

TRAINING MODULES AND TRAINING MATERIALS PART I



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1. Introduction

One of the main targets of the INTENSE project is implementation of a training programme in all Central and Eastern European (CEE) member states. Therefore existing programmes, not only the “Intelligent Energy” programme, were evaluated under a specific focus of possible adaptation of parts of these concepts.

The investigation identified the three Train the Trainer (TTT) programmes, which are based on a TTT concept. These programmes have different target groups and are not specified on a country wise, preselected high professional training institutions like (technical) universities.

The different perspective from a holistic point of view towards these topics should be kept in mind during the adaptation process of the EU directives.

The adaptation process is not only based on theoretical aspects of these topics, but also on synergy effects between the TTT-outcome and the participating municipalities during the process of planning and realization of so called “mini-projects”, which could function as a light house projects for national solutions.

The INTENSE integrates the various experiences and expertise of the participating Universities and the professional organizations of each CEE-country. That means also to be aware about the political, structural and historical base. During the adaptation process of EU directives into national law and regulations and the further implementation strategies about advanced trainings, the participating German experts offer their own knowledge and help to identify the obstacles and challenges for a successful implementation.

To design und build high energy-efficiency buildings, you have to use knowledge and experience of many areas of building-physics topics, designs and building services engineering.

The INTENSE-Project has collected important issues and summaries and split them into 10 modules:

1. Legislation
2. Quality control
3. Settlement planning (orientation, density, mixed land use)
4. Energy carriers (efficient techniques, renewable energy sources)
5. Building physics (Thermal bridges, diffusion, convection, air tightness)
6. Construction elements (windows, walls, roofs, inside insulation, eco materials, retrofitting)
7. Systems engineering (heating & ventilation)
8. Design principles (compactness, organisation of floor plan, structure)
9. Cost-benefit assessment
10. Best practices

This document will be constantly updated throughout the project course. We recommend you to frequently check the INTENSE homepage (www.intense-energy.eu) to obtain the latest updates.

2. Training materials for the modules

2.1 Module 1: Legislation

The current national legislation at the CEE countries varies a lot. Some countries have a well-elaborated legislation; others have a less detailed or fractionally defined legislation.

As INTENSE training programme aims to look in the future then legal acts and regulations related to construction and energy performance of buildings would need clarifications of following definitions deriving from the draft of the recast of the Energy Performance of Buildings Directive:

Nearly zero energy building:

The definition of this type of building varies in the view of different terms of scientific institutions and climate conditions in different European regions.

In general you could define it as a building with a very low energy consumption and annual heat demand (passive house: less than 15 kWh/m²/a in the middle of Europe). The EU-legislation is aiming this standard for new buildings until 2020.

Cost optimal building unit:

The cost optimised planning and erection of a building and its life cycle calculations needs a holistic view on this topic. It is integrating a lot of different factors, which have influence on the cost and benefit of a building not only in a short, but also in a long run.

Major renovation (building + building unit)

The renovation is changing or substitution of parts of a building. A major renovation is the case, where the total cost of the renovation related to the existing building is more than 25% of the value of the building or the case were more than 25% of the building shell undergoes renovation.

New buildings

New buildings are buildings, which are completely new erected. They are constructed by respecting the newest laws and standards, including meeting minimum energy performance requirements laid down in national legislation. A building will be called new, until newer legislation, newer energy performance standards or refurbishments had taken place.

Existing buildings

These buildings represent older energy standard. For these buildings data necessary to assess their energy use are known or can be measured. A new building will become an existing building, as soon as newer standards and energy requirements are published by the national legislation.

Calculation of the Energy performance of buildings

Architects, planners and engineers need instruments for calculating the energy demand of a building. It will be the base of a benchmarking, which will be interesting for investors and also for tenants.

Info about national legal requirements regarding calculation methods

There are different calculation tools, which could be adapted to the specific national situation. A list of tools will be analysed during this project and will be presented later.

Minimum energy performance requirements

For architects and engineers it will be necessary to have national minimum requirements for energy performance of buildings and these may differentiate between new and existing buildings as well as have different categories of buildings. Member States should set minimum requirements for the energy performance of buildings as well as different categories of buildings. The requirements should be set with a view of achieving the cost-optimal balance between the investment involved and the energy cost saved throughout the life cycle of the building.

