imagine 07

REIMAGINING HOUSING

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Ulrich Knaack
Linda Hildebrand
Thaleia Konstantinou
Hansjörg Wieland

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Delft University of Technology, Faculty of Architecture,
Chair of Design of Construction

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SERIES EDITED BY
Ulrich Knaack
Tillmann Klein
Marcel Bilow

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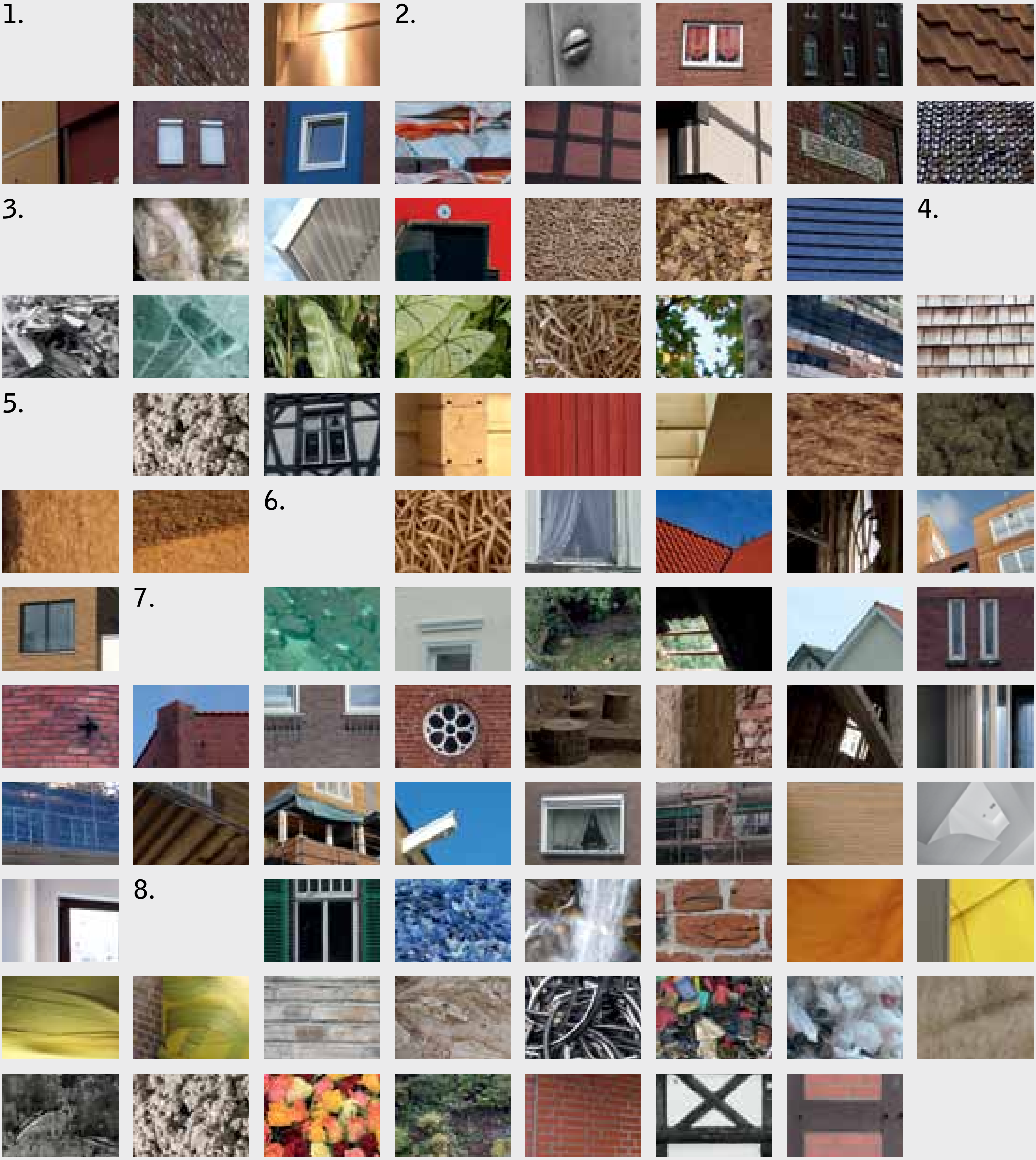
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1. REFURBISHMENT IN THE EMS DOLLART REGION

This volume of the imagine book series is called reimagine housing because our intent is to identify new approaches for the refurbishment of existing buildings with a focus on residential housing. It's that simple – and that complex!

Simple, because all we need to do is to look at current buildings and evaluate technical problems such as building physics, indoor comfort, energy consumption, etc; then find appropriate products to solve these problems, and fix them. By doing so, the buildings can survive the next decades. But the issue is a little more complex – a fact that might actually be turned into an advantage: we need to take into account various levels of involvement. For example, our personal feelings about a particular building – memories, relationships, and personal experiences. In addition, we need to consider a building's value – each one in its particular social and historical context. Does it have an influence on us or other buildings, and how important is this influence? Which issues do we need to eliminate and which not? Complexity increases.

Another point to consider: do we want to support or work against the existing building – do we really like it? Do we want to imprint our own theme, story and habitus, or can we accept it to be understood as a part of development, a part of history? Do we want the building to stand out, to be unique? Or can the existing serve as a basis to perform and maybe even survive longer by being part of a whole?

As mentioned above, this book focuses on aspects of reconsidering, redeveloping and redesigning existing buildings. The topic can be divided into several aspects which are reflected in the individual chapters of this book. Firstly, the technical background of a building and its energetic performance (this goes without saying!). A following chapter discusses the energetic value of existing constructions by evaluating the embodied energy of the overall construction, as well as the potential of building materials with lower embodied energy due to more sustainable production methods (an interesting new topic!). Then we have to study the potential and beauty of reuse – exemplified by some well executed cases which are divided into the following five categories: "restore," "keep the spirit," "refresh," "spice it up" and "all new." If we succeed in restoring a building's spirit in one or other way and create a building that is appreciated and requires less operating energy and hence less carbon emission und low operational costs, we have addressed all relevant aspects. The result is

What is the best way to go about this? We will not succeed if newly developed methods are only made accessible via formal descriptions or regulations. Knowledge needs to be spread in an accessible manner to entice people to do good: because it will provide better solutions, possibly even at no extra cost! This is the goal of the imagine book series in general – it is made for designers and users, manufactures and decision makers – expressing ways in which things can work in an aesthetic, technical, imaginative and resourceful manner. The books are intended to convince us to think differently and follow new paths.

Who is involved? This book was made possible by the European funded project INTERREG IV A Programme Deutschland-Nederland 2007–2013 as “NEND – energienetwerk van onschatbare waarde,” of which this book itself is the work package WP2 UP4a: “Dokumentation Nachhaltiges Bauen.” It was also made possible by the support of the Provincie Groningen, being the leading partner in the project, the participation of 3-N Kompetenzzentrum as well as TU Delft’s Faculty of Architecture. The project team is part of the Façade Research Group at TU Delft. We would like to express our gratitude to all supporters for their work, ambition and enthusiasm, especially the participants of the workshops in Groningen, and the architects, who provided us with information about their respective projects.

One of the many workshop and discussion rounds

sustainable – because we consider the project as well as the user, and if the user likes a building, they will treat it well and it will survive longer – a very sustainable approach!

The Ems Dollart Region (EDR) is a region in the north-east of the Netherlands and the north-west of Germany; divided by a political border but united by landscape, population and historical development. It contains more than 100 municipalities and is populated by more than two million inhabitants in an area of 20,000 km². Former marsh areas alternate with bodies of water, creating a special feeling of vastness that is unique to the area. It is a one-of-a-kind region in the middle of Europe, yet it is also typical in terms of the alternation between villages, farmland and some city conglomerations, and in its Central European climate and building standards. The particularity of the region, and its particularity being characteristic for Europe, was the reason to scan and analyze it and to study the housing stock.

What makes the buildings in this region so unique? The brick! It is the predominant building material in the EDR. It can be found in house constructions across different time periods, in buildings dating back to the 16th century to current constructions. One of the reasons for the widespread use of brickwork, in comparison to natural stone, for example, can be found in the region's topography itself. In the sandy ground of the northern Dutch-German border region, clay – traditionally the raw material for bricks – was easy to find in the proximity of the building sites. Many farmhouses even had their own brick kilns to produce the building material to house the farm activities. Other parameters favoring the use of bricks, especially in the years before 1920, are good infrastructure for production and transport, as well as the building regulations that permitted the construction of clay brick walls without the need for structural calculation.

And today? The Ems Dollart Region is targeting the energy consumption of its housing stock – as are other regions – to substantially reduce CO_2 emissions from the building stock and building industry. The refurbishment of existing buildings obviously bears great potential to support this target. But the production of new constructions offers additional potential if appropriate materials and technologies are applied. Thus, we need to take care to reduce energy consumption when refurbishing as well – while, in many cases, maintaining the building's appearance and purpose so that the user still appreciates it (or because of the intervention). At the same time, we need to bear in mind that the use of new materials will influence energy consumption; not only by possibly reducing operating energy, but also due to the production energy needed to create the material – a new approach! It is this parallel approach that needs to be highlighted and focused on – to make it accessible for architects and engineers, but also for users and decision makers.

2. HOUSING STOCK

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1 Single-family house, DE
2 Farmhouse, DE
3 Row houses in the De Hoogt neighborhood, built 1917-1920, Groningen, NL
4 Street view in Lingen, DE
5 Multi-family house. Each floor accommodates a different dwelling, NL
6 Apartment block, Papenburg, DE

HOUSING STOCK IN THE EMS DOLLART REGION

The first step in every refurbishment project is to investigate the conditions of the existing buildings. In order to propose successful solutions, we need to be able to understand the existing construction and identify the problems. Therefore, this chapter aims at providing an overview of the housing stock in the region. First, general information is provided about the type of housing present in the area; then, construction techniques common in the region are explained; and finally, typical problems are discussed.

GENERAL INFORMATION ON HOUSING TYPES

Houses can be categorized according to size, function, circulation and neighbor relation into the following general types: single-family houses, terraced/row houses, multi-family houses and apartment buildings. Each type's specific characteristics may affect the refurbishment strategy in terms of the decision-making process, as well as the measures applied.

Single-family houses

A single-family or detached house is a house that is separated from its neighbors on all sides. It is the archetypical house; the shelter of the society nucleus, the family. Furthermore, it is the most popular type of housing, and most clients' dream. It realizes the desire for privacy and personal freedom, provides a roof over our heads, and symbolizes a piece of land that we can call our own.

The detached house is surrounded by open spaces and provides the possibility for openings on all sides, allowing great flexibility in floor plan designs. Variations in terms of the size and design of the building and surrounding spaces are endless. The single-family house commonly encountered in the Ems Dollart Region is one to two stories high. Extra usable space is accommodated in the attic, under the – typically – double-pitched roof.

A particular characteristic of the region, the farmhouse type is mainly found in rural areas. It is similar to the single-family house; combined, however, with large, high spaces for farming activities, such as stables or storage.

Terraced houses

Terraced or row houses are single-family houses built in a row, either with one shared exterior side wall, or two exterior walls separated by a small cavity. They have private entrances on the narrow façade facing the street. It is a mostly urban housing type due to space limitations in the urban environment. They are also referred to as townhouses (Chandler et al., 2005). Rural row houses are less common, but can still be found, especially in clustered developments.

Built closely together, terraced houses make efficient use of the land, allowing higher population densities and preserving outside space. Moreover, the shared wall or walls conserve materials and reduce heat loss. Terraced houses are often found in collective residential complexes, having similar floor plans and some exterior visual connection (fig. 3). On the other hand, it is possible to encounter greater variation in row houses if they are not the result of the same design. Separate single-family houses built on adjacent lots and making use of the entire plot width become terraced houses. This is particularly common in city centers due to high density and small plot width (fig. 4).

Multi-family houses

Multi-family houses are detached or row houses, but in this case one street entrance provides access to several dwellings. They can be conceived as vertically stacked single-family dwellings, typically 2 to 5 stories high. As cities have grown and property values have risen, residential buildings become taller to accommodate more dwellings and offer higher density on a given footprint. Often, buildings intended for single families have been converted into multiple dwelling units (Chandler et al., 2005).

Apartment blocks

An apartment is a self-contained housing unit that occupies part of a block. Apartment blocks were developed mainly after the Second World War, due to the extreme housing shortage and the need for higher density buildings. Under those circumstances, traditional building methods became less important as developers looked for rapid and economical construction techniques to fulfill the demand. Apartment blocks range from middle-rise (3-4 stories) to high-rise.

OWNERSHIP

Ownership status of the dwellings is particularly important for the refurbishment discussion, as it determines the decision-making and investment process. In the Ems Dollart Region, the majority of the houses are owner occupied. In the Northern Netherlands, for example, the percentage of owner occupied houses is 61%, with 76% for houses built before 1944 (WoonOnderzoek Nederland). This is an important observation because in the owner occupied market, the investor is also the one who profits from the investment. However, there is often a lack of financial means to invest (Itard & Meijer, 2008). In contrast, the rented sector is characterized by a conflict of interests. One major characteristic is that the owner has to invest, whereas the occupant profits from the investment. In the private rented sector, this may be solved by increasing the rent, insofar as it is desirable and possible within the existing regulations. Since this is more difficult in the social rented sector, specific financial solutions and regulations are necessary (Itard & Meijer, 2008).

CONSTRUCTION

Brick is the predominant building material in the region. It can be found in house construction throughout different time periods, from buildings dating back to the 17th century until current constructions. One reason for the widespread use of brickwork, in comparison to natural stone for example, can be found in the region's topography. In the sandy ground of the northern Dutch-German border area, clay, which is traditionally the raw material for bricks, was easily found in the proximity of building sites. Many farmhouses even had their own brick kilns which were used to produce the building material to house the farm activities. Other parameters favorable to the use of bricks, especially in the years before 1920, are good infrastructure for production and transport, and the building regulations that permitted the construction of clay brick walls without the need for structural calculation (Giebeler, 2009). Clay bricks were initially hand-molded from clay, loam or clay-like substances. Later, they were also extruded, then dried and finally fired at about 900-1200 °C. Traditional bricks are solid and their dimensions may vary according to local format. In the northwest part of Germany and the Netherlands, the traditional unit size is smaller than that of other parts of Germany and other countries.

After the 1920s, the vertically perforated brick became popular in addition to the solid brick. It offers savings in material

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Time period	Benchmarks	Characteristics
Buildings before 1920	• Historical buildings (1600) • Industrial development (1780) • Modern Movement	• Masonry load-bearing internal and external walls • Buildings with tall, big rooms
Buildings of the interwar years 1920-1949	• End of World War I • Political renewal, social and artistic reformations along with technological progress • Modern Movement prevails	• Large, homogenous residential developments • Community urban planning, open public areas, amenities, parks • Apartments with good daylight and ventilation, strictly functional layout
The post-war years 1950-1975	• Years after World War II • Reconstruction	• Functional, sunny airy houses • Middle-rise (up to 4 floors) • Generous distance from adjacent building • Economical constuction
Buildings of the prospeneous years 1975-1990	• Economic growth • Energy crisis in 1973	• Higher quality of construction • First awareness of more 'energy efficient' buildings • First building erfurbishments in older, historical buildings
Curent constructions 1991-today Note: Buildings of that period wouldn't normally be considered for refurbishment	• Ecological and energy awareness (Kyoto Protocol) followed by national and international legislation • Technological achievements in advanced material • Renewable energy sources (RES)	• Minimum thermal performance imposed by regulations (EPBD) • Building performance certificated • Incorporation of RES into buildings • Passivhaus and zero-energy buildings

7 Brick wall
8 Construction of an external wall with insulation in the cavity, Cloppenburg, DE
9 Architectural periods

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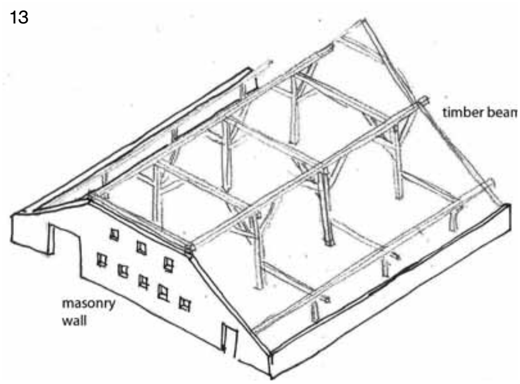

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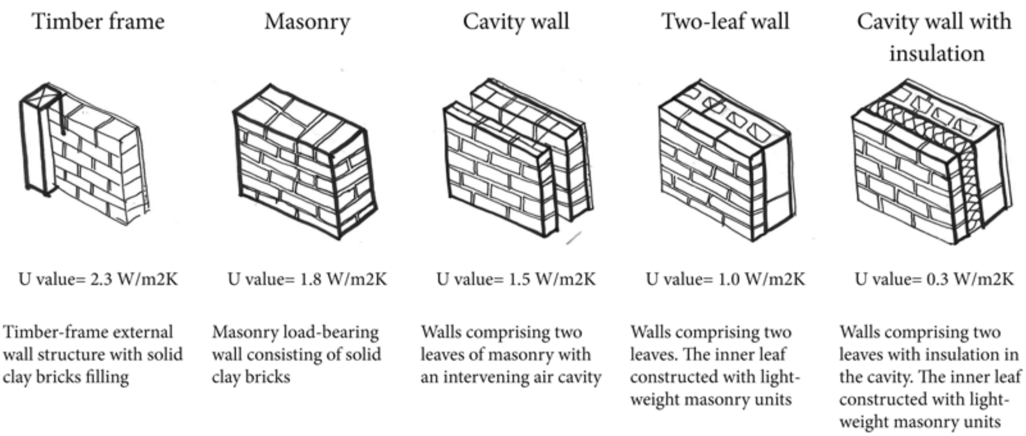

10 Timber frame construction with exposed brick filling, DE
11 Timber frame construction with rendered nogging, DE
12 Single housing with masonry wall construction, DE
13 Farmhouse construction (sketch adapted from Grube and Böttcher, 1978)
14 Thermal conductivity of different wall types

and weight, shorter laying and drying times due to the larger format, and better sound and thermal insulation. In the post war years, hollow bricks (vertically or horizontally perforated) as well as lightweight clay bricks were introduced. Their compressive strength is lower, but they provide higher insulation values. They can be used as a backing wall to rendered or facing brickwork.

Facing bricks are high strength, frost and rain resistant bricks, suitable to be left exposed, instead of rendered, in the outer face of the wall. To gain their high strength they are fired above sintering point (1150-1300 °C). The reason not to build entire walls with high strength bricks was mainly higher costs. To comply with higher insulation standards, facing brick walls with cavity insulation are becoming common, in addition to lightweight clay or concrete walls.

As far as the roof is concerned, pitched timber joist roofs are the norm in the region. The shape may vary from simple double-pitched roofs to more complicated shapes. The vast majority are covered with clay roof tiles (figure 16). However, other materials, such as concrete roof tiles, fiber-cement sheets, or organic material (thatch, particularly in rural houses) are used. More advanced options such as integration of photovoltaic panels are also available, in order to comply with the high requirements of energy efficiency.

TYPES OF CONSTRUCTION

This section aims at giving an overview of construction methods encountered in the region. The construction methods described below do not exclude other constructions and materials, but they are by far the most common types, based on literature review and field observation. The construction types are associated with distinct building methods and coherent time periods. The time span for a particular category is not strict, but rather indicative in terms of technological changes in the building and construction sector, new regulations or historical breaks. Figure 9 presents an overview of time period classification.

Timber frame construction

Timber has been used for building construction since the first human shelters. External timber frame walls are used to carry the weight of the buildings. Several materials can be used for the infill. The most common infill material in the region is brick, which came to replace the wattle-and-daub filling. Examples of this construction are found in both urban and rural areas. The brickwork used to fill the spaces between timbers in a timber-framed building is called nogging (Plumridge & Meulenkamp, 2000). Even though nogging is heavier and sometimes causes structural distortions when replacing wattle-and-daub filling, it has the considerable advantage of being fire-resistant. Moreover, the brickwork is easier and more economical to apply. Brick nogging can be arranged in many forms, such as horizontal or herringbone patterns. The brickwork can be left exposed or rendered. Mixed structures combining timber frame and masonry construction can also be encountered in the region.

Disadvantages of this construction method are primarily related to energy efficiency. The brick infill is single layered and the thermal resistance is far from adequate, providing a thermal transmittance coefficient U-value of around 2.5 W/m^2K (the minimum required by current regulations is 0.24 W/m^2K). Another issue is that the brickwork tends to project beyond the frame, creating many ledges where trapped rainwater can penetrate the bricks and saturate the walls (Plumridge & Meulenkamp, 2000).

