Ecology of construction materials

A handbook

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This handbook has been prepared within the frame of the project „Using ecologic construction materials in new, energy efficient buildings in the Baltic States" (2009-2011) supported by the German Federal Foundation for the Environment (Deutsche Bundesstiftung Umwelt).

Disclaimer

Preface

Nowadays the availability of materials that can be used for construction, insulation or finishing of buildings is increasing on the market. But how to identify the ecologic materials in this wide offer? How to make a competent choice and how to properly apply these materials in order to guarantee the anticipated quality? Is it possible to construct a very energy efficient building (e.g., passive house) using ecologically sound construction materials? Answering these questions requests relevant knowledge and competence in the field. Thus it is important that specialists – architects, engineers and craftsmen recognise the possible options, utilise the experiences already existing in the Europe and successfully apply the gained knowledge in practice.

The handbook "Ecology of construction materials" aims to increase the awareness of specialists in the construction sector and to promote the use of ecologic materials in the Baltic States. The handbook covers environmental and health protection as well as technical aspects of construction materials. Energy performance of buildings is another important issue tackled in the handbook. The printed handbook consists of 2 chapters and has a supplementary material in an electronic form.

The 1st chapter provides general introduction to ecologic construction. It gives guidelines when selecting materials and can provide the reader with ideas and inspirations where ecologic construction materials can be used. It describes what are the main advantages and benefits if applying ecologic materials at homes.

The 2nd chapter is a training manual - a supportive tool for preparation of lectures to students studying architecture, engineering and environmental sciences in the Baltic States. This chapter introduces the criteria for selection of materials and analyses the environmental aspects in the whole building cycle from extraction of raw materials up to disposal and recycling. It gives technical details and advice for proper application of ecologic construction materials. The key aspects related to construction of passive houses applying ecologic construction materials are also presented here.

Each page of this chapter contains illustrative material (power point slide) together with complementary notes explaining in more details the content of the slide on top. Supporting preparation to the lectures relevant background information, linkage with other topics as well as suggestions for discussion topics and practical exercises are given.

The enclosed CD, additionally to the handbook in an electronic form contains: recommendations for use of ecologic construction materials in the Baltic States, possibilities for evaluation of eco-performance of buildings (modelling results of buildings using ecologic and conventional materials) and the list of useful publications on ecologic construction in Estonia, Latvia, Lithuania and Germany.

We hope you find it useful!
Baltic Environmental Forum

Editorial Team

Introduction

This chapter introduces selected aspects of ecologic construction materials. It can provide you with some ideas and inspirations where ecologic construction materials can be used and what makes them ecologic. Choosing such materials can help you improving your indoor climate and reducing the environmental impact of your house. However, before making a decision on ecological materials, we strongly recommend you to think about the energy consumption of your house as a first step. The energy efficiency of your house will have the biggest impact on the environment – the less energy you use for heating, the less you pay and the less carbon dioxide you will emit.

Modern energy-efficient houses and ecologic aspects

When thinking about building a new house each future house owner wonders what his or her future home shall look like. Many different aspects need to be considered, starting from the general appearance of the house from outside until the tiniest details of where the sockets and light switches should be placed. Apart from design principles, two other aspects are steadily gaining importance for the future house owner too: these are environmental and health aspects. Both aspects can increase the building quality and the comfort for the inhabitants.

There are many environmental aspects during the construction or a major renovation of a building. The one that comes first to mind is an adequate thermal insulation which helps saving money through less heat consumption and emitting less CO_2 because in a well insulated house the energy consumption is lower than in badly insulated houses. Besides the insulation there are also many aspects that are less apparent. Before the building materials reach the construction site they are produced in many different ways. Some products need a lot of energy for their production, for example cement. Others need little energy, such as massive wood beams or straw. However, if the tree is felled illegally in tropical rainforest the little energy demand is counteracted by the bad ecologic impact.

After the construction or reconstruction phase ecologic aspects continue to play a role. The right selection of materials can have a positive influence on the interior climate, for example through a regulation of the indoor air humidity or by avoiding emissions from certain materials. Furthermore, the longevity of the components of a house has an environmental effect. Materials that last longer and need to be repaired or exchanged less often decrease the demand for spare parts. This saves money and protects the environment.

During the last years, an increasing number of engineers and architects think about the use of building and building elements after the building has fallen out of its originally planned use. Not only do we think about the recycling of glass bottles nowadays but also about the recycling of houses and conversion of houses for new purposes. Our global resources are limited and we should use them as economical and efficiently as possible. Certain construction principles make the use of a building more flexible and allow for examples a change of walls, when new floor plans are needed. To save material and effort, construction elements should be designed in a way that its parts are easy to assemble during construction and easy to disassemble for recycling and reuse. Such possibilities are seldom influenced by the private house owner, but it is nonetheless worthwhile to keep these aspects in mind when discussing house designs with the architect or engineer. Taking into account all aspects of a building from the production of its element until the recycling of its part or its demolishing is also called a cradle-to-grave approach.

What are eco-materials and where are the environmental problems?

Ecologic materials are materials that reduce the impact of extracting, processing, using, recycling and disposing on our environment. They should furthermore not compromise our health and contribute to a better indoor climate. The overall environmental impact of materials depends on many factors and they may differ from place to place.

Energy

The energy that is consumed during production of the construction material, the transport and the erection process has been considered as negligible in the past. The modern scientific literature tells us that between 10 and 25% of the total energy consumption of a building during its lifetime depend on the choice of materials used. For advanced low-energy houses the figure increases up to 50%. Thinking about future near zero-energy or even plus-energy houses, the role of energy used before living in the house becomes central to the overall energy balance of the house. Plus energy houses are houses that produce more energy e.g. from wind or sun than they consume themselves through heating and electricity consumption.

Materials that we use for construction, such as bricks or mortar or cement, must be gained or produced from natural resources by using energy. Red bricks must be burned; for the production of cement, limestone must be extracted. Other materials occur in nature and can be used without much effort, such as timber, clay or straw. This explains why different materials “contain” already certain amounts of energy when we use them for construction. Architects and engineers talk of different “embodied energies” as a measure of the energy intensity during extraction, production and transport. The embodied energy of different materials is a useful measure for the initial energy consumption. It is typically given in megajoule or kilojoule per mass or volume unit – either kilogram or cubic metre. In some cases, such as windows or paints, also values in kJ/m^2 or MJ/m^2 can be found. It should be taken into account that these values may differ by author and for different locations.

Material	Embodied energy in MJ/kg (without transport to site, non-renewable energy only, approximate values)
Insulation materials	
Extruded Polystyrene (XPS) insulation	102 - 104
Expanded Polystyrene (EPS) insulation	95 - 98
Hemp/Flax plates	31 – 41
Glass wool	25 - 50
Stone wool	14 - 25
Sheep wool	15
Cellulose flakes	4 - 8
Wall constructions	
Certified solid construction wood, massive	10

wood beams (larch, pine, fir or spruce)	
Calcium Silicate bricks	8
Timber – planed, technically dried	4 - 9
Concrete	1
Sand-lime brick	1 – 3

Embodied energy – Overview on selected insulation and construction materials (combined data from various sources, see links at the end of the chapter)

It is important to remember, that the ecologic properties and the embodied energy should be evaluated on the basis of the final construction and not just by comparing single materials. Some materials, which have a high embodied energy per kg but which are used only in small quantities, can have the same ecologic impact as a material which is uses in large quantities and which has a small embodied energy per kg. However, it makes sense to compare the values of two different materials if the one can be substituted by the other. Finally, transport to the construction site has not been taken into consideration in the table above. Obviously, local products have a clear advantage over products which need to be transported for long distances. The weight of the product plays a role, too.

Pollution

Apart from the energy consumption, the production or extraction/harvesting of natural materials causes emissions. Such emissions are relevant, because the production or manufacturing emits greenhouse gases and gases that contribute to the acidification (through acid rain).

Among relevant greenhouse gases is CO_2 which forms during burning and production processes. But also other, much more potent greenhouse gases can result from the production, use and disposal of building materials. Insulation foams may emit hydrofluorocarbons (HFCs) gases for example, and older double pane windows contained sulphur hexafluoride gas (SF_6) between the panes – both compounds have greenhouse warming potentials which are hundreds of times of that of CO_2. In total, 7 to 9% of all emissions of greenhouse gases in Western Europe can be attributed to the production and transport of building materials. As a rule of thumb, you should avoid products that contain CFCs (chlorofluorocarbons) and rather look out for those with HCFCs (hydro chlorofluorocarbons) or HFCs which are usually less harmful to our climate. The best option is of course to avoid such substances altogether.

Lifetime and renovation

Considerations about ecology of houses do not end with the construction of houses. To make a sound ecologic assessment of buildings, the service life of construction parts should be taken into account. The typical lifetime differs by construction elements, but they are around 75-100 years for bearing structures and 25-50 years for windows (depending on material, wood 25-40 years, aluminium 40-50 years). Quality of the construction, maintenance and stress are additional influence factors which increase or decrease the typical service life of a building part. Thus, not only the choice of materials, but also their maintenance and proper installation plays an important part in reducing costs and environmental impacts when the material or construction parts needs to be exchanged.

Some construction parts, such as wooden windows, need higher maintenance efforts as comparable elements made from other materials.

Disposal and recycling

Disposal and recycling are two aspects that play a role in assessing the ecology of a construction as well. Thinking about recycling and disposal starts with the waste that is produced when extracting raw materials and producing construction materials. The packaging of products is the next step where waste can occur. Using regional products might be a possibility to avoid additional efforts for packaging.

When parts of a building need to be exchanged, the old parts need to be disposed or recycled. While some materials can be re-used with little effort, such as cellulose flakes –or clay/stone roof tiles, the majority of materials cannot be re-used in construction as such. These materials are usually downcycled or deposited. Gravel from crushed bricks is for example used for roads. Heat and electricity which is generated from incinerating used construction materials is a final option to make use of old construction parts.

Where are ecologic construction materials used?

Ecologic materials can be used in various ways in constructions or they can replace old parts during the renovation. The focus of this introduction will be floors and walls, including structural elements, insulation and plaster or paint. Further possibilities to think about ecologic alternatives which are not covered in this introduction are windows, roofs and furniture.

Walls

Timber

Wood as a renewable resource has been used for centuries for construction (think of old truss constructions) and is moving again into the focus of house owners, architects and engineers. Wood is easy to process, can bear heavy loads, is visually appealing and can contribute to a pleasant interior climate. Wood is a very ecologic material in terms of climate impact. Timber as such is a carbon neutral product and its impact on our environment is determined by the energy used in forestry, processing and transport. If treated properly, wood can be a very durable material and can be used also after it has been used as a structural material. Wood causes very little waste and only heavily treated wood cannot be re-used or burned and must be landfilled. It is beneficial to the environment if regional wood is used and long transport routes are avoided. The FSC (Forest Stewardship Council) label is found on certified wood and ensures that this wood comes from socially and environmentally responsible forestry.

Timber needs little to no chemical treatment if the construction is properly done and a few rules for working with wood are kept in mind. Timber treated with aggressive chemicals should be used only if it cannot be avoided by using an alternative construction and should not be used inside the house. There are several types of wood products which are used in construction, among them solid timber, plywood, glued laminated timer, fibreboards and oriented strand boards (OSB). Wood boards that consist of several layers of wood or wood chips contain glues. There are several glues used in the wood processing industry and many of them are based on formaldehyde. However, just some of these glues also emit formaldehyde after the wood board has been glued, especially urea-formaldehyde resins. The exposure to formaldehyde from wood products depends on the kind of material used, how it has been glued and how many emitting construction parts are inside the house. Coated and sealed boards can reduce the emissions, but the surface should not be damage afterwards, e.g. by drilling. Besides that, wood products which are free of formaldehyde emissions come with an environmental label in some countries.

Insulation

When it comes to insulation there are several possibilities to use more or less ecologic materials. These ecologic materials form an alternative to conventional, mostly synthetic materials. Although they have generally good insulation properties, there are several concerns to use synthetic materials. Firstly, the energy demand to produce these substances is high, usually more than twice the energy needed to produce ecologic alternatives. Second, some of these products, such as polystyrene products or polyurethane (PUR), rely on petroleum or natural gas which is a limited resource. Third, some materials are produced from base products which are not free of concern. To produce for example PUR foams, noxious isocyanates are needed. Last but not least, although synthetic materials have the same fire resistance as many comparable ecologic materials, they have the significant disadvantage that they produce toxic fumes and thick smoke in case of fire.

Mineral wool insulation

The most commonly chose material is mineral wool (stone wool or glass wool). Mineral wool is made from natural resources, but due to the fact that it is produced at temperatures of more than 1400 °C it is energy intensive. To save resources, up to 60% of the base materials can be replaced by old glass for glass wool or remains from the production for stone wool. Additionally it contains organic resins for shape retention and hydrophobic agents. Mineral wool can be only partly recycled and not composted. Mineral wool can emit small synthetic mineral fibres during handling. These fibres can cause mechanical skin irritations. Mineral wool which is sold in Europe nowadays has biosoluble fibres and is usually classified as non-carcinogenic. However, some uncertainties remain and preventive safety measures (wearing gloves etc.) are recommended. Thanks to its very good insulation properties, mineral wool is a comparatively sustainable choice, especially if a part of the product originates from recycled materials. However the large initial energy demand during production has a negative environmental effect.

Cellulose insulation

Cellulose insulation is commonly available in two forms: as loose flakes or as fibreboards. Both can be used for insulation of e.g. wooden frame constructions and rafter insulations, flakes are suitable to fill small cavities which other less flexible insulation systems can not reach. Cellulose products are produced from shredded recycled paper and require thus a small amount of energy during production. Cellulose insulation flakes and boards contain fire retardants and fungicides up to a third of the mass. Most commonly boric salts (borax) are added, which is problematic when the cellulose material shall be disposed – it cannot be composted. Borates are classified as reprotoxic and slightly hazardous to water as they seep into the ground water. Therefore certain protection should be worn when applying cellulose insulation, such as a mask for mouth and nose. As borates do not evaporate, this material is safe for inhabitants nonetheless once the insulation layer is closed off. Furthermore, first borate free cellulose materials are already available on market in some countries (e.g. Germany). In these products, borates are substituted by other, less harmful agents. The additives do however not impair the possibilities of recycling and re-using cellulose flakes. It is worth mentioning that cellulose flakes should be blown into cavities only by certified craftsmen because the inappropriate insulation process can set free hazardous small dust particles, e.g. by not properly closing the gap around the opening in the insulation layer and tube which is used for blowing the insulation into the wall construction. Cellulose fibreboards are safe for handling by the customer and do not require special precautions. Once installed, all cellulose materials are safe and do not emit any gases.

All in all cellulose insulation is generally an ecologic alternative to conventional materials and borate free products are very sustainable products, as they are produced from abundant resources with little energy input and little environmental impact.

Sheep wool

Sheep wool can be used as insulation material for inside walls and inside ground plates, rafter insulation, and for wood frame constructions. It is sold as fleeces. The sheep wool insulation which is produced in Europe is made from leftovers of processing the wool for other purposes. This is also the reason, why it has a low environmental impact. European sheep wool usually comes from non-intensive farming. If the wool is imported from New Zealand or Australia, the environmental impact of the transport and the more intensive farming in these countries must be taken into account. Sheep wool products can contain additives, such as borates, and synthetic support fibres. Unprotected wool is susceptible to moth infestation. To make sheep wool products mothproof, insecticides - usually sulcofuron which is toxic to marine organisms - are necessary. However, the additives are unproblematic for humans.

Sheep wool insulation has good ecologic properties and furthermore very good fire protection ratings. However moth protection is necessary and additional provisions should be made, to make the insulation wind and airtight to keep larvae away from the insulation.

Hemp and flax insulation

Flax and hemp insulation are based on fibres from flax or hemp which can grow in almost all regions of Europe. Although not very widespread in many countries today, hemp and flax where once two very common cultures, for example in the Baltic States in the 1920s. During the past decades these materials fell out of use and have been almost forgotten. In last years a small renaissance of these plats can be observed. Fields of industrial hemp (sort with very small amounts of the substance THC which is responsible for the intoxicating effect) and linen do not require more than usual effort for growing crops. Both plants are rather undemanding but as with any other culture their crop yields depend on the weather. As regional products hemp and flax can help to reduce transport efforts.

Hemp and flax can be used as insulation materials in wood beam constructions, as rafter insulation, interior insulation of the outside walls, or between suspended ceiling and the supporting structure above. Hemp and flax are sold as fibreboards or fleeces; hemp is also available as loose fibres. Loose hemp fibres they should be blown into the wall by an experienced company as the handling sets free a lot of dust. In some hemp and flax insulation materials, support fibres made from polyester are added. These fibres are the reason the insulation may not be composted after it has been removed. Similar to cellulose flakes or sheep wool, borates are sometimes added as well; in some products soda is used. The future perspective for growing these materials is rather good from a sustainability point of view. This local material has a high potential to reduce transport efforts and to contribute to local economies.

Wood fibreboard insulation panels

Wood fibreboard insulation panels, either flexible or stiff, are versatile insulation materials that can be used in different constructions. They are produced from pressed wood off-cuts either by wet or dry processing, parts of the product can originate from recycled material. In wet processing, polyvinyl acetate can be used to glue thicker layers into plates. Sometimes fungicides or additives to increase fire resistance are added, but these shares are relative small. Some fibreboard panels are coated with bitumen or latex if they are used in water resistant layers of wood frame walls or inside roof constructions. Transport efforts can be reduced, if the wood used is collected close to the place of production. Wood fibreboard is usually not reused and recycled only to a limited extend. Uncoated panels without certain additives or impurities (e.g. without polyvinyl acetate) can be composted. An incineration with energy generation is possible. Wood is an ecologic material with similar insulation properties as other ecologic materials, however processing the wood chips is rather energy-intensive. Therefore wood fibreboard insulation has a higher embodied energy as for example cellulose flakes.

Perlite insulation

Perlite is a mineral that forms through the hydration of obsidian, which is a natural product of volcanic eruptions. By heating small perlite grains quickly to 1000 °C the chemically-bound water is released and perlite expands by 15 to 20 times its size. The resulting product is use as insulation filler in walls, roofs and ceilings; also perlite boards are available. Perlite does not rot and is resistant to weather and vermin. Perlite can be made hydrophobic by coating it with silicon resins or bitumen. Furthermore, supporting fibres can be added in perlite boards. Perlite products can be handled without precaution measures, just masks should be worn if using filler insulation causes dust. Re-using the filler insulation is easy and possible with little effort. If not reused, the insulation must be disposed of on a landfill site. However, products treated with bitumen might require special treatment.

Perlite is mostly produced in Southeast Europe and requires transport considerable efforts to more remote regions. Additionally the high temperatures needed for processing are energy intensive and have an impact to the environment as well. However, being a natural product, perlite is still considered as an ecologic choice in comparison to synthetic insulation materials.

Straw

Straw is a natural dried fibre from crops or other fibre plants, such as hemp or flax. It is a light-weight material which is practically everywhere available in Europe. Straw is thus a material which requires minimal energy for transport. Straw is delivered in bales of different sizes which are built into the wall and then compressed. The most common use nowadays is in straw bale buildings, where straw is used as an insulation material inside a wood frame construction. As an insulation material, straw can be used as an outside insulation, on the ground plate or as rafter insulation. In few cases it is also used as a structural, load-bearing material, however, this is not always permitted by the building law. As straw is binding carbon and only little carbon is released during harvest, drying and transport, it is an excellent climate-friendly material, with a very low embodied energy. However, it should be also said that straw is not a material that is suitable for the mass production of houses and the industrialisation of building. Using straw is very time and manpower consuming and will thus not become a mainstream product for mass markets. It is an interesting alternative for those who are willing to put a lot of own work into their future home.

Flooring

Different flooring types

There are several options for flooring: carpets made from natural (jute, wool, cotton, coconut fibre) or synthetic fibres, elastic flooring from linoleum, polyvinyl chloride (PVC) or cork, or hard flooring such as laminate, wood parquet or stone. The amount of renewable base materials differs between the various flooring. Laminate, wood parquet, linoleum and natural fibres contain a high share of renewable resources. All options for flooring have a range of use and their advantages and disadvantages. From an ecologic point of view, special attention should be given to additives, the durability of the flooring and the recycling potential.

About PVC

For the sake of the environment you should avoid PVC in your home and look for more environmentally friendly alternatives. PVC as such is very resistant to chemicals and sunlight once it is produced, but the base chemicals from which PVC is made are toxic. Furthermore, PVC can contain plasticizers and heavy metal stabilizers which are not chemically bound to PVC and which are released from the plastic over time. Hard PVC itself is chemically stable and does not rot which makes it problematic as it accumulates on dumping side. When PVC waste is incinerated, highly toxic dioxins and other dangerous substances are formed.

Additives: Carpets from natural or synthetic fibres may contain additives to make them moth proof. Such additives are for example isothiazolones or permethrin which are not free of concern. Wood parquet and laminate can be sources of formaldehyde and other volatile compounds which are emitted from the glue and the sealing. However, ecologic alternative which use less problematic glues and sealing are available. Linoleum flooring may emit volatile gases that cause odour sometime after installation. Rooms should be aired regularly and heated in colder seasons during that time. PVC flooring can contain up to 20% plasticizers, stabilizers and other additives. While usually very stable and resistant, PVC floors emit highly toxic substances when it catches fire.

Durability: The durability of different materials depends on the individual material properties. Carpets from natural or synthetic fibres do usually last 10 years, linoleum 25-30 years, PVC 25 years, wood parquet up to 60 years, stone even longer.

The recycling potential of flooring depends not only on the type of flooring used but also on the fact if it is glued to the underground or not. Glued flooring is usually more difficult to remove without damaging the material and also more difficult to recycle. PVC, linoleum can be recycled or downcycled. Flooring from synthetic fibre cannot be recycled; recycling of flooring from natural fibres is not yet common although possible. In both cases, flooring made of fibres can be burned using the heat. Wood parquet and laminate can be theoretically re-used, if they can be removed without being damage. Parquet and laminate can be also burned using the heat.

Cork

Cork is a natural, renewable material which is gained from the bark of the cork tree. The cork which is used to produce materials for buildings is a waste product from the production of bottle cork. Cork can be used as flooring but also as insulation material in form of granulate or expanded granulate. Cork is a not only suitable as for thermal but also for sound insulation. It is a resistant and durable material and does not need additional treatment, but should be protected from permanent exposure to humidity. Cork used as flooring is either used as tiles or as parquet and it gives a soft and warm feeling to the feet. Cork tiles can be sealed or contain glues which impairs their environmental performance slightly. Furthermore, it is a limited resource and the overwhelming amount of cork is harvested in Portugal. Given these facts and its high price, cork will not become an alternative for the mass market.

Plaster and paints

Clay plaster

Clay is an ancient construction material that has been used for millennia. As a construction material applied to outside surfaces, it can be used in hot, arid climate zones only, e.g. Northern Africa, because clay is water soluble. However, using it inside the house has become an interesting application during the last years. From an ecologic point of view clay is a favourable material, as the embodied energy is very low. Unburned clay can be fully recycled and reused; it is durable and contributes to a positive indoor climate. Clay can absorb much more humidity than other materials and can regulate the indoor humidity and thus contribute to the health of the inhabitants. Clay plaster is available as ready-to-use powder which is mixed with water on site and applied directly onto a reinforcement grid. The plaster is available in different earth tones.

Paints and colours

When thinking about the ecology of houses, many people think about colours and paints first. However, it should be kept in mind, the colours and paints contribute only little to the overall ecology of houses. Basically, paints consist of four groups of ingredients which also determine their ecologic properties: pigments, fillers, solvents, and additives. Fillers are usually made from stone and unproblematic. Pigments in colours can be either organic (made from oil products) or mineral (metal compounds). While the production of organic pigments is usually energy and material intensive, mineral pigments are often produced by using strong acids which must be recycled in energy-intensive procedures. Solvents are usually organic compound which are in most cases responsible for the indoor air pollution and odours which the paint emits (“smell of fresh paint”). The last component of additives contains everything else what is in the paint. This can be compounds which are absolutely harmless, but also very problematic toxic substances, such as drying agents (so-called siccatives). As there is such a large variety of paints, it is recommended to consult your local retailer and ask about different alternatives and its advantages and disadvantages. For many applications, ecologic paints are available which are emission-low, are made from natural pigments or which do not contain problematic additives. Many of them come with an environmental label. Ecologic paints can be purchased in practically every desired colour nowadays.

How can ecologic materials contribute to a more comfortable living?

There is a number of ways how ecologic materials can contribute to better comfortable living. There are several factors to which ecologic materials can contribute: indoor temperature, humidity, pollutants in the indoor air and noise protection.

The right choice of insulation material can help to regulate the indoor temperature. Not only does a well selected material keep the heat inside in winter but also slows down heat coming in from the outside in summer. Each material has a characteristic time which is needed to transport the outside heat into the building. A well selected insulation construction has a delay of 8-12 hours, so that the heat reaches the inside in the evening. The humidity inside the house can be regulated for example by clay plaster. The upper layer of the plaster can take up excess humidity and release it again when the air is drier. Ecologic materials can contribute to a better interior climate if emission-low materials and paints are selected. Wooden materials and flooring should not contain glue that emits formaldehyde or other volatile organic compounds. Furthermore, non-textile flooring is more health-friendly for people who are allergic to mites. Last but not least, cork for example can contribute to sound isolation.

How do I select ecologic materials?

Ecologic construction materials can be a benefit to the comfort and contribute to smaller environmental impacts caused by building the house. Nowadays a variety of ecologic alternatives to conventional materials is available on the market. However, such materials should not be used for the sake being environmentally friendly only. Their properties and range of application should be carefully studied just as with any other material. The thermal properties, meaning the conductivity and the specific heat capacity, should be compared and fire resistance or noise protection properties of materials should be kept in mind. If the materials are used for both heat and sound isolation, then the properties for both uses should be considered together. Due to different resistance to water and humidity, some materials have a limited range of application or should be installed with a special vapour barrier. Ask your architect and engineer about possible options.

For many product categories, environmental labels exist. For organic food or energy efficiency classes there are even an EU-wide labels. For building products the situation is different. Besides the general CE-mark which all building products should have, there is a confusing variety of labels across Europe. When buying labelled materials, salesperson should be asked about the meaning of the label and the criteria for awarding. Searching the internet or asking the local consumer advice centre for country specific labels is also recommended in case of doubt.

For smaller products such as flooring, paints and colours, or furniture it is safe to make an informed decision as a customer. Due to the variety of these products it is nevertheless recommended to consult the local salesperson or to get an overview in the internet or in customer advice centres if available. Stores specialized on ecologic construction materials might be located in the nearest larger town.

