intense energy efficiency

Handbook: Holistic energy efficient planning and construction

INTELLIGENT ENERGY EUROPE

Authors:

Dirk Schröder-Brandi
Energie- und Umweltzentrum am Deister e.V.
Germany
Phone: + 49 (50 44) 9 75 21
E-mail: schroeder-brandi@e-u-z.de

Wilfried Walther
Energie- und Umweltzentrum am Deister e.V.
Germany
Phone: + 49 (50 44) 9 75 21
E-mail: walther@e-u-z.de

Christiane von Knorre
Auraplan,
Germany
Phone +49 (40) 63 27 01 81
E-mail: christiane.von.knorre@auraplan.de

Hans Löfflad
Ingenieurbüro für Baubiologie,
Germany
Phone.: +49 (3 33 97) 6 83 88
E:mail: info@ifb-loefflad.de

Philipp Engewald
Baltic Environmental Forum
Germany
Phone: + 49 (40) 53 30 70 75
E-mail: philipp.engewald@bef-de.org

Friedemann Stelzer
Energiebündel,
Germany
Phone: +49 (71 21) 3 82 08 26
E-mail: info@energiebuendel.com

Daina Indriksone
Baltic Environmental Forum,
Latvia
Phone: +371 6735 7550
E-mail: daina.indriksone@bef.lv

Jörg Faltin
Auraplan,
Germany
Phone: +49 (43 51) 76 75 91
E-mail: joerg.faltin@auraplan.de

Sandra Oisalu
Baltic Environmental Forum
Estonia
Phone: +372 65 97 027
E-mail: sandra.oisalu@bef.ee

Ingrida Bremere
Baltic Environmental Forum,
Latvia
Phone: +371 6735 7561
E-mail: ingrida.bremere@bef.lv

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INTENSE – Intelligent energy saving measures for municipal housing in Central and Eastern European countries

Coordinating partner: Ingrida Bremere, Project manager, Baltic Environmental Forum, Latvia

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Introduction

About the Handbook

On 19 May 2010, the European Parliament and the Council of the European Union adopted the recast of the Energy Performance of Buildings Directive (2010/30/EU). The aim of the Directive is to strengthen the energy performance requirements and to clarify and streamline some of the provisions from the 2002 Directive, which it replaces. The Directive clearly states that as of 31 December 2020 new buildings in the European Union will have to consume 'nearly zero' energy and the energy will have to be 'to a very large extent' from renewable sources.

Meeting these requirements means that construction is implemented properly and in a high quality. Already the building boom in many Central and Eastern European countries in 2006-2008 showed that quality differs greatly. Many buildings erected in this period have constructional defects that also affect their energetic efficiency. Settlements were built in the outskirts of larger cities without proper infrastructure and connection to the urban public transport system.
Due to that reason there was a need for a training program having a holistic approach by bringing together different aspects of energy efficient urban planning down to details of construction and finding out how to make energy efficient houses more attractive and desirable for citizens.
Such a training programme should be targeted not only to the immediate decision-makers on municipal level, but also the executing stakeholders both from design and implementation levels. Experts from these two levels are the most important key actors for the implementation of energy efficiency in construction.

In the frame of the project "From Estonia till Croatia: Intelligent Energy Saving Measures for Municipal housing in Central and Eastern European Countries (INTENSE)", which is financed by Intelligent Energy – Europe program, such a training program was elaborated in order to provide tools for further dynamic developments at the pan-European level and to promote the know-how transfer between nations in order to achieve the goal of implementing the European Union standards at a national level.

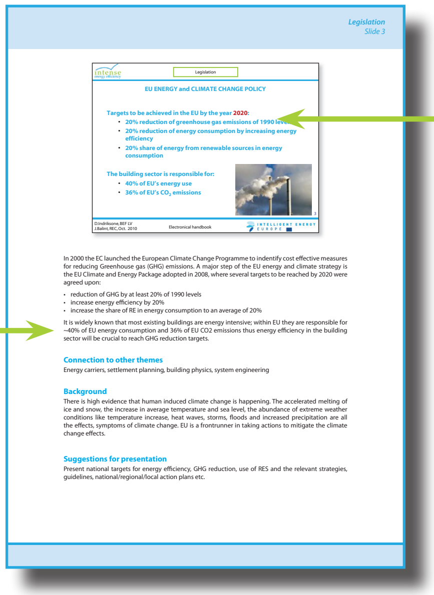
The focus of the INTENSE training program is on the low energy/passive house standard, i.e. how to achieve the standard and to go further ('nearly zero'-buildings, required by the Directive Recast). The training program has a modular approach consists of 9 modules and it allows combining different units according to local needs:

1. Legislation
2. Quality control
3. Settlement planning and design principles
4. Energy carriers and renewable energy sources
5. Ecological materials
6. Cost-benefit assessment
7. Building physics
8. Construction of elements
9. Systems engineering

The handbook is divided into 2 parts – a paper version consisting of key slides with comments of each module and an extended electronic version having deeper information on each module (on CD).

How to use the Handbook

Each chapter contains key slides, which summarize the main contents in form of a presentation and below you can find further explanations on the content, as well as hints for further information or suggestions for how to present the content to your audience. Where applicable you will also find here information about connecting topics.



Slide
The presentation you can find on the enclosed CD.

Notes
Further explanations for you as a trainer with suggestions for further reading and how to present the content .

For each topic the CD will also contain an extended version of the presentation with more detailed explanations and more examples.

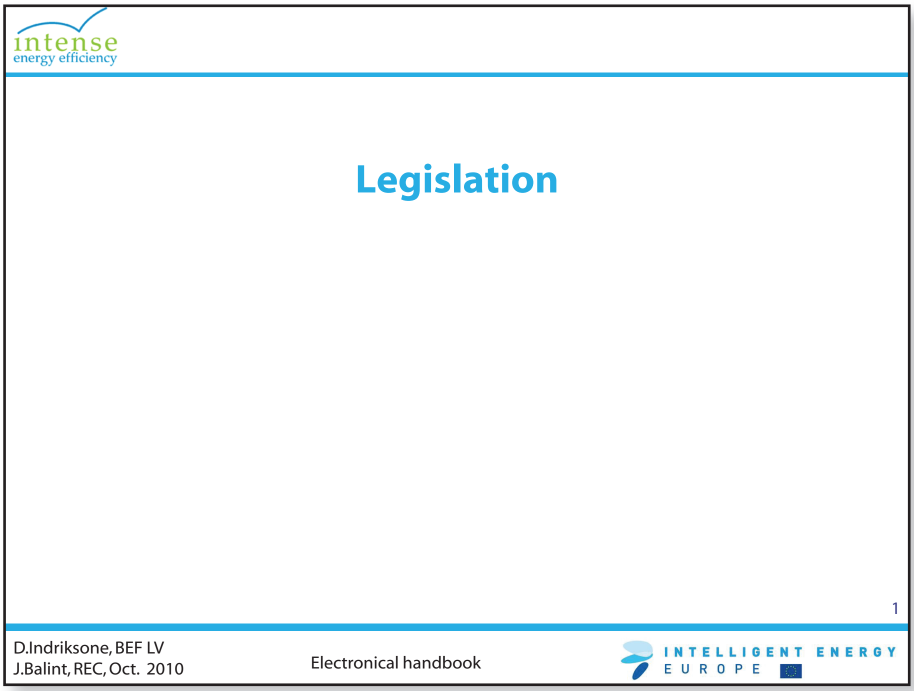
Using and adapting the slides

You are free to use these presentations as a whole or only parts of it in your trainings and you are also free to modify these presentations provided that you give credit to those who have prepared them. In that case we would appreciate a note from you with some information how you have used the slides.

Further information is also available on www.intense-energy.eu

Abbreviations used in this handbook

AC	Air conditioning
A/V	Outer surface to inner volume
BEF	Baltic Environmental Forum
CAD	Computer-aided design
CAPEM	Cycle Assessment Procedure for Eco-Materials
CEE	Central and Eastern Europe
CHP	Combined Heat and Power generation
COP	coefficient of performance
CPC	Compound Parabolic Concentrator
DHW	Domestic hot water
EE	Energy efficiency
EER	Energy efficiency ratio
EC	European Commission
EPBD	Energy performance of buildings directive
EPC	Energy performance certificate
ESD	Energy end-use efficiency and energy services directive
EU	European Union
e.u.z.	energie + umwelt zentrum (energy + environment centre)
GEMIS	Global Emission Model for Integrated Systems
GHG	Greenhouse gas
HR	Heat recovery
HVAC	Heating, ventilation and air conditioning
HVACR	Heating, Ventilation, Air Conditioning and Refrigeration
IEE	Intelligent Energy Europe
INTENSE	From Estonia till Croatia: Intelligent Energy Saving Measures for Municipal housing in Central and Eastern European countries
LCA	Life cycle analyses
LCC	Life cycle costs
LV	Latvia
MS	Member State
PC	Personal computer
PHPP	Passive House Planning (Design) Package
PVC	Polyvinyl chloride
RE	Renewable energy
REA	Riga Energy Agency
REC	Regional Environmental Center
RES	Renewable energy sources
ST	Solar thermal
SWOT- analysis	Strengths, Weaknesses, Opportunities, and Threats analysis
US EPA	United States Environmental Protection Agency



Introduction

Legislation is the main tool applied for many purposes: to regulate, authorize, proscribe, provide (funds), sanction, grant, declare or to restrict. The "Legislation" module is included in the training program because legislation sets the common ground for all activities performed in countries.

For the European policy development, transposition, implementation and enforcement three different levels are important: the European, the national and the regional/municipal level. Once the legal act is adopted at the EU level, the MS are responsible for transposition the provisions into their national legislation and they must ensure that these are effectively applied in practice. For stakeholders at national and local level the most important is national legislation. Nevertheless, local level stakeholders (e.g., architects, engineers, craftsmen, territorial planners) shall be informed about recent provisions adopted by the European Parliament and the Council even if these are not yet transposed into the national legislation.

The following slides reflect the main targets set by the EU Energy and climate change policy as well as the most recent developments in the EU legislation related to buildings, energy end-use and use of renewable energy sources. In the course of presentation it is essential to link this information to the provisions of national legislation.

The content of the module is divided into three steps. It covers the main provisions of legislation derived from the EU directives related to:

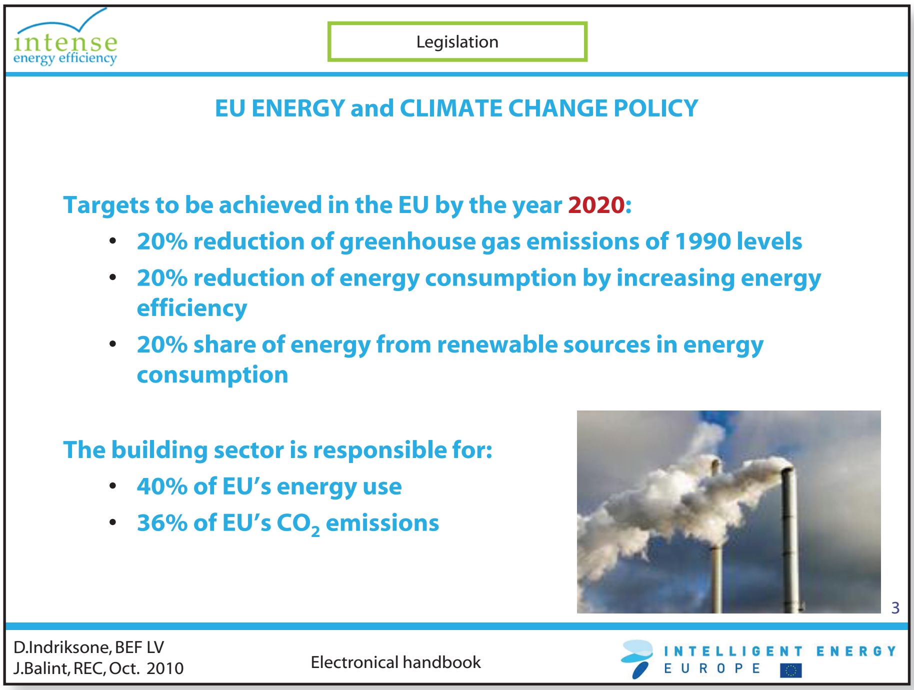
1. Energy performance of buildings
2. Energy end-use efficiency
3. Use of renewable energy sources

Connection to other themes:

Building physics, system engineering, energy carriers, settlement planning, cost benefit assessment, quality control (in the frame of the project's purpose)

Background

- **Directive on energy performance of buildings 2010/31/EU**
  http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:153:0013:0035:EN:PDF
- **Directive on energy end-use efficiency 2006/32/EC**
  http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:114:0064:0064:en:pdf
- **Directive on promotion the use of energy from renewable sources 2009/28/EC**
  http://www.energy.eu/directives/pro-re.pdf
- **Energy efficiency of buildings: glossary of terms in English and 12 national languages**
  http://www.intense-energy.eu/you-are/a-professional



In 2000 the EC launched the European Climate Change Programme to indentify cost effective measures for reducing Greenhouse gas (GHG) emissions. A major step of the EU energy and climate strategy is the EU Climate and Energy Package adopted in 2008, where several targets to be reached by 2020 were agreed upon:

- reduction of GHG by at least 20% of 1990 levels
- increase energy efficiency by 20%
- increase the share of RE in energy consumption to an average of 20%

It is widely known that most existing buildings are energy intensive; within EU they are responsible for ~40% of EU energy consumption and 36% of EU CO2 emissions thus energy efficiency in the building sector will be crucial to reach GHG reduction targets.

Connection to other themes

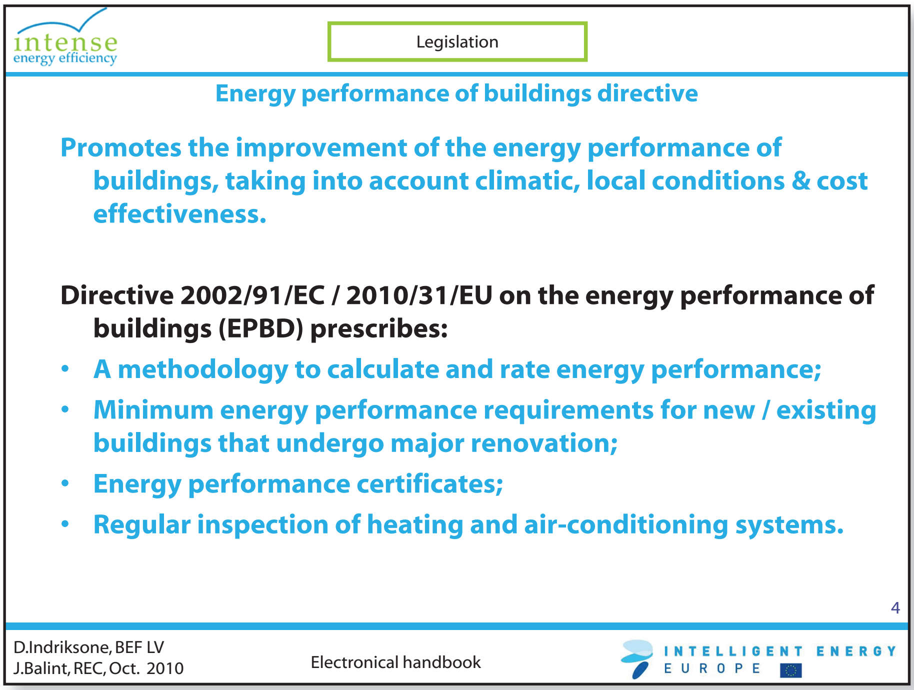
Energy carriers, settlement planning, building physics, system engineering

Background

There is high evidence that human induced climate change is happening. The accelerated melting of ice and snow, the increase in average temperature and sea level, the abundance of extreme weather conditions like temperature increase, heat waves, storms, floods and increased precipitation are all the effects, symptoms of climate change. EU is a frontrunner in taking actions to mitigate the climate change effects.

Suggestions for presentation

Present national targets for energy efficiency, GHG reduction, use of RES and the relevant strategies, guidelines, national/regional/local action plans etc.



The common approach to increase the EE of buildings envisaged by the EC is very challenging. By having adopted the Directive 2002/91/EC (EPBD) and its recast in May 2010 (Directive 2010/31/EU), the EU aims at promoting the improvement of the energy performance of buildings, taking into account outdoor climatic and local conditions, as well as indoor climate requirements and cost effectiveness. Major issues are:

- Introduction of methodology for calculating energy performance of buildings and building units
- Setting, applying and regularly updating minimum requirements to the energy performance of new and existing buildings subject to major renovation
- Energy certification system for new and existing buildings, and for public buildings, where certificates should be displayed in a visible place
- Regular inspection of heating and air-conditioning systems

Connection to other themes:

Quality control, building physics, system engineering

Background

EPBD and its proper implementation is crucial in achieving EU targets - 20% GHG emission reduction and 20% increase of EE. Besides that, EPBD is important in improving our energy security and in creating jobs especially in the building sector.

Suggestions for presentation

Name the main national legal acts related to energy performance of buildings derived from EPBD, point out the role of municipalities.

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Legislation

EPBD recast – improving effectiveness

EPBD recast 2010/31/EU entered into force on 8 July 2010

- **Principles of original EPBD requirements are kept for continuity – but clarified and improved**
- **Provides only framework – gives possibility to MS to adjust implementation to regional /local circumstances**
- **Offers holistic approach towards more energy efficient buildings**
- **Public authorities should play the leading role in the field of energy performance of buildings**

To be transposed in national legislation by July 2012

5

D.Indriksone, BEF LV
J.Balint, REC, Oct. 2010

Electronical handbook

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During the transposition and implementation of the EPBD, EC became aware that some of the provisions and requirements set in the EPBD should be cleared and energy performance requirements should be strengthened. To achieve this, a new version of EPBD, the **EPBD recast** was adopted in May 2010 and MS are requested to transpose the requirements into national legislation by July 2012.

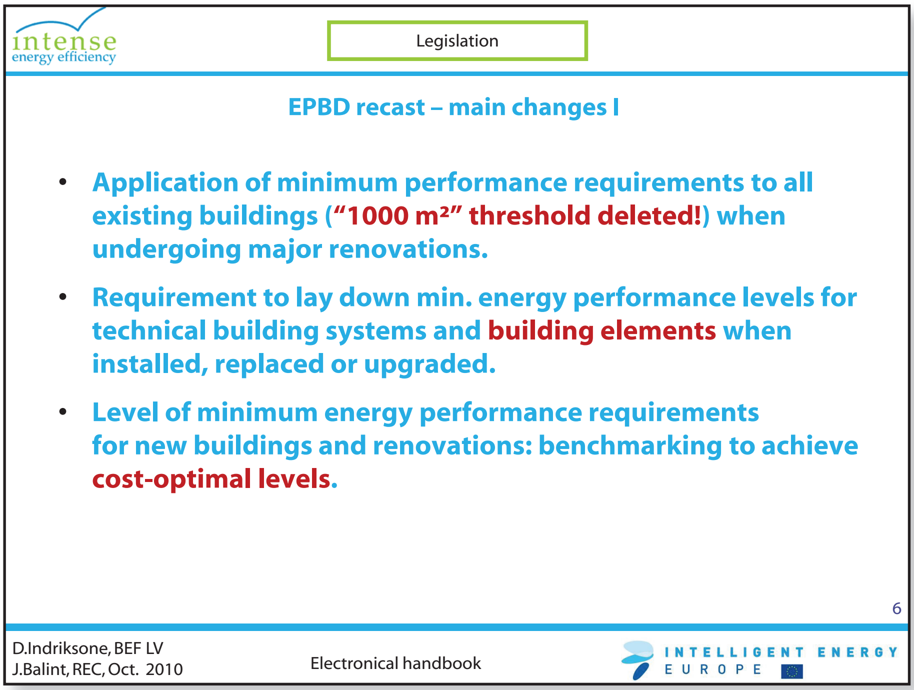
In general principles of the original EPBD requirements are kept for continuity, but clarified and improved. As common, the Directive sets the framework only, thus there is a possibility for MS to adjust implementation to regional /local circumstances. The new Directive offers holistic approach towards more energy efficient buildings. Important aspect – public authorities should play the leading role in the field of energy performance of buildings.

Connection to other themes:

Building physics, system engineering, energy carriers, settlement planning

Suggestions for presentation

Introduce plans to transpose EPBD recast in national legislation; action plans of cities having signed the Covenant of Mayors – where more stringent local policies / targets/ standards might have been introduced supporting EPBD recast. More info about the Covenant of Mayors at: http://www.eumayors.eu.

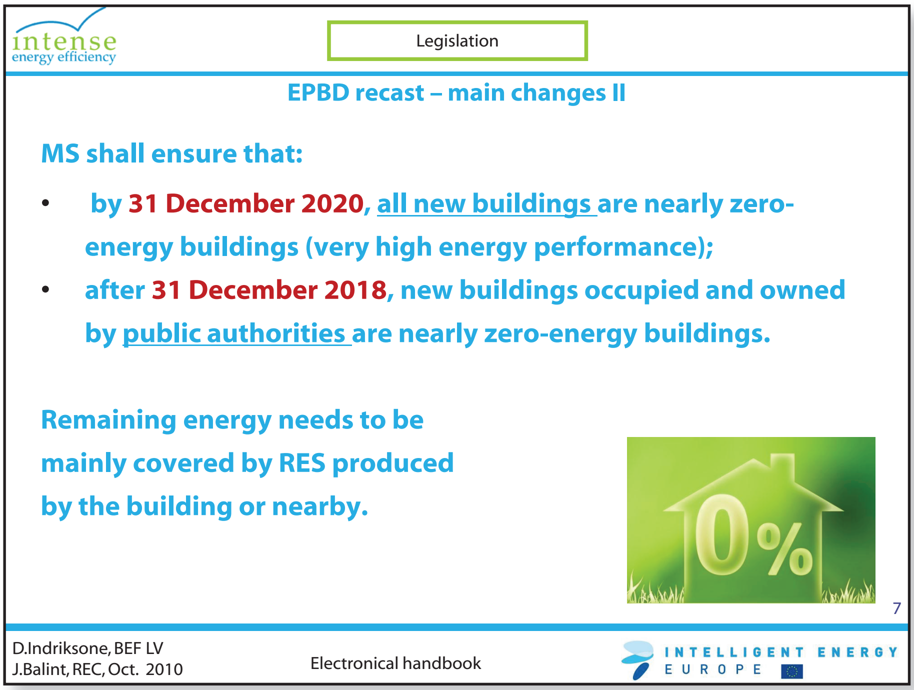


The EPBD recast strengthens several provisions and requirements. Main points of the Directive and differences compared to the previous EPBD are the following:

- MS shall take the necessary measures to ensure that **all existing buildings** that undergo an energy relevant renovation meet minimum energy performance requirements (the 1000m^2 threshold for major renovation has been deleted) in so far as this is technically, functionally and economically feasible.
- Requirement to lay down minimum energy performance levels shall be applied to the renovated building or building unit as a whole. Additionally or alternatively, requirements may be applied to the renovated **building elements**.
- MS shall take the necessary measures to ensure that minimum energy performance requirements for buildings or building units are set with a view to achieving cost-optimal levels. 'Cost-optimal level' means the energy performance level which leads to the lowest cost during the estimated economic lifecycle. The Commission shall establish by 30 June 2011 a comparative methodology framework for calculating cost-optimal levels of minimum energy performance requirements for buildings and building elements.

Suggestions for presentation

Present national legal requirements for setting minimum energy performance requirements, calculation method of the energy performance of buildings.



The Directive envisages new provisions particularly for new buildings:

- All buildings built after 31 December 2020 must be 'nearly zero' energy buildings;
- Public authorities shall play an exemplary role and will have to ensure that all new buildings they own or rent - after 31 December 2018 meet the near-zero-energy standard.

'Nearly zero-energy building' means a building that has a very high energy performance and the nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources, produced on-site or nearby.

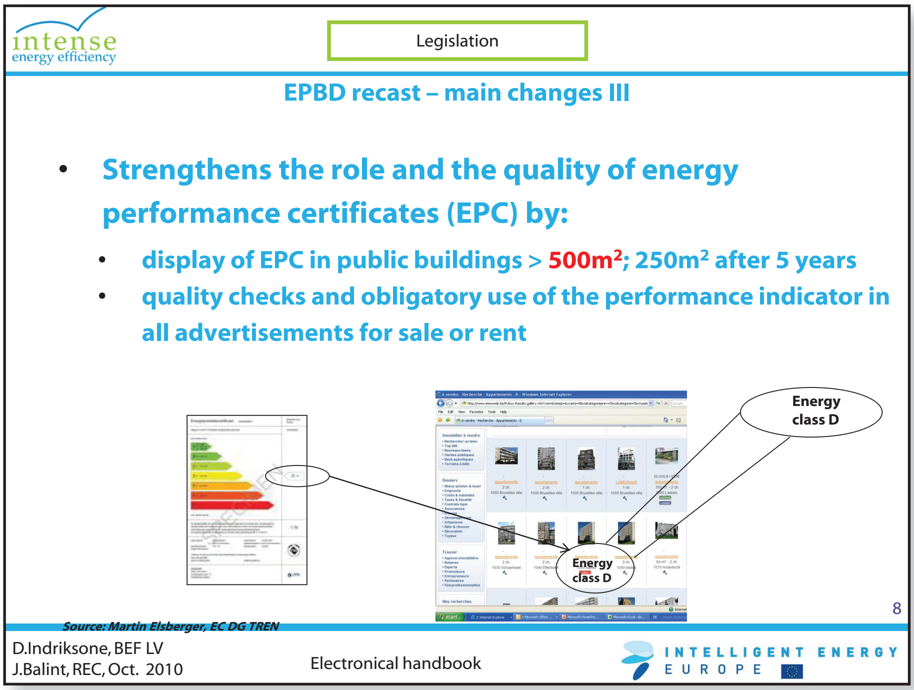
Connection to other themes:

Energy carriers, building physics, system engineering

Suggestions for presentation

Present / discuss national legislation, methodology (if already available) for calculation of the cost-optimal levels, provisions for new and existing buildings

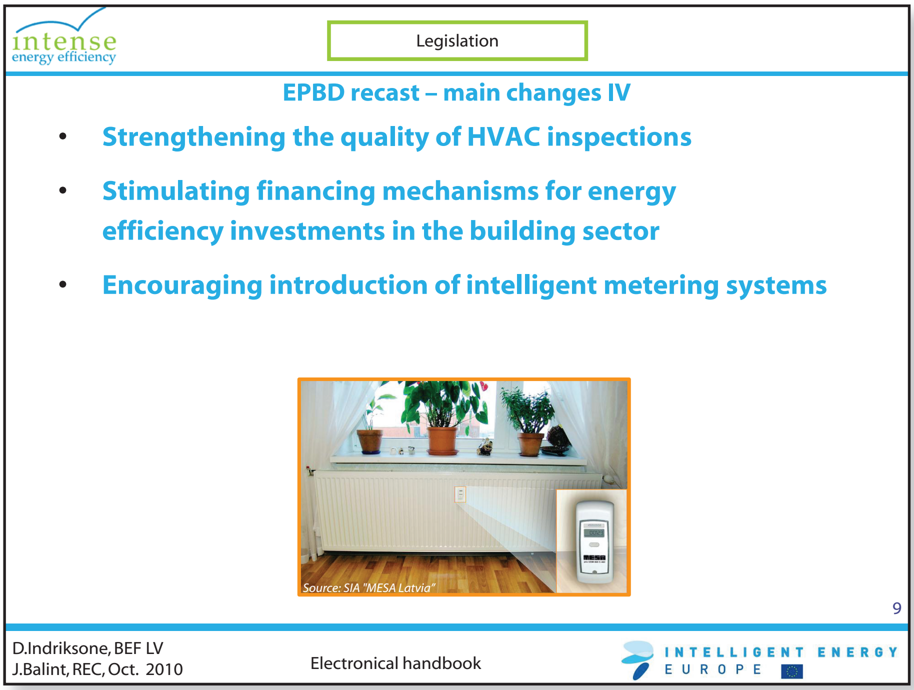
Discuss national system of penalties of non-compliance (if any) in case of not meeting minimum energy performance standards.



A more detailed and rigorous procedure for issuing **energy performance certificates** (EPC) will be required in MS, and a control system should be introduced to check the correctness of the certificates. MS will have to ensure that energy performance certificates are issued for any building constructed, sold or rented out to a new tenant, and also for buildings where a total useful floor area over **500 m²** (1000 m² threshold has been deleted) is occupied by a public authority and frequently visited by the public. Since July 2015 this threshold will be lowered to 250 m². Energy certificates shall be displayed in a prominent place clearly visible to the public. The validity of the certificate – 10 years (provision has remained the same).

Suggestions for presentation

Present requirements for the energy performance certification in the country – who can make energy audits, issue certificates, how to become certified energy auditor. Provide information / register of certified specialists e.g., energy auditors. Give good practice examples from your country where EPC has been displayed. Discuss with participants the main challenges related to practical implementation of EPC.



Additionally Member States have to:

- strengthen the **quality of inspection** of heating and air-conditioning systems;
- draw up national plans for increasing the number of nearly zero energy buildings and by mid-2011, make a list of **financial and other incentives** for the transition, such as technical assistance, subsidies, loan schemes and low interest loans;
- encourage the introduction of **intelligent metering systems** whenever a building is constructed or undergoes major renovation.

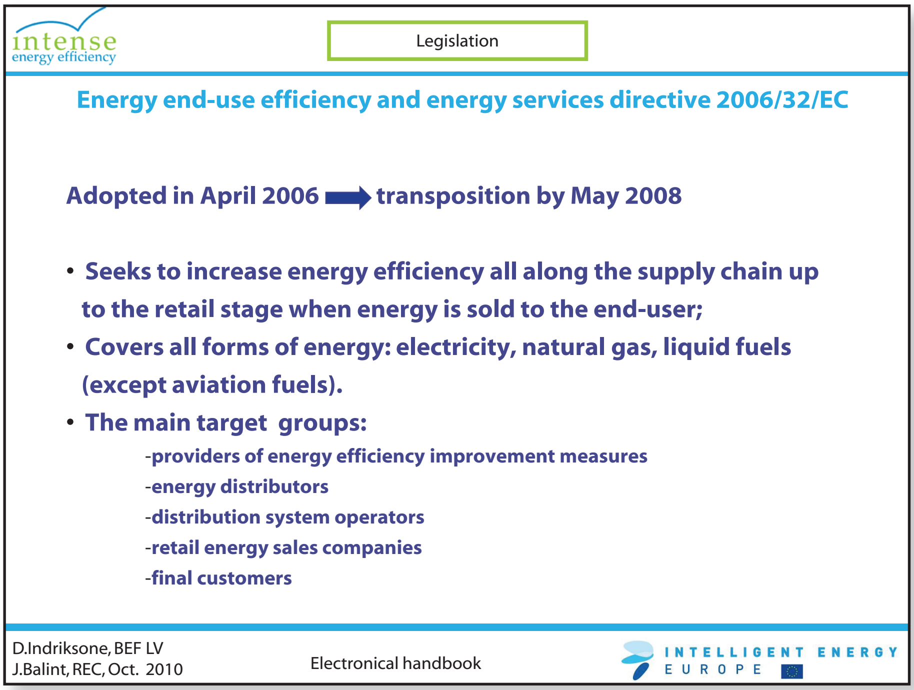
MS will be required to introduce penalties for non-compliance with the provisions of the Directive

Connection to other themes:

System engineering, quality control

Suggestions for presentation

Name national requirements for inspection of heating, air conditioning systems, requirements for reports from inspection, requirements for metering, informative billing of energy consumption. Discuss current experiences with introduction of individual heat consumption metering systems (e.g., heat cost allocators) in the country, successes and challenges. Introduce the EU/national/local funds available supporting implementation of energy efficiency measures e.g., Green Investment scheme.



The Directive 2006/32/EC aims at enhancing the cost-effective improvement of energy end-use efficiency in the EU. MS have to:

- set minimum energy saving targets of 9% to be achieved between 2008-2016;
- prepare national energy efficiency action plans by 2007, 2011 and 2014;
- provide mechanisms, incentives and institutional, financial and legal frameworks to remove existing market barriers and imperfections that impede the efficient end use of energy;
- create the conditions for the development and promotion of a market for energy services and for the delivery of other energy efficiency improvement measures to final consumers.

Connection to other themes:

Cost benefit assessment, system engineering, energy carriers

Background

The Directive contributes to improved security of supply, reduction of primary energy consumption and related mitigation of GHG emissions.

Suggestions for presentation

Name the relevant national legal acts transposing the Directive.

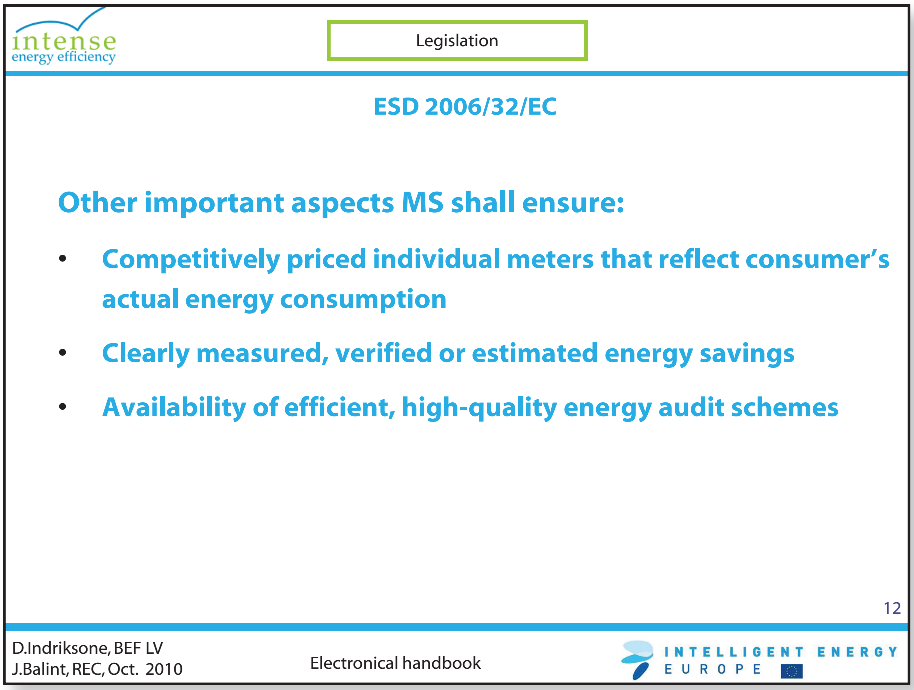
According to the Directive, public sector (including local authorities) shall fulfill the exemplary role in energy efficiency activities. It should set a good example regarding investments, maintenance and other expenditure on energy-using equipment, energy services and other energy efficiency improvement measures. There is a large variety of ways in which the public sector can be "the shining example".

Connection to other themes:

Cost benefit assessment, system engineering, energy carriers

Suggestions for presentation

Indicate how the role of local governments is highlighted in national legislation, what are specific requirements. Provide good examples of local authorities undertaking the exemplary role in the country.



There are also other important provisions set by the Directive. MS shall ensure:

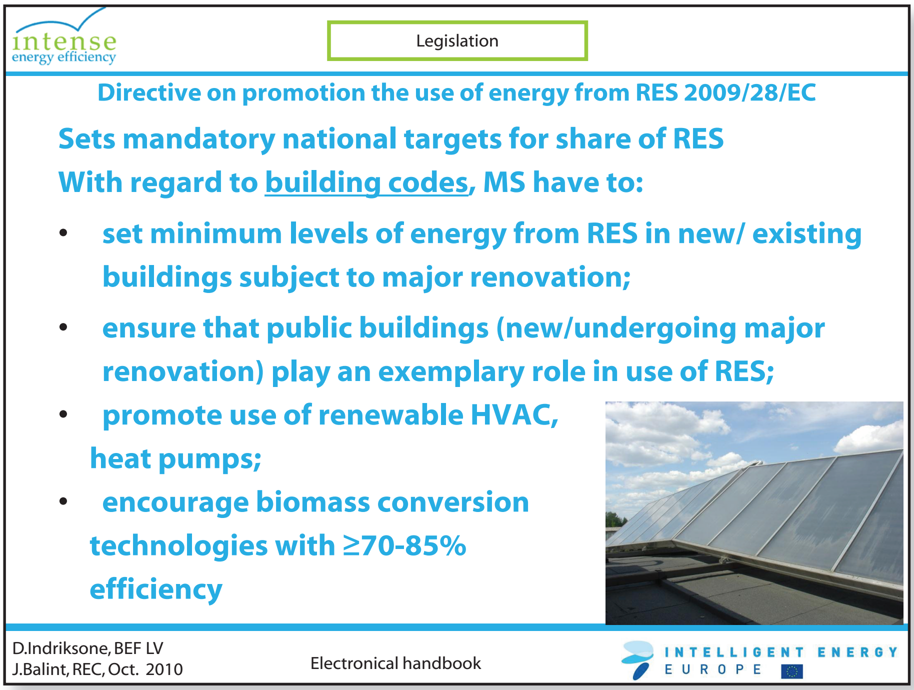
- that final customers for electricity, natural gas, district heating and/or cooling and domestic hot water are provided with competitively priced **individual meters** that accurately reflect the final customer's actual energy consumption. Cost benefit aspects have to be considered.
- energy efficiency improvement measures must result in **energy savings** that can be **clearly measured, verified or estimated**. The Directive gives framework for the measurement and verification of energy savings
- availability of efficient, high-quality **energy audit schemes** which are designed to identify potential energy efficiency improvement measures, and which are carried out in an independent manner, to all final consumers, including smaller domestic, commercial and small and medium-sized industrial customers.

Connection to other themes:

Cost benefit assessment, system engineering

Suggestions for presentation

Name national requirements for data collection, measurement and verification of energy savings, provisions for energy audits in the country, pricing for energy audits.



