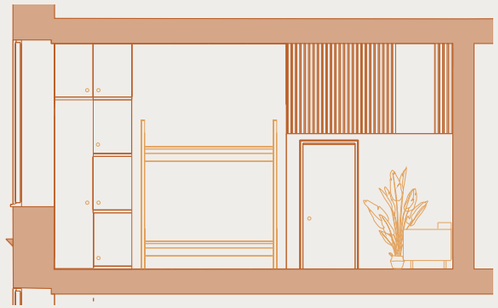


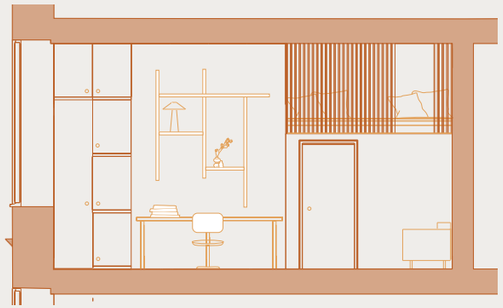
Fig. 144.
Alternative arrangement
1:100

Built-in and movable furniture elements are integrated into *Muligheden* as part of a flexible system, making it easy for residents to rearrange the interior according to changing needs and everyday use. Some different configurations are illustrated in figure 146, showing how the furniture can create different niches with variating use and more defined zones within the open space.

Option 1



Option 2



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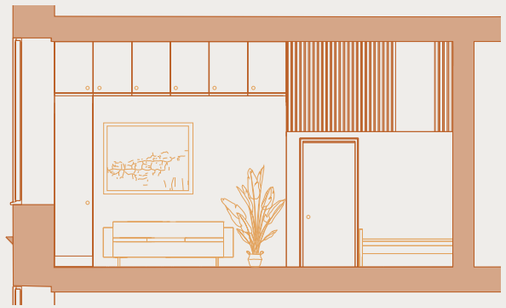


Option 4

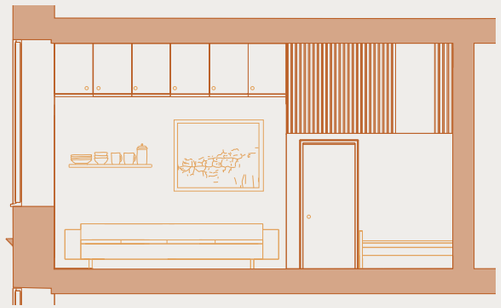


Fig. 146.
Muligheden sections DD
1:100

Fig. 147.
Muligheden

Muligheden allows distinct spatial zones to emerge within an otherwise open layout. The tactile red plywood wall and integrated movable cabinets create a warmer, more sheltered zone for quieter everyday use. At the same time, the existing niche in the thick load-bearing wall allows the bed to be placed at the back of the apartment, giving the sleeping area a greater sense of enclosure. The dwelling therefore maintains its openness while offering more intimate and adaptable areas for living.

MELLEMRUMMET & VASKEHJØRNET

The intermediate space

The existing circulation area is reused to introduce new shared and flexible functions.

A shared laundry, *Vaskehjørnet*, is placed on each floor, allowing this function to be moved out of the dwellings and shared between a limited number of units. It includes a washer-dryer column, storage, sink, and a work surface, and is designed as an integrated and welcoming part of the circulation space.

Adjacent to this, an additional room is introduced as a flexible guest room or supplementary bedroom, *Mellemrummet*. It is activating what was previously a generous service zone, used for school toilet facilities. Positioned close to the dwellings, it allows for an extended domestic setup, where a teenager or guest can occupy a semi-independent space while remaining connected to the household.

The room benefits from natural daylight and includes its own bathroom, placed behind the laundry functions to reduce noise towards the room.

This strategy transforms a generous circulation space into an active and adaptable shared zone, adding flexibility and allowing the room to be used or rented independently without being permanently tied to a single dwelling (fig. 148).

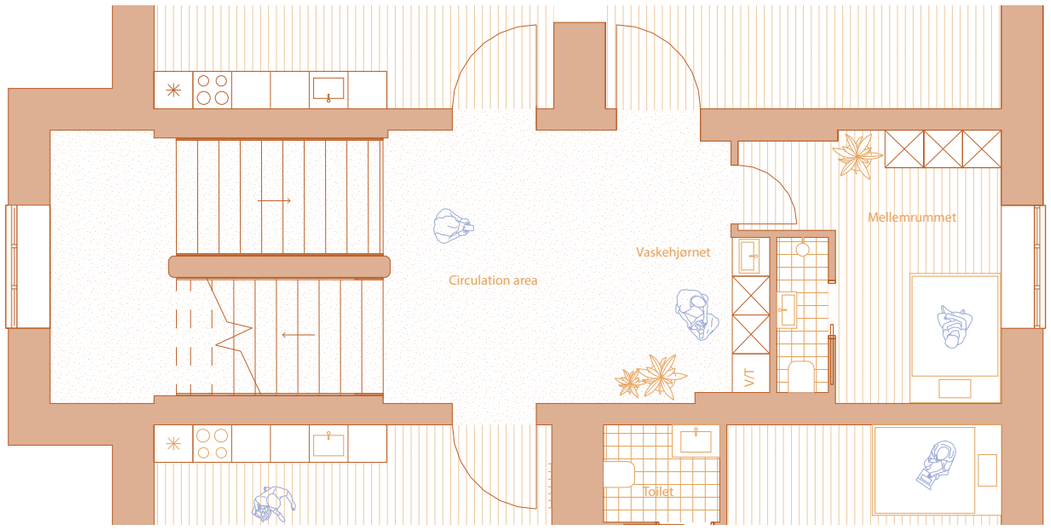


Fig. 148.
The intermidiate space
floor plan 1:100

Fig. 149.
Mellemrummet &
Vaskehjørnet

TOP FLOOR

Udsigten 01 & 02 | Owner-occupied apartments

The top floor has undergone the most significant transformation, as the existing attic was not suitable for residential use due to the window placement, with approximately 2 meters from floor to the underside of the dormers, limiting views and preventing proper rescue openings. Previously, the space consisted of large, undivided volumes.

The intervention includes raising the floor level by 40 cm and introducing new, smaller dormers, bringing daylight further into the space and enabling subdivision into dwellings. At the same time, the ceiling is opened up to the ridge, enhancing spatial quality and allowing the full volume of the roof to be utilised.

The plan is reorganised into four larger apartments: two two-bedroom units of approximately 103 m², *Usigten 01*, and two three-bedroom units of approximately 130 m², *Udsigten 02* (fig. 151).

Towards the west, generous recessed roof terraces are introduced, providing private outdoor spaces with evening sun, sheltered from the street. This establishes a clear distinction between the more formal street-facing roof and the more open, informal and domestic character towards the courtyard side.

Fig. 150.
Udsigten 02

Fig. 151.
Top floor 1:200

BASEMENT

Of *Skolen*

The basement is activated as a functional and accessible level, making use of available daylight and its direct connection to the courtyard. Indoor bicycle parking is provided with direct access, allowing for easy movement between outdoor space, storage, and dwellings (fig. 152).

Shared workshop facilities are introduced, supporting everyday repair and maintenance, including space for bicycle repair. Each apartment is provided with a private storage unit on 3m², while technical rooms and additional shared storage are organised as separate functions within the basement.

The existing material palette is largely preserved, supporting a simple and robust character while reducing the need for new interventions.

Fig. 152.
Basement
1:200

PERFORMANCE

Global warming potential and energy use

In the transformation of *Skolen*, an energy performance calculation of the building's energy demand has been carried out in order to ensure compliance with current requirements. The calculation is based on Be18, and after the transformation the building meets the standards of renovation class 2 (fig. 153). This is primarily achieved through additional insulation and the installation of new secondary glazing, which together reduce the overall energy demand of the building.

In parallel, a Life Cycle Assessment (LCA) has been developed to evaluate the environmental impact of the transformation. The LCA shows that the environmental impact is reduced compared to the existing building in its current state, mainly due to the energy improvements and the reuse of the existing structure. This means that the transformation both improves the building's performance and results in a lower climate impact than a comparable new construction (fig. 154).

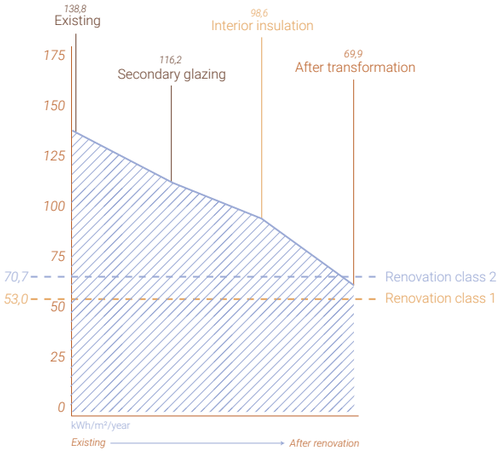
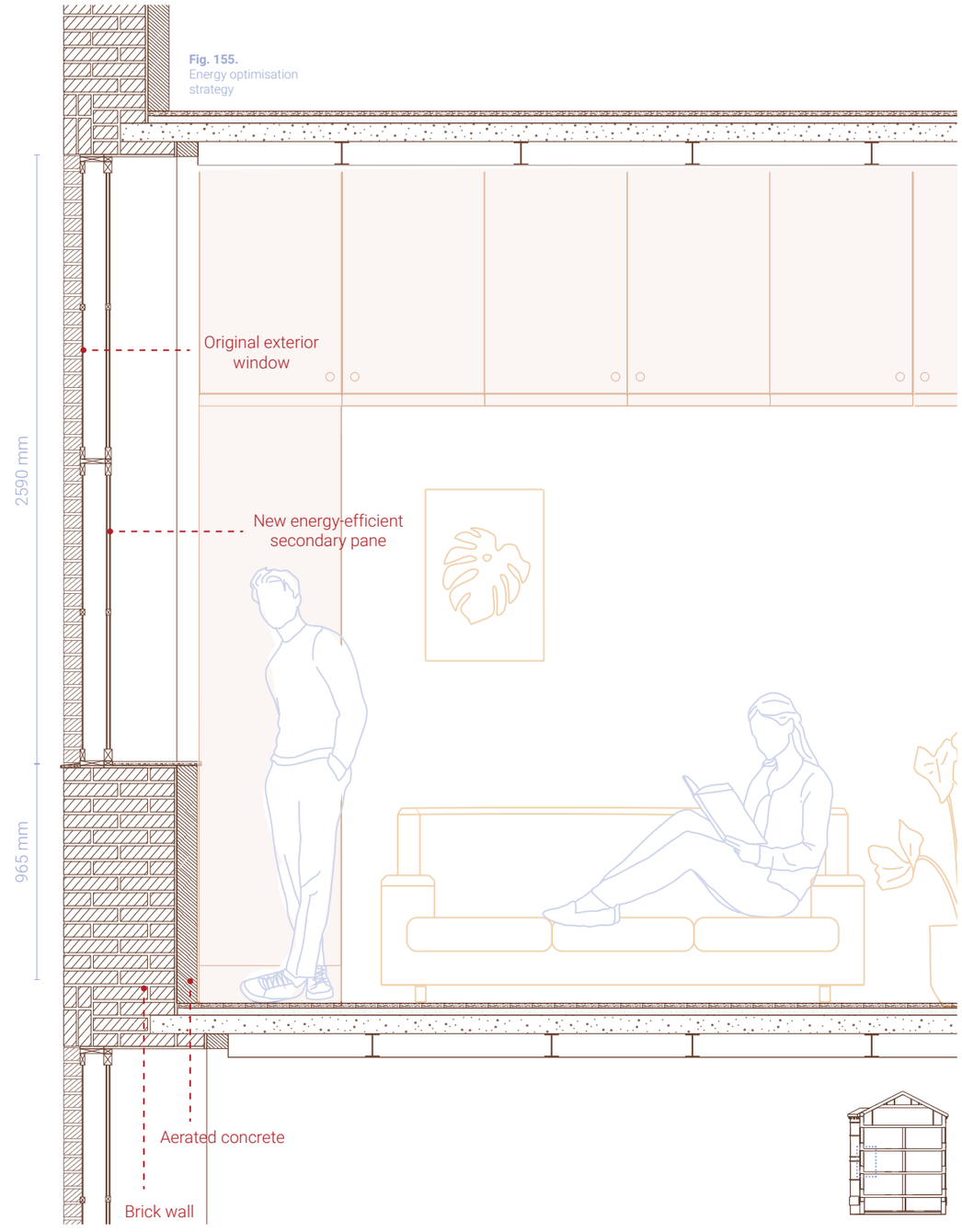


Fig. 153.
Be18 results

Fig. 154.
LCA results

Fig. 155.
Energy optimisation strategy



SPATIAL ORGANISATION

Sectional exploration

The longitudinal section in figure 156 illustrates the overall organisation of the building, where the circulation area and *Mellemrummet* separates the smaller dwellings from *Trygheden*. The section highlights how the ground, first, and second floors share a common structure, while the basement and top floor differ in spatial organisation.

New openings in the gables are introduced within existing niches, bringing additional daylight into the *Trygheden*.

The section also reveals the elevated ground floor windows and the high basement level, reducing direct exposure to street-level activity. The overall symmetry of the building is clearly expressed in the longitudinal cut.

The cross section is presented at a larger scale on the following page to clearly highlight the spatial relationships and interactions between each room.