When deciding for things like insulation of even construction materials for a house to be built, it is always necessary to discuss with an architect or engineer about feasible and economic options. It is important however, to see the costs of the building in the long run and not only during the time of constructions. Certain options might appear more costly in the beginning but they might save money after some time. It is easy to understand how energy efficiency measures pay-off because of lower energy consumption and thus less costs. However, thinking about ecologic materials it makes sense to think about the lifetime of materials. Wood parquet for example may appear very expensive, but might save 3 or 4 times re-carpeting.

General guidelines when selecting materials

It is rather difficult to provide you with one advice for the best product. All materials have advantages and disadvantages and these are often in the eye of the beholder. The following recommendations are for you if you want to have a healthy indoor climate by paying attention to the environmental impact of your house:

1. ***Prefer natural materials over plastics.***
2. ***Avoid PVC.***
3. ***Look out for environmental labels.***
4. ***Buy local products.***
5. ***Prefer wooden parquet or linoleum over laminate, or use low-emission laminate.***
6. ***Use colours that are designated as emission-low***
7. ***Pay attention to your energy and water consumption. The most ecologic material will not decrease the environmental impact of your house if you waste water and electricity and your house is badly insulated.***

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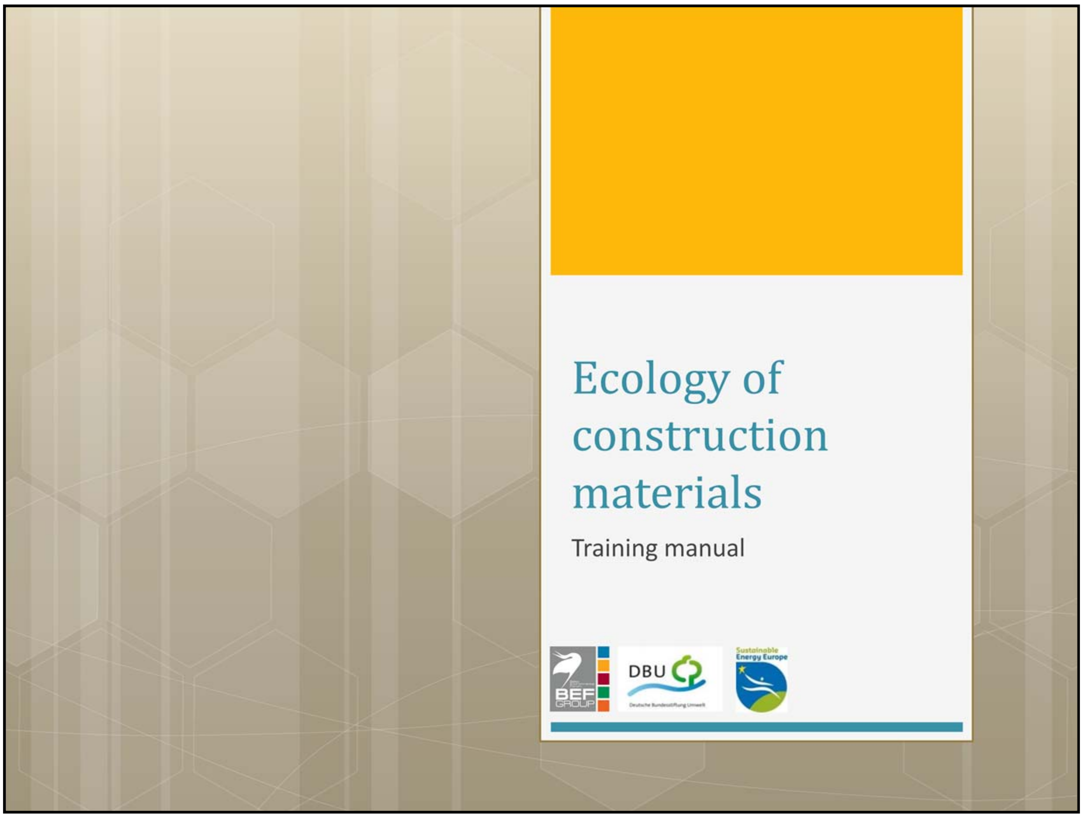
Ecology of construction materials
Training manual
DBU
Sustainable Energy Europe

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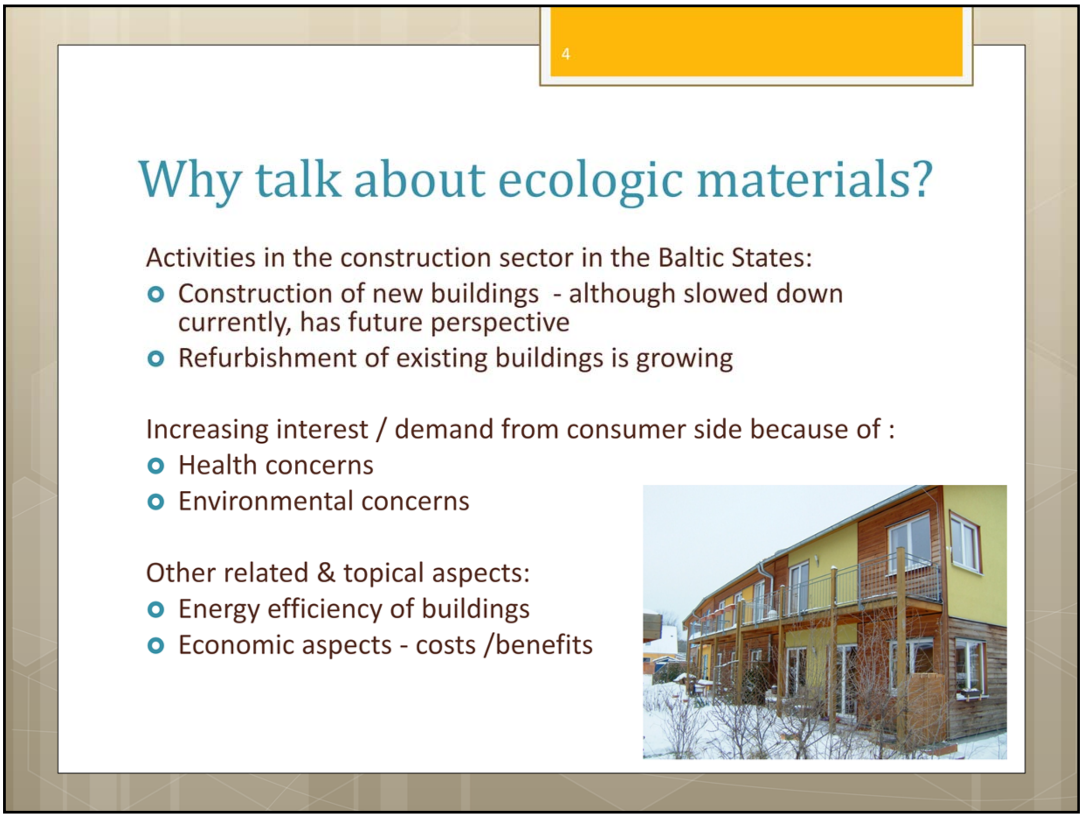
Introduction

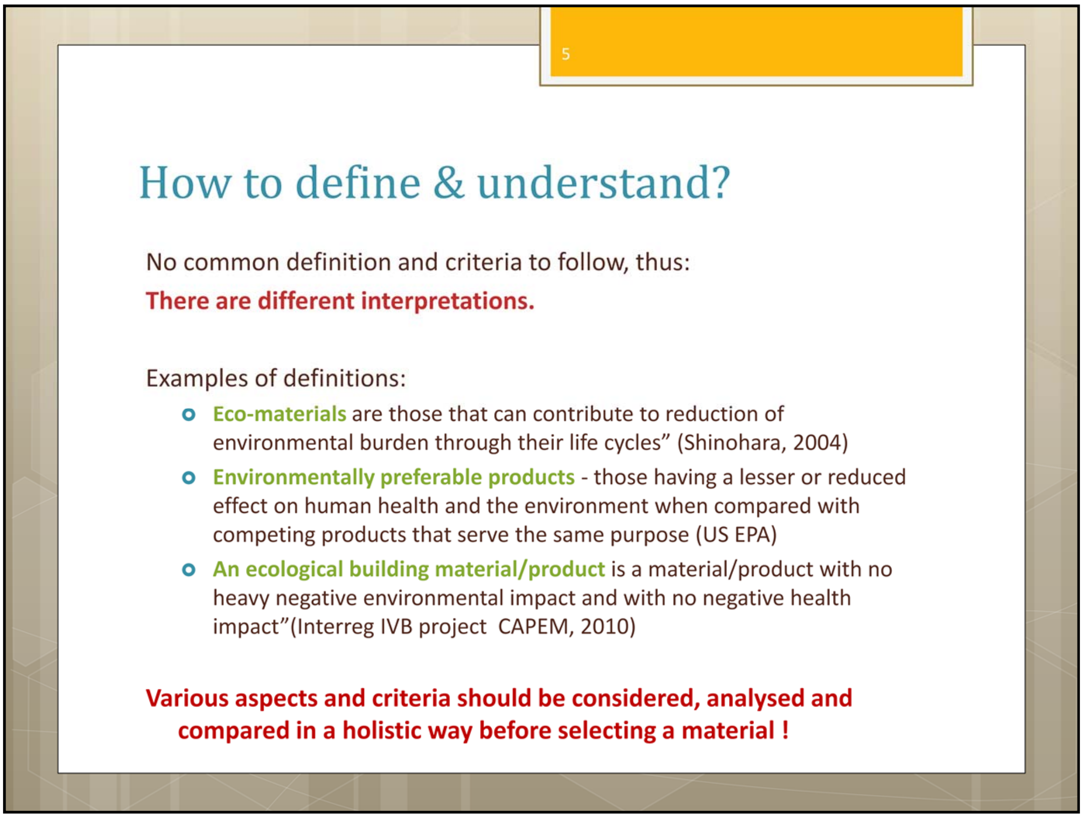


After significant increase in construction volumes since the beginning of the 21st century, due to the economic crisis around 2008 Estonia, Latvia and Lithuania have been facing a significant slowdown in the construction sector, particularly with regard to the construction of new buildings. According to expert opinion construction of new buildings has future perspective in the Baltic States and at the same time refurbishment of existing buildings is receiving a growing interest. Consumers are also starting to pay more attention towards the health and environmental aspects as well as possible savings related to the reduction of energy consumption by their homes by implementing measures that increase the energy performance of buildings.
Thus the current pause in construction activities is the right time to focus on development of real estate in terms of building quality, new technologies and approaches at the same time considering the use of environmentally friendly construction materials for construction (or refurbishment) of houses reaching high energy performance standards (e.g., low energy, passive or near-zero-energy buildings).

Connection to other themes:
Energy performance of buildings.

Background:
EU and national legislation related to construction and construction materials e.g., Directive 89/106/EEC on the approximation of laws, regulations and administrative provisions of the MS relating to construction products, Directive 2010/31/EU on the energy performance of buildings (recast).

Suggestion for presentation:
Discuss the current trends in construction and materials used for construction in the country.

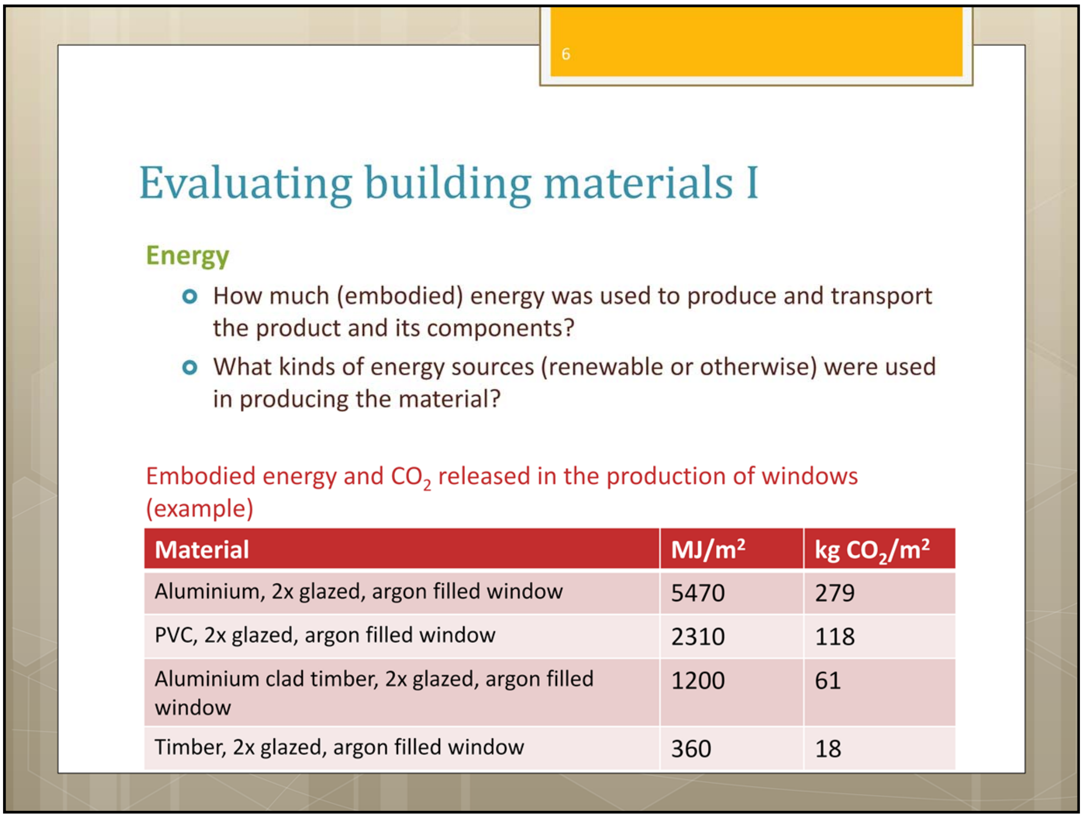


Nowadays the availability of materials that can be used for construction, insulation or finishing of buildings is increasing on the market. But how can the ecological materials be identified from this wide range? There is no common definition for ecological materials, thus allowing various interpretations. The examples of definitions mostly point out aspects of no / no heavy / reduced impacts on human health and the environment thus leading to the conclusion that various aspects and criteria should be considered before deciding on the ecological nature of a material.

Connection to other themes:
Life cycle analyses of materials, green public procurement.

Background:
More information available at the CAPEM (Cycle Assessment Procedure for Eco-Materials) project www.capem.eu.

Suggestion for presentation:
Check if there is a definition of ecological construction materials available in your country, e.g., in requirements for green public procurement.

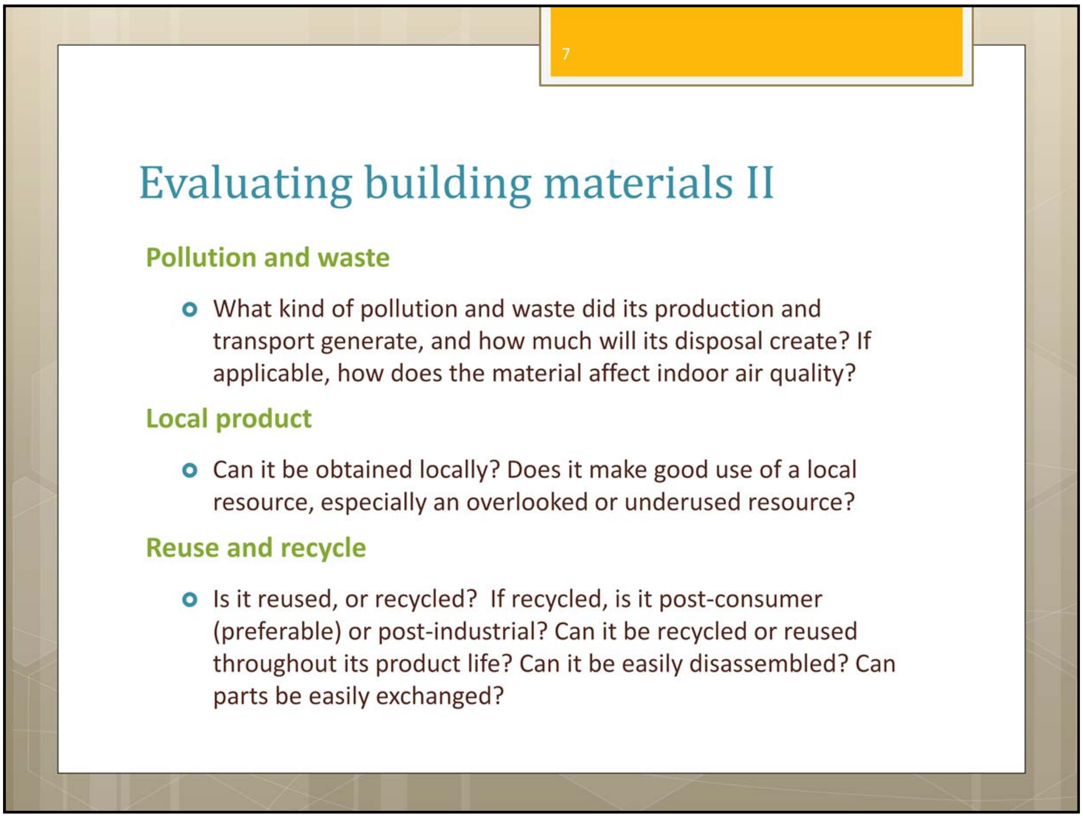


One of the criteria, frequently not taken into account, is the amount of **energy** required to produce and transport the construction material. The amount of energy used is closely linked to the environmental impacts of the product due to emissions of CO_2 into the atmosphere related to the burning of fossil fuels. Thus the energy source (renewable or fossil) used for production of a material/product becomes important. The table in the slide shows the comparison of the energy amount used for the production of different types of windows and the related amount of CO_2 emissions (www.greenspec.co.uk). Windows with timber frames show less environmental impacts than windows with thermoplastic polymer PVC (Polyvinyl chloride) or aluminium. When selecting construction products/materials those having low embodied energy should be given priority. Materials that can be created without elaborate conversion and refining processes and in as few manufacturing steps as possible should be considered first.

Connection to other themes:
Availability and use of various energy sources, green-house gas emissions, global warming.

Background:
The burning of fossil fuels is contributing a great deal to the increase in carbon dioxide in the atmosphere, believed to be strengthening the greenhouse effect. The emissions of carbon are directly proportional to energy consumption.

Suggestion for presentation:
Include practical exercise of calculation of CO_2 emissions released during the production of various construction materials.

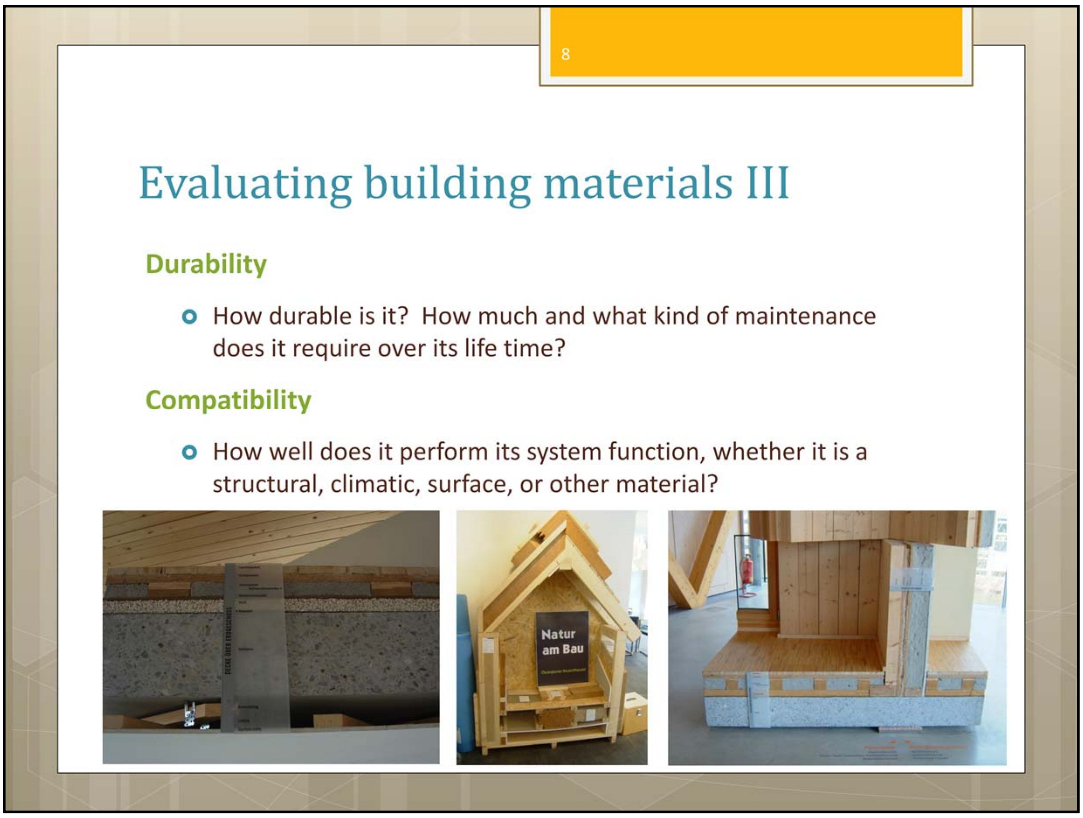


Pollution during the production/transportation of a construction material has a direct impact on the environment (e.g., emissions to air, water) and also to human health in relation to indoor air quality. Priority should be given to materials examined with regard to their health-compatibility and air pollution control. Generation of **waste** during construction processes increases the amount of waste at disposal sites (landfills). Materials that may be reused or recycled should be given preference. Also degradable and compostable construction materials ensure reduced environmental impacts and, in particular, inexpensive disposal. Priority should be given to **local materials** or materials from the nearby neighbourhood. Advantages: reduces energy consumption for transportation, strengthens the local economy, helps to avoid delays due to long distance transportation.

Connection to other themes:
Indoor air quality, workers' health safety, waste management, production and import of (ecological) construction materials in the country.

Background:
Production and application of construction materials (e.g., loose materials) frequently require particular risk prevention measures. During the stage of putting a building into operation, in many cases health problems are caused by emissions (e.g., VOCs) from materials in the building.

Suggestion for presentation:
Give an overview on construction materials that fulfil the above mentioned criteria and are produced locally (e.g., within the country) or in the neighbouring countries. Discuss the list with participants. Discuss the legal requirements for construction waste management and risk prevention measures to be taken when working with certain materials.



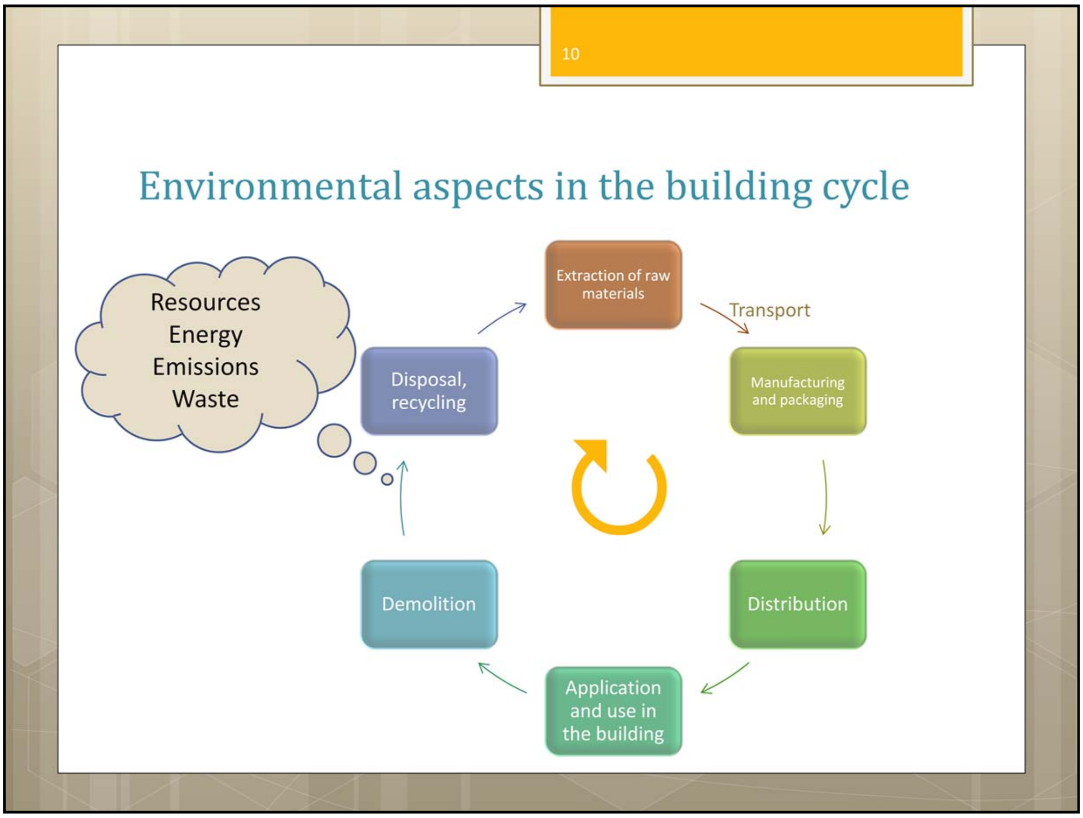
In general materials with a long lifespan and low maintenance costs shall be given priority. The exchanging and replacing of defective components must be simplified in order to extend the building`s life cycle (screwed or inserted joints prior to glued joints if possible). However, the **durability** of a material is dependent on building type, design, use, installation, and maintenance. The durability of many products depend on regular maintenance. This class of products may have a short life span if not maintained or may have a very long life if properly maintained. E.g., wood products, which require repainting or refinishing at regular intervals to prevent moisture or ultraviolet damage. Compatibility & interdependency describe the relationship between the various parts of a system to make the whole system function as designed and ensuring a long life span of the construction unit e.g., installation of cladding with an appropriate drainage plane behind it.

Connection to other themes:
Building physics, construction units e.g., foundation, outside wall, roof.

Background:
It is not possible to simply list the products that have been found to be durable in some projects and expect them to be the best choice for every project. There is no standard or widely accepted methodology for evaluating the durability of building materials. But there are criteria to be considered for evaluating durability: disposal frequency indicated by e.g., manufacturers warranty period; durability based on appropriate maintenance, durability based on compatibility & interdependency of materials in the construction unit (Green affordable housing coalition, 2005).

Suggestion for presentation:
Create construction units with the help of e.g., the pre-printed paper strips of the “Condetti System” available from German company Büro fur Bauphysik Robert Borsch-Laaks, www.holzbauphysik.de, contact: RBL@holzbauphysik.de. Discuss the compatibility of materials and construction units.