The Directive establishes a common framework for the promotion of energy from renewable sources (RES). It sets **mandatory national targets** for the overall share of energy from RES in gross final consumption of energy by 2020 (reference year 2005). E.g., for Latvia the 2020 target is 40% (32.6% in 2005). MS shall adopt a national energy action plan, set national targets for the share of energy from RES in different sectors. It sets certain provisions that can influence national building codes. MS are required:

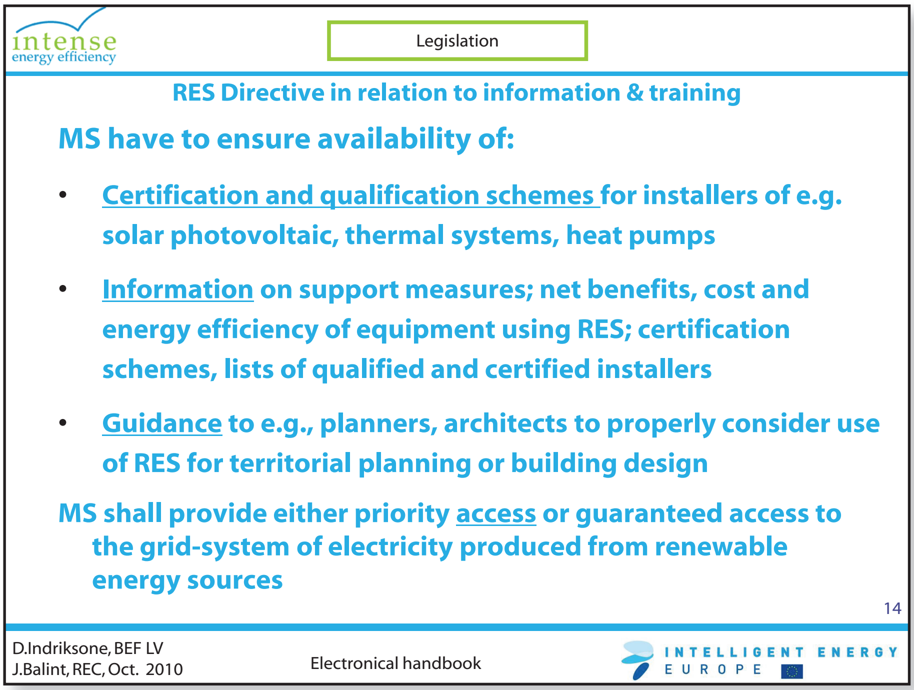
- by 31.12.2014, to set where appropriate **minimum levels of energy from RES** (i.a. through district heating, cooling) in new buildings and existing buildings subject to major renovation;
- to ensure that after 01.01.2012 **new public buildings play an exemplary role** in use of RES (also existing public buildings undergoing major renovation);
- to promote **use of renewable heating and cooling systems** as well as systems that lead to a significant reduction in energy consumption;
- to promote **use of heat pumps** that meet the minimum requirements fulfilling the minimum requirements of eco-labelling;
- to encourage **biomass conversion technologies** with at least 85% efficiency for commercial and residential applications and 70% for industrial applications.

Connection to other themes:

System engineering, energy carriers

Suggestions for presentation

Check national renewable energy action plans, legislation, building codes, if there are particular targets related to construction. Give good practice examples of municipalities using RES in micro-energy generation.



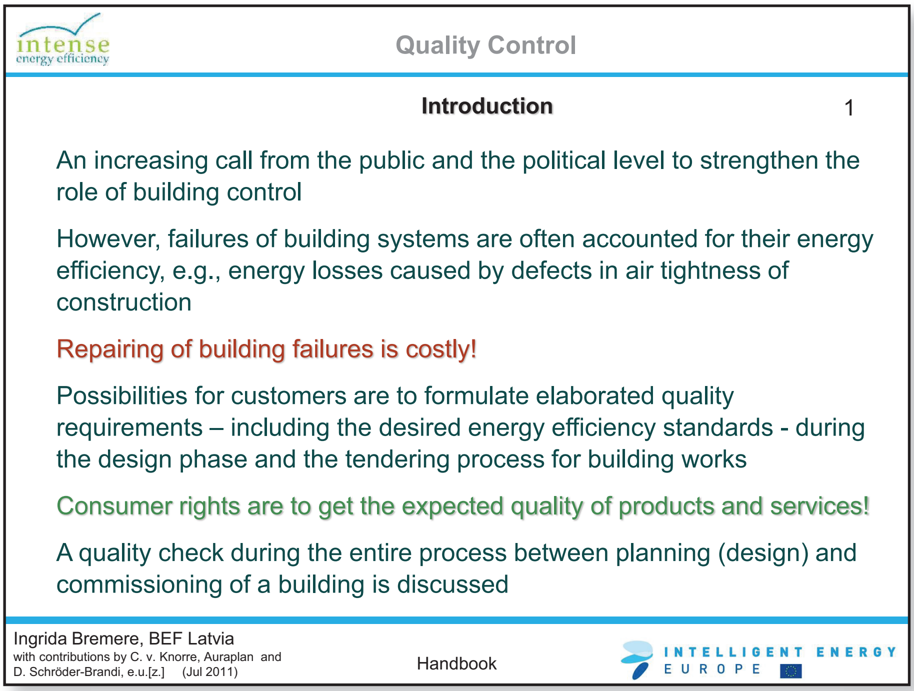
In relation to information and training MS have to ensure that **certification or qualification schemes** are available by 31.12.2012 for installers of small scale biomass boilers and stoves, solar photovoltaic, solar thermal systems, shallow geo-thermal systems, heat pumps. MS also have to make **available information** on support measures to relevant actors e.g., builders, installers, architects, suppliers of RES equipment; net benefits, cost and energy efficiency of equipment using RES for heating, cooling and electricity generation; certification schemes, lists of qualified and certified installers. Also **guidance** has to be available to all relevant actors, notably for planners and architects so that they are able properly to consider the optimal combination of renewable energy sources, of high-efficiency technologies and of district heating and cooling when planning, designing, building and renovating industrial or residential areas. MS shall provide for either **priority access** or **guaranteed access** to the grid-system of electricity produced from renewable energy sources.

Connection to other themes:

System engineering, energy carriers

Suggestions for presentation

Check if any support schemes, guidance in the country are available for use of RES in micro-generation, lists of certified installers, requirements for certification and qualification. Check national legislation for opportunities to sell energy from RES to grid. Check national renewable energy action plan for additional information.



An increasing call from the public and the political level to strengthen the role of building control is associated with the transformation of the European building sector towards higher energy efficiency (refer to the Background).

Building works are meeting certain essential standards of construction safety. However, failures of building systems are often accounted for their energy efficiency. Inefficient constructions will have an implication on energy consumption during the whole operational period (30-50 years of its lifespan).

Repairing of building failures by the reconstruction and/or retrofitting during the operation stage requires additional costs and may also create dissatisfaction and disappointment. Therefore, it is widely accepted that it is cheaper and more efficient to address the energy efficiency of buildings at the construction stage.

Possibilities for customers are to formulate elaborated quality requirements – including the desired energy efficiency standards – during the design phase of the building and the tendering process for building works.

The customer has rights to get the expected quality of products and services.

A quality check during the entire process between planning (design) and commissioning of buildings is discussed in further slides.

Background:

Buildings are responsible for 40% of energy consumption in EU. Energy performance of buildings is a key to achieve the EU Climate and energy objectives. Thus the EPBD (2002/91/EC and 2010/31/EU) is setting main requirements to achieve energy performance of buildings.

http://ec.europa.eu/energy/efficiency/buildings/buildings_en.htm

Connection to other themes: Legislation

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Quality Control

Facets of quality 2

Quality = achieving customer satisfaction	Quality = excellence in implementation
Requirements and customer demands change with time Requirements set by pre-defined building standards (mandatory), or, customer "wish" for better standard in energy efficiency than required by law (voluntary)	Aims to operate without defects or errors Standards contained in specifications, as they are planned and designed Performance monitoring and verification procedures to make all operations error-free
Quality Assurance & Management	**Quality Control**

Ingrida Bremere, BEF Latvia
with contributions by C. v. Knorre, Auraplan and D. Schröder-Brandi, e.u.[z.] (Jul 2011)

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It is essential to consider the "Quality" from its two facets:

Quality is equated with achieving customer satisfaction. Here the requirements and customer demands will change with time. National energy performance requirements will form a baseline for the quality of a building. Member States shall set minimum requirements for the energy performance of buildings, but these may differentiate between new and existing buildings as well as different categories of buildings. Customer may wish for better standard in energy efficiency than required by law. The requirements shall account for the cost optimal balance between the investments needed and the energy savings throughout the life-cycle of the building.

Quality Assurance is looked so, that the quality requirements for a product or service will be fulfilled.

Quality is defined as an excellence in implementation. The aim is to operate without defects or errors throughout the implementation process. Standards will be reflected in specifications as they are planned and designed. Performance monitoring is carried out and procedures for verification are set to make all operations error-free.

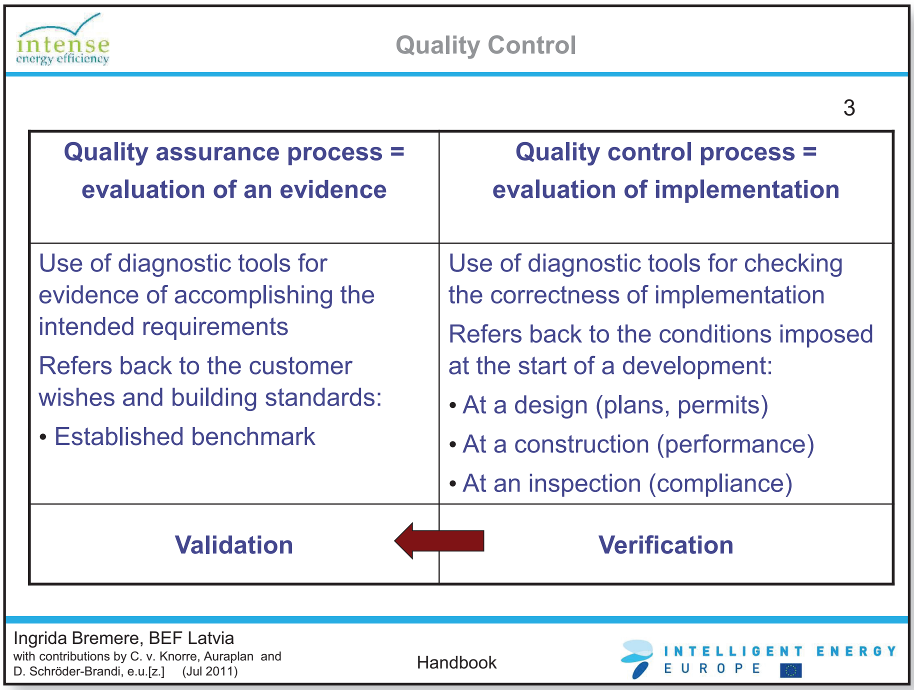
Quality Control is looked as the observation techniques and activities used to fulfil the requirements for quality.

In the building construction sector, the design task shall set the quality requirements to be fulfilled. The Quality Control shall start with the design task.

Connection to other themes: Legislation

Suggestions for presentation:

In order to highlight the situation in your country, please include the information on national energy performance requirements in this presentation.



Quality assurance process is seen as evaluation of an evidence. The quality assurance schemes are advisable to include into the planning of the building. Quality assurance and management ensures that quality aspects are handled at the front-end rather than at the back-end of a building project. Diagnostic tools (e.g., "Blower door" test) are used to obtain the evidence (quantitative) of accomplishing the intended requirements. Quality assurance process refers back to the customer wishes and building standards. Customer defines the quality requirements at the start of the process, but, the quality required by the customer is measured in the end product – the completed building. So, the quality assurance shall be kept through-out the building process.

Validation of a certain quality corresponding to the established benchmark is a documented process (systematic and reproducible) for reaching the quality commitments.

Quality control process is seen as evaluation of implementation. This includes the observation techniques and activities to fulfil requirements for the quality. Diagnostic tools (e.g., thermography, "Blower door" test) are used for checking the correctness of implementation (qualitative). Quality control refers back to the conditions imposed at the start of development. Customers increasingly expect and demand for quality of a building, and this require comprehensive control of the quality and standard of work.

Verification of compliance with the quality norms or standards is performed at the design phase by assessment of building plans and approval of building permits, at the construction phase by monitoring the performance, and, at the inspection phase by certification of compliance.

In building sector, the quality control and verification of compliance is a key to the validation for the quality of the established benchmark.

Connection to other themes: Legislation

Assessment of building plans is a necessary step to eliminate any source of conflict caused by errors and discrepancies in the construction documents.

Obligatory building permission procedure requires conformity check with legal requirements. In many of EU countries, building plans are required to be approved by the building authority (state or local level). Some countries also permit approval of building plans by private independent experts (source: Building Control Report, May 2010, www.cebc.eu/files/reports/CEBC_BCR3_web.pdf).

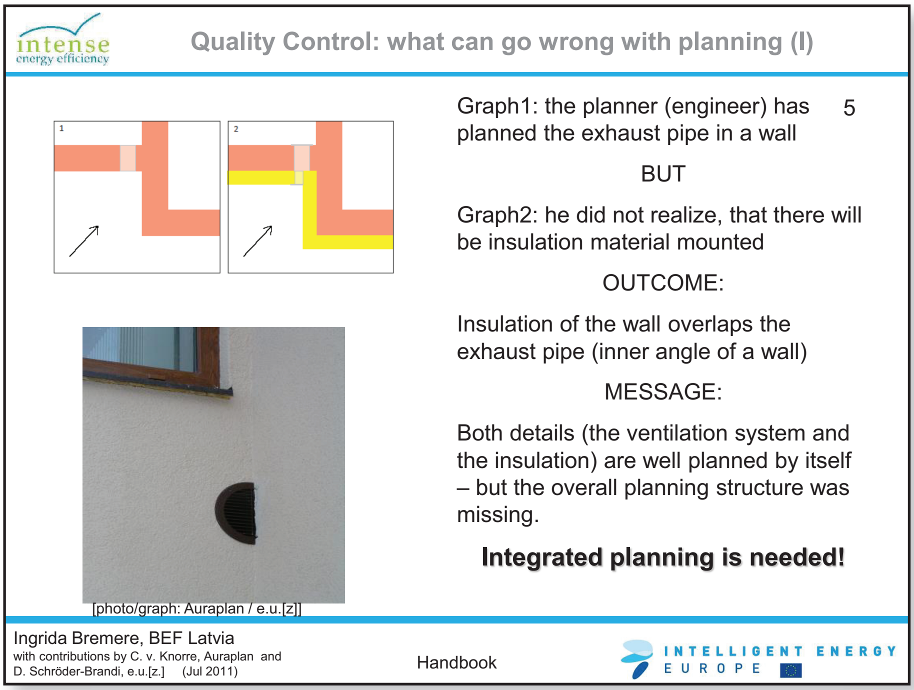
The purpose for assessment of building plans is to achieve compliance of building work with the overall project objectives. Documents are reviewed for clarity, consistency, completeness and ease of construction.

Aim of the quality control is to eliminate discrepancies in construction documents. Architectural, structural and engineering plans are compared to make sure that they agree. An integrated planning of a building could correct simple planning mistakes. Records of the assessment process will ensure effective and continuing control over the design and executed work.

Connection to other themes: Legislation, Settlement planning

Suggestions for presentation:

In order to highlight the situation in your country, please include the information on the building permission procedure and national building regulations in this presentation.



What can go wrong with the planning?

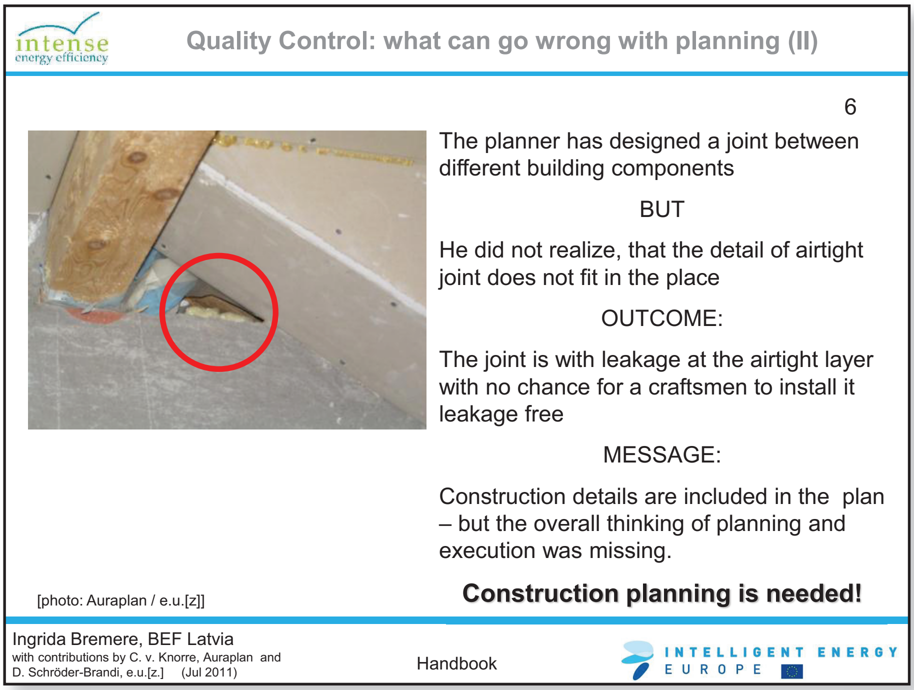
In the shown example the planner (engineer) did not realize, that after installing the exhaust pipe (graph 1) there will be insulation material mounted (graph 2). Insulation of the wall overlaps the exhaust pipe (well seen on the photo). The function of the ventilation system is now affected and this influences the capacity of air exchange.

This example shows a consequence of an isolated view on technical details. Both details were well planned - the ventilation system as well as the insulation – but there was no sufficient control over the planning of all construction. Therefore integrated planning approach is needed!

Connection to other themes: Building physics, system engineering

Suggestions for presentation:

If you have another positive or critical example on the integrated planning of a building from your country, please consider adding it to the presentation



What can go wrong with the planning? – another example

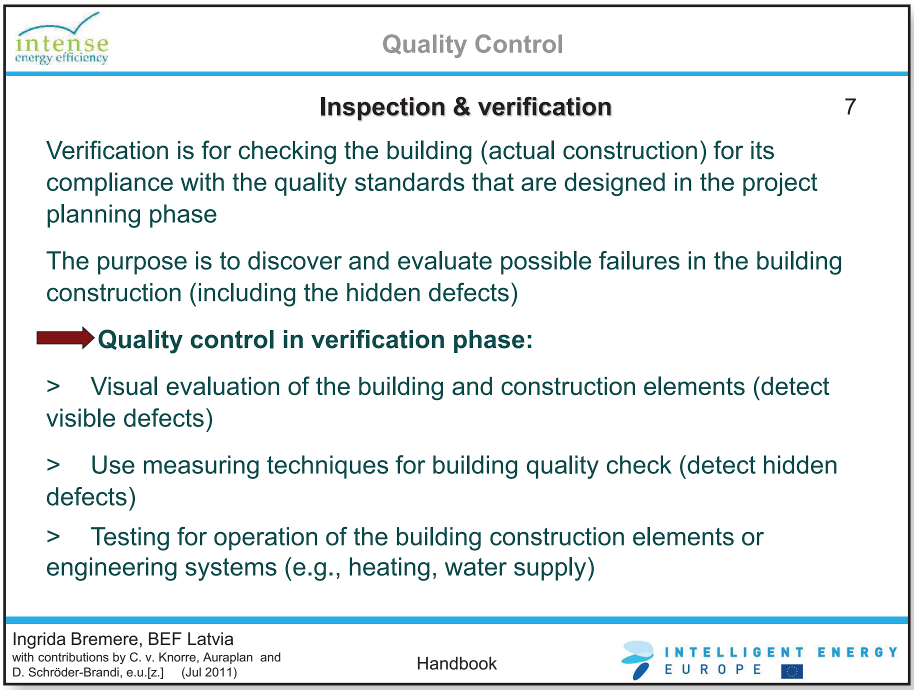
In this example the planner has designed a joint between different building components, but he did not realize, that the detail of airtight joint does not fit in the place. The joint is with leakage at the airtight layer. There is no chance for the craftsmen to install it leakage free.

This example shows a consequence of a poor thinking from different angles – planning and execution. Construction details have to be thought over that there is no gap between planning and execution. The design of the building construction must be installation friendly. Therefore the quality control over the construction planning is needed!

Connection to other themes: Building physics, system engineering

Suggestions for presentation:

If you have another positive or critical example on the construction planning of a building from your country, please consider adding it to the presentation.



Quality control by inspection and verification of the building at its actual construction is for the checking of compliance with the quality standards that were designed in the project planning phase. The purpose is to discover and evaluate possible failures in the building construction.

Quality control in verification phase can be three-fold:

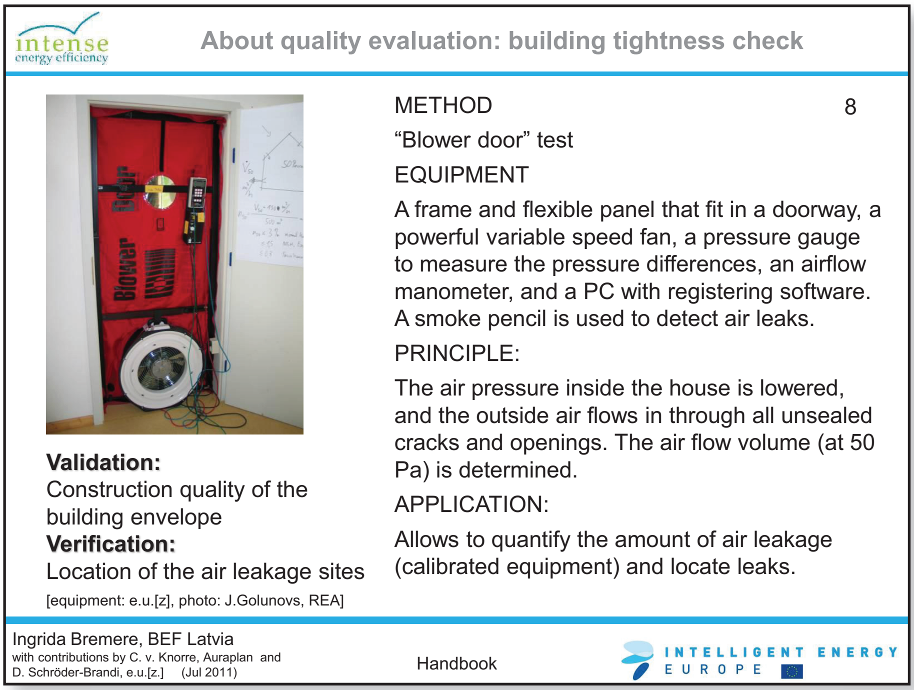
Visual evaluation of the building and construction elements will help to detect visible defects. Severe defects in construction elements can be dangerous. Possible fall of a construction element may result in physical injury or damage to people or property.

Detection of hidden defects is mostly possible by using of measuring techniques for building quality check. Hidden defects usually present no increased risk of injury or damage, however, these cause harm to the property owner in the form of loss of use, diminished value, increased maintenance and operational costs and additional expenses needed for repairing of building failures.

Testing for operation of the building construction elements or engineering systems is used to make certain the proper functioning e.g., of heating system, water supply.

Suggestions for presentation:

If you possess an information on the country specific approaches for inspection and verification, please consider adding it to the presentation.



A "Blower door" test can be applied for validation and verification of the building construction quality.

Brief description of the equipment, principle of the method and application are indicated on the slide.

Background

"Blower door" technology was first used in Sweden (1977). The name comes from the fact that this technology uses a fan (i.e., blower) mounted in a door (source: M.Sherman, http://epb.lbl.gov/blowerdoor/BlowerDoor.html)

Air exchange coefficients are determined for buildings of different energy efficiency standards. For passive house air exchange coefficient (n50) shall not exceed 0.6 h^{-1}. (source: Energy efficiency of buildings: A Glossary, www.intense-energy.eu/you-are/a-professional/)

Air exchange coefficient can be defined by national legislation in countries by national building codes.

Connection to other themes: Legislation, building physics, system engineering

Suggestions for presentation:

In order to highlight the situation in your country, please include the information from national building codes in this presentation.

If you have a possibility for practical demonstration of the "Blower door" test, please consider organizing a separate session in the training course.

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About quality evaluation: check for hidden defects

Validation:
n/a
Verification:
Location of hidden defects in the building, e.g., damaged or insufficient insulation, moist constructions, cracks

[photo: J.Golunovs, REA]

METHOD 9

Building thermography

EQUIPMENT

A remote-sensing survey is carried out using an infrared camera: specially designed electronic device that detects thermal radiation, converts the radiation into thermal images (thermograms) and displays the images in full color on a view screen.

PRINCIPLE:

All surfaces radiate invisible heat energy and variations in the thermal properties of building structures cause variations in surface temperature that is recorded.

APPLICATION:

Surveys to conduct building inspections. Professional interpretation of results is required.

Ingrida Bremere, BEF Latvia
with contributions by C. v. Knorre, Auraplan and D. Schröder-Brandi, e.u.[z.] (Jul 2011)

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A building thermography can be applied for the verification of the building construction quality. This method in its usual application mode does not provide quantitative results and therefore is not suitable for validation purposes.

Brief description of the equipment, principle of the method and application are indicated on the slide.

Background

Building thermography is a method used for indicating the heat distribution over the surface of a building envelope. It is possible to get a qualitative detection of thermal irregularities in building envelopes.

Although, infra-red camera can be easily obtained for use, it is strongly recommended to look for professional thermographer to carry out the test. The professional judgement is required to differentiate between real faults and other sources causing variation in temperature. Inspections of outer surfaces may be influenced by radiation emissions and reflections from e.g., adjacent building or a cold clear sky, or the heating effect that the sun may have on a surface.

Connection to other themes: Building physics, system engineering

Suggestions for presentation:

If you have a possibility for practical demonstration of the building thermography test, please consider organizing a separate session in the training course.

intense energy efficiency

Quality control

10

Third party verification = the persons responsible are independent from those carrying out the building work	**Self confirmation/ certification =** confirmed by the persons who carry out the work
☺ *) independent confirmation *) no risk to come under commercial pressures ☹ *) may cause delays and will add to the cost	☺ *) reduce regulatory burden *) increases control over individual structural elements (e.g., windows) ☹ *) fragmented responsibility, not defined for the building as a whole
By: Building Authority (municipality, state), or private independent expert	By: trained architects, engineers, carpenters, electricians, etc.

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Building quality control can be performed either through independent inspections (third party verification) or persons who carry out the construction works (self confirmation). Each country in Europe has its legislation how the compliance with building standards shall be ensured and verified.

Third party verification is an independent confirmation that the works satisfy relevant requirements. Independent building control body does not risk coming under commercial pressures. However, this form may cause delays to the work and will add to the cost of construction.

Third party verification is usually performed by state or municipal building authority, or private independent expert.

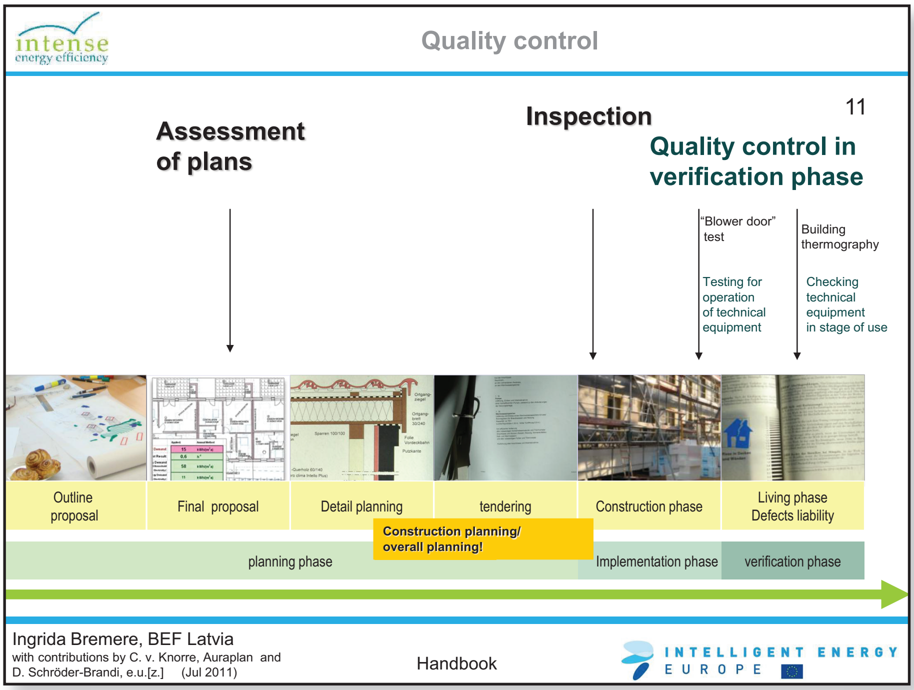
Self confirmation is used to reduce regulatory burden and bureaucracy in countries. Benefit of self confirmation is wider control over individual construction elements by person carrying out the work. Self confirmation can be applied at various stages of a construction project – at the design stage, during construction or at completion of the work. However, drawback of this approach is fragmented responsibility. Therefore assessment of the building as a whole by a third party verification is considered essential.

Self confirmation is performed by trained persons (architects, engineers, craftsmen) who are approved to self confirm their work.

Connection to other themes: Legislation

Suggestions for presentation:

Please indicate the information on how the verification systems operate in your country.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energy efficiency
Quality control
11
Assessment of plans
Inspection
Quality control in verification phase
"Blower door" test
Building thermography
Testing for operation of technical equipment
Checking technical equipment in stage of use
Outline proposal
Final proposal
Detail planning
tendering
Construction phase
Living phase Defects liability
Construction planning/ overall planning!
planning phase
Implementation phase
verification phase
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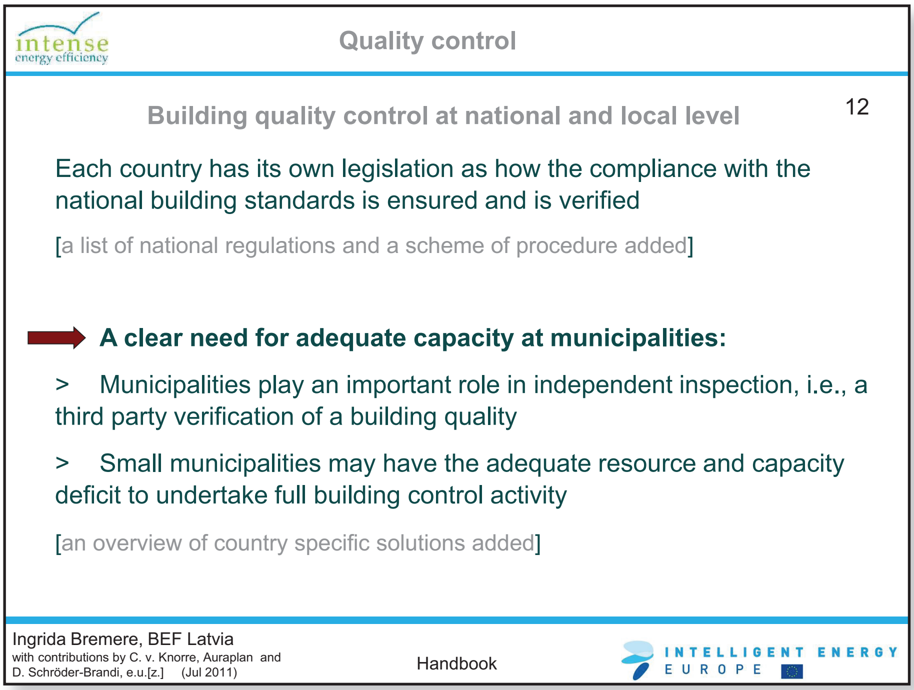


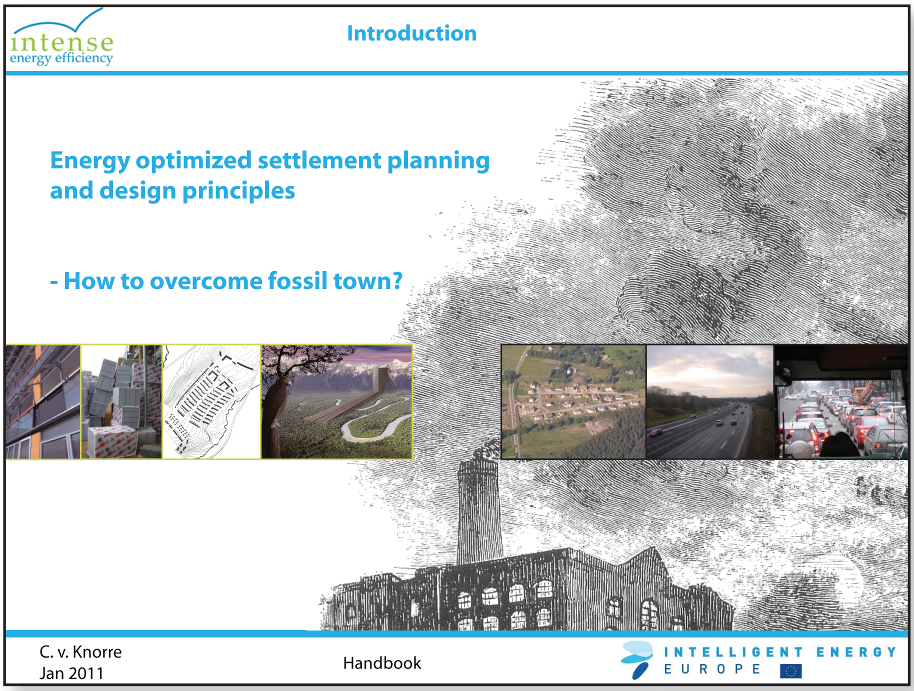
Role of municipalities in building quality control process is defined by national legislation.

When municipalities are aassigned a role of third party verification, there is a clear need for adequate resources and capacities from municipalities to fulfil duties of building quality control and verification. Different examples from various countries are presented in literature (source: Building Control Report, May 2010, www.cebc.eu/files/reports/CEBC_BCR3_web.pdf).

Connection to other themes: Legislation

Suggestions for presentation:

Please indicate the information on how the verification systems operate in your country.



How to overcome fossil town?

What can be the part of planning and designing settlements?

How can development be influenced by municipalities and planners?

Of course it is not possible to find one simple ideal answer that fits for all planning tasks. The best solution for energy optimizing would be the one, which leads to a livable place where people like to live for generations. This means to find compromises between manifold aspects: social economic, aesthetic, functional, technical ...

In the frame of this training it is not possible to cover the art of planning and designing. But it is possible to show existing examples of good solutions and to help to analyze the "making of"and to characterize the main aspects leading to energy optimizing.

More about examples for the "making of " municipal steering instruments,see background paper - http://www.intense-energy.eu/uploads/tx_triedownloads/INTENSE_HolisticPlanning_BG_062009.pdf)

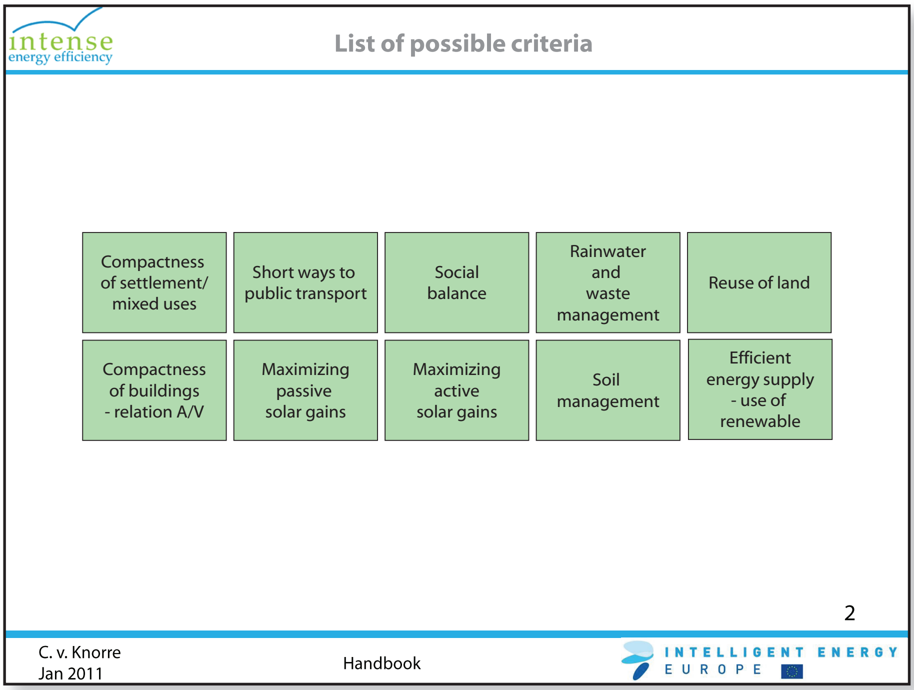
This means to simplify the complicated planning and designing process. Such a useful simplification is the identification of 10 main aspects, see slide 2.

Connection to other themes:

Legislation, energy carriers and renewable energy sources, quality control

Suggestion:

As next step we suggest a small planning and designing exercise: the task to find a scenario for energy optimized settlement, realization in near future for an exact defined plot. Task is to react to the requirements of this special plot but to integrate as much aspects as possible.



As useful simplification: the whole list of criteria for energy optimized settlement planning:

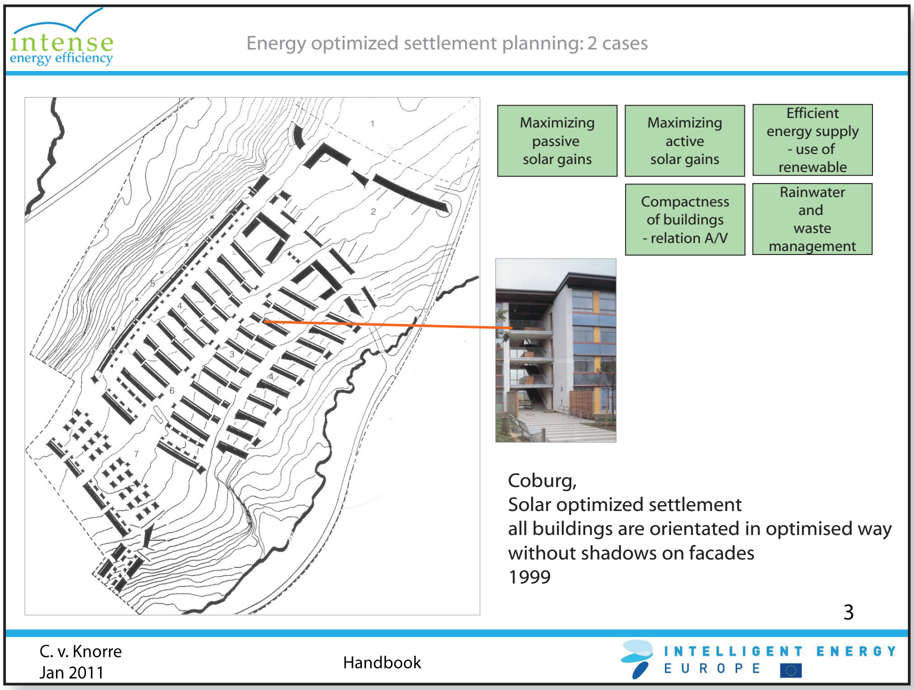
- The compactness of the settlement, short ways to places of interest or working places;
- Short ways to public transport;
- Social balance to get a sustainable living quality for generations;
- plots to realize low energy or passive houses;
- minimizing heat losses: presetting compact building types with good relation A/V (outer surface to inner volume);
- maximizing passive solar gains: good grouping of houses to avoid shadow at the facades;
- maximizing active solar gains: good orientation of roofs or providing areas for direct use of sun energy;
- providing use of district heating: use of renewable as much as possible;
- Minimizing harm to the environment: reuse of land if possible;
- If new settlement: soil management - good use of soil, avoiding big transfers of materials;
- Rainwater management;
- Waste management.

Some more figures as background information:

Some aspects of energy saving urban planning should been proved during the planning process for generating energy savings with low efforts, only by optimizing the form and orientation of buildings. The potentials of measures can be estimated as follows:

1. compactness: difference of energy consumption between multi storey house and 5 row houses, both with similar energy standard: 20%
2. orientation: difference of energy gains between 5 houses with a bad orientation compared with a optimized orientation: 15%
3. passive solar gains, no shadows: difference between solar gains of a row of 5 houses without any shadow at the facade and the same row with shadow at the facade: 10 %
4. optimised roofs for active solar use: difference between solar gains of a optimized orientation of a roof and a bad orientated roof for the use of solar panels for hot water supply: 10 – 15%

See: UVP Handbuch der Stadt Köln Amt für Umweltschutz und Lebensmittelüberwachung/
Dr Goretzki/eboek Köln 1998



Two different cases may help to distinguish manifold ways to come to solutions for energy optimized settlement planning and designing.