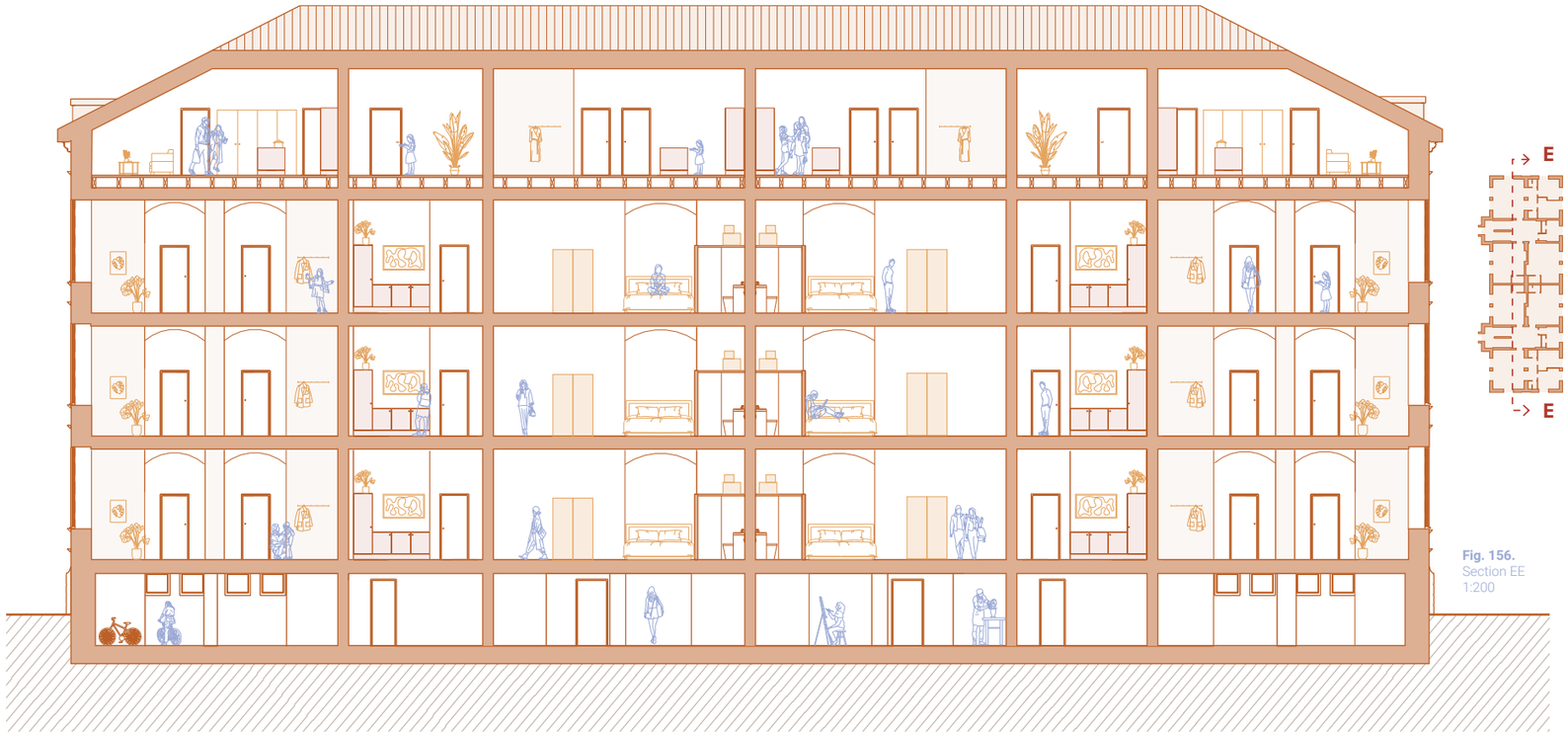


Fig. 156.
Section EE
1:200

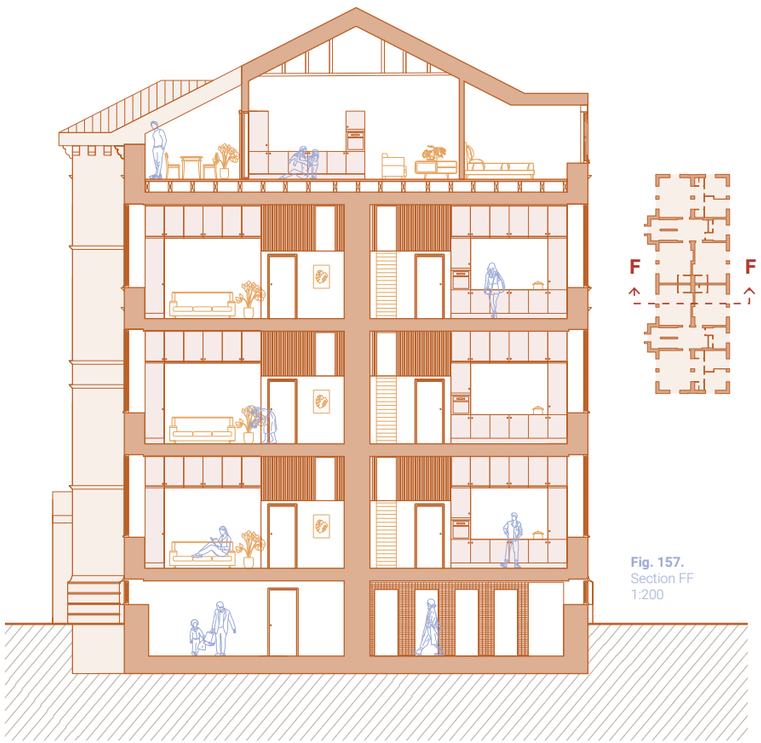


Fig. 157.
Section FF
1:200

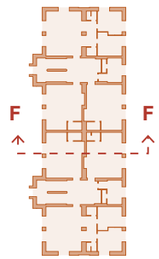
Fig. 158.
Section FF
1:100

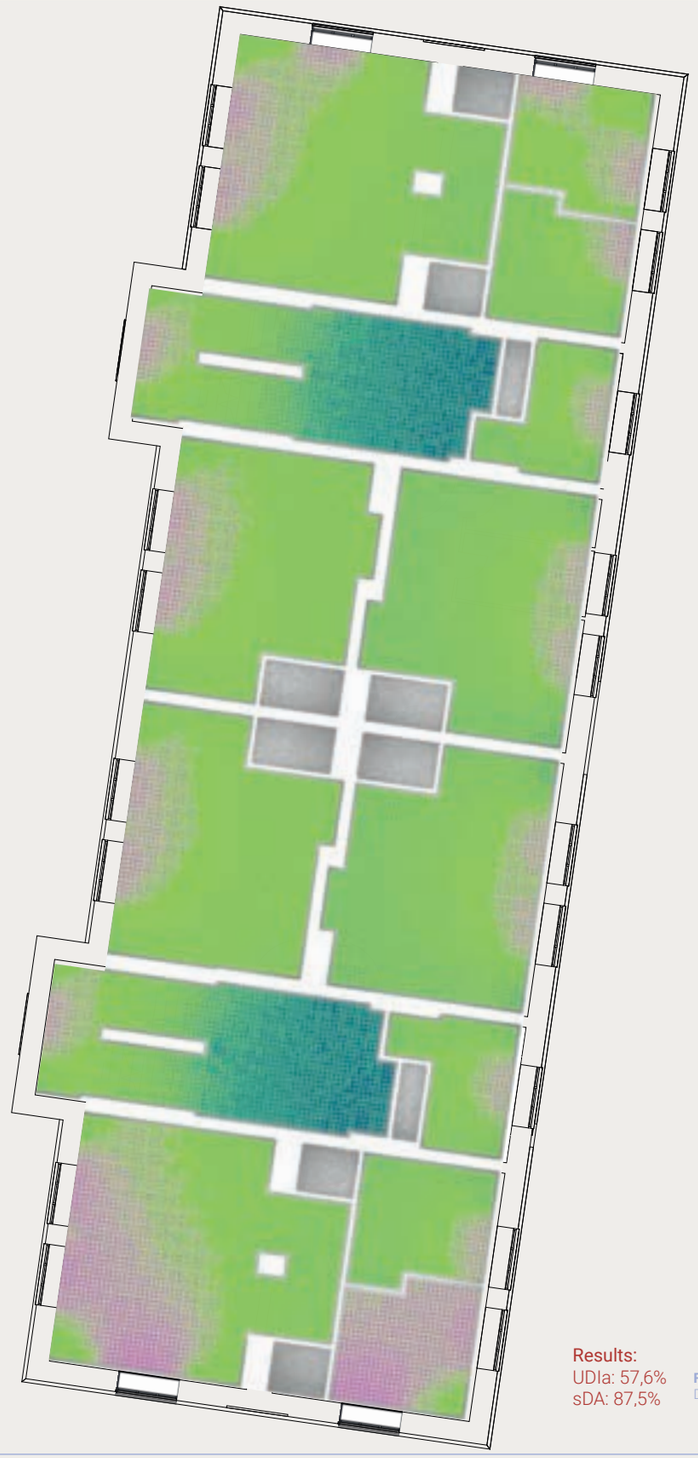
Living within the existing structural frame

The cross section in figure 158 emphasises the spatial transformation of the top floor. New dormers introduce increased headroom and improved daylight conditions, while the ceiling is opened to the ridge, enhancing the sense of volume.

Recessed roof terraces are carved into the west-facing roof surface, where the existing outer wall is retained as a boundary, preserving the original cornice line.

The section also highlights the relationship between different dwelling types, where variation and flexibility are expressed side by side. A continuous load-bearing wall runs through the building, articulated with integrated niches, reinforcing the structural and spatial identity of the existing architecture.





Results:
UDIa: 57,6%
sDA: 87,5%

Fig. 159.
Daylight 1:200

DAYLIGHT

Conditions after transformation

The dwellings are designed with minimal internal partitions, allowing daylight to penetrate deeply into the floor plan and ensuring consistent daylight quality throughout the dwellings.

New gable windows are introduced to improve daylight conditions, increasing daylight levels in the kitchen and living areas of *Trygheden* enhancing the spatial quality and usability. These new windows have resulted in the sDA is increased by 6,8 percentage points, which is considered sufficient, because the existing conditions were already performing well .

The daylight distribution is shown in figure 159, where the Useful Daylight Illuminance (UDI) analysis illustrates variations across the building. The Spatial Daylight Autonomy (sDA) reaches 87,5%, complying with the Danish Building Regulations requirement of a minimum of 50%.

SALEN

The former gymnasium volumes are reimagined as active, shared spaces that extend the life of the building beyond the individual dwelling. Rather than remaining isolated structures, *Salen* becomes a framework for collective use and local engagement.

One hall is opened up for flexible commercial or cultural use, capable of hosting workspaces, small-scale performances, or activities connected to the surrounding neighbourhood. The existing spatial qualities allow for a variety of programs to coexist and evolve over time.

The second hall is transformed into a shared space for residents, supporting everyday and occasional use, from sports and communal dining to larger gatherings and hosting private events. A shared kitchen and storage facilities enable the space to adapt to changing needs (fig. 160).

Together, the gymnasium structures form a social layer to the building complex, fostering interaction, flexibility, and a stronger connection between private living and collective life.

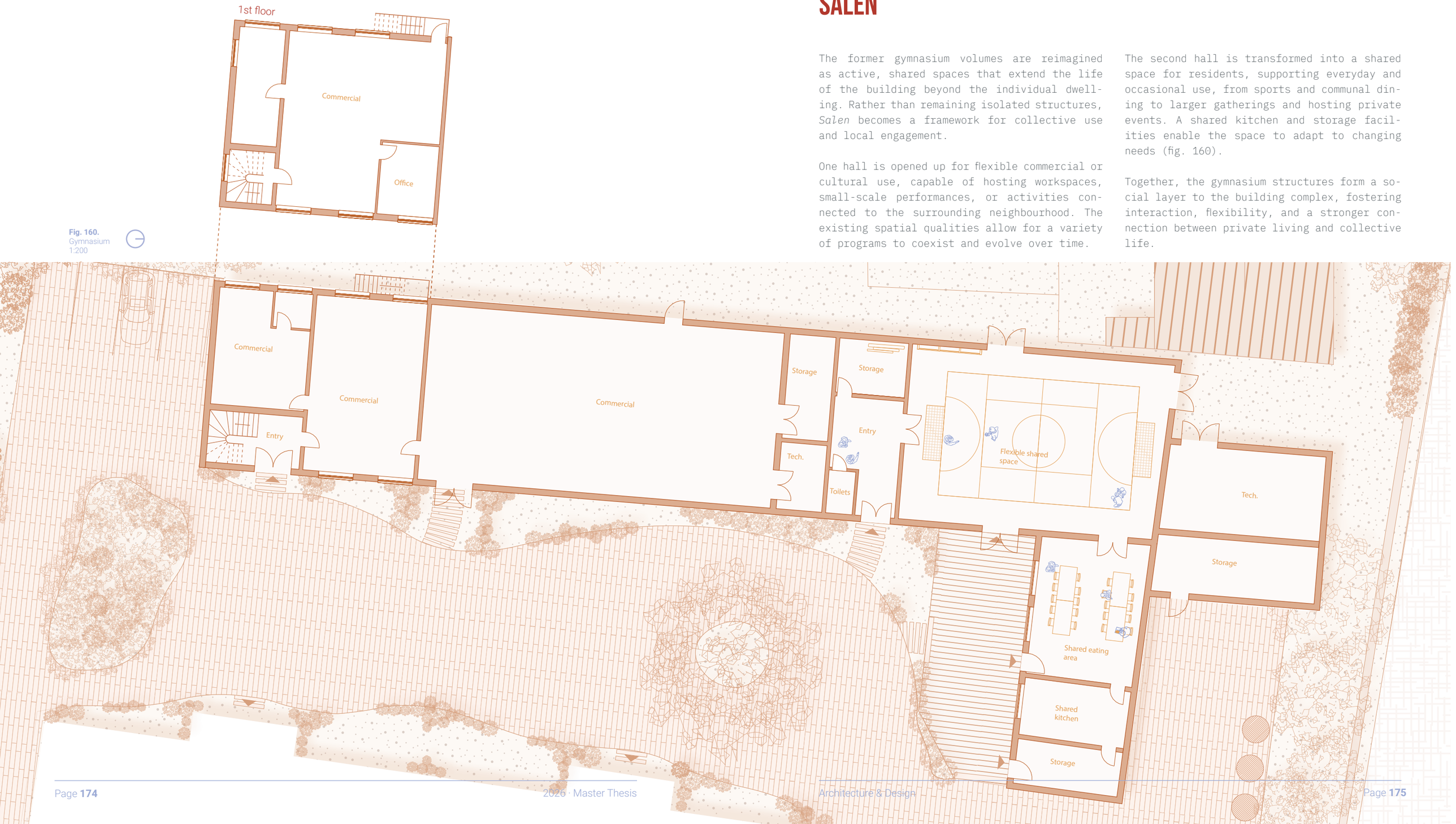


Fig. 160.
Gymnasium
1:200

... AND WITH THAT A CLASSROOM BECAME A HOME

Fig. 161.
Visualisation

CHAPTER
11

EPI LOGUE

CONTENT

Conclusion
Reflection
References
Figures

Fig. 162.
Building,
own photo

The final section concludes the project by summarising the main findings and reflecting on the design process and its outcomes. It also includes references and a list of figures documenting the visual material presented throughout the report.

CONCLUSION

This thesis explores how existing buildings can be transformed into flexible housing for different types of residents. The project is based on the idea that a dwelling should not be fixed in one way of living, but instead be able to adapt over time – both for the same resident and through changes in different users over time. The dwellings are designed as open and flexible frameworks, where personal interpretation and use can evolve. In this way, the housing becomes something that can grow with the inhabitant rather than limit them.

Working with the existing building

A central part of the project has been to listen to the existing building and its architectural qualities. The transformation is not about erasing history, but about building on what is already there. The original structure, circulation zones and spatial qualities have been used actively in the design process. A flexible shared space is created in the former circulation area between the dwellings. This adds value to the building, increases flexibility, and supports different ways of living.

The project creates different types of housing within the same building. The dwellings are combined with shared facilities such as laundry, just outside the dwellings, workspace and larger shared spaces in the former gymnasium. And the larger top-floor apartments are designed as owner units. These homes take advantage of the building's qualities such as exposed beams, high ceilings and balconies with views, creating a very different spatial experience. This variation in housing types allows for a diverse resident group.