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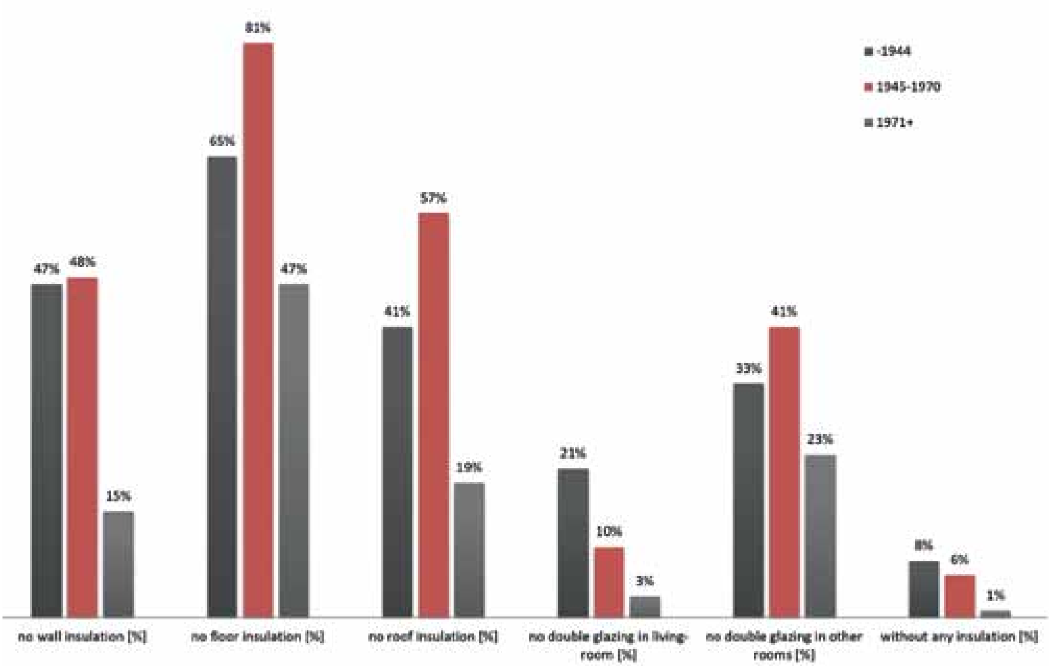

15 Clay roof tiles with moss growth

16 Insulation of the building envelope in the Northern Netherlands (source: WoonOnderzoek Nederland)

Masonry

Masonry can consist of natural or man-made elements. In the region, load-bearing masonry consists almost universally of fired clay bricks. The external walls made of solid clay bricks carry their own load, as well as the loads of the roof, the stories and their contents, by compression. The roof and upper stories are formed by timber joists. The thickness of the wall depends on the number of stories. A minimum thickness was specified for the top floor and increased by half a brick for every additional story. The steps serve as wall plates to bear the floor timber joists.

Numerous examples of this construction method are available, as it was the most common technique until World War II. Buildings with masonry brick construction can be found both in cities and in rural areas as well as in different housing types.

In the case of farmhouses, the external wall is a masonry brick construction as well. However, due to the large size of the spaces and the big span of the roof, an additional post and beam timber structure is often necessary to support the roof's rafters (fig, 13).

Cavity walls

Walls comprising two leaves of masonry with an intermediate air cavity are called cavity walls. This type of construction has been known from earlier years but it became standard in the post-World War II period. It presents certain advantages in comparison to the solid masonry wall. The air cavity improves the thermal insulation properties of the wall. Moreover, it provides better weather protection, as it prevents the façade becoming saturated on the interior on the room side. Additional advantages are material savings and shorter drying times. The disadvantage is the reduced stability of the double-leaf masonry. The connection between the two leaves is achieved by bonders or tiles of galvanized steel incorporated in the masonry.

The use of solid clay bricks began to decrease, to be replaced by perforated clay bricks and lightweight masonry units. Apart from offering better insulation values, they allow for larger formats at the same weight per unit, resulting in faster bricklaying and thus faster and cheaper construction; an important parameter particularly during the reconstruction years after the war. High strength facing bricks are used in the outer leaf of the wall for better weather protection. In many cases, the timber joist floors were replaced with reinforced concrete floors.

After the oil crisis in the 1970s, energy efficiency awareness was rising and accordingly regulations made the use of thermal insulation compulsory. As a result, cavity insulation was used in double-leaf masonry walls.

PROBLEMS

It is difficult to name all possible physical problems that might be encountered in the housing stock. Each case is unique and has to be investigated individually. However, the following lists the most typical problems.

Physical problems

Buildings suffer from a variety of physical problems connected to the structure and the building envelope. Given that some of the building components reach the end of their life cycle, the natural aging process is becoming visible. The goal of refurbishment is, on the one hand, to extend the life of the components whenever possible, and on the other, to replace them if necessary, while using as much of the existing materials as possible. There is a very strong connection between material and construction. Thus, they have to be considered as a whole.

Typical physical problems of the region's housing stock are related to masonry, timber, roof and finishes.

Masonry and cavity walls suffer from structural damage of the masonry due to cracking by shrinkage, temperature changes and structural movements. Moreover, moisture causes a disintegration of the masonry units. Efflorescence (salt crystallization) is often a sign of brick saturation. Biological growth in the form of plants, mosses, algae and mold are encouraged by high moisture content in the masonry. An additional problem of masonry and cavity walls is the decay of the joints connecting the timber floors to the walls.

Moisture is the biggest enemy for timber components. This is particularly important to consider in the humid and rainy climate of the region. Timber is a hygroscopic material, which means that it absorbs moisture and then releases it again. As such, it is mainly damaged by excessive absorption of moisture due to physical shortcomings and poor maintenance (Giebeler, 2009). This may not only cause cracks and deformations due to swelling and shrinkage, but also create a favorable environment for fungal infestation. Moreover, deformations of structural timber elements can also result from inadequate sizing. This is particularly common in buildings built in the 1930s and directly after World War II, when there was a shortage of building materials.

The finishing surfaces of the building envelope, such as the render on the walls or the roof tiles, are the first to show signs of damage as they are exposed to the weather. Cracking due to movement or loose rendering and mechanical damage to the roof by falling branches or wind are common. Moreover, organic growth such as moss or algae creates a degraded appearance.

Energy efficiency

Energy efficiency is one of the main problems of the building stock in question. The materials and techniques used originally have produced buildings with far lower energy and sustainability standards than are required today. Important as it might be to recognize and preserve the historical value and character of the existing building stock and the construction represented in past time periods, the poor performance of the buildings cannot be ignored.

The poor performance refers to the low thermal resistance of the building envelope, resulting in great heat loss and therefore high energy demand and user discomfort. The following figure shows the condition of the building stock in the Northern Netherlands, as this relates to the insulation of the building envelope. This indicates that there is much room for improvement in terms of the energy performance of the housing stock in the region.

Given the necessity to refurbish the housing stock, identifying and understanding the stock itself is an essential process. Not only does it serve to point out the problems that have to be addressed, but knowledge of the existing construction methods also leads to successful refurbishment solutions.
The following chapters present methods, technologies and ideas to make these solutions more sustainable and attractive.

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		Problems	Effect
Energy efficiency		Poor thermal performance of the envelope (roof, walls and windows)	Energy loss, high energy demand
		Poor air tightness of the openings	Energy loss, high energy demand, user discomfort
		Thermal bridges	Energy loss, high energy demand, internal condensation
		Out-dated installations	High energy demand, risk of technical problems, user discomfort
Physical problems	Masonry and cavity wall	Corrosion of ties and fixings	Façade parts destruction, accident risk
		Cracking by shrinkage, structural movements	Structural damage, accident risk , degraded appearance
		Disintegration of masonry units (moisture, salt crystallization, frost)	Degraded appearance
		Poor acoustic insulation	User discomfort
		Poor damp-proofing	Water penetration, user discomfort
	Timber	External joints decay	Structural damage, accident risk , degraded appearance
		Corrosion of ties and fixings	Structural damage, degraded appearance
		Inadequate sizing, wrong choice of timber	Deflection, deformation of structural timber elements
		Inadequate details of the junction with floor slabs and internal walls	Degraded appearance
		Mould growth	Health risk, degraded appearance
		Organic infestation (fungal, insects)	Health risk, degraded appearance
		Rotten wooden parts of the window frame	Health risk, degraded appearance, poor performance
	Roof	Improper layering of roof tiles	Accident risk , water penetration, poor performance
		Inadequate roof pitches	Water accumulation, poor performance
		Efflorescence (salt crystallization) and moss growth	Health risk, degraded appearance
		Mechanical damages	Accident risk, water penetration, user discomfort
	Render	Loose or falling render	Degraded appearance
		Cracking (due to movements)	Degraded appearance
		Growth of algae	Degraded appearance, health risk

17 Overview of typical problems

3. CLIMATE DESIGN ASPECT

and outside, which are expressed by the thermal resistance coefficient U-values. In contrast, ventilation heat loss depends on the permeability of the façade, the size and quality of the openings, etc. The façade design and properties also define the solar heat gains.

Apart from heating, other forms of energy consumption are important in dwellings, such as domestic hot water, electricity for lighting, and appliances. However, more than half of the total energy demand, namely 57% (Itard & Meijer, 2008), is used for space heating. It is also the energy use most relevant to the thermal comfort discussion and the one that can be significantly reduced with refurbishment.

Two courses of actions need to be taken when retrofitting dwellings. First, we need to use the design and properties of the building envelope (passive design) to minimize or maximize the heat losses and heat gains respectively. In addition, active measures such as heating systems and solar power technologies need to be employed to produce and distribute the energy needed to achieve the thermal comfort of the occupants.

PASSIVE DESIGN

Passive design includes principles that are used to minimize the energy demand of the building. Such principles are based on a thorough consideration of the local climate, building layout and material properties. Passive design principles can be broken down into the following general functions.

Heat protection

Heat is a form of energy that flows from a high to a low temperature zone. To reduce the energy demand, the building envelope needs to be able to prevent, or at least minimize, the heat flow from inside to outside during winter and in the opposite direction in summer. Reducing heat transmittance is therefore important during all seasons. It can be achieved by increasing the air tightness and thermal resistance of the building envelope, eliminating thermal bridges, adding insulation on walls, basements, roofs, and replacing windows.

Insulation

Insulating materials improve the thermal and acoustic parameters of a building. They reduce transmission heat losses and produce higher surface temperature, which minimizes ventilation heat losses in winter (Hausladen, 2008). Since thermal resistance of the building envelope is most likely to be insufficient, thermal insulation is one of the first and foremost needed measures in refurbishment projects.

An insulator is a material with high thermal resistance that opposes the transfer of heat between areas of different temperature (McMullan, 2002, p. 37). The insulating effect of a material is based on the low thermal conductivity of enclosed air. Insulating materials are classified into inorganic/mineral and organic types according to their raw materials. Depending on their make-up they are subdivided into fiber, foamed and granulate or loose fill insulation (Hausladen, 2008, p. 122). More details on insulating material can be found in the chapter on Materials.

Window glazing

Glass is a key element in the architectural expression and function of the building. One of the shortcomings of glass is its relatively poor insulating qualities. A lot of hope and effort has been put in the development of coatings, laminates and various specialized types of glass to solve the inherent problems of poor thermal performance and fragility inherent to the material glass.

REIMAGINING CLIMATE DESIGN PRINCIPLES

Given the need to reduce the energy demand of the building sector, a principal concern is to upgrade the existing dwellings into passive, sustainable houses that use less non-renewable energy sources while providing improved conditions for the users. To achieve this goal, simple methods and techniques can be applied using appropriate building design, and material and systems selection.

If these techniques reflect the local climate, make use of environmental elements such as air and sun, and aim to provide thermal and visual comfort, they are referred to as bioclimatic design. The concept of bioclimatic design, identified and developed in the 1960s (Olgyay & Olgyay, 1963), brings together disciplines of human physiology, climatology and building physics. It has been integrated into building design and has been seen as a cornerstone to achieving more sustainable buildings (Hyde, 2008).

Bioclimatic issues, in the form of the occupants' thermal comfort and passive low-energy architecture, have been used by design professionals as a starting point for designing new buildings. However, with refurbishment projects that aim at improving comfort and energy efficiency, it is not only nice but indeed mandatory to consider these factors.

CLIMATE PRINCIPLES FOR REFURBISHMENT

The first step in climate design is to analyze the local climate in order to be able to exploit prevailing environmental conditions. A climate analysis includes average temperatures, precipitation, wind force and direction as well as insulation. The region's climate is classified as a Moist Mid-latitude Climate, with adequate precipitation in all months and no dry season, according to Köppen Climate Classification System (De Blij, Muller & Williams, 2004, p. 77). According to the climate analysis, it can be generally characterized as a moderate, under-heated climate. Heating demand is the main concern, as extra energy for heating is needed during two thirds of the year (Climate Consultant, 2011) to provide comfortable temperatures inside the houses.

Since buildings provide shelter for human activities, people need to feel comfortable inside them. According to the ISO 7730 (2005) standard, thermal comfort is described as being "That condition of mind which expresses satisfaction with the thermal environment." This is a definition most people can agree on, but it is not easily converted into physical parameters. It is generally accepted that most people are likely to feel comfortable at indoor temperatures between 19 and 24 °C and relative humidity between 40 and 70%.

In order to achieve these temperature levels, extra energy is needed to balance the heat loss with heat gain. The following is a general expression of energy balance that is true for summer and winter (McMullan, 2002):

Fabric heat loss + Ventilation heat loss = Solar heat gain + Casual heat gain + Energy for heating or cooling

Fabric heat loss refers to the energy that flows through the building envelope. It is directly dependent of the thermal transmittance of the materials and the temperature difference between the inside

Applying multiple panes of glass with air space between them improves the insulation value considerably. Further improving the thermal performance of glazing units involves reducing the conductance of the air space between the layers by filling the space with a less conductive, more viscous or slow-moving material, such as argon. Additionally, low-emissivity coatings, called Low-E for short, act to reduce the surface emissivity of glass since 1995 (Giebeler, 2009). Such coating materials are mainly transparent across the visible wavelengths of light, but reduce the amount of long-wave infrared thermal radiation both absorbed and emitted by the glass pane.

Air tightness

Air leakage is a major cause of energy loss, accounting for approximately 20% in older houses. Air leakage refers to the uncontrolled flow of air through gaps and cracks in the building fabric, which is not for the specific and planned purpose of exhausting stale air or bringing in fresh air. Ensuring air tightness is achieved through careful and strategic planning throughout the design and construction phases. The application of insulation and window replacement improve the air tightness of a dwelling significantly.

Passive solar heating

Passive solar heating applies in the winter season, when energy for heating is required to achieve thermal comfort. It employs the structural elements of a building to collect, store and distribute solar energy with or without minimal use of mechanical equipment (Hyde, 2008). The sunlight is directly collected through the glazed area of the façade, especially the south oriented surfaces.

Solar energy can also be utilized in the form of indirect gain. These methods involve a heat-absorbing element between the incident solar radiation and the space to be heated. The Trombe wall is a popular technology of indirect solar heating. It consists of a transparent outer layer, a wall of high thermal capacity and an air-gap between the wall and the transparent surface. Solar energy is transmitted through the transparent layer and absorbed by the outer surface of the wall. It is then conducted to the inner surface several hours later, or is conveyed by the air flowing through the air-gap between glazing and wall. In areas that receive inconsistent solar radiation, such as the Ems Dollart Region, indirect solar gain can be of great benefit, especially when combined with air circulation measures (Smith, 2005).

Another way to exploit solar energy for heating is the use of sunrooms. Sunrooms are glazed rooms that allow sun to enter and heat the air and surfaces. The warm air is then circulated into the interior, while the high thermal capacity of the intermediate wall produces a time-delayed shift of the heat conducted to the inner surface. Apart from the advantage in terms of energy efficiency, such constructions have the benefit of enlarging the living space of the dwelling. During summer, when the heating effect is not needed, the glazed parts can be open to introduce a breeze, or protected with adequate shading.

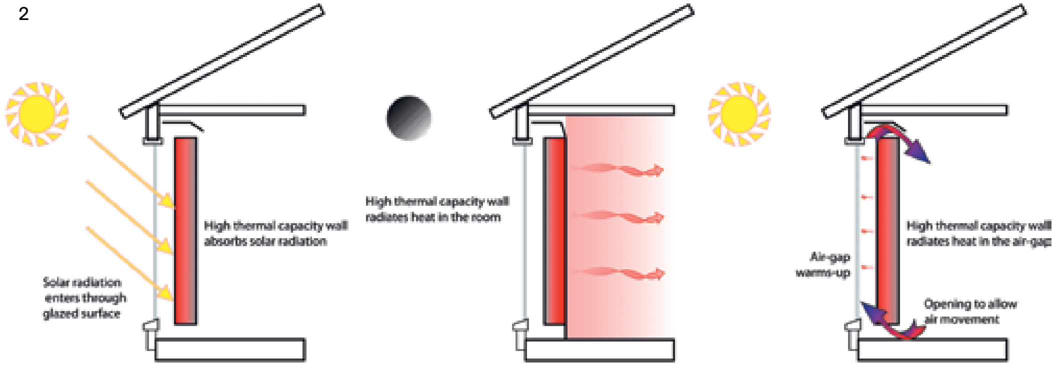
Sun control

Desirable as solar radiation might be during winter, it should be blocked out during summer to prevent the living space from overheating. The easiest way to block unwelcome solar energy is to install shading devices. They come in many shapes and forms, varying from projecting eaves to venetian blinds and curtains. The choice depends on individual performance, as well as functional and aesthetic aspects. External shading, for

1

Glazing	U Value (W/m² K)
Single glazing	5.6
Double glazing	3.0
Triple glazing	2.4
Double with Low-E	2.4
Double with Low-E and Argon	2.2
Triple with Low-E and 2 Argon	1.0

2



1 Comparison of typical heat transfer through different glazing options (source: Smith, 2005, p. 65, table 65.61)
2 How a Trombe wall works

3 Shading device as part of the renovation of Koningsvrouwen van Landlust – Eigen Haard (source: courtesy DeGroot en Visser, photographer F. Huijin)
4 Biomass boiler (source: courtesy 3N e.V.)
5 Wood pellets and wood chips (source: courtesy 3N e.V.)
6 Solar collector panel and photovoltaic cells as roof tiles, Papenburg, DE

example, is more efficient than internal, but the maintenance requirements are higher.

Orientation is another important factor that determines the type of shading to select. Horizontal solar screening louvers can exclude direct sunlight on the south side with little visual interference. Permanent shading features such as cantilevers can be used as seasonal solar screening. They block the high-angle sun in the summer, while allowing low-sun penetration during winter, enabling solar heating. Movable vertical louvers are preferred for east and west facing façades, where the sun strikes at low altitudes. Adjusting the angle of the louvers can block sunlight, while retaining some of the view (Hausladen, 2008).

Heat removal

Avoiding overheating is important during the summer season. Air flowing through buildings exchanges the heated internal air with cool outside air. This can be achieved with natural ventilation, mechanical ventilation, or air conditioning. Air exchange is necessary for health issues as well. Therefore, regulations state minimum air exchange rates and ways to achieve these. Ventilation rates are not connected to air leakage. Air leakage is uncontrolled and therefore needs to be minimized. The principle is "build tight – ventilate well."

There are several techniques to prevent overheating – or at least minimize the overheating effect – while maintaining air quality, before resorting to mechanical means of cooling. Natural ventilation through façade openings is the one most commonly used in residential buildings. The air is moved by buoyancy or the wind. In moderate climates such as that of the Ems Dollart Region, we can exploit natural ventilation during most times of the year, particularly in the domestic environment (Hausladen, 2008, p. 53).

ACTIVE MEASURES

Passive measures alone are not able to eliminate energy consumption during all seasons, particularly in the heating oriented climate of Central Europe. While passive measures aim at minimizing the heating demand, active measures are necessary to produce and distribute energy.

Heating systems

In addition to good insulation, heating systems are used to achieve a comfortable indoor environment. Heating systems can use fossil fuels, such as oil and gas, or energy from renewable resources, contributing to climate protection.

Modern biomass heating systems are an alternative to fossil fuels, and they are as efficient and easy to use as conventional systems. Various renewable resources are available as fuel in modern heating systems, such as wood (in the form of pellets, chips and split logs), vegetable oil or biogas. These heaters can be used in various types of surrounding, so that they are suitable for most buildings, if set up in accordance with the requirements. Wood pellets have to be stored in a dry and frost-free environment. Depending on the heating system, wood pellets come in different qualities according to the DIN Plus classification (from sawdust without bark to industrial pellets with bark). Another possibility is the use of vegetable oil instead of petroleum.

Some systems are designed for combined heat and power, i.e. they produce not only heat but electricity as well. They are typically used for high-voltage equipment, and are therefore not suitable for small projects. However, they can be used as a central power supply unit for several buildings. Such district heating networks can be built for a variety of projects, but the lengths of insulated

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pipes should be kept short to minimize conduction losses. Plants with natural gas or purified biogas (biogas to natural gas quality) can be operated in combined heat and power sectors.

Heat recovery ventilation

The air extracted from a building carries energy. A heat recovery ventilator (HRV) can help make mechanical ventilation more cost effective by reclaiming energy from exhaust airflows. HRV's use heat exchangers to heat or cool incoming fresh air, thereby recapturing 60 to 80% of the conditioned air that would otherwise be lost. Models that exchange moisture between the two air streams are referred to as Energy Recovery Ventilators (ERV's). Typically, these systems are also equipped with pollen filters which is very helpful for people with allergies.