Coburg solar optimized settlement is the one where it is easy to identify the main aspect at one glance: energy saving by maximizing active and passive solar gains.

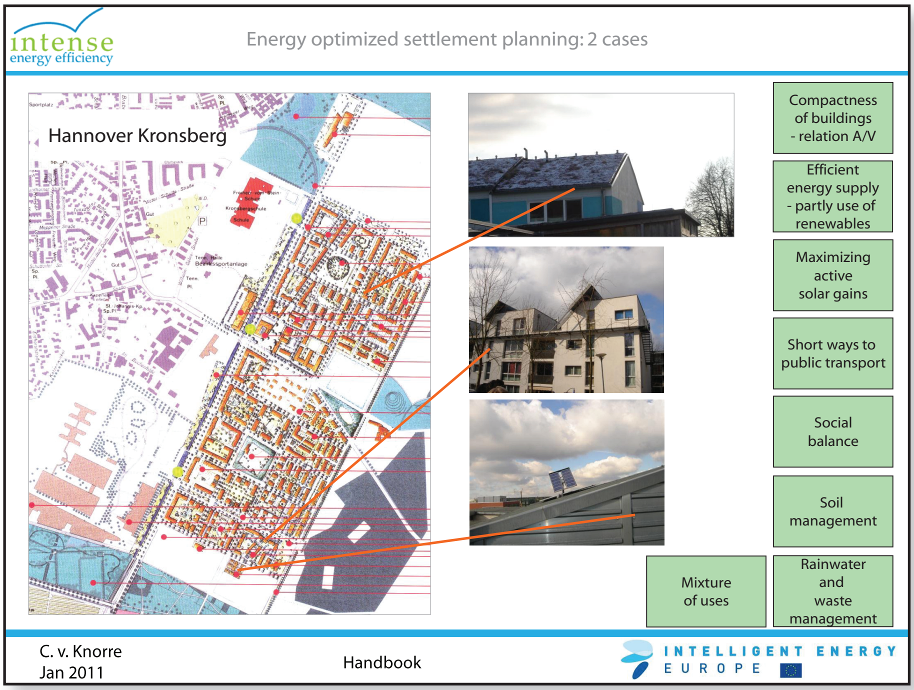
Long rows of multi storey residential houses where orientated strictly to the south west. This focus on orientation can be followed also in the zoning of rooms in the floor plans.

The energy support is partly covered by solar power: solar thermal panels for warm water and heating and photovoltaic panels for electricity.

One further aspect is the compactness of buildings. Heat losses via building envelope where minimized by simple compact forms of buildings and by grouping stair cases outside the heated volume, see picture.

What cannot be recognized at first glance are special efforts for rain water management - rain water is collected on surface and not swallowed in by any drainage.

For more information about the project see:
http://www4.architektur.tu-darmstadt.de/powerhouse/db/248,id_93,s_Projects.en.fb15
key word solar house Coburg



In opposite to the first example, for Hannover Kronsberg it is not soeasy to find the main aspects at the first glance. The plan looks not very special, the whole efforts to create an energy optimized sustainable settlement can only be found by taking a closer look.

No aspect is much stronger than the others.

Flats are grouped in residential or row houses to minimize losses via building envelope. They are mainly orientated in east west direction. Partly there are special efforts to prepare roofs for solar applications, for warm water and heating, see second photo.

Via land sale contracts energy standard for low energy houses and passive houses was fixed, see picture 1.

Energy supply is covered with cogeneration plants and supported by renewable, wind and solar power.

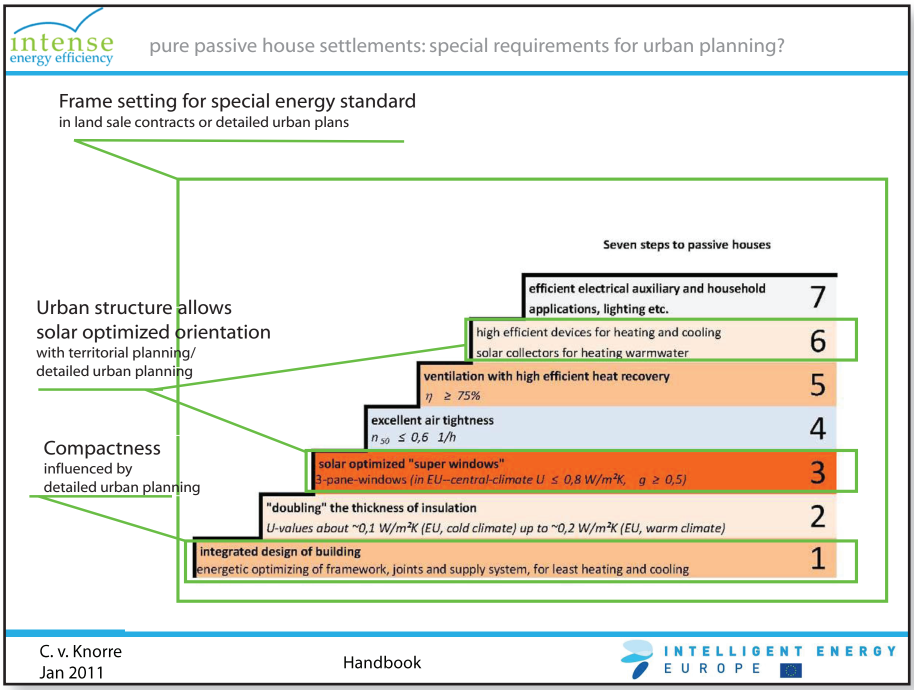
In order to come to the holistic approach of the whole settlement:
A new tramline was constructed, the blue line, so that all parts of the Kronsberg got short ways to public transport. Some efforts were done to mix functions: along the main street with the tram line are located shops and offices. In the near surroundings big companies offer working places.

The settlement is equipped with all kinds of infrastructure, shops for daily use, schools, kindergarten and meeting rooms for different activities.

A mixture of sizes and types of flats should guarantee a good social balance.

Efforts for soil, rainwater and waste management are done,

For more information see:
http://www.oekosiedlungen.de/kronsberg/steckbrief.htm, in German
short description in backgroundpaper page 22 ff



Which one of the typical „seven steps to passive house" has a linkage to urban planning/settlement planning?

Most of the typical measures to fulfil passive house requirements had to be undertaken on site and did not attract the neighborhood, like the doubling of insulation or the ventilation system. But the orientation to optimize active and passive solar gains are very important and in phase of design, the compactness had to been optimized, see the three small green boxes.

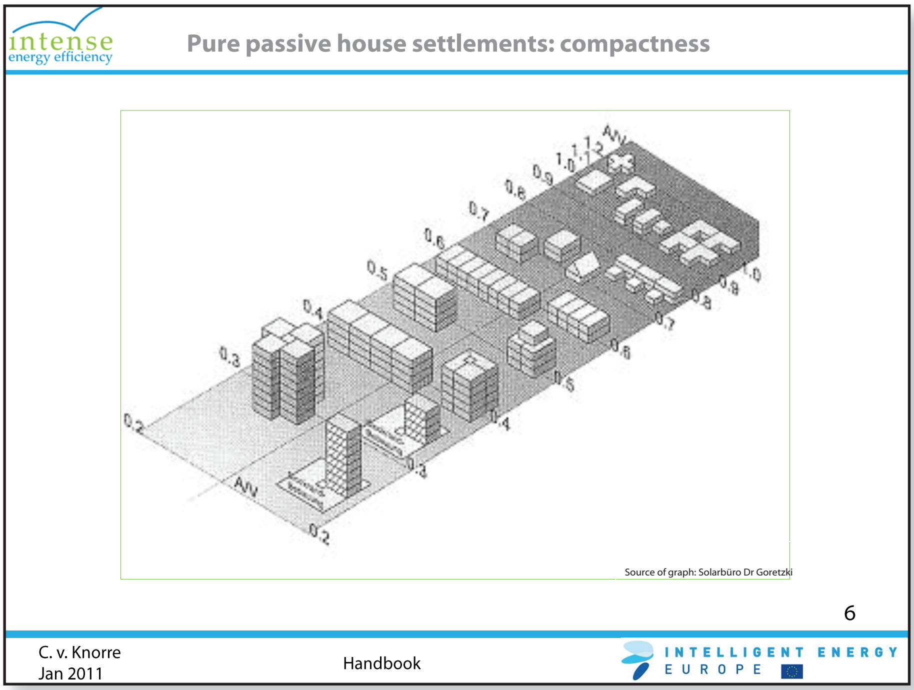
(about compactness see next slide)

If one house should fulfil passive house standard, the site had to be checked, if the orientation can be optimized. If a whole passive house settlement had to be planned, it had to be checked in frame of territorial planning, if the sites allows goop orientation for the settlement. With detailed plans, the best orientation can be fixed.

(About solar orientation, see over next slide)

The big green box indicates the possibility of urban steering instruments to set an energy standard for a new settlement (national standard -30% or passive house standard, plus certification) The best possibility can be to use land sale contracts to fix these special standards.

More about examples for the "making of " municipal steering instruments, see background paper (link: http://www.intense-energy.eu/uploads/tx_triedownloads/INTENSE_HolisticPlanning_BG_062009.pdf)



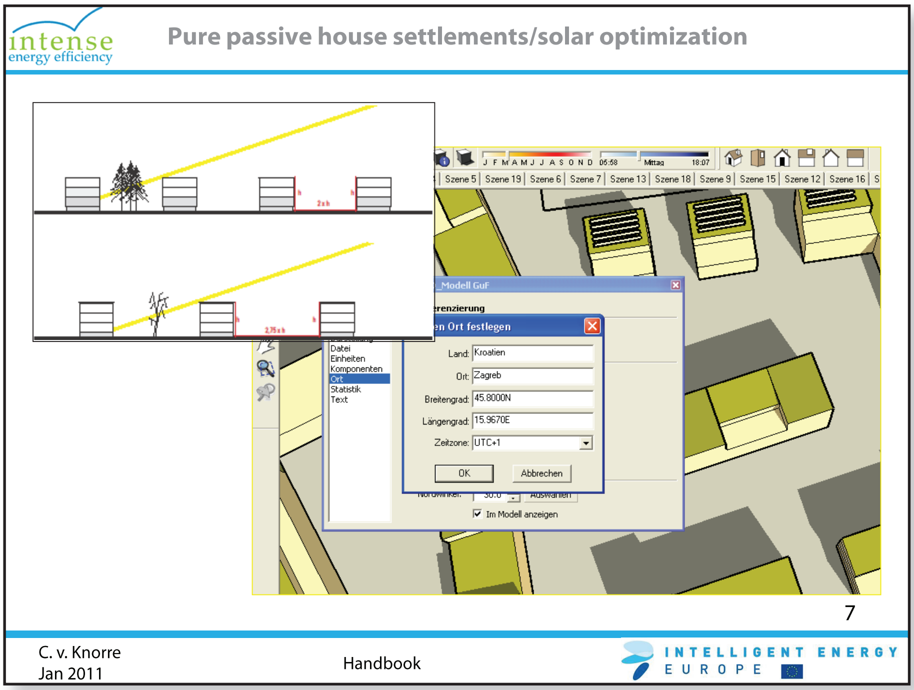
This graph shows typical A/V relations (relation of outer surface to heated volume) of buildings.

The smaller the figure, the better the ratio, the more easy to optimize the building envelope.

It is easy to see, how these figures changes from detached houses, from houses with complicated forms to very simple formed multi storey houses.

The best ratio is easy to find at the biggest, simplest building.

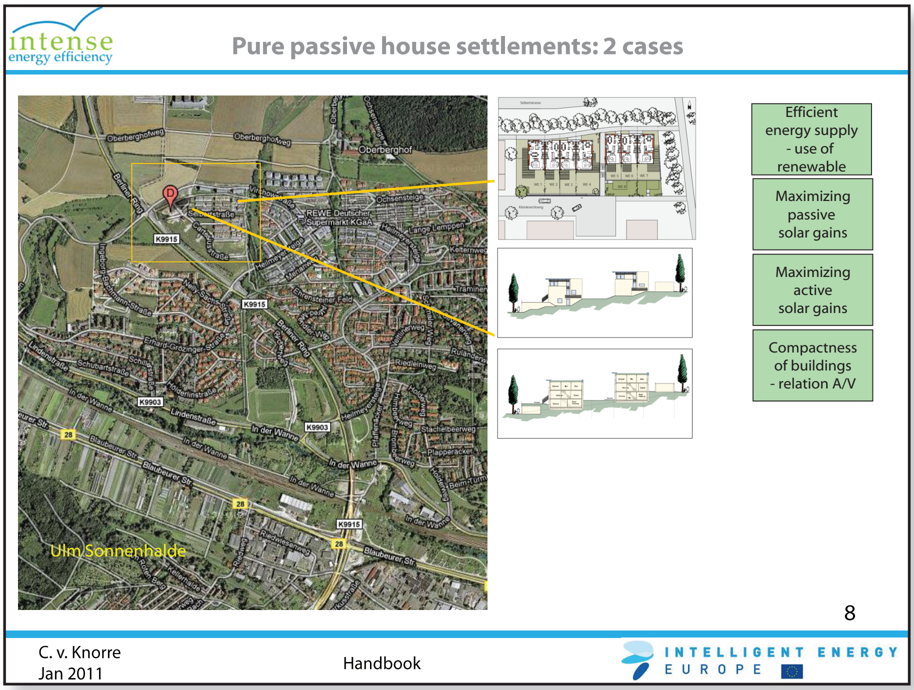
Al that means, the art of urban planning is to find a good compromise between energy efficient A/V ratio and living quality.



The picture left shows:

These very big distances between the buildings can lead to a conflict with the compactness of a settlement. You can see, that on the same ground three rows of houses find place instead of four.

Special software can help to find compromises. The simplest method is to use free ware „sketch up“, as shown on the right. (possibilities to insert location/ month/hour and tp play through shading situation)



One example for optimized orientation:

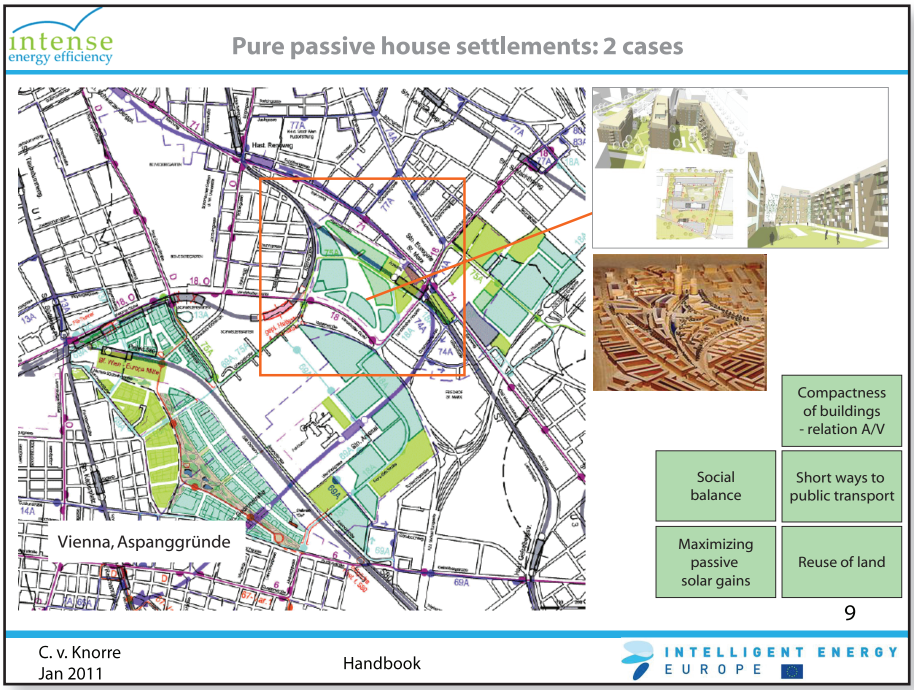
The first example of a „pure passive house settlement" is Ulm Sonnenhalde, realization 1998-2000, 108 flats in row- and double houses.

The settlement is located of the south slope of a valley, so it is predestinated for solar settlement. Even in wintertime, solar gains are "guaranteed".

As shown in the section picture two and three, the distance between the volumes is well balanced, using the slope situation.

The municipality owned the land and fixed via land sale contract, that the 8 involved investors had to prove their buildings as passive houses. They all passed the certification.

The situation on the slope leads is perfect for solar optimization, the types of houses (row houses) shows a good compromise between compactness and living comfort.



On example for optimized density:

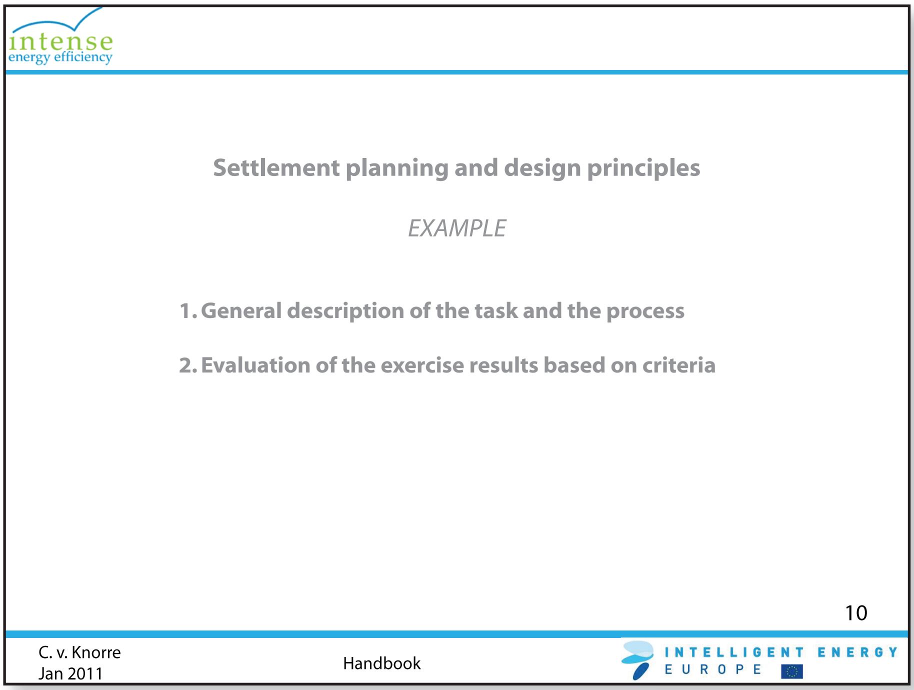
The second example shows one of the biggest planned passive house settlements in Austria:

Vienna Aspanggründe. It is a typical brownfield development. Changes in railway transport systems opens the possibility to reuse this area in the densely build up city.

The area will offer 400 new flats and working places in passive house standard.

In opposite to the first pure passive house example, here is strictly compactness/density the issue. The more compact a building, the less the efforts to reach the passive house standard. In this case, most of the buildings will be built as social residential homes.

But the orientation of the big buildings had been checked and optimized as good as possible, see picture 1.



1. General remark:

The INTENSE partner municipality of Cesis offered the plot and plans. Cesis is elaborating a ***NEW TERRITORIAL PLAN FOR CĒSIS MUNICIPALITY INCORPORATING ZONES FOR ENERGY EFFICIENT BUILDINGS*** as one INTENSE mini project.

The plot is one of the possible areas for energy efficient buildings owned by municipality.

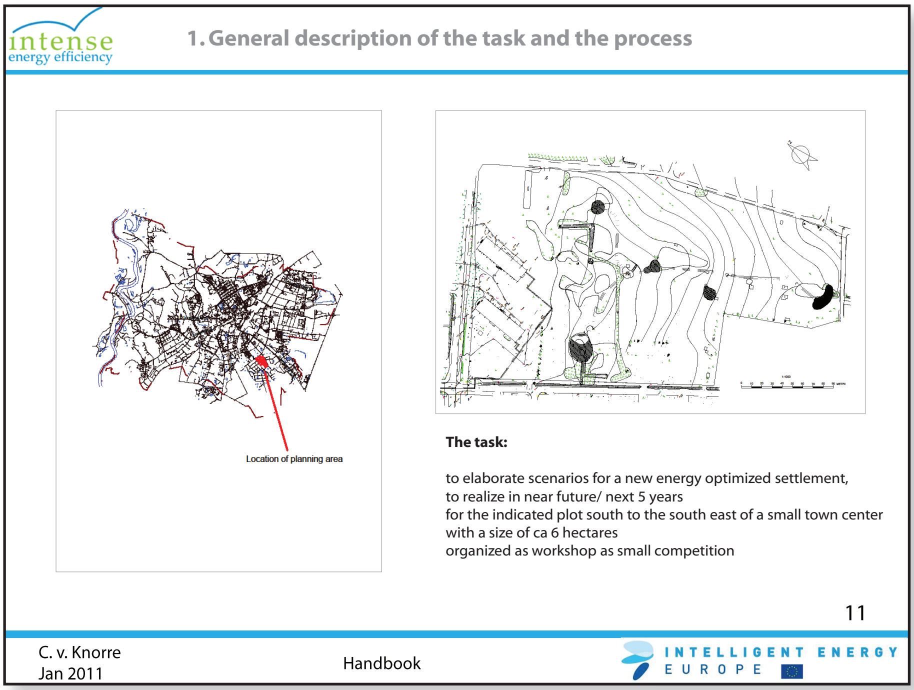
In this case some decisions are fixed by municipality and could **not** be influenced by "planners of the exercise": the location of the plot in the town, distance to town center, the land use of plot and surroundings, distance to important infrastructure and distance to main axes of public transport.

This situation can be seen as typical task for a competition for urban planners or architects.

To organize the exercise as competition with working groups of competing teams brings in a fruitful "fever".

In the first part of this presentation the task and the plot will be described in detail by adding some technical hints.

In the second part, the results of example group work from INTENSE 2nd Train the Trainers event will be shown and it will be brought out which of the ten criteria can be found in these scenarios.



The left plan shows the whole territory of Cesis without fixed scale. The location of the plot is marked to get an impression about distance to town center, main routes, station and the open field.

The right plan shows the plot. In a scale of 1:1000 it covers a A3 format. The scale is not very detailed but allows to show type, grouping and orientation of houses, parking places, public and private space. Numbers of storeys can be indicated.

The lines indicating the altitude: all 0,50 m

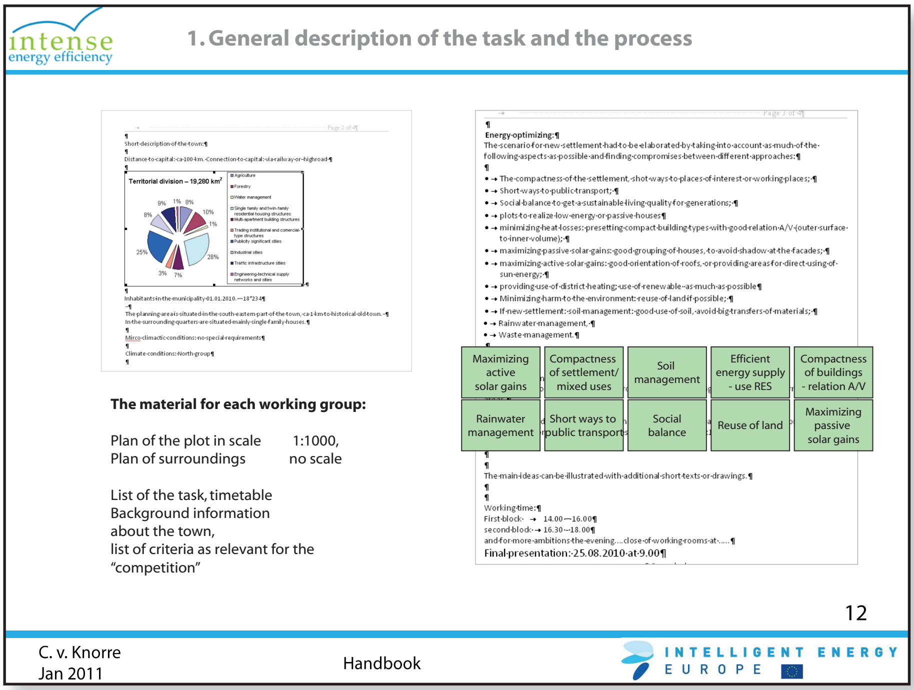
In the northern corner of the plot are located two old multi storey buildings. It is up to the competitors to renovate or demolish the buildings.

Material to prepare:

All competitors should get copies of both plans, transparent paper, different markers, copies of background material, see next slide.

All equipment should be easily available and usable in the usual conference rooms.

If this exercise takes place in the university, there are of course more possibilities: to use styro cutter and styro foam or other material to create also a model in three dimensions or to use CAD or sketchup for simple 3D sketches.



All competitors got a task list with some background material about the town and the list of the 10 criteris.

Experience shows that all background materials were read carefully by competitors and questions where asked for better understanding during the first hour. It was useful for organisers to go from table to table to ask for misunderstandings.

In this case the groups worked in two rooms – twogroups in one room and three groups in other room. No problem!

The sizes of groups were different: three to five persons.

In this case this was obviously no problem to get all participants involved in the process but better are groups of three to four.

The groups got two working table plans, background material, transparent paper and flip chart paper to prepare the final presentation.

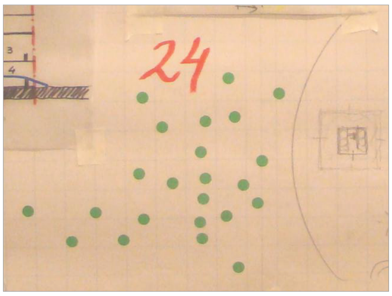
Two groups asked for using CAD. This causes no problems!

intense energy efficiency

1. General description of the task and the process

Evaluation of competition:

- presentation of working group results
- exchange about criteria or extra aspects
- All competitors change into jury after presentation,
- they got two dots per person and were asked to glue the dots to the result, they judge as best solution for the task
- the dots were counted, to find out the winner



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C. v. Knorre
Jan 2011

Handbook

INTELLIGENT ENERGY EUROPE

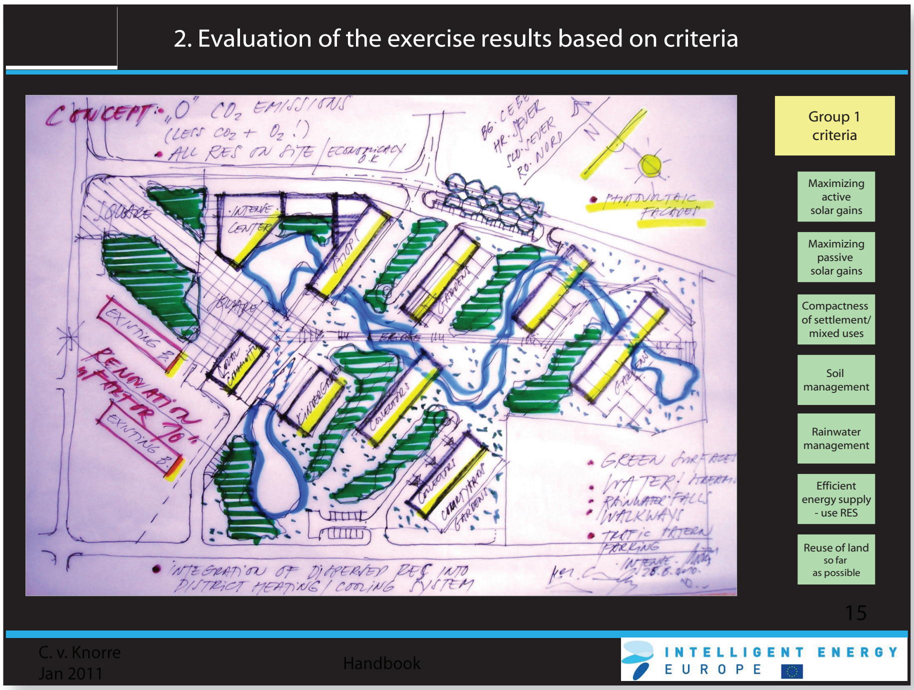
Material to prepare:

Looking for a place, where plans can be presented and all participants can have access to place the dots later on.

Preparation of small dots to glue for all participants.

Do not forget a small gift for the winning crew!

Do not forget to take photos of results and winning team!



Main idea of the scenario:

optimizing of orientation of row- and blockhouses for active an passive solar use. Economically reasonable building types.

Houses and private gardens of row houses are embedded in green public space with lakes and rivers.

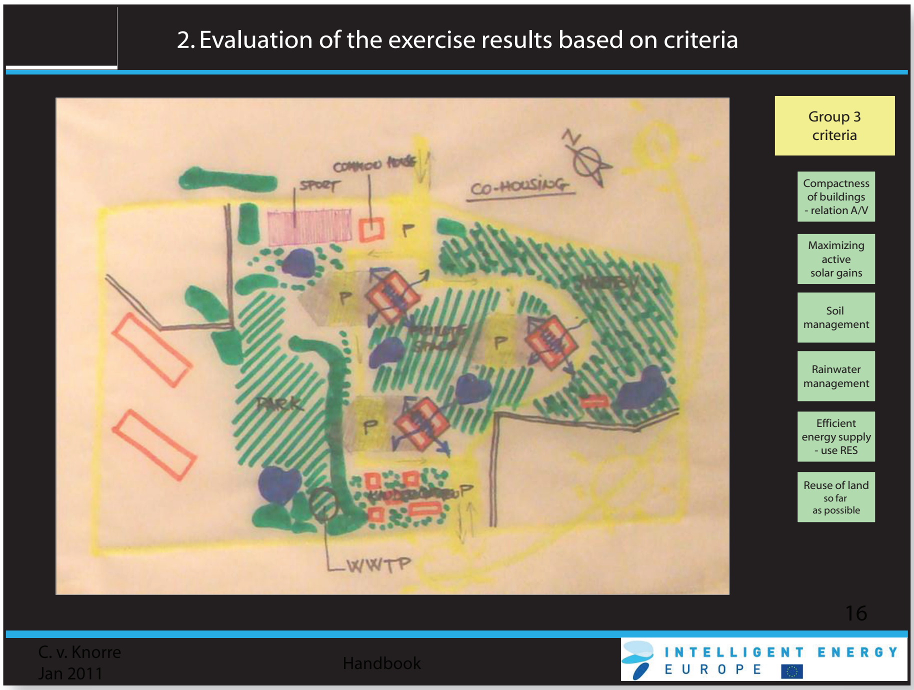
Density decreases from north to south.

The north east edge is formed as entrance of settlement with public uses, shopping

The old buildings would be renovated.

Parking places are grouped and concentratede so that the inner part stays car free.

Energy supply with district heating, using RES.



Main idea of the scenario:

Open public space, park, green with few solitaire houses of up to 10 storeys, see picture below.

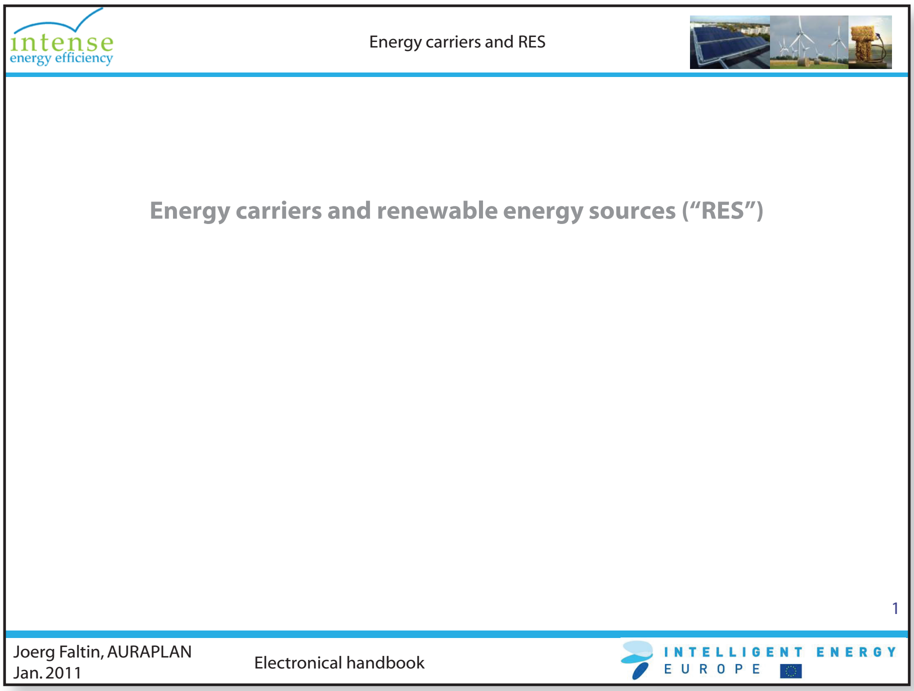
Some infrastructure is integrated into the houses, exept the sport yard, which is separated in the north east part of plot.

Public/social space is integrated into the solitaires Atrium as middle axe.

The old buildings would be renovated.

Parking places are grouped and concentrated so that the inner part stays car free.

Energy supply with district heating, using RES.



This module shows two aspects of the energy supply of buildings:

On the one hand it explains the current situation of available and most used energy carriers and its perspectives for changes.

On the other hand this module shows what could be available and appropriate solutions for the use of the RES.

(„RES" is the short form to "renewable energy sources")

Besides this fact that we are learning more and more globally and that we can have all these masses of information we have to respect the local situations, which are individually very different. Also for real projects there have to be done local decisions, which are all different.

This individuality could not be covered totally by this module. So it is the aim to give ideas and an overview about the ongoing developments and types of technical solutions and to show principles, which help to find out these locally reasonable solutions.

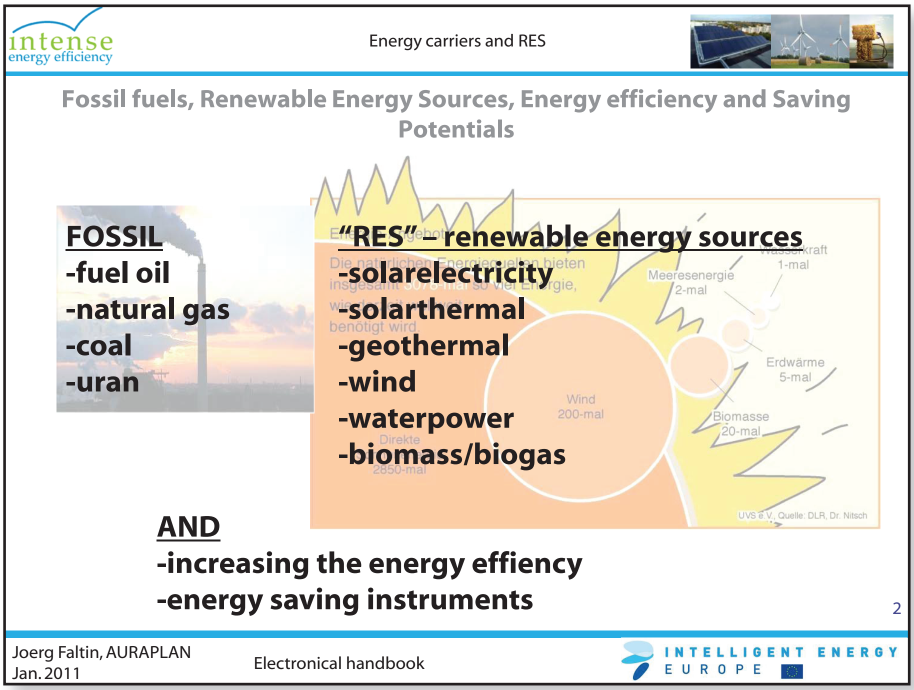
Where we find basic differences for planners and for the implementation of ideas and plans, there we give special planning information and for the realizing companies and craftsmen.

Connection to other themes

settlement planning, systems engineering: heating and cooling

links

www.unendlich-viel-energie.de/en
www.postcarbon.org



Overview over ***ALL options of energy supply***

Multiple options for using – and not using energy carriers.

Energy carriers can be fossils, renewables – and also savings and efficient use by efficient appliances.

This module leads to
1.) information and importance of saving potentials
2.) information and importance of energy efficient appliances
3.) Applying appropriately sized energy systems from fossil to renewable energies
4.) Special view to planning and implementation aspects

Additional information is given to the regional creation of value by choosing the energy system.

Note: technology develops fast so we need basic principles for taking sustainable decisions today and tomorrow.

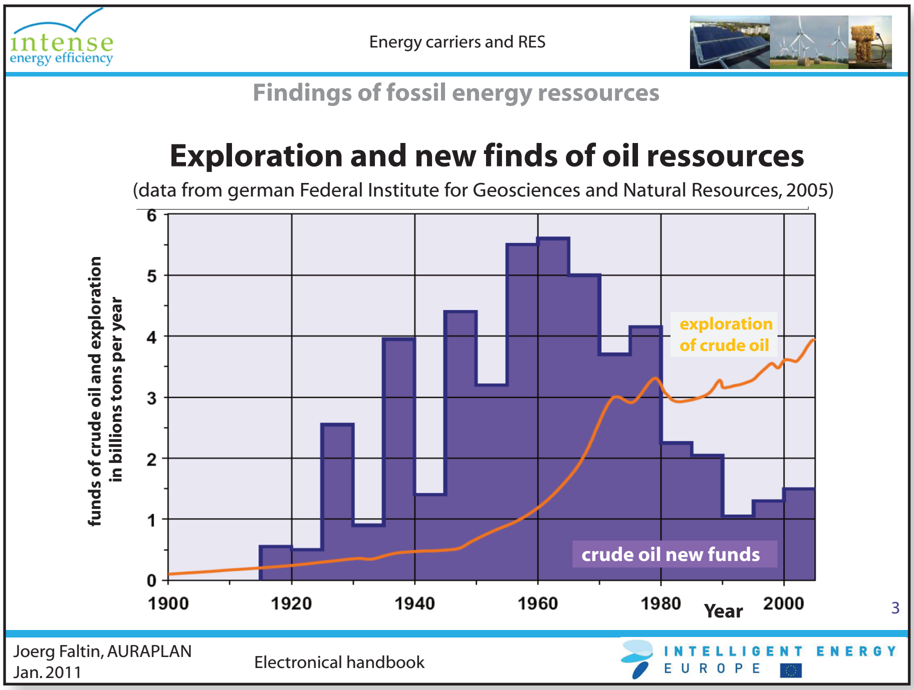
Background

Statistical data from your region or country

Book: Energy Autonomy – The Economic, Social and Technological Case for Renewable Energy, Earthscan/James&James

links

www.wcre.org



Background

Fossil energy sources become more and more expensive. Also irregular and unpredictable variations in their price is obvious. It is obvious that the easy and cheap exploration of e.g. crude oil is more or less over, we are living in the time of the "peak oil day", which means that this day with the absolute biggest exploration is probably already history.