Technical building systems

The quality of installed technical systems should be provable under standardised requirements and metering conditions. New planned (engineers) and installed (craftsmen) systems should be optimised in focus of a long-term life cycle and the profile of using the building. Therefore it is necessary to define national standards.

Energy performance certificates

A energy performance certificate documents the energy performance of a building. Member States shall insure that, when buildings are constructed, sold or rented out. The validity of the certificate shall not exceed 10 years. The energy certificate for buildings shall include reference values such as current legal standards and benchmarks in order to make it possible for consumers to compare and assess the energy performance of buildings. The certificate shall be accompanied by recommendations for the cost-effective improvement of the energy performance. The certified auditors should be listed transparent for all interested persons and institutions.

Certification of auditors

Candidates should be pre-qualified as architects, engineers or technicians. The certification-course should be standardised countrywide. Up to now there is no EU wide certification standard.

Inspection of heating systems and of air-conditioning system

This is a substantial part of quality control after installation the systems and during the useful life.

That includes the analysis of functionality of the heating system including integrated additional systems like solar heating or heat pumps.

Reports from inspection

Standardised reporting schemes will help to simplify the inspection and to get base datas for a further evaluation about the current situation and the future evolution not only for each building, but for building areas and different types of buildings.

Liabilities for different target groups

Each of the involved target groups (planner, architect, engineer, technician, craftsman) has its own responsibility for a high quality building and installation. This could only be demanded by detailed legislation, which has all aspects in view. Only in this case it will be possible to have a claim for damage situations.

Exemplary projects of municipalities

With own programs the municipalities can demonstrate that it is possible to build high-energy efficient new buildings but also to renovate existing buildings with high-energy efficient components. These buildings could be lighthouse projects and give impulses for other (not only municipal) buildings.

Energy efficiency monitoring for renovated and new houses

Inspection, survey and analysis of energy flows in a building will give a detailed overview about the energy dynamics of the system. Typically a monitoring is conducted to seek opportunities to reduce the amount of energy input into the system without negatively affecting the output. Member States shall ensure the availability of efficient, high quality energy audit schemes, which are carried out in an independent manner, to all final consumers. The measuring tools should be standardised. (i.e. Blower Door test, thermography).

Renewable Energy

Deriving from the renewed Directive on promotion of the use of energy from renewable sources relevant aspects for our target groups were identified and will be introduced in frame of the INTENSE training programme.

Renewable energies are for example wind power, solar energy, hydropower and biomass. Using renewable energy sources helps to lessen the use of fossil fuels.

The more regional renewable energy sources are used the more independent the user will be in future related to the prices for fossile energy and it will stabilise the regional added value.

The planners and architects have to check whether there are national overall targets in renewable energy action plans and support schemes available.

It is important to check whether there is anything related to the construction of a building (dimensions, energy demands etc.)

Administrative procedures, regulations and codes

For planners, architects, engineers and craftsmen it will be necessary to know whether they have to adapt municipal planning and building regulations and codes.

Ecolabels for ecologically produced and used materials and energy efficiency could be an argument for investors related to healthy and sustainable living conditions.

Information and training

All involved professional target groups must be trained under the focus of the key issues. Listing them for interested investors could support their extraordinary knowledge.

They – and the potential investors - should get a guideline with all necessary informations about energy efficiency and renewable energy sources.

Requirements from national legislation for selling from RES to grid

The selling conditions should be transparent and fixed for a defined period of time. The national legislation must give the frame for this compensation.