The building cycle

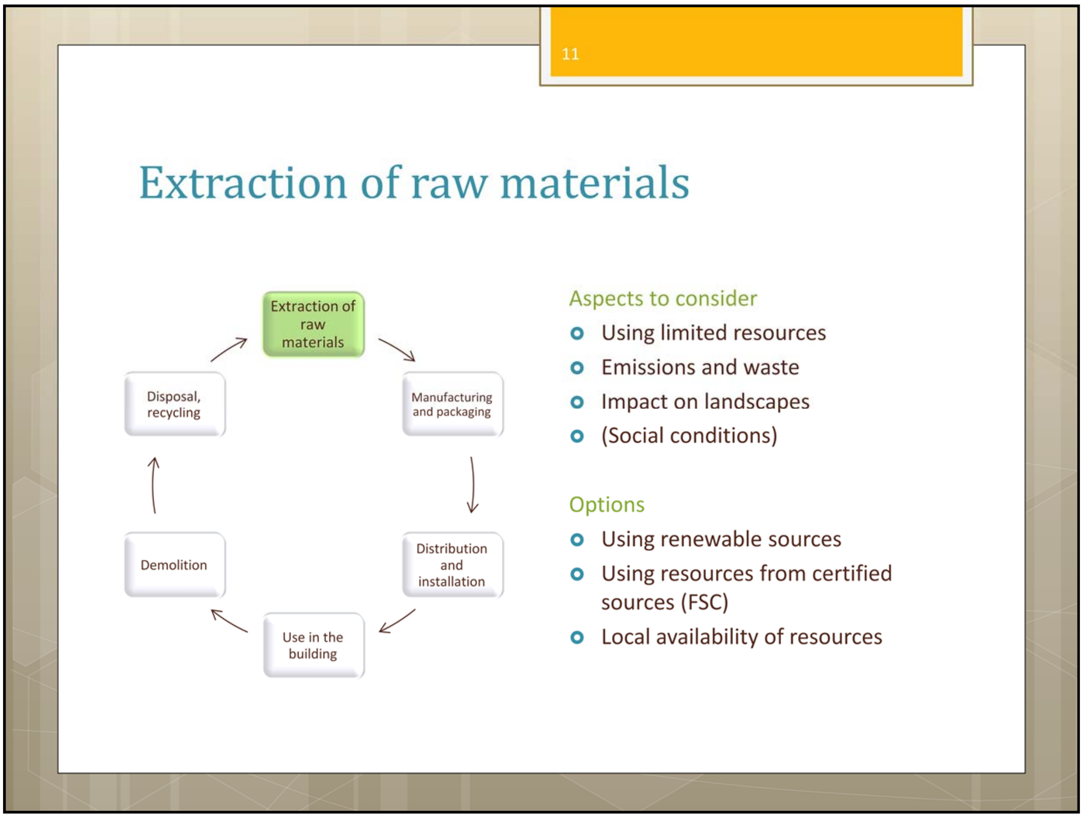


Throughout the whole "life cycle" of a material / product starting from the extraction of raw materials until its disposal or re-cycling ("cradle-to-grave or reincarnation") there are smaller or larger impacts on the environment. The main impacts are related to the use of resources and energy as well as impacts resulting from emissions to e.g., air and water as well as from waste generation at all stages of the building cycle. Additional impacts are caused by the transportation required.

Connection to other themes:
Life cycle analyses (LCA) - compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life cycle is a measure of the environmental sustainability of the system (Chemistry Innovation Ltd 2009).

Background:
In general the priority in choosing materials for construction, insulation and finishing should be given to those materials causing a low environmental impact during the whole life cycle. However, experts discuss that sometimes there might be exceptions - relatively small quantities of materials that have a high impact, due to their other outstanding properties e.g., durability (e.g., steel) may be preferable to large quantities of materials that have a lower impact. Thus, very often designers, builders and building owners have to seek a balance between conflicting considerations.

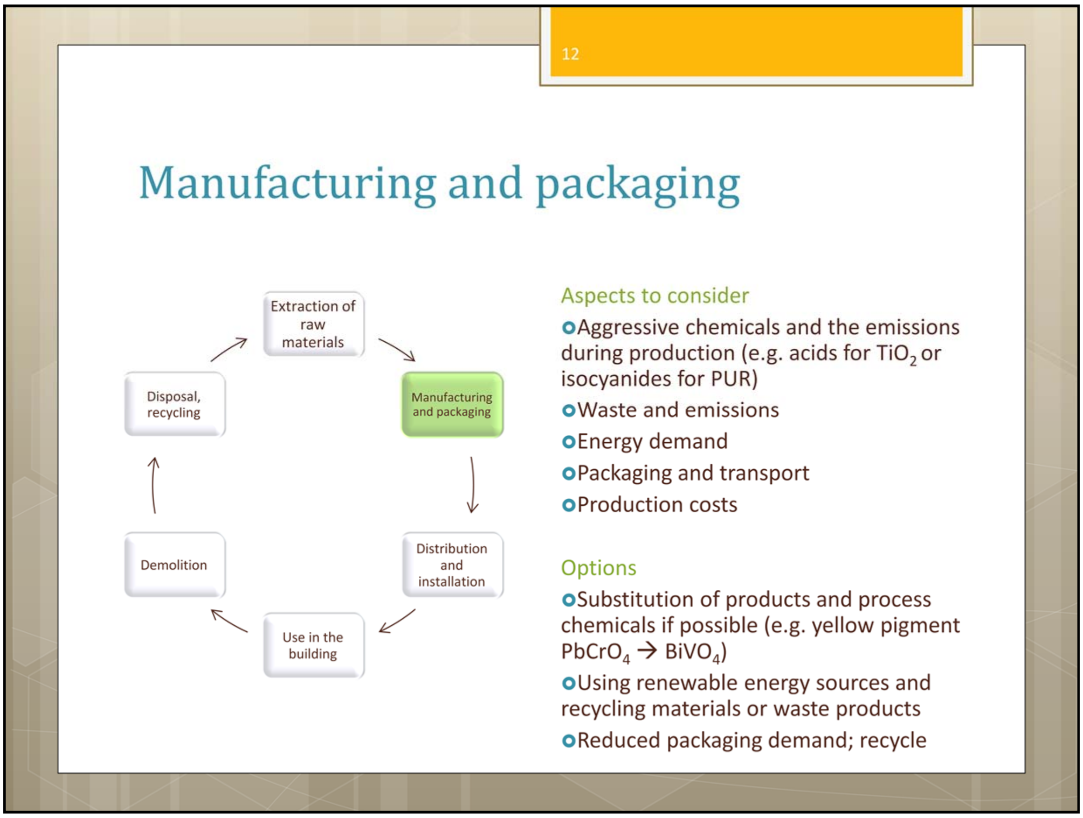
Suggestion for presentation:
Present examples of life cycle analyses e.g., for concrete, clay brick, PVC, straw. Compare the potential environmental impacts and discuss the results with participants.



The extraction of raw material is the first step in the building cycle unless recycled materials are used. The extraction of raw material can put a big impact on the local environment and can cause emissions and leave waste. The impacts on the environment are higher for oil-based products than for natural products; in addition fossil resources are limited. During the building process this can play a role, e.g. when using polymer insulation or building foams. Renewable energy sources are the only option in the long-term perspective as we will run out of fossil fuels eventually. The goal should therefore be to design as many components as possible by using renewable materials. It is recommended to use certified materials, e.g. look out for an FSC-label when using wood, in order to ensure a fully sustainable production process.
The production of some materials can be very energy intensive, e.g. the production of aluminium for window frames requires enormous amounts of electrical energy. In some cases, not the energy costs, but the labour costs can pose limitations. Sheep wool, cork or insulation materials from natural fibres are comparatively labour intensive.
Transport of materials is an important aspect to consider. The distance and total weight of material to be transported are the relevant parameters in this context. While transport costs may not put a high burden on the construction budget, these costs (and transport caused emissions) can often be avoided easily. In many cases local, equally ecological options will be available.

Connection to other themes:
Life cycle assessment, environmental labels, primary energy demand.

Suggestions for presentation:
The production process of aluminium and wood can be compared – the amount of energy and the transport processes. Participants can discuss if it is actually possible to fully replace conventional materials (e.g. what to do with bitumen coatings which are required in the case of standing groundwater?).

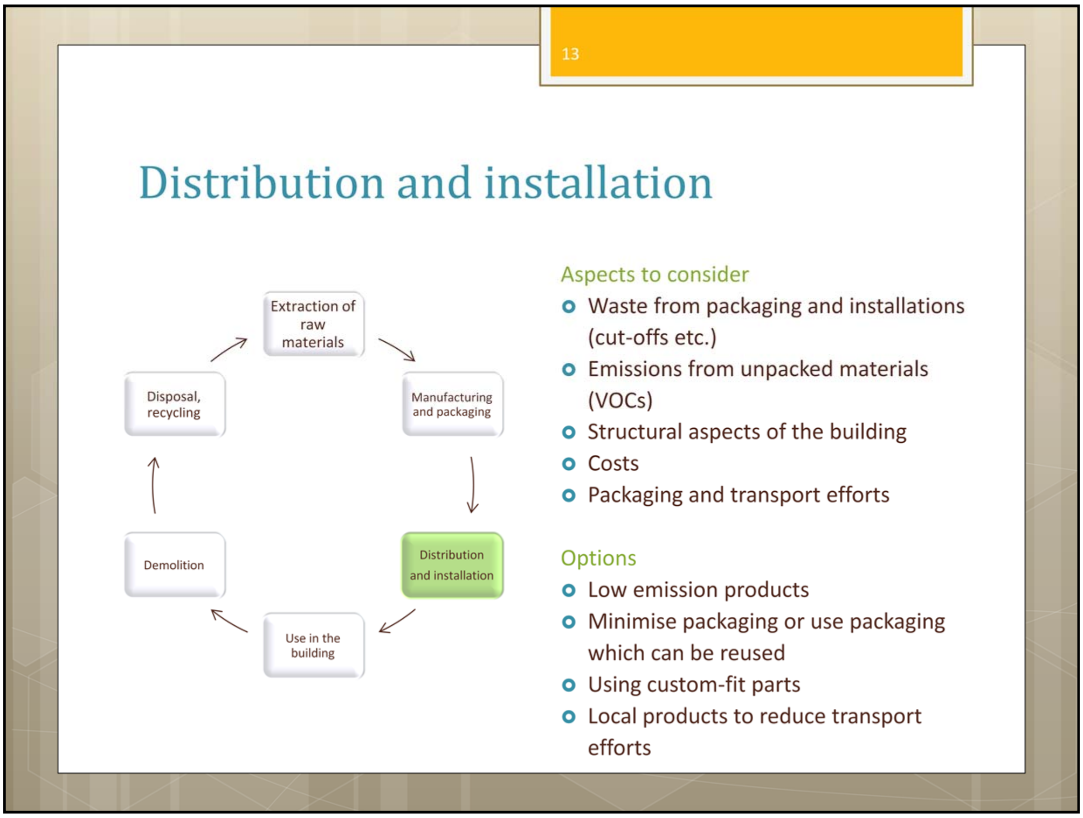


Many materials are not used in their raw forms but are either compounds of several raw materials or are produced in chemical processes. During the production processes, aggressive chemicals were or are in use. Example: For the production of titanium white (TiO_2), sulphuric acid (H_2SO_4) was used until the 1970s which was simply disposed of in the North Sea. Today, toxic isocyanides are still used to produce polyurethane (PUR); hydrochloric acid (HCl) is used for production of polyvinylchloride (PVC). Although these chemicals are not emitted to the environment under normal circumstances, they still pose a hazard to workers and some of them are released from the products again in case of fire. During the last decades it was possible to substitute dangerous base products with less dangerous or harmless ones. To give an example: A very toxic yellow pigment in colours - lead chromate ($PbCrO_4$) - was replaced by the problem-free substance bismuth vanadate $BiVO_4$.
Besides problem substances, there is also the issue of energy use and waste production in production and packaging. Using renewable – untreated – resources, e.g. wood or fibres, eliminates the waste problem as cut offs or leftovers can either be used for different parts or composted or burned. A prefabrication of several components in one place might save packaging as less construction parts are transported to the building site. In any case, a reduction in especially non-recyclable plastic packaging should take high priority.
Regarding transport, the notes from the previous presentation slide also apply to manufacturing and packaging.

Connection to other themes:
Life cycle assessment, health aspects, primary energy demand.

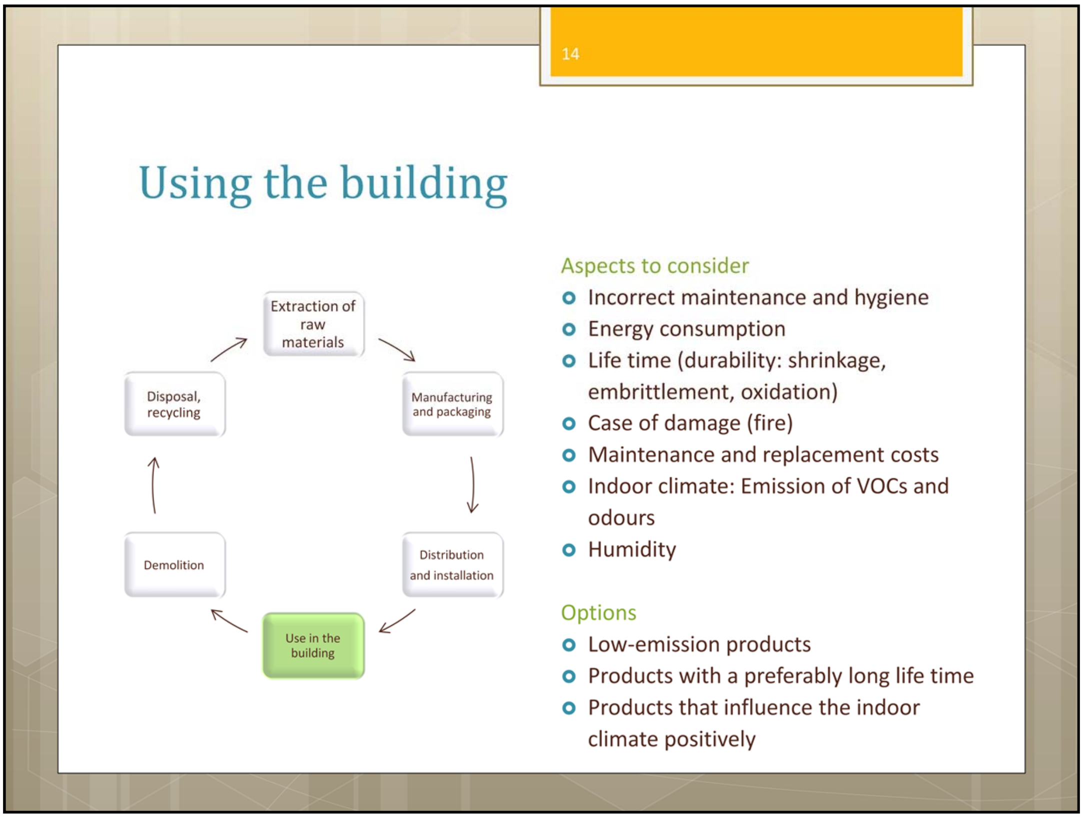
Suggestions for presentation:

Certain construction parts and their components could be discussed, e.g. laminated timber taking into account various resin glues. Participants should discuss how packaging can be avoided.



For distribution and installation, the issue of waste from cut-offs and packaging is also highly relevant. Custom fit parts and packaging that can be reused (or even entirely omitted) contribute to a reduction of waste. Transport costs also play a larger role in this step. Longer transport routes might reduce the environmental balance of a material significantly. After being unpacked, some materials might emit unwanted substances; formaldehyde is a prominent example here. Labels can help when selecting materials that are emission-low. In some cases, the installation of ecological materials is a question of installation costs – one example might be the use of reeds on roofing. In this case the labour costs for installation contribute substantially to the price of the material.

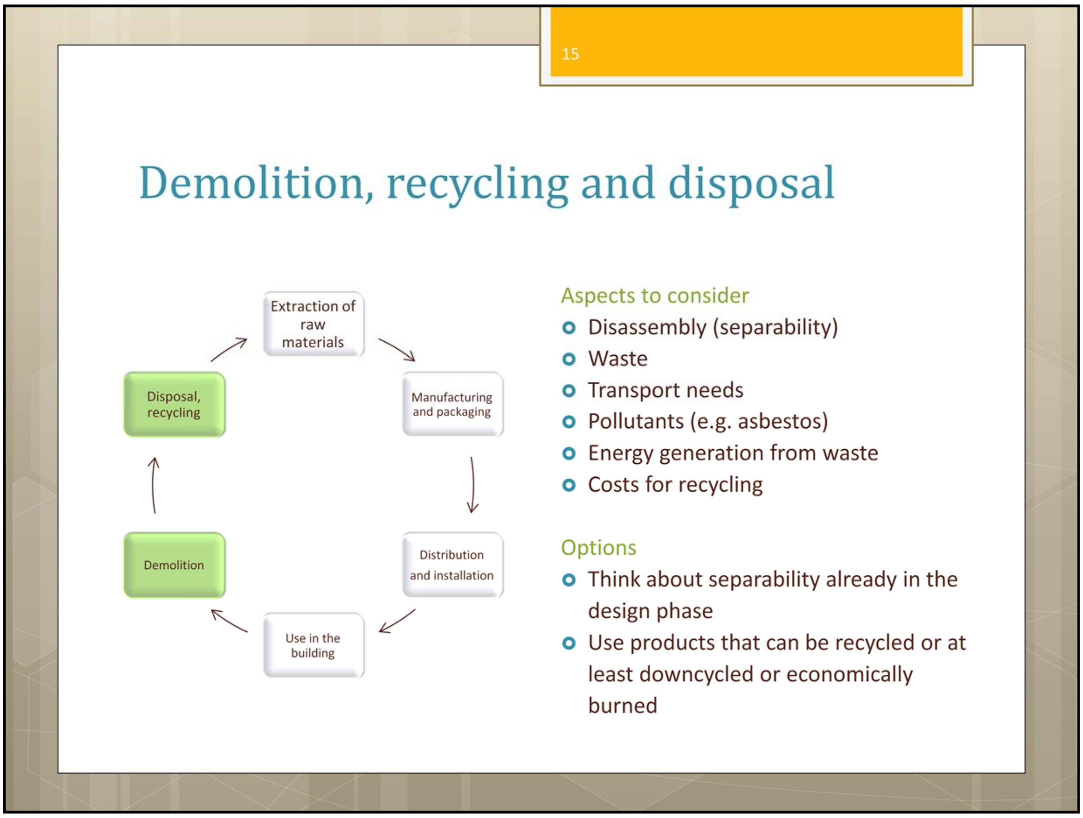
Connection to other themes:
Health aspects, costs, example about reeds.



Once a building has been completely erected, the materials should perform well for a long time. This means that they should have a high durability, showing little shrinkage, embrittlement or oxidation. Proper maintenance and hygiene can support a longer life time. Wooden windows for example have quite a long service life. With proper care a high quality wooden window can be in use for several decades. However, maintenance and replacement costs need to be taken into account.

The improvement of the indoor climate is an important aspect for many users and is also a motivation to use ecological alternatives. Products can either improve the indoor climate, e.g. clay which regulates the indoor humidity, or they can be emission-low, thus removing the unwanted impacts of other products.

Connection to other topics
Colours, paints, clay plaster, consumer issues



Demolition, disposal and recycling are important aspects of the building cycle. This does not necessarily refer to an entire house, but can be limited to selected construction parts as well. Thinking about disposal and recycling is important starting from the design phase. Smart design can minimise the material volume of spare parts or allow a higher degree of recycling, e.g. by designing building elements that are easy to separate. If there is no possibility of recycling construction parts, then downcycling or waste incineration are other options.

The choice of materials is critical for the disposal phase, especially when thinking about demolition or disposal. An example of bad material is asbestos which has been used widely in many countries. When removing asbestos from constructions (roofs, isolation materials), exposure to the tiny asbestos fibres may cause health problems. Old asbestos must be disposed of as hazardous waste which is usually limited. The chemical or thermal treatment of asbestos would be expensive and technically complex.

Although the expected service life of a building is approximately 80 years (for economic considerations), the actual lifetime may be much longer. The duration of certain construction parts (e.g. wooden windows) might differ vastly depending on the degree of maintenance.

Connection to other themes:
Salvageability, life cycle assessment.

Suggestions for presentation:
Select a few construction elements and discuss their disposal and recycling. A planned building can be evaluated from the point of view of disposal and recycling.

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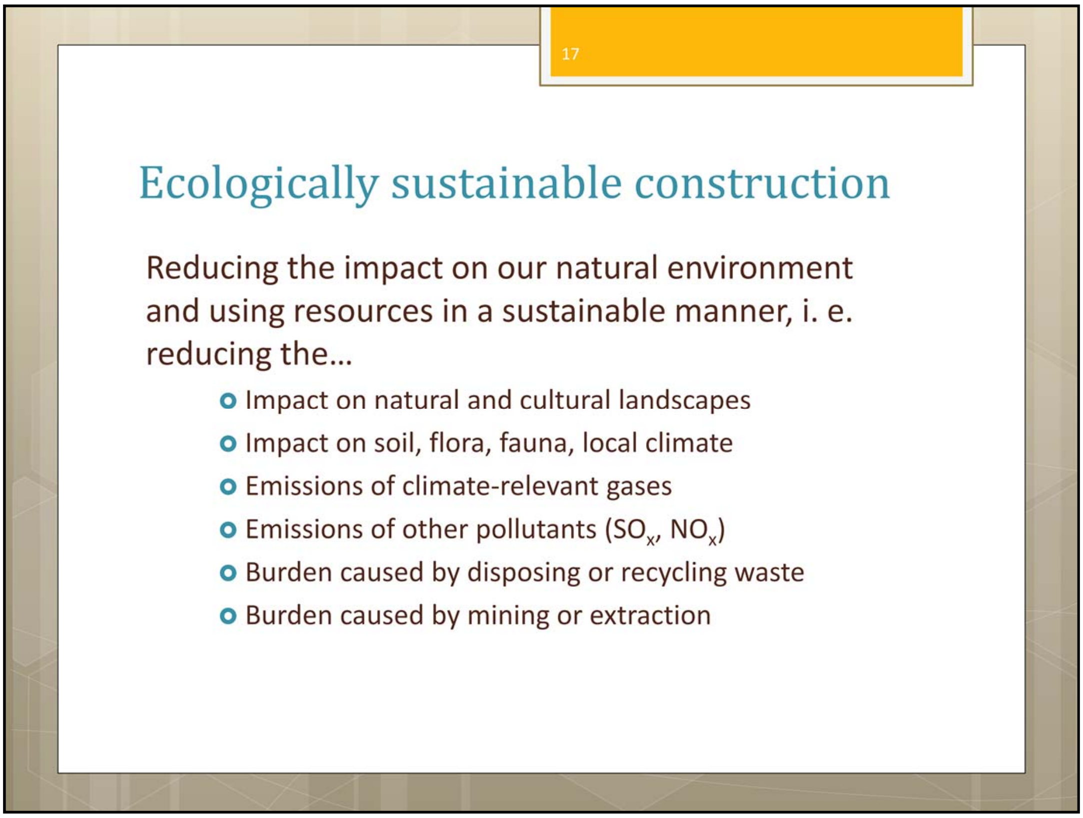
Aspects of ecology

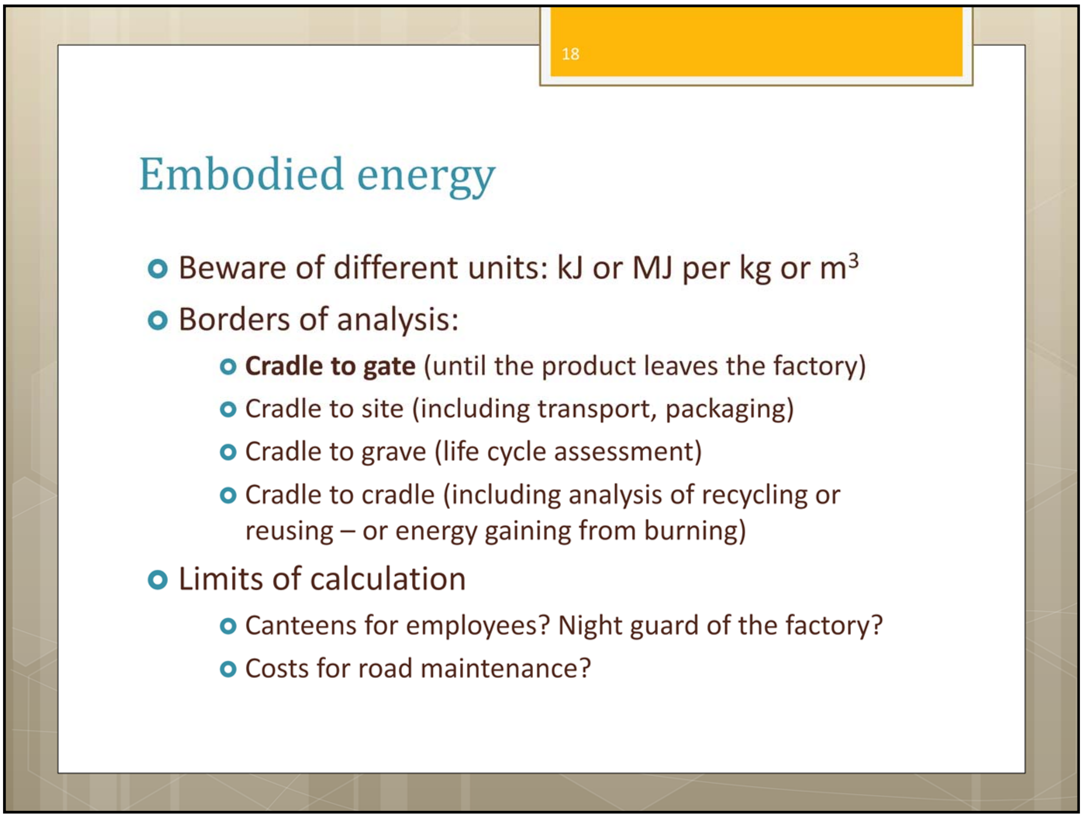


There are various environmental impacts that are associated with the use of materials during the building process. They occur at all stages of the building cycle. Reducing this impact means reducing harmful emissions, reducing the burdens caused by mining, extraction and waste disposal. A proper analysis tries to take such impacts into account. They are not directly measured but expressed in terms of their potential to harm the environment. Typical indicators are the potential for acidification (expressed as SO_2-equivalent) or ozone-depletion potential.

Connection to other themes:
Life cycle assessment, building cycle.

Background:
The building process is associated with several environmental impacts which should be minimised as much as possible.

Suggestion for presentation:
Selected impacts can be illustrated along the production chain of materials (do not forget to talk about recycling and disposal). A slide which illustrates the production of concrete is available in this handbook as an example.