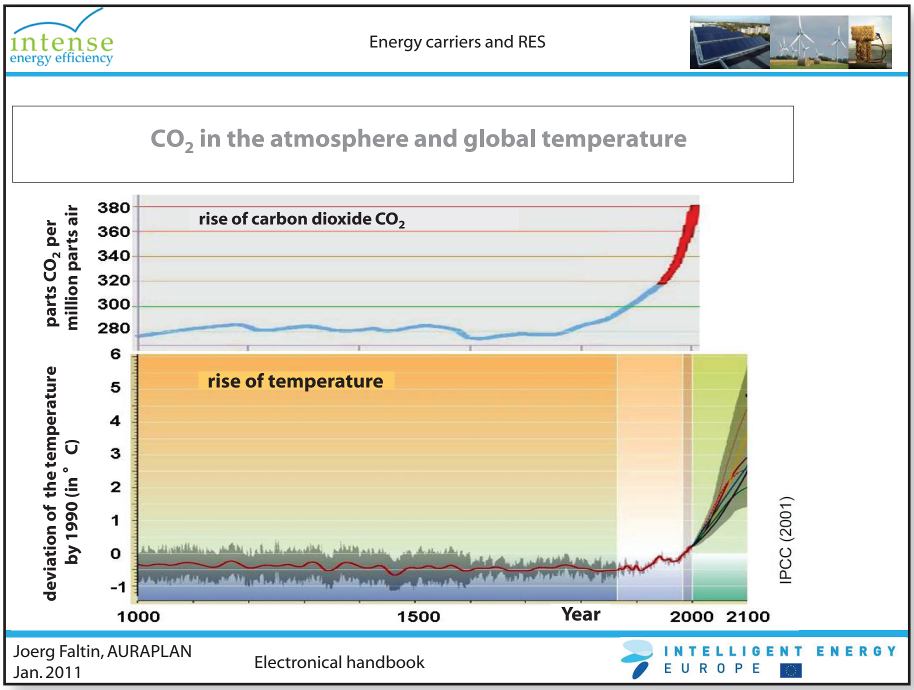
One consequence is the search for new oil sources, for example in Canada, where are found oil sands. But this is problematic for the reason of a higher price and because of environmental damages.

links

www.wolfatthedoor.org.uk
www.energywatchgroup.org

Suggestions for presentation

show other graphs and statistics with the last decades of availability of energy resources.



Connection to other themes:

legislation

costs of CO_2, prices of emission rights you find here: www.eex.com

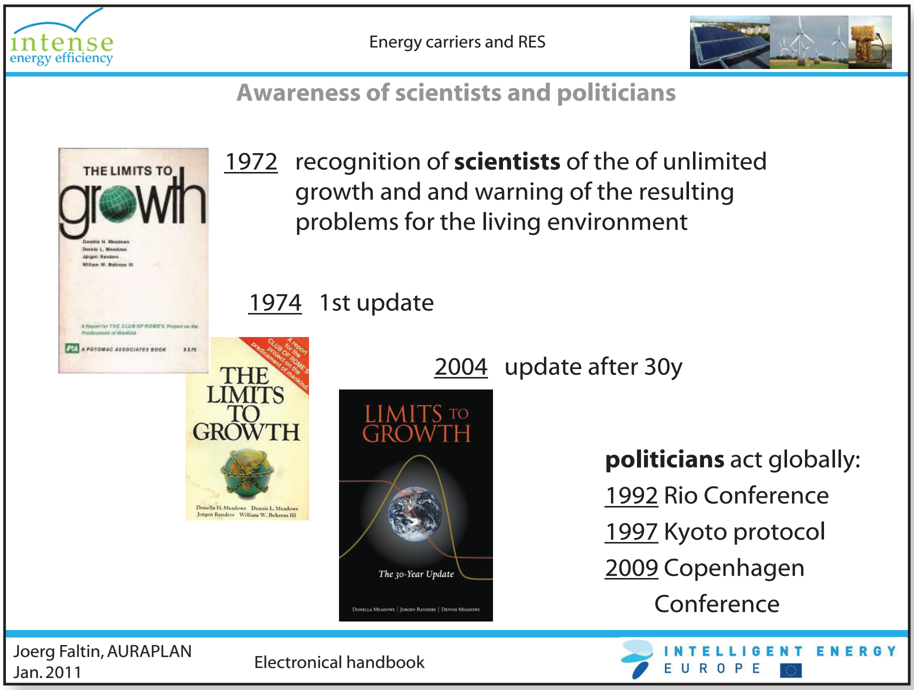
Background

global warming; climate change

Suggestions for presentation

Show own or public graphs and facts.

Show what is already realized to lower climate impact in your region, what is planned to do.



Connection to other themes:

legislation

Background

1972 + 1974 "The limits to growth" by Donella and Dennis Meadows, Jorgen Randers, William Behrens

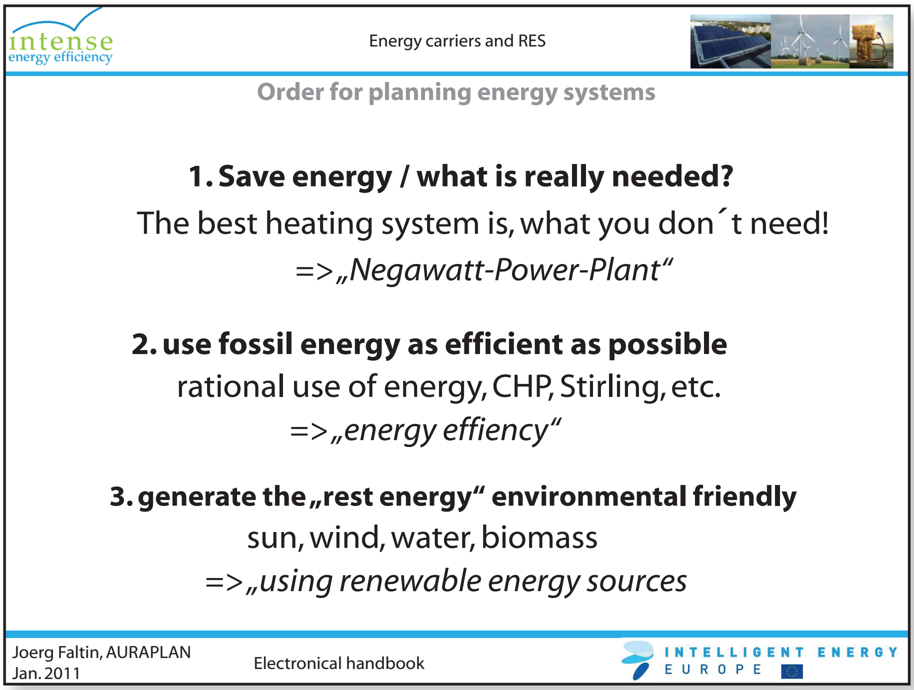
Watch a video (english): www.chelseagreen.com/bookstore/item/limits_to_growth:paperback/video_growth_vs_development

links

www.worldfuturecouncil.org
http://energywatchgroup.org

Suggestions for presentation

- show publications and position of scientists and politicians of your country
- discuss or present the publications of scientists and the decisions of politicians, which have influence to your local situation
- discuss or present the options of each single houseowner
- discuss or present the safety of energy supply in awareness of political decisions
- discuss or present for the stability of prices in awareness of political decisions



Connection to other themes:

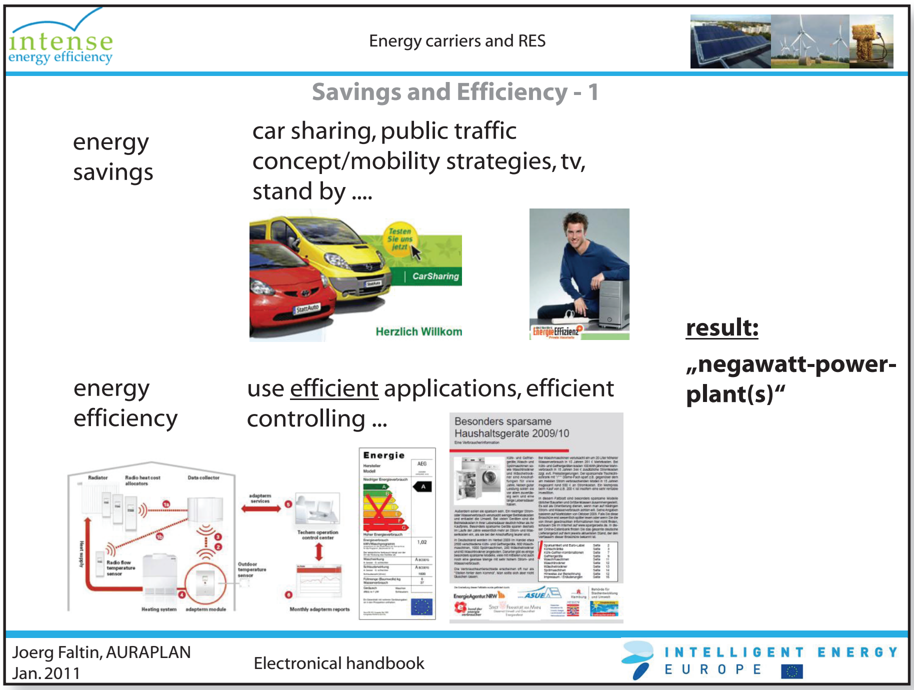
- quality control:
- proper design and planning should realize all good ideas, concepts and details of building design, also site design (solar-energetical optimization). Saves energy by not using it because basic principles of energy optimized designing of a house / settlement were respected.
- efficiency of energy systems could also be reached by proper planning, tendering and installing of high efficient systems.
- one step more energy efficient: external control of the designed and planned system can afford the most up to date efficient measures and technologies
- systems engineering, -tendering / green public procurement for energy efficiency

Background - see also next slides

Not using saving potentials often leads to inefficient and expensive technical solutions! Installing of just a technical system could appear as an easy and attractive solution but experience has shown that in reality all is connected and depends on each other. So it is not a good solution to improve one single aspect to very good and leave others in old and not so good condition. So this planning order is economic.
Energy saving by optimizing procurement processes: http://deep.iclei-europe.org
Improving energy efficiency for low income families: www.oe2.de/index.php?id=40

Suggestions for presentation

Discuss pro and con´s if only one step would be realized and the others not!



It is not a task mainly for technical planning. But planners in a wider range of this profession, if they like structuring and organizing processes with people, and like to work with people, they can realize savings in the size of real power-plants!

There is a high potential for saving energy, if private households get general and individual consultancy for these issues.

Connection to other themes

see other INTENSE activities like awareness raising strategies, communication strategies, at: www.intense-energy.eu/english/you-need/communication-to-citizens

Background: development to higher energy efficiency is realized by not only technical solutions but also communication and organizational activities help to save energy.

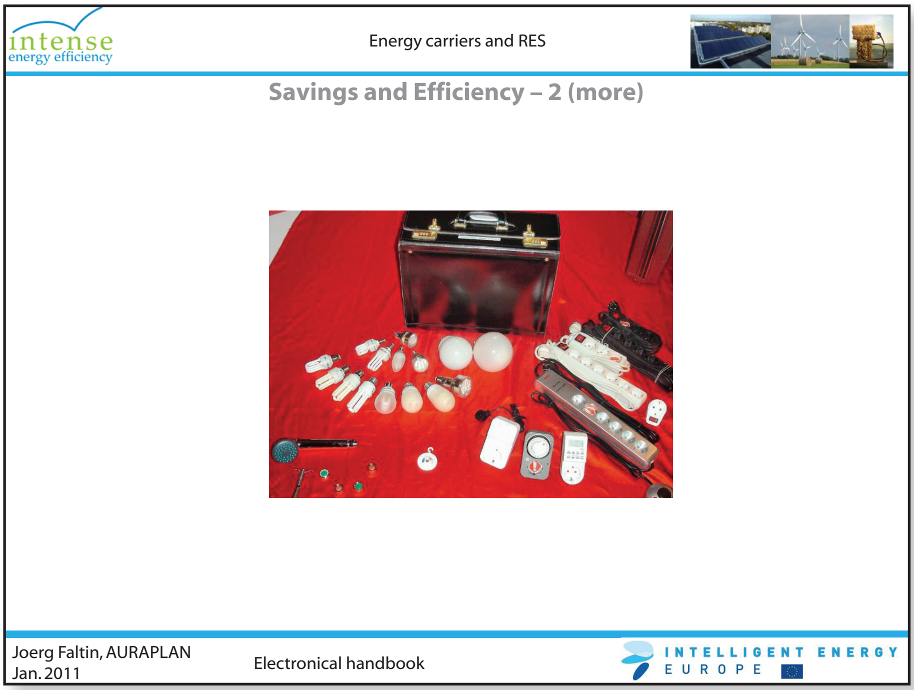
Suggestions for presentation: Present results/statistics of energy actions for citizens as energy consumers. A lot of projects have been realized with awareness rising and informing of end users, keeping the same level of comfort.

Present realized „Negawatt-Power-Plants“. Negawatt is an artifical new word from Non and Mega, which means, that No Megawatt is required – if saved by organisational work.

Sometimes it has been realized as school projects that big amounts of not spent energy could be as big as a new powerplant or heating system.

Often it is less expensive to „organize“ a Negawatt-Power-Plants than installing a real one.

For example see IEE-project documentation "buildings" from November 2009: www.odyssee-indicators.org/publications/PDF/brochures/buildings.pdf "Household energy efficiency for EU-27 has improved by 8-10% since 1997", Page 20, Box 2-3 "Overview of household saving technologies": "The most common saving measures are…, Advanced saving measures ..., Renewable options ..."



…

links

www.energieverbraucher.de/de/Umwelt-Politik/Politik/Brennstoff-Armut/Caritas-Stromcheck__2588

www.bmu-klimaschutzinitiative.de/en/for_consumers www.dereinsparshop.de/strom-sparen.html

www.en.wikipedia.org/wiki/European_Union_energy_label

www.utopia.de/negawatt/64kw/index.html (german and english version)

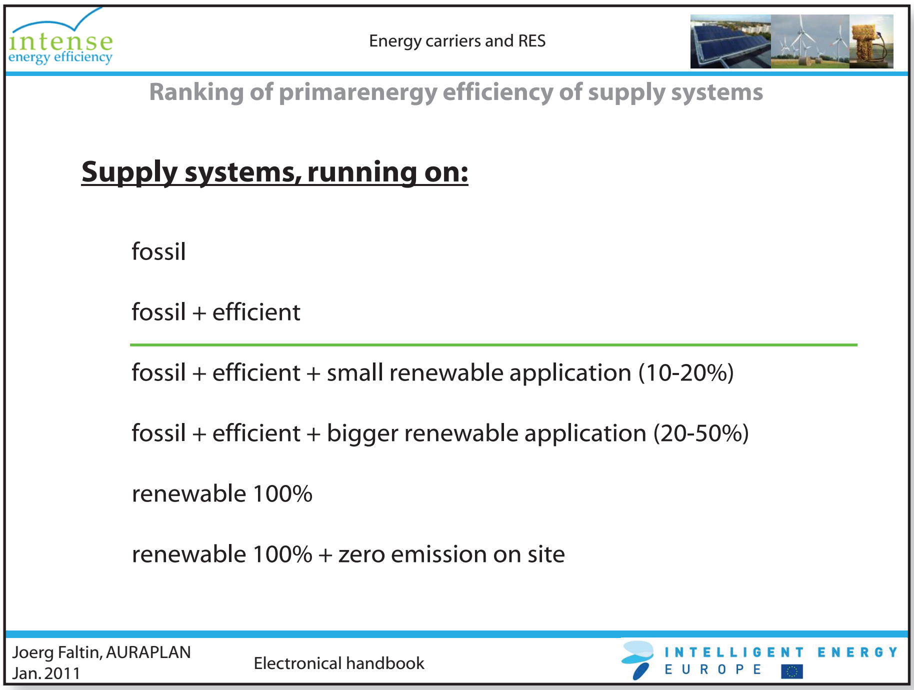
www.duesseldorf-astrhein.de/fakten.htm (german, but interesting to show the dimension, here promoted for a big power-plant for the state capital of NRW - northrhein-westfalia, a region for 16 million people)

www.negawatt.org

www.heise.de/tp/r4/artikel/19/19056/1.html

Here is mentioned the "Staudinger Gesamtschule",with it´s Negawatt Project. Also other links to e.g. english and french sites are there.

online translation of also complete websites e.g. here: http://de.babelfish.yahoo.com



Planning knowledge necessary:

- small systems: general knowledge, no special.
- medium systems: basic planning knowledge and experience
- big systems: basic and special knowledge; experience, and new information from market, about products are strongly recommended

Helpful in every cases are: study visits, project documentation neutral and additional from producers, planning advice written or personal from neutral institutes/experts and additional from producers.

Connection to other themes:

Settlement planning, systems engineering, HVAC

Background

- evaluation of different heating systems
- dissemination of for example cogeneration as efficient energy supply system, see:

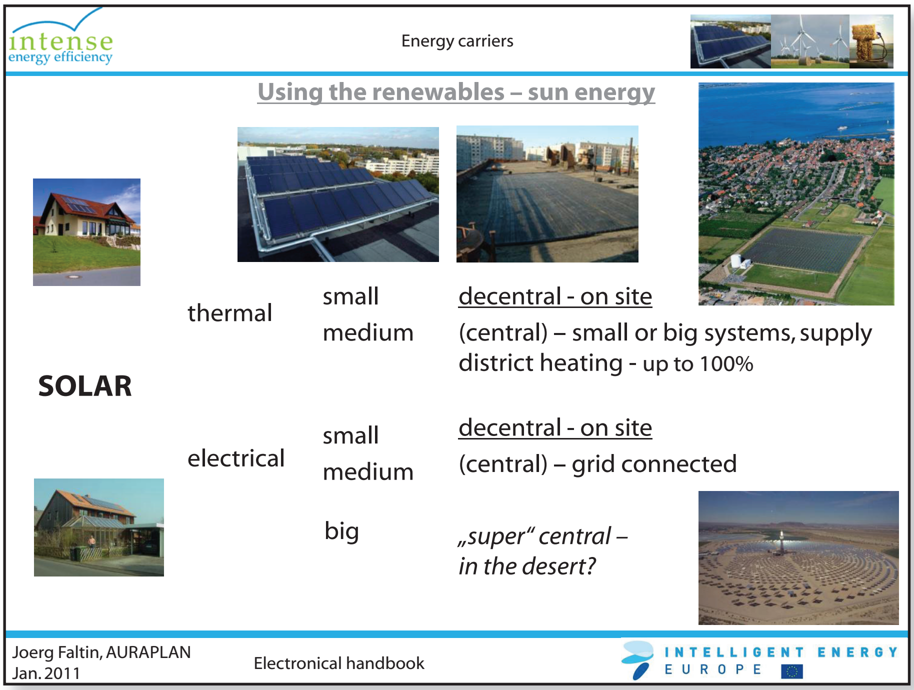
www.cogeneurope.eu/category/about-cogen/what-is-cogeneration
www.cogeneurope.eu/wp-content/uploads//2009/02/share-of-CHP-in-EU.bmp

Suggestions for presentation

Discussion themes:

- what examples are known locally for these different supply situations?
- what other efficient energy supply systems are common at your country or region?

Add to this slide efficiency parameters and local information of percentages of dissemination.



Pictures on 1st row

Unknown one family house; decentralised collectors for heating warmwater of a multistorey residential building; Solarthermal field on flat roof in Kirghizia for district heating; 18.000sqm solarthermal for district heating in Denmark since 1996

Pictures on 2nd row

Unknown one family house with roof applied photovoltaik system.

Connection to other themes:

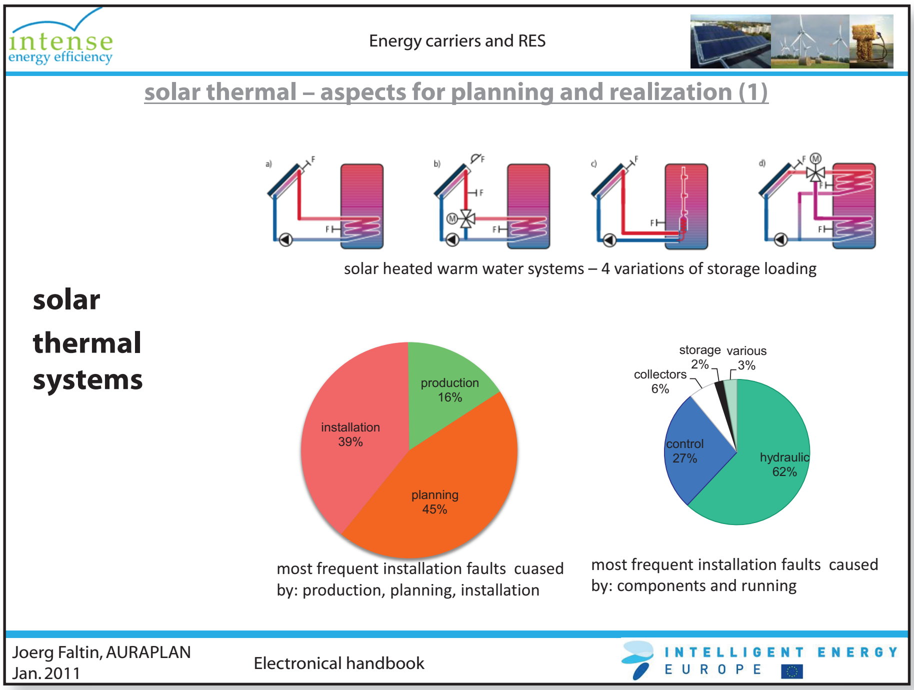
- systems engineering
- settlement planning
- legislation

Background

www.estif.org/st_energy/technology/introduction
www.ises.org/ises.nsf

Suggestions for presentation

Discussion of:
- what is known in your country as good real examples
- how can district heating systems with big solar thermal supply work technically?
- Temperature levels
- Solar fraction



Planning: Ever -and with planning of ST systems this is more important than with using a simple gas boiler- it is first to ask after the purpose and the aim(s).

This exists of a technical optimum AND an economical optimum (which usually can not be reached both together). This simple procedure could leed in different regions with different cirumstances to complete different results!

One basic and very important planning information is the level of the needed temperature. With this the possible (economically) fraction of solar rate is determined.

With the additional also basic information of needed amount the size of the system can be calculated.

For medium and bigger solar thermal systems it is very important to have a balanced hydraulic field of collectors – otherwise it will work only partly and earnings will be bad.

Realization: It is an comfortable established principle to have a pressure about 5bar in the solar circle. Than it is possible to leave out the automatic air separators, which in practice (statistic proved) often leads to faults and stagnation of the collector.This is uncomfortable to repair and can so easily be avoided.

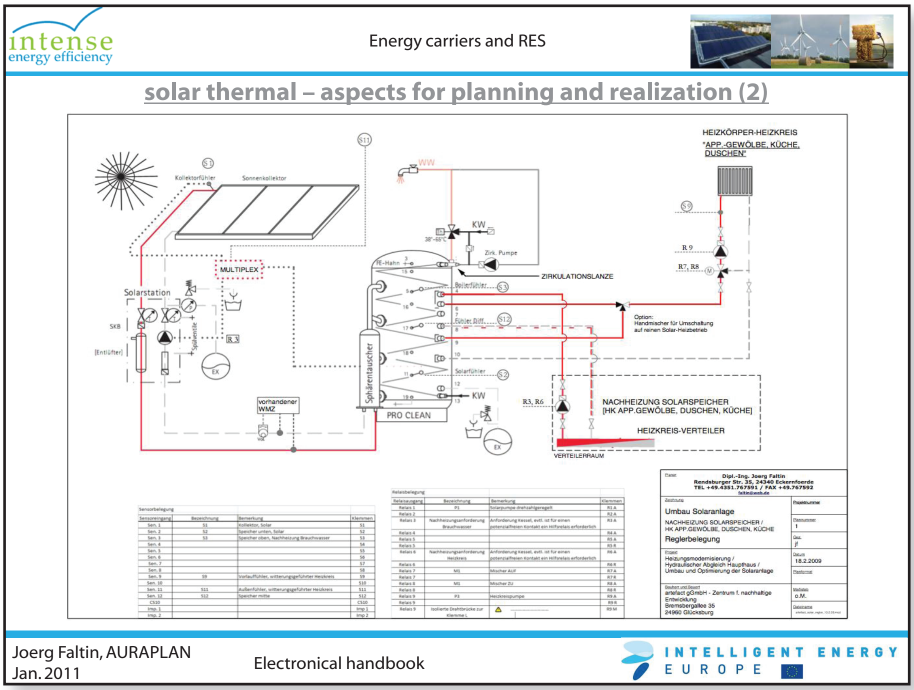
Strongly recommended: drawing of hydraulic scheme, additional with drawing of el. wiring (see example) of control and sensors.

Connection to other themes:

system engineering

Suggestions for presentation

Discussion of:
- who has already installed solar thermal systems?
- which size
- what is supplied with
- how is maintenance organized



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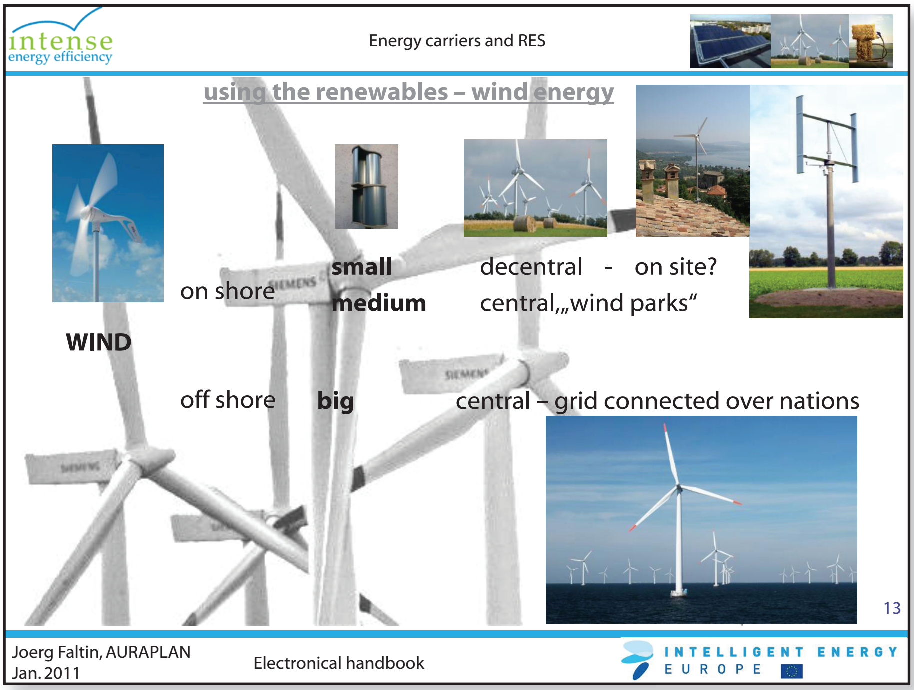
links

www.estif.org/st_energy/technology/introduction/ Information to different ST systems
www.estif.org/on_going_projects/ongoing_projects/ Other EU-Projects with ST
http://austriasolar.at/ (only german, but very much and good sorted information!)
www.tisun.com good supplier with lots of technical information for good working solar systems, small and medium. Realizes also big systems.



Connection to other themes

cost benefit; settlement planning

Background

Energy Mix of our upcoming energy supply

Suggestions for presentation

Discussion of:

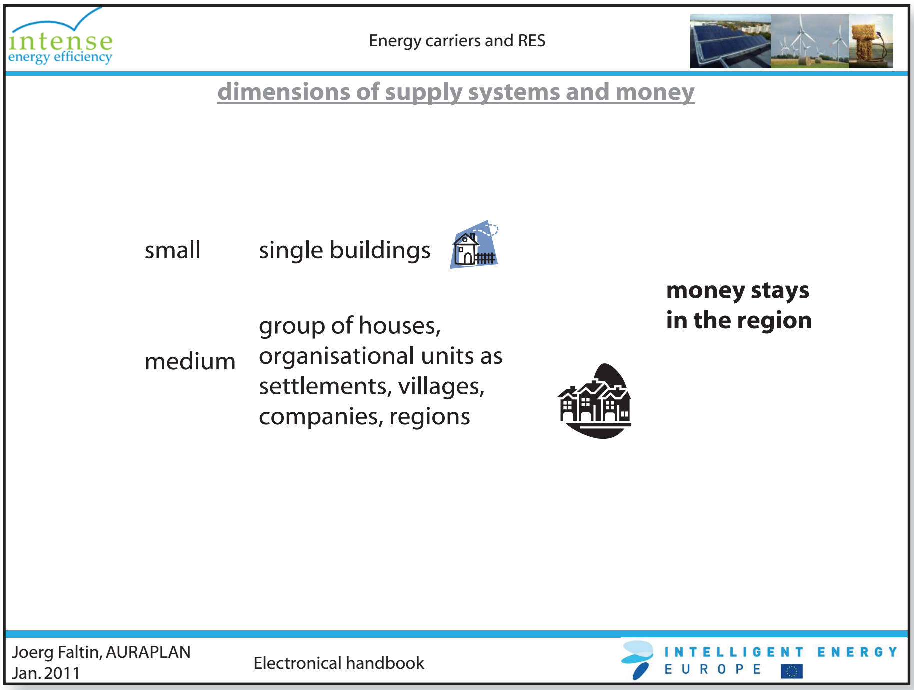
- how we see our future: big wind parks – pro and cons, or small wind turbines for everyone?

Therefore keep in mind the EU directive, where is foreseen zero emission buildings and Great Britain as first EU country has already decided this as standard for new buildings erected by 2016.

links:

www.kleinwindanlagen.de
www.energysavingtrust.org.uk/

online translation of also complete websites e.g. here: http://de.babelfish.yahoo.com/



Connection to other themes:

Settlement planning, legislation, system engineering, local policies, cost benefit

Background

The spending capacity of people could be used more in the region so the money does not go only to the globally acting companies.

Therefore it is attractive to use regionally available energy sources and also supply systems which locally have a positive effect on jobs.

Some regions have developed this and plan to be 100% neutral to climate in the next years. Few regions already have reached this with different concepts and mix of methods and energy carriers.

links

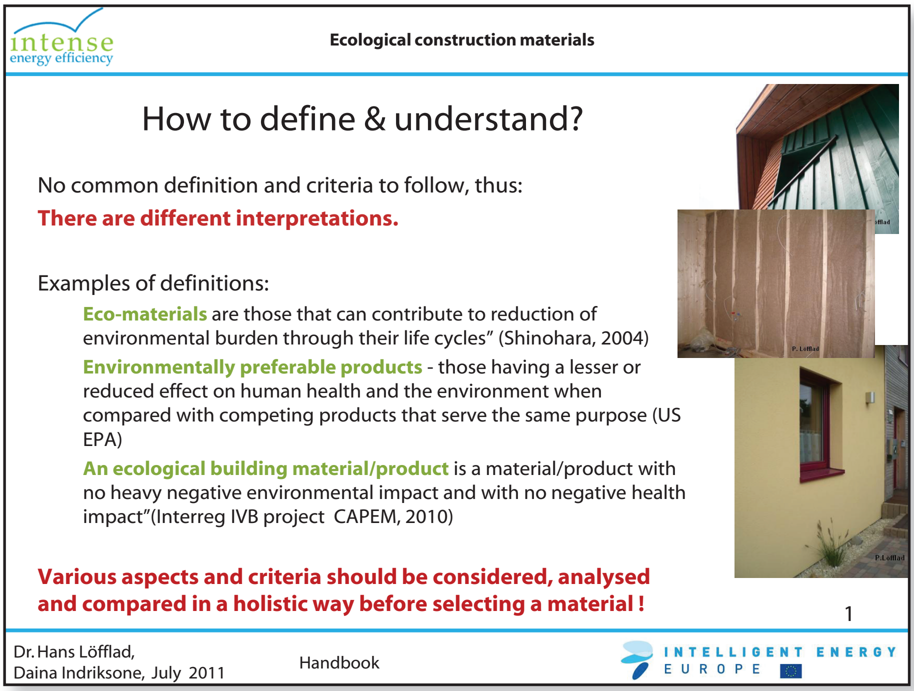
www.global-change-2009.com/weblog/

Suggestions for presentation

- how much money is going abroad by spending money for energy (citizens, municipalities)?
- show the structure of local energy consumption

for discussion:

- how much money could be useful to invest to attract people to use local energy resources?
- develop concept for CO_2 free region



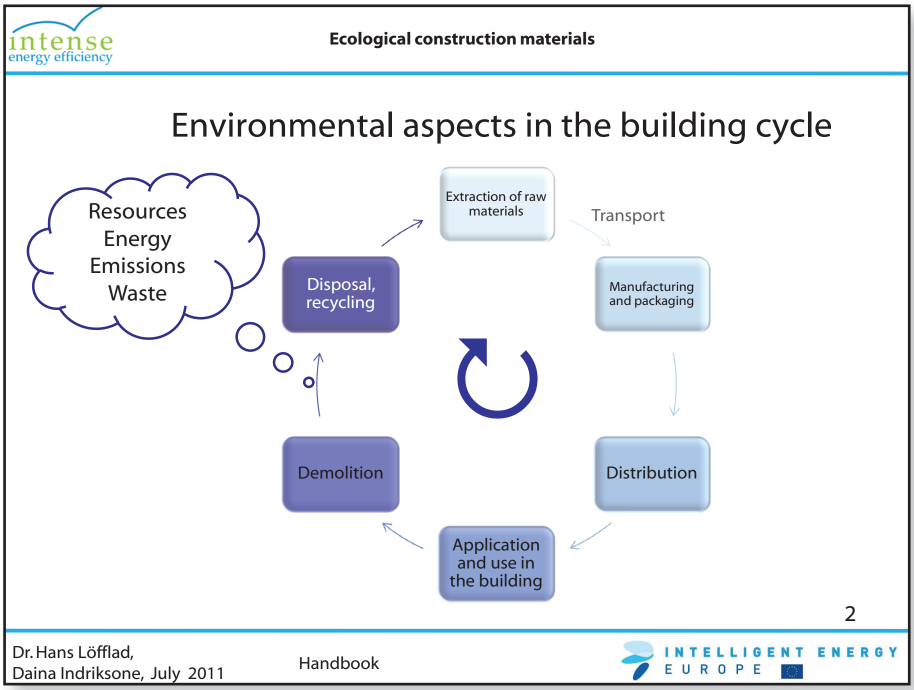
Nowadays the availability of materials that can be used for construction, insulation or finishing of buildings is increasing on the market. But how can the ecological materials be identified from this wide range? There is no common definition for ecological materials, thus allowing various interpretations. 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.

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.



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.

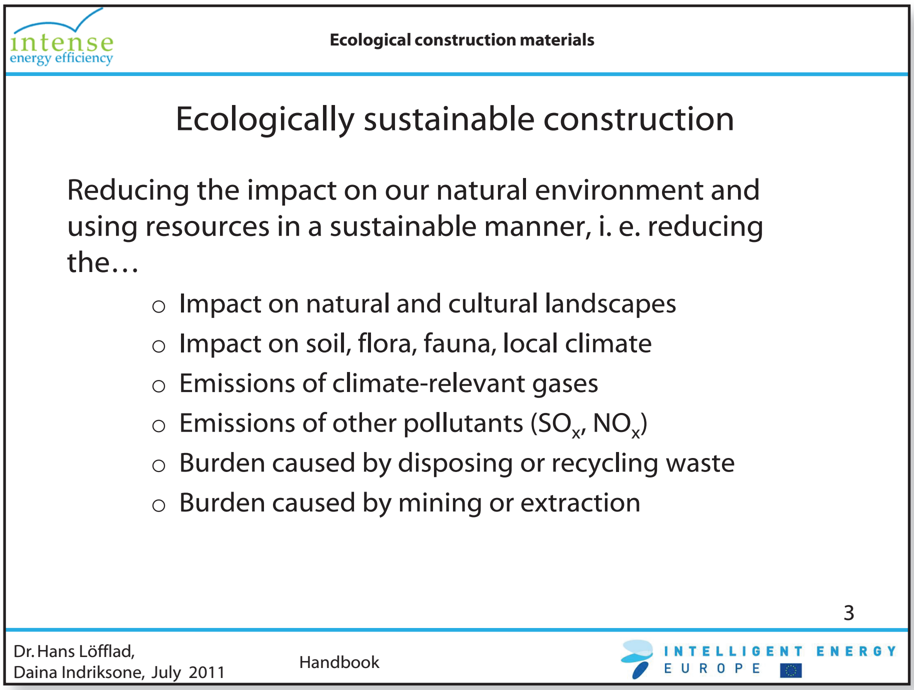
Background:

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).

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.



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.

Background:

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

Suggestion for presentation:

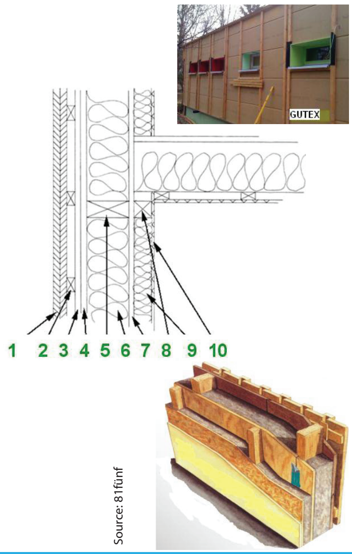
Selected impacts can be illustrated along the production chain of materials (do not forget to talk about recycling and disposal).

intense energy efficiency

Ecological construction materials

Timber frame 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



Dr. Hans Löfflad,
Daina Indriksone, July 2011

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INTELLIGENT ENERGY EUROPE

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.

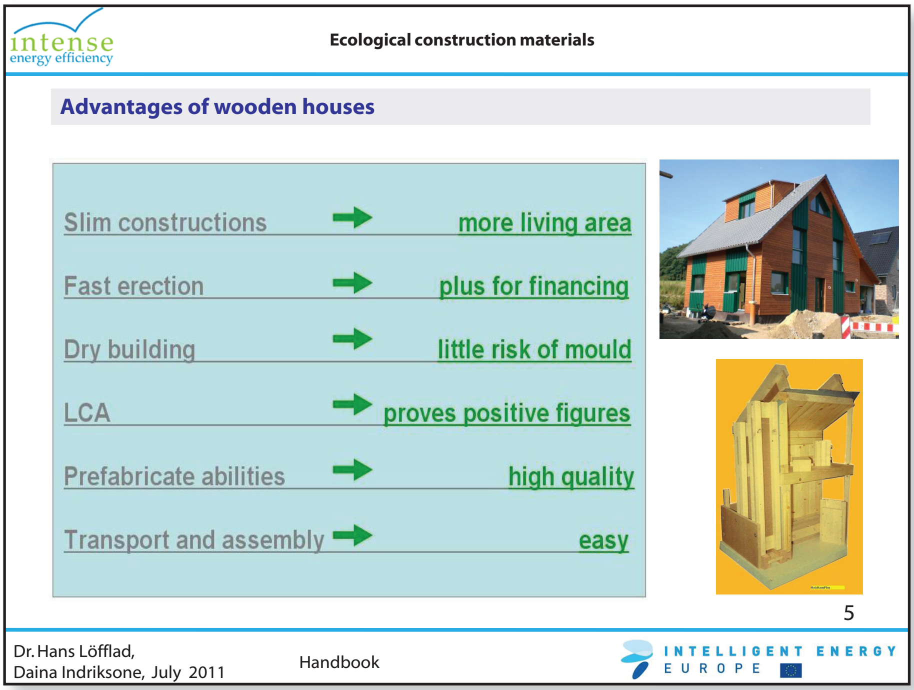
For insulation a loose or fleece material should be used. The best insulation of the cavities of technical installations is a fleece material due to the thinness of the construction. For loose material a cavity approximately 10 cm in width is required, and high pressure for installation of this material (a second wooden board has to withstand the pressure of blowing in the insulation).