In addition, part of the former gymnasium is used for commercial rental, such as offices, workshops or cultural use. This brings activity into the building beyond the residential use and creates a social layer between private living and public life, supporting interaction and a more dynamic everyday use of the building.

Spatial quality and technical performance

A key design strategy has been to maximise daylight conditions through open-plan layouts and careful spatial organisation. Instead of traditional apartments, the design allows light to penetrate deep into the floor plan, supported by the original large windows. The aim has been to preserve the external architectural expression while improving the internal living quality. This balance between old and new strengthens the identity of the building and keeps the story of the former school visible in the transformation.

The project integrates energy and climate considerations as an active part of the design process. Existing windows are preserved and supplemented with secondary glazing to reduce heat loss, while additional insulation improves the overall energy performance. LCA calculations show that, over a 50-year period, the transformation results in a lower climate impact per square meter compared to the existing and new construction.

Conclusion

Overall, the project shows how transformation of existing buildings can create new, flexible and diverse housing typologies while preserving architectural value and history. By combining spatial adaptation, sustainability strategies and a strong understanding of the existing structure, the project demonstrates that older buildings can be reactivated as meaningful frameworks for contemporary urban living.

Fig. 163.
Visualisation

REFLECTION

Process and method

From the beginning, the project developed through an investigation of how this specific existing building could be transformed into housing based on its existing qualities, structure, and identity. Rather than applying a predetermined housing programme, the process evolved through working with the building's own premises and spatial conditions. This created a more open and iterative design process, where housing typologies, user groups, and spatial organisation gradually emerged through studies of the existing structure, daylight conditions, and spatial qualities.

Working with an existing building fundamentally changed the design approach compared to a conventional new-build process. The project became less about imposing a fixed architectural intention and more about understanding and negotiating the possibilities and limitations already embedded within the structure. Existing classrooms, circulation spaces, proportions and structural systems continuously informed the development of the project and often redirected the design process itself.

The process was primarily driven through iterative studies of layouts and daylight analyses, continuously tested through different design proposals. In particular, the smaller dwellings became central investigations into how compact dwellings could support multiple forms of inhabitation through flexible spatial organisation. This meant that the larger dwellings were not studied to the same level of detail, as the smaller homes required the greatest precision due to their simple structure, which makes them particularly sensitive to spatial adjustments. This revealed that simplicity in housing typology does not necessarily reduce complexity in the design process, but instead increases the need for precision and careful spatial organisation.

Housing typologies and the final design

The final proposal developed into four differentiated housing typologies with varying degrees of openness and flexibility. *Muligheden* and *Friheden* explored compact and open domestic structures aimed primarily at singles and couples, while *Trygheden* introduced a more structured family-oriented organisation with flexible intermediate spaces. Udsigten offered larger owner-occupied apartments with a more traditional spatial organisation while still maintaining flexibility in use.

Across all typologies, the ambition was not to create housing for everyone, but to develop spatial frameworks capable of supporting different ways of living. Several apartments deliberately avoid traditional enclosed bedroom structures in favour of more open and adaptable spatial organisations. While this creates opportunities for flexibility, it also introduces limitations regarding privacy and suitability for certain resident groups.

Throughout the process, compromises became necessary in order to balance preservation, housing quality, flexibility and technical performance. In several situations, daylight quality, openness, and the preservation of the building's architectural character were prioritised over maximising private floor area and efficiency. This became a defining architectural position within the project.

Technical and interdisciplinary aspects

The technical focus areas throughout the project were daylight performance, Life Cycle Assessment (LCA), and energy optimisation. These analyses became active design parameters rather than final technical validations added after the architectural design was completed. Daylight studies influenced the organisation of functions and spatial qualities within the dwellings, while energy optimisation and thermal investigations informed decisions regarding preservation strategies, insulation, and material use. Working with LCA also reinforced the environmental value of retaining large parts of the existing structure and reducing the need for demolition and new construction.

The project highlighted how architectural and engineering considerations continuously influence one another throughout the design process. Spatial ambitions regarding openness, atmosphere, and flexibility had to be balanced alongside technical, environmental, and regulatory requirements, creating a process where technical analyses directly shaped architectural decisions while architectural intentions simultaneously challenged technical limitations.

Learning outcomes and further perspectives

Throughout the design process, it became evident that transformation is not only about introducing new functions into an existing building, but about working with the structures and spatial qualities already present. The housing typologies therefore emerged largely as a consequence of the building's existing character rather than from a predetermined typological idea. Working with daylight, structure, access conditions, and spatial connections continuously influenced the project's development, making the process more complex, but also more site-specific. The absence of a fixed programme from the start, meant that a significant part of the early process was spent exploring different directions and defining the project's focus before more detailed development could begin. While this reduced the time available for later detailing, the process was necessary to understand which housing types and spatial qualities the building could support.

The process also revealed that compromises were necessary. In several situations, preserving the existing spatial qualities limited the possibility of creating more conventional and efficient housing layouts. Rather than following a conventional residential layout, the project consistently prioritised daylight quality, openness, and flexibility in use. This also meant accepting that some housing types would appeal to more specific resident groups rather than attempting to create universally applicable dwellings.

One of the most important insights gained through the project was the understanding that working with existing buildings requires a fundamentally different design approach than designing from a blank slate. Existing structures should not only be understood as constraints, but as active generators of spatial qualities, housing typologies, and architectural decisions. The project also demonstrated that flexibility in housing is not created through neutral spaces alone, but through carefully considered spatial relationships that allow for multiple forms of inhabitation over time.

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CHAPTER 12

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01 | MICROCLIMATE

Noise

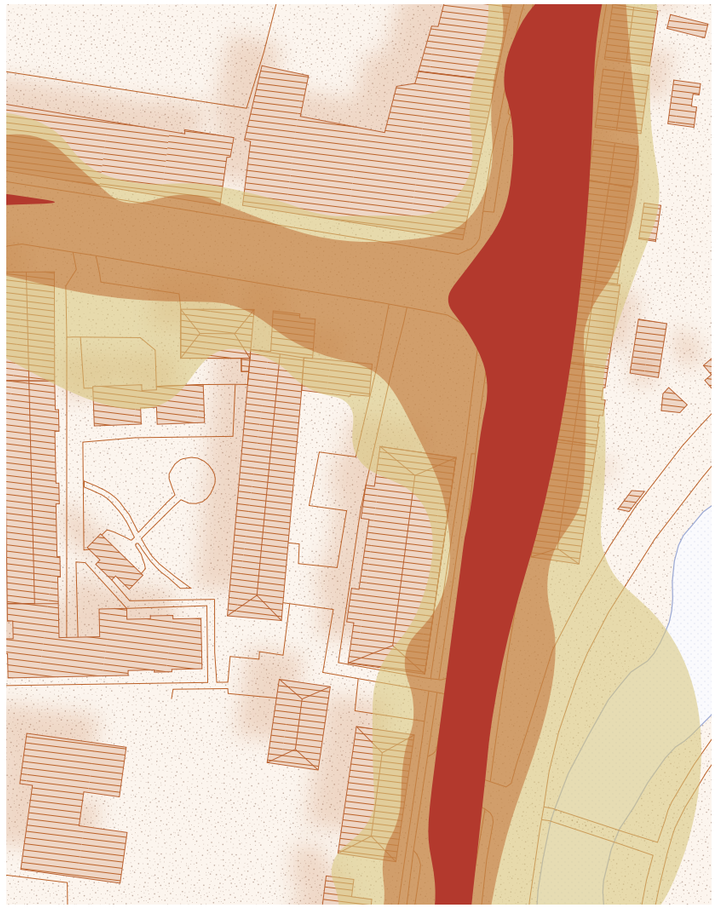


Fig. 164.
Noise

The analysis was conducted in Autodesk Forma (Autodesk, 2026).

Wind

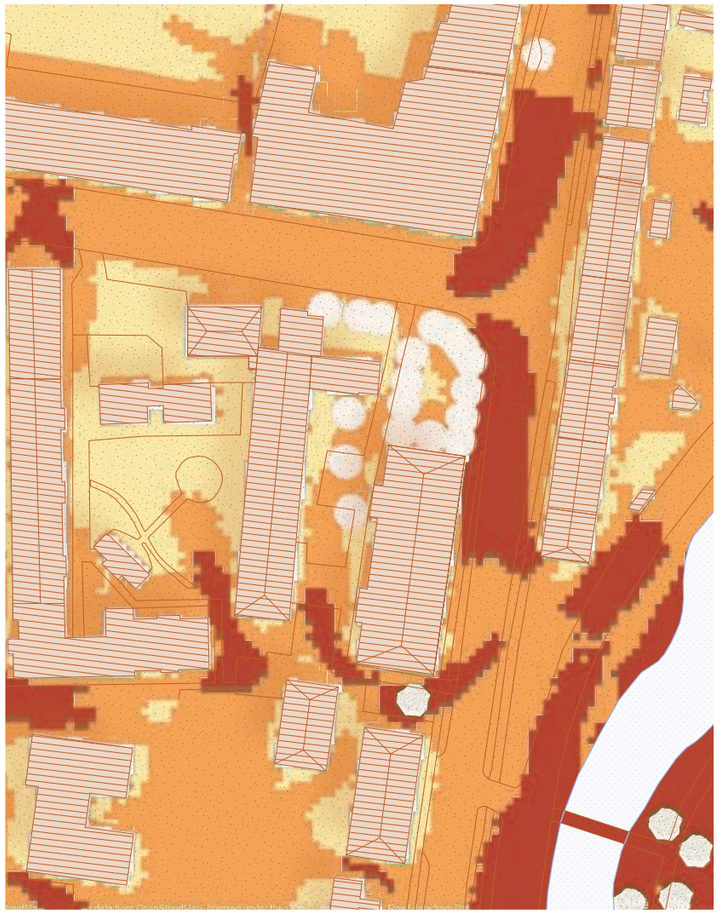


Fig. 165.
Wind

The analysis was conducted in Autodesk Forma (Autodesk, 2026).