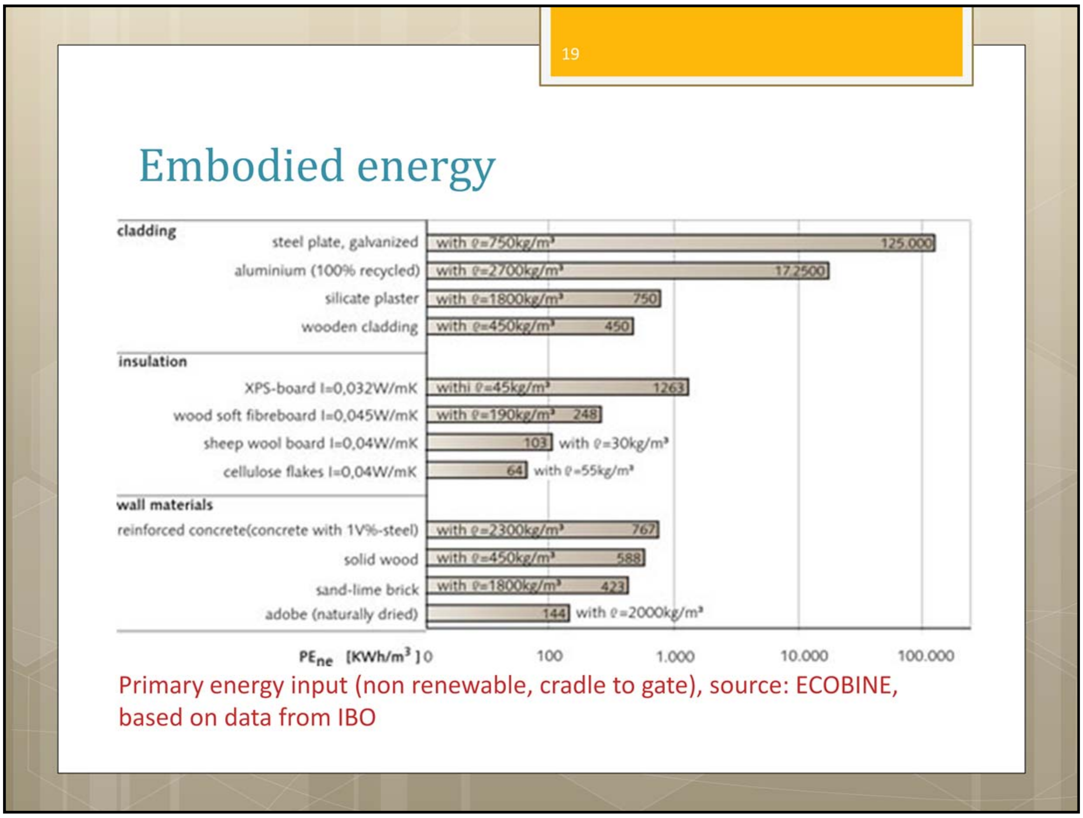


There are several ways to calculate the embodied (or grey) energy and several possible units. It is important to keep the units in mind and to use the density for conversion if necessary. The cradle to gate approach is the most common one, but it neglects transport. Regardless of which approach is used, the question of the border of calculation is worth a discussion. How much of the costs and effects are externalised? What about energy that is used to prevent pollution, e.g. production, installation and maintenance of filters in chimneys?
The more variables are taken into account the more complicated and less practical the calculation gets.

Connection to other themes:
Life cycle assessment, building cycle.

Background:
There are several ways to calculate the embodied (or grey) energy and several possible units.

Suggestion for presentation:
Participants could discuss the different concepts. The calculation of embodied energy can be demonstrated along the lifecycle of one material.

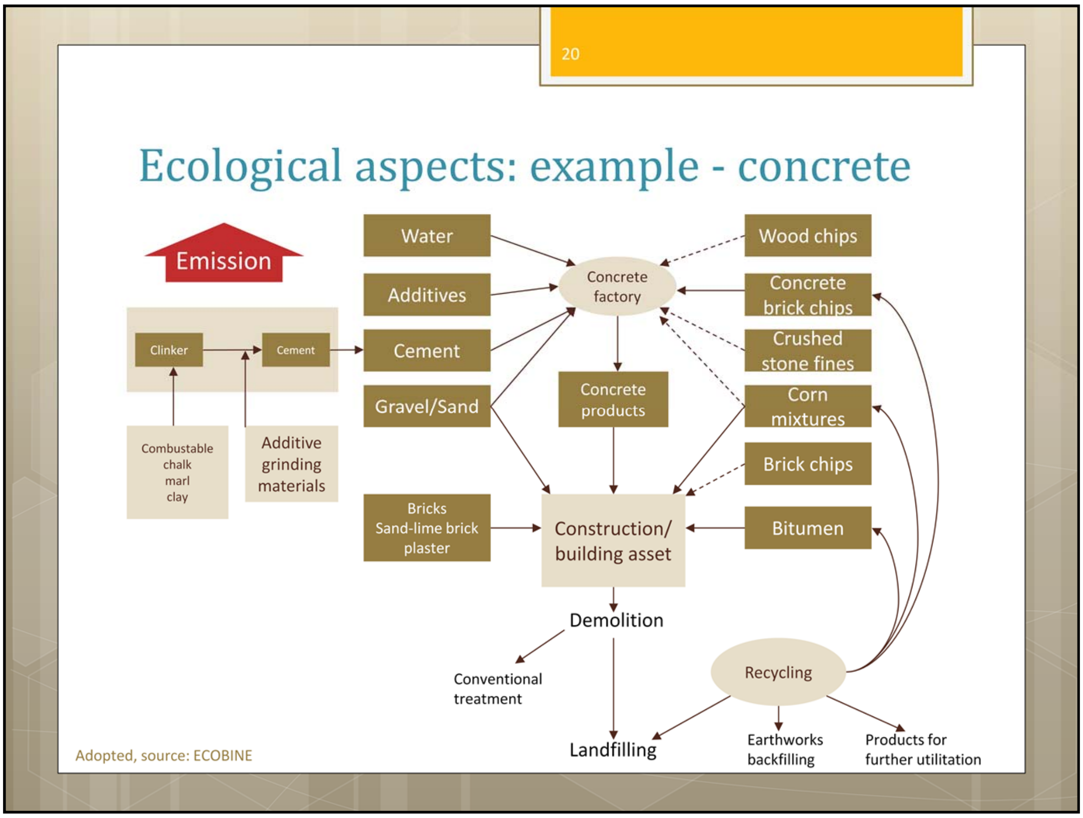


The primary energy which is needed for production (cradle to gate calculation) can be divided into renewable and non-renewable primary energy PE_{ne}. In many cases only the non-renewable share is indicated as it is the most relevant one concerning the overall environmental impact.

Connection to other themes:
Life cycle assessment, building cycle.

Background:
The primary energy demand that is needed for the production of building materials can be divided into a share of renewable and non-renewable energy.

Suggestion for presentation:
This slide can be presented to give a few exemplary values for different materials of one part of the construction.



This slide demonstrates the material flow and associated environmental impacts (but not the associated energy flows) for one basic element of the construction process – concrete. The production of cement is very energy intensive, making concrete production one of the major carbon dioxide emitters.

Connection to other themes:
Life cycle assessment, building cycle.

Background:
Concrete production has various environmental impacts. Its production causes large CO_2 emissions.

Suggestion for presentation:
Present this slide and go through the individual steps.

Limitation of resources

Resource	Reserve [years]	Reserve base [years]	Annual growth in consumption 1999-2006 [%]
Aggregate (sand, gravel)	Very large	Very large	
Arsenic	20	30	6
Bauxite	141	180	6
Betonite (Montmorillonite)	Large	Large	
Boric salts	35	86	1
Brom	Large	Large	
Cadmium	26	77	1
Chrome	Ca. 25	Ca. 40	8
Clay, for fired products	Very large	Very large	
Copper	31	61	3
...			
Coal	150		4,5
Natural gas	63		3
Crude oil	41		1,4

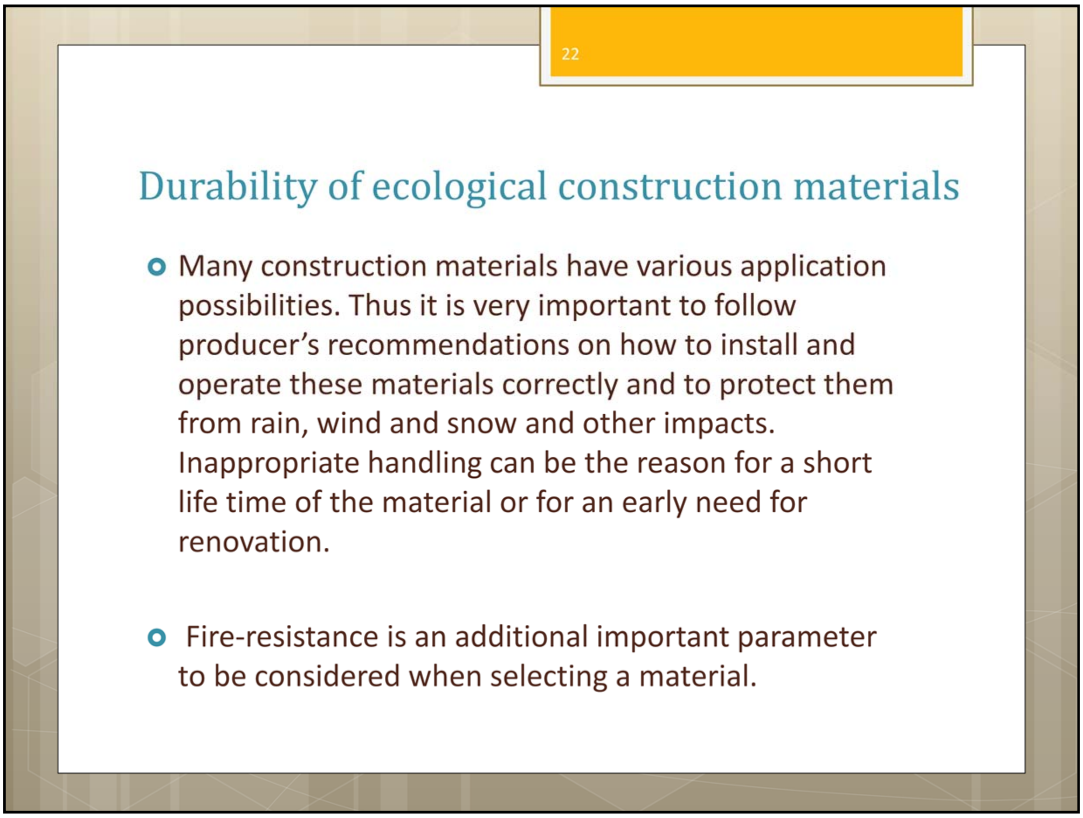
Berge, B. (2009): The Ecology of Building Materials: 4-5

Not only fossil fuels are limited but also other base products for the construction industry. In addition, globally widely available resources can be scarce on a local scale. In the table above some materials are listed including the assumed reserves and the reserve base. Reserve means that the extraction of the material is financially beneficial. The reserve base includes those reserves whose extraction is considered to be sub-economic. The last column shows the annual growth in consumption of this material. You can see that there is still an increase for all raw materials indicated.

Connection to other themes:
Using renewable resources in construction, e.g. timber constructions, wood frame.

Background:
Making the building process truly sustainable should include a consideration of limited resources (not only fossil fuels).

Suggestion for presentation:
Participants should discuss which of these raw materials are used where, and how a shortage can influence the construction sector. How can some of these materials be substituted? It is recommended to discuss the dependency on fossil fuels separately and to distinguish between materials (Polystyrene (PS) insulation, bitumen, high density polyethylene (HDPE) foils and pipes, synthetic polymer resins) and fossil fuels for heat production. A practical example can be discussed using the production process of solar panels. Materials used as semiconductors needed are very rare materials, e.g. indium, gallium, tellurium and selenium.

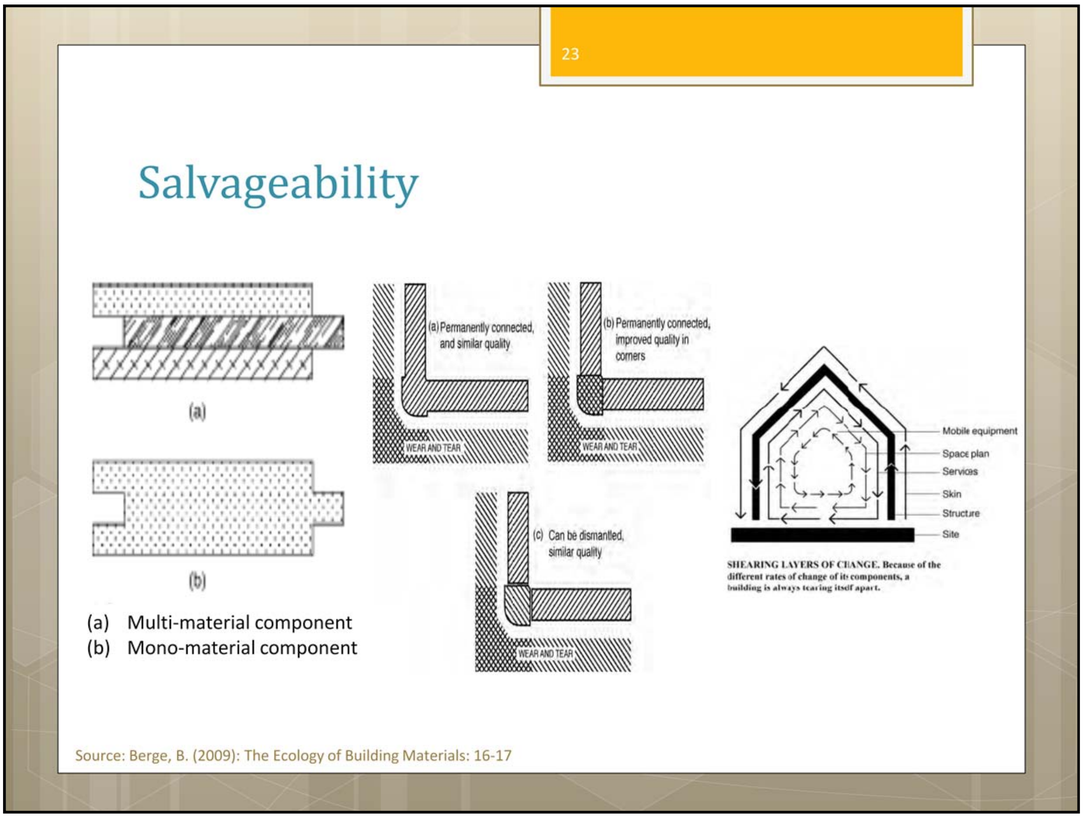


One of the important properties of construction material is durability. The durability of material indicates how long a material will last if it is used in a proper way and installed following the producer’s recommendations. The durability of a construction material can be affected by moisture, heat, sunlight, rodents, insects, mould and material defects. Also fire resistance as a parameter of material, affects the durability of material and should be taken into account when selecting a material.

Connection to other themes:
Sustainable construction, life cycle assessment (LCA) of materials.

Background:
Often, a durable material is considered to be a low-maintenance material. For example, an exterior wall that doesn’t need frequent repainting is considered more durable than a wall that needs repainting every 5 years.

Suggestion for presentation:
Show pictures of what materials look like if they are not used and maintained properly.



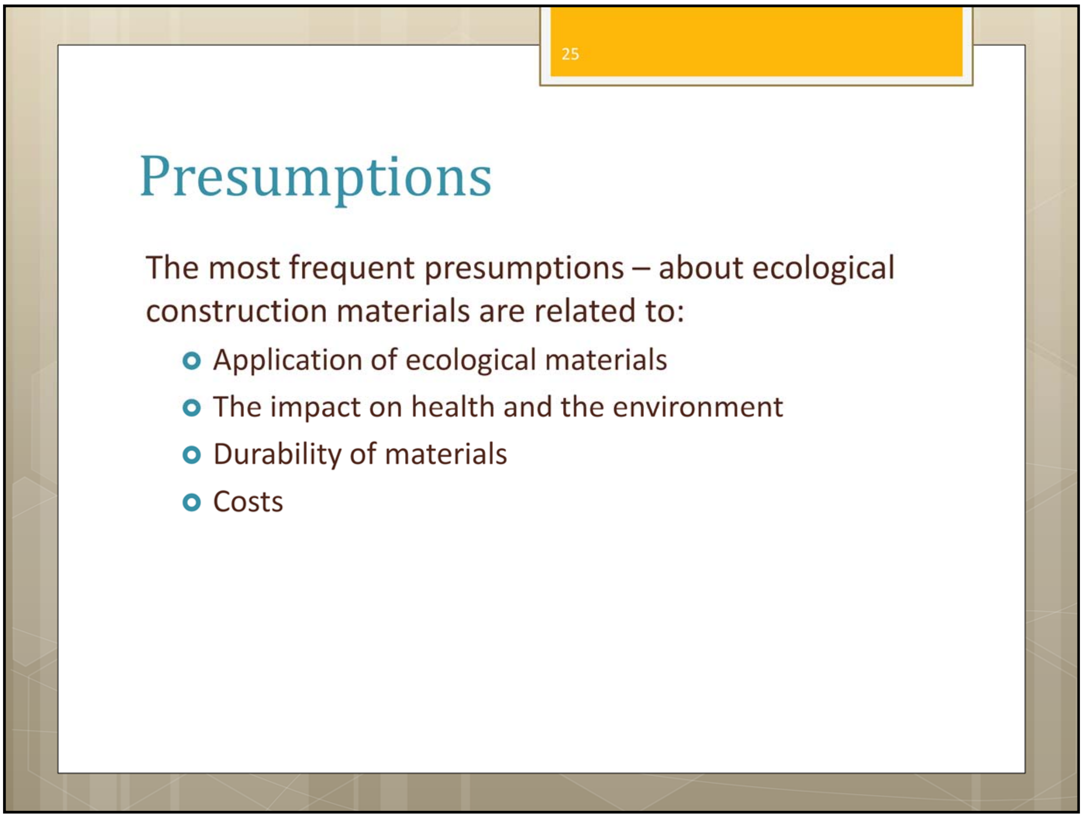
A lot of material could be spared and waste reduced if the principle of salvageability is taken into account. This means the material layers or components are connected and combined in a way that they can easily be separated for removal or exchange. In case of damage only the small component that is not working is exchanged instead of a larger compound. Furthermore, having separate elements or layers facilitates recycling of the materials. It is clear that it will sometimes be necessary to e.g. glue materials tightly and a high degree of salvageability cannot always be achieved.

Connection to other themes:
Building cycle (recycling, disposal).

Background:
Applying the principle of salvageability helps reduce the amount of materials needed and facilitates recycling.

Suggestion for presentation:
Depending on the degree of knowledge of the participants, construction details and the potential for applying this principle could be discussed.

On selected materials

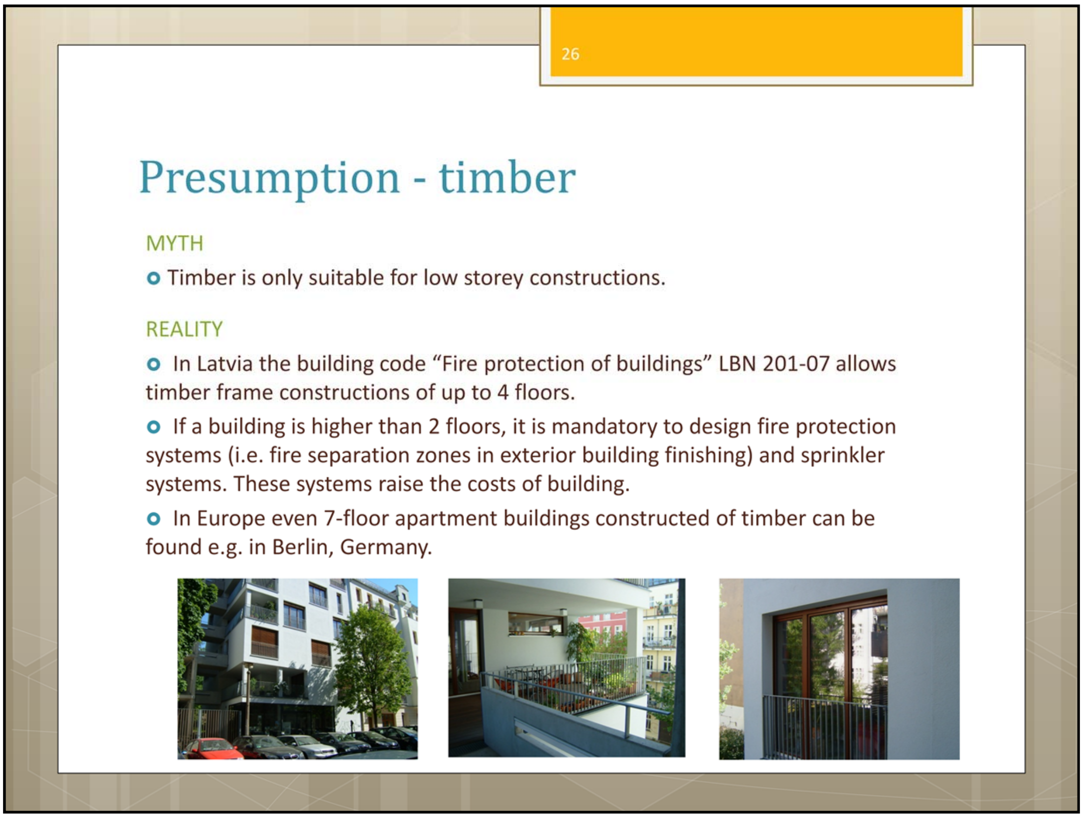


A lot of potential home owners before starting to build their dream house consider, together with the architect and engineer, the design of the house, utilities and construction materials. And consumers have presumptions related to the application of ecological construction materials, the impact on health and the environment, durability and costs.

Connection to other themes:
Life cycle assessment of materials, technical and physical properties.

Background:
There is a lack of information for the consumer about the real structure of material and properties. Very often the architect and engineer influence the choice of a client about the materials for constructing a house.

Suggestions for presentation:
Discuss with participants the presumptions they have related to ecomaterials.



The advantages of using wood as a construction material are known for years – a pleasant and natural interior, excellent thermal insulation, sound performance and shorter building time are a few of them. It is the opinion of some experts that timber as a construction material can only be used for low storey single-family or two-family houses. In Europe e.g. Berlin, Germany even 7-floor residential buildings are constructed of timber. In Latvia the building code „Fire protection of buildings" LBN 201-07 allows timber frame constructions to be built up to 4 floors; if a building is higher than 2 floors, it is mandatory to design fire protection systems, which could be the fire separation zone in the exterior finishing of a building, automatic fire extinguishing system (sprinkler system) etc. These protection systems raise the costs of building.

Connection to other themes:
Sustainable construction, fire protection systems, flammability classes, FSC certificate.

Background:
With regard to the origin of timber materials, a wooden framed house can be called ecological if the wood is certified with an FSC certification, meaning that the construction materials are produced from sustainable managed forests, or other similar certification.

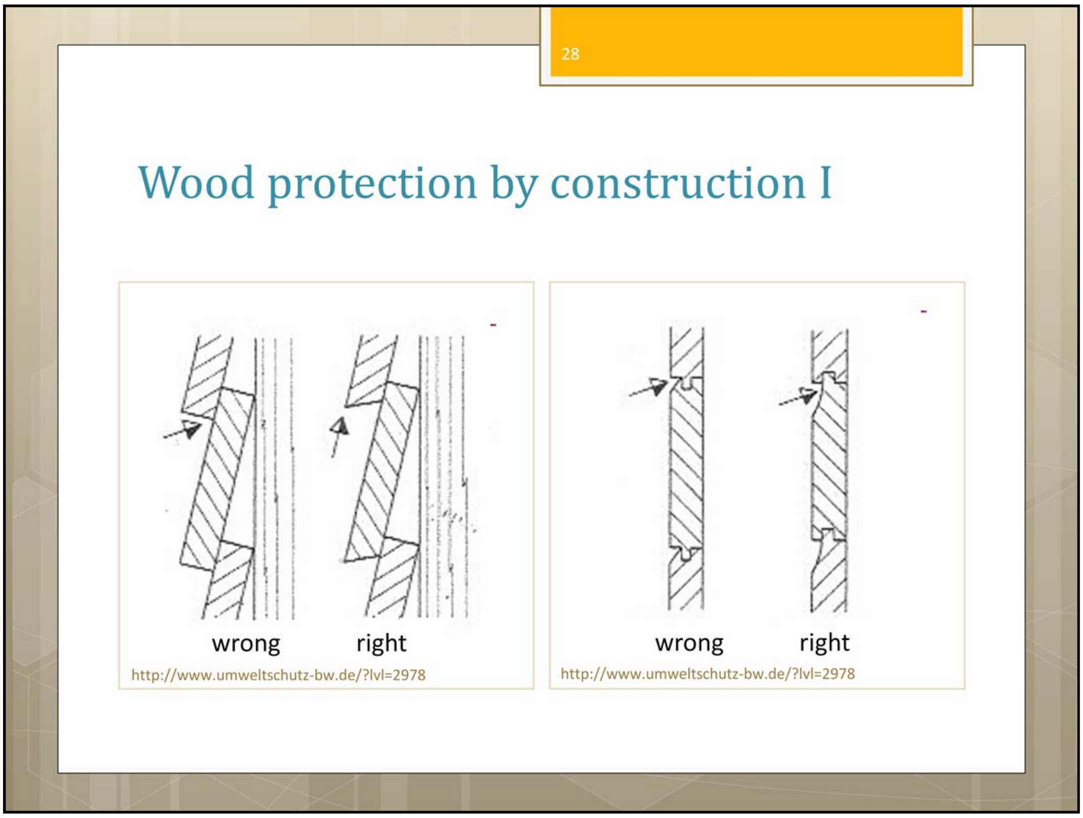
Suggestion for presentation:
Present to participants the best examples of timber-framed multi-storey buildings.

Are the log houses ecological simply because of the material used for construction? If the term “ecological house” is taken widely then the main idea is to use a small amount of construction materials to achieve the maximum result. The consumption of construction materials for a log house is great and using the same amount of materials it is possible to build 2-3 wooden frame houses. The benefit of a log house is that the construction material used for construction is timber and it is renewable but it took almost 60-100 years for a tree to grow to the necessary size for a log house construction.

Connection to other themes:
Sustainable house, timber frame house, indoor air quality.