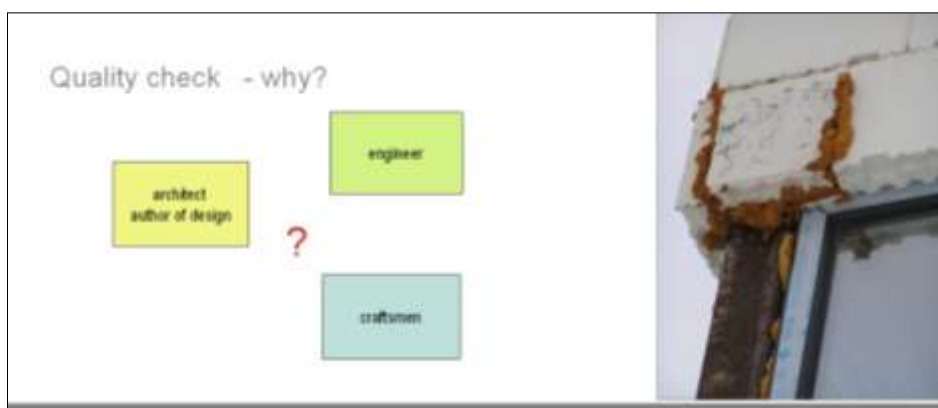
Certification of installers

All professionals should get a certificate about their competence of planning and installing renewable energy systems according to national standards.

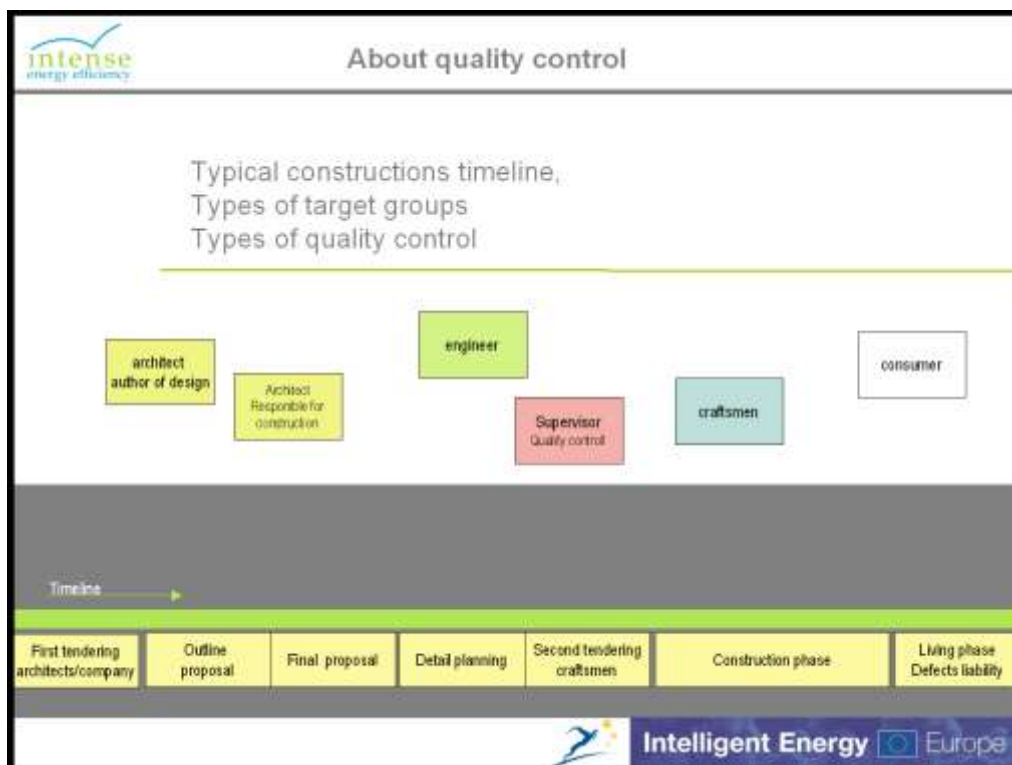
2.2 Module 2: Quality control

Steps of quality control in general

The complexity of tasks and targets is a challenge in all construction processes, even more if the target is a building with very low energy standard. In this case there are requirements for good planning, execution and joint efforts of all target groups in all stages of the process.



The timeline (scale at the bottom) can help to identify all aspects of the process and the involved experts or expert groups.



After first tendering procedure, architects in the role of authors of design prepared the outline and final proposals. In most countries, the final proposal, plans mostly in the scale 1:100, descriptions, calculations are the materials requested by local construction board to proof the conformity of the proposal with all legal requirements.