Active solar collectors

An efficient solution, particularly in the summer, is a solar thermal system (e.g. using evacuated solar heating panels) combined with large hot water storage to supply domestic hot water (DHW) and heating. Solar collectors convert direct solar radiation into another form of energy, i.e. they preheat water using a closed circuit calorifier (Smith, 2005, p. 61).

Different types of solar collectors are available, depending on the system construction. Evacuated solar heating panels are more efficient than conventional flat plate type collectors and will perform considerably better in cold, cloudy and windy conditions. The higher efficiency of evacuated solar heating tubes means less necessary roof area – a desirable feature appreciated by most customers.

Photovoltaic panels

Photovoltaic (PV) installations are technical systems that transform radiation directly into electricity. Solar cells at the core of the installation are combined into modules that produce DC voltage (Schittich, 2006, p. 50). Photovoltaic modules can help to reduce the electricity demand from external electricity networks, as well as produce sufficient power to feed electricity into those networks.
The annual output of PV systems is also determined by the orientation and the angle of the module's surface. For Northern Europe, the highest annual radiation occurs at an angle of 30° for south-facing systems.

The main drawback of the PV technology is cost related. It is still expensive, even though it bears potential to reduce the environmental impacts caused by human activities. However, a number of developments, such as silicon based systems, have led to higher efficiency and reduced costs for the manufacturing process. As a result, prices of photovoltaic modules have dropped significantly over the last few years, making a purchase economically viable, particularly with regard to rising electricity prices. Furthermore, more efficient storage options for individual use are possible. The electricity stored could be used to operate an electric car.

4. THE MATERIALS ASPECT

The life cycle assessment includes quantitative evaluations related to functionality. It does not offer calculated absolute values but rather determines the ecologically most sensible measure by means of comparing variants.
A categorization, such as is typical when evaluating operating energy, is not common for building components.

The embodied energy of a solidly constructed dwelling house built to EnEV 2007 standard corresponds to approximately 30 years of operating energy. With decreasing operating energy, embodied energy becomes more relevant in an overall comparison. The energetic expenditure needed to produce a building poses a potential that, under consideration of the increasingly stringent protection of natural resources, is becoming more and more important. Depending on the type of construction and useful life, existing buildings bind a significant share of the overall amount of energy in the building fabric. The resources necessary for production have already been expended; they are part of the building fabric. This parameter is important when trying to decide whether to refurbish or build new.

4.1. THE POTENTIAL OF EMBODIED ENERGY

Legal regulations in the building sector define minimum standards for operating energy consumption, and thereby control the use of natural resources.

Besides turning resources into energy carriers, processing resources into building components offers a hitherto mostly ignored potential for climate protection. Since energy is needed for every step of the production chain, for example to make bricks from clay or concrete from cement, this energy must flow into a holistic consideration. The sum of all amounts of energy used in the production process yields the ecological footprint of a product. This share of energy is called embodied energy. While operating energy exclusively relates to the utilization phase, embodied energy includes the energy needed for the production and deconstruction phases. Linking both amounts of energy allows for a holistic examination of the ecological potential in the building sector.

Besides the passive effects on operating energy, producing as well as deconstructing a façade involves a certain amount of energy as well as emissions. This material-bound energy becomes increasingly important as operating energy is reduced. Material-bound energy and emissions are the focus of this study.

Calculating embodied energy is done on the basis of a Life Cycle Analysis, LCA. This method in turn is based on DIN ISO 14040: Environmental management – Life cycle assessment – Principles and framework.

The goal of a life cycle assessment is to identify and analyze the environmental impact resulting from the production all the way to the disposal of a particular product. It consists of a compilation and assessment of the input and output influences and potential environmental impact of a product system throughout its entire life cycle. The results of a life cycle assessment are illustrated by seven factors; whereby embodied energy such as non-renewable primary energy and global warming potential in kilogram CO_2 equivalents are the factors most frequently considered.

In Germany, life cycle assessment values are available for most material groups. Ökobau.dat, which was developed by PE International and the Chair of Building Physics at the University of Stuttgart, is a major contributor; the database contains a broad spectrum of building materials and building products. The German Federal Ministry of Transport, Building and Housing (Bundesministerium für Verkehr, Bau und Stadtentwicklung BMVBS) has published Ökobau.dat on the internet at www.nachhaltigesbauen.de. Another source for life cycle analysis values of building products is the Institute for Construction and Environment (IBU). IBU is mainly contacted by companies and associations to independently document the life cycle analysis values of their products in addition to other conventional properties. The format in which the LCA data is represented is called Environmental Product Declaration (EPD), and is based on DIN 14025.
IBU provides a general regulation encompassing all product group regulations (PCR) that allows the comparison of individual products.

4.2. A NEW PARAMETER FOR REFURBISHMENT

As a general rule, housing built during the past decades no longer meets current building technical requirements. Due to continuous heat loss in winter the buildings do not offer optimum indoor climate while creating high operating costs. Another aspect is that individual aesthetic perception also changes over time, and therefore demands a redesign at individually different intervals. Both issues can be resolved with refurbishment. The decision about refurbishing or building new must be preceded by a holistic ecological evaluation that encompasses all phases of a building's life cycle (production, use, deconstruction). First and foremost, the decision about an existing building is a question of quality of the living space and the building fabric. Continuing to use an existing building makes sense if an attractive living environment for the user/renter can be achieved cost-effectively. However, some aspects cannot be changed with refurbishment – it might therefore make sense to abandon the use of a building if it shows serious structural damage or highly unfavorable floor plan designs. Creating sustainability means generating quality, in this context living space quality.

Ecological aspects are relevant planning parameters when justifying either demolition and new building or refurbishment. Whereas operating energy is a factor often incorporated, the expenditures for production and deconstruction are seldom considered.

Embodied energy is a factor that needs to be considered in the decision making process if we want to make a holistic assessment. Buildings bind the energy consumed during production in the building fabric. Demolition means losing this energy. And additional resources are needed for a new building. If the share of metal parts is high, then components can be deconstructed and reused. This is seldom the case with mineral materials. Typically, these are deconstructed in an uncontrolled manner and the materials are used for a different purpose (downcycling). As a general rule it can be stated that the more solidly constructed a building is, the more energy there is bound in its fabric. And it is also true that by using an existing building for a longer period of time we can avoid consuming resources that are needed to build a replacement. Accordingly, building a new building is an energetic investment whose exchange value must be high quality use over a long period of time.

The following example illustrates this point of view. A building from the 1960s requires treatment; the amount of energy needed for heating is very large and some building components require structural reinforcement.

A solidly constructed three-story building with non-insulated reinforced concrete ceilings and stairs, a façade made of honeycomb brick plus outer leaf, double-glazed PVC windows, and a wooden roof structure with bitumen sheeting from 1962 stores approximately 3,500–4,000 MJ/m^2. With a primary energy demand of 330 kWh/m^2*a (1188 MJ/m^2*a) for the previous operation of the building, the embodied energy corresponds to approximately three years.

The embodied energy of the building is distributed as shown in figure 1. Plotted on a typical distribution, this value is relatively low for a solidly constructed building. This is due to the then typical thinness of the ceiling (130mm) and low

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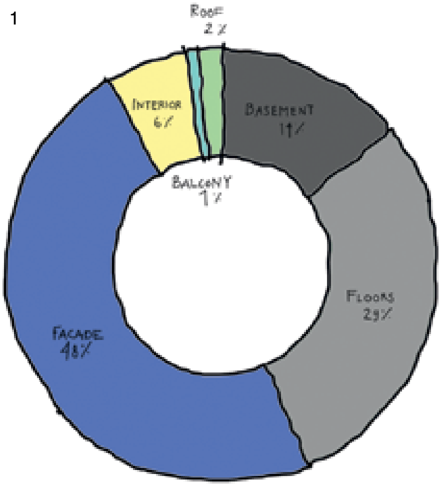

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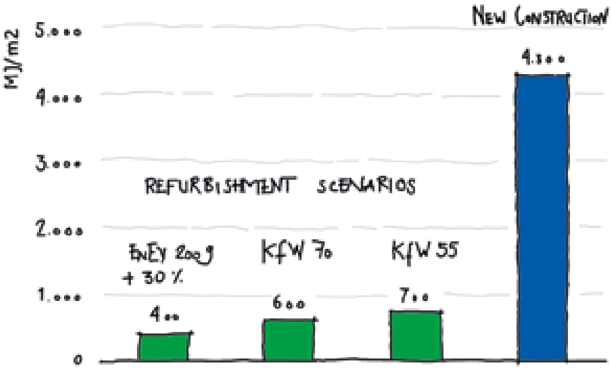


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1 Embodied energy for a multi-family house, 1962
2 Comparing embodied energy for refurbishment and new construction
3 Aluminum profiles sorted out for recycling
4 Broken laminated glass sorted out for recycling
5 Renewable energy and bases for bioplastics (corn)

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6 Leaves embodying carbon
7 Timber strings
8 Tree in autumn - carbon storing decreases
9 Timber brick - wood in building materials is storing carbon
10 Timber tiles - wood in building materials is storing carbon

story heights (2.75m). A refurbishment to the standard of EnEV 2009+30% would mean that the energetic expenditure would rise to 4,300 MJ/m^2, for KfW70 to 4,500 MJ/m^2 and for KfW55 to 4,750 MJ/m^2. A renewal of the roof structure is incorporated in this calculation even though it does not have a great share in the overall balance due to the great amount of timber used.

This building is compared to a new building of the same value. Even though this comparison tries to incorporate equal functional properties wherever possible, some parameters have changed over time and cannot be of the same quality (ceiling height, for example).

The expenditure to produce the new building is slightly higher than that of the existing building. The comparison of the ecological investment of refurbishment versus new building shows an advantage of the existing building.

An energetic analysis determines the heating demand (Qp) of the new building as well as the refurbishment scenarios. According to EnEV, the existing building may be operated with 30% more energy than the new building. This additional expenditure is considered in the overall energy analysis.

Thus, the new building uses a little less energy than the refurbished variant. The amount of embodied energy consumed to produce the EnEV 09 standard corresponds to one year of operating energy of the existing building; for the KfW 70 standard it is two years, and for the KfW 55 standard six years (figure 2).

The deciding factor is to compare the expenditure of the refurbishment and the new building: The new building requires approximately seven times the primary energy than the existing building. Therefore, the savings in operating energy only amortize after sixty years. Such long amortization periods highlight the relevance of the energy bound in the building fabric, and they support the use of existing buildings as long as functionality allows.

The comparison shows the ratio of embodied energy and operating energy. If the functionality of a building is maintained, a building's energetic potential should be exploited by long-term use.

With decreasing operating energy, there is an increasing awareness of embodied energy which changes the perspective on existing buildings. Using the energy bound in existing building stock can support the protection of natural resources, and therefore contribute to a more sustainable interaction with nature. Thus, refurbishment offers the potential to adhere to the climate protection goals of many governments.

5. MATERIAL AND CONSTRUCTION

wirksamer als Vorräte anhäufen," Wald und Holz, 4/10: 3.)

The usage of wood for building elements has three material group specific advantages:

- The material withdrawn from nature can be reproduced in relatively short periods of time
- The usage of renewable materials prevents the consumption of fossil resources
- The use of wood products extends the phase when the CO_2 is captured

Renewable materials bear high potential, particularly for refurbishment. They not only contribute to decreasing the energy amount needed for the building's operation but generally embody less energy than products from non-renewable resources. They exploit the entire potential for minimum environmental impact in the building context, namely the reduction of operational and embodied energy.

Many products are available that constitute an equivalent alternative to common products from non-renewable resources.

The ones with the largest potential for refurbishments in the Ems Dollart Region are introduced here. They are categorized according to their physical properties and load-bearing and insulating capacity.

NOTES

1 www.nachwachsenderohstoffe.de/basisinfo-nachwachsende-rohstoffe/ueberblick
2 www.bafu.admin.ch/wald/01198/01209/01210/index.html?lang=en
3 www.fsc.org

5.1. RENEWABLE MATERIALS IN THE BUILDING CONTEXT

The building industry drastically interferes with natural cycles. Therefore, the building sector must strive to build with the least possible harm to nature, with regard to the construction itself and the building materials used. The longer it takes nature to replenish the withdrawn resources, the more harmful the impact on environmental processes. Renewability refers to the time nature needs to fill the gap caused by the use of natural resources. In the definition by the German Federal Ministry of Food, Agriculture and Consumer Protection (Bundesministerium für Landschaft und Verbraucherschutz), renewable materials are agricultural and silvicultural products that are not used for food and fodder.[1]

Typically, renewable materials used in the building industry are made of plant fiber. They find application in various functions, for example as part of a building structure, interior and exterior surfaces and as insulation material. Most renewable products in the building industry consist of wood.

Plants' ability to absorb and store CO_2 has a positive impact on the global greenhouse effect, as CO_2 is one of the most relevant greenhouse gases. In order to fulfill the politically defined obligation to reduce the amount of CO_2, countries are allowed to account national forests in their national GWP (global-warming potential) balance. Therefore, forest cultivation is part of the global strategies to face climate change. Capturing carbon works as a carbon sink which helps to reduce the global greenhouse balance.[2]

The relevance of renewable materials is not limited to the positive impact on the greenhouse effect as they are an important factor of our ecosystems. For example, roots keep the soil soft and stable and thereby prevent erosion and flooding. Furthermore, forests are home to numerous animal and plant species.

The ecological quality of wood is defined by the characteristics of the forest. International organizations such as the Forest Stewardship Council[3] request standards for human, ecological and economic parameters.

The ecological footprint of a building can be positively influenced by employing renewable materials.

As part of the process of photo-synthesis, carbon dioxide is used when plants grow. From the perspective of the life cycle assessment methodology, this period is considered the production phase. The use of carbon dioxide leads to positive GWP numbers for the production phase of wood. In Europe, vast areas are covered with forest, so wood is readily available. Only a few steps are necessary from harvesting the material to the end product; additional energy intensive processing steps, such as the use of high temperatures, are rarely required.

Wood captures and uses CO_2 during its growing phase and releases it when rotting or being burnt. The longer carbon is stored in the renewable material, the longer it takes for it to become a (potentially harmful) greenhouse gas. Installing a wood product in a building as compared to letting it rot in the forest helps extend the storage period and postpones the moment of release. (Cf. Ariane Walz et al.(2010), "Holz nutzen ist

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1 Timber frame construction
2 Loghouse façade
3 Loghouse close-up

5.2. BUILDING STRUCTURE: TIMBER CONSTRUCTION

Wood as a building material has a long tradition. The forest grows back; it binds CO_2 and produces oxygen. Forest management in Germany, for example, has been subject to sustainability laws for more than 200 years; meaning that over a certain period of time only the amount of wood may be withdrawn that can grow back.

The use of wood leads to long-term CO_2 storage in wood products (log cabins, for example). In Germany, 18 million metric tons of CO_2 are bound as carbon in wood products annually. Since in contrast to other materials wood requires less energy during processing, the use of wood further protects the environment. Such material substitution prevents 57 million metric tons of CO_2 per year.

Unfortunately building with wood has long gone out of style, but in the course of an increasing environmental awareness the number of new wooden buildings is rising. In Germany, the number of building permits for single and two family houses made of wood has increased in 2010 by 9.3% within one year. This means that the market share of wooden prefabricated houses has now increased by 15%.

Since building a wooden house typically requires only dry building materials, the drying and overwintering process typical for masonry in earlier days is eliminated. The flexibility inherent to wood constructions leaves a lot of room for individual designs and future adaptations to a different use. The natural material also evokes an unmistakable domestic ambience. Modern timber houses are an economic investment and have lasting value.

Properties of the material wood:

- Easy to process, by machine or manually
- High degree of prefabrication
- Low weight
- Low thermal conductivity
- Good electric insulation properties
- Capability to create a comfortable room climate by absorbing, storing and releasing humidity
- Good acoustic properties
- Good fire protection properties due to low heat conductivity and the forming of a heat-insulating charcoal layer (load-bearing capacity is maintained even in the case of fire)
- A wood construction planned and executed in a way appropriate to the material needs no chemical protection

Timber constructions can be realized in different ways, categorized as follows:

- Timber frame construction
- Log house construction
- Wood frame construction and wood panel construction
- Wood skeleton construction
- Solid wood constructions
- Mixed building systems

TIMBER FRAME CONSTRUCTION

Timber frame construction is a historic system that is rarely used for new buildings. The load-bearing structure is assembled from horizontal and vertical timbers stiffened by braces. The spaces between the timbers are filled in with clay or brickwork and plastered. On the weather sides, the wooden load-bearing structure is often protected from the elements by a plastered surface or a rear-ventilated wooden cladding. Many well-maintained timber frame constructions are several hundred years old.

LOG HOUSE CONSTRUCTION

Log house construction is one of the oldest types of building system. In former times the walls were built by stacking logs. For today's log house constructions, very thick, dimensionally stable boards with tongue and groove joints are used. The boards sometimes form two leaves, and are joined with box joints and dovetail connections at the corners and other connecting areas. Due to the solid, horizontally layered wood cross-sections, settling occurs because the wood shrinks; an unavoidable fact that must be considered during planning and addressed by careful detailing. The particularities of this building system pose high requirements in terms of planning and execution quality.

WOOD FRAME CONSTRUCTION AND WOOD PANEL CONSTRUCTION

With this type of construction, the building components are made of a load-bearing frame of technically dried solid wood sections or other rod-shaped wood carriers, which are stiffened by a planking of timber material boards or gypsum boards. The construction grid, with posts set at a distance varying between 625 mm and 1000 mm, is dependent on the dimensions of the planking used.
The space between the framed areas is completely insulated. The wood frame construction is protected from the elements by a separate, usually rear-ventilated cladding made of wood, wood-based material or plaster-base sheeting, by thermal insulation composite systems with a plastered surface or by a separate leaf of rear-ventilated brickwork. Wood frame and wood panel constructions use prefabricated elements that allow for short set-up times and therefore quickly protect the shell of the building from weather conditions.

In practice, the terms "wood frame construction" and "wood panel construction" are used interchangeably. Insofar as one of the terms is used by itself in the following, the statements made are true for both systems. The difference between the two building systems lies in the degree of prefabrication; the construction principle is the same. Today, the carpenter-like wood frame construction is barely different from wood panel construction that is employed by suppliers of prefabricated housing. The degree of prefabrication depends on the building task at hand. Both building systems allow for rain-tight assembly of one or two family homes in only one day. With this method of construction, the ceiling elements are laid onto the walls below, creating a platform on which the next story can be erected.

A different method of wood frame construction is so-called "balloon framing." Hereby, the wall elements extend across the entire height of the building, forming a complete exterior envelope (balloon). The ceiling elements are suspended inside the envelope. "Quasi balloon framing" has developed from a combination of the two methods of construction. It also involves creating a continuous envelope. But the panel elements are separated above the ceiling. Wood frame and wood panel construction methods benefit from a high degree of prefabrication because the elements are produced in dry conditions, ensuring quality.

WOOD SKELETON CONSTRUCTION

A rod-shaped load-bearing structure made of vertical supports and horizontal carriers (post-beam construction) is characteristic for skeleton construction. This building system differs from other principles of construction in that the distance between the support posts is

4 Wood skeleton with weather boards
5 Wood skeleton, construction phase
6 Massive wood construction (by Lutz Artman)

The great benefit of this method of construction lies in the use of a large share of building material made from renewable resources which, in the case of straw bales, are scarcely processed and are a natural by- or waste product of harvesting. Additionally, if a house is built in a rural area the transport distance can be very short.

larger (up to five meters), and that the load-bearing structure and the enveloping structure are separated. Stiffening is achieved with braces, sometimes also with infills from wood frame building elements. Since the enveloping walls are not load-bearing, this system offers a high degree of flexibility in terms of floor plan design.

SOLID WOOD CONSTRUCTIONS

Load-bearing and space enclosing building elements in solid wood constructions are made of nailed or doweled board stack or layer elements, or glue-laminated board elements. They are used as solid planar ceiling or wall elements. These robust constructions are usually processed fully automatically in the factory. Typically, the elements are insulated on the outside with insulation layers covering the entire surface, or with insulation installed in the spaces between screwed onto lattice constructions.
As with the wood frame and wood panel construction methods, interior and exterior cladding can be freely selected. Insofar as the building elements cannot be dimensioned in accordance with current norms, building inspectorate approval is on hand. Numerous test certificates are available related to fire and noise protection properties.

NEW AREAS OF APPLICATION AND MIXED BUILDING SYSTEMS

Buildings based on wood constructions have been long established in the one and two family housing sector. Changes in building laws have made it possible to now build up to eight story high residential and administrative buildings in wood. And wooden constructions are increasingly used for vertical and horizontal extensions. Furthermore, the above mentioned construction methods are sometimes combined, for example by adding solid wood construction-type ceilings to buildings based on wood frame construction.

Another option that is becoming increasingly recognized is the possibility of constructing highly thermally insulated building envelopes very cost-efficiently by combining wood frame building elements with load-bearing structures made of other materials (e.g. reinforced concrete skeleton structures). Such mixed construction methods are also increasingly applied to refurbishment measures, for example as part of façade refurbishment using prefabricated façade elements.