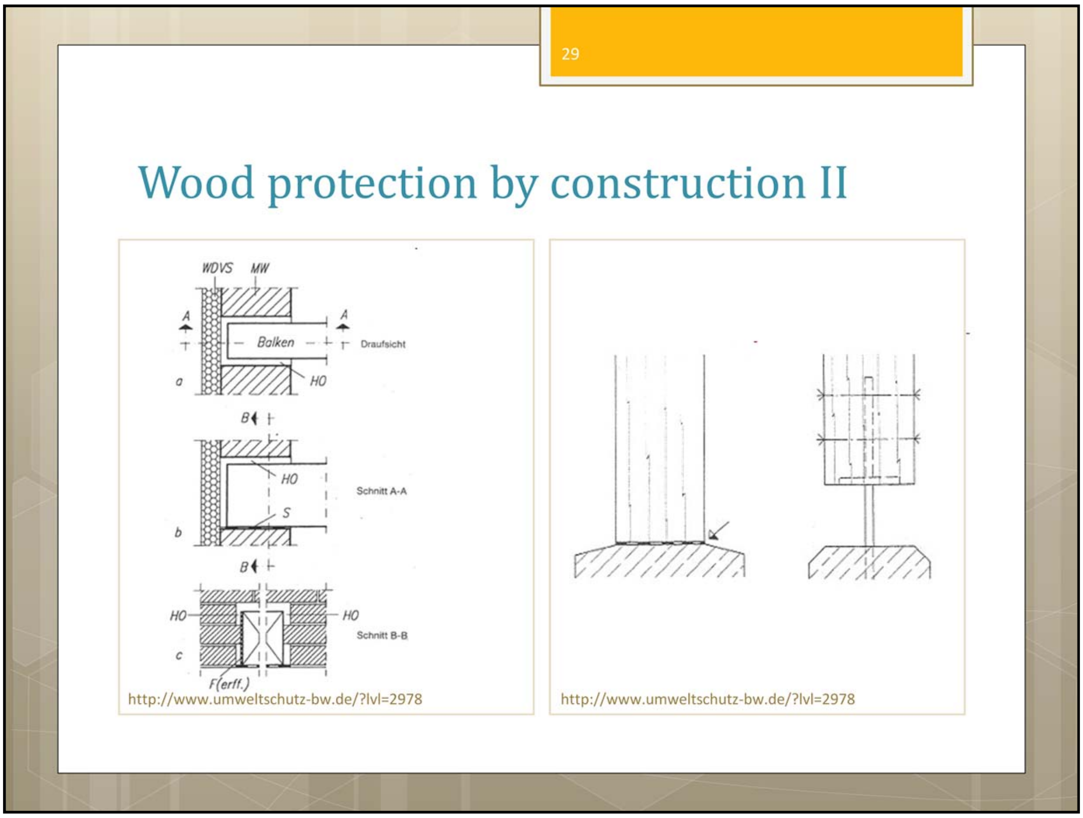
Background:
In this case, the statement that a log house is ecological is considered only from the material position. The whole impact of building can be shown in the life cycle assessment.

Suggestion for presentation:
Brief discussion with participants about the term “ecological material”.



Wooden constructions need to be protected from humidity. This means that the construction should allow rain to run or drip off. When such wooden constructions are properly designed, chemical treatment might be unnecessary.

Connection to other topics
Wood constructions, timber



Wood constructions need to be protected from vermin and humidity. Joints of different parts should be designed to allow air to circulate between wooden surfaces in order to lead humidity away. Direct contact of wooden surfaces should be prevented with a moisture barrier (foil). Again, such relatively simple principles can be used instead of chemical treatment.

Connection to other themes:
Wood constructions, timber

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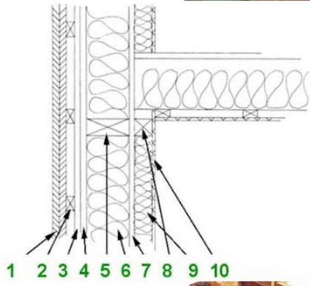
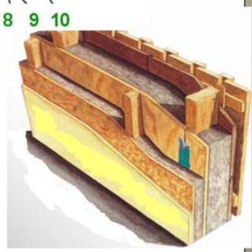
Timber framed houses

Construction Parts	Materials
Facade 1 2 3	Wood
Outer layer / protection of insulation 4	Wood fibre board
Insulation in cavities between wooden posts 6	Loose insulation
Construction 5 7 8	Solid wood, wooden boards
Insulation for the cavity area of technical installation 9	Fleece insulation





Various solutions for construction of timber frame houses are possible. The construction example shown here is an improved version with a cavity area for technical installation. Due to this construction the air-tide membrane, here a wooden board, is quite safe against damages that might be caused during technical installation.
The facade can be built up with wooden planks and air circulation or with plaster. When choosing a plaster facade the wood fibre board (4) should have a thickness of minimum 60 mm; for a wooden facade minimum 20 mm. The main timber frame construction elements are wooden posts, wooden boards and insulation material.
For insulation a loose or fleece material should be used. The best insulation of the cavities of technical installations is a fleece material due to the thinness of the construction. For loose material a cavity approximately 10 cm in width is required, and high pressure for installation of this material (a second wooden board has to withstand the pressure of blowing in the insulation).

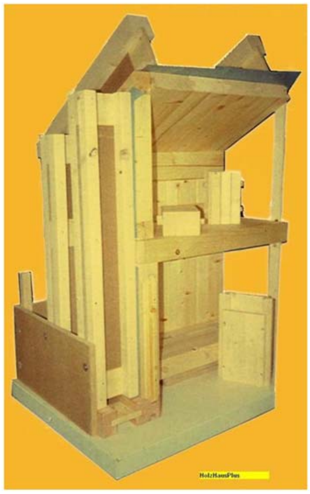
Connection to other themes:
Advantages of wooden houses, life cycle assessment (lca) figures, insulation materials.

Background:
Good quality timber framed houses cost approximately the same as stone houses of the same quality, especially in the area of thermal insulation.

Suggestions for presentation:
Participants should draw different timber wall, roof and floor constructions with the connecting parts and discuss the advantages and disadvantages of the constructions.

Solid wooden houses

Construction Parts	Materials
Supporting construction	Solid wood
Air tight membrane	Paper
Insulation	Loose insulation
Outer shield / production of insulation	Wood fibre board
Facade	Wood



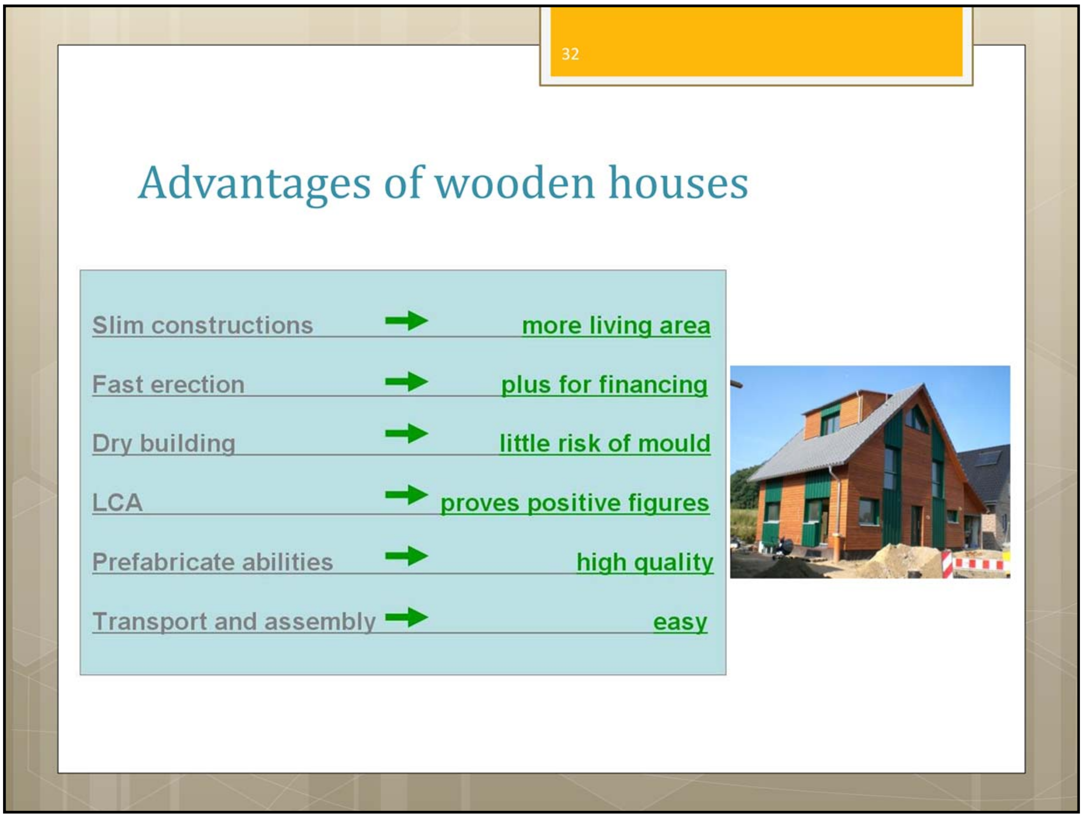
HolzHausPlus

The most well known solid wooden houses are log cabins. New solid wooden houses are quite different, having a high thermal insulation. They have a solid wooden layer (connected with glue, nails, wooden dowels etc.) in the interior of the wall or/and roof construction. Additional materials required are air-tight membranes and insulation material. In the picture shown here you can see a specially insulated I-beam installed to avoid a thermal bridge. In the cavity it’s best to use loose insulation, or alternatively fleece. For the outer shield it’s best to use wooden fibre boards. When choosing little thermal insulation, insulation boards can be fitted directly onto the solid wood construction.

Connection to other themes:
Timber frame house, advantages of wooden houses, lca figures, insulation materials.

Background:
Advantages of solid wooden houses are:
A little more wood is used > more work in the forest
Solid timber in the interior > high thermal storage
Solid timber in the interior > very good application of screws etc.
Solid timber in the interior > very good interior moisture balancing

Suggestion for presentation:
Participants should draw different solid timber wall, roof and floor constructions with the connecting parts and discuss the advantages and disadvantages of the constructions.

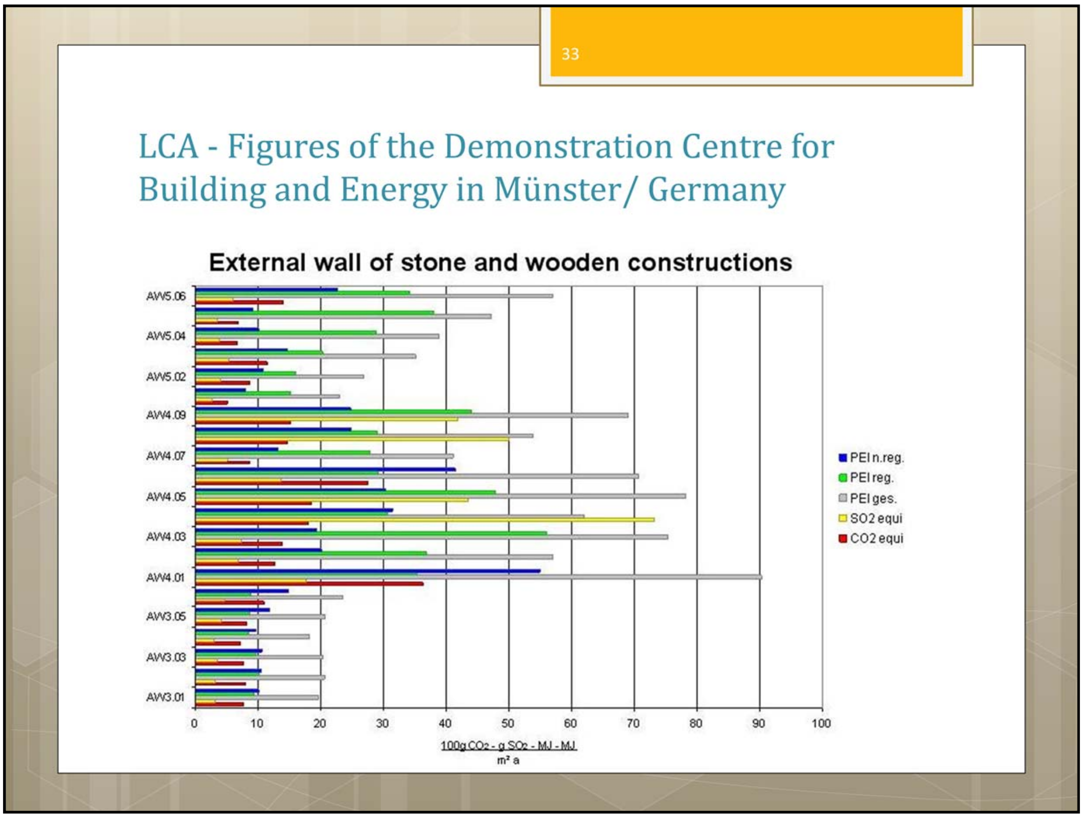


Applying timber constructions you might gain 5 – 10 % more living area with the same outside parameters.

Connection to other themes:
Timber framed house, solid wooden houses, LCA figures.

Background:
Wooden houses have many advantages in comparison to stone houses.

Suggestion for presentation:
Participants should find more advantages of wooden houses.



LCA – a Life Cycle Assessment has been made for the Demonstration Centre for Building and Energy in Münster, Germany. In the project 141 different constructions have been calculated. In the slide the wall constructions are shown. The lca – figures show clearly that wooden constructions are environmentally friendlier constructions. The six constructions presented at the bottom of the slide are all wooden constructions showing the best results.

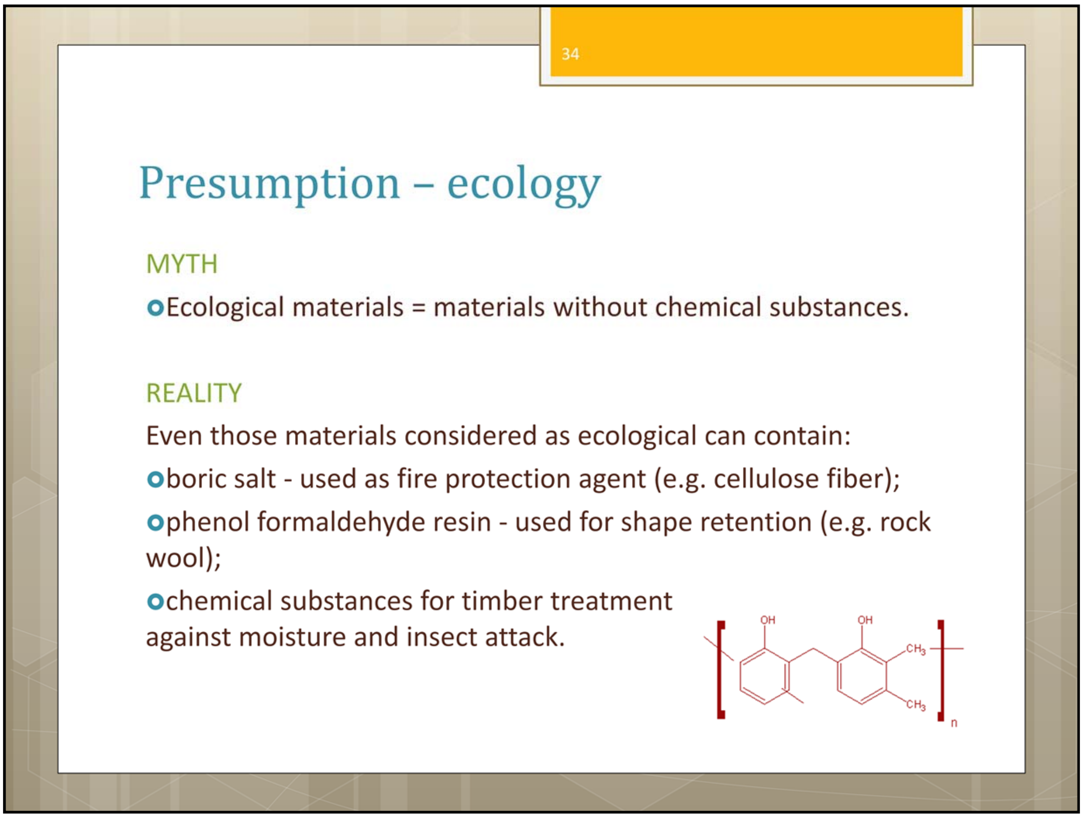
Abbreviations used:

PEI n.reg. = Primary energy content non-regenerative
PEI reg. = Primary energy content regenerative
PEI ges. = Total primary energy content
SO2 equi = SO_2 equivalent
CO2 equi = CO_2 equivalent

Connection to other themes:
Timber and solid wooden houses, insulation.

Background:
There are many examples of calculations to describe “green” materials and constructions. All the calculations show that in general timber and wood constructions are environmentally friendly. A rough indication in figures: the lighter the construction is, the more environmentally friendly it is.

Suggestion for presentation:
Participants should design very light wall and roof constructions.



Almost all construction materials which are factory produced contain some chemical substances. For example, the hemp short fibres are bound with synthetic support fibres polyethene and polyester (ca. 18M%) fibres. Ammonium polyphosphates or soda solutions are used as flame protection agents. And cellulose fibre insulation contains boric salt and boric acid (H_3BO_3) as fire protection agent and for protection from insects. These boron compounds prevent the growth of fungi and even existing fungus die when they come into contact with cellulose fibre insulation.

Connection to other themes:
Life cycle assessment of construction materials, chemical substances, impact on human health and environment.

Background:
The chemical additives improve the properties of material such as durability (e.g., fire-resistance, protection against moisture and insects).

Suggestion for presentation:
Brief discussion about how construction materials can affect human health. Which chemical substances are forbidden to be used in production of construction material.

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Sources and materials of insulation

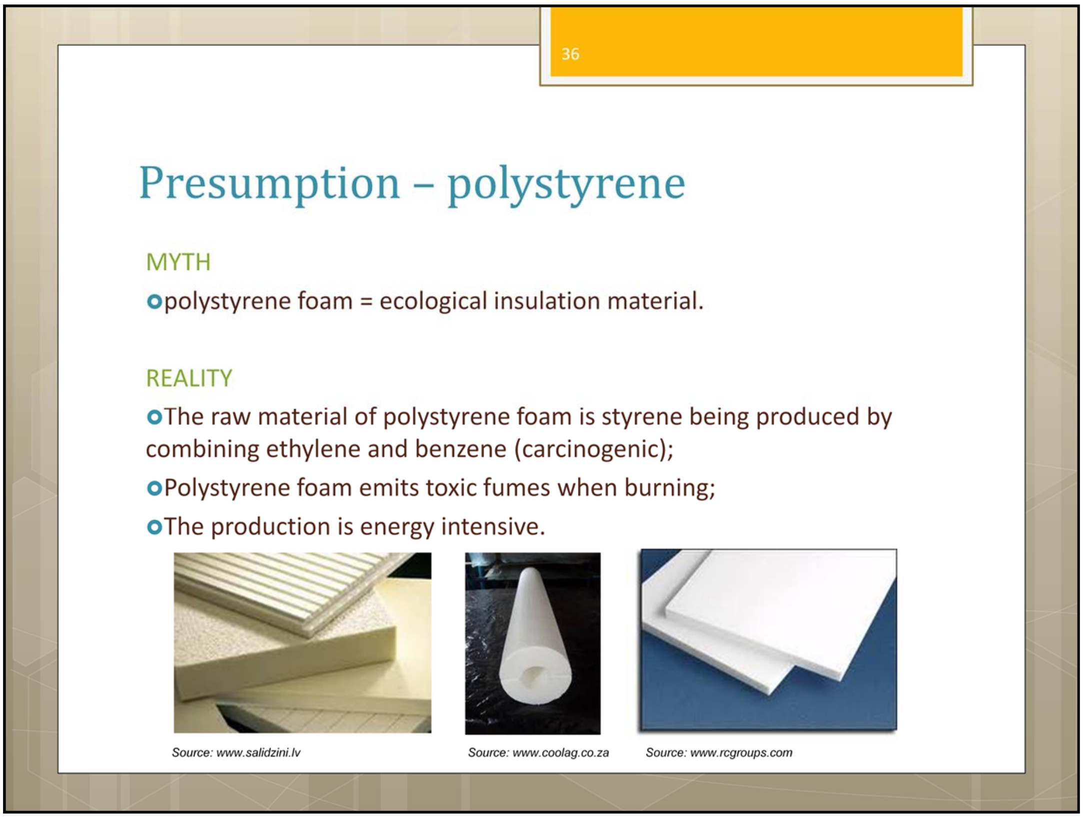
Mineral	Synthetic	Renewable
Foam glass	Expanded Polystyrene	Cork
Expanded Perlite	Extruded Polystyrene	Cotton
Expanded Mica	Polyurethane	Hemp, flax
Calcium Silicate	Polyester	Wood fibre
Expanded glass	Resol	Coconut fibre
Expanded clay	Vacuum insulation panels	Reed
Mineral foam		Straw
		Gras
		Seaweed
		Wood shavings
		Wood wool cement boards
		Cellulose fibre
		Wool

The table in the slide gives an overview on various insulation materials – mineral, synthetic, renewable.

Connection to other themes:
Production of materials, composition, lca – figures.

Background:
Most insulation materials from renewable sources are environmentally friendly, particularly if not containing any chemical additives.

Suggestions for presentation:
Participants should write down and later discuss which insulation materials are produced and / or available in their own country.

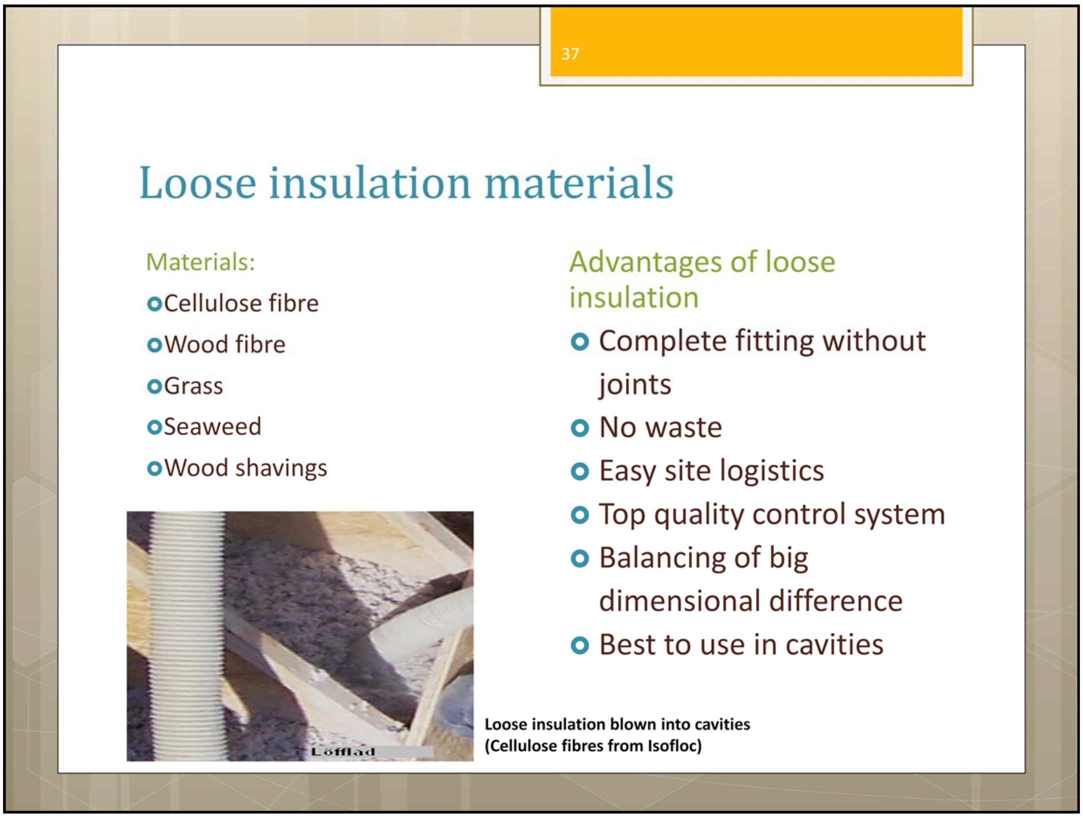


A lot of discussions are held about the environmental impact of polystyrene foam insulation material. In the production process a high amount of energy and chemicals are used. Expanded polystyrene (EPS) and extruded polystyrene (XPS) are produced from styrene (poisonous to the nervous system).

Connection to other themes:
Life cycle assessment of polystyrene foam insulation, advantages and disadvantages of material.

Background:
Advantages of material: e.g., good insulation properties, low price, long lifespan and low maintenance costs.

Suggestion for presentation:
Show samples of different polystyrene foam insulation types (XPS and EPS). Show graph of polystyrene foam insulation life cycle and compare advantages and disadvantages with different insulation materials (e.g. rock wool, cellulose fibre, sheep wool, straw).



In this slide a selection of loose insulation materials are pointed out which could be produced within the country.

Connection to other themes:
Production and availability of renewable raw materials in the country, timber and wooden houses, lca – figures.

Background:
All loose insulation can be blown into cavities filling the smallest gaps. Avoiding cutting of the material means less work and no waste. Material is transported by the blowing machine up to 6 storeys high. Even if dimensions in cavities vary, loose insulation fills them up completely. A top quality control system with internal and external check ups shall be applied.

Suggestion for presentation:
Show the blowing in of loose insulation with pictures, or better still, a video, best during a field trip to a construction site.

Here a selection of fleece insulation materials of a good technical quality and from renewable sources are presented. At least some of them could be produced within the country.

Connection to other themes:
Production and availability of renewable raw materials in the country, timber and wooden houses, lca – figures.

Background:
Fleece insulation materials are used for wall, roof and floor constructions. For floor constructions the applied material has to be more dense. Disadvantage - fleece insulation materials from renewable sources are difficult to cut.

Suggestion for presentation:
Participants should have samples from fleece and fibre insulation and be asked to discuss the way of application of these materials. They should test how the material can handle moisture.

A selection of insulation boards are presented here. Most of them could be produced within the country.

Connection to other themes:
Production and availability of renewable raw materials in the country, timber and wooden houses, lca – figures.

Background:
Wooden fibre boards and cork have very good thermal conductivity. Reed boards are as strong as wooden planks. Straw is very cheap. Wood wool cement boards are very good for plastering.

Suggestion for presentation:
Participants should discuss practical application of insulation boards.