02 | CURRENT FLOOR PLANS

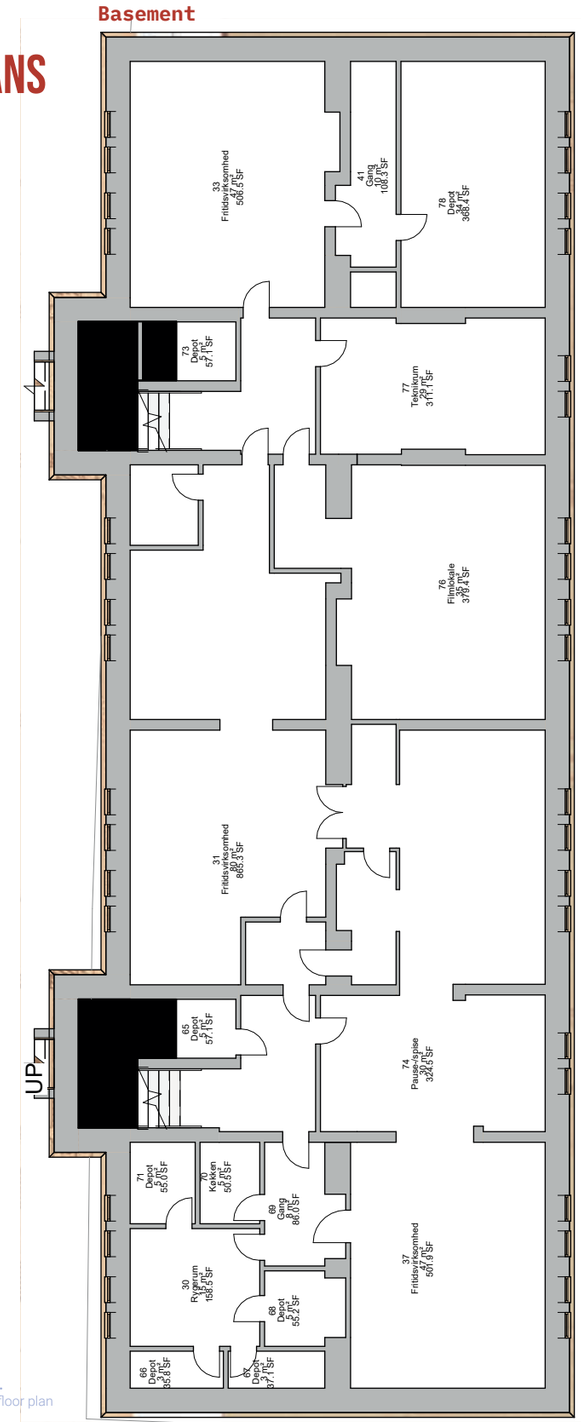


Fig. 166.
Current floor plan

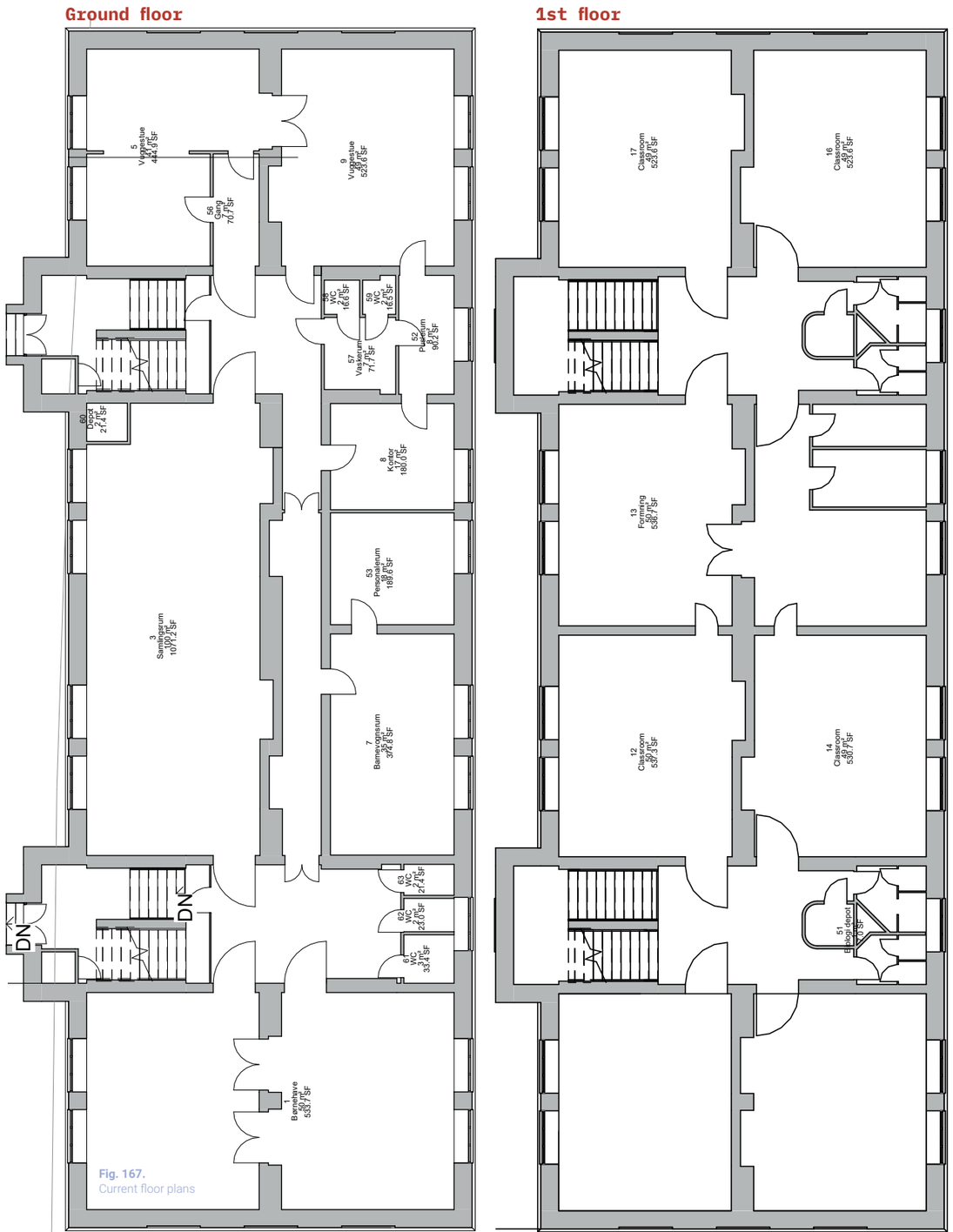
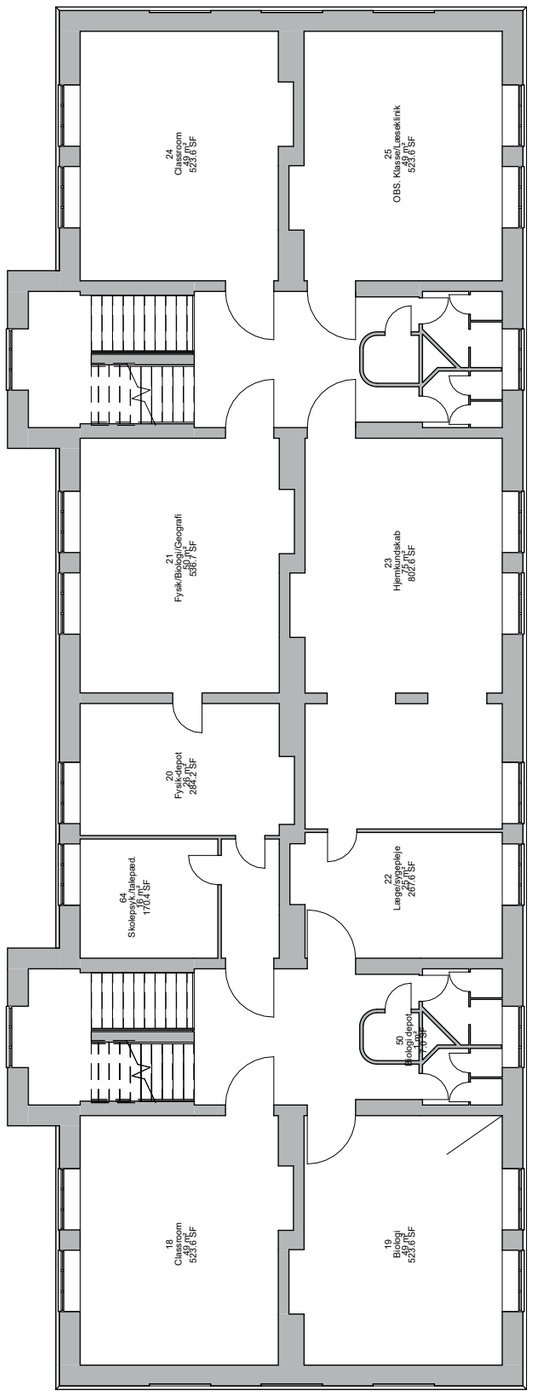
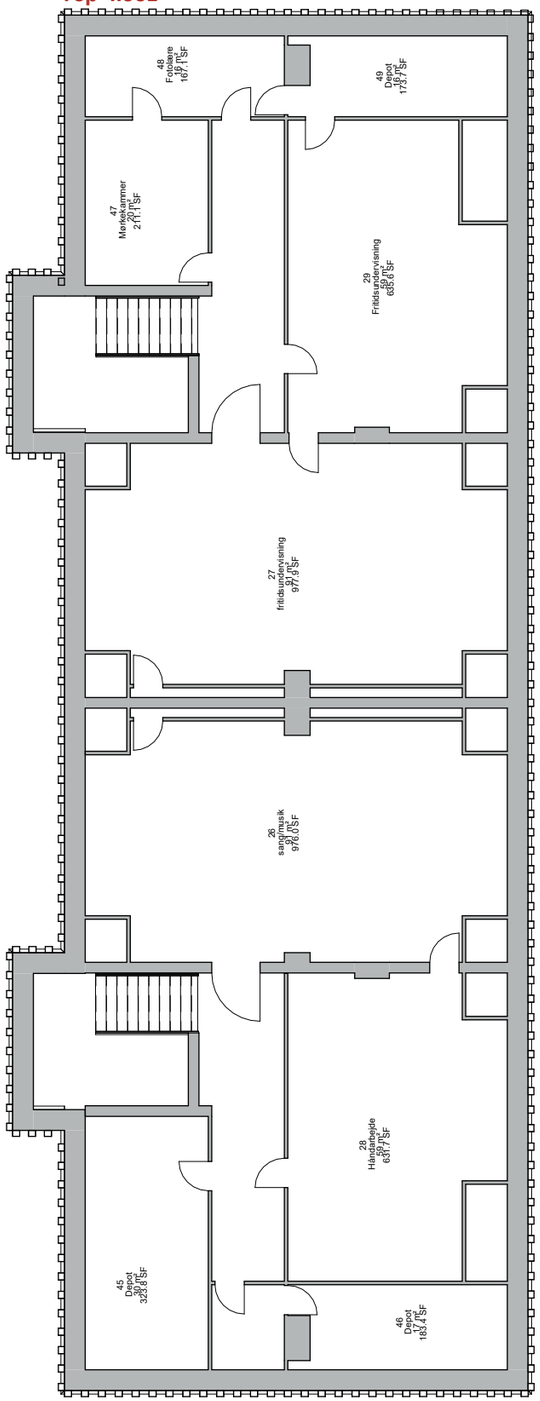


Fig. 167.
Current floor plans

2nd floor



Top floor



03 | EXISTING FACADES

South

North

West

Fig. 168.
Existing facade photos

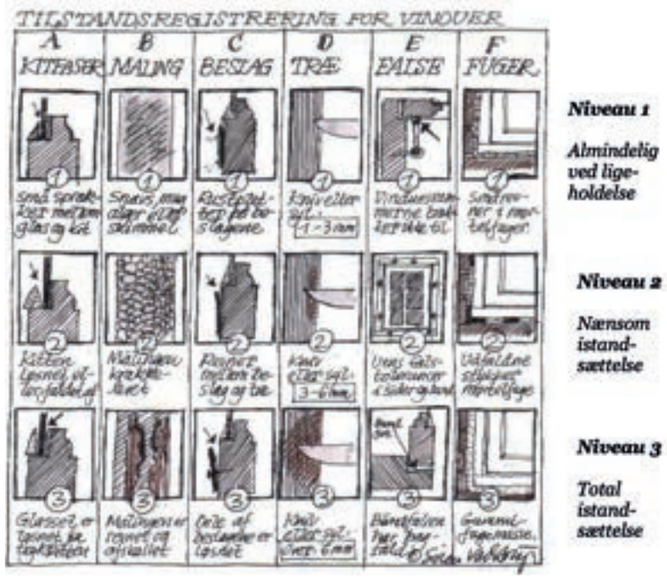
West

Fig. 170.
Existing west facade

East

Fig. 169.
Existing east facade

04 | ASSESSMENT OF WINDOW CONDITION



(Vadstrup, 2010, p. 2)

A	B	C	D	E	F
Glazing Putty	Paint Coating	Ironmongery	Timber	Frame/Rebate	Joints
2	3	1	1	2	2
Putty debonded or deteriorated	Coating failure with flaking and peeling	Corrosion (rust spots) on hardware	Knife/awl penetration: 1–3 mm (early decay)	Uneven clearances/tole-rances at jambs and sill	Localized damage in mortar/sea-lant joint

Fig. 171.
Assessment of window condition

05 | BE18 - KEY NUMBERS

Before transformation

Nøgletal, kWh/m² år

Renoveringsklasse 2

Uden tillæg	Tillæg for særlige betingelser	Samlet energiramme
95,7	0,0	95,7
Samlet energibehov		138,8

Renoveringsklasse 1

Uden tillæg	Tillæg for særlige betingelser	Samlet energiramme
71,8	0,0	71,8
Samlet energibehov		138,8

Energiramme BR 2018

Uden tillæg	Tillæg for særlige betingelser	Samlet energiramme
41,3	0,0	41,3
Samlet energibehov		138,8

Energiramme lavenergi

Uden tillæg	Tillæg for særlige betingelser	Samlet energiramme
33,0	0,0	33,0
Samlet energibehov		138,8

Bidrag til energibehovet

Varme	107,3
El til bygningsdrift	25,0
Overtemp. i rum	0,0

Netto behov

Rumopvarmning	96,7
Varmt brugsvand	5,3
Køling	0,0

Udvalgte elbehov

Belysning	25,0
Opvarmning af rum	0,0
Opvarmning af vbv	0,0
Varmepumpe	0,0
Ventilatorer	0,0
Pumper	0,0
Køling	0,0
Totalt elforbrug	32,3

Varmetab fra installationer

Rumopvarmning	3,9
Varmt brugsvand	0,0

Ydelse fra særlige kilder

Solvarme	0,0
Varmepumpe	0,0
Solceller	0,0
Vindmøller	0,0

Fig. 172.
Be18 results existing

After transformation

Nøgletal, kWh/m² år

Renoveringsklasse 2

Uden tillæg	Tillæg for særlige betingelser	Samlet energiramme
70,7	0,0	70,7
Samlet energibehov		69,9

Renoveringsklasse 1

Uden tillæg	Tillæg for særlige betingelser	Samlet energiramme
53,0	0,0	53,0
Samlet energibehov		69,9

Energiramme BR 2018

Uden tillæg	Tillæg for særlige betingelser	Samlet energiramme
30,3	0,0	30,3
Samlet energibehov		69,9

Energiramme lavenergi

Uden tillæg	Tillæg for særlige betingelser	Samlet energiramme
27,0	0,0	27,0
Samlet energibehov		69,9

Bidrag til energibehovet

Varme	73,1
El til bygningsdrift	4,1
Overtemp. i rum	0,0

Netto behov

Rumopvarmning	55,6
Varmt brugsvand	13,1
Køling	0,0

Udvalgte elbehov

Belysning	36,7
Opvarmning af rum	0,0
Opvarmning af vbv	0,0
Varmepumpe	0,0
Ventilatorer	4,1
Pumper	0,0
Køling	0,0
Totalt elforbrug	17,2

Varmetab fra installationer

Rumopvarmning	2,3
Varmt brugsvand	0,0

Ydelse fra særlige kilder

Solvarme	0,0
Varmepumpe	0,0
Solceller	0,0
Vindmøller	0,0

Fig. 173.
Be18 results transformation

06 | LCA

Wall construction comparison

Existing

wall			ronmental						calculation - decl. Unit				
	Product	Dimension	Gen. Dataset	Dеor	Decl l	A1-3	Decl C3	Decl C4	D	Calc quantity m3	Density [kg/m3]	Quantity decl unit	Weight/m2 wall ton
bevares	brick	585 mm	Teglsten, gule, rosé, brune eller lign.	1	ton	265,38	3,43	0,17	-2,38	0,47	1800	0,84	0,84
	joint mortar (fuge r	12 mm	Muremørtel, tør, kalk-cement (KC) (#	1	ton	366,30	2,98	19,69	-1,82	0,12	1660	0,19	0,19
	plaster (puds)	25 mm	Kalkmørtel (Kh, KKh) (#D1580)	1	ton	273,90	2,98	0,90	-1,82	0,03	1850	0,05	0,05
	paint	2 layers	Overflade, Vinduesmaling, hvid	1	kg	1,89	0,79	0,00	-0,21	0,00017	1500	0,2500	0,00025
SUM													
Adding insulation													
add-on	Klæbe mørtel	2 mm	Elementfugemørtel, tør, cement	1	ton	433,40	1,00	0,90	-1,85	0,0020	2150	0,00430	0,0043
	Porebeton	100 mm	Porebeton, isoleringsplade	1	m3	108,24	1,49	1,37	-11,16	0,10	115	0,10	0,01
	plaster (puds)	10 mm	Kalkmørtel (Kh, KKh) (#D1580)	1	ton	273,90	2,98	0,90	-1,82	0,010	1850	0,02	0,02
	paint	2 layers	Overflade, Vinduesmaling, hvid	1	kg	1,89	0,79	0,00	-0,21	0,00017	1500	0,2500	0,00025
SUM									-14,823				
add-on	Steel	1 mm	Stål, plade #D1595	1	ton	3432,00	2,73	0,00	-1737,00	0,00100	7850	0,0079	7,85
	Isolering	45 mm	Træfiberisolering(#G0012)	1	m3	-63,91	78,00	0,00		0,045	50	0,05	14,500
Væg ud til altan	Dampspærre	0,2 mm	Dampspærre PE (tykkelse 0,0002 m	1	m2	0,40	0,56	0,00	-0,23	0,0002	950	1,000	0,19
	Lægter	145 mm	Konstruktionstræ af nåletræ, Høvlet	1	m3	-652,00	709,00	0,00	-425,00	0,01	536	0,01	5,36
	Isolering	145 mm	Træfiberisolering(#G0012)	1	m3	-63,91	78,00	0,00		0,145	50	0,15	14,500
	Vindspærre	9 mm	Gipsplade, vindspærre	1	m2	1,84	0,04	0,56	-0,17	0,01	900	1,00	8,10
	Lægter	45 mm	Konstruktionstræ af nåletræ, Høvlet	1	m3	-652,00	709,00	0,00	-425,00	0,02	536	0,02	10,72
	Gips	12,5 mm	Gipsplade, brand	1	m2	3,89	0,14	0,56	-0,02	0,0125	1016	1	12,70
	paint	2 layers	Overflade, Vinduesmaling, hvid	1	kg	1,89	0,79	0,00	-0,21	0,00017	1500	0,2500	0,00025
SUM													
Adding insulation (study)													
1	Wood fiber insulati	200 mm	Træfiberisolering(#G0012)	1	m3	-63,909	78	0		0,1	50	0,2	14,500
	Spruce	190x45 mm	Konstruktionstræ af nåletræ, Høvlet (Fo	1	m3	-652	709	0	-		500	0,0171	8,550
	Dampspærre	0,2 mm	Dampspærre PE (tykkelse 0,0002 m	1	m2	0,40	0,56	0,00	-0,23	0,0002	950	1,000	0,19
	Wood fiber insulati	45 mm	Træfiberisolering(#G0012)	1	m3	-63,909	78	0		0,045	50	0,045	14,500
	Spruce	45x45 mm	Konstruktionstræ af nåletræ, Høvlet	1	m3	-652	709	0	-		500	0,0171	8,550
	Gips		Gipsplade, standard #D1515	1	m2	1,727	0,407	0,3685	-0,230	-	500	0,0171	8,550
SUM									-0,230				