STRAW BALE CONSTRUCTION

A special type of sustainable building is building with baled straw from crops. The so-called “construction-type straw bale” was officially approved as building material a few years ago. There are specifications in terms of density, humidity content and dimensions. Straw bales are used in combination with wooden construction methods and clay as render material on inside and outside surfaces. In Germany, this building material is subject to the limitation that it can only be used in combination with a wood stud frame construction. A load-bearing construction without a structural wood construction has not yet been approved. Therefore, straw bale houses are built with a wood stud frame construction, whereby the straw bales are inserted into the spaces in between the studs, or are mounted on the outside of the frame as a continuous wall. If used as infills, the bales can be used horizontally or vertically because they do not need to carry great loads. Due to the fibered structure of the haulms and the width of the bales, straw bales have very good thermal insulation properties. Using clay on interior walls provides a balanced indoor climate.

5.3. THERMAL INSULATION

Currently, energy used for heating purposes causes approximately 25% of the overall CO_2 emissions. Besides selecting a suitable energy carrier and installing sophisticated heating systems, improving thermal insulation of the building envelope can play a key role in reducing pollutant emission. Thus, every single thermal insulation measure is a contribution to protecting the environment. For thermal insulation, materials should be chosen that are environmentally friendly themselves, and do not contain or release pollutants, either resulting from the production process or due to their chemical composition. They should save more energy than is needed to produce or reuse them. Insulation materials made of renewable resources meet these demands perfectly. During growth, plants absorb CO_2 from the atmosphere. Additionally, compared to conventional insulation materials, the production of insulation material made of renewable resources requires very little energy, i.e. less energy is consumed to achieve equal insulation properties, and the disposal of insulation material made of renewable resources does not release more CO_2 than the plant originally absorbed from the atmosphere.

Similar to conventional products, insulating properties are achieved with the small air chambers in and between the fibers. Humidity behavior is a different matter. In contrast to mineral and synthetic products, natural insulation materials can store and release humidity; they are water vapor permeable. This property can be employed to regulate the humidity level within a building. Formation of condensation such as it occurs in enclosed rooms is not an issue. Using humidity regulating materials can help to avoid the “sick building syndrome.” The resulting indoor climate is beneficial. Insulation material made of sheep’s wool is even known to absorb a certain amount of formaldehyde, which means it can clean contaminated rooms.

INSULATION FROM RENEWABLE MATERIALS

However, due to their natural structure, insulation materials made of renewable resources offer even more advantages. Compared to conventional products, they feature a higher density and can therefore store more thermal energy.

Modern insulation materials made of renewable resources have been produced for several decades. Primarily, they consist of vegetable and animal fiber as well as of granulate from vegetable components (rye, cork). Due to their technical and building physical properties, different insulation materials are suited for different applications. Depending on the application, the insulation material comes in different forms of delivery (loose, matting, panels). Loose material, for example, is well suited to be inserted between wooden posts and beams (e.g. in ceilings) – or, more generally, in any structural hollow space. There is no loss of material and all cavities can be filled. Insulating panels or matting are cut to size and can then be accurately installed. The insulation materials made of renewable resources currently on the market have building inspectorate approval, i.e. they have proven their usability and applicability as defined by national building codes, just like the conventional products.

The fibers most often used to produce insulating materials made of renewable resources are flax, hemp, wood, wood

5

Resource	Flax
Fire resistance	B2
Thermal conductivity (W/mK)	0.040 – 0.050
Diffusion coefficient	1 – 2
Effective heat capacity (J/kgK)	1900
Products	Matting, boards, insulation ropes, blow-in insulation

6

Resource	Hemp fiber
Fire resistance	B2
Thermal conductivity (W/mK)	0.040 – 0.050
Diffusion coefficient	1 – 2
Effective heat capacity (J/kgK)	1600
Products	Matting, boards, insulation ropes, blow-in insulation

7

Resource	Recovered paper
Fire resistance	B2
Thermal conductivity (W/mK)	0.040 – 0.045
Diffusion coefficient	1 – 1.5
Effective heat capacity (J/kgK)	2200
Products	Matting, boards, blow-in insulation

8

Resource	Wood
Fire resistance	B2
Thermal conductivity (W/mK)	0.040 – 0.055
Diffusion coefficient	1 – 10
Effective heat capacity (J/kgK)	2100
Products	Boards, blow-in insulation

5 - 8 Insulation material from renewable resources and their physical properties

9 Cellulose
10 Flax

shavings, cellulose, sheep's wool as well as grass, seaweed and reed. In addition, granulates from rye or cork are used (fill and blow-in insulation).

Thermal insulation is primarily used on exterior walls and the roof. Whereas in the roof area the thermal insulation material (usually in the form of rolls or panels) is protected from wetness, various systems are used on the façade. New buildings are typically equipped with panel or matting type insulation material that is then covered with a layer of clinker bricks or a wood façade. However, over the past few years, so-called thermal insulation compound systems have enjoyed increasing application. These are insulation panels, made of wood fiber for example, that are already combined with a plaster base and plaster. The panels are fixed onto a flat surface by means of dowels or glue. The joints between the panels are spackled to form a homogenous surface. The plaster used is weather-resistant. The advantage lies in the fact that there is no need for a substructure such as is required in the case of an exterior wood façade.

This type of insulation can be used for new buildings as well as for refurbishment projects. If refurbishment of certain existing buildings is subject to restrictions, as might be the case with historic buildings, other methods of insulation can be used depending on the façade type. If, for example, the façade consists of double-shell brickwork, the cavity between the two brick layers can be filled with blow-in insulation or insulating foam. Unfortunately, few insulating materials made of renewable resources are approved for this particular purpose. Thus, products made of mineral wool and Styrofoam are typically used. Interior insulation can be a viable alternative. Even though it is more challenging with regard to building physical aspects, it can be realized without difficulty if the set-up of the brickwork and possible thermal bridges are considered. When using insulating materials made of renewable resources for this type of insulation, it is important to integrate a vapor retarder to achieve a wall that is capable of diffusion. The material must be able to release absorbed humidity back into the interior space. One option is humidity-adaptive vapor retarders. The material (e.g. polyamide-based) that these vapor retarders are made of changes its permeability depending on current humidity levels, and thus prevents too much water from gathering and possible condensation occurring.

In addition to good thermal insulation properties, insulating materials made of renewable resources offer particularly good properties in terms of sound insulation. Especially in inner city areas or areas with high noise levels (e.g. in the vicinity of construction sites or airports), a healthy living environment requires that the sound level inside buildings must remain low. This can be primarily achieved with soundproof windows; but also by using insulating materials made of renewable resources that, due to their high density levels and fiber structure offer sound-absorbing properties.

5.4. SUMMARY

Products made from renewable materials are relatively young and are often perceived as niche products. This perception will change fundamentally over the next years. Renewable products will replace materials from non-renewable resources as these become rare and more energy intensive to produce. Products from renewable materials bear a high potential to reduce the overall environmental impact of the building industry. The production energy is far lower than that of non-renewable materials. Additionally, the amount of waste will be reduced by the application of biodegradable products.

Wood constructions are especially relevant for new buildings or for adding volumes to an existing structure. They offer many advantages for building construction. The material is light, flexible in terms of the possible range of application, and a high degree of prefabrication means short on-site installation times. Many variations are available, from solid wood constructions to combined solutions including reinforced concrete or wooden frameworks in which only the structure is made of wood.

Insulation material from renewable resources contributes directly to energy reduction. Even though the higher thermal conductivity inherent to these materials as compared to conventional ones yields relatively less energetic performance, renewable insulation material still decreases the environmental impact because it stores the energy that was expended to produce it. But we do need to take into consideration that in order to achieve the desired insulating effect, the thickness of renewable insulation material might have to be thicker than that of conventional material.

Blow-in insulation has shown to be effective particularly for existing buildings. EIFS (Exterior Insulation Finishing System) made from wood fibers is of significant relevance. A frequently installed product is EIFS with polyurethane or expanded polystyrene, as it is a cost-effective way of improving the thermal capacities of a wall. The vapor resistance of the insulation materials brings with it humidity problems; which means that this type of wall mounting has a relatively short usable lifetime. After ten years, it has to be serviced or even replaced. Moisture damage such as mold on the inside can appear, caused by the wall's resistance to humidity. Another serious issue is recycling EIFS's made of non-renewable materials. In this respect, the products introduced above offer essential advantages. In contrary to EIFS, which has to be deposited at hazardous waste sites, renewable materials can be recycled or become part of energy generating processes.

For the planning of refurbishment measures, products from renewable materials can significantly contribute to achieving a sustainable solution. It is worth checking and comparing the properties and capabilities of conventional and renewable products.

This topic is of particular relevance for the Ems Dollart Region. Not only does the region manufacture a variety of products, but institutes such as 3 N support energy from renewable resources by conducting informational events.

11 Hemp
12 Grass
13 Wood fibre

6. APPROACHES TO REFURBISHMENT

1 Restore - Oldenburger Hundehütte (doghouse)
2 Keep the spirit - De Hoogte
3 Refresh - Dwelling and office in Niehove
4 Spice it up - Lighthouses in Groningen
5 All new - Reconstruction of a residential house from 1962 in Lingen

THE WHY, WHAT AND HOW OF REFURBISHMENT

As described in the previous chapters, various topics influence the decisions of why, what and how to refurbish. Chapter 3 refers to climate design principles and the consequences as well as technical problems that can occur if they are not applied properly. Chapter 4 highlights the potential of embodied energy as one major aspect of the decision making process. Chapter 5 discusses the typical types of construction and material seen in the particular region chosen for this exercise.

The Ems Dollart Region discussed in this book should be understood as an exemplary region to express the issues as well as the potential of rethinking housing. General refurbishing typologies, strategies and technologies have to be varied depending on the local tradition and environment – with the consequence that each design, each reuse, refurbish and intervention activity becomes unique and individual. The very first sentence of Paul Meurs´ introduction to the book Discovering the assignment by Job Roos[1] can be quoted here: "There is no ready-made recipe for interventions in historical buildings. Respect for the existing is important."

WHAT ARE WE TALKING ABOUT SPECIFICALLY?

This book focuses on rethinking existing buildings – mostly housing – and the need or desire to refurbish them by cleaning them up, replacing, subtracting and adding physical elements to maintain or give new functionality and performance. By doing so, the building is subject to actions that prevent demolition and offer a new functional lifetime. Technically speaking, the parts of the building that need dealing with are such components as the building envelope (roof, wall, façade, window, and exposed floors), the structure (if separate), the interior and the building services.

HOW ARE WE GOING ABOUT THIS?

To organize the various alternatives of interaction with existing buildings, we defined five general categories. Obviously, this is a subjective definition based on concrete experiences, investigations and research – but the alternatives should be understood as a basis for discussion since the borders between them are fluid and the potential for concrete designs varies.

The first category, which we have called "Restore," is defined as the broad range of measures related to cleaning up and/or replacing faulty or damaged parts in the same style and technology as the original. The goal of these measures is not to change the functionality or performance of the existing building, but to enable the building to survive in its original design.

Another approach is what we call "Keep the spirit." Here, the principal functionality and style of the building is to be maintained, while technologies may change to fulfill new requirements and functions. New technologies are also considered if they are more sustainable or simply cheaper.

"Refresh" as we define it is the principal possibility to not only replace old technologies with new ones, but also to add new components that interact with the building's style and function. New building volumes and significant changes in the layout and organization of functions, structure and components can be seen as a means of refreshing the building.

- 10 cm additional insulation within an existing roof structure: payback after approximately 12 years
- All of the above: new insulated glazing, 10 cm external insulation and 10 cm additional insulation in the roof: payback after approximately 19 years. The increased payback time is due to the fact that higher investments pay back later, but doing all of these measures also shortens relative payback time because of the resulting energy savings.

These figures are related to an average housing block in the region, built as a solid construction with single-glazed windows and without insulation. The suggested payback times are only related to the direct investment and based on energy costs levels of 2012, with gas being the main source of energy. If energy costs increase, the time of payback will be shorter, whereas the interest burden for the investment might increase the payback time.

We want to point out that these figures can only be seen as a first indication and obviously have to be adjusted for each individual project and its technical opportunities as well as the regional markets.

If we consider the technical aspects of refurbishment described in previous chapters and combine them with the functional aspects, the expected design result offers more value than the sum of the individual actions. This is due to the interaction of all choices, and the future potential of the building. The following chapter highlights examples of different types of buildings from the Ems Dollart Region (in relation to chapter 3) and describes various alternatives for intervention, documenting possible ways to approach a refurbishment project and the corresponding results. The last two chapters of this book illustrate “imagine” ideas – to stimulate the imagination and provide inspiration for users and designers alike.

The final result should always be more than just the sum of the parts.

NOTE

1 Job Roos, Discovering the assignment: Redevelopment in practice, Delft: VSSD, 2007

More aggressive interventions with drastic changes in layout and organization coupled with significant changes in appearance by adding or subtracting larger building volumes are categorized as “Spice it up.” Here the focus lies not only on adding building parts but on a general change of the building’s appearance and functionality which results in a spirit of newness, with a tendency to neglect the existing.

Lastly, there is the “All new” approach, in which some parts of the building are kept due to legal, technical or financial reasons but the essential parts are new. This approach is based on ignoring the previous building design and focusing on an entirely new appearance, new surfaces and functionalities.

Before beginning any refurbishment measure it is important to thoroughly investigate and record the existing – to understand the decision making processes in order to come to well-founded decisions yourself, which might result in the decision to deconstruct. Any new measure must be clearly illustrated – which includes referencing any part of the original design and/or existing building that remains as part of the new design. Therefore, all existing components, used as well as new, must be isolated, exposed and documented.[1]

WHY ARE WE DOING THIS?

Besides public interest in redeveloping certain regions, neighborhoods and individual buildings, as well as maintaining heritage, this book focuses on the individual owner of a building. In this regard, we can identify the following driving forces behind developing refurbishment measures:

Security: The building is no longer safe, which causes risks to the user and/or environment. This means that the building needs treatment to prevent further damage – which is the responsibility of the owner.

Comfort: Either a new function requires a new comfort level, or the existing comfort level does not meet current expectations while the functions are maintained. This relates to temperature, humidity, air quality and visual comfort as well as to “esthetic” comfort in the sense of creating appealing surfaces.

Budget: And lastly, financial reasons must be considered as a driving force to refurbish. This could result from an interest to reduce the costs for energy consumption, and therefore to search for opportunities to improve physical performance. Or from the desire to provide the building with new functions to make it more attractive for the user.

When considering budget, the prevailing question is whether the investment will pay back. And, of course, when will it pay back? Which are the first steps to take? Which ones make more sense than others? Experiences from previous research projects offer the following rough estimations, which can help in identifying an appropriate approach:

- Single glazing/early uncoated double-glazing replaced by up-to-date insulated glazing (U-value around 1.0 W/m^2k): payback after approximately 10 years
- 10 cm external insulation and plaster added to a solid construction: payback after approximately 12 years
- 20 cm external insulation and plaster added to a solid construction: payback after approximately 15 years
- 10 cm internal insulation added to a solid construction: payback after approximately 9 years. Here we need to take into account possible thermal bridges and the resulting risk of moisture, as well as the loss of floor space.

7. BEST PRACTICE EXAMPLES

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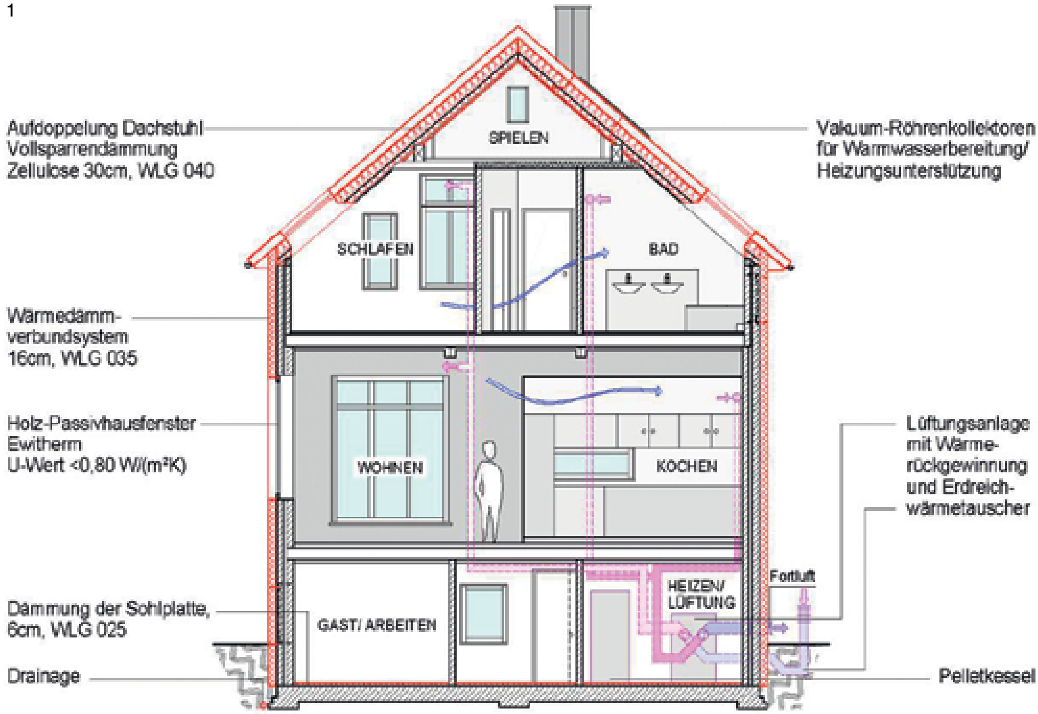

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1 Funtional scheme (by team 3 architects)

2+3 Oldenburger gabled house after the refurbishment (by team 3 architects)

7.1. RESTORE - OLDENBURGER HUNDEHÜTTE (DOGHOUSE)

BUILDING TYPE Residential/office
LOCATION Oldenburg, Germany
CLIENT Family X
ARCHITECT Team 3 architects
YEAR (ORIGINAL CONSTRUCTION / REFURBISHMENT) 1869/2006

"Oldenburger Hundehütte" (Oldenburg doghouse) is a building type that was built frequently in the city of Oldenburg, Germany and the surrounding area over a period of several decades during the 19th century. It is characterized by simple, standardized forms which might well have led to its nickname. The plain (upper) middle-class houses are often located directly adjacent to the city centre.

A fully usable souterrain, representative mezzanine level and ample space in the attic story – a total of 283 square meters – made it possible to combine living and working under one roof.
The formerly representative rooms on the street side were converted into offices, and the small sheds in the outbuildings on the rear side were transformed into open kitchens with spacious living/dining areas that open up toward the garden with story-high windows. In the attic story several dividing walls disappeared as well to create three children's rooms, a master bedroom and a bathroom.

The energy consumption of approximately 46 liters of oil per square meter of the 19th-century building was very high; a consumption rate that nowadays presents an ecological and financial burden for the environment and the client. After being refurbished in 2006, the building fell below the EnEV requirements (German regulation for energy saving in buildings and building systems) by half, and could be promoted by the KfW banking group (credit institute for reconstruction) as well as by Dena (German Energy Agency) who added the "Oldenburger Hundehütte" as a model project for "Low energy house – existing buildings."

For the architect and the client it was just as important to maintain the character of the existing building as it was to achieve optimum thermal insulation. In spite of thick layers of insulation and window frames, the old façade proportions and therefore the appearance of the building was maintained. To achieve this, the planners pushed the windows further out and adjusted the roof overhangs.

7.2. KEEP THE SPIRIT - DE HOOGTE

BUILDING TYPE Residential
LOCATION Groningen, Netherlands
CLIENT De Huismeesters
ARCHITECT KAW architecten & adviseurs
YEAR (ORIGINAL CONSTRUCTION / REFURBISHMENT) 1920/2012

In the spring of 2009, De Huismeesters housing corporation began the large-scale, sustainable refurbishment of houses in two characteristic neighborhoods: De Hoogte and Tuinwijk. Both were built during the 1920s and '30s, and primarily consisted of social housing, encompassing a total of almost 800 households. De Hoogte is a neighborhood of 494 houses and Tuinwijk a neighborhood of 284 houses.

In addition to the building refurbishment project, the public spaces of both neighborhoods will be revitalized with various measures, from solving parking problems to redesigning green space and meeting places for residents. This integral and sustainable approach is a result of an intensive and often organic collaboration between the housing corporation, the municipality of Groningen and the residents. The residents were organized in planning groups, supported by a professional and independent advisor paid by De Huismeesters.

Over the past years residents of both neighborhoods have indicated a need for larger living areas. Therefore, some of the 780 ground and second floor apartments will be vertically merged to create around 110 larger homes for families and other households. All dwellings will be significantly improved with the restoration of unique façades and architectural constructions as well as efficient interior facilities such as renewed toilets, bathrooms, hot water and electrical installations. At the same time, significant investments will be made in order to make all homes more energy-efficient. A large package of energy-saving measures is to be carried out. All roofs, façades and floors will be insulated; the houses will be equipped with HR++ glass, efficient heating and an intelligent ventilation system with heat recovery. These investments result in a substantial improvement of the energy label of the buildings from label E/F to label B/C. This means that energy consumption can be reduced by around 30% without any change in user behavior.