Connection to other themes:

Construction of elements, building physics.

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.



Wooden houses have many advantages in comparison to stone houses. For example, applying timber constructions you might gain 5 – 10 % more living area with the same outside parameters.

Connection to other themes:

Construction of elements, building physics.

Background:

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

Suggestion for presentation:

Participants should find more advantages of wooden houses.

Ecological construction materials

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

6

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Daina Indriksone, July 2011

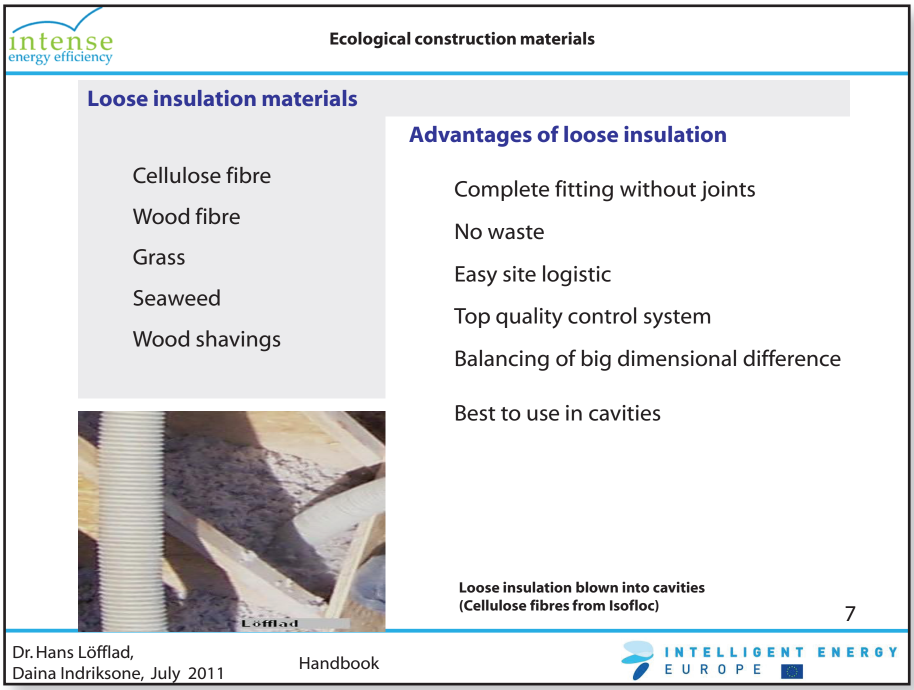
Handbook

INTELLIGENT ENERGY EUROPE

The table in the slide gives an overview on various insulation materials – mineral, synthetic, renewable. The embodied energy or primary energy content is a very good for evaluation of the environmentally friendliness of a material. The table below shows embodied energy values for several insulation materials.

Suggestions for presentation:

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



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

Connection to other themes:

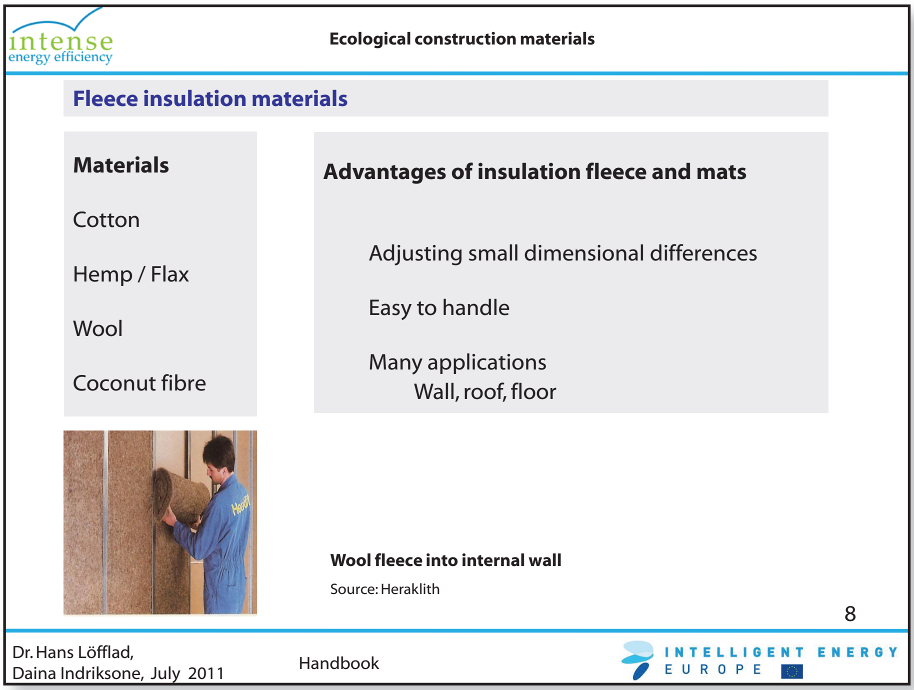
Construction of elements.

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:

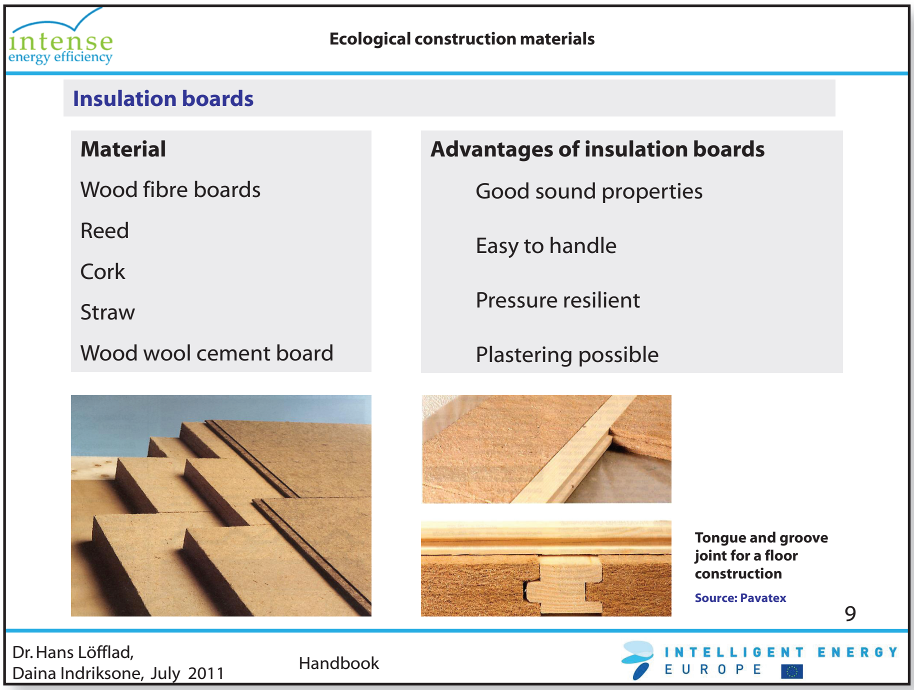
Construction of elements.

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:

Construction of elements.

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:

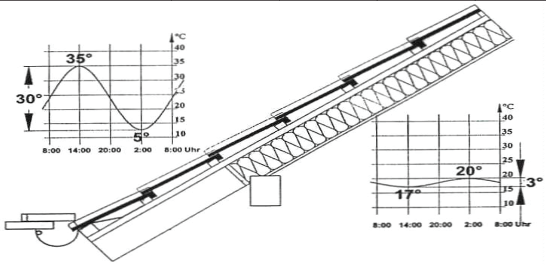
Participants should discuss practical application of insulation boards.

intense energy efficiency

Ecological construction materials

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

10

Dr. Hans Löfflad,
Daina Indriksone, July 2011

Handbook

INTELLIGENT ENERGY EUROPE

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:

Building physics.

Background:

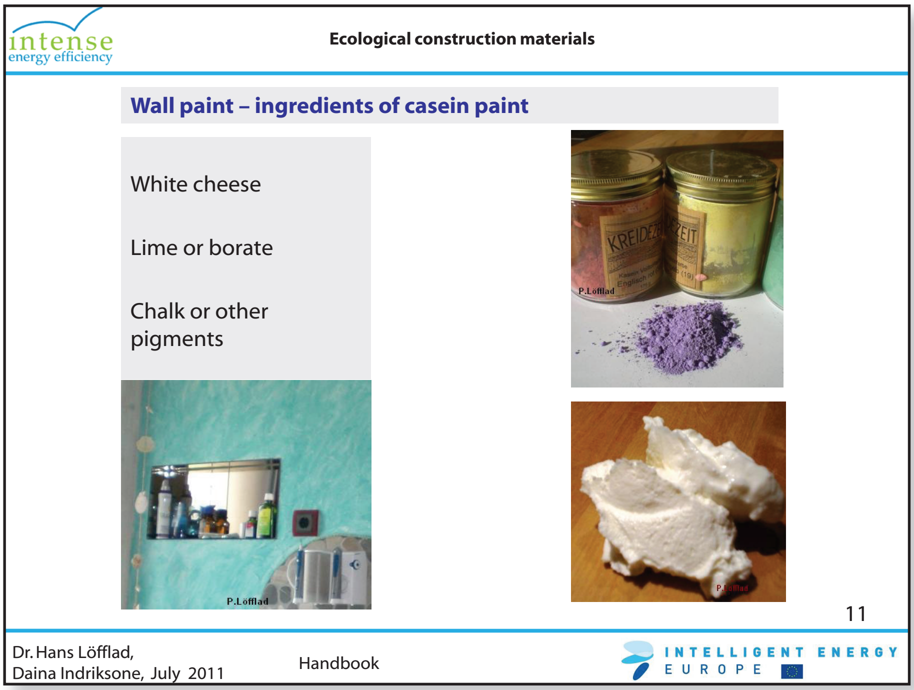
Time-shift is quite complex to calculate. It is easier to calculate thermal diffusivity a [m²/h].

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.



A wall paint with "food" as an ingredient can't be dangerous J

Connection to other themes:

Construction of elements, building physics.

Background:

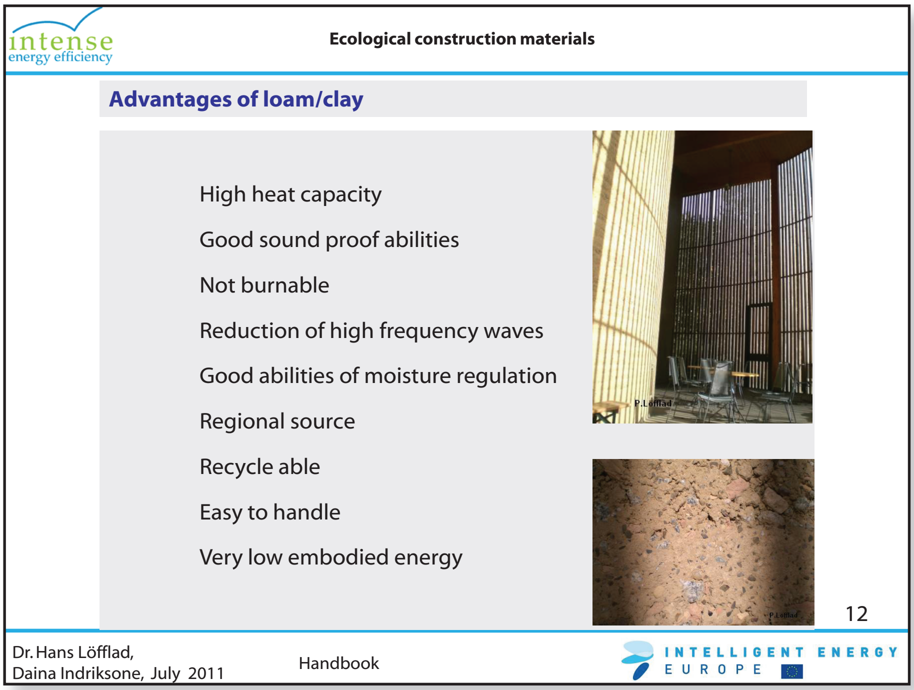
Get more information from www.kreidezeit.de (in English) and

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.



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

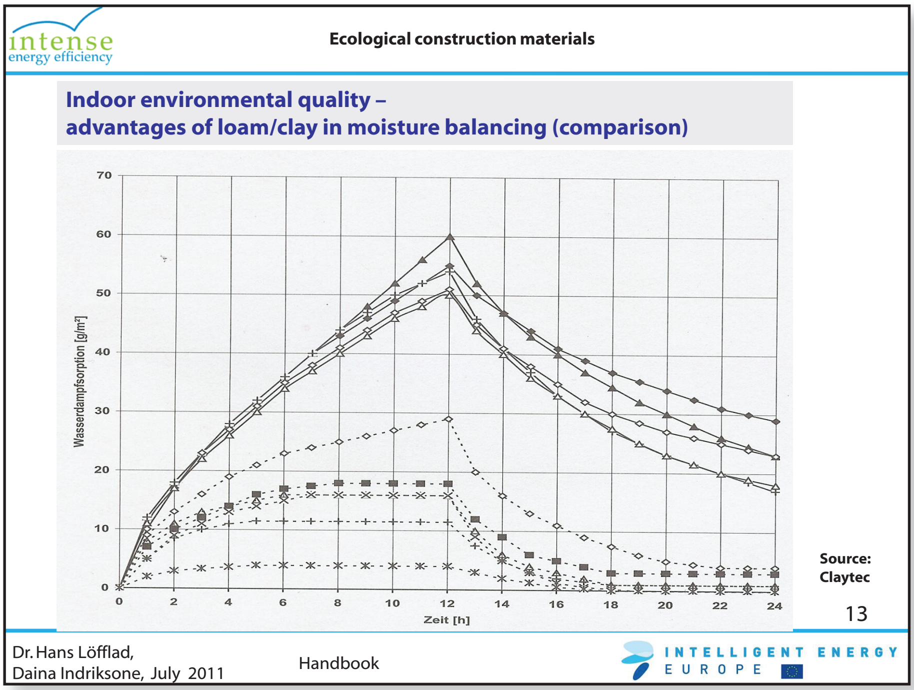
Construction of elements, building physics.

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 shows the advantages of loam and clay in moisture balancing in relation to indoor environmental quality. The chart shows the water vapour absorption [g/m^2] 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:

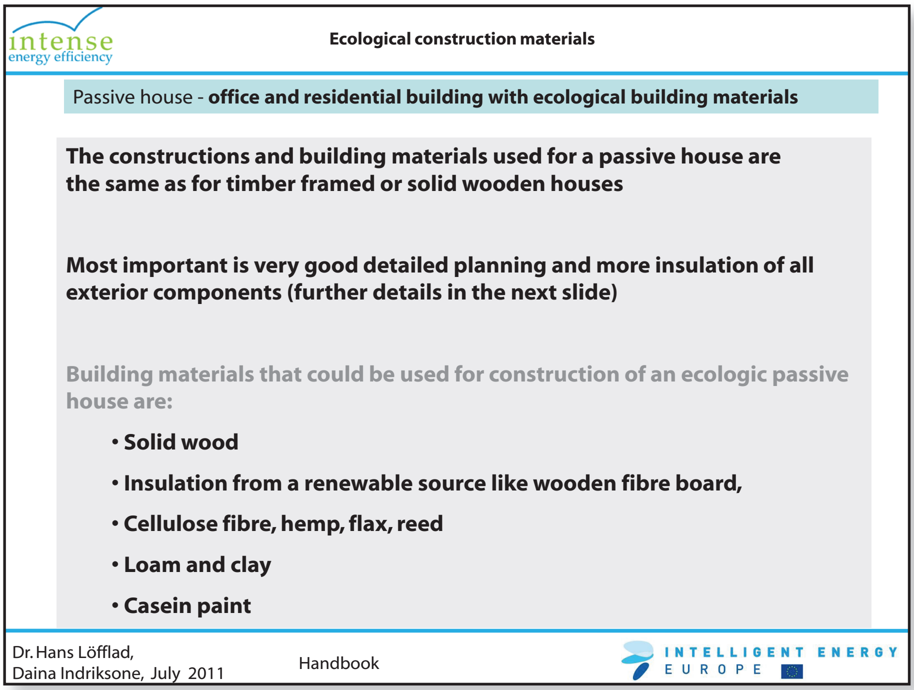
Building physics.

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.



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:

Quality control, settlement planning and design principles.

Background:

Definition of Passive House according to Passivhaus Institut Darmstadt, Germany (www.passiv.de): 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).

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.

Connection to other themes:

Building physics, construction of elements, systems engineering.

Background:

Passive house is considered as best practice example in Europe (Experience and lessons learned from Western Europe and from CEE countries on best practice examples of energy savings in buildings, 2009 www.intense-energy.eu). 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.

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.

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Ecological construction materials

Dr. Dipl. Ing. Hans Löfflad

Thälmannstrasse 86
D – 16348 Wandlitz
Germany
Tel.: 0049 33397 68 388

Info@ifb-loefflad.de
www.ifb-loefflad.de

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Dr. Hans Löfflad,
Daina Indriksone, July 2011

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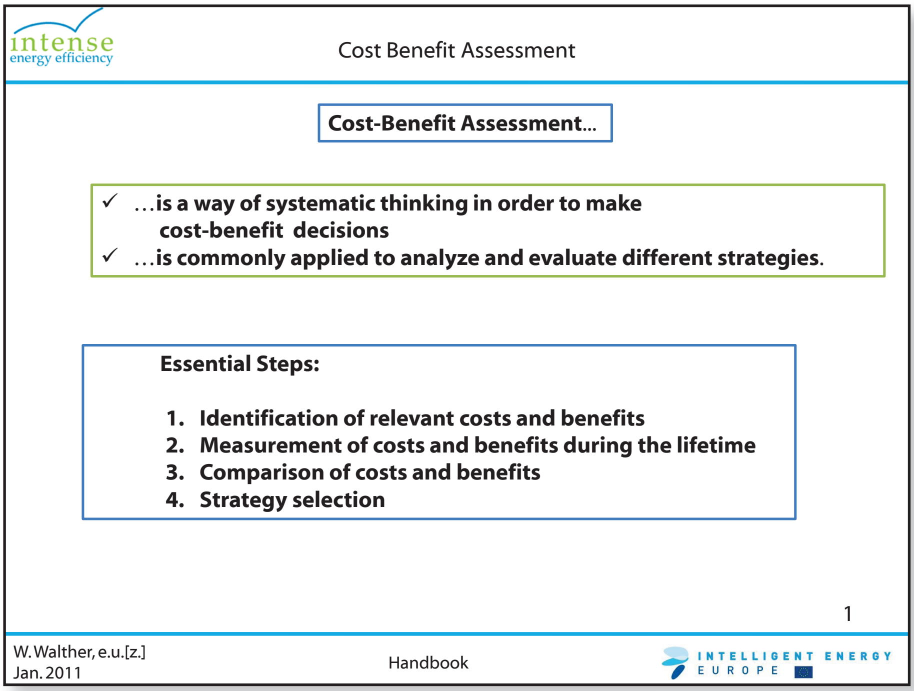
INTELLIGENT ENERGY EUROPE



Often there are different designs (standard building or low-energy building), strategies (roof insulation or wall insulation), or products (which kind of material) available with which to achieve a specific goal or service. Choices are often made based on whether the method meets the current minimum standard or whether it is the least costly. With this kind of simple approach, however, modern, sustainable designs, strategies, or products have no chance at all to assert themselves on the market. To counter this, the cost of a strategy and its cost benefits must be added up before making a decision. Only after comparing the costs and cost benefits for the lifetime of a given strategy, a well-founded result can be achieved.

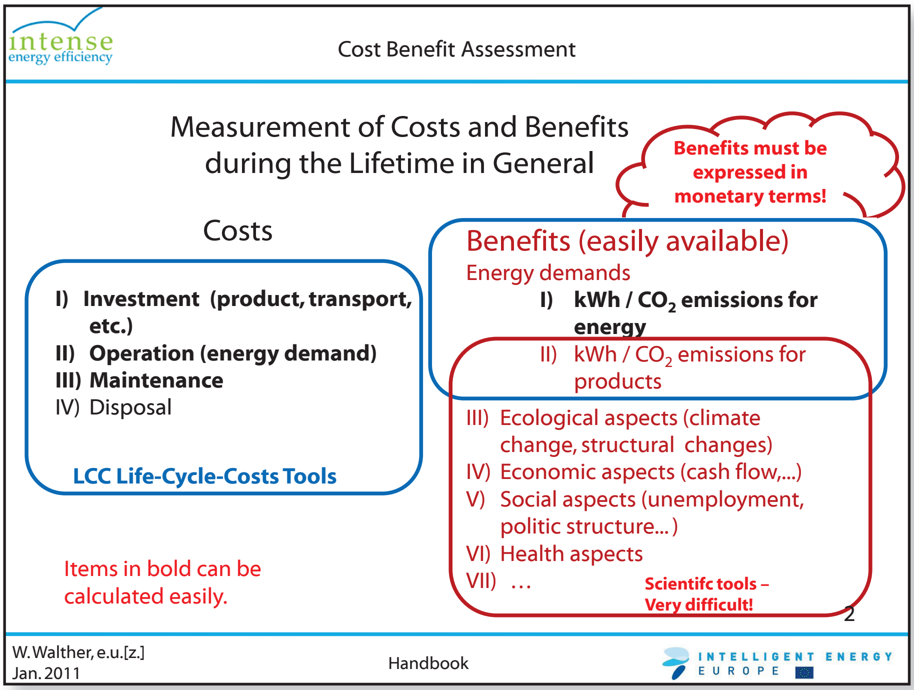
This "Cost-Benefit Assessment" module lists all costs and cost benefits in bullet point form and shows a pragmatic solution for the INTENSE themes of energy efficiency. Not all costs and cost benefits have to be determined—there is no need for it. We can carefully consider which costs have an impact and which ones less so, thus making it possible to carry out an assessment without any great effort.

In order to be able to make a decision regarding the different options, strategies, or designs (standard building, low-energy building, Passivehouse), all costs and cost benefits have to be determined and added up. Only then can a decision be made. If costs are hidden or not considered, the decision being made is certainly not sustainable.

It is the goal to develop a simple method.

The life span is often underestimated. For a wall or roof insulation, 50 years can be estimated. We have learnt from the past that, only after a complete change of use or sale of the object, changes are made. The cost comparison of different strategies can be carried out or the costs and cost benefits can be compared. It is possible to rank the strategies according to the comparison results or to determine the strategy with the best benefit-cost ratio.

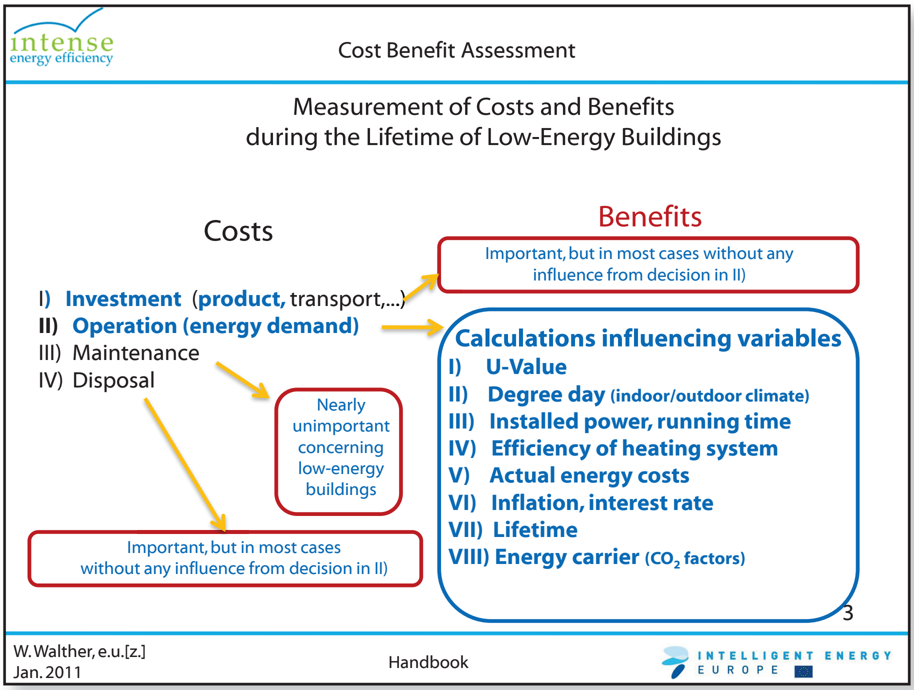
There are a lot of "science" lectures on this topic available. Keywords on the Web: cost-benefit analysis



The costs of a strategy must be added up for its life cycle. If the life span is chosen too short, the cost benefits arising during the operation phase would not be considered properly and wrong decisions will be made.

Since it is very difficult to establish a monetary value for the cost benefits, we will not carry out this step for the INTENSE project and introduce a simplification as has already been suggested in the LCC Life-Cycle-Costs Tools of the project "intelligent energy." Only the data printed in bold are used and CO_2 emissions are not converted into monetary values. The benefits are not given as a monetary value but as a much more easily calculated value called "energy content of the product" (kWh) and the energy consumption during its use (kWh). Provided that data are available, the energy consumption in kWh are converted into CO_2 emissions so that options with different energy sources can be taken into account.

The more factors of influence are reduced, the easier the calculation will be. In the slide after the next, we will choose the factors of influence that simplify the calculation, but without significantly affecting the result.



When we proceed with the argument that we should only calculate costs that are easily available, then we come to the following decision:

We calculate the costs of investment, operation, and maintenance and calculate the benefits either with the kWh of energy savings or with the total amount of savings. The benefits can be easily gathered from standard consulting software or calculation programs such as "Passivhaus Projektierung (PHPP) and CO_2 emission values in GEMIS.

In practice it has been found that additional criteria have no impact to speak of on the decision-making process (red frame). In the end we will also have a look at the following important criteria: manufacturing costs of the product and the energy costs over its lifetime (blue frame).

For example, if we set the INTENSE theme "low-energy building" and "Passive House", it will be sufficient to only consider and calculate the criteria highlighted in blue, without distorting the decision. Transport costs apply to all products and—in comparison to the energy consumption costs of II)—are rather minimal. Thus we can relegate the transport analysis to the back. The same applies to the maintenance costs. Disposal costs also apply to all products and—in comparison to the operation costs over many decades—have very little impact on the decision.

At this point it must be weighed as to whether the product costs must be inserted into the calculation at 100%. For the purpose of the assessment, it is quite legitimate to only use those costs that arise for a specific strategy in addition to the initial cost. The unavoidable costs may be subtracted.

The variables in the field highlighted in blue are values that play a role in the following example of the Payback Trainer.

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Cost Benefit Assessment

Comparison of Costs and Benefits

Ratio	Value	Comments
Benefits € / Costs €	-	Only if you can express benefits in monetary terms, can you get a benefit-cost ratio. Mostly the benefit in € varies across a wide range; thus the error margin is often high.
Costs / Saved energy Costs / Saved CO_2	€ /kWh € / tCO_2	The cost-energy savings ratio is most suitable to compare different strategies. It shows exactly which strategy is the best. The error margin is extremely low. No information about cash flow.
Payback period Different strategies	[year]	The period of time required for one (new) strategy to meet the same total cost as the other (older) strategy. The error depends on the actual costs and future costs for energy. No information about cash flow.
Monthly balance of costs **Different strategies**	**€/month**	**The monthly difference of the costs of the old strategy in comparison to the new strategy. In this way you can check the monthly cash flow.**

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This table shows various options how to determine key figures. All of the above-listed key figures have their advantages and disadvantages.

In order to determine a ranking for different strategies, the cost-energy savings ratio has proven to be most suitable. Decisions in the financial area are often based on the payback period. Is the payback period longer than the life span of the strategy/method, then it is obviously a pointless project. But it can also happen that the costs for the construction were set too high or too few cost benefits were calculated. In the example of the "Payback Calculater", the balance of the sum total of the costs of two projects are analyzed in such a way that an additional monthly financial charge is shown.

Benefits € / Costs €: If the value is > 1 the strategy is acceptable. A ratio >1 plus inflation rate à the strategy is more than positive

Costs / Saved energy: If the ratio € /kWh is lower than the actual price of energy, the strategy is very favorable and should be selected. If the ratio €/kWh is lower than the mean value of the price of energy during the lifetime, the strategy should be selected.

Payback period: If the payback period is shorter than the lifetime of the new strategy, then the strategy should be chosen.

Monthly balance of costs / Different strategies: In addition to the payback period, the strategies with the lowest monthly costs should be chosen.

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Cost Benefit Assessment

Table of Measures, Ratios and Decisions

Measure (Do-something scenario)	Initial investment	Maintance annual cost	Annual Savings	Life-time	Costs over life-time	Savings over life-time	Ratio cost / benefit € costs / saved kWh	order of priority	ratio: lower the actuall costs	ratio: lower the lifetime costs
	€	€/a	kWh/a	years	€	kWh	€ / kWh			
New pump 80W - 15 W	300	0	234	10	300	2340	0,13	6	no	yes
100 new light fitting 60W - 12 W	5000	0	13770	6	5000	82620	0,06	4	yes	yes
New condensed boiler	3500	80	6000	15	4700	90000	0,05	3	yes	yes
New Windows 10 m² U=2,8 U=1,1	4000	0	1462	30	4000	43860	0,09	5	no	yes
Attic floor insulaltion 100 m² U=1,2 U=0,2	8000	0	8600	40	8000	344000	0,02	1	yes	yes
Wall insulation 100 m² U=1,4 U=0,2	11000	0	10320	25	11000	258000	0,04	2	yes	yes

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The table shows various methods including their savings potential, cost-energy savings ratio, and the resulting ranking of the various strategies:

An old 80 W heat pump is replaced with a new 15 W pump. The cost is EUR 300.00, and over the next 10 years 2.340 kWh electricity are saved. This strategy is listed at place six and only becomes an economic choice when the electricity costs €/kWh rise within the pump's lifetime to above 0.13 €/kWh.

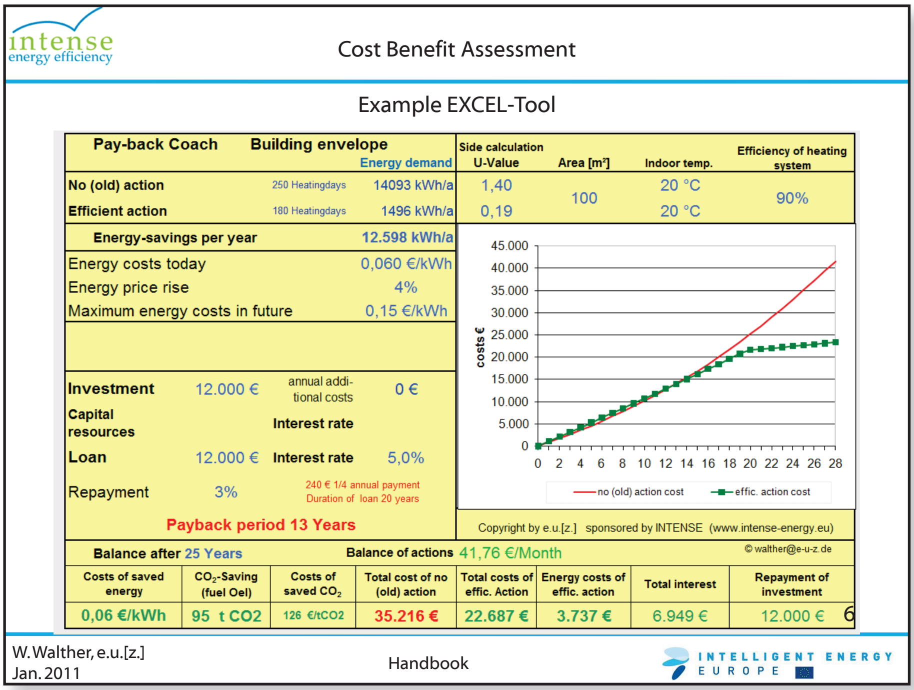
100 incandescent lamps are replaced with compact fluorescent lamps. This strategy is already economical today because the electricity costs per kWh saved are lower than the actual price of electricity.

A new furnace is installed. Again, the costs per kWh saved are lower than the actual heating costs per kWh.

New windows are only economical when considered over a longer period of time and include the total costs.

Insulating the ceiling of the uppermost floor is the most economical strategy.

Insulating an old masonry wall is also very economical, considering the current energy costs.

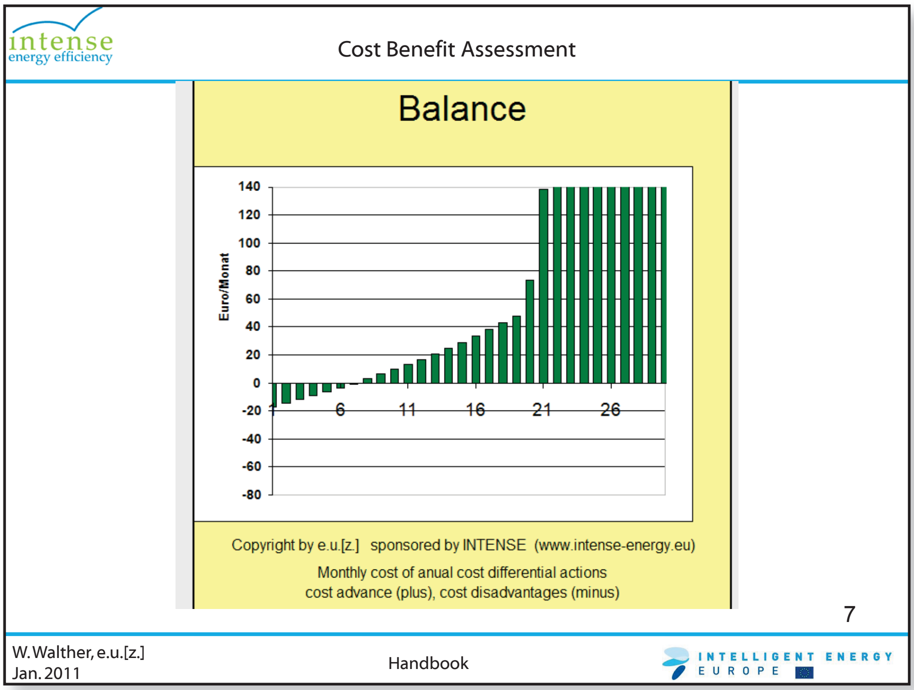


This slide shows the cost performance result of two strategies regarding the building envelope. In the graph the cost performance (energy costs) of an existing wall (red) is shown and the cost performance of an external wall with an efficient wall insulation, including an investment (12.000€) made through a line of credit with an interest rate of 5%. For the first 13 years, the cost performance of the energy-efficient strategy is slightly above the old strategy. Thus we have a payback period of 13 years. In the 14th year, the cost performance falls below the red curve (break-even line). After 20 years the credit is repaid (kink in the green curve) and only the lower energy costs are left to be paid.

The values in the side calculation show input values that describe the status of the building envelope and the heating system.

The three lines at the bottom are the resulting numbers. A balance and assessment are performed for after 25 years (lifetime). On average 41.76€ per month are saved over 25 years.

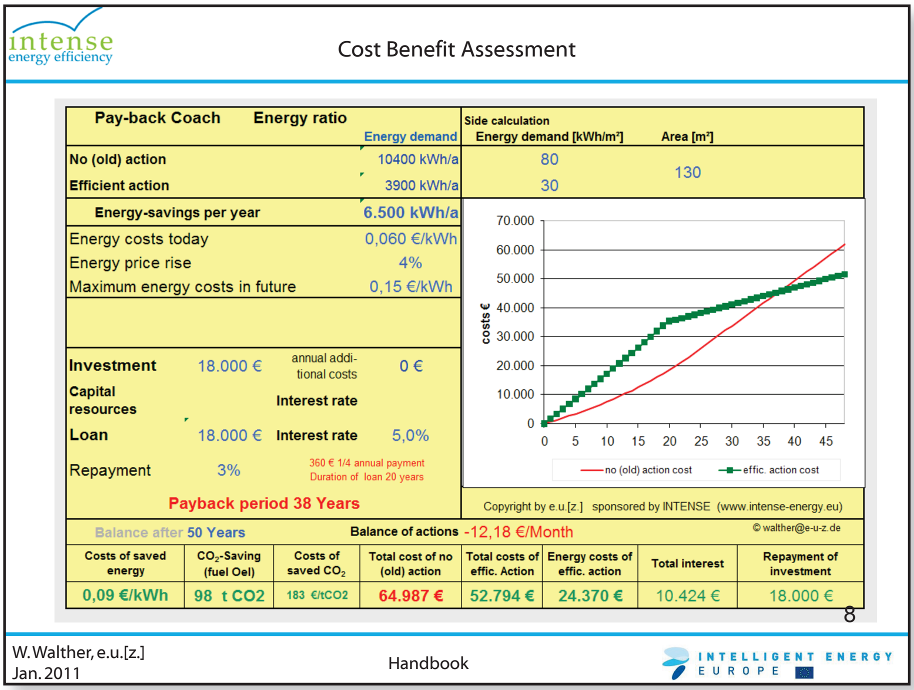
In the EXCEL chart, the calculations are made transparent. It is worthwhile taking a closer look at the individual columns and rows. The EXCEL-charts are available from e-mail: Walther@e-u-z.de



This graph shows an analysis and balance of the monthly financial situation for every year.

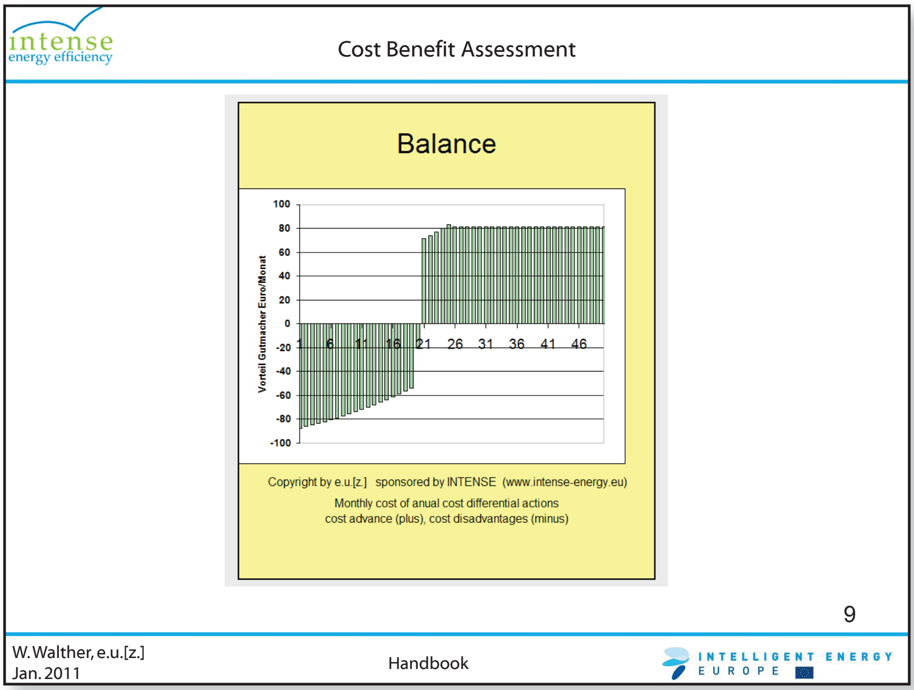
In the beginning the additional cost per month amounts to only 17 euro/month and decreases to 0 € in year 7.