calculated				transport				waste of 10%				
A1-3	C3	C4	D	Vehicel	Emissionfactor	Distance	A4 (inkl. waste)	Wastage factor	A5	Service life [years]	Replace-ments [number]	SUM:
	2,89	0,14	-2,00							100,00	0,00	brick 3,04
	0,58	3,82	-0,35							100,00	0,00	joint mortar (fuge mørtel) 4,40
	0,14	0,04	-0,08							100,00	0,00	plaster (puds) 0,18
	0,20	0,00	0,00	Standard	8,97E-05	200,00	0,00	0,10	0,00	20,00	2,00	paint 0,59
0,000	3,804	4,011	-2,439				0,00		0,00			Total: 8,21
0,000	45822,543	5885,488										
1,86	0,00	0,00	-0,01	Standard	8,97E-05	100,00	0,00004	0,10	0,19	50,00	0,00	Klæbe mørtel 2,06
10,82	0,15	0,14	-0,13	Standard	8,97E-05	50,00	0,0001	0,10	1,08	100,00	0,00	Porebeton 12,19
5,07	0,06	0,02	-0,03	Standard	8,97E-05	100,00	0,0002	0,10	0,51	120,00	0,00	plaster (puds) 5,65
	0,20	0,00	0,00	Standard	8,97E-05	200,00	0,00	0,10	0,00	20,00	2,00	paint 0,59
17,755	0,208	0,157	-0,170				0,00028		1,78			Total: 19,90
18136,498												
	0,02	0,00	-13,64	Truck max	8,97E-05	200,00	0,14	0,10	2,69	50,00	0,00	Steel 29,80
-2,876	3,510	0,000		Standard	8,97E-05	539,00	0,7712	0,10	-0,29	50,000	0,000	1,12
0,40	0,56	0,00	-0,23	Truck max	8,97E-05	128,00	0,00	0,10	0,04	50,00	0,00	Dampspærre 0,99
-3,49	3,80	0,00	-2,28	Truck max	8,97E-05	36,40	0,02	0,10	-0,35	50,00	0,00	Lægter -0,03
-9,267	11,310	0,000		Standard	8,97E-05	539,00	0,7712	0,10	-0,93	50,000	0,000	1,89
1,84	0,04	0,56	-0,17	Truck max	8,97E-05	200,00	0,15	0,10	0,18	50,00	0,00	Vindspærre 2,76
-13,04	14,18	0,00	-8,50	Truck max	8,97E-05	36,40	0,04	0,10	-1,30	50,00	0,00	Lægter -0,13
3,89	0,14	0,56	-0,02	Truck max	8,97E-05	150,00	0,17	0,10	0,39	50,00	0,00	Gips 5,16
	0,20	0,00	0,00	Standard	8,97E-05	200,00	0,00	0,10	0,00	20,00	2,00	paint 0,59
4,390	33,557	1,122	-24,830				2,05		0,44			Total: 41,56
-12,782	15,600	0,000		Standard	8,97E-05	539	0,7712	0,1	-1,28	50,000	0,000	Wood fiber insulation blow 2,31
-11,149	12,124	0,000		Standard	8,97E-05	90,2	0,0761	0,1	-1,11	50,000	0,000	Spruce -0,06
0,395	0,556	0,000	-0,23	Truck max	8,97E-05	298,00	0,0056	0,10	0,04	50,000	0,000	Dampspærre 1,00
-2,876	3,510	0,000		Standard	8,97E-05	539	0,7712	0,1	-0,29	50,000	0,000	Wood fiber insulation blow 1,12
-11,149	12,124	0,000		Standard	8,97E-05	90,2	0,0761	0,1	-1,11	50,000	0,000	Spruce -0,06
0,030	0,007	0,006	-0,230	Standard	8,97E-05	90,2	0,0761	0,1	0,00	50,000	0,000	Gips 0,12
-13,996	15,641	0,006	-0,230				0,9233		-1,40			Total: 4,42

Fig. 174. External wall

GWP - Materials inside

			environmental data						calculation - decl. Unit					calculated				transport					waste of 10%					SUM:	
	Product	Dimensio	Gen. Dataset	De	Decl	Decl A1-3	Decl C3	Decl C4	D	Calc quantity m3	Density [kg/m3]	Quantity decl unit	Weight/m2 wall ton	A1-3	C3	C4	D	Vehicel	Emission factor	Distance	A4 (inkl. waste)	Wastage factor	A5	Service life [years]	Replace-ments [number]		
Vægge																													
gips væg	Gips	12,5 mm	Gipsplade, brand	1	m2	3,89	0,14	0,56	-0,02	0,0125	1016	1	12,70	3,89	0,14	0,56	-0,02	Truck max	8,97E-05	150,00	0,17	0,10	0,39	50,00	0,00	Gips	5,16
	paint	2 layers	Overflade, Vinduesmaling, hvid	1	kg	1,89	0,79	0,00	-0,21	0,00017	1500	0,2500	0,25	0,47	0,20	0,00	-0,05									paint	0,67
SUM														4,367	0,339	0,561	-0,072				0,171		0,389			Total:	5,83
krydsfiner	Plywood	12 mm	Krydsfiner, ubehandlet	1	m³	-599,00	743,00	0,00	-391,00	0,0125	480	0,0125	6,00	-7,49	9,29	0,00	-4,89	Truck max	8,97E-05	150,00	0,08	0,10	-0,75	50,00	0,00	Plywood	1,13
SUM														-7,488	9,288	0,000	-4,888				0,081		-0,749			Total:	1,13
lud krydsfiner	Plywood	12 mm	Krydsfiner, ubehandlet	1	m³	-599,00	743,00	0,00	-391,00	0,0125	480	0,0125	6,00	-7,49	9,29	0,00	-4,89	Truck max	8,97E-05	150,00	0,08	0,10	-0,75	50,00	0,00	Plywood	1,13
	lud	1 lag	Overflade, Parket lak transparent	1	kg	1,91	0,91	0,00	-0,20	0,100	50	0,100	0,10	0,19	0,09	0,00	-0,02	Standard	8,97E-05	50,00	0,0005	0,10	0,02	100,00	0,00	lud	0,30
SUM														-7,296	9,379	0,000	-4,907				0,08		-0,73			Total:	1,43
														-7452,94													
Gulve																											
trægulv slibes	Gulv behandling	1 lag	Overflade, Parket lak (primer til træ; fo	1	kg	3,38	0,91	0	-0,20	0,100	50	0,100	0,10	0,34	0,09	0,00		Truck max	8,97E-05	500,00	0,005	0,10	0,0338	15	3	Gulv behandling	1,872
SUM														-7452,60	0,091	0,000	0,000				0,005		0,034			Total:	1,87
trægulv slibes	Gulv behandling	1 lag	Overflade, Parket lak (primer til træ; fo	1	kg	3,38	0,91	0	-0,20	0,100	50	0,100	0,10	0,34	0,09	0,00		Truck max	8,97E-05	500,00	0,005	0,10	0,0338	15	3	Gulv behandling	1,872
lud trægulv	lud	1 lag	Overflade, Parket lak transparent	1	kg	1,91	0,91	0,00	-0,20	0,100	50	0,100	0,10	0,19	0,09	0,00	-0,02	Truck max	8,97E-05	50,00	0,0005	0,10	0,02	100,00	0,00	lud	0,30
SUM														0,529	0,183	0,000	-0,020				0,01		0,05			Total:	2,17
Lofter																											
maling af akustik	Metal primer	1 lag	Primere og bindere	1	kg	2,90	0,47	0,00	-0,31	0,100	20	0,100	0,10	0,29	0,05	0,00		Truck max	8,97E-05	400,00	0,004	0,10	0,0290	20	2	Metal primer	1,112
	Metal maling	2 lag	Metalllack (lösemittelbasiert) #G099	1	kg	2,22	0,14	0,00	-0,03	0,100	0,21	0,100	0,02	0,22	0,01	0,00		Truck max	8,97E-05	400,00	0,001	0,10	0,02	20	2	Metal maling	0,779
SUM														0,513	0,062	0,000	0,000				0,00		0,05			Total:	0,78
troldtekt	Troldtekt	1 m2	Akustikpanel, træbeton, umalet	1	m²	1,66	0,00	11,11	-0,50	0,02	460	1,00	1,00	1,66	0,00	11,11	-0,50	Truck max	8,97E-05	50,00	0,0049	0,10	0,17	100,00	0,00	Troldtekt	12,94
SUM														1,658	0,000	11,110	-0,501				0,00		0,17			Total:	12,94
gips	Gips	12,5 mm	Gipsplade, brand	1	m2	3,89	0,14	0,56	-0,02	0,0125	1016	1	12,70	3,89	0,14	0,56	-0,02	Truck max	8,97E-05	150,00	0,17	0,10	0,39	50,00	0,00	Gips	5,16
SUM														5,552	0,143	11,671	-0,522				0,17		0,39			Total:	5,16
krydsfiner	Plywood	12 mm	Krydsfiner, ubehandlet	1	m³	-599,00	743,00	0,00	-391,00	0,0125	480	0,0125	6,00	-7,49	9,29	0,00	-4,89	Truck max	8,97E-05	150,00	0,08	0,10	-0,75	50,00	0,00	Plywood	1,13
SUM														-7,488	9,288	0,000	-4,888				0,08		-0,75			Total:	1,13

Fig. 175. Materials inside

GWP - Floor slab

Existing

	floor slaps		environta					calculation - decl. Unit					calculated				transport				waste of 10%				
	Product	Dimension	Gen. Dataset	Decl	Decl unit	Decl A1-3	Decl C3	Decl C4	D	Calc quantity m3	Density [kg/m3]	Quantity decl unit	Weight/m2 wall KG	A1-3	C3	C4	D	Vehicel	Emissionfactor	Distance	A4 (inkl. waste)	Wastage factor	A5	Service life [years]	Replace-ments [number]	SUM:
bevares	Linoleum	25 mm	Linoleum gulvbelægning (tyk	1	m2	4,08	4,44	0,00	-1,36	0,003	1200	1,00	3,00		4,44	0,00	-1,36							50	0	Linolium 4,44
	Trægulv	20 mm	Trægulv, stavparket, 22 mm	1	m2	-13,82	21,03	0,00	-5,90	0,02	575	1,00	11,50		21,03	0,00	-5,90							50	0	Gulv 21,03
	Kalkmørtel (afretning)	30 mm	Kalkmørtel (Kh, KKh) (#D158	1	ton	273,90	2,98	0,90	-1,82	0,03	1660	0,05	49,80		0,15	0,05	-0,09							50	0	Kalkmørtel (afre 0,56
	Uarmeret beton	80 mm	Fabriksbeton (C20/25 SCC)	1	m3	215,00	6,94	5,13	-4,74	0,08	2212	0,08	176,96		0,56	0,41	-0,38							50	0	Uarmeret beton 0,97
	I-bjælker	100 mm	Konstruktionsstål, valsede	1	ton	1639,00	52,58	45,87	-284,40	0,00003	7850	0,00025	0,25		0,01	0,01	-0,07							50	0	I-bjælker 0,02
	Stål loftplader	0,6 mm	Stål, plade #D1595	1	ton	3432,00	2,73	0,00	-1737,00	0,00300	7850	0,0236	23,55		0,06	0,00	-40,91							50	0	Stål loftplader 0,06
SUM														0,000	26,250	0,467	-47,345				0,00		0,00			Total: 27,08
Apartment floor																										
add-on	Gulv behandling	1 lag	Overflade, Parket lak (primer til	1	kg	3,38	0,91	0	-0,20	0,100	50	0,100	0,10	0,34	0,09	0,00		Standard	8,97E-05	500,00	0,005	0,10	0,0338	15	3	Gulv behandling 1,872
	Metal primer	1 lag	Primere og bindere	1	kg	2,90	0,47	0,00	-0,31	0,100	20	0,100	0,10	0,29	0,05	0,00		Standard	8,97E-05	400,00	0,004	0,10	0,0290	20	2	Metal primer 1,112
	Metal maling	2 lag	Metalllack (lösemittelbasiert)	1	m2	2,22	0,14	0,00	-0,03	1,00	0,21	1,00	0,21	2,22	0,14	0,00		Standard	8,97E-05	400,00	0,008	0,10	0,22	20	2	Metal maling 7,792
SUM														2,851	0,283	0,000	0,000				0,017		0,285			Total: 10,78
Raised floor at top floor level																										
add-on	Konsturktionstræ i grid	400 mm	Konstruktionstræ af nåletræ,	1	m3	-652,00	709,00	0,00	-425,00	0,04	536	0,04	20,37	-24,78	26,94	0,00	-16,15	Standard	8,97E-05	36,40	0,07	0,10	-2,48	50	0	Konsturktionstra -0,24
	Isolering	200 mm	Træfiberisolering(#G0012)	1	m3	-63,909	78	0		0,2	50	0,2	14,500	-12,782	15,600	0,000	0,00	Standard	8,97E-05	539	0,77	0,10	-1,28	50	0	Isolering 2,31
	Gulvspånplader	12 mm	Spanplatte (generisch) #G07	1	m3	-852,1	1361	0	-290,7	0,012	700	0,012	8,400	-10,225	16,332	0,000	-3,49	Standard	8,97E-05		0,00	0,10	-1,02	50	0	Gulvspånplader 5,08
	Trægulv	12 mm	Stabparkett (generisch) #G1	1	m²	-13,82270178	21,026366	0	-5,897454539	0,012	11,5	1,000	11,500	-13,823	21,026	0,000	-5,90	Standard	8,97E-05		0,00	0,10	-1,38	30	1	Trægulv 11,64
SUM														-61,606	79,900	0,000	-25,536				0,844		-6,161			Total: 18,80
Balcony floor																										
add-on	Kalkmørtel (afretning)	20 mm	Kalkmørtel (Kh, KKh) (#D158	1	ton	273,90	2,98	0,90	-1,82	0,02	1660	0,03	33,20	9,09	0,10	0,03	-0,06	Standard	8,97E-05	10,00	0,03	0,1	0,91	100	0	Kalkmørtel (afret 10,16
	Vandtæt membran, tagpap	2 mm	Tagpap, bitumen toplag, skife	1	m2	4,98	0,00	0,52	0,00	0,002	3100	1,00	6,20	4,98	0,00	0,52	0,00	Standard	8,97E-05	539	0,33	0,1	0,50	50	0	Vandtæt membra 6,34
	Drænlag/gummimåtte	20 mm	Spanplatte (generisch) #G07	1	m3	-852,1	1361	0	-290,7	0,012	700	0,012	8,400	-10,225	16,332	0,000	-3,49	Standard	8,97E-05	200	0,17	0,1	-1,02	100	0	Drænlag/gummi 5,25
	opkldosning	4 stk		1	kg	3,57	0,21	0,00	-	-		4,00	4,00	14,28	0,85	0,02	0,00	Standard	8,97E-05	500	0,20	0,1	1,43	100	0	opkldosning 16,77
	Lægter	45 mm	Konstruktionstræ af nåletræ,	1	m3	-652,00	709,00	0,00	-425,00	0,004	536	0,004	2,17	-2,64	2,87	0,00	-1,72	Standard	8,97E-05	36,40	0,01	0,1	-0,26	30	1	Lægter -0,05
	Terrassebrædder	25 mm	Stabparkett (generisch) #G1	1	m²	-13,82270178	21,026366	0	-5,897454539	0,012	11,5	1,000	11,500	-13,823	21,026	0,000	-5,90	Standard	8,97E-05	200,0	0,23	0,1	-1,38	30	1	Terrassebrædder 12,10
SUM														1,670	41,177	0,572	-11,167				0,960		0,167			Total: 50,57