40

Comparison of embodied energy of insulation materials

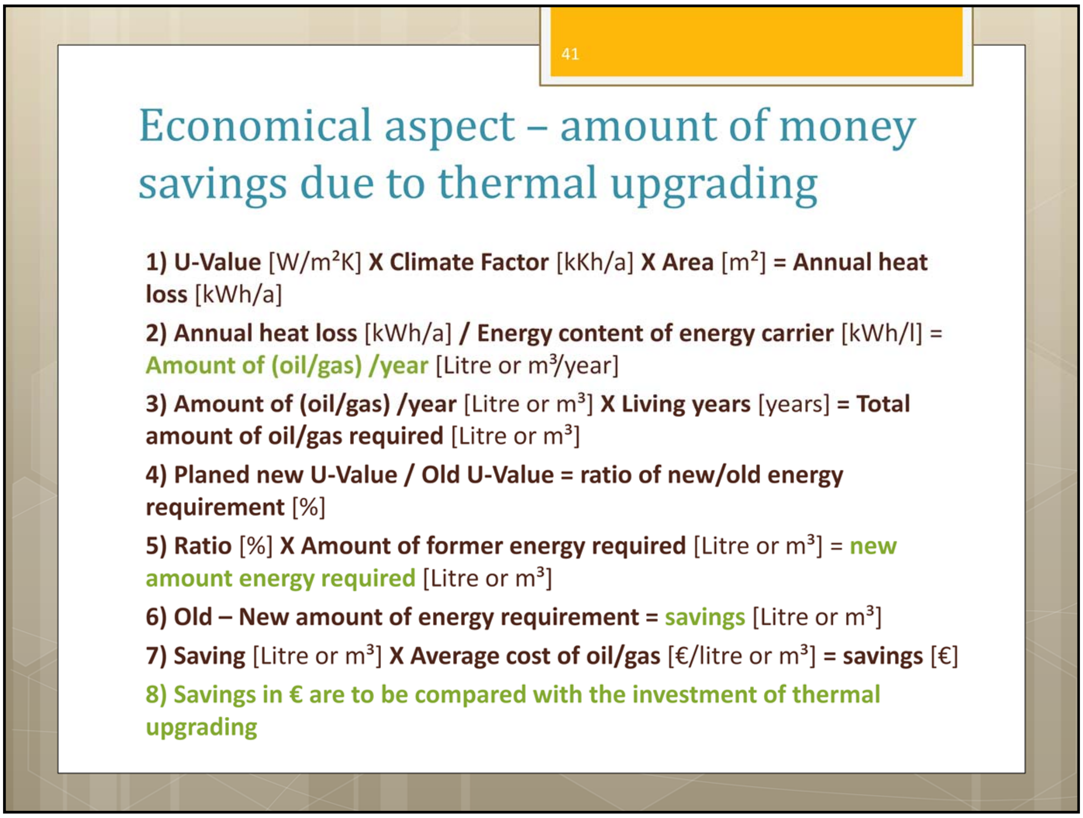
Material	kWh/m³	Material	kWh/m³
Cellulose Fibre (loose)	10 - 60	Glass Wool	40 - 1167
Wood Shaving	50	Rock Wool	270 - 986
Wood Wool Cement Board	35 - 95	Foam Glass	320 - 975
Cellulose Fibre Boards	55 - 80	Cork Boards with Synthetic Glue	360 - 440
Cork	35 - 65	XPS	470 - 1032
Wool, Flax	70 - 80	EPS	190 - 1050
Cork Granulate	90	Wood Fibre (loose)	600 - 785
Cotton	90 - 100	Wood Fibre Board	1510 - 1705
Coconut fibre	95	PU Boards	838 - 1330
Expanded Perlite	210 - 235	PU Foams	1140 - 1330

The embodied energy or primary energy content is a very good for evaluation of the environmentally friendliness of a material. The slide shows embodied energy values for several insulation materials. The first 9 mentioned in the table are from renewable sources and have low figures of embodied energy.

Connection to other themes:
Timber and wooden houses, lca – figures, insulation materials, evaluation of eco-performance of materials.

Background:
Not just the primary energy content indicates the environmentally friendly "character" of a material. The figures for SO_2 and CO_2 equivalents should also be considered for comparison and evaluation. More information on evaluation of eco-performance of materials and buildings using indicators can be found at:
• DI Robert Stanek, DI Dr. Bernhard Lipp, *Modeling of buildings using conventional and ecological materials:* Evaluation of the eco-performance of buildings, 2010 available at **www.bef.lv/data/file/Modelling_Report.pdf**

Suggestion for presentation:
Participants could discuss the possibilities and environmental impacts of a building constructed with ecological and conventional materials.



When applying ecological construction materials it is important at the same time to consider the energy performance of a building. This slide gives information on how to calculate economical benefits from the thermal insulation of buildings. The calculation example shows savings using the new U-Value 0,4 W/m²K (applied in Germany). Savings can be even higher if using the U-Value 0,1 W/m²K (passive house). This is a rough calculation without interest rate, renovation costs, etc.

Calculation example:

1) U-Value of wall 1,5 [W/m²K] X Climate Factor (degree hours) 84 [kKh/a] X Area of the wall/roof 200 [m²] = Annual heat loss 25 200 [kWh/a]

2) Annual heat loss 25 200 [kWh/a] / Energy content of energy carrier 10 [kWh/l or m³] = Amount of (oil/gas) /year 2 520 [Litre or m³/year]

3) Amount of (oil/gas) / year 2 520 [Litre or m³] X living years (how many years the person expects to live more) 50 [years] = Total amount of oil/gas required 126 000 [Litre or m³]

4) Planned new U-Value after thermal upgrading 0,4 [W/m²K] / old U-Value 1,5 [W/m²K] = ratio of new/old energy requirement 27 [%]

5) Ratio 27 [%] X amount of former energy required 126 000 [Litre or m³] = new amount energy required 34 020 [Litre or m³]

6) Old amount 126 000 [litre or m²] – new amount of energy requirement 34 020 [litre or m²] = savings 91 980 [Litre or m³]

7) Savings 91 980 [Litre or m³] X average cost of oil/gas at the time of requirement (cost of oil in 25 years) 2,00 [€/litre or m³] = savings 183 960 [€]

8) Savings of 183 960 € have to be compared with the investment for thermal upgrading (Indicative info – for upgrading 200 m² of wall/roof = 919,80 €/m²)

Connection to other themes: Insulation.

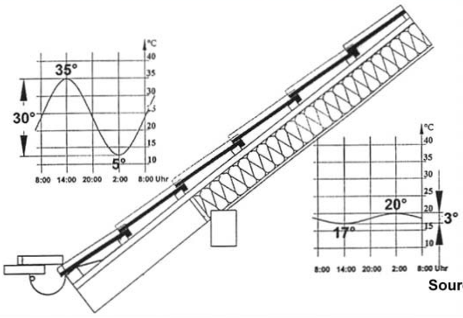
Background: Most probably the cost of energy will increase and thermal upgrading has a greater advantage.

Suggestion for presentation:

To exercise the calculation once more with figures chosen by the participants.

Summer heat protection

Insulation 20 cm	Weight kg/m³	c-Value J/kgK	λ W/mK	U-Value W/m²K	Time shift [hours]
Mineral Fibre	20	1000	0.040	0.18	7
Wool	20	1720	0.040	0.18	7.6
Cellulose	60	1930	0.040	0.18	10.8
Wood shavings	90	2100	0.055	0.23	11.6
Wood Fibre Board	170	2100	0.040	0.18	15.8



Source: ea NRW

Summer heat protection shows the time-shift in hours, how much time does it take for the higher temperature outside (35°C, 14.00 hours) to move through the construction to the interior side (20°C, 02.00 hours). See the figures in the picture. The time-shift depends on the material used. In particular with respect to the light roof construction it is very important which insulation material is chosen. The time-shift of a roof construction should be at least 10 hours, or even better, 12 hours and more.

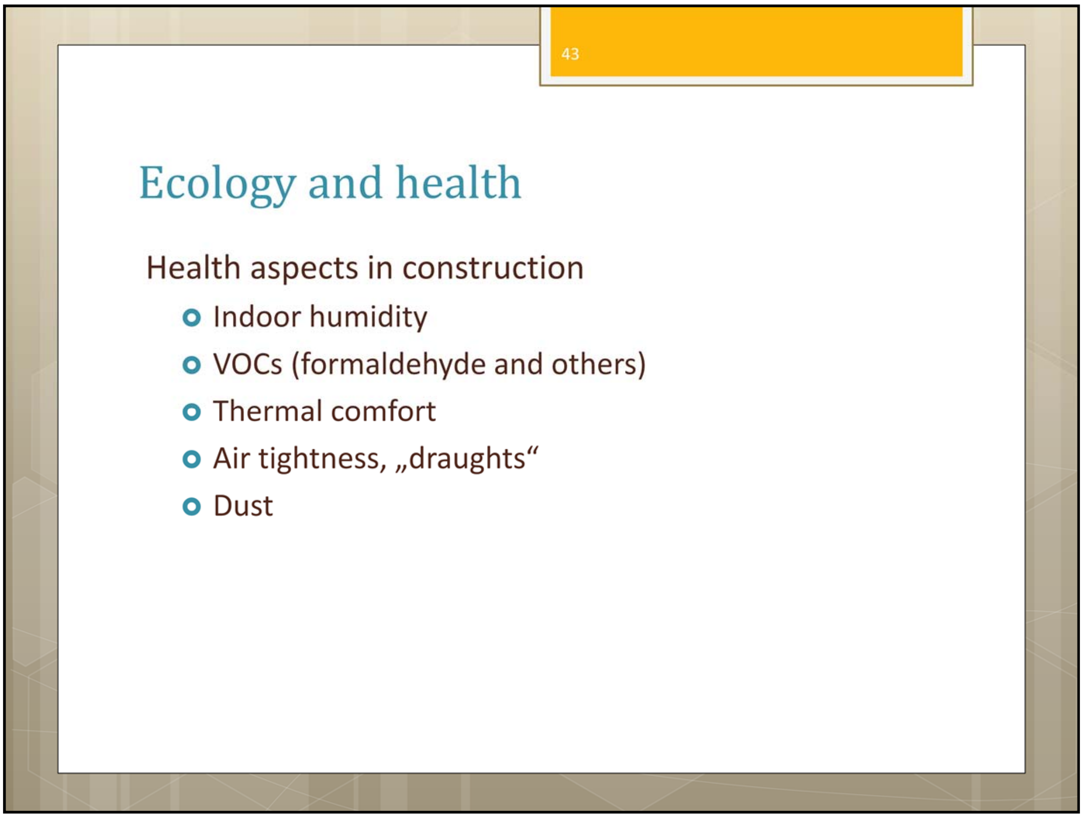
Connection to other themes:
Timber and wooden houses, insulation.

Background:
Time-shift is quite complex to calculate. It is easier to calculate thermal diffusivity a [m²/h].

Thermal diffusivity a [m²/h] = thermal conductivity [W/mK] / density [kg/m³] x thermal storage [Wh/kgK]

The lower the calculated figure is the more slowly the temperature will move through the construction. Best materials in this sense are wood and wooden fibre boards.

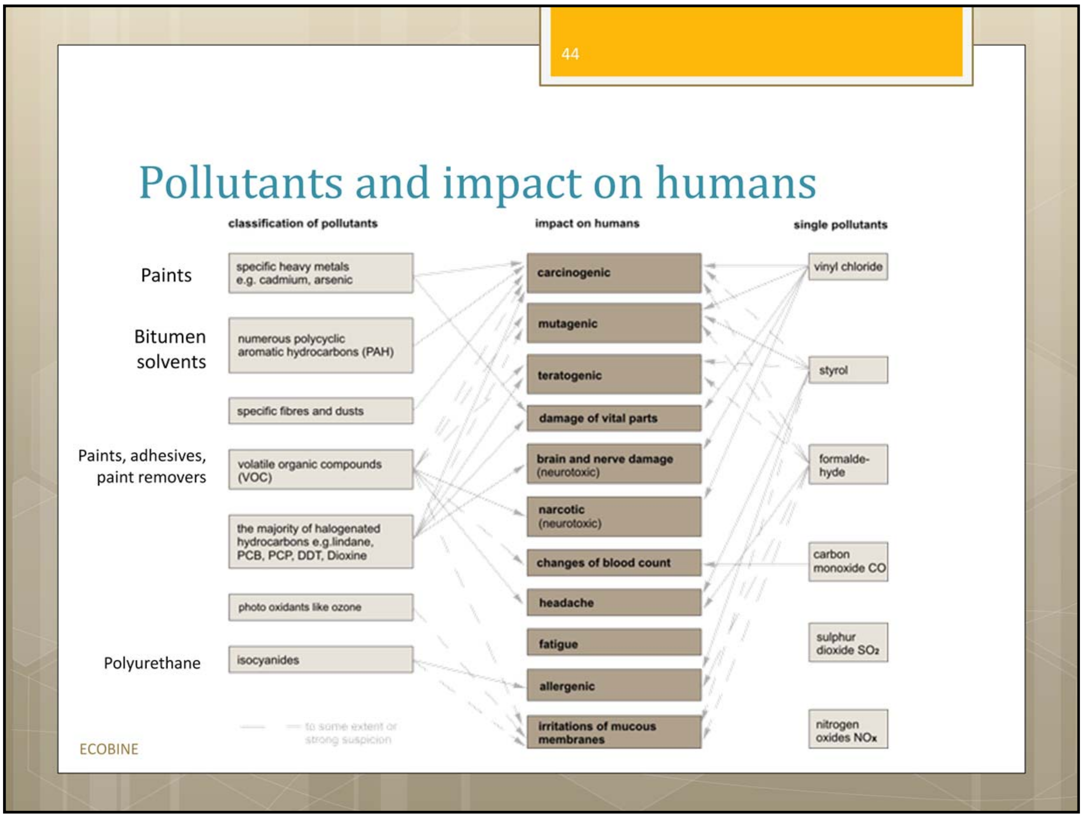
Suggestions for presentation:
Participants should calculate the temperature transfer figure for different materials and compare them.



Various health aspects are related to constructions. Indoor humidity can for example be regulated using clay plaster. VOCs should be avoided; VOCs can originate from e.g., furniture (formaldehyde). Thermal comfort is important – it is determined by the indoor temperature, humidity but also materials. Some materials feel cold to the touch – others warm. This could be an important aspect when choosing materials for flooring. Movement of air, especially when cold can impair thermal comfort. This is however more a question of designing airtight constructions.

Connection to other themes:
Health impacts of pollutants, clay plaster.

Background:
A good selection of materials can contribute to a better indoor climate and contribute to better health.

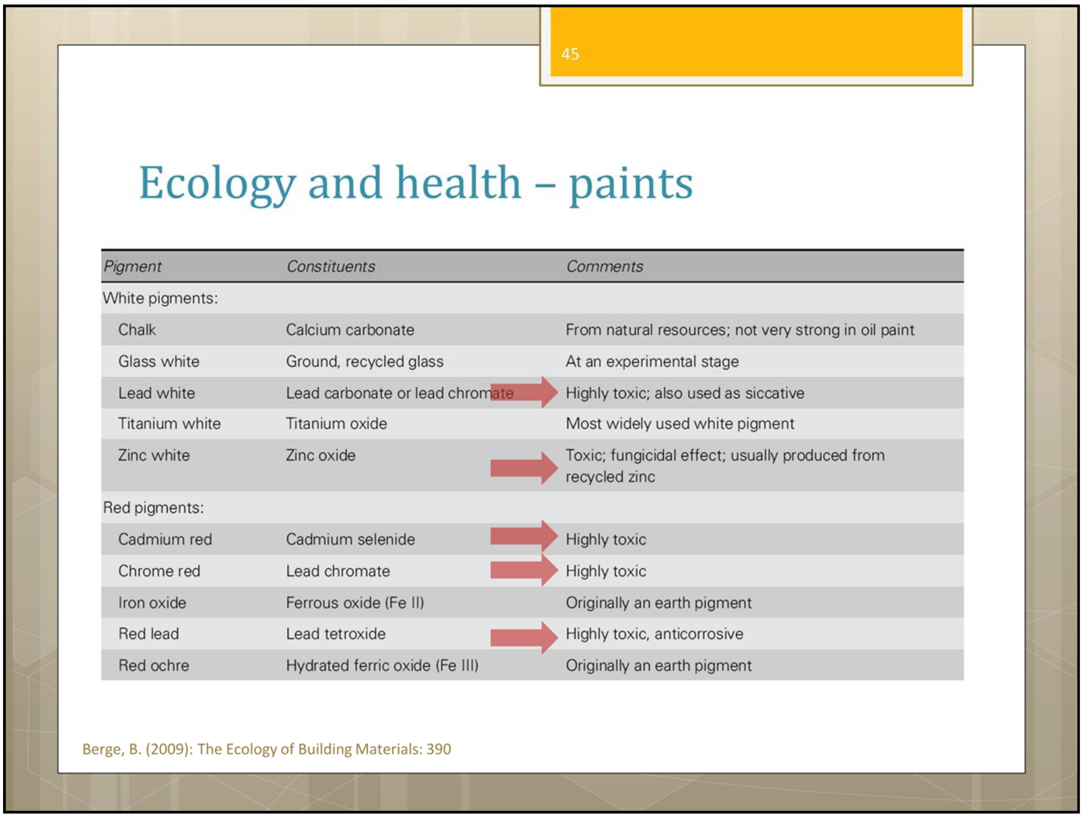


On this slide some single pollutants or classes of pollutants and their associated impacts on humans can be seen. These substances are found in different stages of the building cycle, some only during the production of materials, e.g. vinyl chloride which is the monomer of PVC, others are released only during combustion. The most problematic ones are those to which inhabitants are exposed during the living phase.

Connection to other themes:
Health aspects, ecological paints, insulation materials.

Background:
During the building cycle harmful substances or substance groups are used or formed.

Suggestions for presentation:
The illustration is quite dense, it is recommended to select some substances or substance groups and explain the impact in more detail.


45

Ecology and health – paints

Pigment	Constituents	Comments
White pigments:		
Chalk	Calcium carbonate	From natural resources; not very strong in oil paint
Glass white	Ground, recycled glass	At an experimental stage
Lead white	Lead carbonate or lead chromate	Highly toxic; also used as siccative
Titanium white	Titanium oxide	Most widely used white pigment
Zinc white	Zinc oxide	Toxic; fungicidal effect; usually produced from recycled zinc
Red pigments:		
Cadmium red	Cadmium selenide	Highly toxic
Chrome red	Lead chromate	Highly toxic
Iron oxide	Ferrous oxide (Fe II)	Originally an earth pigment
Red lead	Lead tetroxide	Highly toxic, anticorrosive
Red ochre	Hydrated ferric oxide (Fe III)	Originally an earth pigment

Berge, B. (2009): The Ecology of Building Materials: 390

As seen on the previous slides, not only solvents but also pigments in paints, can pose a health hazard. A few white and red pigments are listed here. The toxic ones are indicated with a red arrow. Many of these pigments are no longer used in paints.

Connection to other themes:
Health aspects, ecological paints.

Background:
Heavy metal salts are used as pigments in paints, many of them are toxic to humans.

Suggestions for presentation:
Participants could check for themselves the paints on the market and examine the contents.

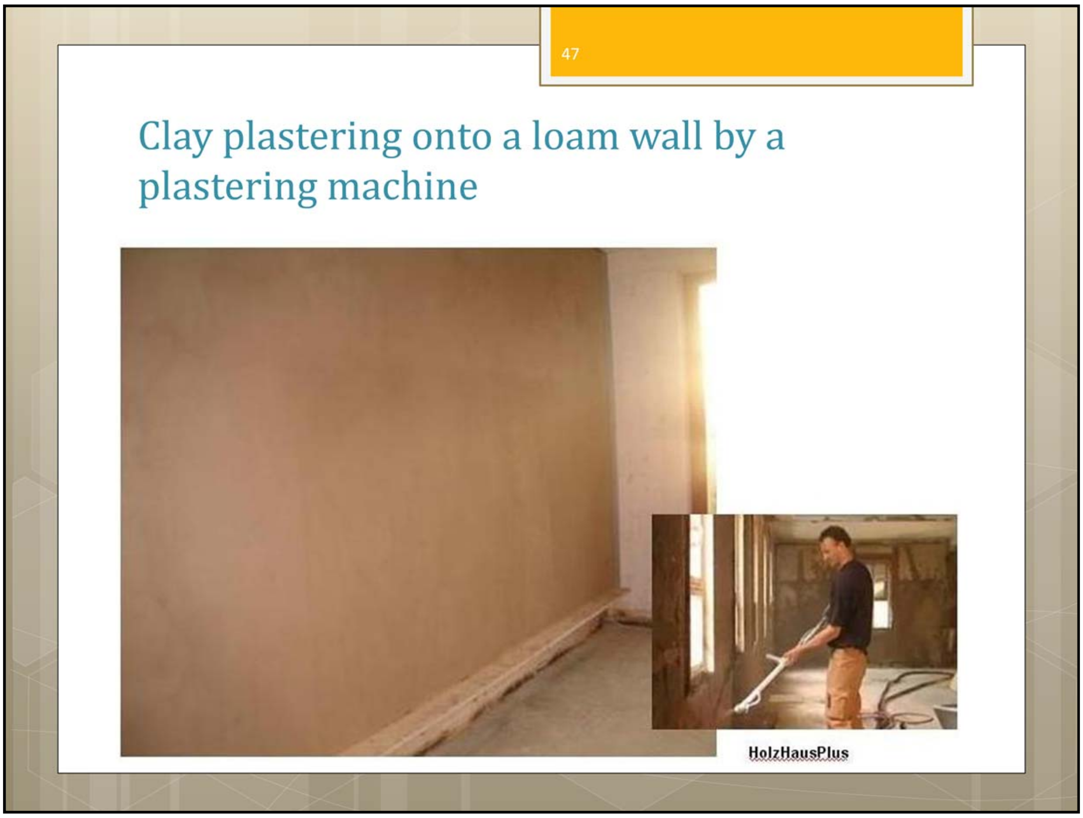
A wall paint with “food” as an ingredient can't be dangerous ☺

Connection to other themes:
Indoor air quality, timber and wooden houses.

Background:
Get more information from www.kreidezeit.de (in English) and www.natur-am-bau.de (in German).

Suggestions for presentation:
Prepare a paint together with participants and paint a piece of wall paper or better a complete wall.

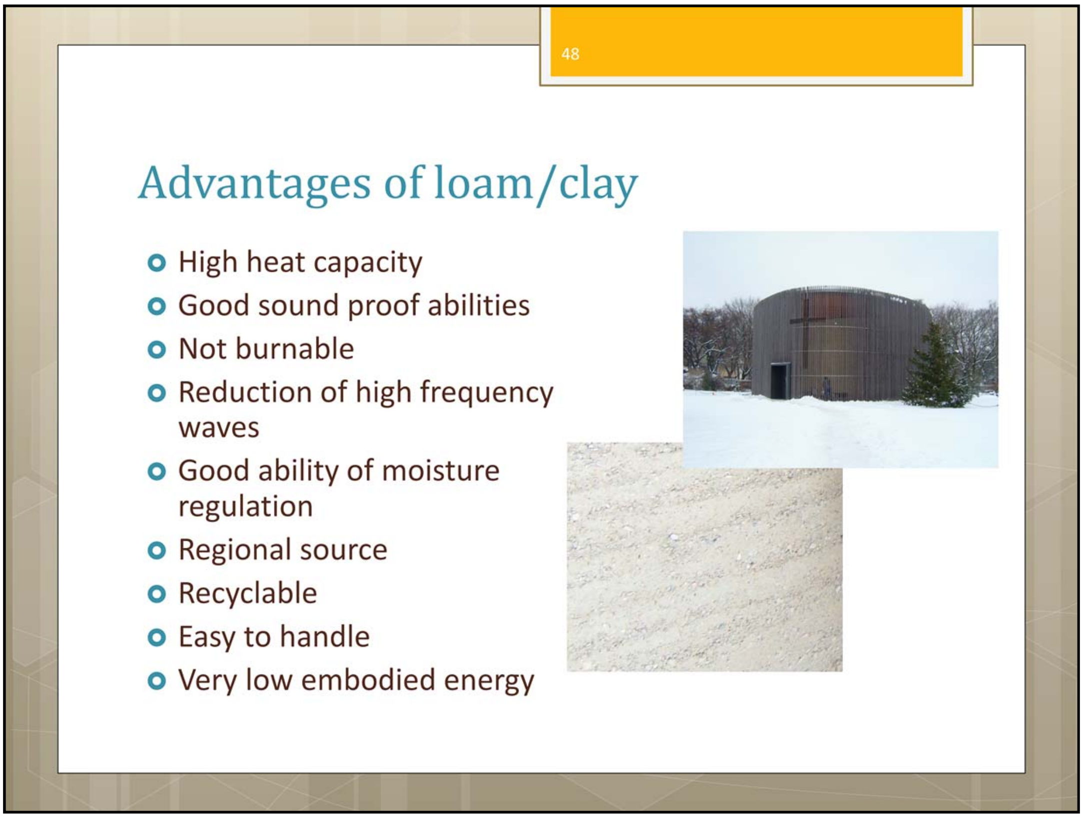
Note: while the paint is wet, it is a bit grey. When the paint gets dry, it becomes white. If mixing it with other pigments you can get nice effects. The paint is very long lasting. In Germany there are paintings of casein paint applied on church ceilings and having remained for more than 800 years without renovation.



Clay plaster can be fixed onto the wall manually or with the help of a plastering machine. Clay plasters are available in bags, large bags or in containers to be fed directly into the plastering machine. The application is the same as for other plastering materials e.g. gypsum. One of the advantages of using clay: there is no need to clean the plastering machine each day when being used - clay can be smoothed many times and thus lasts longer.

Connection to other themes:
Lca – figures, timber and wooden houses.

Suggestions for presentation:
To organise a workshop where participants can work with clay and loam.

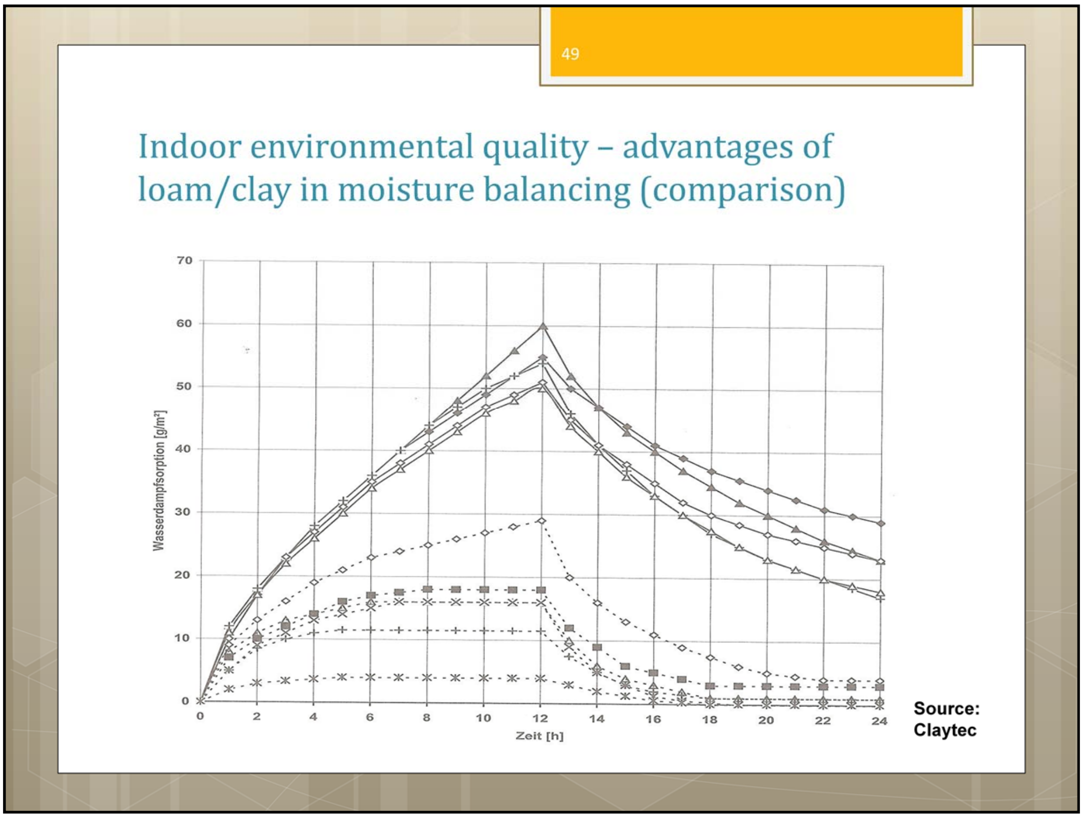


In this slide the main advantages of loam and clay are pointed out.