The total investment of the renovation at De Hoogte and Tuinwijk is around € 72 million.

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4 Oldenburger gabled house after the refurbishment (by team 3 architects)
5 Garden view (by team 3 architects)
6 Oldenburger gabled house before the refurbishment (by team 3 architects)

5

6

1 De Hoogte before renovation
2 De Hoogte after renovation (by KAW architects)
3 De Hoogte after renovation (by KAW architects)
4 De Hoogte site plan (by KAW architects)
5 A street view in De Hoogte in the 1920s
6 A street view in De Hoogte today

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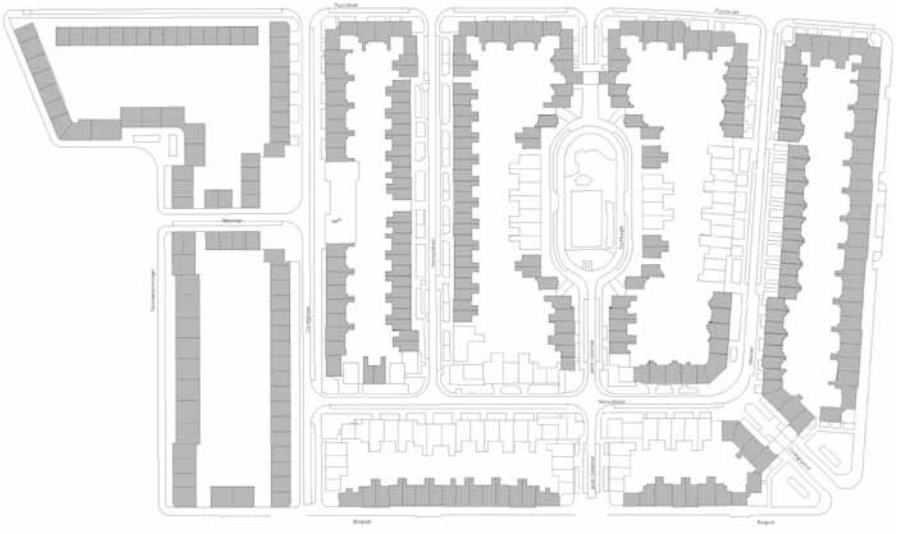

The idea of using a farmhouse barn as a large umbrella under which separate new volumes are assembled like furniture is a design concept that does not only feature special spatial qualities, but also matches the new manner of utilizing former barns in building physical terms. To insulate an entire barn would result in a situation in which the roof could no longer ventilate and move, as old barns do; the load-bearing structure would be wrapped, and an enormous volume would have to be heated. As interior elements, free-standing volumes under one roof are easier to build and optimize in terms of the building physics. And on top of that, the roof remains intact. The confined volume of the office can easily be kept at the desired temperature with a heat pump system. The climate in the unheated intermediate space is such that throughout most of the year, the space can be used for various living and working activities. The utilizable space changes with the seasons.

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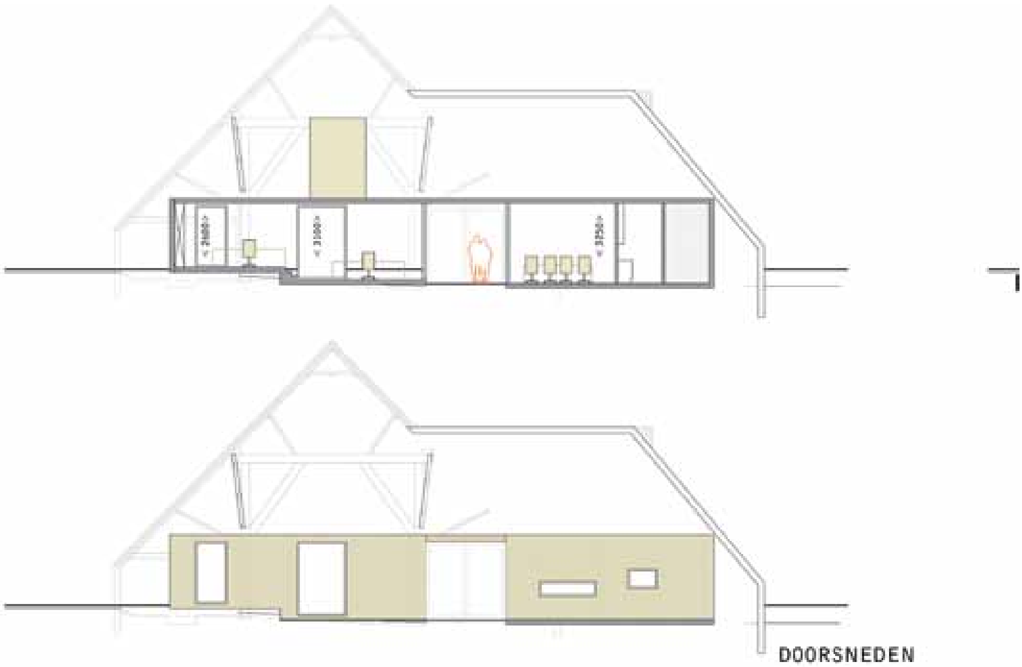

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The Lighthouse consists of wood constructions which are delivered and positioned in modules. On Rabenhauptstraat, they are finished with a wood cladding; but in principle other materials can also be used as cladding. Thus, apartments can be assembled at ground level (the true ground level), in business premises, warehouses, parking garages and individual garages. But they can also be built on top of higher buildings, two-story apartments and existing apartments such as on Rabenhauptstraat. Free-standing as well as joined, two, three or four stories high, from studio to full-scale apartment. Since the modules are lifted and positioned by crane, there is no need for scaffolding.

An even greater degree of variation can be achieved by stacking one, two or three completely prefabricated apartment modules. Currently, work is being carried out together with Meeuw Bouwsystemen to optimize the modules and the concept. The goal is to further reduce cost, increase the joining possibilities and improve logistics.

An advantage not to be ignored is the fact that this concept keeps existing social structures, facilities and activities intact, and that demolition is kept to a minimum. The relatively small dimensions and quick assembly make this concept suitable for individual apartments and to fill otherwise unused gaps, as well as for large-scale local customization of a particular area.

The material chosen as the all-over cladding is a double-leaf plastic panel, with each apartment featuring a different color. A few windows cut through this semi-transparent skin; other façade openings are located on the interior side and are only visible when the lights are switched on.

7.4. SPICE IT UP - LIGHTHOUSES IN GRONINGEN

BUILDING TYPE Residential
LOCATION Groningen, Netherlands
CLIENT Vlasblom Projectontwikkeling
ARCHITECT DAAD Architecten
YEAR 2004

Many of us like to live in downtown areas. But city centers usually offer very limited living space – except on the roof! This is a possibility not yet fully exploited. Using the roof as a secondary ground level is a realistic possibility in many locations – as exemplified by the Lighthouses in Groningen. Entirely prefabricated apartments can be placed on rooftops. The Lighthouse was developed specifically for this purpose; a prefabricated, secondary ground level apartment that can be built in accordance with current regulations and development plans. With the completion of the project on Rabenhauptstraat in Groningen in spring 2005, another important step in the design process of the Lighthouse was taken.

The secondary ground level is an elevated street level that can encompass all of the functions that are usually located on the ground. Apartments, ateliers and work areas can be developed as well as terraces and yards, public and private spaces. It offers the opportunity to keep dynamics, diversity, peripheral activities – new or existing – in the city center, in short maintaining the character of old downtown areas.
A site on Rabenhauptstraat was the first to be examined for its suitability as a secondary ground level project. The roof of the existing building was demolished in order to make space for a wood/steel panel construction – on the secondary ground level. The wood/steel panel construction serves as the shell of the building which can then be finished in different ways. Five new studio-type condominiums were developed on the secondary ground level. The basis for these condominiums is a three-level wood skeleton construction of prefabricated elements. The lowest level, counted from the secondary ground level up, accommodates public terraces and the entrance areas to the apartments. Living room and kitchen are located on the second floor, bedroom and bathroom on the third. The little houses – individual three-story towers – are arranged such that each apartment benefits from maximum sunlight and offers fine views.

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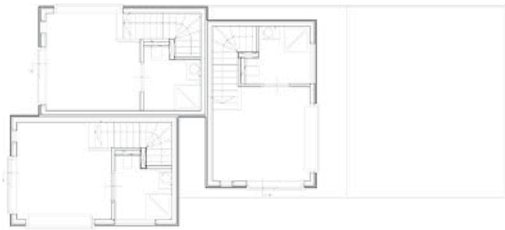

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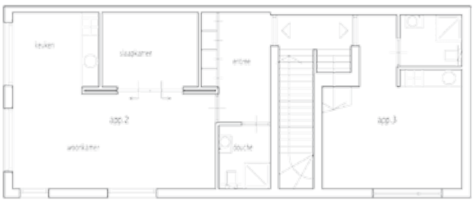

1 Construction phase (by DAAD architects)
2 Positioning the modules (by DAAD architects)
3 Positioning the modules (by DAAD architects)
4 Street view
5 First story plan (by DAAD architects)
6 Second story plan (by DAAD architects)
7 Third story plan (by DAAD architects)
8 Fourth story plan (by DAAD architects)

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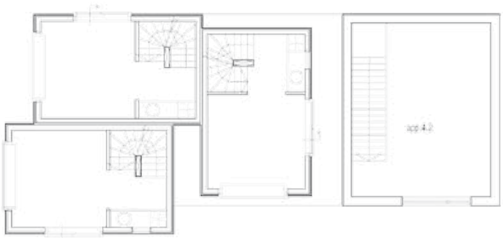


The unfinished attic with its slanted ceiling was difficult to use, and even the stairs did not offer sufficient headroom. Several types of roofs were examined in terms of design and price. The final choice offers a generous attic story encompassing a work area for the parents and the master bedroom.

The old pitched roof was replaced by a new attic story built in a wood panel construction. Due to the use of prefabricated parts, this ecological solution characterized by renewable resources and good insulation values was built quickly and cost-effectively.

The stone and parquet floors on the ground floor were refinished; defects were repaired. These materials are evocative of the original house of 1962. The stairway was modernized and the door openings were heightened.

The unconventional modification measures turned the existing building into contemporary architecture with spacious light-flooded rooms that meet the demands of the young family.

7.5. ALL NEW - RECONSTRUCTION OF A RESIDENTIAL HOUSE FROM 1962 IN LINGEN

BUILDING TYPE Residential
LOCATION Lingen, Germany
CLIENT Private
ARCHITECT Deeken Architects
YEAR (ORIGINAL CONSTRUCTION / REFURBISHMENT) 1962/2010

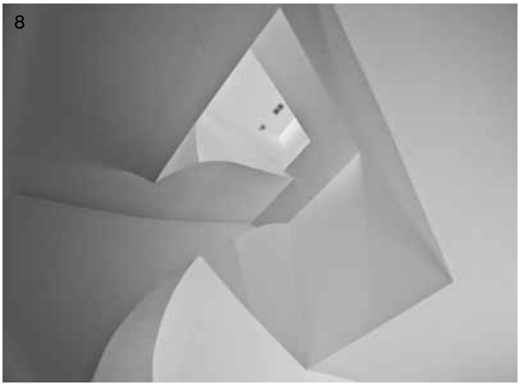
The client for this particular project actually meant to build a new house. The search for just the right piece of property led them to the "Bögen-Gebiet", a central area close to Lingen city center, directly adjacent to the Dortmund-Ems Canal. They found a prime-location residential house built in 1962, which was perfectly positioned on a beautiful lot with a big yard.

However, the house itself had little in common with the house that the young family envisioned for themselves. It was not insulated, the rooms were dark, and thermal bridges were omnipresent. In spite of these drawbacks, the client could be convinced not to demolish the house but rather to exploit the solid substance and revitalize it. Besides the existing, spacious basement offering ample storage space it was the surprising conversion possibilities of this house typical of the 1960s that promised to meet the client's ideas.

The design concept was based on two main steps: subtracting parts of the old building, and adding new elements. Thus, the white plaster cube was partially broken open, and the pitched roof was eliminated completely.

The newly added elements can be easily identified because they are made of wood and polygonally shaped. The new attic story with its dynamic shape cuts into the white volume of the building. It is oriented toward a park and the water. The two jutties frame a private roof terrace facing south. An added balcony and the new carport were also clad with larch wood; they dock onto the sides of the cube.

The first step taken was to cut large window openings into the stone base construction that makes up the ground and first story, in order to allow for more light infiltrating the rooms. The base construction was energetically refurbished, insulated and equipped with exterior sun protection. The floor plan was changed by merging individual rooms into larger ones to meet the family's needs. The ground floor makes up the central living area with living room, kitchen and hallway. The children's rooms are located on the second floor.



1 Elevation drawings
2 Ground plan
3 Reconstruction scheme
4 Before the reconstruction (by Sebastian Deeken)
5 Reconstruction phase (by Sebastian Deeken)
6 After the reconstruction, exterior (by Jens Passoth)
7 Redone staircase (by Hans Einspanier)
8 Redone staircase (by Hans Einspanier)

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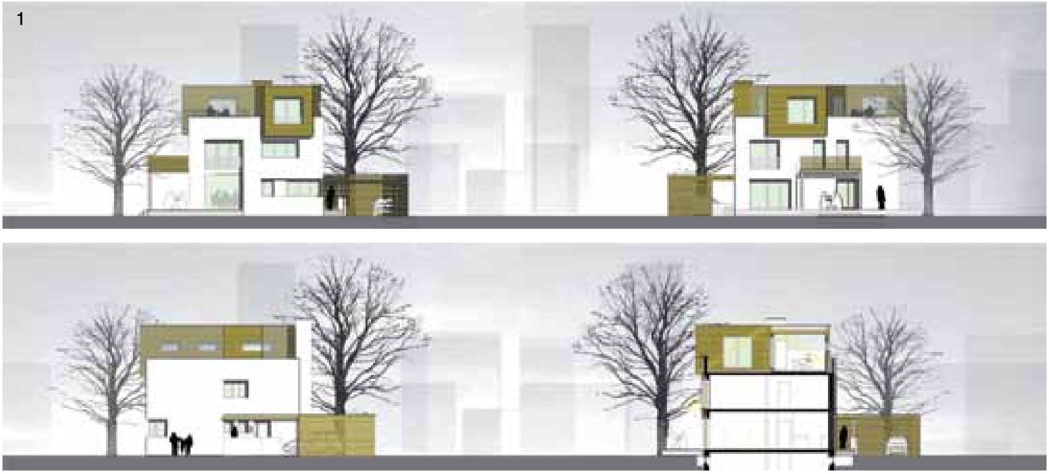

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GRUNDRISS ERDGESCHOSS M 1:200

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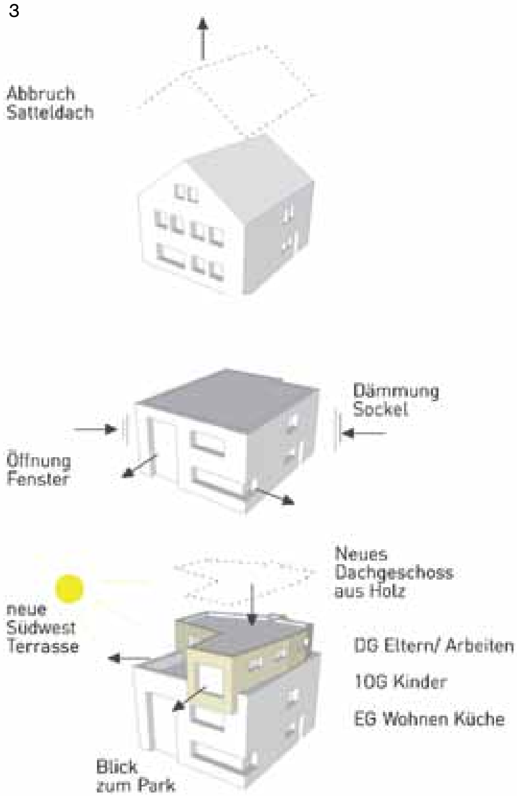
Abbruch
Satteldach
Dämmung
Sockel
Öffnung
Fenster
Neues
Dachgeschoss
aus Holz
neue
Südwest
Terrasse
DG Eltern/ Arbeiten
1OG Kinder
EG Wohnen Küche
Blick
zum Park

8. PRINCIPLES

ACTIVE MULTI-USE WINDOW
BIO CUP FAÇADE
BIOPLASTIC WATERFALL
BIODEGRADABLE BRICK
BLOW UP
BRICK-LIKE WOOD FIBER INSULATION
BURNABLE INSULATION
COLOR INSULATION SPRAY
CONVERTED TROMBE WALL
GRADIENT ORIENTED STRAW BOARD
HIDE OUT HEMP
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INSULATION COCOON_1
INSULATION COCOON HOUSE
INSULATION PATCH
INVERTED ROW HOUSE
MOLD INSULATION FAÇADE
NEW BOX IN AN OLD SHELL
ORIENTED VENTS
PIERCED SOLAR CHIMNEY
PREFABRICATED CELLULOSE ROOF
SEASONAL ROOF
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SHOW YOUR LIFE PHASE
STRETCH ROOM
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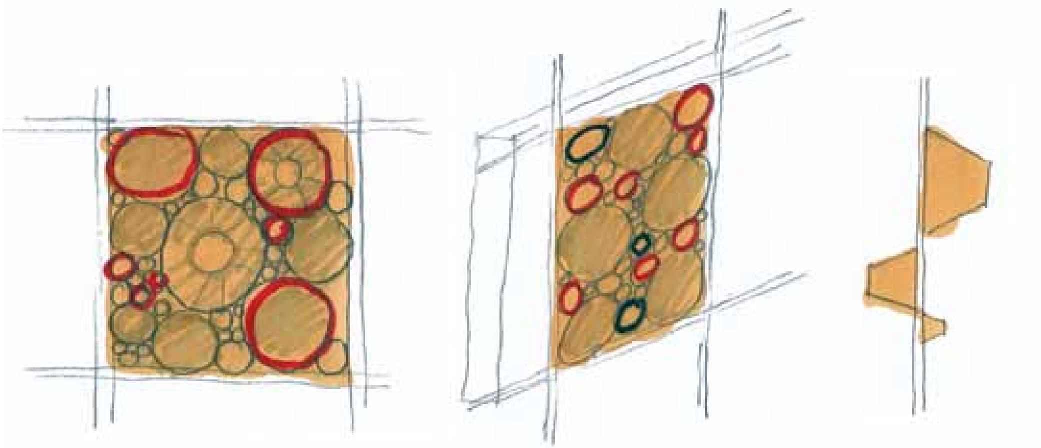
TAPED ON WOODEN FRAMES_2
TEMPERATURE SENSITIVE SUNSCREEN
TIMBER FRAME FILLING
WINTER COVER – SUMMER SHELL

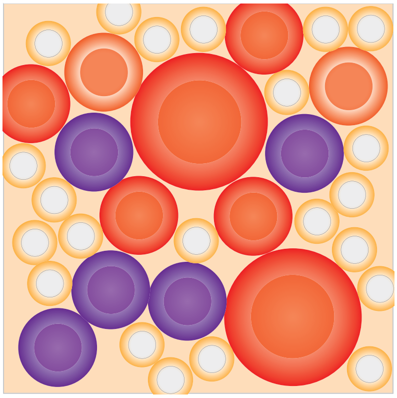
BIO CUP FAÇADE

29-05-2012

IMAGINED BY NEND Workshop “Re-Imagine the House”
KEYWORDS bioplastic, cup, 3D application

The fascination of 3D façade applications and the possibility of molding bioplastics into a desired shape meet in the bio cup façade. Instead of non-renewable resources, this façade is made of natural renewable materials and does not pose any end-of-life issues. The rear façade is attached to the load-bearing layer and is mounted in a modular grid. The surface consists of cup shaped elements of different size and color, installed in a way that both the outside and the inside of the cups are visible. The variation in size, color and orientation creates an appealing compilation for a unique façade, which might also feature open edges to increase the 3D appearance.