After the 8th year, the additional cost turns into a positive value and continues to increase until year 21. After the 21st year, the financial cost amounts to more than 140 euro because there is no loan to repay.



This slide shows the cost performance result of two strategies regarding the whole building by using the energy ratio kwh/m^2. In the graph the cost performance (energy costs) of an "normal new house" (no action) is shown and the cost performance of an "passive house" (efficient action) including an investment (18.000€) made through a line of credit with an interest rate of 5%. For the first 38 years, the cost performance of the energy-efficient strategy is slightly above the old strategy. After 20 years the credit is repaid (kink in the green curve) and only the lower energy costs are left to be paid. Thus we have a payback period of 38 years. After the 39th year, the cost performance falls below the red curve (break-even line). The values in the side calculation show input values that describe the status of the energy-ratio and the heating area. A balance and assessment are performed for after 50 years (lifetime). On average 12.18 euro per month are saved over 38 years.

In the EXCEL chart, the calculations are made transparent. It is worthwhile taking a closer look at the individual columns and rows.



This graph shows an analysis and balance of the monthly financial situation for every year.

In the beginning the additional cost per month amounts to only 90 euro/month and decreases to 0 € in the next 21 years.

After the 22nd year, the additional cost turns into a positive value, that means that you save every month 80 euro with regard to the no-action curve.

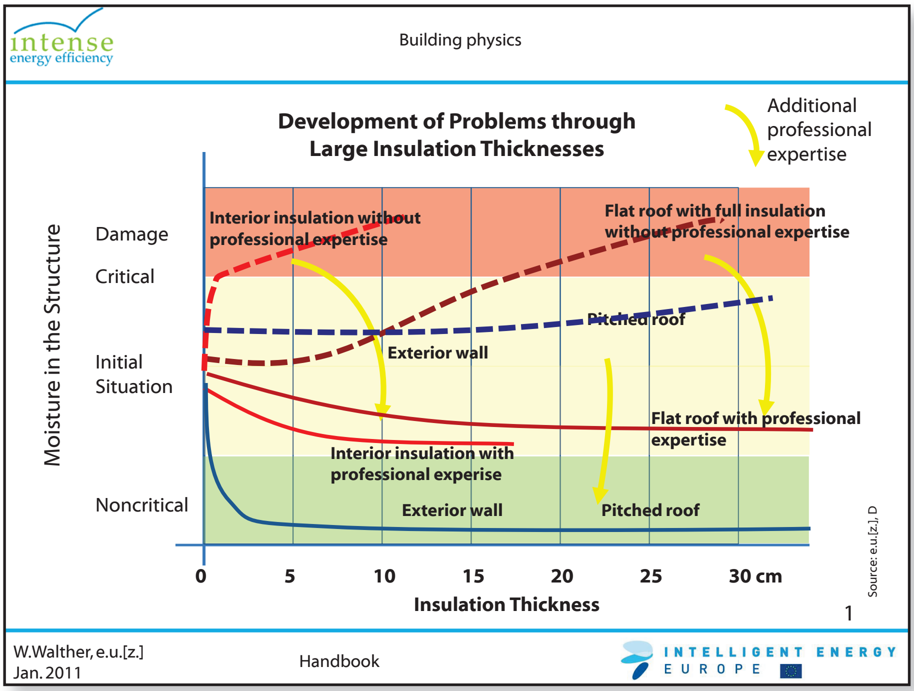
In summary, we can say that

… the additional cost is low.

… after the payback period the financial benefit is much greater than the initial additional financial cost.

… energy-saving strategies are always economical when the period under consideration is chosen sufficiently long.

… taking action makes sense from a purely physical as well as mathematical perspective.



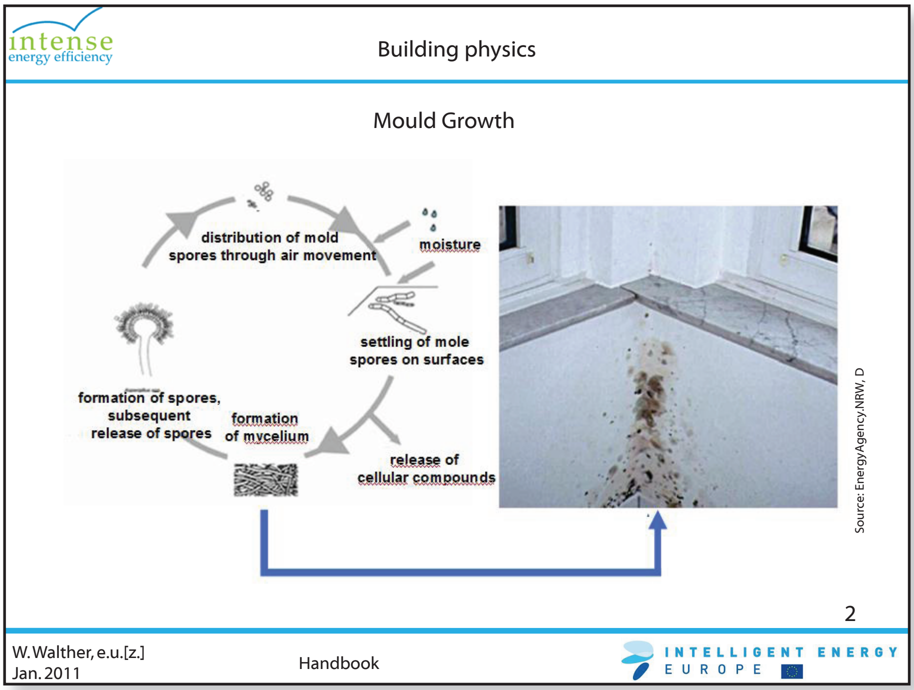
Despite large insulation thicknesses, the building envelope of the passive house can be implemented without any risks. However, this requires professional expertise with regard to mould prevention, thermal bridges, diffusion, and airtightness of the building envelope. The large insulation thicknesses of the building envelope differ in their impact on the moisture behaviour within the various structural components.

Exterior insulation and basement ceiling insulation cause the least problems. Exterior walls and pitched roofs in all systems of solid construction, wood construction, wood product boards, insulating materials, and exterior plasters are extremely durable. They can be installed in such a way that the structure remains dry and damage free. The only risk is in providing insufficient airtightness. The issue of airtightness has therefore gained special importance in building physics.

In the case of flat roofs, which cannot be ventilated because of their large insulation thickness, damage often occurs due to improperly dimensioned vapour retarders and the lack of airtightness. Professional expertise is very important in these cases.

As far as interior insulation is concerned, many critical issues need to be addressed that otherwise can easily result in damage, unless professional expertise is applied. The example of interior insulation is well suited to discuss the problems associated with thermal bridges, diffusion, and airtightness of the building envelope and how they can be avoided by installing the materials properly.

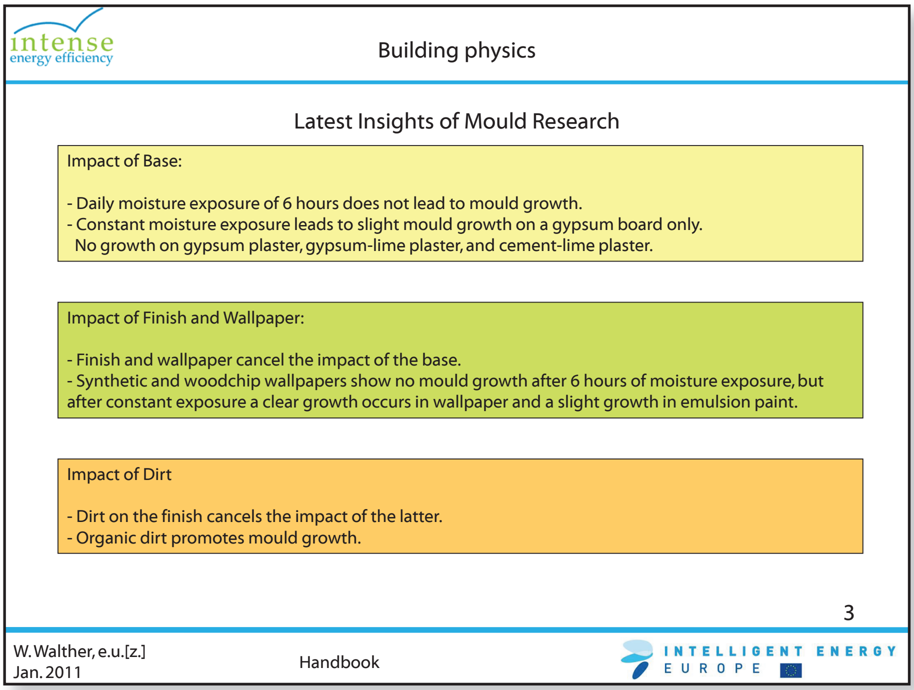
All efforts concerning the proper installation of materials focuses on avoiding moisture in the structure and thus mould growth.



Mould-like fungi belong to the microorganisms. They reproduce by producing numerous spores, which are ubiquitous. When appropriate climate conditions are provided, spores mature and form a mycelium. Food intake, metabolism, and reproduction take place there. Food consists of carbon and water. Carbon can be found in such materials as paint, adhesives, wallpapers, wood, etc., but also in fibers, dust, soap remnants. After a certain time period, fruit bodies grow from the mycelium, and the mould becomes visible. Then the fruit bodies produce spores that are dispersed through indoor air.

The photo to the right shows an outer corner with obvious mould growth. The growing conditions are reached only in the lower corner, and they are rather clearly defined. In the wall area away from the corner, the conditions are not reached and no fruit bodies are formed.

Mould growth is directly linked with indoor air humidity and surface temperature. The lower the surface temperature of the wall, the higher the moisture level in the surface of the building component. Mould spores are natural allergens. After repeated contact, they can trigger allergies in susceptible people.



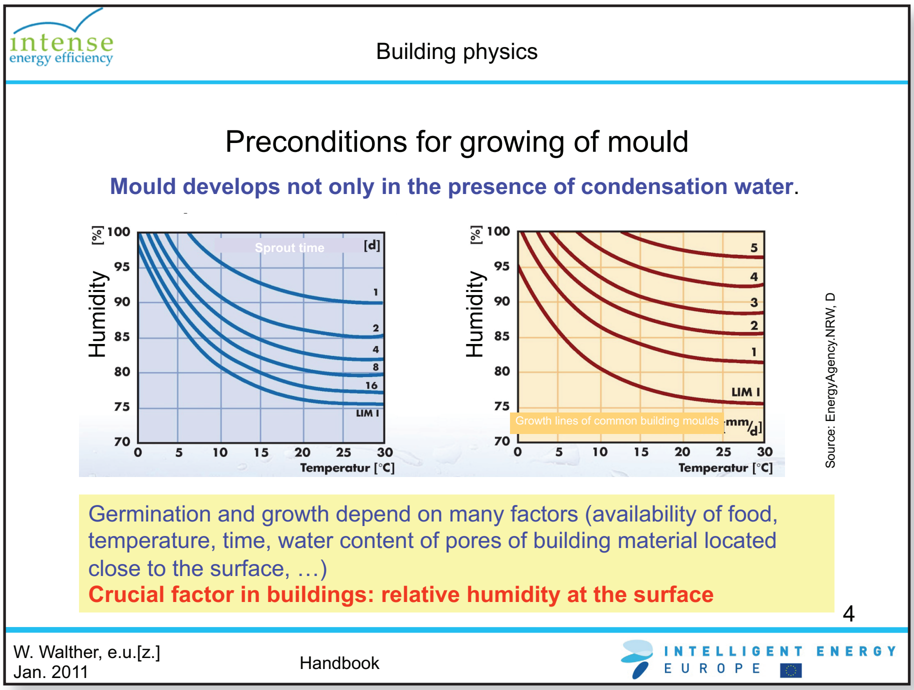
In order to avoid mold growth in buildings, we need to know its growing conditions.

In the figure above, the term "base" refers to materials that are newly installed or free of dirt. Surfaces of alkaline materials provide poor growing conditions.

A "constant moisture exposure" is equivalent to rel. air humidity levels above 80% air humidity.

Any finish contains "organic" compounds as a basic food source for mould growth. Fungicides in surface treatment systems have a "fungicidal" effect, which in most cases lasts only for a short period of time. Some months later, the active ingredient will have diffused into the indoor air.

Mould growth often occurs in locations where considerably more dust layers have accumulated. This is often the case on materials with great surface roughness or in hard-to-reach areas such as corners and edges. Mould growth, however, is also observed on smooth surfaces when the surface is a food source (soap remnants, oil film, aromatic substances).



Mould germination and growth rate depend on the temperature, but especially on the relative humidity of the surface of a given material. To be safe from mold growth, relative humidity levels need to be at least below about 75%. At temperatures of about 10 °C, the growth conditions are achieved at 80% r.h. (see graph).

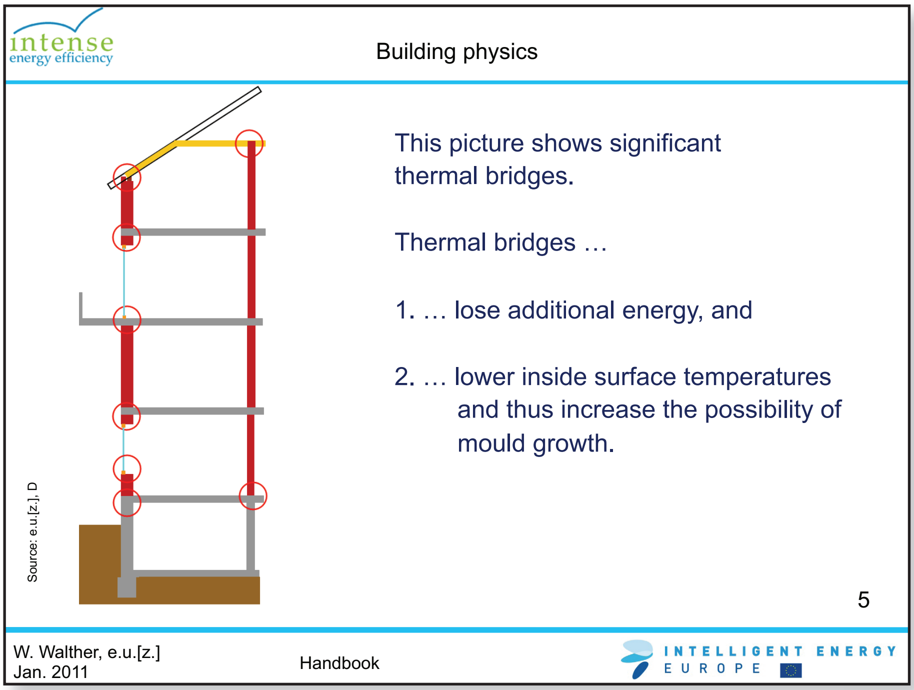
The mold growth remains dormant when the climate conditions are dry. Whenever (again) the growing conditions are reached, mould continues to grow. Owing to this special feature of mould, it can take very long before the mould becomes "visible."

Short-term moisture peaks are not an issue. Favorable growing conditions must be reached for more than 3 h/day in order that mould continues to grow.

At a given indoor temperature and relative air humidity of e.g. 20°C and 50% r.h., air humidity levels will be higher than 80% r.h when temperature levels fall below 12.6 °C.

The causes of mould and how to avoid them can be broken down into 6 topics.

1. Increase of Wall Temperature: exterior insulation, interior insulation, continuous heating. Do not allow rooms to become cool. Do not place furniture in front of outside walls.
2. Promote Low-Moisture Conditions: Ventilate for short periods of time and with open windows. Turn on ventilation system. Use space dehumidifier.
3. Prevent Moisture Sources: Do not dry laundry indoors. Cover aquarium (hamster instead of fish). Take a shower away from home. Cook with lids on pots (eat out). Cacti instead of palm trees.
4. Reduce Building Moisture: Protect construction site from rain. Do not use water-absorbing materials.
5. Ensure Airtightness of Building Envelope: Prevent leaks in membranes (especially in roof area). Seal around penetrations through membranes.
6. Miscellaneous: Use anti-mould finish. "Create" alkaline surfaces.



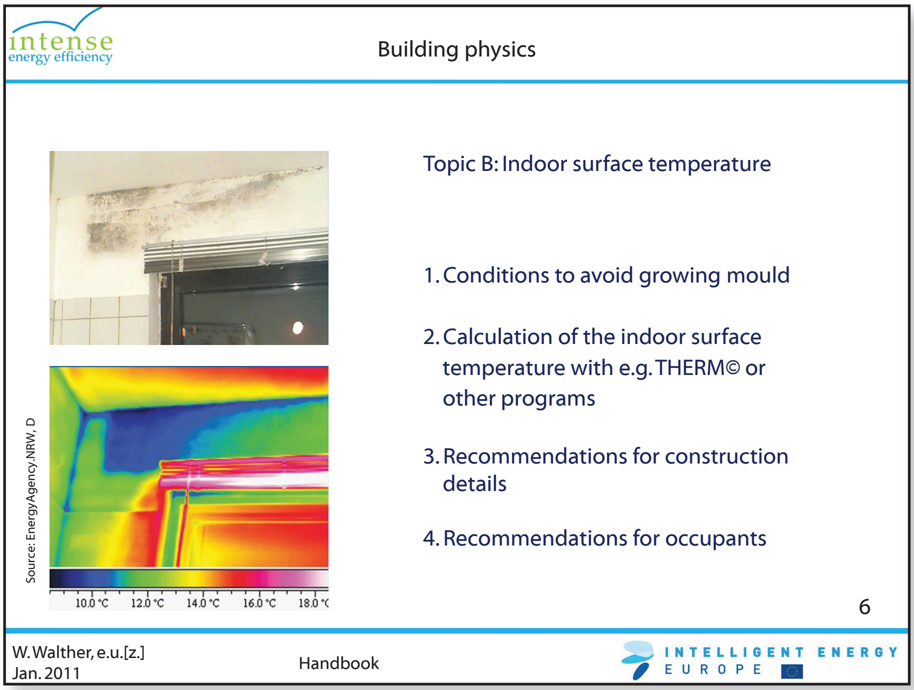
There are two reasons why we have to calculate and avoid thermal bridges. The additional energy requirement can be about 10-20 kWh/m^2.The inside surface temperature can be less than 12°C.

The building envelope of a passive house needs to be designed and installed in such a way that the impact of all thermal bridges are kept as minimal as possible. For a passive house this means: There are (almost) no thermal bridges!

Thermal bridges are avoided by covering all areas where building components are connected to each other with additional insulation, by not installing cantilevers (balconies), and by using load-bearing materials with minimal thermal conductivity (lambda < 0.13 W/mK).

Facts

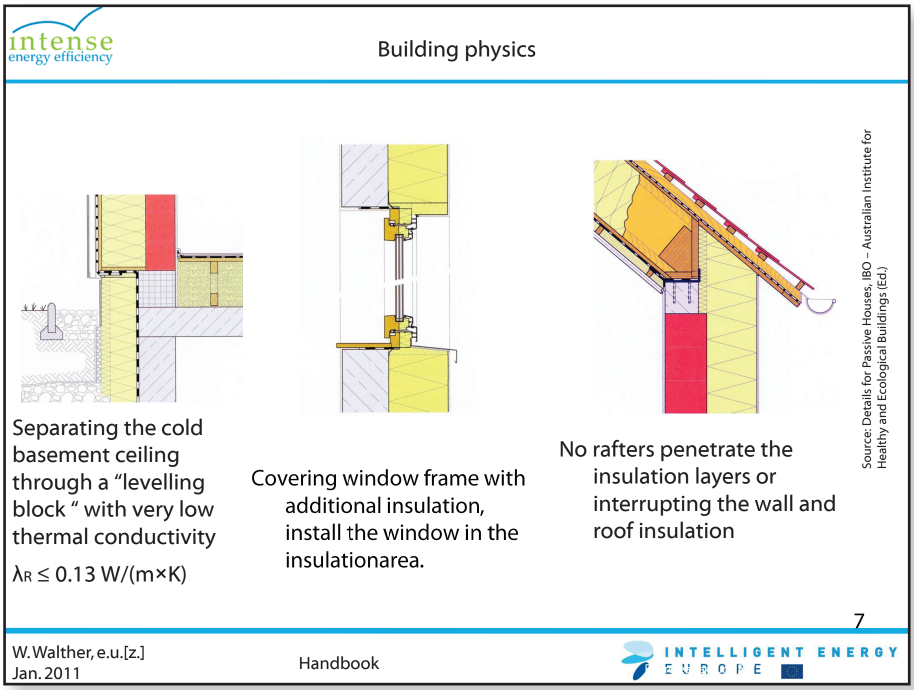
- In new construction it is easy to prevent thermal bridges.
- Exterior insulation eliminates a wide range of thermal bridges.
- Remaining thermal bridges in exterior insulation as well as interior insulation are acceptable concerning energy savings.
- Energy retrofitting of existing buildings is economically feasible despite the thermal bridges.



The two images show the same situation; the top one is taken with a normal camera and the bottom one with a thermal imaging camera.

The thermographic image shows in the temperature legend from green to blue an area of ca. 11°C ± 0.5°C.

It is interesting to note here that mould grows within a very small temperature range or not. More about this in the module "Avoiding Mould".

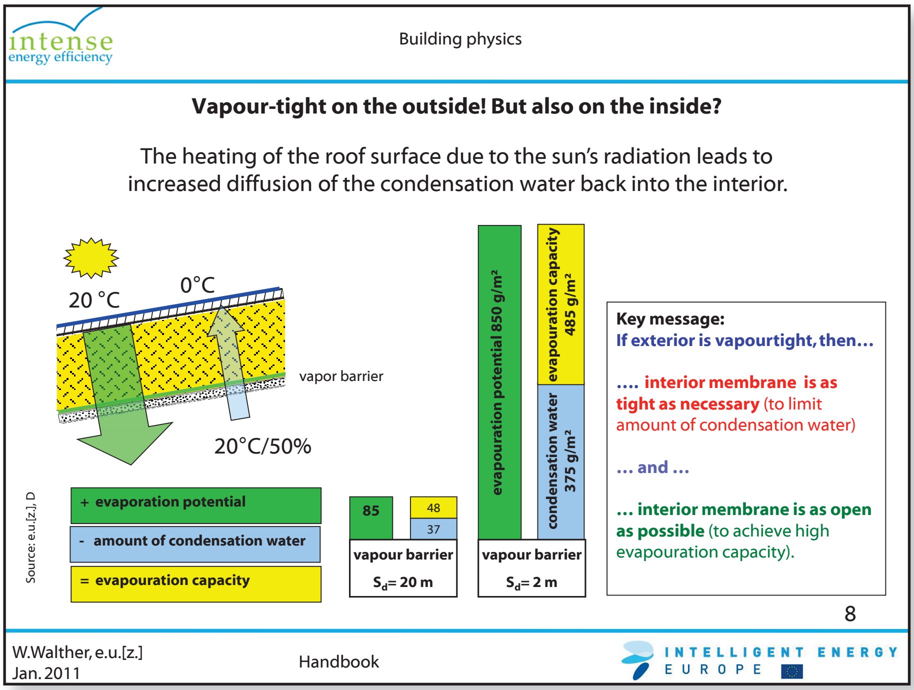


Passive house construction is easy to realize.

- Separating the cold basement ceiling through a “levelling block “ with very low thermal conductivity

λR ≤ 0.13 W/(m×K)

- Covering window frame with additional insulation
- install the window in the insulation area
- No rafters penetrate the insulation layers or interrupting the wall and roof insulation



If structures open to diffusion on the outside, they are free of risk! But if they are vapourtight on the outside?

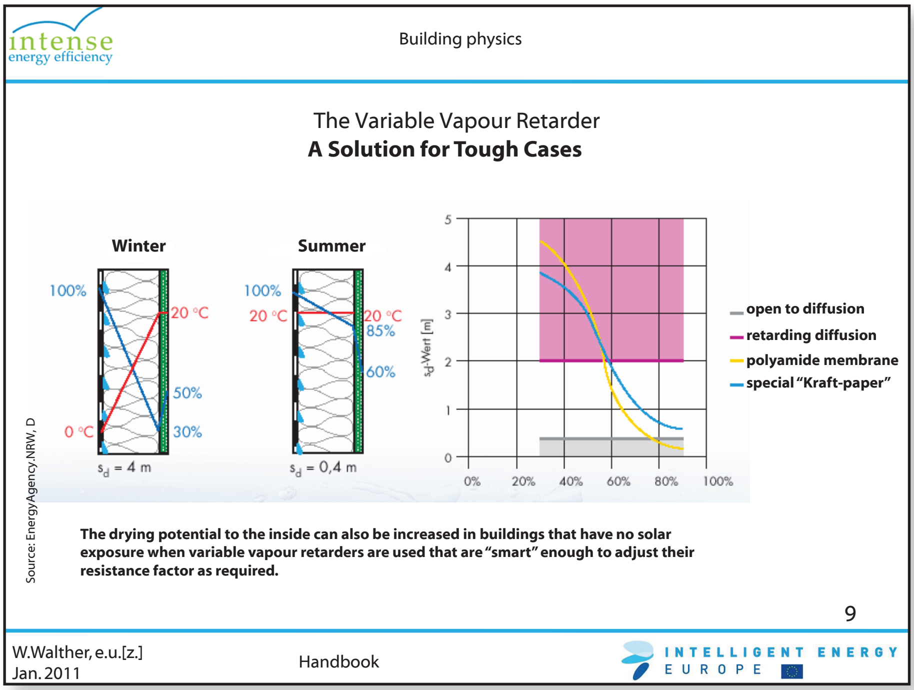
In flat or low-slope roofs without any ventilation between insulation and exterior membrane (watertight bitumen membrane and wood sheathing), condensation water caused by diffusion occurs at the wood sheathing during the winter season. In order to keep this water at a minimum, often an interior vapour barrier with a high resistance factor is chosen.

In the example above, vapour barrier has an sd-value > 20 and the amount of condensation water is only ca. 37 g/m2. At the same time, the possible evapouration potential during "summer" will be very small. Only ca. 85 g/m² can pass through the vapour barrier to the interior during summer.

If a vapour barrier with an sd-value of 2 m instead of 20 m is chosen, the amount of condensation water increases to ca. 365 g/m², but the maximum permissible value has not been exceeded yet (500 g/m² or 5 as mass percentage in wood sheathing). In comparison to choice 1, the potential amount of evapouration with 850 g/m² is higher by a factor of 10 and thus the structure has a higher "evapouration capacity". The structure is more "moisture safe".

If the structure becomes moist because of e.g. leaks and airflow from the inside during winter, this water can now move to the interior "without any problems."

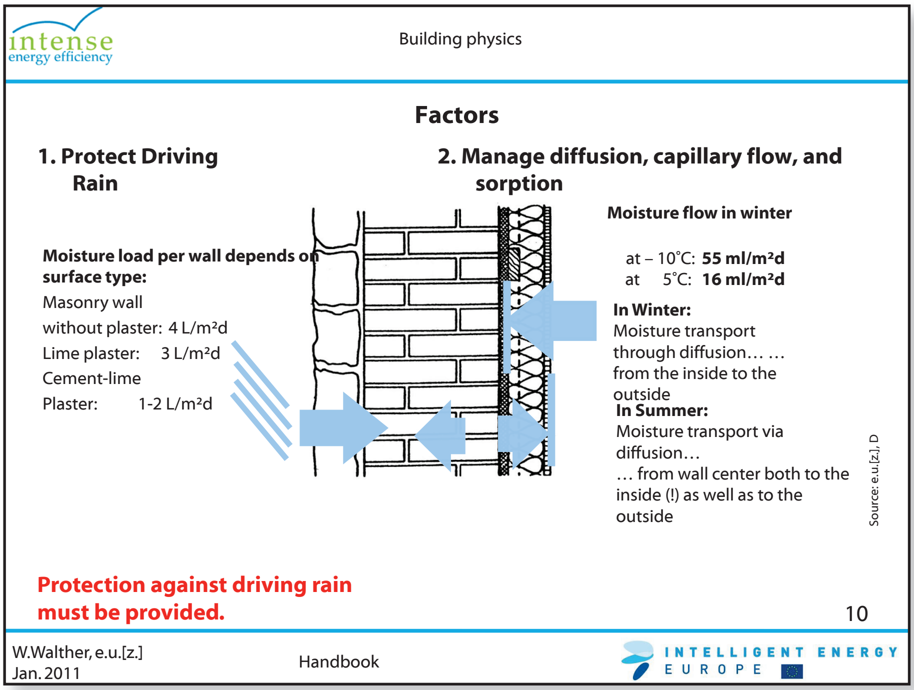
The driving force for the "back diffusion" is the increased surface temperature on the roof caused by the sun's radiation. The moisture of the wood sheathing moves to the cooler side of the structure, that is to the inside, and the structure dries out.



Many building materials have an sd-value independent of relative humidity. They are shown as a horizontal line (color column) in the figure. Wood and wood products, vapour retarder membranes based on paper as well as polyamide membranes and polypropylene liners change their sd-value depending on the relative humidity.

In winter, condensation water occurs at the sealing membrane of a structure with an exterior vapor barrier (left in above figure); the relative humidity is 100% r.h. The temperature increases toward the interior to 20°C in the insulation and the rel. humidity drops to a level of 30% r.h. The sd-value of the vapour retarder responds to the surrounding air humidity (ca. 40% r.h.) with a value of 4 m (yellow curve in graph).

In summer (solar exposure), the water on the now warm side evaporates and increases the air humidity in the insulation and in the wall assembly up to the vapour retarder to 85% r.h. The vapor retarder responds with an sd-value of 0.3 m, letting the water vapour pass through. All vapour retarders up to 0.3 m are considered to be open to diffusion; above this value they are considered to retard diffusion. Only from the sd-value threshold >100 m, they are called vapor barriers.



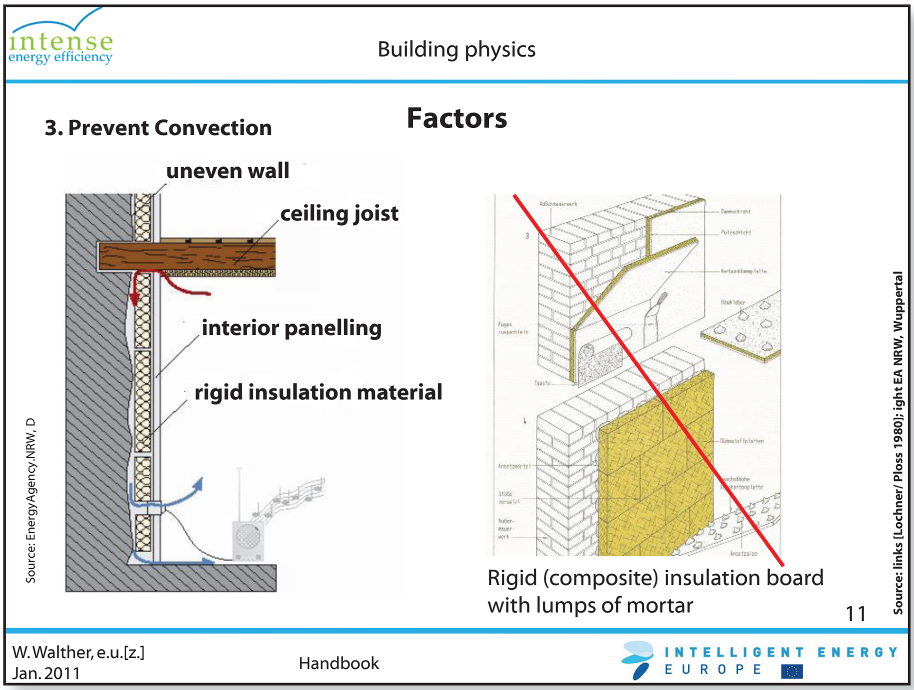
In general the interior insulation of exterior walls increases the moisture content of the exterior wall. Therefore it is important that the exterior wall is protected on the outside against driving rain. Since exterior walls can take up a great deal of rainwater this is a risk for interior insulations.

An important rule: **Protection against driving rain must be provided.**

A look at the exterior wall from the inside:

The interior insulation prevents the solid wall from heating up during winter. The surface temperature of the interior insulation is sufficiently warm to the inside but the solid exterior wall is cold. The water vapour moves from the warm side through the interior insulation to the cold outside. The amount of water vapour is low, and usually an accumulation of moisture in the solid exterior wall does not occur.

During summer the effect works the other way around: the water vapour moves from the humid, warm exterior wall through the interior insulation into the indoor space. If there is a vapour barrier on the inside of the interior insulation, there will be a problem. The water vapour can cause moisture in the insulation material and on the vapour barrier. In certain circumstances a vapour barrier can be dangerous.



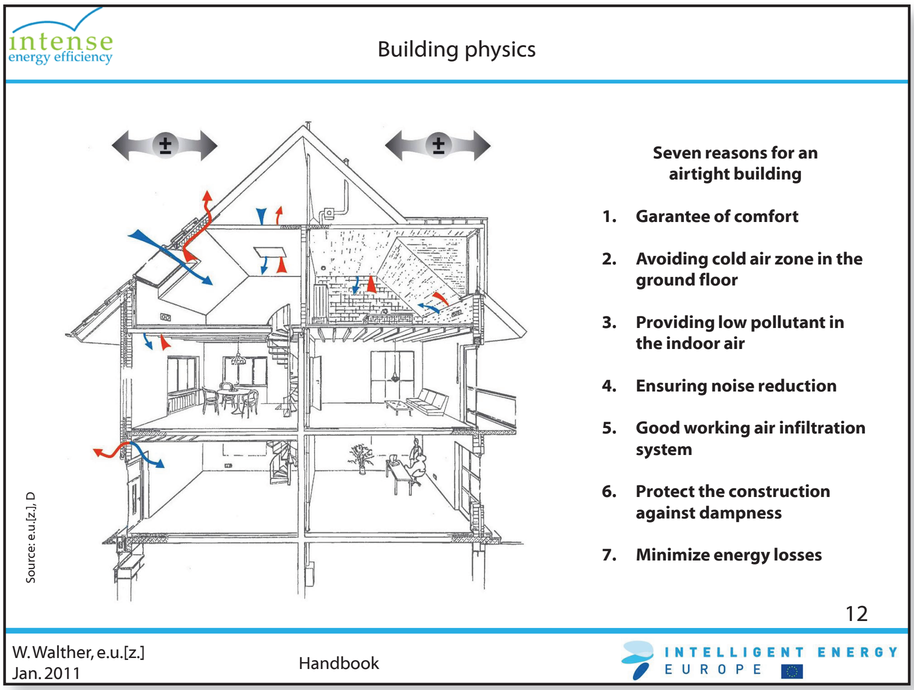
Removal of an old interior insulation made from gypsum board an Polysyrol, 5 cm thickness, shows some areas where mould has grown behind the insulation. The causes are quickly identified.

The interior insulation was attached with lumps of plaster to an uneven wall and leaving a gap. As a result warm (humid) indoor air flowed behind the insulation. The cold cavity becomes moist and mould starts growing. Conclusions for a risk-free insulation:

Avoid cavity between interior insulation and wall - Avoid airflow through a sealing layer.

There are many ways to plan and carry out an interior insulation. Many decision have to be made. Depending on the type of interior insulation system, other preparatory work has to be done and other decisions have to be made.

Remove windowsills - Move radiator unit - Fill recess alcove of radiator unit with solid masonry - Remove wallpaper - Remove plaster? - Remove old paint - Remove gypsum plaster - Improve base, adhesion - Extension of wires - Heating pipes insulated where facing exterior wall - Clarify details of ceiling connection - Clarify details of wall connection



Garantee of comforttableness: Through leakages cold air flows from outside into the building and causes draught. Draught can appear among others at windows and exterior doors but also at sockets.

Cold air zones: Even without the impact of wind, air flows out of the building envelope n the upper stories. Cold outside air flows coeval in the lower building zones. As the cold air is heavier than the inside air it arises a cold air zone at the ground. The effect: cold feet.

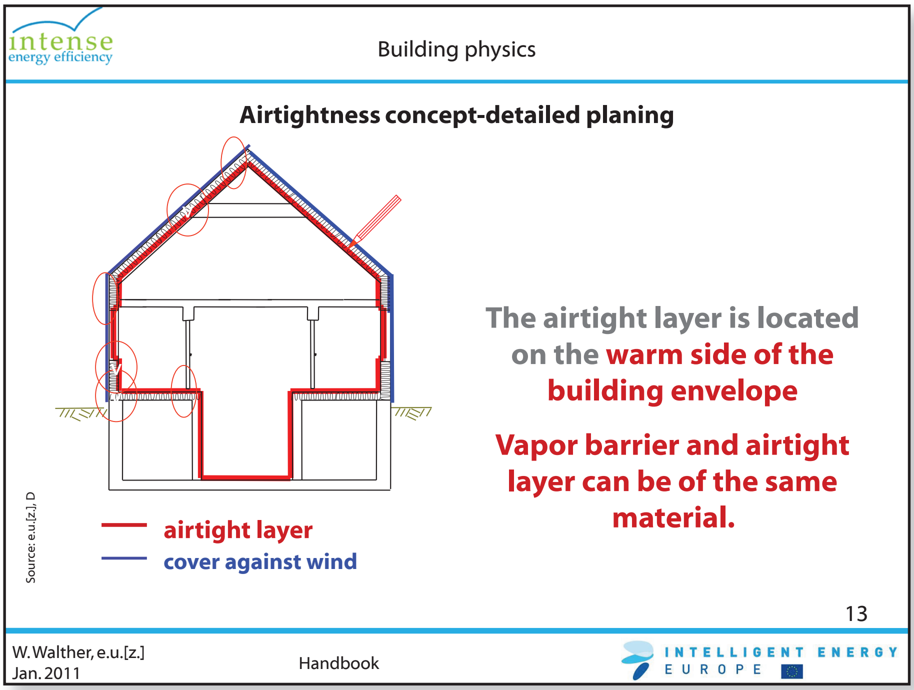
Avoiding pollutant entry: If indoor air flows through cavities in the construction the terms of growth of mildew and micro organism can be supported by the moisture (indoor air condensate in the void).

Noise insulation/protection: Noise protection is only achievable by tight joints and junctions of structural components.

Efficient working Ventilation system: A great advantage of ventilation systems (even simple exhaust-air units) is the constant and predictable air supply, the ventilation inside the building and the air removal. Outside air enters in living rooms and bedrooms (rooms with incoming air) and will transported outside in kitchen, toilet and bathroom (rooms with outgoing air). An airtight building envelope is essential for this, because leakages in the building envelope trouble the susceptible airflow. Air circuits/drifts can cause that some zones are not ventilated.

Protect the construction against dampness: Warm humid air goes into the insulation, condenses at cold zones in the construction and causes damages (dampness)

Minimize energy losses: If the air exchange per hour is - in case of leakage of the building envelope - about 0.3 [1/h] higher, the need for thermal heat will increase in the next 50 years about 15,730 m3 natural gas or liters fuel.



The required airtight envelope should be regarded in the choice of the building construction already in the stage of draft.

Similar to the thermal building envelope this layer must surround the entire heated building zone without any leak or other discontinuity at any building component.

In a multiple family dwelling the airtight layer serves the purpose to separate each apartment of the other and of the stairwell in an airtight way.