Fig. 176. Floor slab

GWP - Foundation

Existing

	foundation		environmental data						calculation - decl. Unit					calculated				transport				waste of 10%				
	Product	Dimension	Gen. Dataset	Decl factor	Decl unit	Decl A1-3	Decl C3	Decl C4	D	Calc quantity m3	Density [kg/m3]	Quantity decl unit	Weight wall KG	A1-3	C3	C4	D	Vehicel	Emissionfactor	Distance	A4 (inkl. waste)	Wastage factor	A5	Service life [years]	Replace-ments [number]	SUM:
bevares	Klinker	10 mm	Keramikfliser, g	1	m2	6,04	0,15	0,00	-0,03	0,01	2000	1,00			0,15	0,00	-0,58	Standard	8,97E-05	500,00	0,987	0,10	0,0000	30	1	Klinker 2,27
	Kalkmørtel (afretning)	30 mm	Kalkmørtel (Kh,	1	ton	273,90	2,98	0,90	-1,82	0,03	1660	0,05			0,15	0,05	-90,54	Standard	8,97E-05	500,00	2,457	0,10	0,0000	30	1	Kalkmørtel (afre 6,44
	Uarmeret beton	120 mm	Fabriksbeton	1	m3	215,00	6,94	5,13	-4,74	0,12	2212	0,12			0,83	0,62	-1258,19									Uarmeret beton 1,45
	Kappilarbrydende lag	200 mm	Grus 2-32 mm	1	kg	0,03	0,01	0,00	0,00	0,20	1850	370,00			2,74	0,00	-0,53									Kappilarbryden 2,74
SUM														0,000	3,864	0,661	-1349,256									Total: 4,52

Fig. 177. Foundation

GWP - Roof

Existing

	roof		environmental data						calculation - decl. Unit					calculated				transport				waste of 10'				
	Product	Dimension	Gen. Dataset	Decl factor	Decl unit	Decl A1-3	Decl C3	Decl C4	D	Calc quantity m3	Density [kg/m3]	Quantity decl unit	Weight/m2 wall kg	A1-3	C3	C4	D	Vehicel	Emissionfactor	Distance	A4 (inkl. waste)	Wastage factor	A5	Service life [years]	Replace-ments [number]	SUM:
bevares	Tagpap	2 mm	Tagpap, bitum	1	m2	4,98	0,00	0,52	0,00	0,002	3100	1,00	6,20		0,00	0,52	0,00							50	0	Tagpap 0,52
	Fast underlag ((	20 mm	Krydsfiner, ub	1	m3	-599,00	743,00	0,00	-391,00	0,02	480	0,02	9,60		14,86	0,00	-7,82							50	0	Fast underlag (plader) 14,86
	Eternitskifre	4 mm	Fibercement,	1	ton	901,35	0,00	17,41	0,00	0,004	1590	0,006	6,36		0,00	0,11	0,00							50	0	Eternitskifre 0,11
	Lægter	45 mm	Konstruktions	1	m3	-652,00	709,00	0,00	-425,00	0,01	536	0,01	5,36		3,80	0,00	-2,28							50	0	Lægter 3,80
	Hanebåndsspæ	100 mm	Konstruktions	1	m3	-652,00	709,00	0,00	-425,00	0,02	536	0,02	10,72		14,18	0,00	-8,50							50	0	Hanebåndsspær 14,18
	Isolering	100 mm	Mineraluld, fle	1	m2	1,55	0,00	0,03	0,00	0,100	60	0,33	6,00		0,00	0,01	0,00							50	0	Isolering 0,01
	Dampspærre	0,2 mm	Dampspærre	1	m2	0,40	0,56	0,00	-0,23	0,0002	950	1,000	0,19		0,56	0,00	-0,23							50	0	Dampspærre 0,56
	Gips	12,5 mm	Gipsplade,	1	m2	3,89	0,14	0,56	-0,02	0,0125	1016	1	12,70		0,14	0,56	-0,02							50	0	Gips 0,70
	paint	2 layers	Overflade,	1	kg	1,89	0,79	0,00	-0,21	0,00017	1500	0,2500	0,00025		0,20	0,00	0,00	Standard	8,97E-05	200,00	0,00	0,10	0,00	20,00	2,00	paint 0,59
SUM														0,000	33,539	1,205	-18,848				0,00		0,00			Total: 34,74

Fig. 178. Roof

GWP - Internal walls

Existing

internal wall			environmental data						calculation - decl. Unit					calculated				transport				waste of 10%					
	Product	Dimension	Gen. Dataset	Decl factor	Decl unit	Decl A1-3	Decl C3	Decl C4	D	Calc quantity m3	Density [kg/m3]	Quantity decl unit	Weight/m2 wall ton	A1-3	C3	C4	D	Vehicel	Emissionfactor	Distance	A4 (inkl. waste)	Wastage factor	A5	Service life [years]	Replace-ments [number]	SUM:	
bevares	paint	2 layers	Overflade,	1 kg		1,89	0,79	0,00	-0,21	0,00017	1500	0,2500	0,00025		0,20	0,00	0,00	Standard	8,97E-05	200,00	0,00	0,10	0,00	20,00	2,00	paint	0,59
	plaster (puds)	25 mm	Kalkmørtel (Kh,	1 ton		273,90	2,98	0,90	-1,82	0,03	1850	0,05	0,05		0,14	0,04	-0,08									plaster (puds)	0,18
	brick	348 mm	Teglsten, gule,	1 ton		265,38	3,43	0,17	-2,38	0,28	1800	0,50	0,50		1,72	0,09	-1,19									brick	1,81
	joint mortar (fug	12 mm	Muremørtel, tør	1 ton		366,30	2,98	19,69	-1,82	0,07	1660	0,12	0,12		0,34	2,27	-0,21									joint mortar (fug	0,39
	plaster (puds)	25 mm	Kalkmørtel (Kh,	1 ton		273,90	2,98	0,90	-1,82	0,03	1850	0,05	0,05		0,14	0,04	-0,08									plaster (puds)	0,18
	paint	2 layers	Overflade,	1 kg		1,89	0,79	0,00	-0,21	0,00017	1500	0,2500	0,00025		0,20	0,00	0,00	Standard	8,97E-05	200,00	0,00	0,10	0,00	20,00	2,00	paint	0,59
SUM														0,000	2,399	2,403	-1,485				0,00		0,00			Total:	4,80

new internal addition walls			environmental data						calculation - decl. Unit					calculated				transport				waste of 10%					
	Product	Dimension	Gen. Dataset	Decl factor	Decl unit	Decl A1-3	Decl C3	Decl C4	D	Calc quantity m3	Density [kg/m3]	Quantity decl unit	Weight/m2 wall kg	A1-3	C3	C4	D	Vehicel	Emissionfactor	Distance	A4 (inkl. waste)	Wastage factor	A5	Service life [years]	Replace-ments [number]	SUM:	
bevares	paint	2 layers	Overflade,		1 kg	1,89	0,79	0,00	-0,21	0,00017	1500	0,2500	0,25		0,20	0,00	-0,05	Standard	8,97E-05	200,00	0,00	0,10	0,00	20,00	2,00	paint	0,60
	Gips	12,5 mm	Gipsplade,		1 m2	1,73	0,41	0,37	-0,02	0,0125	1016	1	12,70		0,41	0,37	-0,26									plaster (puds)	0,78
	Isolering	45 mm	Mineraluld, flek		1 m2	1,55	0,00	0,03	0,00	0,045	60	1,50	2,70		0,00	0,05	0,00									Isolering	0,05
	Lægter	45*45 mm	Konstruktionstra		1 m3	-652,00	709,00	0,00	-425,00	0,01	536	0,01	5,36		3,80	0,00	-2278,00									joint mortar (fug	4,17
	Gips	12,5 mm	Gipsplade,		1 m2	1,73	0,41	0,37	-0,02	0,0125	1016	1	12,70		0,41	0,37	-0,26									plaster (puds)	0,78
	paint	2 layers	Overflade,		1 kg	1,89	0,79	0,00	-0,21	0,00017	1500	0,2500	0,25		0,20	0,00	-0,05	Standard	8,97E-05	200,00	0,00	0,10	0,00	20,00	2,00	paint	0,60
SUM														0,000	5,007	0,784	-2278,631									Total:	5,79

internal load bearing			environmental data						calculation - decl. Unit					calculated				transport				waste of 10%					
	Product	Dimension	Gen. Dataset	Decl factor	Decl unit	Decl A1-3	Decl C3	Decl C4	D	Calc quantity m3	Density [kg/m3]	Quantity decl unit	Weight/m2 wall ton	A1-3	C3	C4	D	Vehicel	Emissionfactor	Distance	A4 (inkl. waste)	Wastage factor	A5	Service life [years]	Replace-ments [number]	SUM:	
bevares	paint	2 layers	Overflade,		1 kg	1,89	0,79	0,00	-0,21	0,00017	1500	0,2500	0,00025		0,20	0,00	0,00	Standard	8,97E-05	200,00	0,00	0,10	0,00	20,00	2,00	paint	0,59
	plaster (puds)	25 mm	Kalkmørtel (Kh,		1 ton	273,90	2,98	0,90	-1,82	0,03	1850	0,05	0,05		0,14	0,04	-0,08									plaster (puds)	0,18
	brick	520 mm	Teglsten, gule,		1 ton	265,38	3,43	0,17	-2,38	0,42	1800	0,75	0,75		2,57	0,13	-1,78									brick	2,70
	joint mortar (fug	12 mm	Muremørtel, tør		1 ton	366,30	2,98	19,69	-1,82	0,10	1660	0,17	0,17		0,51	3,40	-0,31									joint mortar (fug	0,56
	plaster (puds)	25 mm	Kalkmørtel (Kh,		1 ton	273,90	2,98	0,90	-1,82	0,03	1850	0,05	0,05		0,14	0,04	-0,08									plaster (puds)	0,18
	paint	2 layers	Overflade,		1 kg	1,89	0,79	0,00	-0,21	0,00017	1500	0,2500	0,00025		0,20	0,00	0,00	Standard	8,97E-05	200,00	0,00	0,10	0,00	20,00	2,00	paint	0,59
SUM														0,000	3,423	3,570	-2,180				0,00		0,00			Total:	6,99

Internal apartment partition wall

internal load bearing			environmental data						calculation - decl. Unit					calculated				transport				waste of 10%					
	Product	Dimension	Gen. Dataset	Decl factor	Decl unit	Decl A1-3	Decl C3	Decl C4	D	Calc quantity m3	Density [kg/m3]	Quantity decl unit	Weight/m2 wall ton	A1-3	C3	C4	D	Vehicel	Emissionfactor	Distance	A4 (inkl. waste)	Wastage factor	A5	Service life [years]	Replace-ments [number]	SUM:	
add-on	paint	2 layers	Overflade,		1 kg					0,00017	1500	0,2500	0,00025		0,20	0,00	0,00	Standard	8,97E-05	200,00	0,00	0,10	0,00	20,00	2,00	paint	0,59
	Gips	2 lag	Gipsplade, stan		1 m2					0,025	600	2,00	15,00	3,45	0,81	0,74		Standard	8,97E-05	90,20	0,13	0,10	0,35	120,00	0,00	Gips	5,48
	Wood fiber insul	70 mm	Træfiberisolering		1 m3	-63,91	78,00	0,00		0,070	50	0,070	3,50	-4,47	5,46	0,00		Standard	8,97E-05	539,00	0,19	0,10	-0,45	100,00	0,00	Wood fiber insu	0,73
	Spruce	70x45 mm	Konstruktionstra		1 m3	-652,00	709,00	0,00		0,006	536	0,02	3,38	-11,15	12,12	0,00		Standard	8,97E-05	90,20	0,03	0,10	-1,11	120,00	0,00	Spruce	-0,11
	Gips	2 lag	Gipsplade, stan		1 m2					0,025	600	2,00	15,00	3,45	0,81	0,74		Standard	8,97E-05	90,20	0,13	0,10	0,35	120,00	0,00	Gips	5,48
	paint	2 layers	Overflade,		1 kg	1,89	0,79	0,00	-0,21	0,00017	1500	0,2500	0,00025		0,20	0,00	0,00	Standard	8,97E-05	200,00	0,00	0,10	0,00	20,00	2,00	paint	0,59
SUM														-8,715	19,212	1,474	0,000				0,48		-0,87			Total:	11,58