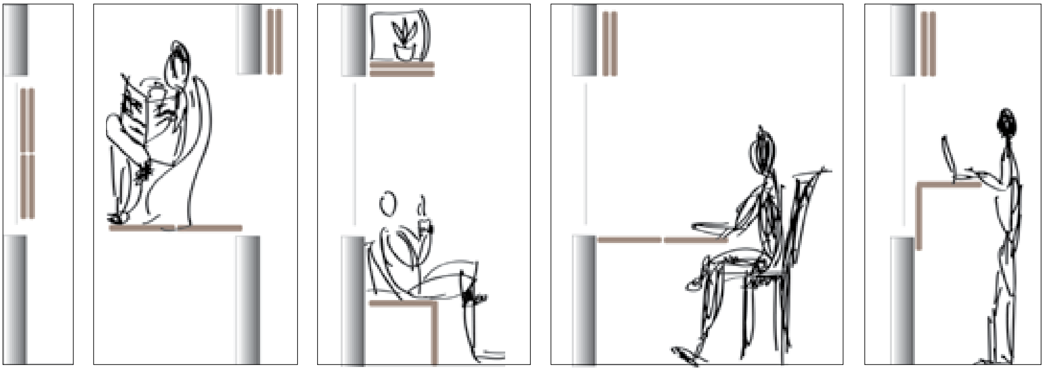


ACTIVE MULTI-USE WINDOW

29-05-2012

IMAGINED BY NEND Workshop “Re-Imagine the House”
KEYWORDS human centered design, foldable, multi-use

Windows not only define the relationship between the inside and the outside; they also influence the activity that takes place inside and outside of the open part of the wall. The installation of a window permanently defines this activity.
An active multi-use window could counteract this permanence if it were adjustable to various needs, depending on the current situation. If so desired by the user, an active multi-use window could become a balcony, thus providing access to the outside and opening up the relationship between inside and outside. The inside layer could also be used to block this relationship by applying a sunblind. And reaching even further beyond traditional window properties, the opening could be turned into a piece of furniture. In this case, the inside layer would be foldable and could be converted into a table or a shelf. If additional seating area is desired, the window could fold into a bench. And turning the window into a lectern would offer a work space with a lot of natural light.



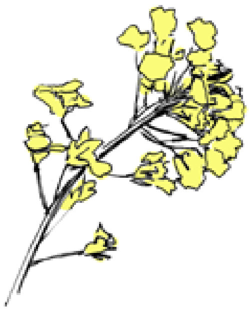
Different applications of the active multi-use window

BIODEGRADABLE BRICK

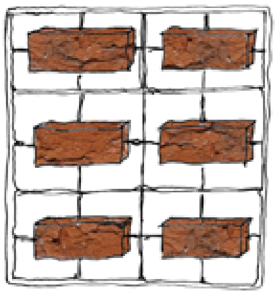
29-05-2012

IMAGINED BY NEND Workshop “Re-Imagine the House”
KEYWORDS bioplastic, brick, temporary usage

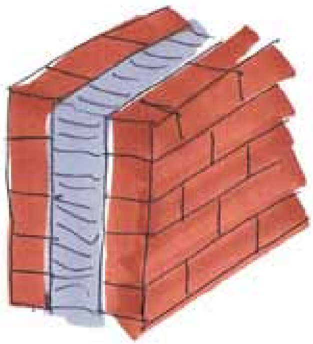
Bioplastics offer high potential for a broad range of different applications. They have similar qualities to plastics made of non-renewable resources, and can be adapted to various forms and colors.
Brick is typically subjected to various weather conditions, which reduces its potential at the end of its functional life. Biodegradable brick could be an alternative as it mimics brick in appearance, and features an insulation layer in the cavity. At its end-of-life it can be melted, or it degrades.
However, the functionality of bioplastic bricks and clay bricks is different; the biodegradable brick could ideally be applied in temporary buildings such as camping facilities or exhibition rooms.



origin



production

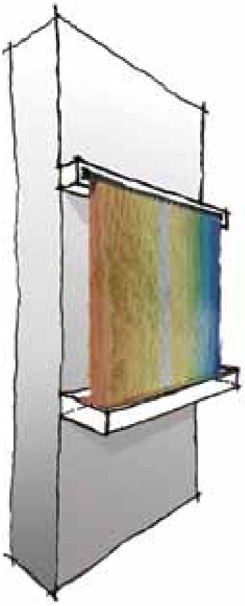


BIOPLASTIC WATERFALL

29-05-2012

IMAGINED BY NEND Workshop “Re-Imagine the House”
KEYWORDS bioplastic, comfort, heating

During winter, when temperatures make us want to stay indoors and feel warm and comfy, the bio waterfall could not only deliver pleasant warmth but also a cozy comfortable atmosphere.
In this concept, bioplastics are melted at high temperatures in a box installed on the wall. The material turns into a viscous liquid, which flows downward into a basin, similar to a gentle waterfall. The heat required to melt the plastic helps to condition the room.
And the heat of the bioplastic surface is emitted into the room, generating a comfortable indoor climate. The sound of the flowing liquid has an acoustically comforting effect on the occupant. As bioplastics are available in many colors, this waterfall could be a colorful and stimulating indoor attraction.

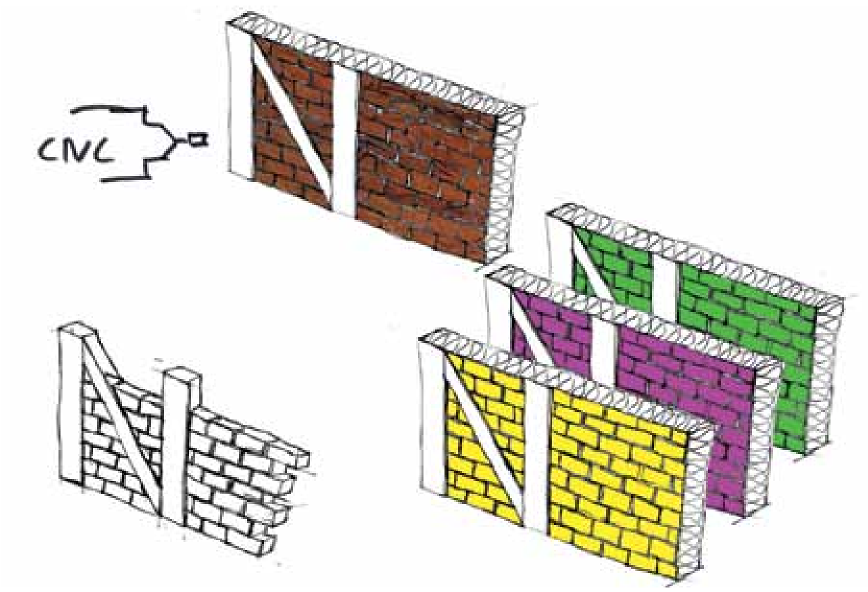


BRICK-LIKE WOOD FIBER INSULATION

29-05-2012

IMAGINED BY NEND Workshop “Re-Imagine the House”
KEYWORDS exterior insulation, wood fiber insulation, CNC

Brick is a beautiful material. It has a long tradition and expresses local context. But in terms of building technological aspects, it now has to adapt to the advanced requirements of a modern wall. The heat loss through masonry or cavity walls is rather high. Insulation is most efficient on the very outside of the building, which conflicts with the characteristics of the brick wall.
A new insulation material could be used that mimics the architectural qualities of brick and thus preserves them. Wood fiber insulation is ideal for this application as it can easily be shaped to any desired form with CNC equipment. Individual characteristics of the traditional brick can be maintained while generating an ecological solution with a high level of indoor comfort.

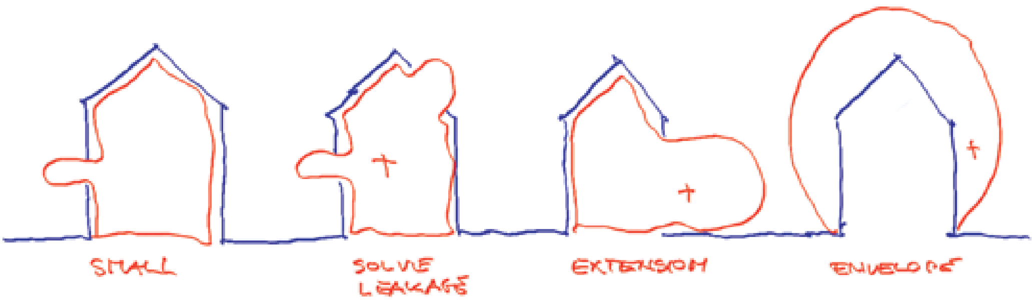


BLOW UP

21-02-2012

IMAGINED BY NEND Workshop “Re-Imagine the House”
KEYWORDS blow up, pneumatic construction, short construction time, limited construction

The “blow up” idea results from the desire for fast, temporary and, of course, cheap solutions! This means eliminating constructions that are too complex, use large amounts of materials (too much embodied energy, too many people to handle them, too much waste) or require a great deal of labor (too expensive). Thus, the solutions must be fast to execute and involve as little material as possible. Ideally, they should also be recyclable – or, even better, reusable in different locations.
The answer is simple – a pneumatic construction! This is inflated inside an existing construction and arranged such that it creates the desired new spaces. Yes, this does mean that energy is needed to provide air pressure at all times and that an entryway needs to be created – but as this idea is based on the concept of extreme reduction of material and construction, compromises need to be made. The sample shown here was developed by Marcel Bilow at the HS OLW (University of Applied Sciences) in Germany.



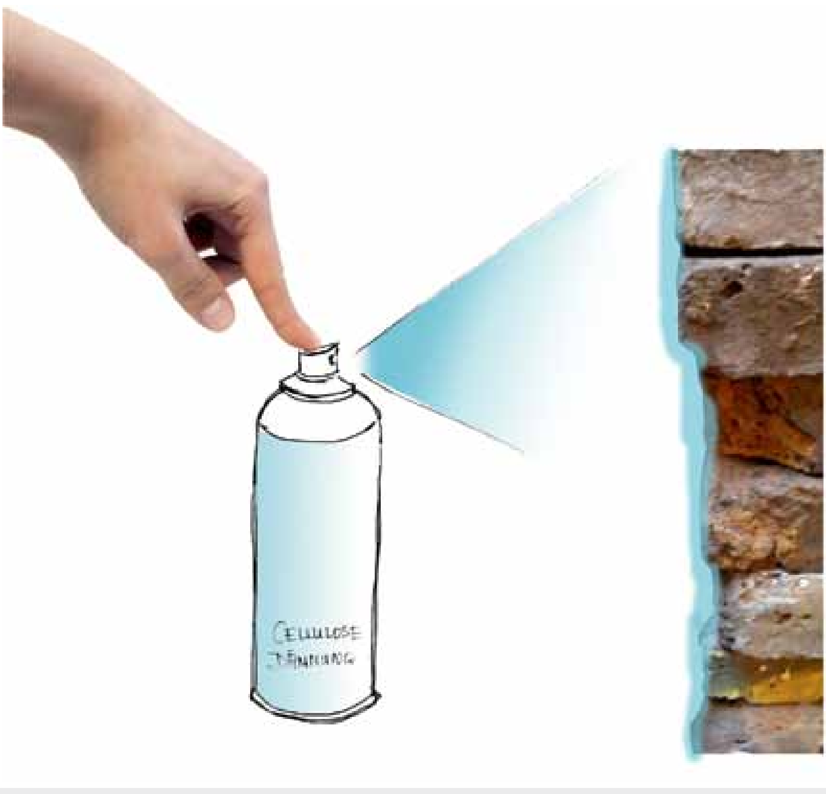
COLOR INSULATION SPRAY

29-05-2012

IMAGINED BY NEND Workshop “Re-Imagine the House”
KEYWORDS insulation, spray, cellulose

Why should color only be on the surface? Why could it not be three-dimensional and embody functions such as insulation?

The color insulation spray uses cellulose as an adhesive which can be easily colored with pigments. If we want to change the color of a wall, the color insulation spray could be applied to give the wall an interesting three-dimensional appearance. Of course, the insulating functionality would also work on a flat wall. If used on the outside, a two-component application could be used to seal the surface with a water barrier to repel rainwater and exterior humidity. The color insulation spray helps to reduce operating energy and uses recycled material to do so.



BURNABLE INSULATION

21-02-2012

IMAGINED BY NEND Workshop “Re-Imagine the House”
KEYWORDS seasons, heating, insulation

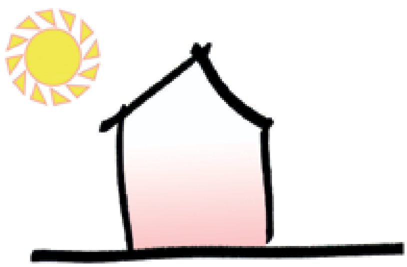
The thermal behavior of a building depends on temperature differences between the inside and the outside; thus, insulation requirements vary according to season.

Based on the possibility of seasonal adjustability, this idea proposes a way both to adjust the thermal resistance of the envelope and to provide fuel to produce the energy needed. At the beginning of the heating season extra insulation is added to the building envelope. It reduces heat loss but also functions as energy storage. The insulation should be of some sort of organic material, such as meadow grass, hemp or cellulose. This sort of insulating material can also be used as fuel for biomass heating systems. If used for heating, it is gradually eliminated, until lower temperature differences in summer require lower thermal resistance of the building envelope.

Non-insulated existing house in winter

Add insulation to existing house

Use insulation as fuel.
Insulation layers are reduced



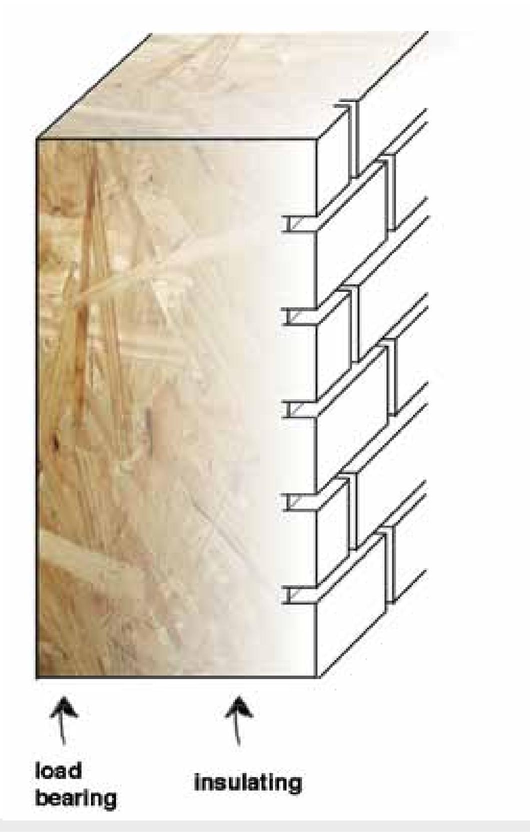
The additional insulation is used up by summer, when such high resistance is not necessary

GRADIENT ORIENTED STRAW BOARD

29-05-2012

IMAGINED BY NEND Workshop “Re-Imagine the House”
KEYWORDS OSB, OSSB, gradient, load-bearing, insulating, various surfaces

Oriented Structural Straw Boards (OSSB’s) are produced from agricultural waste, in particular wheat straw. Resins are added to bind the fibers and the OSSB’s are then formed by applying pressure.
Replacing the resin with bio plastics would make the OSSB into a 100% renewable product. The resin layer on the outside prevents water from penetrating through the surface. Detailed three-dimensional applications could be created by placing fibers of specified length on the outside of the board. The intermediate section of an OSSB wall has a low density to insulate the building against heat loss. Further into the center of the boards, the share of resin could be smaller so that a high share of fibers would deliver good load-bearing capability. Such a wall would consist of a renewable gradient material that embodies all qualities a wall should have: load-bearing, insulating and allowing for a variety of surfaces.



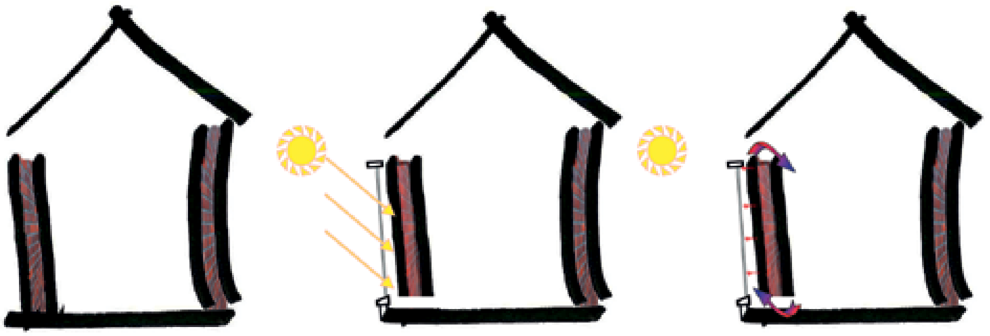
CONVERTED TROMBE WALL

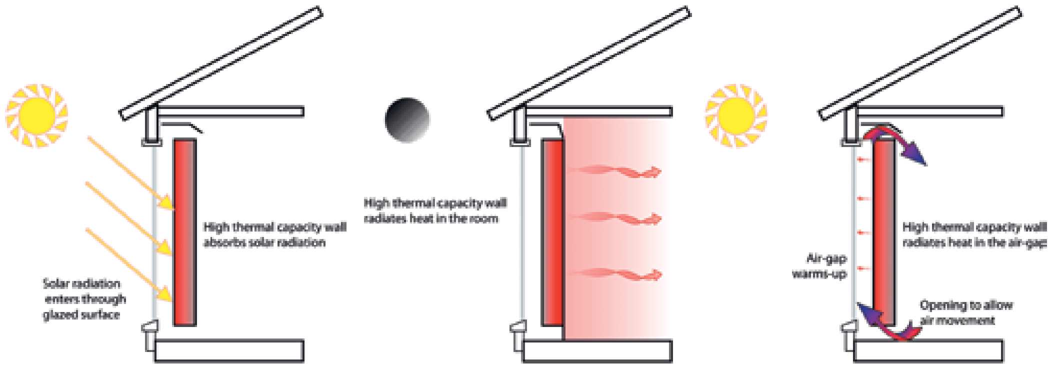
21-02-2012

IMAGINED BY NEND Workshop “Re-Imagine the House”
KEYWORDS Trombe wall, thermal capacity

The Trombe wall is a system often used to reduce heating demands. It requires a glazed surface that allows solar radiation to penetrate and a wall with a high thermal capacity that absorbs the radiation, heats up and transmits the heat into the living space.

In refurbishment projects, existing walls often have adequate thermal mass, particularly if they are made of masonry brick. The only additional feature required to achieve a Trombe wall function is the addition of exterior glazing. If required, the thermal mass can be improved with the use of PCM. The air in the resulting cavity between the brick and the glazing heats up and reduces the heat loss across the façade.



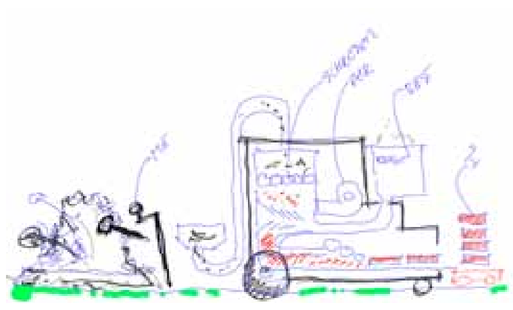


INDIVIDUAL INSULATION – I^2
21-02-2012

IMAGINED BY NEND Workshop “Re-Imagine the House”
KEYWORDS insulation, individuality, recycling, reuse, do-it-yourself

This idea is based on the general principle of insulation: energy is exchanged through air molecules that are heated at one surface, then travel through or rise within a cavity until they reach a colder surface where they cool down; thereby carrying the energy from one surface to another. Testing indicated that this process of convection does not occur in smaller spaces, meaning there is no exchange of energy (this is the reason why insulated glass works with a maximum spacer distance of about 15 mm). Insulating requires a space between two surfaces that offers a limited potential for the air molecules to travel. This is why we need “fluffy“ materials; materials that can contain air but do not allow the air to move around and enter a heating/cooling cycle – materials such as sheep’s wool, hemp wool, stone wool, polystyrene or polyurethane bubbles, blocks etc.

This concept envisions a personal shredder that creates insulation material: a machine that shreds and then reassembles any organic or inorganic material into fluffy, air-enveloping units of insulation material. The construction of such a machine is a technical question that cannot be solved in the scope of this book’s imaginary concepts – but the potential of such a device for all do-it-yourself builders is obvious.

HIDE OUT HEMP

29-05-2012

IMAGINED BY NEND Workshop “Re-Imagine the House”
KEYWORDS hemp, 3D cut, scenery

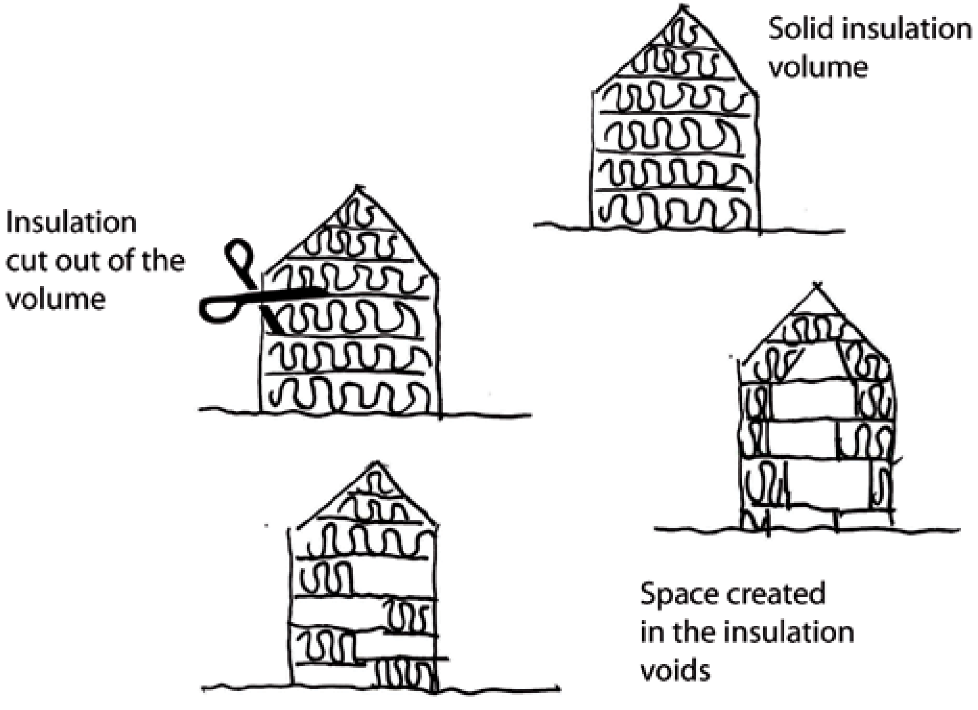
Hemp is renewable, it is cheap and it insulates. If pressed into units it can adapt to various shapes.
Stackable story-high units are conceivable that could be cut by CNC controlled saws to the desired shape. Using this method, entire sceneries could be created that serve any desired purpose. Beyond the traditional theater context it could be used to create a secret place in a remote area. The hemp hideout would be installed in front of the façade, mimicking the shapes and forms of the surrounding forest. The outside would have to be clad with a weather barrier which could be used to color the surface to create the perfect illusion.