In the picture is shown a cross-sectional drawing of a building:

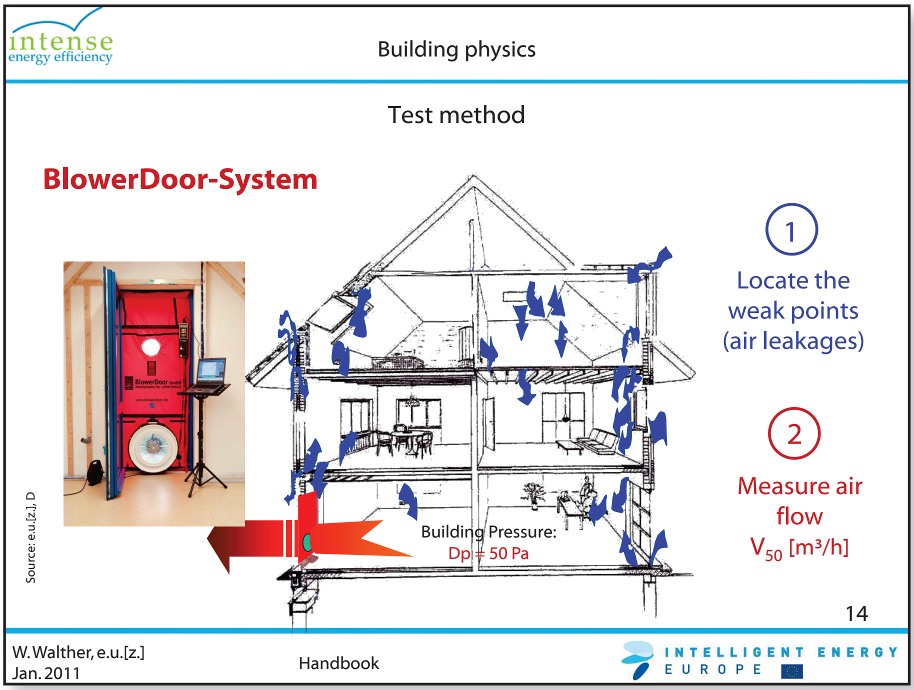
The airtight layer must be build in a way, that it could be drawn as a continuous line without any interruption around all construction components.

The airtight layer corresponds in most cases to the interior plastering of the outer walls and in the roof area to the vapour barrier on the inside.

It is important to lay this membrane in a second level behind the gypsum board.

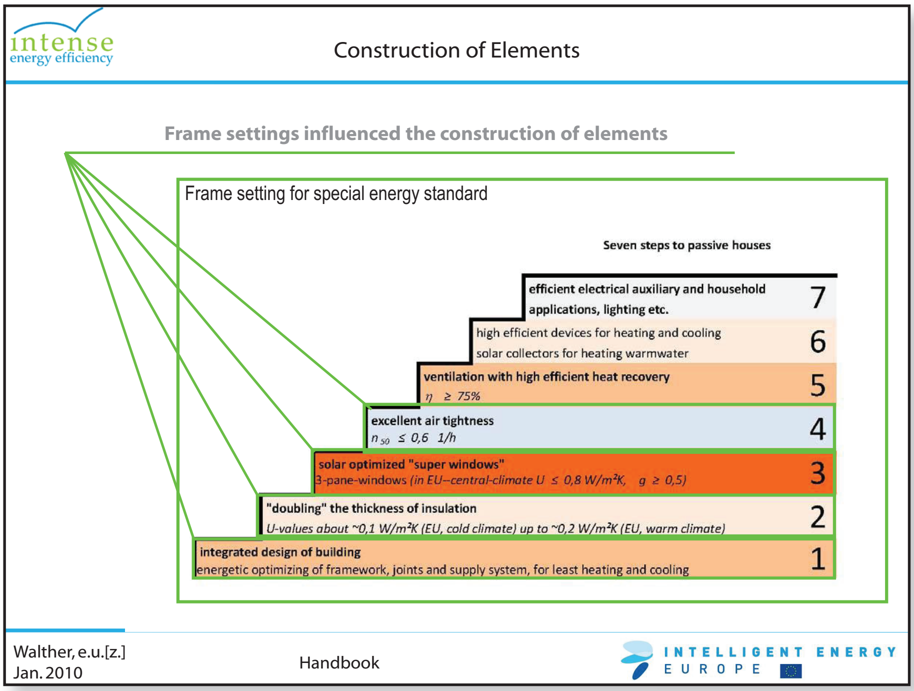
Thus it is eliminated, that cables and tubular feed through demolish the airtightness.

It should be used suitable materials for building airtight envelopes of notable producers, who offers compatible adhesive tapes and adhesive pulp in cartridges.



We check the quality of the air tight layer with the BlowerDoor system. A fan will be installed in the opening of an external door. With help of an adjustable aluminium frame with a nylon sheet and an opening for the fan, it is possible to fit it tightly in the door frame. Pressure measuring devices are installed to measure the differential pressure between inside and outside as well as the transported airflow rate.

The fan sucks air out of the building until the difference in pressure is 50 Pascal. During the time that the fan runs, air flows through gaps and holes that are in the building envelope. This leakages can easily be located. At the end of the test, the BlowerDoor-System measures the airflow at 50 Pascal and calculates the air change rate per hour. Software evaluates the gained dates and determines the parameters.

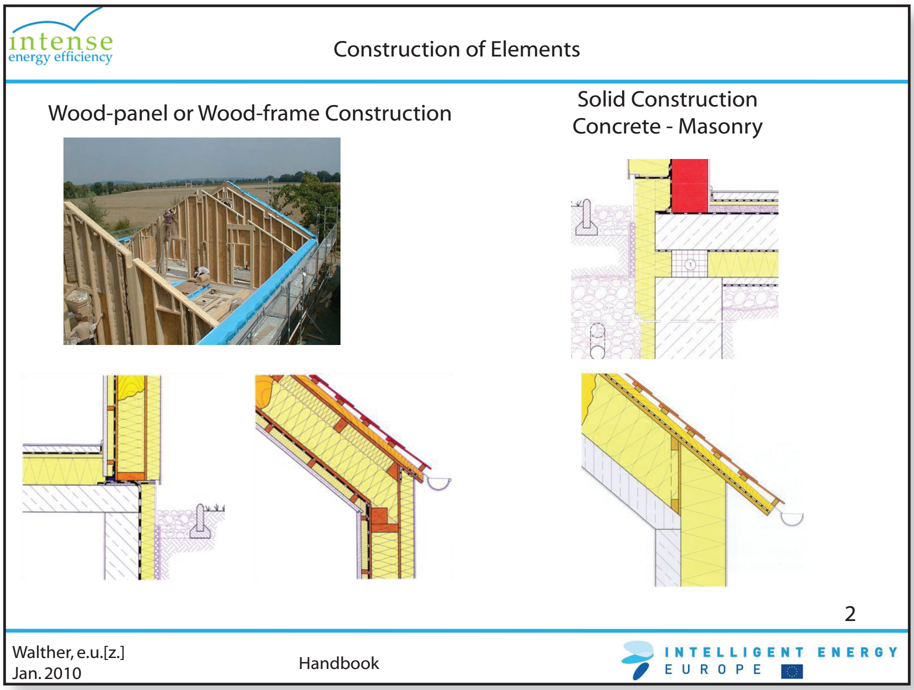


Which one of the typical „seven steps to passive house" has a linkage to construction of elements?

It demands several steps to realize a Passive-House

The construction of elements are mainly influenced by doubling the thickness insulation, the optimized installation of windows and the excellent air tightness of the building envelope.

The precise design and accomplishment of the building envelope has the deciding influence to the following steps of ventilation, heating und cooling and there efficiency .



The "Construction of Elements" module combines the topics

- Design principles
- Building physics
- Eco-materials

Passive houses can be built using different building methods.

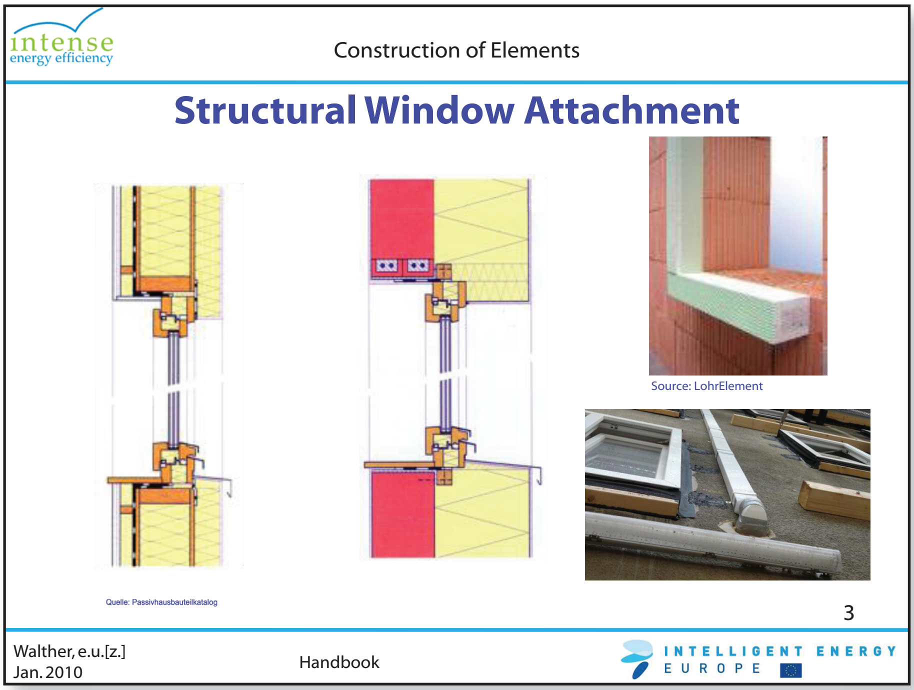
Wood-panel or wood-frame construction is the favourite choice. This is so because the thermal insulation can be integrated into the load-bearing wall structure, and thus all thermal bridges are minimized—without any additional efforts. The wall thickness is only about 4 cm greater than the thickness of the thermal insulation.

In the case of a solid construction, be it masonry or prefabricated concrete panels, thermal insulation has to be added to the load-bearing wall afterwards and thus increases the wall thickness for about 10-16 cm. Passive house construction has no thermal bridge so that no solid building component (rafter, concrete support, balcony) penetrates the insulation.

In order to eliminate the many thermal bridges in a solid construction in a very easy and cost-effective manner, the concrete is poured into prefabricated and insulated forms, or as an alternative the concrete foundation is placed on crushed foam glass.

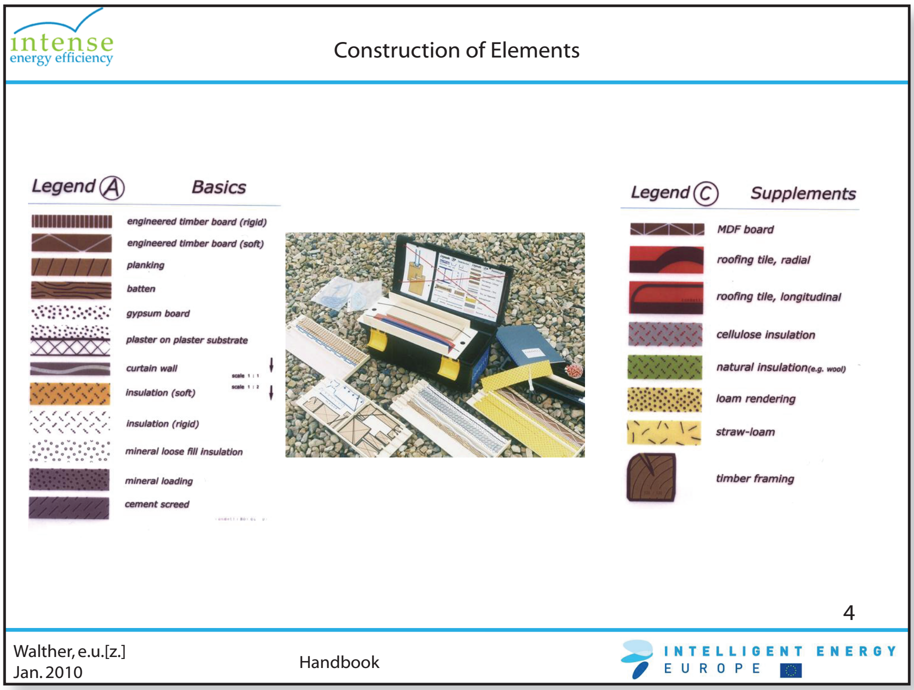
Solid walls are placed on a layer of foam glass insulation (levelling block) in the area of the basement ceiling or the foundation slab to avoid thermal bridges.

Using the above-shown planning examples, problems can be discussed and solutions can be optimised, including how to avoid thermal bridges, how to select and install insulating materials, how to determine the correct installation of vapour barriers and sealing tapes, airtightness, eco-materials.



Within the wall structure, the window should be placed in the centre of the insulation layer. This is easily accomplished in wood construction. In solid construction, however, the window is placed for economic reasons as shown in the picture above. Windows are fastened with metal brackets or on window beams, which are attached to the exterior wall. In all construction types, the window frame is covered with insulation material.

The picture above shows an exterior wall seen from the outside that has windows and ventilation ducts installed. The wood joists serve as a support for the window frame. The window is attached to the exterior wall with metal brackets, and an airtight seal is applied from the outside. The next step is to install a 24 cm thick insulation on the existing wall.



It is also possible to create a construction detail with the help of the pre-printed paper strips of the "Condetti System". The seminar participants are divided into teams that work on a detail in small groups of max. 5 persons and present their result to all seminar participants. This result of the small team can be discussed in the whole group and optimised even further.

The educational tool "Condetti" is very suitable and is used in Germany at trade schools, continuing education training centres, and even at conferences.

The Condetti Box contains five tableaus with colour strips for solid building materials (concrete, brick, aerated concrete, etc.) and building material cross-hatching (insulation, fibreboards, plasters, gypsum boards), joist cross sections, windows, and other building elements as well as pins, threads (vapour barrier), measuring scale, marker pens, scissors, and other accessories required for the display at the pinboard. The construction detail is pinned to the softboard at the scale 1:2.

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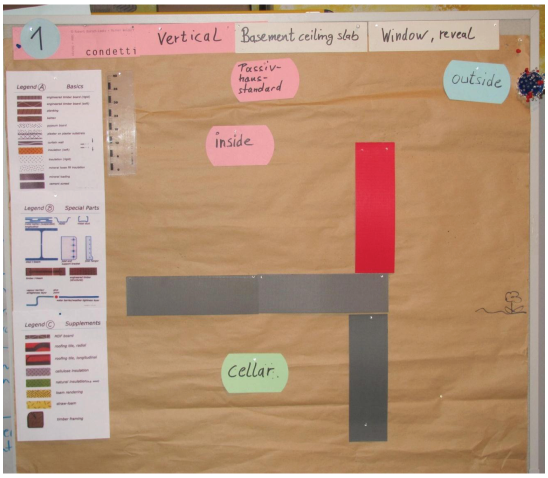
Construction of Elements



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First situation of a new construction is given. We can see the concrete basement (cellar) and the brickwall (red). The task is to create a passive house and provide a solution for a window reveal.

The team discusses the situation, determines the materials and insulation thicknesses, and pins a joint solution to the softboard.

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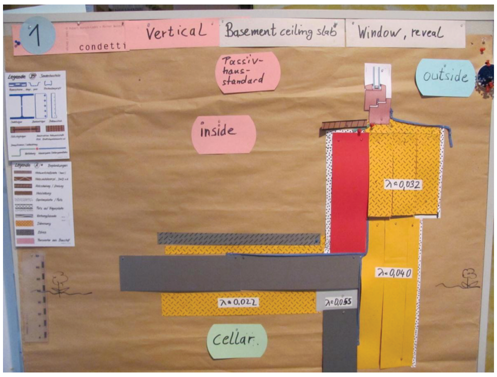
Construction of Elements



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The team presents the result:

The basement ceiling is insulated from below. The thermal bridge of basement ceiling/basement wall can be avoided by placing the concrete on a foam glass insulation. The thickness of the exterior insulation is specified with ca. 30 cm. The window is fastened to the exterior wall with metal brackets, covered with insulation and made airtight on the inside of the solid wall. The interior plaster is applied across the entire wall area up to the basement ceiling.

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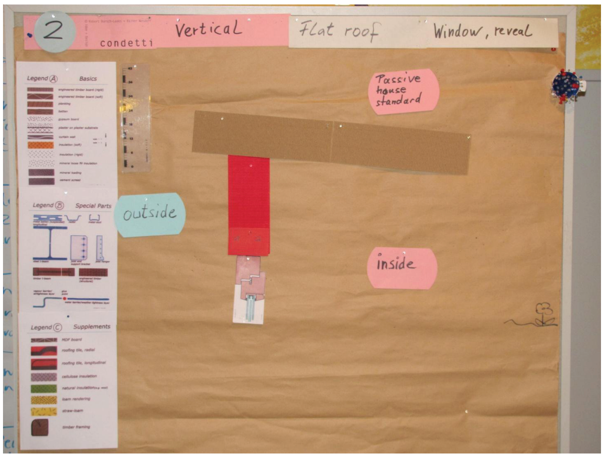
Construction of Elements



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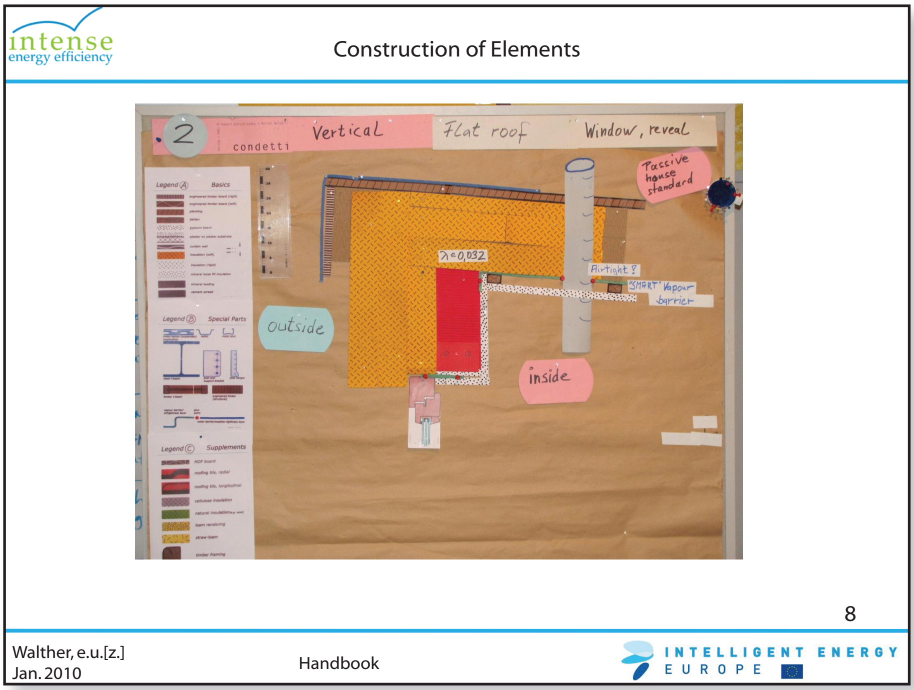
Second situation of a new construction is given. We can see a flat roof construction and the brickwall (red).



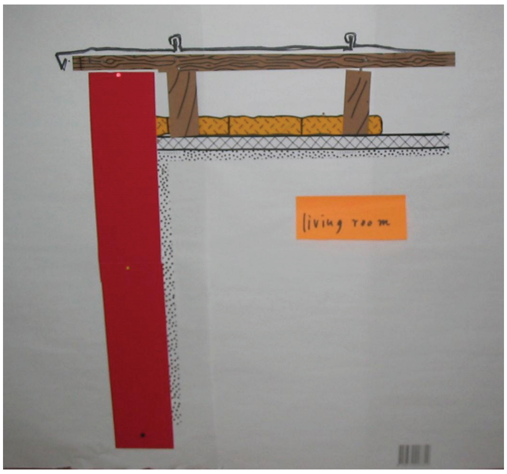
The team presents the result:

The exterior wall receives a 30 cm thick insulation on the outside and reaches without any gap to the roof insulation with 30 cm on top.

The vapour retarder (vapour retarders must change their sd-value, depending on the relative humidity) also acts as the air barrier, which is why the barrier is very carefully sealed. The vapour barrier must also form an airtight seal around all walls, ducts.

In order to ensure a fully functional roof structure, it must be checked if the flat roof needs to be ventilated. Depending on the outdoor climate of a given region, ventilation requirements can vary greatly.

Construction of Elements



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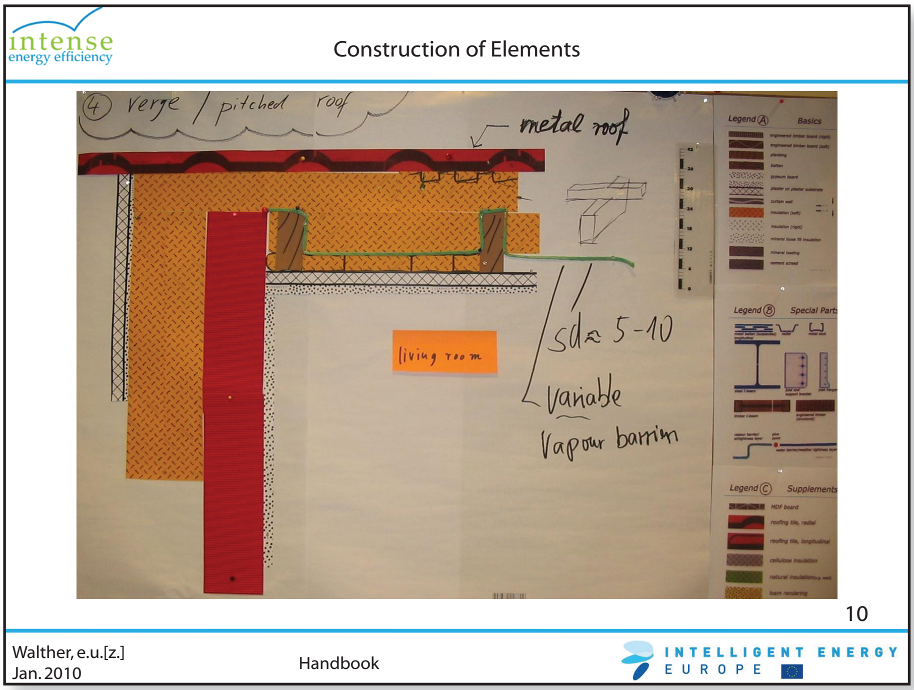
This example shows an exterior wall (gable wall) with a roof (metal roofing). The room is occupied and shall not be disturbed during the renovation. The pitch of the roof features wood wool panels and cement plaster. There is some insulating material between the rafters.

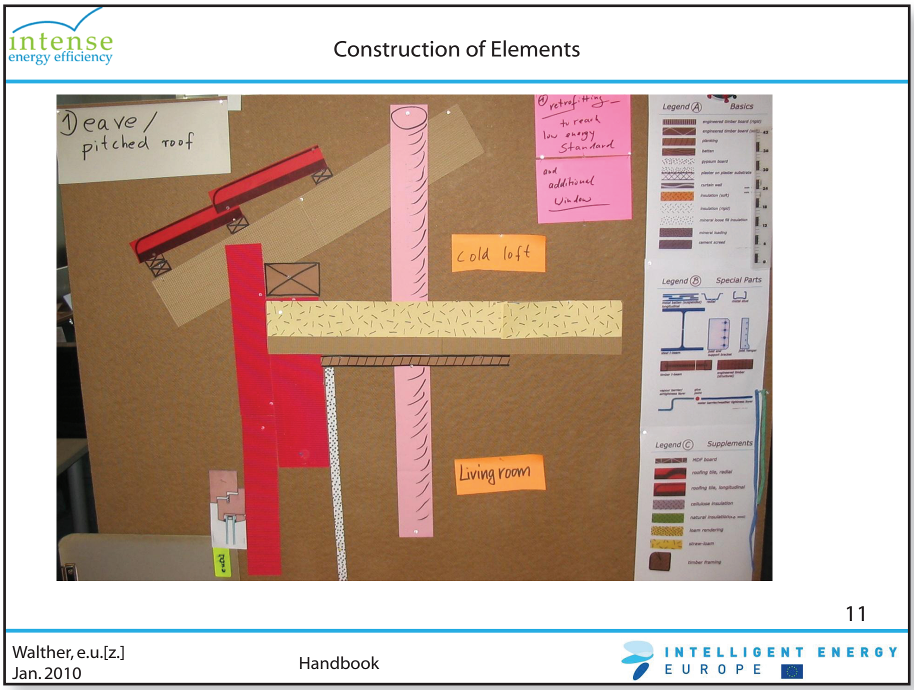


The team presents the result:

The roof is insulated from the outside. The total thickness of the insulation is 30 cm. The old insulating material is used and put over a variable vapour barrier, which is put across the insulation and the rafters. The vapour barrier also acts as the air barrier, which is why the barrier is very carefully sealed. The vapour barrier must also form an airtight seal around all walls, ducts. In order to increase the insulation thickness, an additional layer of insulation is put across the rafters above which the metal roof is installed.

The exterior wall receives a 24 cm thick insulation on the outside, and the top of the wall must also be covered with insulation.

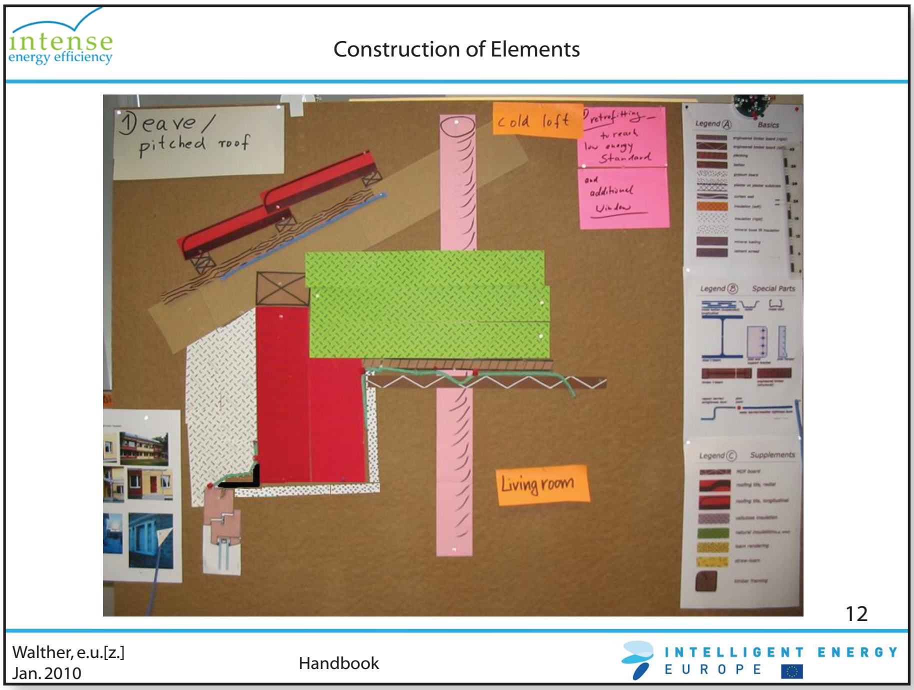
In order to ensure a fully functional roof structure, it must be checked if the metal roof needs to be ventilated. Depending on the outdoor climate of a given region, ventilation requirements can vary greatly.



This is an old building situation that is to be modernised. As a next project, a window needs to be installed and we need to find a solution for the sealing of the ventilation duct between the living space and attic.

Other additional planning requirements include:

- Low-energy standard
- Attic will not be used as living space in the future
- Window is to be installed without any thermal bridges



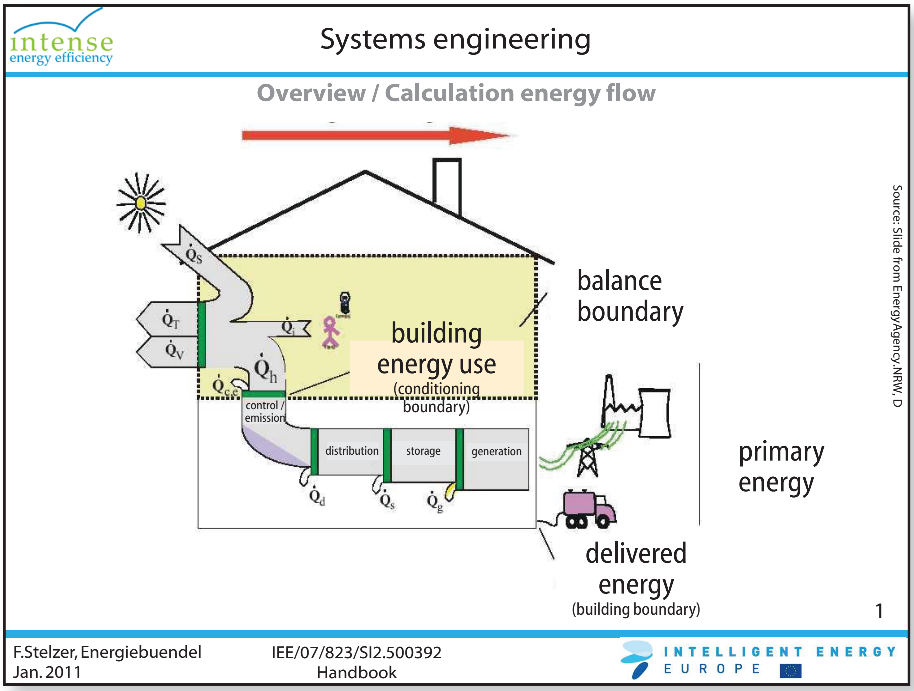
The team presents the result:

The uppermost ceiling is insulated; the old clay infill between the rafters is removed and then a 30 cm thick insulation is installed.

With metal brackets, the window is installed in the centre of the future insulation plane. Airtightness is created from the outside (green line) by gluing a plastic tape along the window frame and the exterior wall (red dots).

The exterior wall is insulated with a thickness of 24 cm, and the window is installed. The interior ceiling cover is taped with an air barrier attached to the duct, and below that an insulating fibreboard is installed. The air barrier membrane is also glued to the interior plaster.

The Condetti material also allows for a very detailed planning. On paper cards materials can be identified with thick felt pens, adding notes about the installation or the order of individual installation steps.



HVACR is Heating, Ventilation, Air Conditioning and Refrigeration, meaning all the building equipment and appliances. Including hot water, which is used mainly in domestic houses but also i.e. in schools an sport facilities.

To calculate the energy demand of passive houses first the balance boundary and its energy balances are defined. Next step (and beginning of this topic) is the efficiency of the ventilation system and the further steps are the therefore necessary energy usage, losses, the delivered energy and finally the primary energy. The comfort of the passive house is affected by the systems as well and designing must consider it!

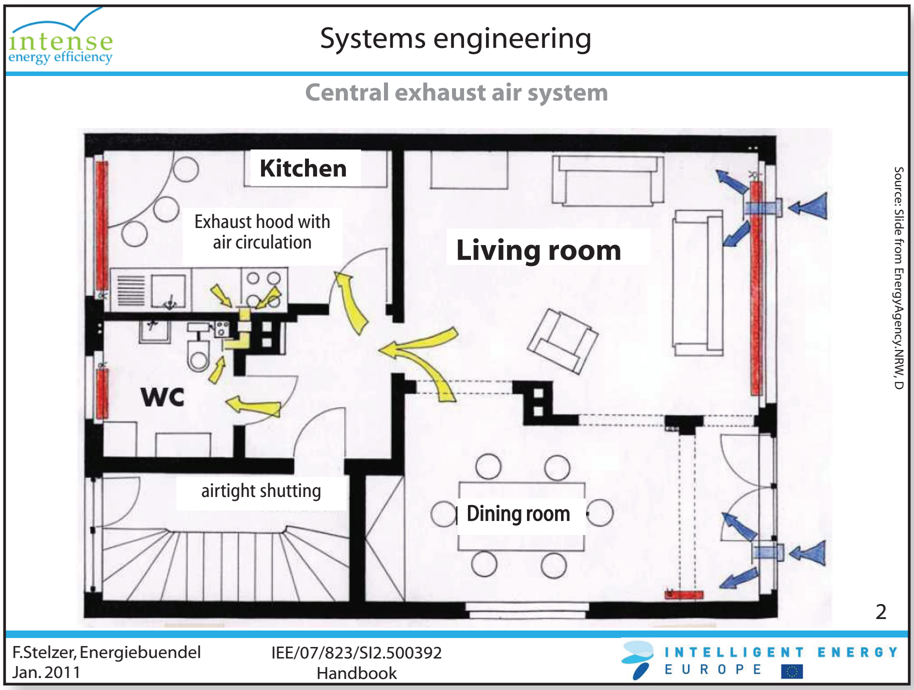
All of the system equipment has a huge influence on the energy efficiency of the building or even settlement. The difference between energy demand and delivered energy is main, but not the only object of this topic. Also there are descriptions of important technologies of minimizing energy demands.

The target of this module is to introduce important technologies that provide energy efficiency and if possible are based on renewable energy resources in all of the appliances. These should be judged with SWOT-Analysis, which is shown in an example.

Therefore the relation of energy demands for the different energy types (Heating, Cooling, Hot Water, Ventilation) as well as the criteria of indoor comfort will be considered. In an holistic view settlement planning and architectural design influences strongly the energy demands and should be kept in mind.

The slides shows the important calculations steps from used to delivered energy:

Control / emission, distribution, storage and generation.



The ventilation system is a central part of an passive house. Normally only systems with heat recovery are used. This is the system with the most influence on comfort, hygiene, heating and cooling. Also building physics is influenced.

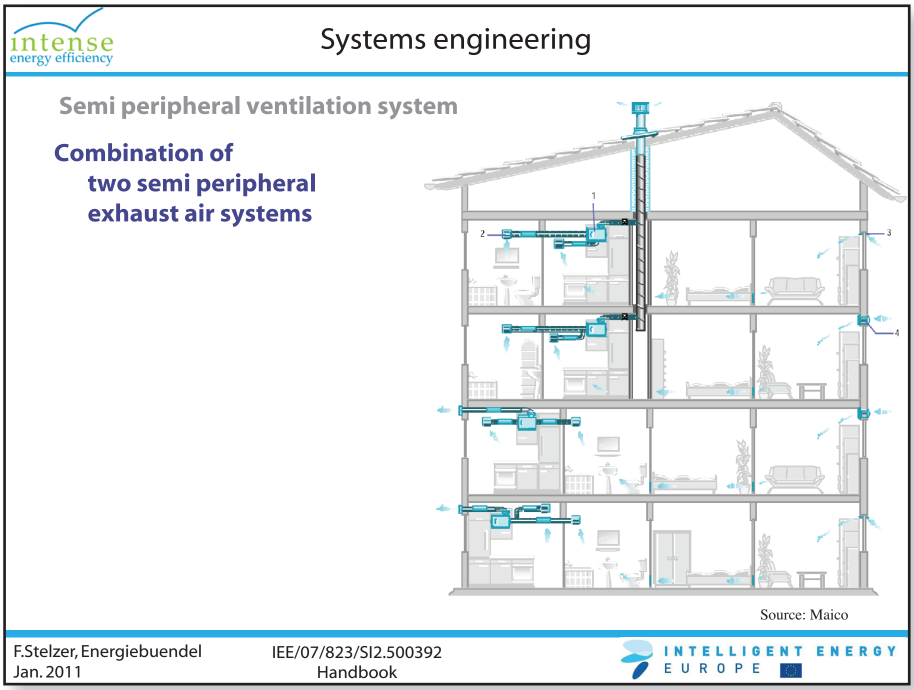
All the elements of a ventilation system are important and there are huge differences between ventilations units for housing buildings and non-residential buildings.

Speaking about ventilation systems in apartment houses, the air is generally used several times, i.e. there are rooms with fresh air supply (living room, dining room, study, children's rooms) with an supply air valve, there are transfer air rooms (hall, corridor, staircase) with slots under, in or above the doors and finally exhaust air rooms (kitchen, bath, toilet) with further valves (see slide).

For municipal buildings this is also a possibility of designing. But usually there are supply **and** extract air valves in each office, classroom, conference hall etc.

The slide shows the basic principle for a very simple system. Good for explaining and understanding. For more complex buildings like central ventilation units in office buildings the principle is the same but the supply air is brought with ducts and valves to the offices and meeting rooms.

The amount of the air change rate depends on design principles variing by the type of usage (Office, class rooms, toilets etc. The most common parameters for the design of the air quality are CO_2, H_2O and VOC content.



The basic design of ventilation systems are

- Peripheric systems are usually installed in walls or windows (good for retrofitting, systems with an high heat recovery ratio for passive houses are available).
- Semi central systems are with some conditionings centralized in the building, other conditionings are local in single housing units or rooms.
- Central ventilation systems are usually for housing units with heat recovery only.
- Central AC units are the most completed systems with all kind of air conditioning.

The slide shows a combination of different semi peripheral systems. It is the same for ventilations system with heat recovery. In one single apartment one own central system is the same like in a single family house. The upper one has some central parts, in the chart just a duct. In systems with heat recovery also the heat exchanger as well as the filters could be central.

The variety of system setups is huge and this slide shows a not very well known system.

intense energy efficiency

Systems engineering

Heat recovery systems

System	separated supply and extract air possible?	Humidity recovery	Moving parts	Heat recovery ratio (without condensation)
Recuperator - cross flow - counter flow	no	no	no	45 - 65% 60 - 90%
Water recirculation system	yes	no	yes	40 - 70%
Heat pipe	no	no	no	35 - 70%
Rotation heat exchanger (without hygroscopic coating)	no	yes (little)	yes	65 - 80%
Rotation heat exchanger (with hygroscopic coating)	no	yes (good)	yes	65 - 80%

Source: Data from Recknagel-Sprenger

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F.Stelzer, Energiebuendel
Jan. 2011

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There are different types of heat recovery (HR) systems. The classic one is the recuperator, which is mainly used in residential buildings.

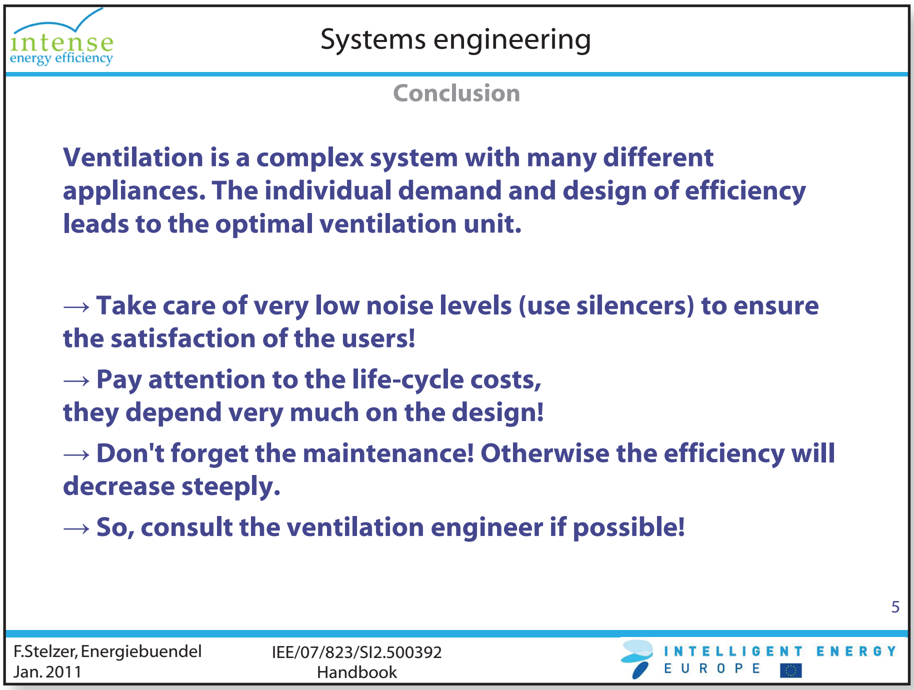
In the big central AC units the counter flow systems are not used, the crossing of the big ducts is not that easy.