Connection to other themes:
Lca – figures.

Background:
The picture shows a church in Berlin, Germany mainly built from loam and wood. More information about the church is available at www.kapelle-versoehnung.de

Suggestion for presentation:
To organise a workshop where participants can work with clay and loam.

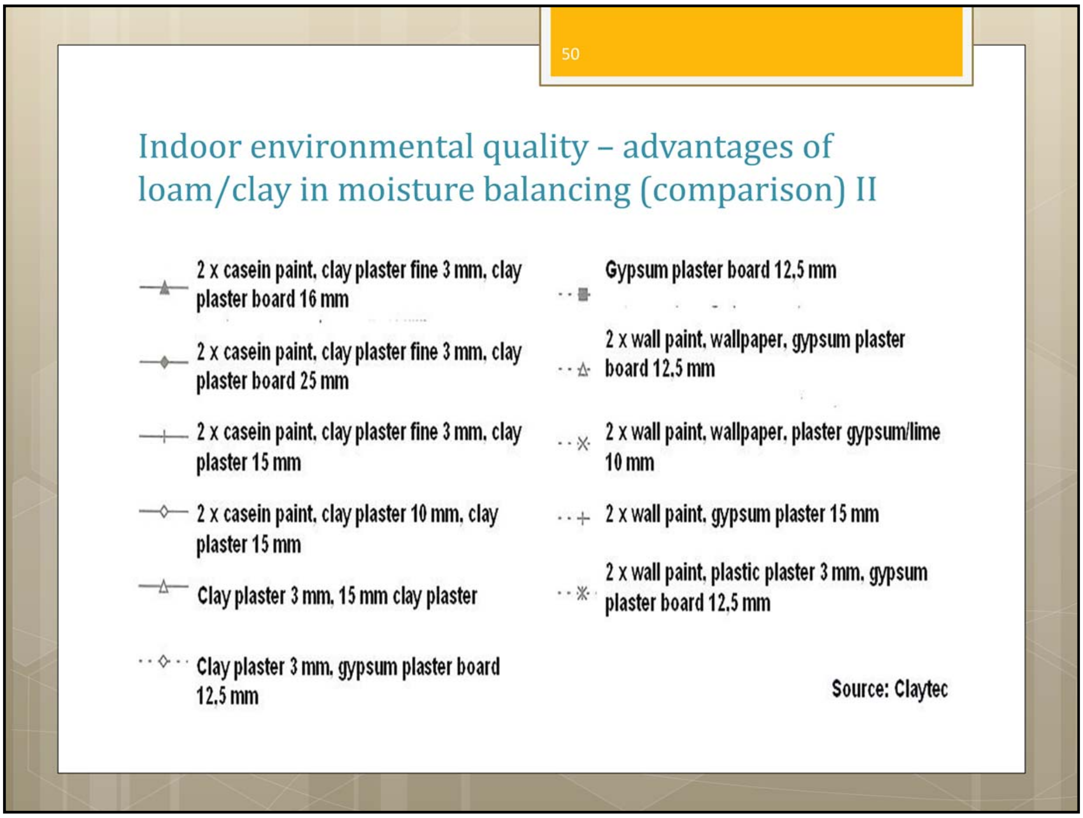


This slide and the next one are interlinked with each other. They show the advantages of loam and clay in moisture balancing in relation to indoor environmental quality. The chart shows the water vapour absorption [g/m²] of different finishing materials. All samples were tested in the same climate for 12 hours. The absorption was measured and the samples were dried under the same conditions. All finishing surfaces with clay and casein paint show fast and high moisture absorption.

Connection to other themes:
Indoor environmental quality, timber and wooden houses.

Background:
Natural and renewable raw materials are of great benefit to the indoor climate.

Suggestions for presentation:
Participants should measure the indoor air humidity during the day and note down the changes.



This slide and the previous one are interlinked with each other. This slide explains the composition of various materials tested for absorption. All samples were tested in the same climate for 12 hours. The absorption was measured and the samples were dried under the same conditions. All finishing surfaces with clay and casein paint show fast and high moisture absorption.

Connection to other themes:
Indoor environmental quality, timber and wooden houses.

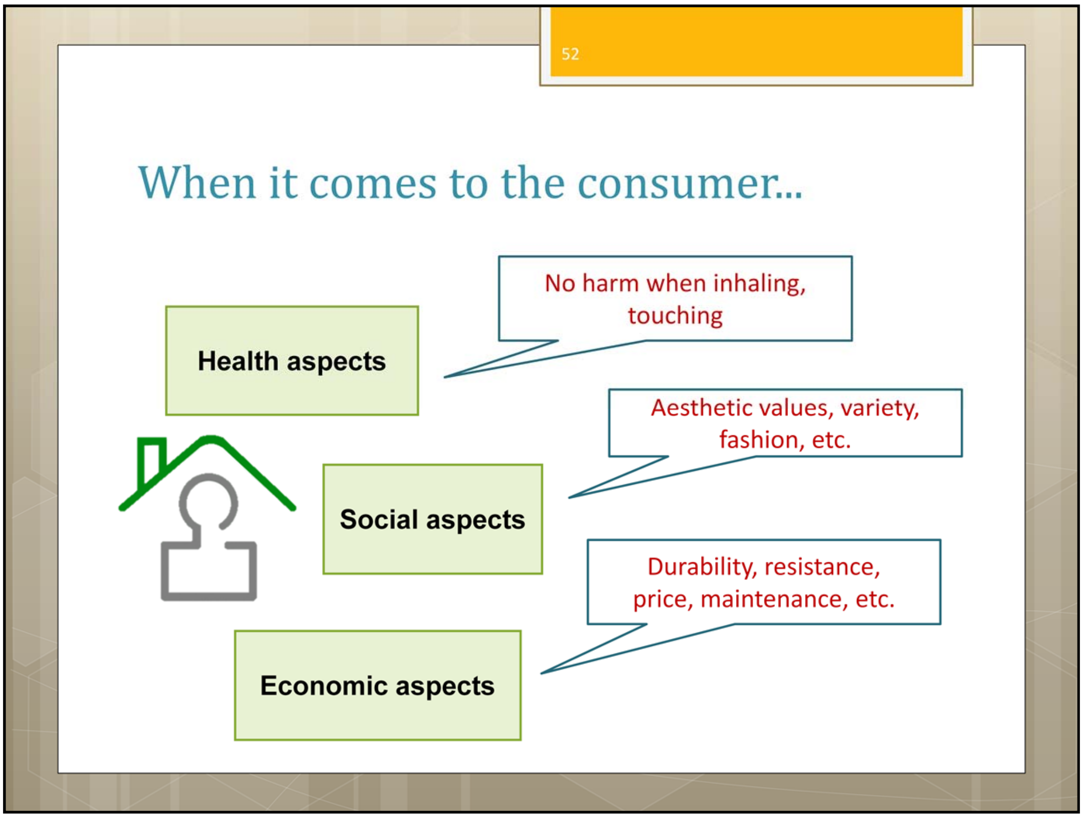
Background:
Natural and renewable raw materials are of a great benefit to indoor climate.

Suggestions for presentation:
Participants should measure the indoor air humidity during the day and note down the changes.

Various players and stakeholders apart from the general public have an influence on the increased application of ecological materials. On the one hand there are the market players with a direct financial interest, such as producers, retailers of ecological construction materials and architects/engineers who design buildings using them. Both groups advertise their products or services and have their own selfish interest in the increased use of ecological materials.

Some stakeholders have an indirect influence or interest. These are stakeholders who work with or about ecological materials for other reasons. Public administrations do have quite an important role as they can be catalysts in the realisation of “green” building projects taking into account ecological construction principles and materials. Funds that support the application of ecological materials create an additional incentive. Customer advice centres and other interest groups can contribute towards overcoming misconceptions and raise awareness. They are often considered a more neutral case than companies that are interested in selling their products.

Background:
Apart from market players with a direct financial interest there are also other stakeholders that could support an increased application of ecological construction materials.



Apart from environmental concerns, health, social and economic aspects are the prevailing factors influencing the consumers choice of building materials.

Connection to other themes:
Construction trends and the use of materials for construction, insulation and finishing of new and existing buildings in the Baltic States.

Background:
Producers of construction materials as well as architects in the Baltic States experience increasing interest and demand from consumers in environmentally friendly construction, insulation and finishing materials. The reasons for this interest can vary e.g. allergies caused by conventional materials, aesthetic values, "Choosing "green" is in fashion". These aspects are evaluated against the price of material in most cases not being favourable to ecological materials.

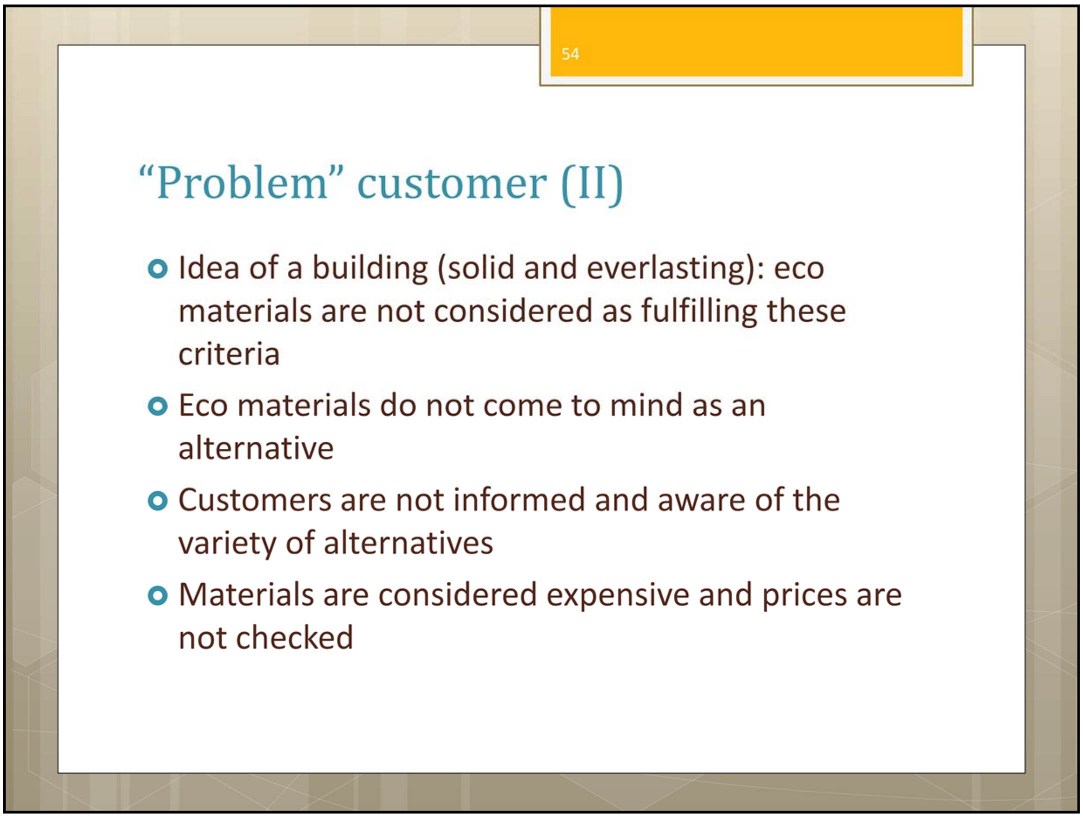
Suggestion for presentation:
Discuss with participants the main arguments that would encourage a customer (client) to decide on selecting ecological materials for a building.

Many customers have an idea of what a house should look like; that it should be huge and made from stone. The ecological benefits or even financial benefits are therefore sometimes not enough to convince potential customers to decide on more ecological options. You should be aware that emotions, values, habits, the image of companies and personal beliefs play a role when it comes to making a purchase. This is not always a rational decision.

The picture with the three piglets illustrates the belief that only a stone house can last and is durable.

Connection to other themes:
Consumer issues.

Background:
Purchase decisions do not only rely on price and apparent benefits but also on emotions, values and beliefs.



Some of the barriers that hinder the introduction of ecological constructions are not on the supply but on the demand side. There are different barriers at the moment that need to be overcome. While beliefs and ideas were already mentioned in the previous slide, ecological materials simply do not come to mind for many people at all. This is because alternatives are not known and customers tend to go for conventional solutions as these are easier to find and there are more examples accessible to examine. Besides that, there is a common belief that ecological material must be more expensive. However in reality, many constructions can be realised by using ecological alternatives without or without significant increasing the construction / insulation / finishing costs.

Public buildings that are realised with ecological materials have an important function as cases of local good practice. If adequately promoted in public, such buildings can contribute to a process of raising general awareness.

Connection to other themes:
Slide about the three piglets (beliefs of costumers), slides about presumptions.

Background:
Some of the barriers that hinder the introduction of ecologic constructions are not on the supply but on the demand side – the customer.

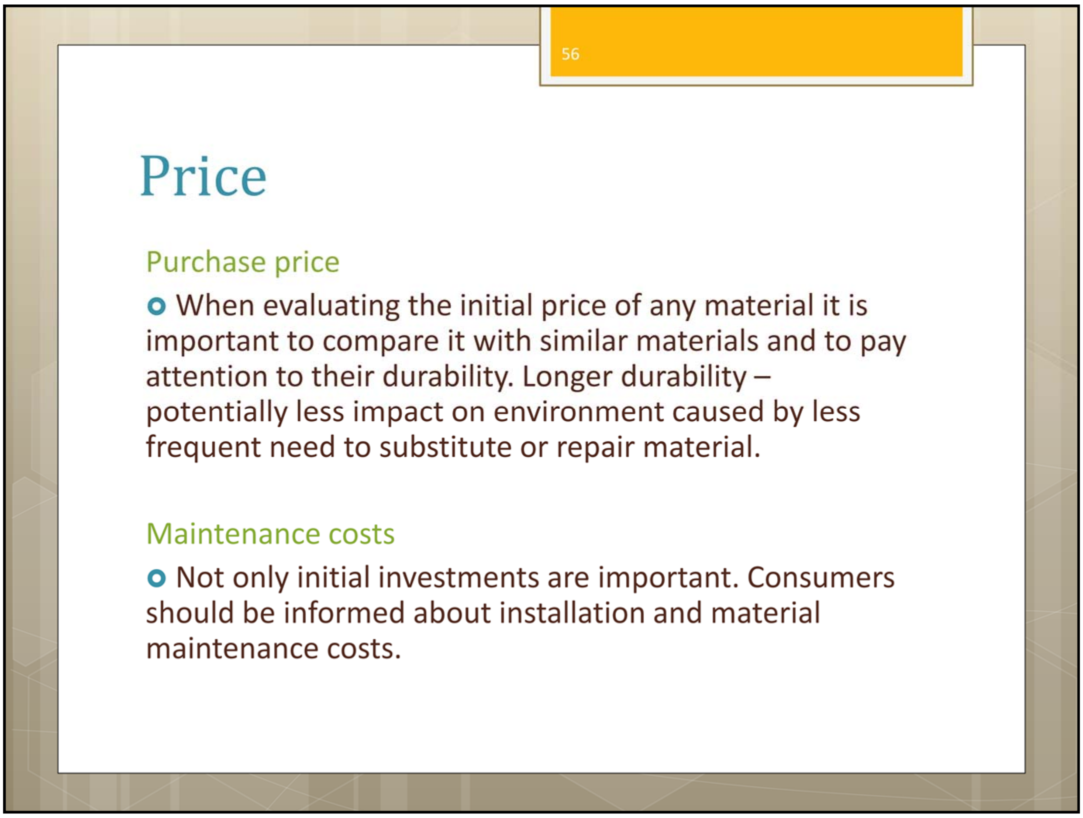
Suggestions for presentation:
Discuss with participants how the interest in ecological constructions from the side of the customers can be increased.

A large variety of labels (above are listed those which can be found in Germany) might be very confusing for customers. The criteria for labelling products are usually not obvious.

Connection to other themes:
Consumer issues.

Background:
Labels are developed to ensure a certain level of quality for the consumers. However, the variety and unclear criteria for the award is confusing and often does not support the customer in his purchase decisions.

Suggestions for presentation:
Discuss which labels are known to the listeners and available in your country and if they know what they stand for and how the label is awarded.

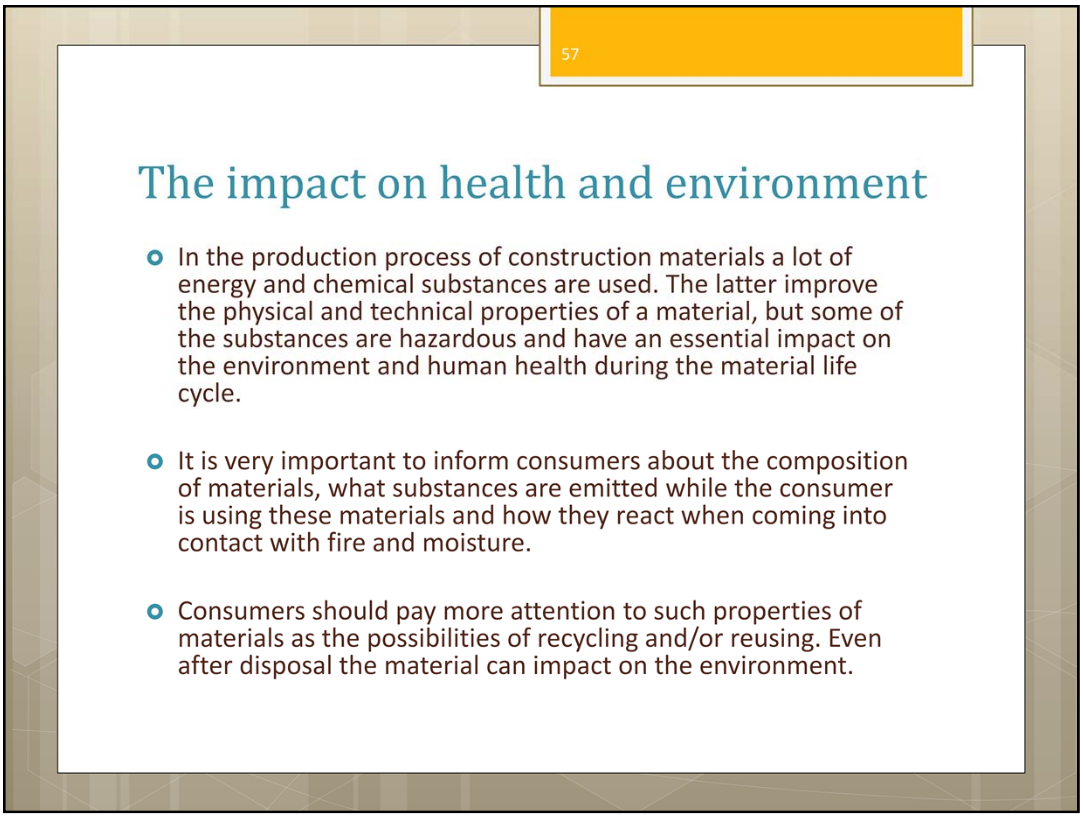


When the consumer starts to think about construction materials one of the main selection criteria is price. The consumer is interested in high quality materials which have a reasonable price. There is an opinion between consumers that the prices of ecological material (similarly to ecological food products) are much higher and in many occasions its true. Very often before purchasing materials consumers don't find out how much the installation of a particular material costs. Consumers should pay more attention also to the maintenance costs of material during its lifetime. Durable construction materials need less investments for renovation which means less impact on the environment.

Connection to other themes:
Physical and technical parameters of construction materials (e.g. U value, fire resistance, durability).

Background:
Sometimes there are cases where a material is low in price but to install it or use it in the construction of a building is very costly (e.g. straw – as a material it is cheap but to build a straw house might be costly because e.g., it is a time consuming process and there are not many professional builders who can do it properly).

Suggestions for presentation:
Show practical examples of incorrect installation and usage of material and the circumstances.

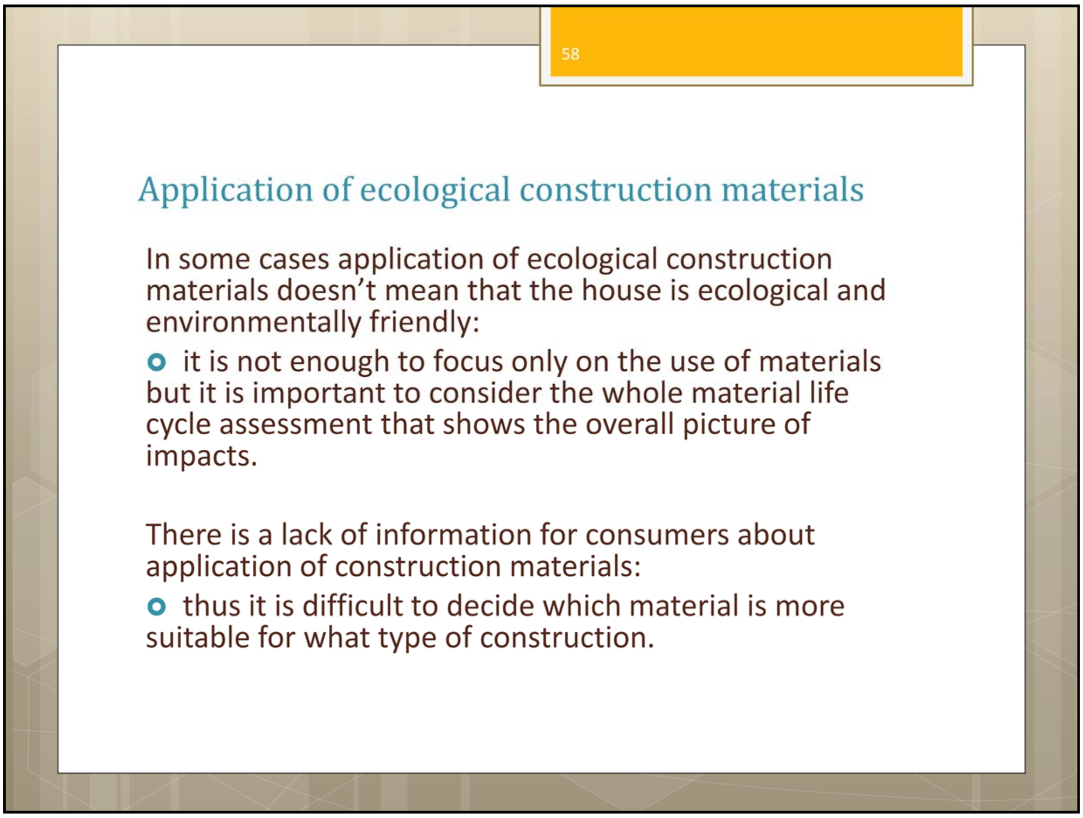


The consumers should be informed about chemical substances which are in the structure of materials or which are used in the production of material. Not all additives have an essential impact on human health and the environment and if material is used properly the impact can be minimised. Consumers should pay attention to such material properties like recycling or/and reusing and should be informed what to do when the material is no longer useful. For example, not to burn polystyrene foam insulation because it emits substances harmful to health.

Connection to other themes:
Chemical substances and their impact on human health and the environment.

Background:
There is a lack of information for consumers about the real structure of material and properties. Very often architects and engineers influence the choice by clients on which materials to use for house construction.

Suggestions for presentation:
Present best practice examples in European countries where people can dispose of faulty construction material for recycling.

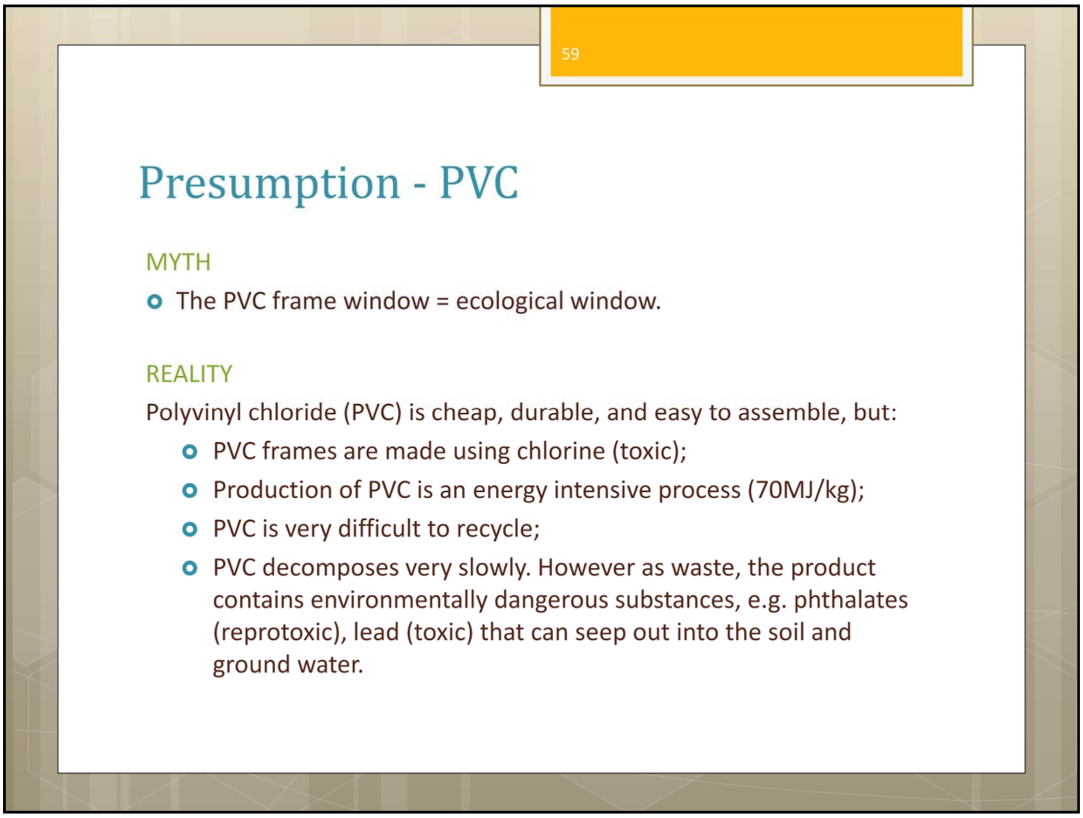


The life cycle assessment of material shows the whole picture of the impact on health and the environment.