Detail planning follows normally after finishing the permission requirements. Now the proposal is so developed, that the tendering procedure can start. It is possible to define the quality to work out by the craftsmen.

In the construction phase, the craftsmen do their work according to the design, the details and the requirements negotiated in the tendering. Architects as good as possible supervise the work.

In common building processes, the living phase is the very first test, if the buildings quality is well done or if it was possible to reach the promised energy standard.

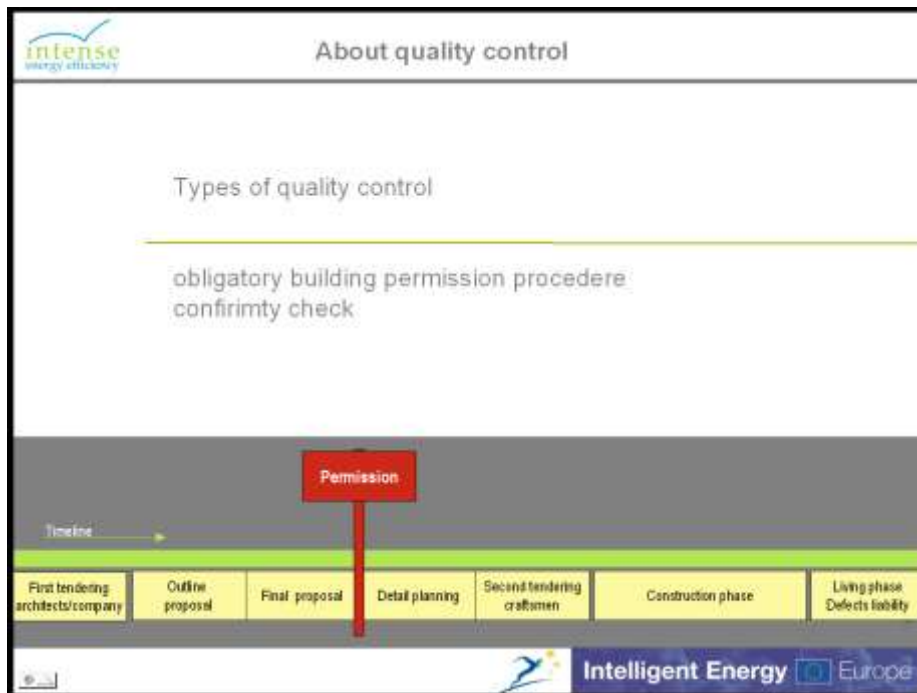
This can be too late, even more if the legal position of the consumer is too weak to get all defects cured.

What can be installed as quality control?

Possibilities of obligatory building permission

If the building permission check came in force short after the final proposal, it can be used as conformity check with legal requirements including energy certification and detailed urban plans.

The compliance with the accepted construction design and construction standards can be examined.



But it is not the most efficient instrument to ensure good detailed planning and good construction quality, for example air tightness is a very important issue for energy efficiency but that cannot be checked this way. In the early stage, after finishing the proposal only in the scale 1:100 a few details like connection points between walls and roofs are known.

More possibilities of voluntarily quality check

As one very advanced example the quality control of Hanover region pro clima energy funds shows more possibilities what can be checked.