Wall between apartment and stairwell

internal load bearing			environmental data						calculation - decl. Unit					calculated				transport				waste of 10%					
	Product	Dimension	Gen. Dataset	Decl factor	Decl unit	Decl A1-3	Decl C3	Decl C4	D	Calc quantity m3	Density [kg/m3]	Quantity decl unit	Weight/m2 wall ton	A1-3	C3	C4	D	Vehicel	Emissionfactor	Distance	A4 (inkl. waste)	Wastage factor	A5	Service life [years]	Replace-ments [number]	SUM:	
add-on	paint	2 layers	Overflade,		1 kg					0,00017	1500	0,2500	0,00025		0,20	0,00	0,00	Standard	8,97E-05	200,00	0,00	0,10	0,00	20,00	2,00	paint	0,59
	Gips	2 lag	Gipsplade, stan		1 m2					0,025	600	2,00	15,00	3,45	0,81	0,30		Standard	8,97E-05	90,20	0,13	0,10	0,35	120,00	0,00	Gips	5,05
	Wood fiber insul	95 mm	Træfiberisolering		1 m3	-63,91	78,00	0,00		0,095	50	0,095	4,75	-6,07	7,41	0,00		Standard	8,97E-05	539,00	0,25	0,10	-0,61	100,00	0,00	Wood fiber insu	0,98
	Spruce	95x45 mm	Konstruktionstra		1 m3	-652,00	709,00	0,00		0,009	536	0,02	4,58	-11,15	12,12	0,00		Standard	8,97E-05	90,20	0,04	0,10	-1,11	120,00	0,00	Spruce	-0,10
	paint	2 layers	Overflade,		1 kg	1,89	0,79	0,00	-0,21	0,00017	1500	0,2500	0,00025		0,20	0,00	0,00	Standard	8,97E-05	200,00	0,00	0,10	0,00	20,00	2,00	paint	0,59
SUM																										Total:	6,52
						-13,767	20,544	0,300	0,000												0,43		-1,38				

Apartment bathroom partition wall

internal load bearing			environmental data						calculation - decl. Unit					calculated				transport				waste of 10%					
	Product	Dimension	Gen. Dataset	Decl factor	Decl unit	Decl A1-3	Decl C3	Decl C4	D	Calc quantity m3	Density [kg/m3]	Quantity decl unit	Weight/m2 wall ton	A1-3	C3	C4	D	Vehicel	Emissionfactor	Distance	A4 (inkl. waste)	Wastage factor	A5	Service life [years]	Replace-ments [number]	SUM:	
add-on	paint	2 layers	Overflade,		1 kg	1,89	0,79	0,00	-0,21	0,00017	1500	0,2500	0,00025		0,20	0,00	0,00	Standard	8,97E-05	200,00	0,00	0,10	0,00	20,00	2,00	paint	0,59
	Vådrums gips	2 lag	Gipsplade, vådı		1 m2	3,50	0,05	0,69	-0,21	0,025	600	2,00	0,02	7,00	0,11	0,07		Standard	8,97E-05	90,20	0,00	0,10	0,70	120,00	0,00	Vådrums gips	7,88
	Wood fiber insul	70 mm	Træfiberisolering		1 m3	-63,91	78,00	0,00		0,070	50	0,070	3,50	-4,47	5,46	0,00		Standard	8,97E-05	539,00	0,19	0,10	-0,45	100,00	0,00	Wood fiber insu	0,73
	Spruce	95x45 mm	Konstruktionstra		1 m3	-652,00	709,00	0,00		0,009	536	0,02	0,00	-11,15	12,12	0,00		Standard	8,97E-05	90,20	0,00	0,10	-1,11	120,00	0,00	Spruce	-0,14
	Vådrums gips	2 lag	Gipsplade, vådı		1 m2	3,50	0,05	0,69	-0,21	0,025	600	2,00	0,02	7,00	0,11	0,07		Standard	8,97E-05	90,20	0,00	0,10	0,70	120,00	0,00	Vådrums gips	7,88
	Fliseklæb	2 mm	Mørtel, fliseklæ		1 kg	1,50	0,47	0,02	-0,031	0,002	1700	3,40	0,0034	5,09	1,60	0,03		Standard	8,97E-05	150,00	0,00	0,10	0,51	20,00	2,00	Fliseklæb	21,69
	Fliser		Keramikfliser, gla		1 m2	6,04	0,15	0,00	-0,029	0,005	2200	0,50	0,01	3,02	0,07	0,00		Standard	8,97E-05	200,00	0,00	0,10	0,30	20,00	2,00	Fliser	10,19
SUM														-1,631	17,800	0,148	0,000				0,19		-0,16			Total:	48,22

Fig. 179. Internal walls

GWP - Windows

Window 2500x1900

wall			environmental data						calculation - decl. Unit					calculated				transport				waste of 10%						
	Product	Dimension	Gen. Dataset	Decl factor	Decl unit	Decl A1-3	Decl C3	Decl C4	D	Calc quantity m3	Density [kg/m3]	Quantity decl unit	Weight/m2 wall kg	C3	C4	D	Vehicel	Emissionfactor	Distance	A4 (inkl. waste)	Wastage factor	A5	Service life [years]	Replace-ments [number]	SUM:	
bevares	Glas	4 mm	Glas 4 mm #C	1	m2	13,35	0,00	0,18	0,00	0,004	2563	4,75	48,6	0,00	0,84	0,00	Truck max 26 t (:	8,97E-05	120,00	0,52	0,00	0,00	25,00	2,00	Vindue	45,48
	Vinduesramme	8,8 m	Vinduesramm	1	m	-0,09	3,83	0,00	-1,53	8,80	2,11	8,80	18,5	33,73	0,00	-28,34							50,00	0,00	Vinduesramme	33,73
	Tætning	8,8 m	Gummitætnin	1	kg	3,65	3,04	0,00	-0,89	0,00088	1200	0,001	1,0	0,00	0,00	-0,94							50,00	0,00	Tætning	0,00
	Sprosser	11 m	Konstruktions	1	m3	-652,00	709,00	0,00	-425,00	0,02	536	0,02	5,3	16,11	0,00	-2278,00							50,00	0,00	Tætning	16,11
SUM														0,000	49,850	0,836	-2307,273								Total:	50,69

Window kviste 1000x2500

wall			environmental data						calculation - decl. Unit					calculated				transport				waste of 10%						
	Product	Dimension	Gen. Dataset	Decl factor	Decl unit	Decl A1-3	Decl C3	Decl C4	D	Calc quantity m3	Density [kg/m3]	Quantity decl unit	Weight/m2 wall kg	C3	C4	D	Vehicel	Emissionfactor	Distance	A4 (inkl. waste)	Wastage factor	A5	Service life [years]	Replace-ments [number]	SUM:	
bevares	Glas	8 mm	2-lags	1	m2	36,64	1,52	0,35	-0,44	0,008	2563	2,50	51,2	3,80	0,88	-22,76	Truck max 26 t (:	8,97E-05	120,00	0,55	0,00	0,00	25,00	2,00	Vindue	130,85
	Vinduesramme	10 m	Vinduesramm	1	m	-0,09	3,83	0,00	-1,53	10,00	2,11	10,00	21,1	38,33	0,00	-32,20							50,00	0,00	Vinduesramme	38,33
	Tætning	7 m	Gummitætnin	1	kg	3,65	3,04	0,00	-0,89	0,00070	1200	0,001	0,8	0,00	0,00	-0,75							50,00	0,00	Tætning	0,00
SUM														0,000	42,135	0,880	-55,706								Total:	43,01

Window roof 800x800

wall			environmental data						calculation - decl. Unit					calculated				transport				waste of 10%						
	Product	Dimension	Gen. Dataset	Decl factor	Decl unit	Decl A1-3	Decl C3	Decl C4	D	Calc quantity m3	Density [kg/m3]	Quantity decl unit	Weight/m2 wall kg	C3	C4	D	Vehicel	Emissionfactor	Distance	A4 (inkl. waste)	Wastage factor	A5	Service life [years]	Replace-ments [number]	SUM:	
bevares	Glas	3,2 m	2-lags	1	m2	36,64	1,52	0,35	-0,44	0,008	2563	0,64	13,1	0,97	0,23	-5,83	Truck max 26 t (:	8,97E-05	120,00	0,14	0,00	0,00	25,00	2,00	Vindue	115,28
	Vinduesramme	3,2 m	Vinduesramm	1	m	-0,09	3,83	0,00	-1,53	3,20	2,11	3,20	6,7	12,27	0,00	-10,30							50,00	0,00	Vinduesramme	12,27
	Tætning	3,2 m	Gummitætnin	1	kg	3,65	3,04	0,00	-0,89	0,00032	1200	0,000	0,3	0,00	0,00	-0,34							50,00	0,00	Tætning	0,00
SUM														0,000	13,240	0,225	-16,472								Total:	127,55

Window 2500x1900 forsatsrude

wall			environmental data						calculation - decl. Unit					calculated				transport				waste of 10%						
	Product	Dimension	Gen. Dataset	Decl factor	Decl unit	Decl A1-3	Decl C3	Decl C4	D	Calc quantity m3	Density [kg/m3]	Quantity decl unit	Weight/m2 wall kg	C3	C4	D	Vehicel	Emissionfactor	Distance	A4 (inkl. waste)	Wastage factor	A5	Service life [years]	Replace-ments [number]	SUM:	
add-on	Glas	8 mm	2-lags	1	m2	36,64	1,52	0,35	-0,44	0,008	2563	4,75	97,3	174,05	7,22	1,67	-2,11	Truck max 26 t (:	8,97E-05	120,00	1,05	0,00	0,00	25,00	2,00	Glas	551,96
	Vinduesramme	8,8 m	Vinduesramm	1	m	-0,09	3,83	0,00	-1,53	8,80	2,11	8,80	18,5	-0,79	33,73	0,00	-13,43									Vinduesramme	32,94
	Tætning	8,8 m	Gummitætnin	1	kg	3,65	3,04	0,00	-0,89	0,00088	1200	0,001	1,0	0,00	0,00	0,00	0,00									Tætning	0,01
	Sprosser	11 m	Konstruktions	1	m3	-652,00	709,00	0,00	-425,00	0,02	536	0,02	5,3	-14,82	16,11	0,00	-9,66									Sprosser	1,30
SUM														15,605	49,850	0,000	-23,089			0,000		0,000			Total:	586,20
trernede resuret	Maling	0,3 kg	Lacksysteme	1	kg	1,89303595	0,7855643608	0	-0,2050542832	-	-	0,300	0,30	0,57	0,24	0,00	-0,06	Truck max 26 t (:	8,97E-05	650,00	0,02	0,10	0,06	20,00	2,00	Maling	2,63

Fig. 180. Window

GWP - Roof comparison

Existing roof

	Tag		environmental data						calculation - decl. Unit				
	Product	Dimension	Gen. Dataset	Decl factor	Decl unit	Decl A1-3	Decl C3	Decl C4	D	Calc quantity m3	Density [kg/m3]	Quantity decl unit	Weight/m2 wall kg
bevares	Tagpap	2 mm	Tagpap, bitumen toplag, s	1	m2	4,98	0,00	0,52	0,00	0,002	3100	1,00	6,20
	Fast underlag (	20 mm	Krydsfiner, ubehandlet (F	1	m3	-599,00	743,00	0,00	-391,00	0,02	480	0,02	9,60
	Eternitskifre	4 mm	Fibercement, bølgeplade	1	ton	901,35	0,00	17,41	0,00	0,004	1590	0,006	6,36
	Lægter	45 mm	Konstruktionstræ af nålet	1	m3	-652,00	709,00	0,00	-425,00	0,01	536	0,01	5,36
	Hanebåndsspæ	100 mm	Konstruktionstræ af nålet	1	m3	-652,00	709,00	0,00	-425,00	0,02	536	0,02	10,72
	Isolering	100 mm	Mineraluld, fleksibel isole	1	m2	1,55	0,00	0,03	0,00	0,100	60	0,33	6,00
	Dampspærre	0,2 mm	Dampspærre PE (tykkels	1	m2	0,40	0,56	0,00	-0,23	0,0002	950	1,000	0,19
	Gips	12,5 mm	Gipsplade, brand	1	m2	3,89	0,14	0,56	-0,02	0,0125	1016	1	12,70
	paint	2 layers	Overflade,	1	kg	1,89	0,79	0,00	-0,21	0,00017	1500	0,2500	0,00025
SUM													

	Vindue kviste 1000x2500		environmental data						calculation - decl. Unit				
	Product	Dimension	Gen. Dataset	Decl factor	Decl unit	Decl A1-3	Decl C3	Decl C4	D	Calc quantity m3	Density [kg/m3]	Quantity decl unit	Weight/m2 wall kg
bevares	Glas	8 mm	2-lags	1	m2	36,64	1,52	0,35	-0,44	0,008	2563	2,50	51,25
	Vinduesramme	10 m	Vinduesramme, træ #G0	1	m	-0,09	3,83	0,00	-1,53	10,00	2,11	10,00	21,10
	Tætning	7 m	Gummitætning #G0608	1	kg	3,65	3,04	0,00	-0,89	0,00070	1200	0,001	0,84
SUM													

	Tagvinduer 800x800		environmental data						calculation - decl. Unit				
	Product	Dimension	Gen. Dataset	Decl factor	Decl unit	Decl A1-3	Decl C3	Decl C4	D	Calc quantity m3	Density [kg/m3]	Quantity decl unit	Weight/m2 wall kg
bevares	Glas	8 mm	2-lags	1	m2	36,64	1,52	0,35	-0,44	0,008	2563	0,64	13,12
	Vinduesramme	3,2 m	Vinduesramme, træ #G0	1	m	-0,09	3,83	0,00	-1,53	3,20	2,11	3,20	6,75
	Tætning	3,2 m	Gummitætning #G0608	1	kg	3,65	3,04	0,00	-0,89	0,00032	1200	0,000	0,38
SUM													

Existing roof + nye kviste og vinduer

	roof		environmental data						calculation - decl. Unit				
	Product	Dimension	Gen. Dataset	Decl factor	Decl unit	Decl A1-3	Decl C3	Decl C4	D	Calc quantity m3	Density [kg/m3]	Quantity decl unit	Weight/m2 wall kg
bevares	Tagpap	2 mm	Tagpap, bitumen toplag, s	1	m2	4,98	0,00	0,52	0,00	0,002	3100	1,00	6,20
	Fast underlag (	20 mm	Krydsfiner, ubehandlet (F	1	m3	-599,00	743,00	0,00	-391,00	0,02	480	0,02	9,60
	Eternitskifre	4 mm	Fibercement, bølgeplade	1	ton	901,35	0,00	17,41	0,00	0,004	1590	0,006	6,36
	Lægter	45 mm	Konstruktionstræ af nålet	1	m3	-652,00	709,00	0,00	-425,00	0,02	536	0,02	10,72
	Isolering	100 mm	Mineraluld, fleksibel isole	1	m2	1,55	0,00	0,03	0,00	0,100	60	0,33	6,00
	Dampspærre	0,2 mm	Dampspærre PE (tykkels	1	m2	0,40	0,56	0,00	-0,23	0,0002	950	1,000	0,19
	Gips	12,5 mm	Gipsplade, brand	1	m2	3,89	0,14	0,56	-0,02	0,0125	1016	1	12,70
	paint	2 layers	Overflade,	1	kg	1,89	0,79	0,00	-0,21	0,00017	1500	0,2500	0,00025
SUM													