Connection to other themes:
Sustainable building criteria, life cycle assessment.

Background:
Sustainable, energy efficient and ecological house combine many criteria and one of these is ecomaterials. It is very important to include as many criteria as possible in planning, designing and constructing phases.

Suggestions for presentation:
To prepare a list of different web pages about ecological materials which provide information for consumers in a comprehensible manner.

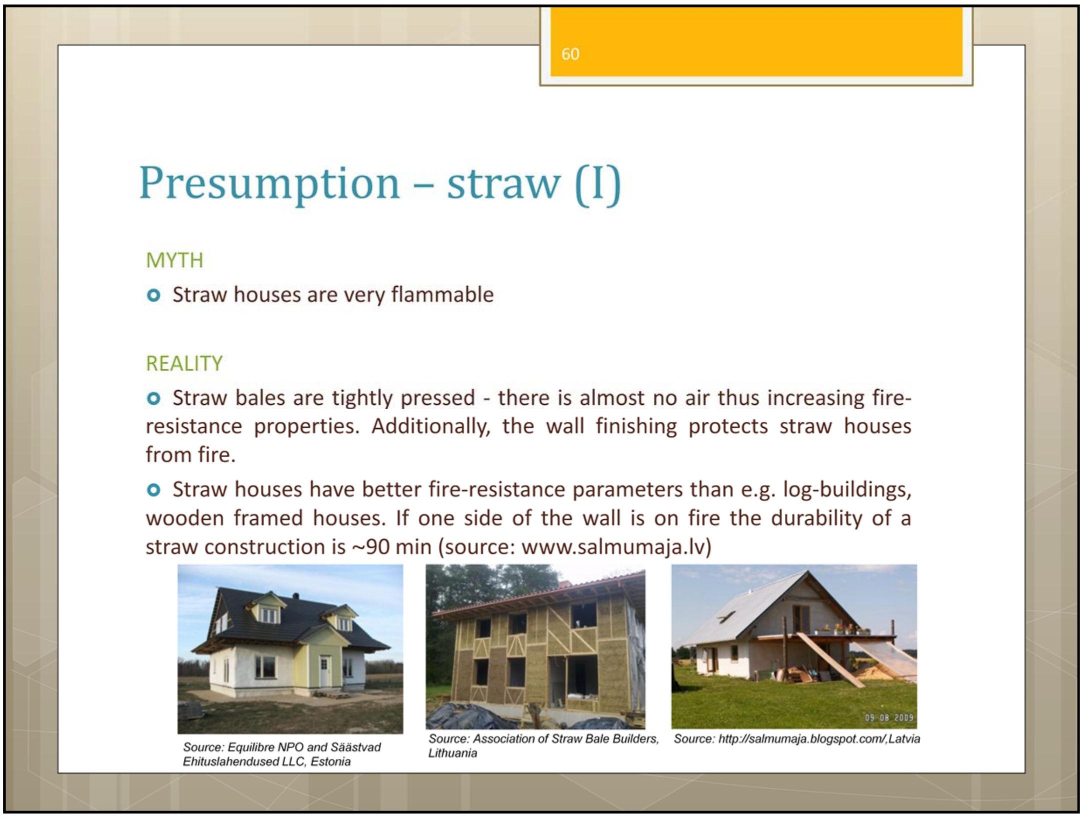


Polyvinyl chloride (PVC) is a synthetic material, made up of repeating units of vinyl chloride. PVC is comprised of chlorine, carbon, and hydrogen and its resin is 51% chlorine by weight. The remainder is hydrogen and carbon, which are derived from fossil fuels: primarily natural gas and petroleum. The production of PVC is also an energy-intensive process (70MJ/kg) and produces many poisonous pollutants such as hydrocarbons, dioxins, vinyl chloride, phthalates and heavy metals required for processing. PVC is relatively inert in use, with no evidence of health risk to occupiers. PVC decomposes very slowly and as a waste product it contains environmentally dangerous substances that can seep out into soil and ground water. Recycling of PVC is possible, but very difficult and the chemical process of doing so is environmentally damaging. Incineration is contentious, as the potential for releasing harmful chemicals makes it a high risk process.

Connection to other themes:
Life Cycle Assessment (LCA) approach, different material frame windows – aluminium and timber.

Background:
PVC frame windows have low maintenance costs and are considered to be durable windows.

Suggestions for presentation:
To show participants the life cycle assessment scheme of PVC, timber and aluminium frame windows and evaluate these frame materials regarding their production taking
into account the affiliated energy and environmental impacts.

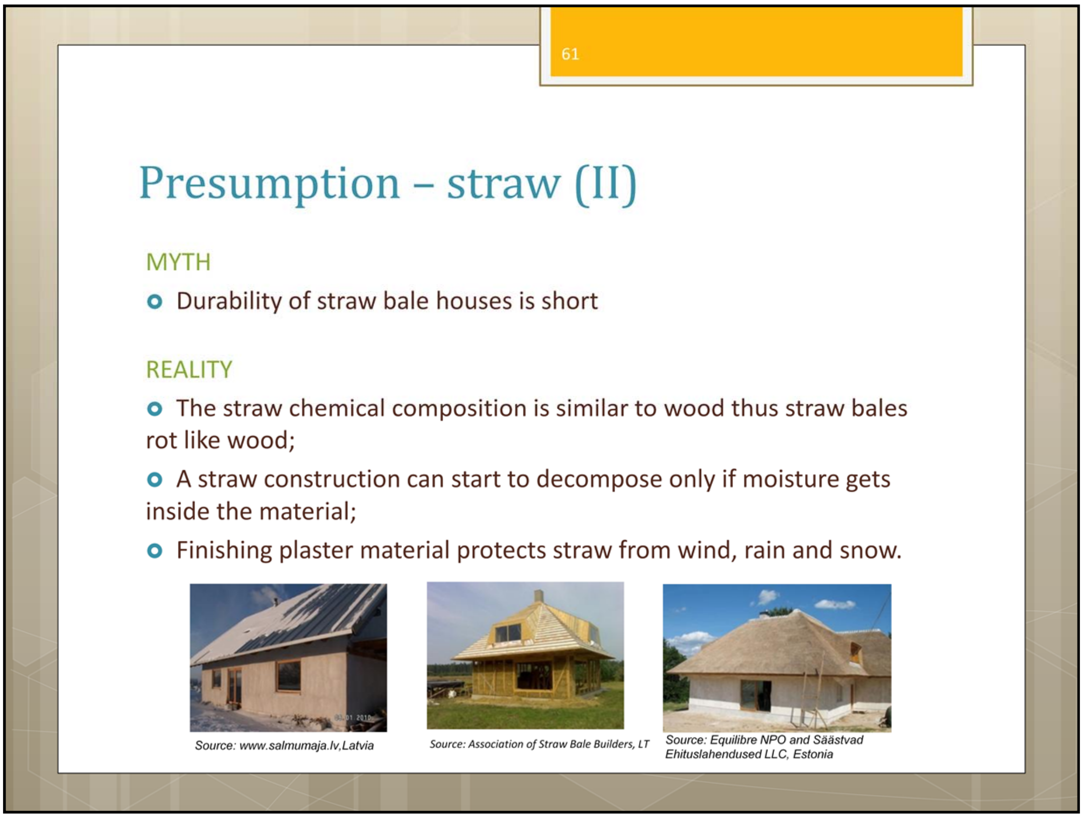


There is an opinion that straw bale houses are very flammable. Loose, dry straw is indeed flammable, but the bales are so tightly packed that they actually increase fire resistance. In a tightly packed bale, there's no oxygen, which reduces the chance for combustion. The plaster coating of the walls adds an additional fire-resistant seal.

Connection to other themes:
Straw bale house construction - advantages and disadvantages, fire resistant classes.

Background:
There are several studies made and articles available providing evidence that straw houses have good fire-resistant parameters like log buildings, wooden framed houses or houses built of conventional construction materials. More information can be found at
wwww.strawbale.com/straw-bale-fire-resistant-southern-california;
www.engineeringuk.com/viewitem.cfm?cit_id=382858.

Suggestions for presentation:
To show participants the fire test (video) on the performance of different wall materials.

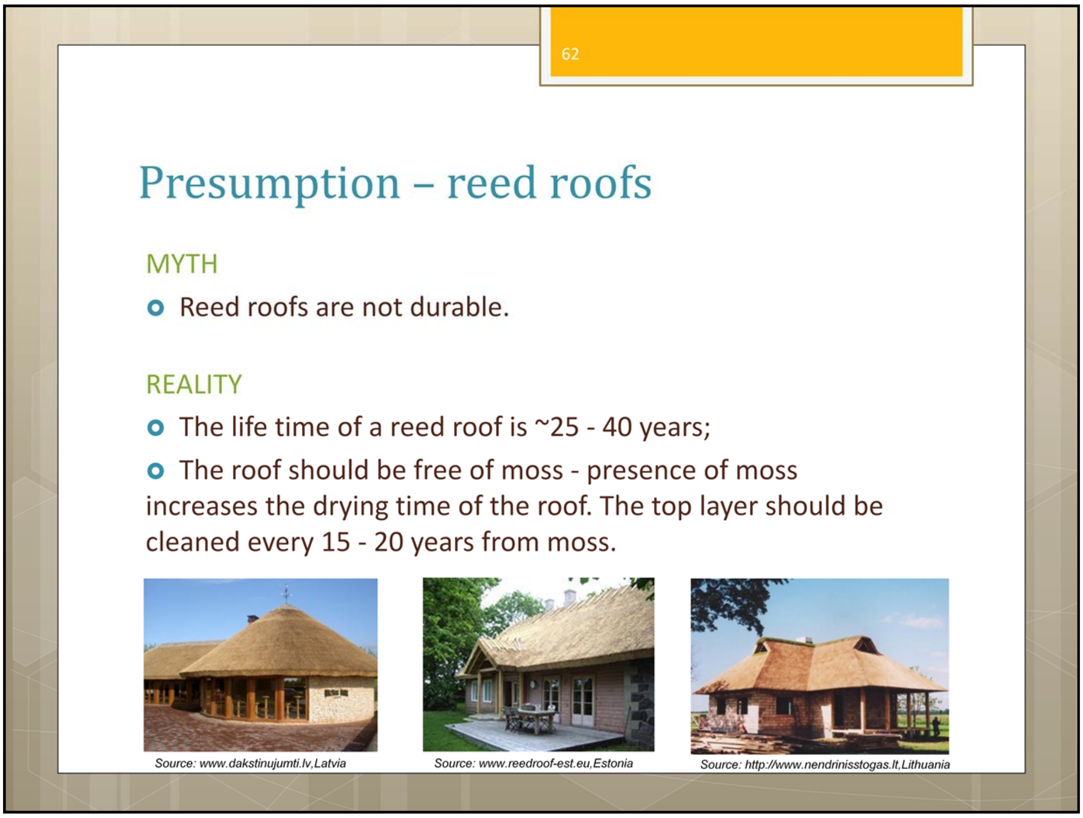


Straw bales can last for many decades, as long as water doesn't leak into cracks in the walls. Moisture is a real concern in straw-bale constructions. A properly designed and constructed straw-bale house will last as long as a “conventional” house. Straw should be kept dry, both during and after construction. Without proper procedures, straw will start to rot. Straw bale walls should remain breathable, and protected with good anti-moisture barriers.

Connection to other themes:
Straw-bale house advantages and disadvantages, construction of straw-bale building.

Background:
The straw chemical composition is extremely close to wood. The largest part is cellulose and the differences between wood and straw are insignificant. More information is available at www.lowimpact.org/factsheet_straw_bale_building.htm

Suggestions for presentation:
To show video with practical examples of how to protect straw-bale walls from moisture and rotting.



A well constructed and maintained reed roof lasts for many decades. The average lifetime of the reed roof is about 25 or even longer in cases of good service. The roof hips that are often damaged by the weather need to be renewed every 10 – 15 years. The moisture can decrease the lifetime of the roof. One of the reasons why moisture accumulates in the reeds is moss. The moisture can prevent the roof from breathing.

Connection to other themes:
Durability of material, reed roof construction technique, advantages and disadvantages of reed roofs.

Background:
More information is available at www.thatchadvicecentre.co.uk

Suggestions for presentation:
Show participants pictures of reed roofs which are not maintained according to producers recommendations, as well as good practice examples.

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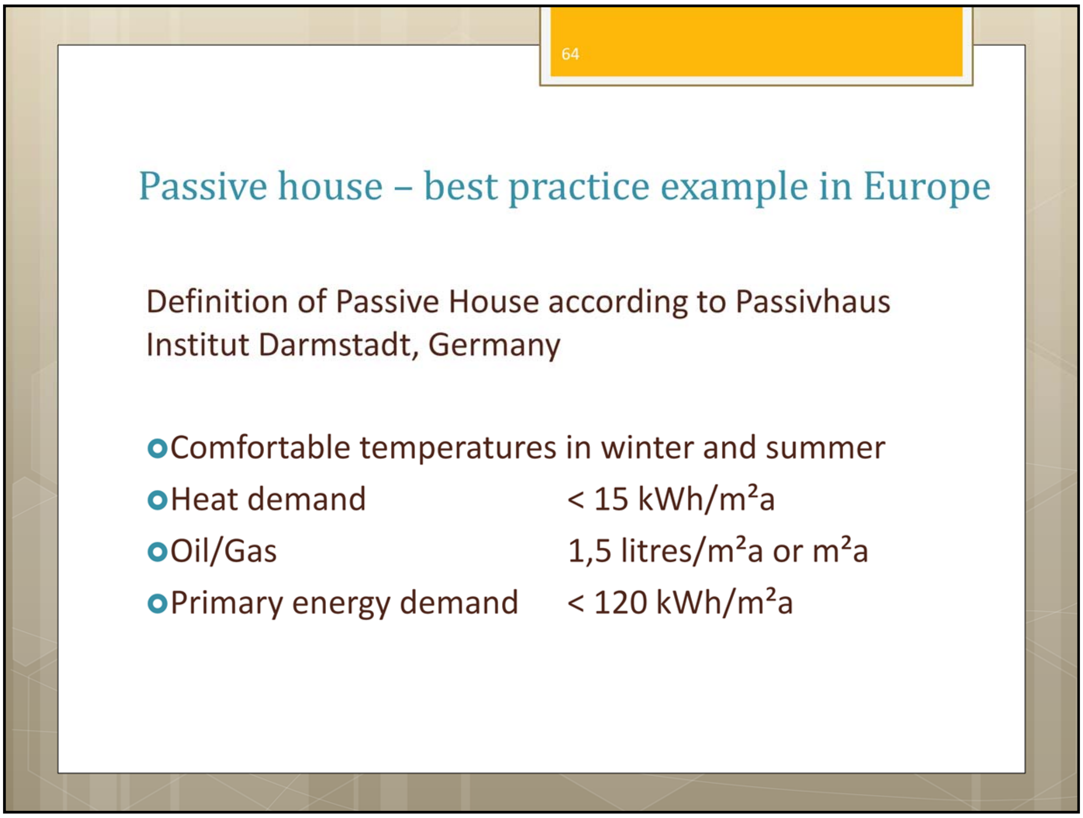
Ecological construction materials & energy performance of buildings



Environmental impact of a house is also connected to its energy performance. Less energy demand – less impact on the environment. Currently passive house can be considered as the best practice example in Europe, leading to a further step: near-zero-energy building.

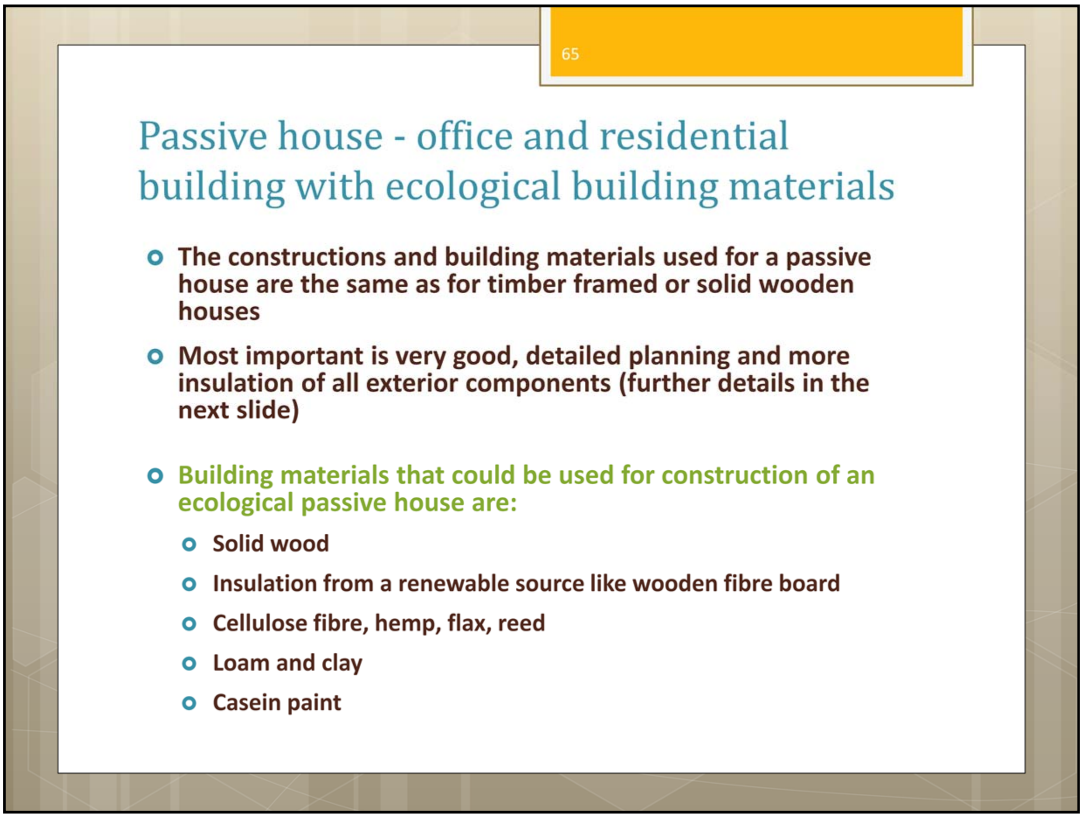
A **passive house** is a building in which a comfortable room temperature of about 20°C can be achieved without conventional heating and cooling systems. Such buildings are called "passive" because the predominant part of their heat requirement is supplied from "passive" sources, e.g., sun exposure and heat of persons and technical devices. The heat still required can be delivered to rooms by the controlled ventilation system with heat recovery. The annual space heat demand for passive houses is very low – in Central Europe ~**15kWh/m²/year**. The need for the total primary energy used should not exceed **120kWh/m²/year** (including heating and cooling, domestic hot water, and household electricity).

Background:
Get more information on passive houses at Passive House Institute in Darmstadt, Germany www.passiv.de. More information on new EU requirements can be found at the EU Directive 2010/31/EU on the energy performance of buildings (recast) http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:153:0013:0035:EN:PDF

Connection to other themes:
Energy performance of buildings.

Suggestions for presentation:

Discuss with participants the current practices for construction of new buildings or refurbishment of existing ones in the country. Discuss the possibilities and challenges of (re)construction according to passive /near-zero-energy house standards in the country.

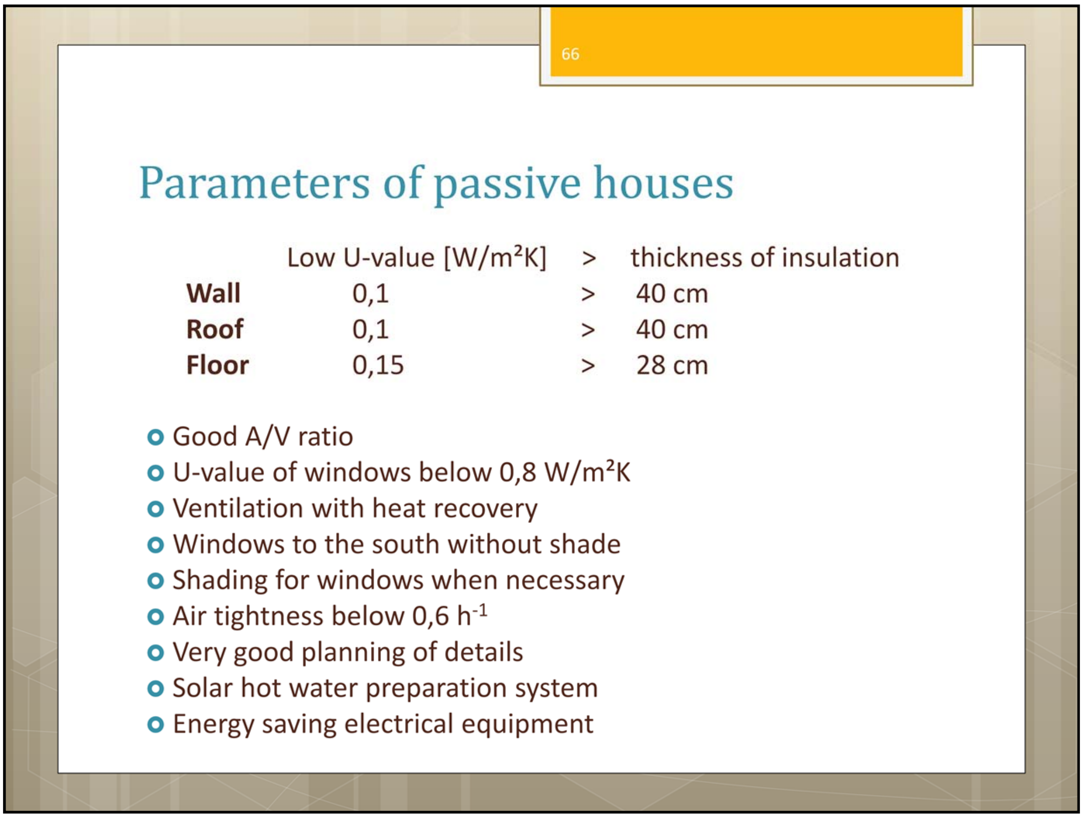


Considering environmental impacts from building process, the constructions and building materials used for a passive house are the same as for timber framed or solid wooden houses.

Most important is very good, detailed planning (technical design) avoiding thermal bridges and better (bigger) insulation than conventional exterior components. Additionally particular attention should be paid to the quality control during the whole construction process.

Connection to other themes:
Energy performance of buildings.

Background:
More information on construction of passive houses from ecological construction materials is available at *Details for Passive Houses – A catalogue of ecologically rated constructions*, IBO – Austrian Institute for Healthy and Ecological Building (Ed.) 2009, SpringerWienNewYork (3rd edition) in German and English. This updated and expanded edition, includes a large number of standard cross-sections that now conform to passive house standards as well as up-to-date ecological evaluations.



In this slide the most important aspects for implementation of passive houses are listed. The design of passive houses is a holistic process of planning and realisation, taking into account local climatic and geographical conditions as well as inter-linkage with already existing buildings in the surrounding area. It can be used for designing new buildings or for energy renovation of existing houses.

Abbreviations used:
A = area of all exterior components
V = internal volume of building
U-value = heat transmission coefficient

Connection to other themes:
Energy performance of buildings, quality control of air-tightness of the building (e.g., blower door test), use of renewable energy sources, holistic planning.

Suggestions for presentation:
Make a comparison of construction standards of conventional buildings (according to national legislation) and passive house standards. Discuss certification options of passive houses in the country.

There are various examples of passive houses built using ecological construction materials available in various countries all over Europe (e.g., Germany, Austria, Sweden, Slovenia, the Czech Republic) – office as well as residential buildings.

Background:
Get more information on good practice examples of passive houses at www.passivhaustagung.de/Passive_House_E/Examples_passive_houses.html and at www.igpassivhaus.at

Connection to other themes:
Energy performance of buildings.

Suggestions for presentation:
Introduce good practice examples of passive houses from your country, especially if ecological construction materials have been applied. Organise a site visit to these objects.

References and useful links

- Information about green building products, materials, construction techniques, UK
  www.greenspec.co.uk/html/materials/embodied_energy.html
- Eco-friendly construction, UK
  www.sustainablebuild.co.uk/EcoFriendlyConstruction.html
  www.sustainablehomes.co.uk
- Building materials in a green economy, Canada
  www.greeneconomics.net/BuildMatEssay.html
- A complete study course on ecological construction
  www.ecobine.de
- Details for Passive Houses. A catalogue of ecologically rated constructions (3^{rd} edition), IBO, Austria, 2009 (in German, English)
- A free database with (ecological) material, Austria (in German)
  www.baubook.at
- Brochure on “Ecologic construction materials”, BEF, 2011 (in Latvian, Estonian)
  www.bef.ee/index.php?id=838
  www.bef.lv/394/785/?

The end.

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Content on the accompanying CD

1. Handbook „Ecology of construction materials" (pdf)

The handbook aims to increase the awareness of specialists in the construction sector and to promote the use of ecologic materials in the Baltic States. It covers environmental and health protection as well as technical aspects of construction materials. Energy performance of buildings is another important issue tackled in the handbook.

2. Training Manual (ppt)

A supportive tool for preparation of lectures to students studying architecture, engineering and environmental sciences in the Baltic States. It introduces the criteria for selection of materials and analyses the environmental aspects in the whole building cycle from extraction of raw materials up to disposal and recycling. It gives technical details and advice for proper application of ecological construction materials. The key aspects related to construction of passive houses applying ecological construction materials are also presented.

3. Recommendations for using eco materials in the Baltic States (pdf)

The paper gives an overview on construction trends and future perspectives in the Baltic States to use ecomaterials for construction, insulation and finishing. The main aspects for evaluation of materials and gives guidance to find environmentally sound solutions for selection of materials taking into account environmental and health aspects. Good practice examples of using ecological materials in energy efficient buildings are highlighted.

4. Evaluation of eco-performance of buildings (pdf)

A comparison of the ecological impact of different building types using conventional and ecological materials and having different energy consumption levels required for heating. The evaluation of the environmental performance of building materials is done based on life cycle analyses. The study describes how impacts of structural components and entire buildings can be assessed using the ecological indicator based approach referring to the respective global warming potential, acidification potential and Non-renewable energy resource requirement.

5. Publications and info materials in the Baltic States and Germany (pdf)

Overview on publications and other informative materials available in Estonia, Latvia, Lithuania and Germany on ecological materials for construction, insulation and finishing.

6. Trainings in the Baltic States and Germany (pdf)

Overview on trainings, seminars, videos on application of ecological materials for construction, insulation and finishing, building energy efficiency and sustainable technologies in Estonia, Latvia, Lithuania and Germany. Only materials available on Internet are presented.