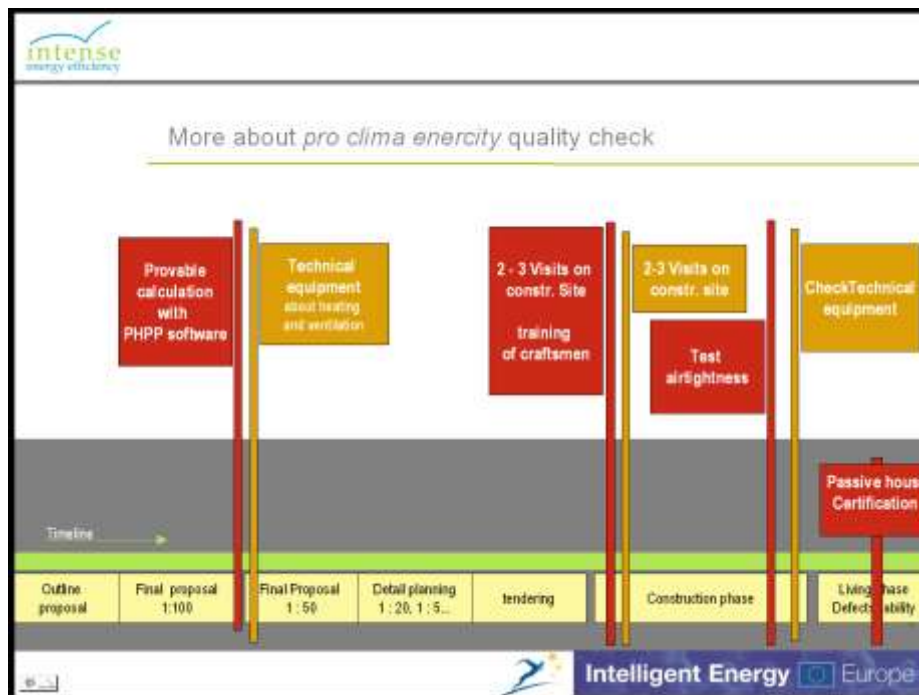
In this case, the quality check is done in several steps in all important stages of construction process, focusing not only on the buildings envelope, but the technical equipment as well.

The checking is based on calculations - using the passive house projection software - and on the practical work at construction site

Visits on construction site are more than just control; it is also qualification of craftsmen.

The checking insists on provable testing methods like Blower Door test.

Specialised independent engineer offices execute the check.



The extra costs, about 5 EUR per square meter of total space in this case, were covered by the investors but the obligation to invest in quality control was fixed within the land sale contracts.

If the investor is interested in this contract, he had to accept the quality control.

For more info and technical figures contact: proKlima – Der enercity-Fonds, Glockseestraße 33, 30169 Hannover.

Passive house certification

A whole panel of checking methods is available if investors are willing to go for passive house standard with certification: provable calculation with PHPP software, check of plan materials, thermal bridges and at the end the Blower Door test.

Some CEE countries have their own certification institutions. If there are no institutions then it is possible to contact the Passive House Institute, if the building has some extra aspects. In this case, the Institute would be interested for research reasons. At least is possible to contact the passive house Dienstleistungs GmbH for the certification of common building types.

For consultancy in passive house technology for common building types:

Passivhaus Dienstleistung GmbH
Rheinstr. 44/46
64283 Darmstadt

Tel.: 06151 - 399 499 - 0
Fax.: 06151 - 399 499 - 11

E-Mail: post@passivhaus-info.de
<http://www.passivhaus-info.de>

Obstacles and challenges:

However, these methods have their obstacles:

- The obligatory permission control is more a conformity check rather than a test for high energy standard.
- Voluntary checks can come in force only if there is an interest by the investors. The instrument can be efficient, if independent engineer offices or institutions are engaged. These offices or institutions need a market to run their business and to collect experiences.

This means: increasing the market demand is a long but necessary way.

One first step in the right direction can be paying more attention to the tendering process. In tendering process it is possible to define the standard to reach in execution or to describe the result. The companies can sign a contract, what is binding them to reach a certain standard.

2.3 Module 3: Settlement planning

2.4 Module 4: Energy carriers

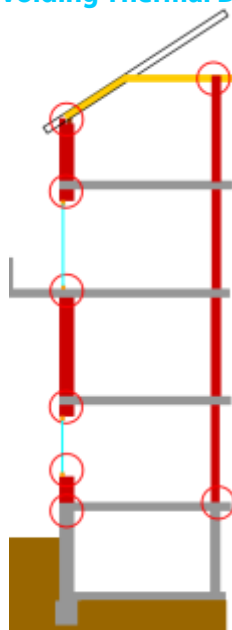
2.5 Module 5: Building physics

This module is divided into following topics:

- Avoiding thermal bridges
- Optimize Diffusion
- The important rule of the airflow through leakages
- Avoiding mould on surfaces and inside construction
- Seven reasons for a building air tightness
- Detail designing and sealing on building site
- Measure the air tightness of a building
- Risk free inside insulation

Starting point is a very high insulated building construction with the aim that this construction is free of mould in the long term and shows the planned low energy losses.