	Vinduer kviste 1500*2000 mm		environmental data						calculation - decl. Unit				
	Product	Dimension	Gen. Dataset	Decl factor	Decl unit	Decl A1-3	Decl C3	Decl C4	D	Calc quantity m3	Density [kg/m3]	Quantity decl unit	Weight/m2 wall kg
	Glas	8 mm	2-lags	1	m2	36,64	1,52	0,35	-0,44	0,008	2563	3,00	61,50
	Vinduesramme	9 m	Vinduesramme, træ #G0	1	m	-0,09	3,83	0,00	-1,53	10,00	2,11	9,00	21,10
	Tætning	9 m	Gummitætning #G0608	1	kg	3,65	3,04	0,00	-0,89	0,00070	1200	0,001	0,84
SUM													

	Kviste		environmental data						calculation - decl. Unit				
	Product	Dimension	Gen. Dataset	Decl factor	Decl unit	Decl A1-3	Decl C3	Decl C4	D	Calc quantity m3	Density [kg/m3]	Quantity decl unit	Weight/m2 wall kg
	Steel	1 mm	Stål, plade #D1595	1	ton	3432,00	2,73	0,00	-1737,00	0,00100	7850	0,0079	7,85
	Isolering	45 mm	Træfiberisolering(#G0012)	1	m3	-63,909	78	0		0,045	50	0,045	14,500
	Dampspærre	0,2 mm	Dampspærre PE (tykkels	1	m2	0,40	0,56	0,00	-0,23	0,0002	950	1,000	0,19
	Lægter	145 mm	Konstruktionstræ af nålet	1	m3	-652,00	709,00	0,00	-425,00	0,01	536	0,01	5,36
	Isolering	145 mm	Træfiberisolering(#G0012)	1	m3	-63,909	78	0		0,145	50	0,145	14,500
	Vindspærre	9 mm	Gipsplade, vindspærre	1	m2	1,84	0,04	0,56	-0,17	0,01	900	1,00	8,10
	Lægter	45 mm	Konstruktionstræ af nålet	1	m3	-652,00	709,00	0,00	-425,00	0,02	536	0,02	10,72
	Gips	12,5 mm	Gipsplade, brand	1	m2	3,89	0,14	0,56	-0,02	0,0125	1016	1	12,70
	paint	2 layers	Overflade,	1	kg	1,89	0,79	0,00	-0,21	0,00017	1500	0,2500	0,00025
SUM													

	Tagvindue 500*8000 m		environmental data						calculation - decl. Unit				
	Product	Dimension	Gen. Dataset	Decl factor	Decl unit	Decl A1-3	Decl C3	Decl C4	D	Calc quantity m3	Density [kg/m3]	Quantity decl unit	Weight/m2 wall kg
	Glas	8 mm	2-lags	1	m2	36,64	1,52	0,35	-0,44	0,008	2563	0,40	8,20
	Vinduesramme	2,6 m	Vinduesramme, træ #G0	1	m	-0,09	3,83	0,00	-1,53	10,00	2,11	2,60	21,10
	Tætning	2,6 m	Gummitætning #G0608	1	kg	3,65	3,04	0,00	-0,89	0,00070	1200	0,0003	0,84
SUM													

Fig. 181. Roof comparison

		calculated				transport				waste of 10%				
		A1-3	C3	C4	D	Vehicel	Emissionfa	Distance	A4 (inkl. wast	Wastage factor	A5	Service life	Replace-ments [number]	SUM:
			0,00	0,52	0,00									Tagpap
			14,86	0,00	-7,82									Fast underlag (plader)
			0,00	0,11	0,00									Eternitskifre
			3,80	0,00	-2,28									Lægter
			14,18	0,00	-8,50									Hanebåndsspær
			0,00	0,01	0,00									Isolering
			0,56	0,00	-0,23									Dampspærre
			0,14	0,56	-0,02									Gips
	paint		0,20	0,00	0,00	Standard	8,97E-05	200,00	0,00	0,10	0,00	20,00	2,00	maling
SUM		0,000	33,539	1,205	-18,848				0,00		0,000			Total:

		calculated				transport				waste of 10%				
		A1-3	C3	C4	D	Vehicel	Emissionfa	Distance	A4 (inkl. wast	Wastage factor	A5	Service life [years]	Replace-ments [number]	SUM:
			3,80	0,88	-1,11	Truck max 26 t (:	8,97E-05	120,00	0,55	0,00	0,00	25,00	2,00	Vindue
			38,33	0,00	-15,26									Vinduesramme
			0,00	0,00	0,00									Tætning
SUM		0,000	42,135	0,880	-16,371						0,00			Total:

		calculated				transport				waste of 10%				
		A1-3	C3	C4	D	Vehicel	Emissionfa	Distance	A4 (inkl. wast	Wastage factor	A5	Service life [years]	Replace-ments [number]	SUM:
			0,97	0,23	-0,28	Truck max 26 t (:	8,97E-05	120,00	0,14	0,00	0,00	25,00	2,00	Vinde
			12,27	0,00	-4,88									Vinduesramme
			0,00	0,00	0,00									Tætning
		0,000	13,240	0,225	-5,168						0,00			Total:

		calculated				transport				waste of 10%				
		A1-3	C3	C4	D	Vehicel	Emissionfa	Distance	A4 (inkl. wast	Wastage factor	A5	Service life [years]	Replace-ments [number]	SUM:
			0,00	0,52	0,00									Tagpap
			14,86	0,00	-7,82									Fast underlag (plader)
			0,00	0,11	0,00									Eternitskifre
			3,80	0,00	-2,28									Lægter
			14,18	0,00	-8,50									Hanebåndsspær
			0,00	0,01	0,00									Isolering
			0,56	0,00	-0,23									Dampspærre
			0,14	0,56	-0,02									Gips
	paint		0,20	0,00	0,00	Standard	8,97E-05	200,00	0,00	0,10	0,00	20,00	2,00	maling
SUM		0,000	33,539	1,205	-18,848				0,00		0,00			Total:

		calculated				transport				waste of 10%				
		A1-3	C3	C4	D	Vehicel	Emissionfa	Distance	A4 (inkl. wast	Wastage factor	A5	Service life [years]	Replace-ments [number]	SUM:
		109,92	4,56	1,06	-1,33	Truck max 26 t (:	8,97E-05	120,00	0,66	0,10	10,99	25,00	2,00	Vindue
		-0,81	34,50	0,00	-13,73							50,00	0,00	Vinduesramme
		0,00	0,00	0,00	0,00							50,00	0,00	Tætning
		109,118	39,061	1,056	-15,067				0,66		10,99			Total:

		calculated				transport				waste of 10%				
		A1-3	C3	C4	D	Vehicel	Emissionfa	Distance	A4 (inkl. wast	Wastage factor	A5	Service life [years]	Replace-ments [number]	SUM:
		26,94	0,02	0,00	-13,64	Truck max 26 t (:	8,97E-05	200,00	0,14	0,10	2,69	50,00	0,00	Steel
		-2,876	3,510	0,000		Standard	8,97E-05	539	0,7712	0,1	-0,29	50,000	0,000	Isolering
		0,40	0,56	0,00	-0,23	Truck max 26 t (:	8,97E-05	128,60	0,00	0,10	0,04	50,00	0,00	Dampspærre
		-3,49	3,80	0,00	-2,28	Truck max 26 t (:	8,97E-05	36,40	0,02	0,10	-0,35	50,00	0,00	Lægter
		-9,267	11,310	0,000		Standard	8,97E-05	539	0,7712	0,1	-0,93	50,000	0,000	Isolering
		1,84	0,04	0,56	-0,17	Truck max 26 t (:	8,97E-05	200,00	0,15	0,10	0,18	50,00	0,00	Vindspærre
		-13,04	14,18	0,00	-8,50	Truck max 26 t (:	8,97E-05	36,40	0,04	0,10	-1,30	50,00	0,00	Lægter
		3,89	0,14	0,56	-0,02	Truck max 26 t (:	8,97E-05	150,00	0,17	0,10	0,39	50,00	0,00	Gips
	paint		0,20	0,00	0,00	Standard	8,97E-05	200,00	0,00	0,10	0,00	20,00	2,00	maling
SUM		4,390	33,557	1,122	-24,830				2,05		0,44			Total:

		calculated				transport				waste of 10%				
		A1-3	C3	C4	D	Vehicel	Emissionfa	Distance	A4 (inkl. wast	Wastage factor	A5	Service life [years]	Replace-ments [number]	SUM:
		14,66	0,61	0,14	-3,64	Truck max 26 t (:	8,97E-05	120,00	0,09	0,10	1,47	25,00	2,00	Vindue
		-0,23	9,97	0,00	-32,20							50,00	0,00	Vinduesramme
		0,00	0,00	0,00	-0,75							50,00	0,00	Tætning
		14,424	10,575	0,141	-36,587				0,09		1,47			Total:

New roof

	Roof		environmental data						calculation - decl. Unit				
	Product	Dimension	Gen. Dataset	Decl factor	Decl unit	Decl A1-3	Decl C3	Decl C4	D	Calc quantity m3	Density [kg/m3]	Quantity decl unit	Weight/m2 wall kg
	Steel	1 mm	Stål, plade #D1595	1	ton	3432,00	2,73	0,00	-1737,00	0,00100	7850	0,0079	7,85
	Isolering	45 mm	Mineraluld, fleksibel isole	1	m2	1,55	0,00	0,03	0,00	0,045	60	0,15	2,70
	Dampspærre	0,2 mm	Dampspærre PE (tykkels	1	m2	0,40	0,56	0,00	-0,23	0,0002	950	1,000	0,19
	Lægter	145 mm	Konstruktionstræ af nålet	1	m3	-652,00	709,00	0,00	-425,00	0,01	536	0,01	5,36
	Isolering	145 mm	Træfiberisolering(#G0012)	1	m3	-63,91	78,00	0,00		0,145	50	0,15	14,500
	Vindspærre	9 mm	Gipsplade, vindspærre	1	m2	1,84	0,04	0,56	-0,17	0,01	900	1,00	8,10
	Lægter	45 mm	Konstruktionstræ af nålet	1	m3	-652,00	709,00	0,00	-425,00	0,02	536	0,02	10,72
	Gips	12,5 mm	Gipsplade, brand	1	m2	3,89	0,14	0,56	-0,02	0,0125	1016	1	12,70
	paint	2 layers	Overflade,	1	kg	1,89	0,79	0,00	-0,21	0,00017	1500	0,2500	0,00025
SUM													
	Vinduer		environmental data						calculation - decl. Unit				
	Product	Dimension	Gen. Dataset	Decl factor	Decl unit	Decl A1-3	Decl C3	Decl C4	D	Calc quantity m3	Density [kg/m3]	Quantity decl unit	Weight/m2 wall kg
	Glas	8 mm	2-lags	1	m2	36,64	1,52	0,35	-0,44	0,008	2563	3,00	61,50
	Vinduesramme	9 m	Vinduesramme, træ #G0	1	m	-0,09	3,83	0,00	-1,53	10,00	2,11	9,00	21,10
	Tætning	9 m	Gummitætning #G0608	1	kg	3,65	3,04	0,00	-0,89	0,00070	1200	0,001	0,84
SUM													

	calculated				transport				waste of 10%				
	A1-3	C3	C4	D	Vehicel	Emissionfa	Distance	A4 (inkl. wast	Wastage factor	A5	Service life [years]	Replace-ments [number]	SUM:
	26,94	0,02	0,00	-13,64	Truck max 26 t (:	8,97E-05	200,00	0,14	0,10	2,69	50,00	0,00	Steel
	0,23	0,00	0,00	0,00	Truck max 26 t (:	8,97E-05	120,00	0,03	0,10	0,02	50,00	0,00	Isolering
	0,40	0,56	0,00	-0,23	Truck max 26 t (:	8,97E-05	298,00	0,01	0,10	0,04	50,00	0,00	Dampspærre
	-3,49	3,80	0,00	-2,28	Truck max 26 t (:	8,97E-05	36,40	0,02	0,10	-0,35	50,00	0,00	Lægter
	-9,267	11,310	0,000		Standard	8,97E-05	539,00	0,7712	0,10	-0,93	50,000	0,000	Isolering
	1,84	0,04	0,56	-0,17	Truck max 26 t (:	8,97E-05	200,00	0,15	0,10	0,18	50,00	0,00	Vindspærre
	-13,04	14,18	0,00	-8,50	Truck max 26 t (:	8,97E-05	36,40	0,04	0,10	-1,30	50,00	0,00	Lægter
	3,89	0,14	0,56	-0,02	Truck max 26 t (:	8,97E-05	150,00	0,17	0,10	0,39	50,00	0,00	Gips
		0,20	0,00	0,00	Standard	8,97E-05	200,00	0,00	0,10	0,00	20,00	2,00	maling
	7,498	30,047	1,127	-24,830				1,315		0,750			Total:
	calculated				transport				waste of 10%				
	A1-3	C3	C4	D	Vehicel	Emissionfa	Distance	A4 (inkl. wast	Wastage factor	A5	Service life [years]	Replace-ments [number]	SUM:
	109,92	4,56	1,06	-1,33	Truck max 26 t (:	8,97E-05	120,00	0,66	0,10	10,99	25,00	2,00	Vindue
	-0,81	34,50	0,00	-13,73							50,00	0,00	Vinduesramme
	0,00	0,00	0,00	0,00							50,00	0,00	Tætning
	109,118	39,061	1,056	-15,067				0,66		10,99			Total:

Fig. 182. Roof comparison

GWP - Results

EXISTING	GWP/m2	Antal/m2	samlet	
External wall	8,21	1467	12044,8	
Internal partitian wall	4,80	793	3807,4	
NEW internal partition wall	5,79	425	2461,6	
Internal load-bearing wall	6,99	657	4591,5	
Floor slab	27,08	2153	58302,5	
Foundation slab	4,52	538	2435,2	
Roof	34,74	604	20985,1	
Windows 2500*1900	50,69	60	3041,2	
Window kviste 1000x2500	43,01	12	516,2	
Window roof 800x800	127,55	10	1275,5	
B6 Energiforbrug	2,6		0,0	
TOTAL			**2.189,22**	Total kg CO²eq over 50 years
		uden tag	1.733,68	Total kg CO²eq over 50 years

TRANSFORMATION	GWP/m2	Antal/m2	samlet	
External wall efteriso	19,90	1021,5	20323,9	
External wall altan	41,56	445,5	18515,9	
Internal partitian wall - indeni lejlighed	11,58	300	3474,8	
Internal partitian wall - mod gang	6,52	174	1134,6	
Toilet skillevæg	48,22	250	12056,2	
Floor slab - altan	50,57	96	4854,6	
Floor slap - behandling af trægulv + m	10,78	2105	22681,1	
Floor slab - hævet gulv	18,80	442,2	8313,3	
Roof	-	-	25516,3	
Windows forsatsrude + nye i gavl	586,20	72	42206,4	
Maling af eksisterende vinduer	2,63	60	158,0	
B6 Energiforbrug	1,3		0,0	
TOTAL with out roof			**133.718,72**	Total kg CO²eq over 50 years
TOTAL with roof			**159.235,04**	Total kg CO²eq over 50 years

Fig. 183. LCA result page