INSULATION COCOON HOUSE

21-02-2012

IMAGINED BY NEND Workshop “Re-Imagine the House”
KEYWORDS insulation

Developing the insulation cocoon concept further, we might imagine a house made entirely of solid insulation material such as hemp. This means ordering a huge solid body of insulation material which is brought to the building site and placed on a prefabricated foundation. Once the cube is in place all the owner needs is a saw to cut the desired openings in order to create a customized house. The cube is denser on the outside, and consists of four layers: The outermost layer has a rain barrier, followed by a 30 cm thick layer of low density insulation, then a 20 cm thick layer of higher density insulation to provide stability; and all that is left is soft and easy to cut. To create a multi-story house, additional cubes can be cut to the desired shape and stacked.

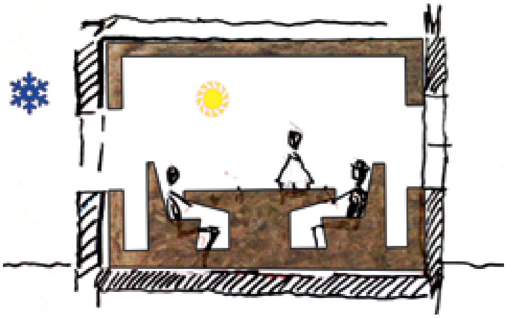


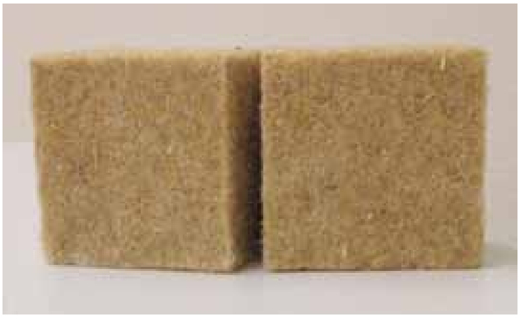
INSULATION COCOON_1

21-02-2012

IMAGINED BY NEND Workshop “Re-Imagine the House”
KEYWORDS insulation, cocoon, wood fiber

Insulation material could be used for other purposes than thermal insulation alone.
It is a very soft and warm material, particularly if made from natural materials such as wood and hemp fibers.
If the outer appearance of an existing building is to be maintained, the insulation is applied on the inside. This application could be extended to create furniture from additional material which becomes part of the room. In this manner, the insulation material surrounds the inhabitants and provides a cozy cocoon. A wide range of insulation material is available featuring a variety of performance and finishing properties. Possible materials include wood fiber, wool, hemp and cellulose.





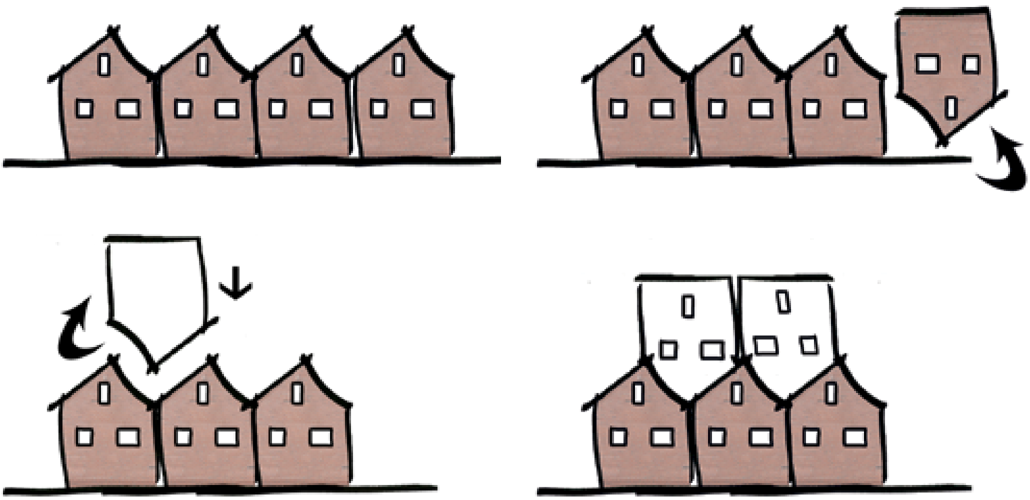
INVERTED ROW HOUSE

21-02-2012

IMAGINED BY NEND Workshop “Re-Imagine the House”
KEYWORDS add-on, row house

A common problem present in existing houses is the need for extra habitable space. However, it is not always possible to extend the house, particularly in the case of row houses, where the exterior walls are directly adjacent to other buildings.

Therefore, we extend the house vertically. The idea is to use the existing concept of adjacent exterior walls, but in this case transformed into adjacent pitched roofs by inverting the row house. Thus, we double the living area – to be used for inside or outside activities.



INSULATION PATCH

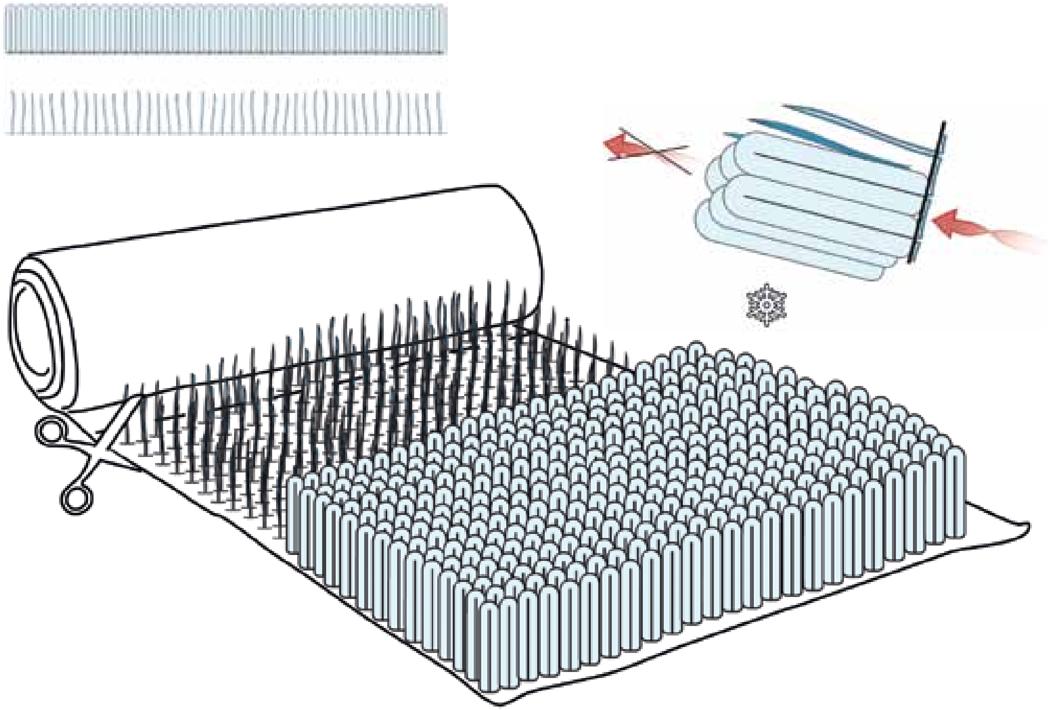
21-02-2012

IMAGINED BY Daniel Smidt, Jan Schepko, Thaleia Konstantinou
KEYWORDS dynamic insulation, fibers, inflatable

Looking at the current condition of the built environment, many problems can be identified, one of which is low thermal resistance.

How about creating a solution to “heal“ the building’s skin – like a patch to heal human skin? In this manner, we can patch up our cities and help them recover. The idea is based on recent developments in the textile industry. Rubber fibers with inlaid air pipes can provide dynamic insulation. When air is pumped into the fibers, air pockets expand, increasing the thermal resistance of the wall while creating a new outward appearance.

Patches could be used to help with other problems as well. Supporting the reduction of performance energy by active or passive measures is one aspect. They could also help to increase the level of comfort. Acoustic, visual or thermal applications can be easily attached on the inside or outside of the building. Patches could be especially relevant for open offices to provide individual comfort zones. Every user/occupant installs the patch that fits their individual needs.



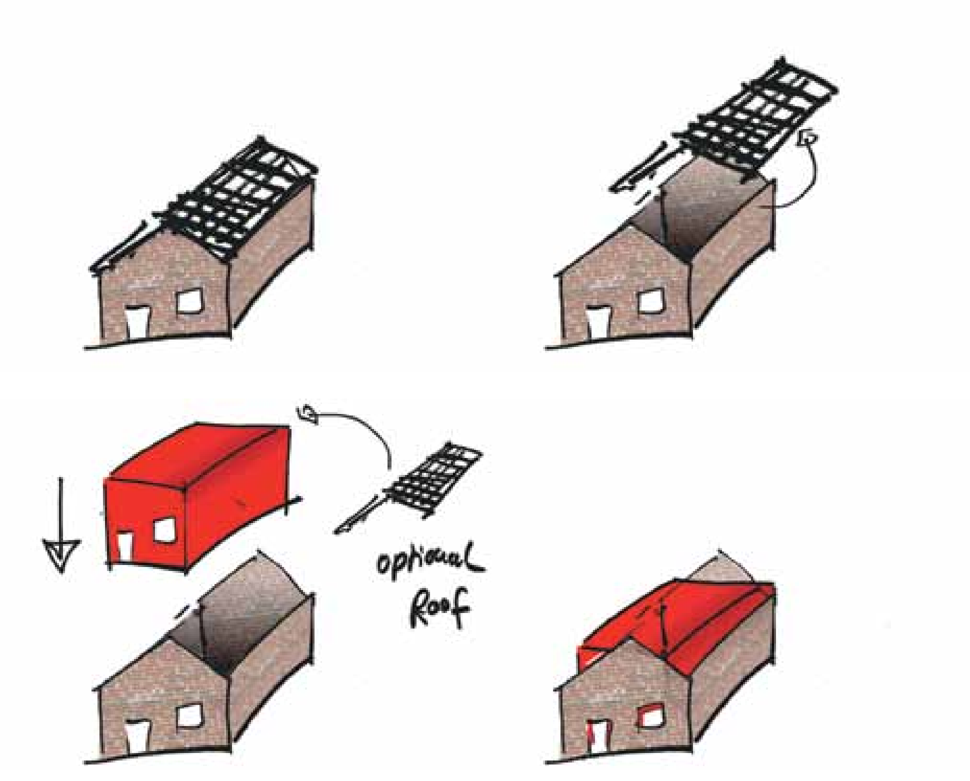
NEW BOX IN AN OLD SHELL

21-02-2012

IMAGINED BY NEND Workshop “Re-Imagine the House”
KEYWORDS shell, preserve, performance requirements

Existing, older building envelopes often do not comply with today’s performance standards. But many refurbishment measures need to take into account that the general appearance of the building should be maintained.

An alternative to cladding a building with EIFS might be to leave the old shell intact, remove the roof and insert a new box that features an energy efficient envelope.
It should match the size and openings of the existing building envelope but fulfill today’s requirements of thermal and acoustic comfort. This solution meets both needs; maintaining the outside character as well as installing an ecological solution.

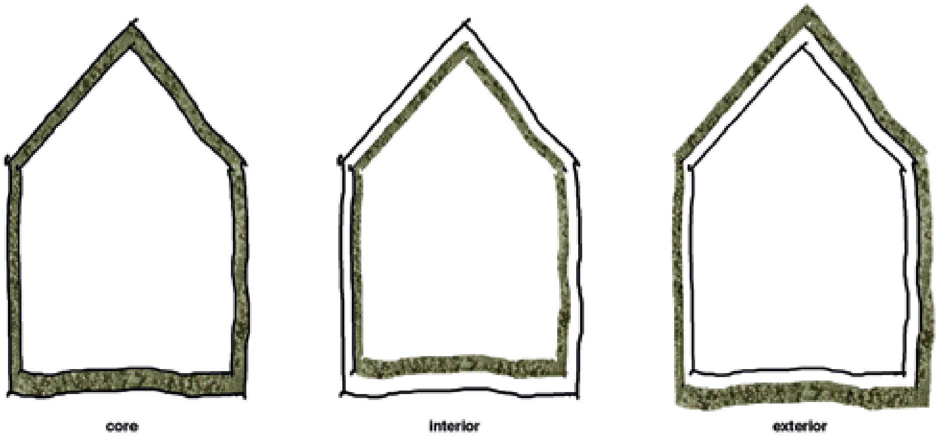


MOLD INSULATION FAÇADE

29-05-2012

IMAGINED BY NEND Workshop “Re-Imagine the House”
KEYWORDS mold, insulation, recovered paper

How simple would it be if we could eliminate our waste by simply throwing it into parts of our building? The wall would digest and make use of the waste. A pizza box including leftovers enters the wall, is crushed and then blown into a cavity that is either inside or outside the wall. The moisture of the waste develops mold which spreads throughout the entire volume of the cavity. The mold generates heat which contributes to the passive thermal capacity of the wall. Those daring to have a look inside the cavity would be able to observe the chemical process, and for even greater impact the cavity’s skin could be transparent.



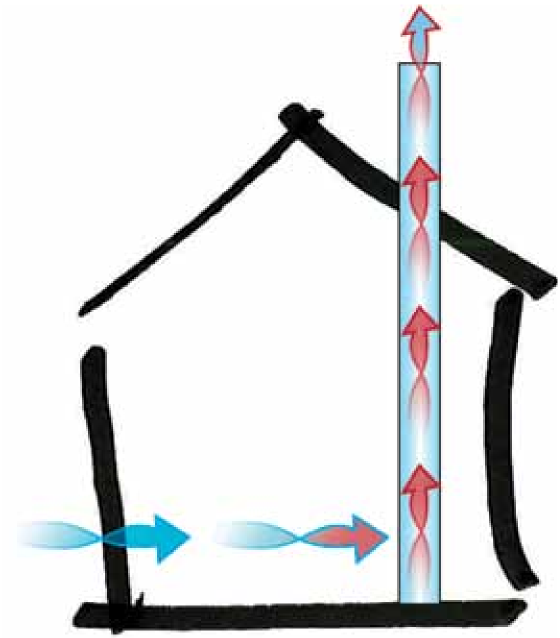
PIERCED SOLAR CHIMNEY

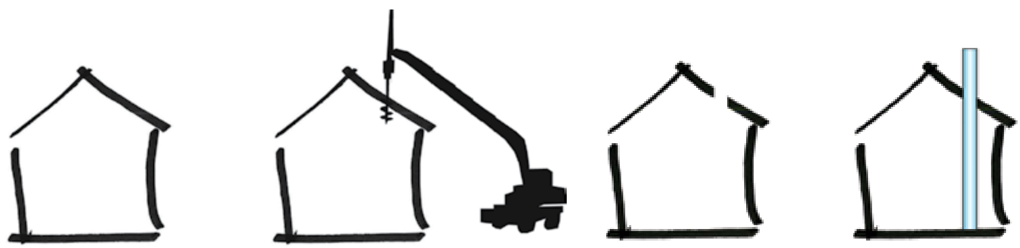
21-02-2012

IMAGINED BY NEND Workshop “Re-Imagine the House”
KEYWORDS ventilation, solar chimney

Ventilation is one of the major issues of old houses.

One method to enhance ventilation is to introduce a solar chimney into an existing house. The solar chimney generates air movement by creating pressure differences due to the air at the top of the chimney heating up. Besides contributing to the comfort and performance energy of a building, a solar chimney pierces the building and thereby creates an exciting combination of two building volumes.





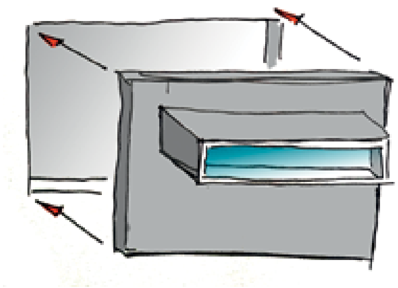
ORIENTED VENTS

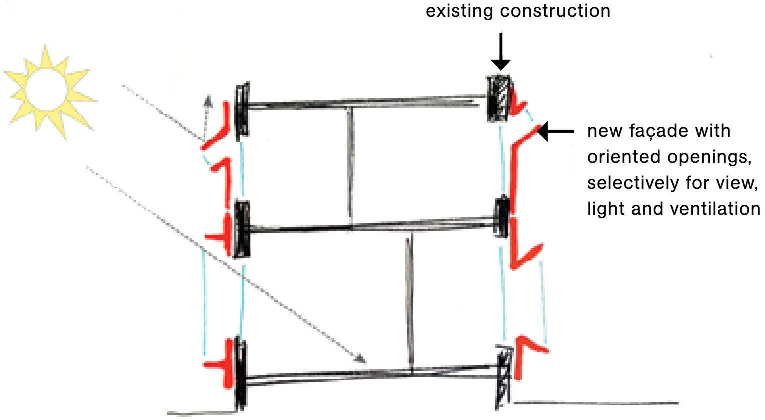
21-02-2012

IMAGINED BY NEND Workshop “Re-Imagine the House”
KEYWORDS solar gains, light, add-on windows

The openings in a building envelope need to be able to provide ample light while some form of shading is necessary as well to protect from excessive heat and glare. Every function in a building has different requirements as regards natural lighting. While the living room or work area usually requires direct light, diffuse light is the most pleasant for reading in the library, and very little light is needed for the bathroom together with visual protection from the outside.

Add-on window boxes could be used to modify existing windows; the openings could be oriented to accommodate the sun and the inside function in order to provide shading, block direct sunlight or direct natural light into the interior. These add-on windows could also be transferred to other windows when a particular indoor function changes.





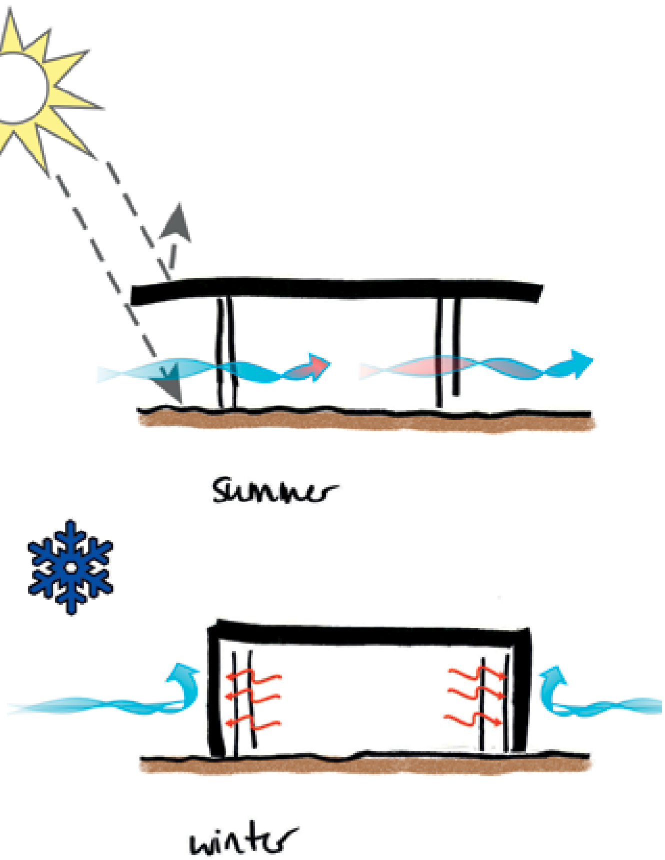
SEASONAL ROOF

21-02-2012

IMAGINED BY NEND Workshop “Re-Imagine the House”
KEYWORDS roof, seasonal, adjustable

Ideally, the building envelope should be adjustable to seasonal conditions.

The seasonal roof can be adjusted depending on changes in temperature and radiation. During winter, when more insulation is needed, the roof forms the building envelope. In the summer, the walls are converted into an overhang to generate better airflow through the house, and to provide more usable exterior space.