Avoiding Thermal Bridges



We deal with the thermal bridges to calculate correct energy loss and to calculate and check an inside surface temperature.

Obvious fact: Low and a very low energy building standards need very little until no thermal bridges (red circles).

You can only reach Low-Energy-Standards with very little thermal bridges but also a good indoor environment quality, health and comfort in avoiding growing mould on the indoor surface.

The thermal bridges are part of building envelopes, where the heat transfer coefficient is higher due to inhomogeneous thermal insulation, change in shape (corners, contacts), build in inhomogeneous material. Their impact on a heat transfer is measured with line Y and point heat transfer coefficients c .



In a new construction it is easy to prevent the thermal bridges. The insulation material overlaps the inhomogeneous materials and critical points. Balconies are placed in front of the exterior wall. The first layer of blocks of a wall on a concrete basement ceiling is made from a material whose thermal conductivity is smaller than 0.21 W/mK.

In performing of retrofitting, it is just as well possible to lower the thermal bridges, while taking economic feasibility into account. Thermal bridges can be prevented as follows:

- Installing insulation above masonry walls at all locations, minimum thickness 6 cm.
- Installing insulation above window jambs, window frame, and thickness 3 cm.
- Installing exterior insulation at basement-ceiling-to-foundation intersection, with a thickness of 6 cm and a width of 50 cm.
- Balconies are placed in front of the exterior wall.
- The first layer of blocks of a wall on concrete ceiling is made from a material whose thermal conductivity is smaller than 0.21 W/mK.

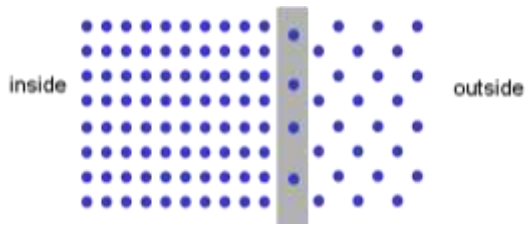
Remaining thermal bridges in exterior insulation, as well as interior insulation, somewhat reduce the energy savings. The remediation strategy as a whole, however, is economically feasible despite the thermal bridges.

Conclusion

- In a new building it is easily possible to prevent thermal bridges
- Energy savings on a building are possible, although there are thermal bridges
- By retrofitting you have to check for thermal bridges

Optimize Diffusion

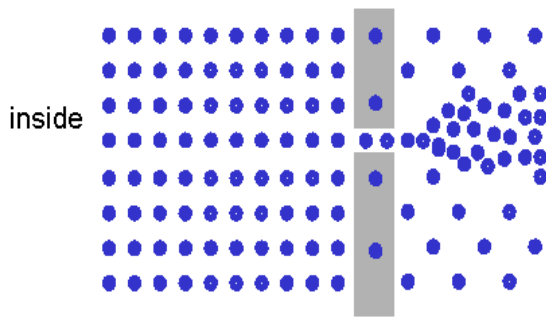
Diffusion is a very slow physical process of “water vapour movement”. The total amount of a water vapour transfer is less and reaches not more than 7 g/m² on a cold winter day through a roof construction (inside temperature/humidity 20°C/50%). In most cases and with paying regard to common experience, such a small amount can’t damage constructions.



The modern building physics deals with the diffusion balance between the “condensation” in the winter period and the “dry-period” in the summer time. If you follow this conception you get an optimal solution with a vapour retarder that varies the diffusion permeability with the humidity conditions. The diffusion permeability of an “intelligent” vapour retarder is high in the summer conditions and low in the winter conditions. This offers optimum safety for the insulation system even if there is an unexpected increase in moisture from e.g. leaks.

Airflow through leakage

The air flow through leakage is a very fast process of “water vapour movement”. The total amount of a water transfer is more than 200 g/m² of a leakage with a 1mm wide and 1m long gap e.g. in the vapour retarder.