In these cases for efficient HR rotation heat exchangers are the best choice but they require more space. Additional to the indicated numbers the HR (enthalpy recovery) ratio is even higher considering the humidity recovery.

The most expensive systems are
- the heat pipe, which has no moving parts and
- the water recirculation system, which is used in case of space reasons.

Beside the ventilation itself, which is necessary, the heat recovery is the central part for saving energy and for the parameters of a passive house!

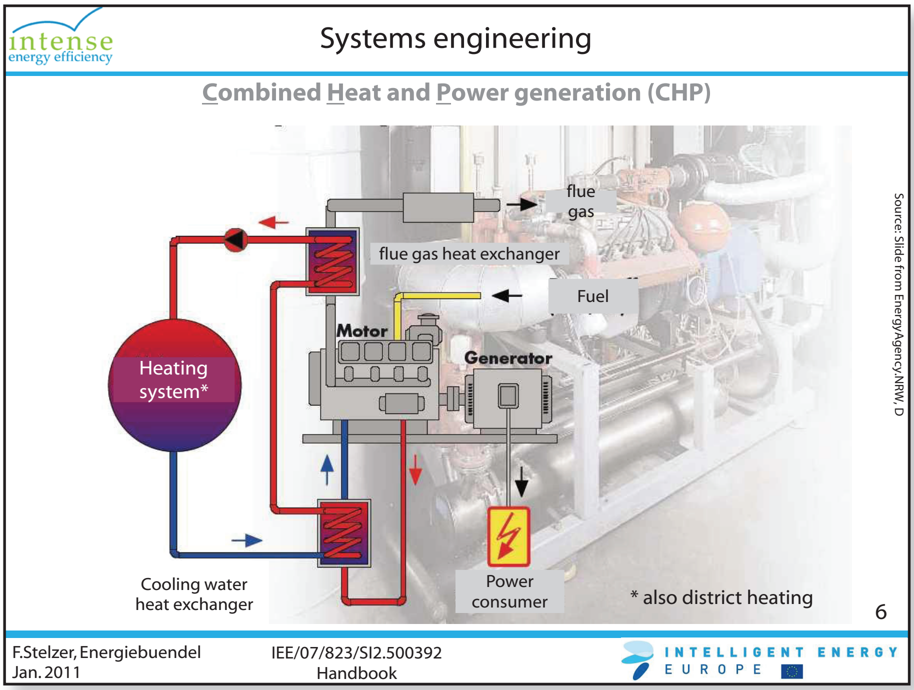
Beside the heat recovery ratio the duct design concerning the pressure drop as well as the fan itself are the main elements for an high efficiency



Beside the power consumption the filter change is an expense factor. And resulting, if cleaning is necessary, too! So take big filters with optimized life time cycles to reduce costs here. Filter selection is beside the energy consumption a maintenance factor.

In the conclusion the point of comfort and acceptance is new and important! The system should be used and accepted, otherwise the base for an efficient operation is missing.

And reducing noise is another part of environmental protection.



Passive houses usually still need a heating after optimizing the energy demand and ventilation. One basic part is the type of radiators, heating surfaces or damper register in the ventilation system. On the other end there is the most popular part of the heat generator itself:

One possibility to deliver the heat in municipal houses is a CHP. Mostly realized just for the base load.

Therefore the electrical power consumption is the main design parameter. Usually the CHP should run 4000 to 6000 h/a.

The motor drives the power generator. The cooling water of the motor heats the heating water in first step and in the second step this is done by the flue gas.

The substitution of the big fossil fuel power plant is only possible with a big number of local, small and very efficient power plants. This is possible by cogeneration of heat and power. In first step most of them still use fossil fuel, in the second step regenerative fuels as biogas or plant oil can be used.

There are two important systems of the configuration:
- independent, usually controlled by local demand of heat
- as virtual power plant controlled centrally according to power demand of the electrical power grid.

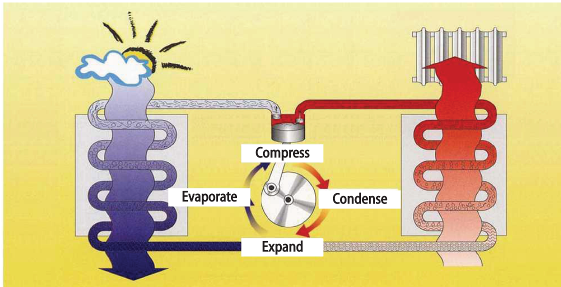
intense energy efficiency

Systems engineering

Heat pump principle

Strength:
- comfortable
- efficient for low temp. heating

Weakness:
- needs electrical energy
- not efficient for hot water systems
- only about 30% renewable energy*



Source: Slide from EnergyAgency.NRW, D

Opportunity:
- efficient low temp. base load
- efficient in combination with cooling
- combination with CHP

Threads:
- skill enhancement of craftsmen
- local production of renewable electrical power

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* for Germany

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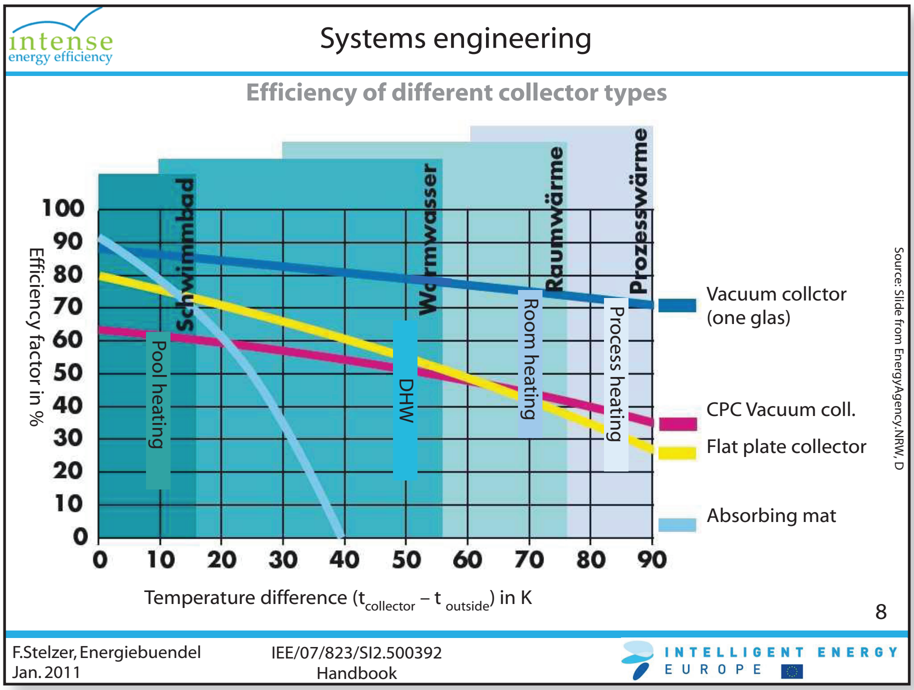
Especially in office buildings as passive houses with no hot water consumption the heat pump can be very efficient. The thermodynamical process of the heat pump is the same as of the classical fridge in each household.

On the left side is the heat source, on the right side the heat consumer.

The relativly high amount of electrical energy is needed by the motor. In a gas heat pump the motor is driven by gas and you can use the additional heat from the exhaust air for heating.

A gas heat pump usually has a nominal capacity of 100 kW or more. Just now there are some new developments of units with less power.

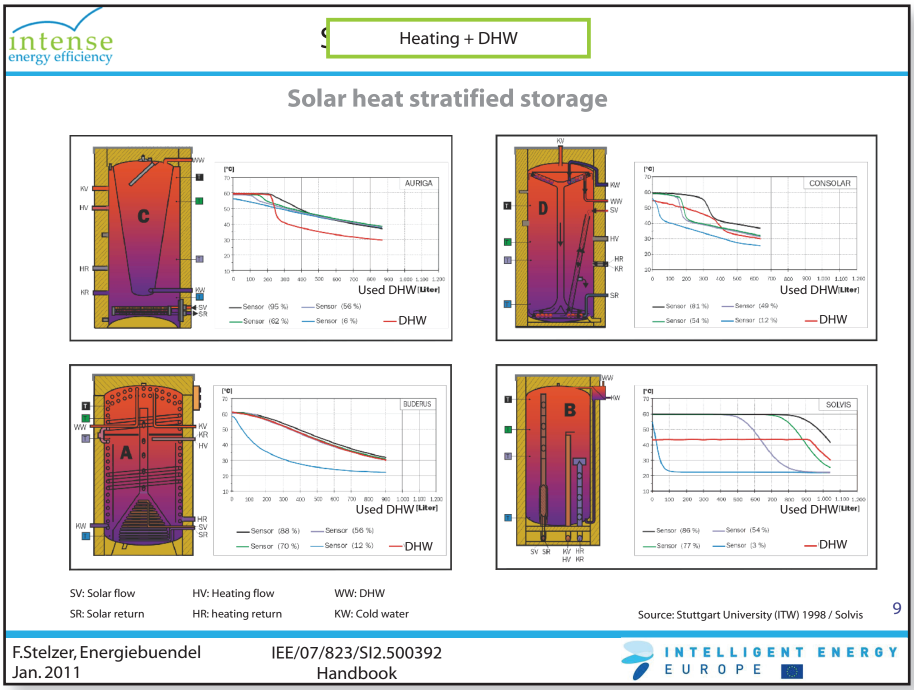
This slide is an example for a SWOT-analysis. SWOT stands for Strength, Weakness, Opportunity and Threads. Such a slide you can add for every system. Of course, the arguments may vary from country to country.



Beside using heat pumps there are other possibilities to use renewable energies: Thermal solar collectors and wood boilers mainly based on pellets as a standardized fuel as well as many other possibilities

The efficiency of different solar collector types shows clearly, which collector should be used for which usage.

The selection of the appropriate system depends on the building parameters and the necessary temperature levels. How much area is available, what orientations and inclinations are possible? In what system the heat is used?

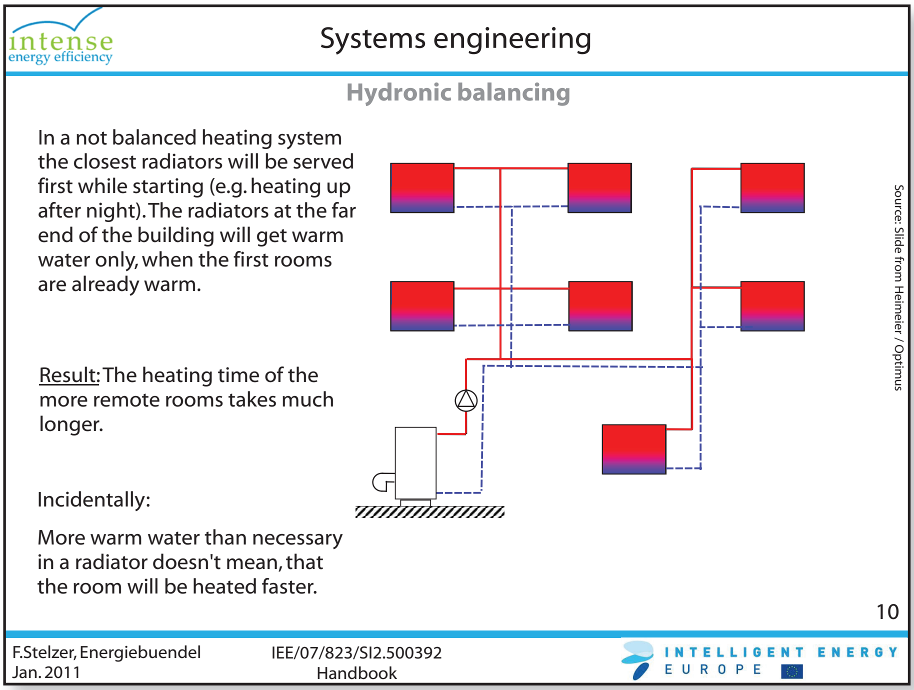


Efficient heat generation is one important part of a heating (or DHW, cooling) system but also the storage, distribution and control and emission are important to get a completly efficient system.

As a conclusion of the generation part are the two points:
- the selection of an individual applicable combination of renewable energy resources and possibly fossil boilers is the big challenge. There is no general reciepe to decide, which system is the best.
- for the selection of the best system examine the conditions at the site: shading, possible heat sources etc.
- consider at least the demands of energy:
  At what temperature levels are they?
  How is the relation between the different demands?
  How will the demands develop in future?

In many cases the discussion of efficient heating is reduced on the selection of the heat generator. But this is by far not enough. All other components as storage, distribution and control and emission have an important influence on the efficiency as well!

As example the slide shows differences of efficient hot water storages as stratified storages. The red line in these graphs indicates the temperature at which hot water can be used. It shows that the different storage types do have different properties!



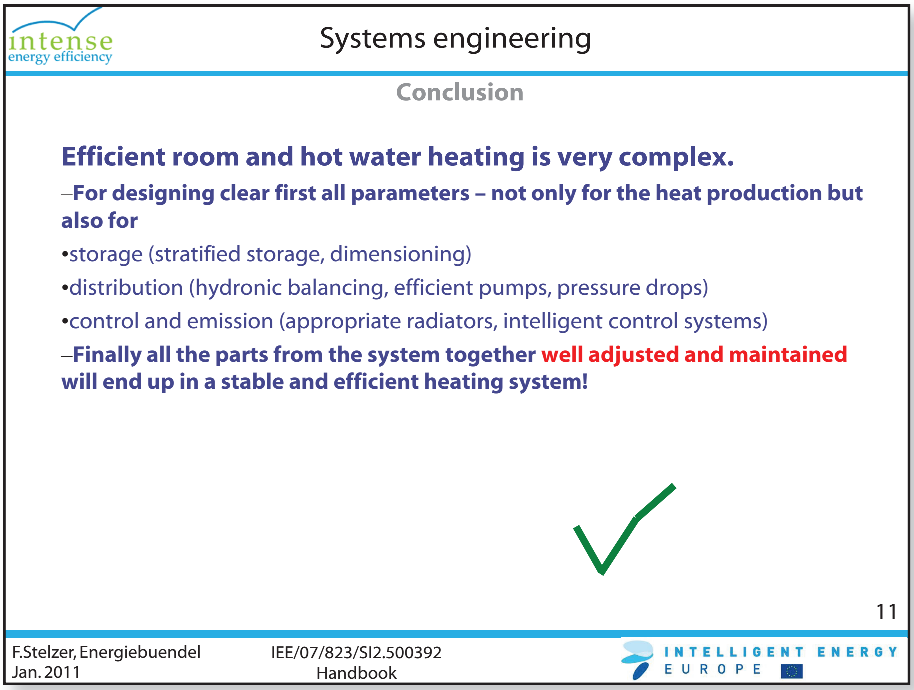
The hydronic system of the heating circuits and storages (stratified storages!) are very complex and especially in passive houses very important for the efficiency of all systems (heating, cooling, hot water and ventilation as well, concerning the pneumatical design.)

The hydronic balancing of the heating (or cooling) system is based on the piping design. In each line the maximum pressure drop (most remote radiator) is determined and all other radiators are adjusted to the same pressure drop with the adjustable thermostatic valves.

This secures that the return flow temperature will have the designed value.

In new heating systems with condensing boilers the difference may be 30% of the energy delivered!

A LARGER AMOUNT OF warm water than necessary DOES NOT AUTOMATICALLY mean that the room will be heated faster.



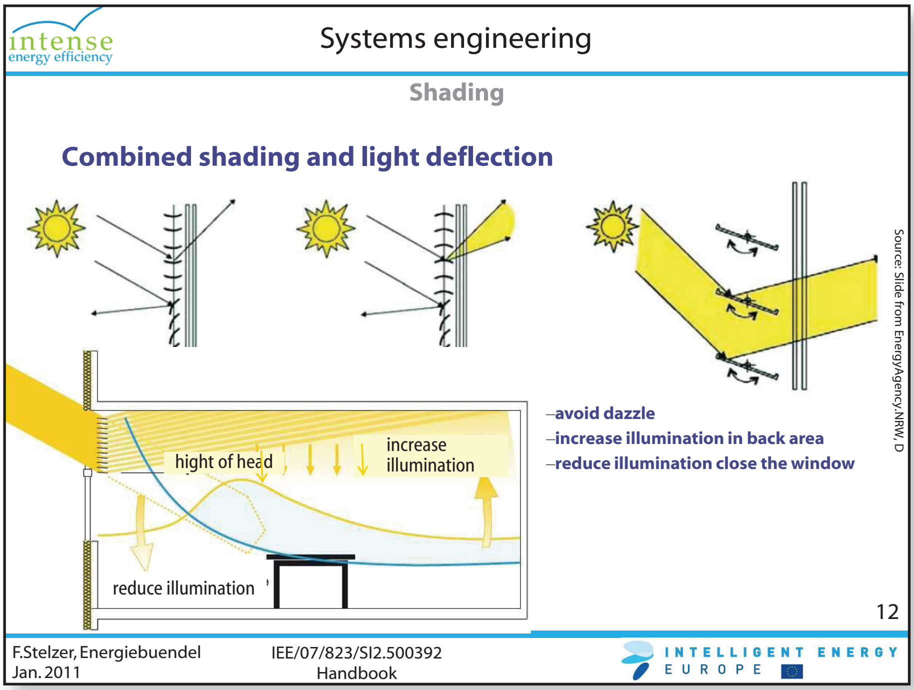
All parts of the system are important and should be considered. The technological improvements are amazing and is guiding the focus of designing in other directions than heat generation only.

How to choose a system, how to make decisions?

Basis of all is the architectural draft. When this is optimized for low energy consumption (calculated, not estimated!), the mechanical systems for heating and DHW are planned. Depending on the building you first choose the way, the heat comes to the rooms incl. control systems, then you design distribution and production/storage. The selection is made according to what is suitable. That is the way an efficient system can be designed.

The awareness for the adjustment and maintenance is still low because of the cheap oil prices in the past. Now this should change rapidly because the investments are low and the rise of efficiency is high.

The slide is applicable for cooling/chilling, too. There are the same problems.



Cooling has especially in the southern countries the highest energy demands. Therefore cooling systems are an important part of building efficiency.

The lesson should show passive possibilities how to reduce heating demand. Try not no refrigiate!

Then the possibilities of calculating the cooling demand should be shown. In case you have national standards explain them, too.

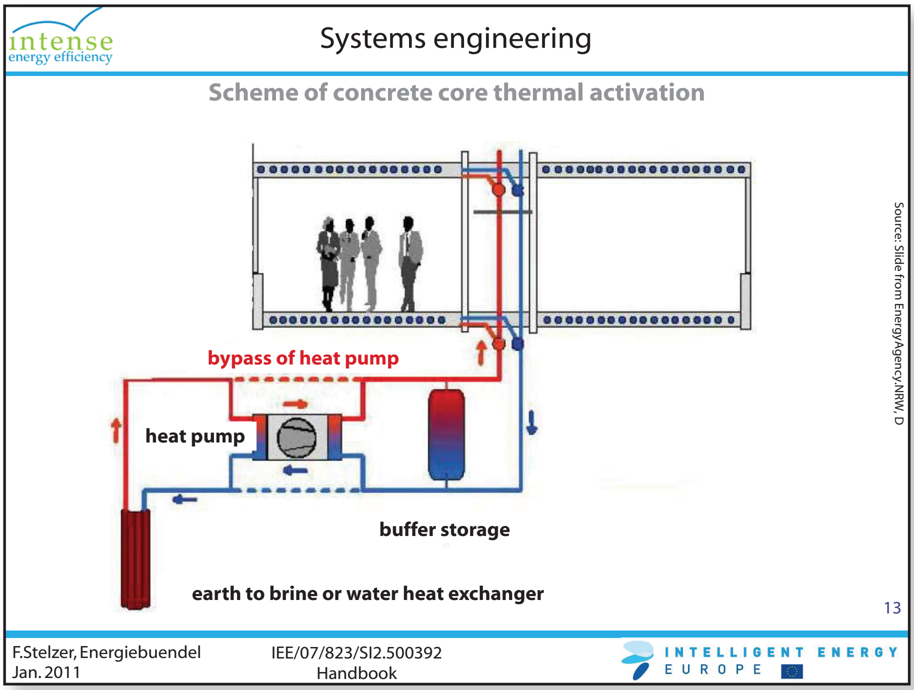
Then the intelligent production of cold water with delivery (control and emission) and distribution are part of the lesson. For all of these systems there are modern and efficient technologies available, which minimize the energy demand and they should be discussed.

To reduce solar gains jalousies are a common application. These are also available with light deflecting parts in the upper area of the windows. This reduces additionally the heat impact of electrical lighting. The higher this area is, the more the room gets illuminated.

Especially in office buildings on sunny days the jalousies are closed and the light is switched on. This is not efficient at all. Especially in passive houses the impact of electrical energy of the building should be reduced.

As well the usage of efficient office applications (computing, printing, telecommunication, copying …) decreases the cooling load and saves therefore twice!

An other possibility of reducing cooling load is high ventilation rates during colder night times.



Control /emission:

Concrete core thermal activation mostly can use free cooling. The water supply temperature (15°C) is higher than the average earth temperature (10°C). Potentially a heat pump could be added.

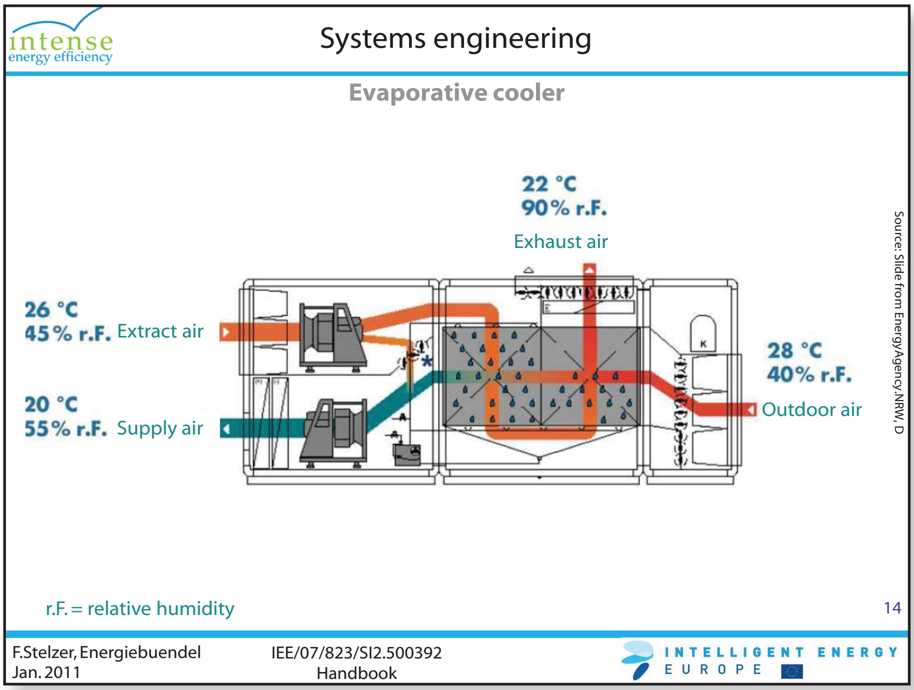
Especially in office buildings with low hot water demand and relatively high internal loads this could be a very efficient system. Combined with heating – and in some times heating and cooling alternate quickly (morning, afternoon, night) – the EER of the heat pump can reach about 5!

It is well known that for heating the wall heating is much more comfortable than the ceiling heating. Vice versa for cooling it is much more comfortable and efficient (like floor heating) the ceiling cooling. Thus concrete core cooling or ceiling radiant cooling panels are the best choice.

Therefore in regions with a relevant cooling demand compared with the heating demand, this system is very comfortable as well.

It must be admit, however, the system is slow.

For passive houses the concrete core thermal activation is a modern system. Based on very low temperature differences heating and cooling can be very efficient and alternating quickly. If there is a heat load in the morning and cooling loads in the afternoon systems like this might be the best choice. In particular in combination with adequate storage, e.g. earth storage served with heat pumps, the cooling part don't need more energy than the circulation pump of the heat transfer medium.



Cooling without chiller:

An evaporative cooler is cooling by vaporisation of water thus the efficiency is depending strongly on the indoor air humidity!

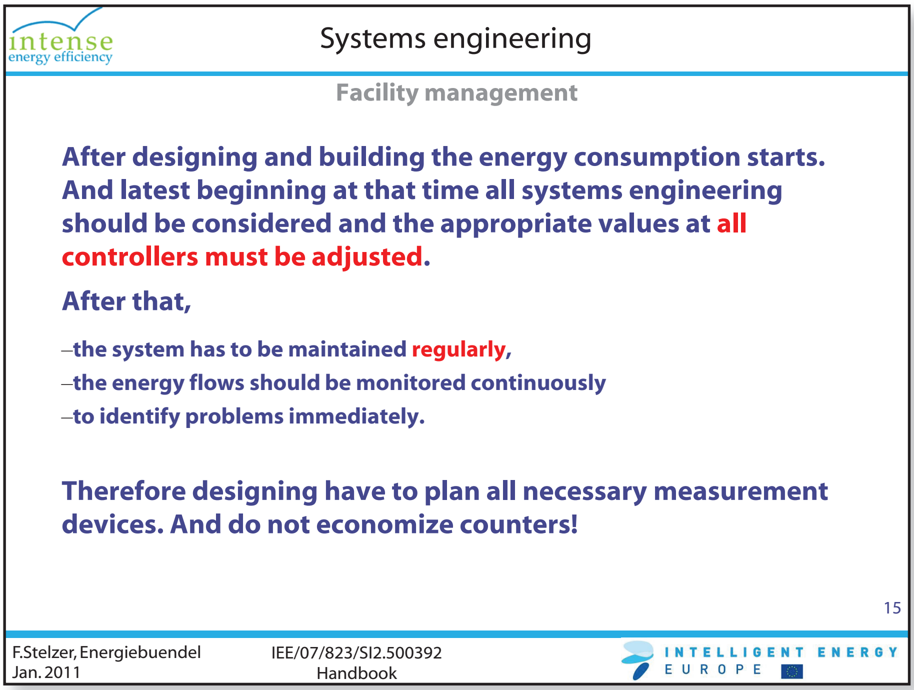
It is not energy but water, which cools the air. The water should be pure otherwise the demand of water increases. Rule of thumb for the cooling temperature: ambient temperature minus one third of the difference between the ambient temperature and the dew point. Add 3-5 K.

An other possibility of efficient cooling is a solar absorption chiller. It is a perfect choice if the cooling load correlates with solar radiation. Especially in southern countries this is the solution for the future. The systems are on the marked but the development has not finished.

The normal thermodynamic process of a heat pump remains the same and only the pump of the refrigerant is substituted by the absorption cycle:

In the absorber water is absorbed by the other fluid (ammonia or more common lithium bromide). This mixture is pumped (no pressure boost), heated by the heat exchanger and with the high (solar) temperature the water is desorbed as steam, pressure increases. The other fluid is pumped back through the heat exchanger for cooling, the steam is condensed by cooling water, throttled and then vaporised by the chilled water.

$COP = Q_c/Q_{th}$ achieves around 0,65 - 0,75 and depends on the desorption temperature.



Even more than for heating and similar to ventilation the perfect adjustment of the controllers of the system and a regularly maintenance is very important for a stable efficient process. In passive houses the energy demand may vary enormously if the systems are not maintained properly.

The maintenance is a requirement written down in the EPBD.

The requirements of the facility management should be considered while designing the buildings with their mechanical systems.

Conclusion Cooling and Chillers

1.) In efficient and well designed buildings no cooling is necessary or you have the choice of several very efficient cooling systems.

2.) Even if cooling is needed, there are some better cooling systems than the "normal" split systems for room cooling.

3.) Especially in modern office buildings with glass façades heating and cooling are at the same time possible or at least quickly alternating. For this there are some efficient systems with heat recovery available (names vary by each manufacturer):
– VRF variable refrigerant flow
– 3-pipe system
– 2 step heating and cooling (20°C main circulation)

4.) Don't forget to design a perfect storage, distribution and control and emission as well!

Annexes

Annex A1. CD containing the extended training program

The handbook folder contains a CD with two sets of PowerPoint presentations: one version with the same content as printed in this handbook and for each topic an extended version with more information and additional examples.

NOTE:

If you have downloaded this document from the internet, and you are interested in the PowerPoint documents, please contact the coordinator of INTENSE:

Ms. Ingrida Bremere
Baltic Environmental Forum Latvia
E-Mail: ingrida.bremere@bef.lv
Tel.: +371 6735 7555
Web: www.bef.lv

Annex A2. Beneficial calculation tools

Attention! The information in the tables below, especially with regard to prices and versions of software, are subject to change.

phpp	Does energy-conscious design require sophisticated simulations? This was indeed the case for the first Passive Houses that were completed in 1991. Calculating the energy balance of buildings with very low energy consumption is a demanding task - existing regulations, standards and pre-standards lack the required precision. Nevertheless, we have identified the critical factors for preparing reliable balances - with tools that are simple to use and with acceptable effort in terms of data input.	demo-version for free www.passive-on.org
Delphin	Delphin is a comprehensive numerical simulation tool for the combined heat, moisture, and matter (e.g. salt) transport in porous building materials. It is mostly applied to calculate transient processes in building envelopes and construction details, and predict condensation problems and durability risks in general	Different licensing options www.eere.energy.gov
AnTherm	Calculates temperature distributions, heat flows and (optionally) vapor diffusion flows in building structures - particularly those with thermal heat bridges. AnTherm (Analysis of Thermal behaviour of Building Construction Heat Bridges) is designed for the technically qualified designer by providing thorough and reliable evaluation of thermal performance in accordance with current European standards (EN ISO).	Up to 5.000,- € www.kornicki.de/antherm
Heat 2	Calculates two-dimensional transient and steady-state heat conduction within objects that can be described in a rectangular grid. It is well adapted to the following applications: General heat conduction problems Analysis of thermal bridges Calculation of U-values for building construction parts Estimation of surface temperatures (surface condensation risks) Calculation of heat losses to the ground from a house Optimization of insulation fitting Analysis of floor heating systems Analysis of window frames	about 520,- $ www.buildingphysics.com/index-filer/Page691.htm
Heat 3	Three-dimensional transient and steady-state heat conduction within objects that can be described in a rectangular grid. HEAT3 can be used for analyses of thermal bridges, heat transfer through corners of a window, heat loss from a house to the ground, to mention a few applications. Arbitrary thermal properties and initial temperatures can be specified. HEAT3 can handle such internal modifications as heat sources and internal boundaries of prescribed temperature.	About 500,- $ Heat 2 + Heat 3 Package price: 600,- $ www.buildingphysics.com/index-filer/Page691.htm
LESOKAI	Computes the static and dynamic thermal transmission properties of simple building components, estimates the risk of water vapour condensation and mould growth, and checks if the component complies with the Swiss SIA 180 standard. It also allows the calculation of optimal thickness in terms of energy or cost. Calculations are performed according to the most recent European standards. Included is a comprehensive materials data base. Lesokai 4 is part of the LESO series, and has the same user interface as Lesosai.	550,- CHF http://apps1.eere.energy.gov

MOIST	Program to predict combined transfer of heat and moisture in multi-layer building construction. Inputs hourly weather data from diskette and predicts the moisture content and temperature of the construction layers as a function of time of year. Can be used to develop guidelines and practices for controlling moisture in walls, flat roofs, and cathedral ceilings.	For free www.bfrl.nist.gov/863/moist.html
Physibel	Suite of heat and mass transfer programs: 2-D /3-D steady state heat transfer for building details, thermal bridges, window frames. 2-D /3-D transient heat transfer for ground heat losses, building details, and efficiency of thermal capacity: SECTRA, VOLTRA. Improved Glaser method for vapour transfer, condensation, and drying: GLASTA. multi-zone transient heat transfer for heating, cooling, overheating, sunscreens, and passive solar energy: CAPSOL.	- www.physibel.be
THERM	Analysis of two-dimensional heat transfer through building products. Includes a graphical user interface that allows users to draw cross sections of fenestration and other building products, which can then be analyzed by an automatic mesh generator and finite-element heat transfer algorithms. Results are displayed graphically.	For free http://windows.lbl.gov/software/therm/therm.html
UMIDUS	Models coupled heat and moisture transfer within porous media, in order to analyze hygrothemal performance of building elements when subjected to any kind of climate conditions. Both diffusion and capillary regimes are taken into account that is the transfer of water in the vapor and liquid phases through the material can be analyzed. The model predicts moisture and temperature profiles within multi-layer walls and low-slope roofs for any time step and calculates heat and mass transfer. Umidus has been built in an OOP language to be fast and precise easy-to-use software. Umidus is especially useful for studies of hygrothermal behaviours of building envelope and roofs. Users can quickly build different construction elements and compare them in terms of heat flux, mass flow and moisture content and temperatures profiles. Reports of building parameters and graphs of results can be effortlessly exhibited.	- http://apps1.eere.energy.gov
WUFI	Advance hygrothermal model that solves the coupled heat, and moisture transport in building envelope systems such as walls and roofs.The model is joint development between the Oak Ridge National Laboratory and the Fraunhofer Institute in Building Physics (IBP). WUFI-ORNL/IBP is an easy-to-use, menu-driven program for use on a personal computer which can provide customized solutions to moisture engineering and damage assessment problems for various building envelope systems. The model was specifically developed for architects, and engineers alike. It is excellent education tool as the user can visually review the transient thermal and moisture distributions as the simulation is executed.	For free http://web.ornl.gov/sci/btc/apps/moisture
Pay-back Trainer	Calculation of cost-benefit situations for all investments of a building.	About 40,- € www.amortisationstrainer.de

Measuring instruments and construction-planning tools

condetti®PÄD **condetti®BOX** **condetti®Max**	Condetti is a planning tool for building details with boards or at PC as virtual construction. You can visualise and discuss the detailed planning in workshop groups	Information upon request www.condetti.de

Blower-Door testing instruments	Measuring instruments for quantifying the airtightness of a building. Air temperature and humidity levels are important issues for occupant health and comfort. A professional design and examination of the building's air barrier protects from draughts and dry indoor air resulting from air leaks through joints and gaps. Construction damages like mould caused by moisture finding its way into the insulation can be avoided. An airtight envelope protects from energy losses and takes care of the environment and the economy.	Information upon request www.blowerdoor.de
Thermography cameras	Measuring instruments for imaging the heat losses of a building envelope (from outside or inside)	www.gs.flir.com www.pce-instruments.com

Annex A3: Useful tips for event preparation

"Reminder" for the trainer's preparation

Target of the event

Relevant questions:

> **What shall be the result of the event for the target group?**
> **Knowledge transfer (could it be done by reading a book)?**
> **Learning of competences (knowledge transformation)?**

Participants

> **Is my event focused on a special target-group?**
The more precise the event content is offered the better you could be aware of the kind of "specialists" who will take part. It could be a more homogeneous participant group.

> **Is it a heterogeneous or homogeneous target-group (experience/ knowledge/ age)?**
If the group is heterogeneous – each participant will have different expectations – it may be a problem not to react on it as the lecturer/trainer of this group!

> **Do I know the level of knowledge and expertise? What could be the expectation of the participants?**
On the one hand it is useful to know something about their level of knowledge and on the other hand it is helpful to know something about their expectations. Ask them! Both will help to find the right approach to satisfy all participants. If you do not know anything about your participants – be flexible in the content and way of presentation.

> **Can I anticipate the questions the participants have in mind (it is likely to correlate with their expectations)– how can I integrate these questions into my event?**
If you ask the participants before starting your presentation – you could reflect about these questions during my presentation – or are you flexible enough to allow questions during the presentation process?

> **How many participants will take part?**
You should know the number of participants during preparation of event (before hand!):

> > **The smaller the group of participants – the more direct and intensive the communication could be.**
> > **The bigger the group the better must be the planning of the event (different working groups in different rooms – material, media, facilitators for group work)**
> > **You could copy the needed number of lecture-material**
> > **You could prepare the setting of the room where it will take place (desks, chairs)**

Event-planning

> **What kind of event will be the best for the target-group?**
There are several options for presenting special contents. Each of these options has its own positive or critical aspects – You should be aware of it (lecture/ workshop/ training/ exercise/ exchange of experience – or a mixture).

> **Will I integrate my participants?**
The more flexible you react to the participants – the more interesting the interacting between me and audience will be – for all (!). "Info-tainment" means not only to give a "package" of information to the audience – but to "play" with the process between all persons in this room.

> **What kind of media (or equipment) do I need?**
Each of the different kinds of events needs its own preparation (see above).

...and remember to make the best out of your equipment:

Beamer:

It is now the most common presentation technology. But if using it, you should also use the technological options of my computer/ laptop: Animations, comics, graphs, pictures, films – all is possible – and you should be aware of these very useful features of software – it will make your presentation more interesting for your audience (and interesting presentation will be more in mind of the participants later on).

Day-light-procetor (over-head-procetor):

It is an "old" technology – but useful if you want to write something (with pen) or if you want to write and describe some graph (calculations etc.) during your presentation.

Flip chart

They give the chance to collect useful comments and questions from the audience during the presentation. You also may use it as prepared papers (e.g. with graphs or graphic model cuts of building details etc.) which should be commented during the presentation.

All written material could be photographed and used as document later on.

Meta-plan-board

It is a bigger sized wall than flip chart – useful for collecting and clustering relevant points of discussion by little "post-it´s" during a workshop.

Also useful for tools like "condetti" – e. g. to visualize construction details

Black board / white board

It is often in seminar rooms of schools – could be used like a flip chart (with different colored pieces of chalk) and be photographed for documentation.

Extra-material

- **Pens in different colors and sizes (not too slim!)**
- **Post it´s (paper)**
- **Paper for flip chart or meta plan boards**
- **Glue sticks**
- **pins**
- **Prepared flip chart for feed back (ranking by dotting)**

Last, but not least: rules for a good presentation

- **Be aware of your position between audience and presentation board**
- **Speak directly to the audience during presentation**
- **Give an overview about that what you want to present - "red thread"**
- **Give clear and exact comments corresponding to the shown slide**
- **All contents shown must be commented**
- **Keep text short!**
- **Diagrams, graphs and letters must be recognizable on the slide**
- **Not too much different information on one slide**
- **Do not read a longer text on the slide**
- **Do not read from a script directly (it could be too monotonous)**
- **Good speech modulation is good for the attention of the audience**
- **Use the technical options for an interesting presentation (see above!)**
- **Use demonstration material which could be given to the participants (models of construction elements/ insulating material/ tapes)**
- **Alternation between passive and active participation will animate and inspire the audience**

We hope these little hints will be helpful for your planning!

We wish you a successful presentation!

Your INTENSE-team