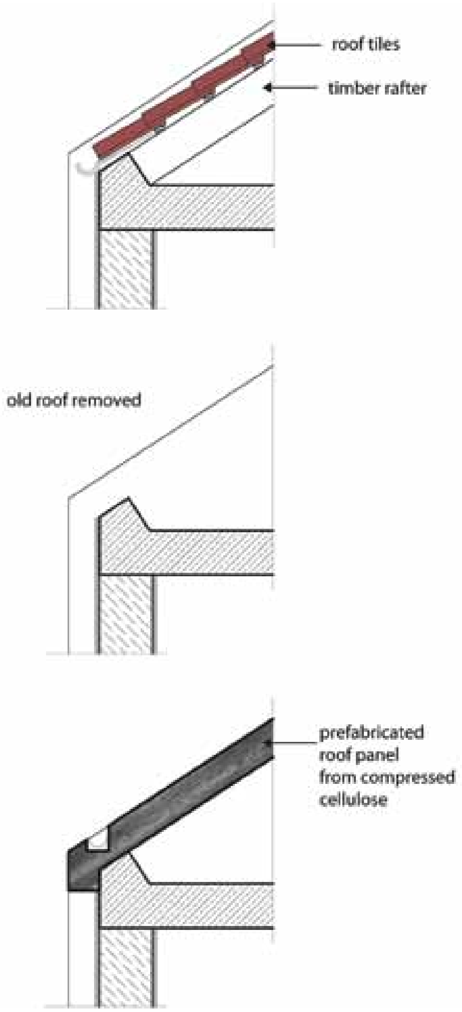
PREFABRICATED CELLULOSE ROOF

21-02-2012

IMAGINED BY NEND Workshop “Re-Imagine the House”
KEYWORDS insulation, thermal performance, roof, prefabricated elements

Insulating the roof is an important aspect of upgrading a building envelope. Particularly in old houses, the roof is often constructed with timber joist and wooden planks, without any insulating material. Moreover, parts of the roof construction and tiles are possibly damaged and need to be replaced.

Cellulose is an insulating material fabricated from plant fibers, also found in recycled paper, cotton, straw etc. The idea is to create prefabricated roof panels from compressed cellulose that are able to carry the roof loads. In this manner, the roof is being insulated, while damaged parts are fixed at the same time. The dimensions of the prefabricated elements make installation quick and efficient.



SHOW YOUR LIFE PHASE

29-05-2012

IMAGINED BY NEND Workshop “Re-Imagine the House”
KEYWORDS changing façade, plants

Even though human life is typically divided into three main phases, we all go through more than that throughout our lifetime.

The perception of beauty varies over time and considering how long a house serves as a home (in Germany at least for an average of 80 years), the façade should adapt to these changes. Green façades could address this need as they have proven to contribute positively to the operating energy, they exhibit a positive feel, and they are flexible. Different plants for different phases can completely change the façade’s appearance.

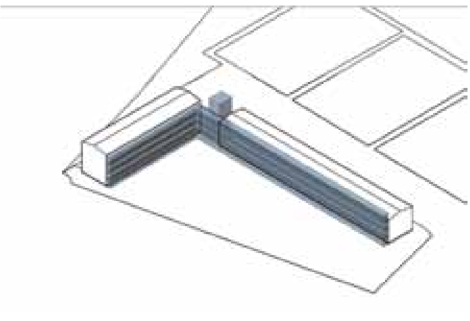
Once upon a time there was a man who lived in his house all alone for ten long years. The plants growing on his façade were of a monotonous green, without any blossoms. Then one day the man met the woman he wanted to share his whole life with. They harvested the façade for biogas and planted roses all over it, as these were her favorite flowers and Sleeping Beauty her favorite fairytale. And if they only changed the façade to produce other beautiful flowers, they probably lived happily ever after.

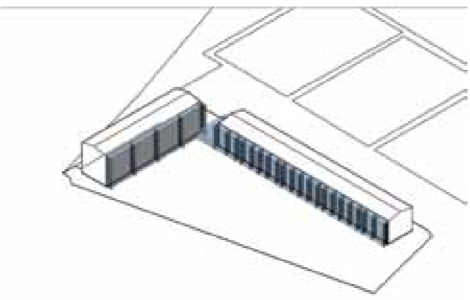
SECOND SKIN

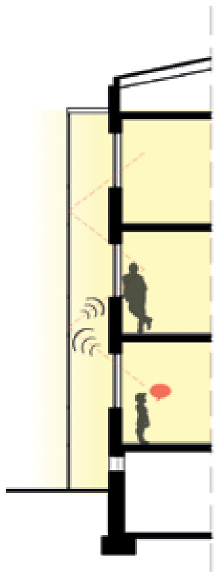
16-04-2010

IMAGINED BY Ulrich Knaack, Thaleia Konstantinou
KEYWORDS add-on, sunroom, loggia

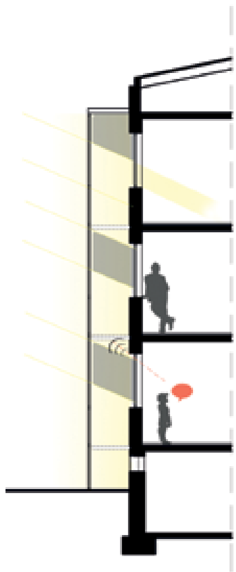
In general, there are two possibilities to improve a building's insulation. Firstly, the walls are insulated and existing windows replaced with better ones. Or, and that is the second option, an entire façade is placed outside the existing one. Such measures could be used to build sunrooms or glazed balconies, which means creating new living space in addition to improving insulation.







double façade:
overheating
sound distraction



double façade:
shading
floor separation

TAPED ON WOODEN FRAMES_1

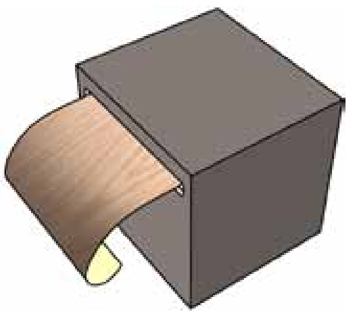
21-02-2012

IMAGINED BY NEND Workshop “Re-Imagine the House”
KEYWORDS windows, replace

In old buildings, windows typically consist of small single-glazing panes. The small dimensions of the individual glass panes are due to old glass manufacturing techniques that did not allow for bigger panes. In many cases, such windows are now part of monumental buildings, a fact that prohibits changing the overall appearance.

Over time, glass technology has advanced significantly, not only in terms of possible pane sizes but also in terms of thermal performance. However, it is still difficult to mimic the appearance of the old windows, mostly due to the weight of the glass which does not allow for slim frames.

One idea to solve this problem is to replace the old windows with the required advanced glazing, and to attach a tape to the new glazing that mimics the original wooden window framing.



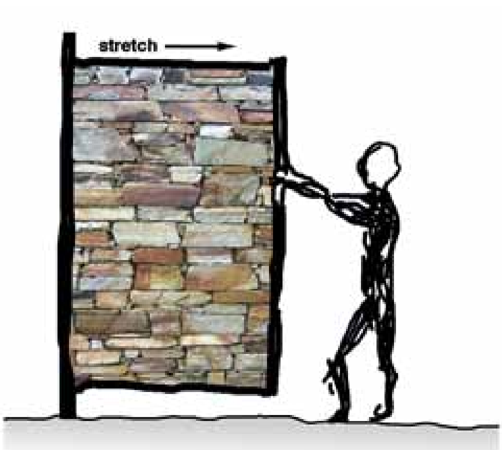
STRETCH ROOM

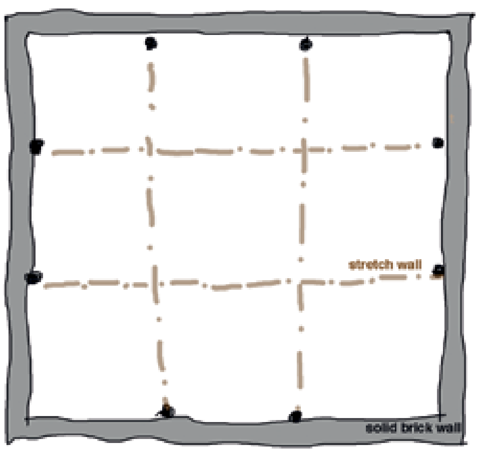
29-05-2012

IMAGINED BY NEND Workshop “Re-Imagine the House”
KEYWORDS bioplastic, expansion

Brick is a material made to last a long time and therefore offers permanence. However, with regard to interior walls, a building should be able to adapt when there is a need for changes to the interior division.

The stretch room system offers the possibility to easily modify the room organization within a building. The outer shell is permanent and made from brick. But the interior walls are made of a bioplastic fabric that can be extended or retracted, depending on individual and current needs. The boxes in which the bioplastic walls are mounted are arranged in a grid, allowing for many spatial variations. Thus, the functionality of the building remains open.





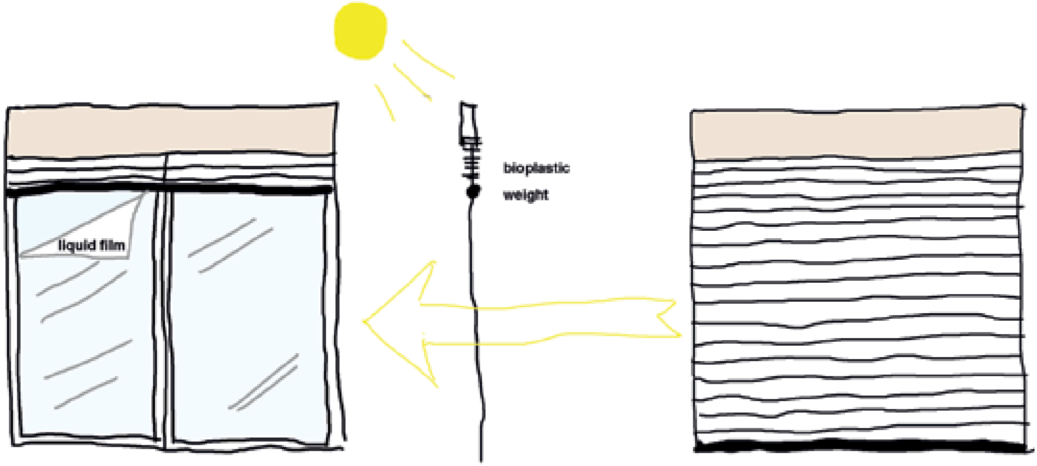
TEMPERATURE SENSITIVE SUNSCREEN

29-05-2012

IMAGINED BY NEND Workshop “Re-Imagine the House”
KEYWORDS liquid, expansion, temperature

Sun protection is needed when the sun shines and heats up the air and exterior surface of a building. When clouds block the sun, however, transparent areas of the façade should be unobstructed so that diffuse sun radiation can enter the room.

The temperature sensitive sunscreen reacts to changing climate conditions. The concept is based on a liquid that is installed across the entire window area. The liquid expands when temperatures rise, moving a weight which in turn makes the sunblind expand and shut out the sun’s light and heat. When the temperature falls, the sunblind contracts and opens up the visual relationship between the inside and outside.

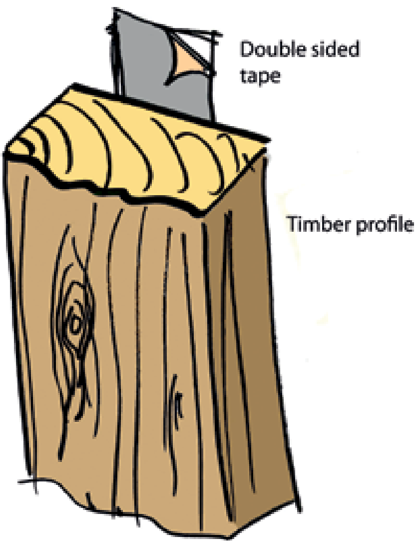


TAPED ON WOODEN FRAMES_2

21-02-2012

IMAGINED BY NEND Workshop “Re-Imagine the House”
KEYWORDS windows, replace

An alternative to the fake timber tape described in the previous principle is the taped-on window frame. Any type of wooden profile can be taped on new glazing to mimic the appearance of old windows, or even to easily create entirely different pane shapes. Moreover, if the timber is taped to a brick wall, it can give the impression of a timber frame construction.

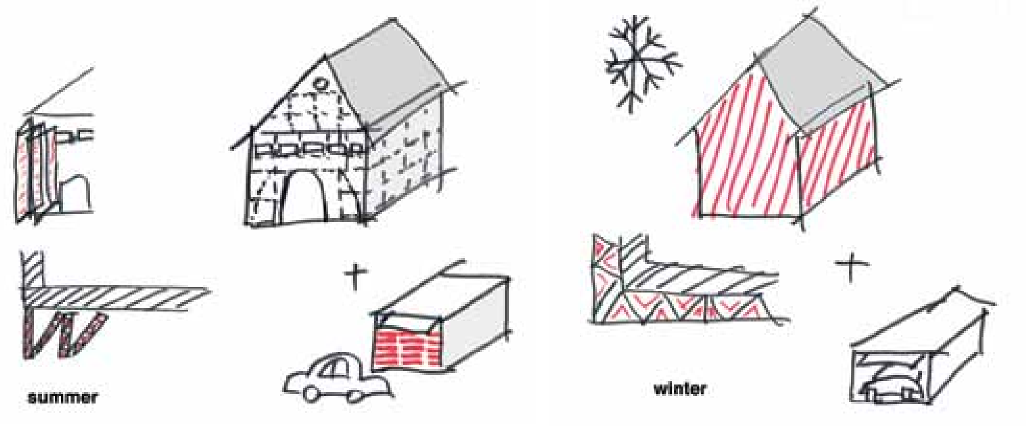


WINTER COVER – SUMMER SHELL

21-02-2012

IMAGINED BY NEND Workshop “Re-Imagine the House”
KEYWORDS seasons, heating, insulation display

In Central Europe, insulation is only required during the winter season. During summer, the insulation material could be stored away in order to show off a beautiful façade. The cladding that provides insulation during winter could also vary to change the outward appearance of the building. Insulation material not needed in summer could be used for a different purpose, and a multifunctional system could deliver an additional quality. While during winter the insulation keeps the heat inside the building, during summer it could be assembled into a structure used to provide a shaded seating area in the garden or a carport to keep the car clean and cool.



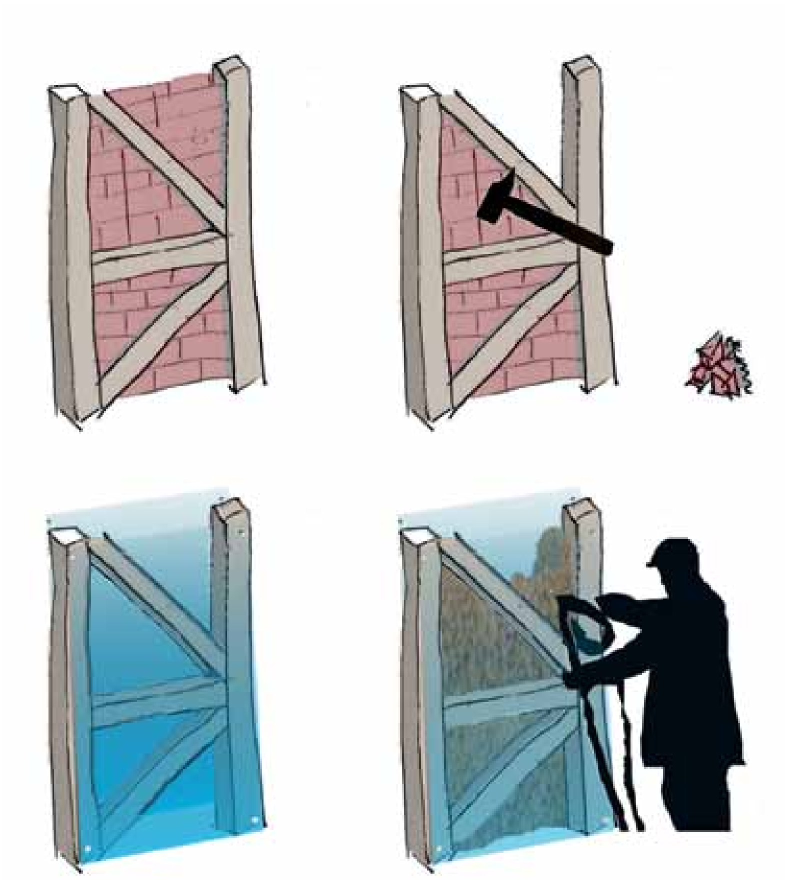
TIMBER FRAME FILLING

21-02-2012

IMAGINED BY NEND Workshop “Re-Imagine the House”
KEYWORDS insulation, thermal performance, wall, timber frame construction

Contrary to masonry walls, the brick in timber frame constructions (Fachwerkhaus) is only used as infill while the timbers form the load-bearing structure. This means that the infill can be replaced without affecting the structure. The possibilities are endless, not only in terms of improving thermal performance but also in changing the appearance of a building.

One idea is to clad the structure with transparent panels after the original brick infill has been removed, creating boxes between the timber beams. These boxes can be filled with insulation, such as perlite or cellulose. Thus, the thermal resistance of the wall increases and the appearance is renewed, without losing the original impression of the “Fachwerkhaus.“



APPENDIX


GAZELLE
UNION

for the building sector as well as teaching Sustainable Construction at Detmold.
She is part of Delft's Façade Research Group and was involved in several publications including the imagine book series and various research projects.

THALEIA KONSTANTINOU (*1982) studied Architecture at the National Technical University of Athens. Since 2006, she has been a certified architect. In 2008, she graduated with distinction from the Master of Science program on Environmental Design and Engineering at The Bartlett School of Graduates Studies, University College London. During and after her studies, she has worked as an architect in Greek and international practices. Currently, she is conducting a PhD research at the Faculty of Architecture, Delft University of Technology, Netherlands. Her research on the topic "Façade Refurbishment Strategies of the residential building stock" is part of the research program "Green Building Innovation" and the Façade Research Group of the chair of Design of Construction.

CVs

PROFESSOR DR. ING. ULRICH KNAACK (*1964) trained as an architect at the RWTH Aachen, Germany. He continued there as a researcher in the field of structural use of glass, finishing with a PhD. Then he worked as an architect and general planner in Düsseldorf, Germany, winning many national and international competitions. His projects include high-rise housing and office buildings, commercial buildings and stations. Today he is Professor for Design of Construction at Delft University of Technology, Netherlands, where he developed the Façade Research Group. Since 2009 he has been head of the Building Technology Department.
He has organized interdisciplinary design workshops and symposiums with such themes as facades, high rise, and complex buildings. Parallel to this, he was appointed Professor for Design and Construction at the Detmolder Schule für Architektur und Innenarchitektur at the Hochschule OWL, Germany, where he has been dean of the faculty since 2011. He is the author of several well-known references books, articles and lectures.

TILLMANN KLEIN (*1967) studied architecture at the RWTH Aachen, completing his studies in 1994. He subsequently worked in several architectural offices; from 1996 onward he was employed by Gödde Architekten, focusing on the construction of metal and glass façades and glass roofs. At the same time, he attended the Kunstakademie in Düsseldorf, Klasse Baukunst, completing the studies in 2000 with the title "Meisterschüler." In 1999, he was co-founder of the architectural office rheinflügel baukunst with a focus on art-related projects. His practical work includes the design of a mobile museum for the Kunsthaus Zug, Switzerland, the design and construction of the façades for the ComIn Business Centre, Essen, project management for the construction of the Alanus Kunsthochschule, Bonn, and project management for the extension of the University of Applied Sciences, Detmold. In 2005, he taught building construction at the Alanus Kunsthochschule, Bonn-Alfter. The same year, he was awarded the art prize of Nordrhein-Westphalen for young artists. Since September 2005 he has led the Façade Research Group at the TU Delft, Faculty of Architecture.

MARCEL BILOW (*1976) studied architecture at the University of Applied Science in Detmold, completing his studies with honors in 2004. During this time, he also worked in several architectural offices, focusing on competitions and later on façade planning. Simultaneously, he and Fabian Rabsch founded the "raum204" architectural office. After graduating, he worked as a lecturer and became leader of research and development at the Chair for Design and Constructions at the FH Lippe & Höxter in Detmold under the supervision of Prof. Dr. Ulrich Knaack. Since 2005, he has been a member of the Façade Research Group at the TU Delft, Faculty of Architecture and in 2012 he became head of the façade prototype course, the Bucky Lab. The same year he finished his PhD thesis on climate related façades.

LINDA HILDEBRAND (*1983) completed her study of Architecture at the Detmolder Schule für Architektur und Innenarchitektur in 2008. Having devoted her graduation thesis to green certificates in the building industry she started her career by applying the German DGNB certificate in the pilot phase. That same year she began her PhD research at TU Delft, analyzing the relevance of embodied energy

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Ulrich Knaack, Linda Hildebrand, Thaleia Konstantinou, Hansjörg Wieland

TEXT EDITING
Usch Engelmann, John Kirkpatrick

DESIGN
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