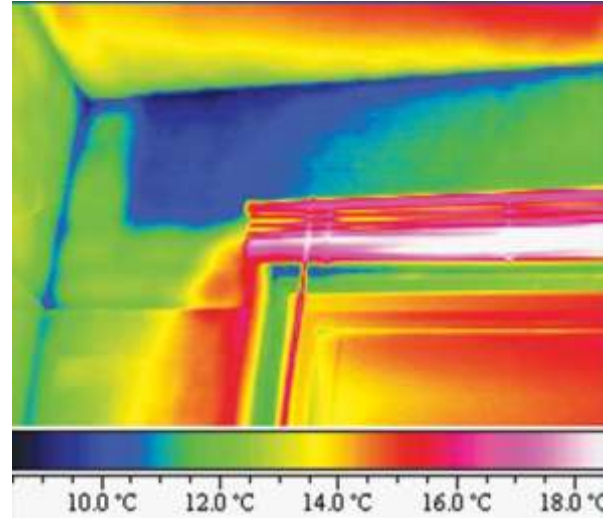


The most common reason of mould growth and rot within structural timber and insulation is caused by airflow through leakages from inside to outside. The air, which moves into construction, transports vapour into the insulation, which results in a great amount of moisture.

Avoiding mould on surfaces and inside construction

There are three topics that should be discussed:

- a) Conditions to avoid the growing of mould
- b) Recommendations for the construction details
- c) Recommendations for inhabitants



a) Conditions to avoid the growing mould

At the Fraunhofer Institute for Building Physics in Stuttgart, Germany, mould growth has been studied for a wide range of common building moulds, surface substrates, and climate conditions.

The first research result was that the dew point of air (= 100% rel. humidity) must not be reached in order to enable mold growth. 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 the mould growth, relative humidity levels need to be at least below about 75% r. h. At temperatures of about 10 °C, the growth conditions are achieved at 80% r.h.

Short-term moisture peaks are not an issue. Favorable growing conditions must be reached for more than 3 h in order for the continuation of mould growing.

b) Recommendations for construction details

Exterior insulation eliminates a wide range of thermal bridges. All the structural thermal bridges have to be covered with insulation, at least 60 mm in thickness and window jambs with insulation, at least 30 mm. At the wall-to-foundation intersection, run exterior insulation 500 mm below the basement. Remaining thermal bridges in exterior insulation as well as interior insulation rises up the surface temperature to a good level.

c) Recommendations for inhabitants

The causes of avoiding mould growth can be broken down into 6 topics.

1. Increase the wall temperature with...
... 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 with...
... ventilating for short periods of time and by opening windows, turning on ventilation system and using space dehumidifier.

3. Prevent moisture sources

Do not dry laundry indoors, cover aquarium, cook with lids on pots, cactuses instead of palm trees, take a shower away from home...

4. Reduce Building Moisture

Protect construction site from rain and other water sources.

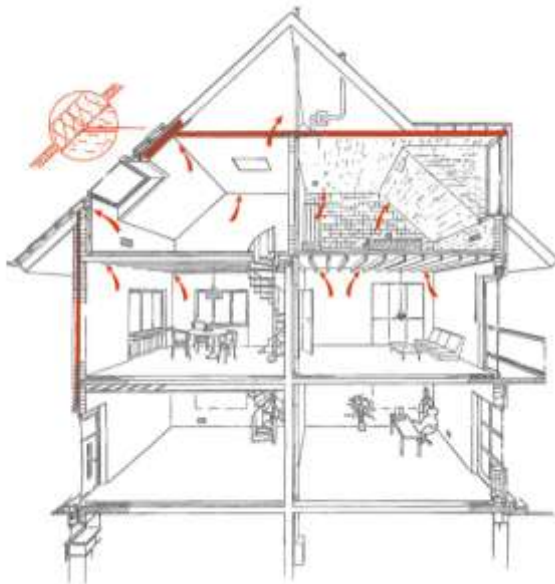
5. Ensure Airtightness of Building Envelope by

... preventing leaks in membranes (especially in roof area), sealing around penetrations through membranes.

6. Miscellaneous

Use anti-mould finish, "create" alkaline surfaces.

Seven reasons for a building air tightness



Building air tightness means avoiding an uncontrollable indoor-air mass flow through leakages. We know 7 reasons for the necessary building air tightness:

1. Guarantee of comfort
2. Avoiding cold air zone in the ground floor
3. Providing low pollutant in the indoor air
4. Ensuring a noise reduction
5. Good working air ventilation system
6. Protect the construction against too much moisture
7. Minimize energy losses

Measurement of air infiltration (air-tightness)

The measurement is described in EN 13829, the preparation of the building, steps to be followed for the technical process and the analysis of an air tightness measurement. The procedure of a measurement is divided into the following steps:

- Preparation of the building
- Installation of the measuring instruments
- Preceding test
- Determination of the airflow rate at different building pressure
- Analysis/Evaluation
- Protocol

Fan should be installed in the opening of an external door or window. With a help of an adjustable aluminium frame with a nylon sheet and an opening for the fan-case, it is possible to fit it tightly in the doorframe. Pressure measuring devices are installed to measure the differential pressure between inside and outside, as well as the mass airflow volume in m^3/h .

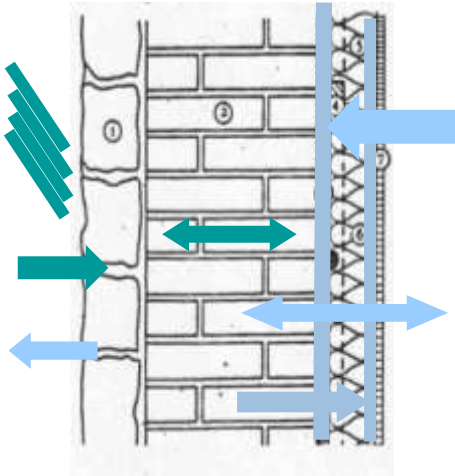
The measured airflow rate at the fan corresponds to the total of all leakage airflow rates at the building envelope. With a help of a density correction (temperature difference of inside and outside air), the airflow rate at the fan is mathematically calculated to a normalized leakage rate V_{50} and is used as a reference value for the calculation of n_{50} .

Software evaluates the gained dates and determines the parameters.

The universal air-tightness specification is the air change rate at 50 Pascal, n_{50} [1/h]. In many countries, building should reach an air change rate less than 3.0 [1/h], and buildings with ventilation system should reach a value below $n_{50} = 1,5$ 1/h. For "passive houses", it is necessary that the value reach below $n_{50} = 0,6$ [1/h].

2.6 Module 6: Construction elements

Risk free inside insulation



If there is no possibility to insulate a wall from outside, you can also insulate the wall from the inside. Due to the interior insulation, the thermal bridges occur to a large extent at the intersections of ceilings and interior walls. As the example of a residence shows, the heat loss of the exterior wall can be reduced by over 65% with a 12-cm interior insulation. The potential savings through an exterior insulation are 80%. The difference in a heat loss represents the unavoidable loss. It is quite clear, that you can't get very low energy building with inside insulation, but if it is not possible to insulate from the outside, it is better than doing nothing.

The interior Insulation can be risk free, when you use "industrial produced materials" and observe several steps:

- No rising moisture in the wall from the cellar or foundation
- Appropriate protection against driving rain from the outside
- Air tightness against the penetration of indoor airflow behind insulation
- Jamb insulation
- No insulation gaps
- Ensure "normal" indoor air humidity
- Insulation of adjoining building components at a ceiling

To build on site the inside insulation, there is a lot of work to do and to decide what is necessary and what needed to be done.

- Remove windowsills
- Move a radiator unit
- Fill a recess alcove of radiator unit with a solid masonry
- Remove a wallpaper
- Remove a plaster?
- Remove an old paint?
- Remove a gypsum plaster?
- Improve base, adhesion?
- Run wiring, extension
- Heating pipes have to insulated, where it's facing exterior wall

- Clarify details of a ceiling connection
- Clarify details of a wall connection
- Install a smaller radiator

2.7 Module 7: Systems engineering

2.8 Module 8: Design principles

2.9 Module 9: Cost-benefit assessment

2.10 Module 10: Best practices

