Block 3: Energy Efficiency Measures and Technologies

3.1. General energy efficiency measures in buildings

Feedschools, by GEA

This block is part of a training package developed to provide local authorities with free tuition that may inspire and help them in adopting new technical and financial solutions to implement ‘nearly Zero Energy Building’ (NZEB) renovation activities in schools.

After an introduction to the context and importance of the building sector, this block will introduce to typical energy efficiency measures in buildings and how to find them in your buildings.

Advanced: Technical knowledge is needed (heating and control systems, lighting, energy auditing)

Learning Objective:

In this block attendees will be provided with an overview of typical energy efficiency measures in public buildings (especially schools), how to find some measures and recommendations for planning, insulation measures, heating, electricity, lighting and ventilation. Aim is to get to know the most important efficiency measures in buildings.

3.1 Units	3.1.1 Importance of the building sector	3.1.2 Typical measures in buildings and potentials	3.1.3 First step - get to know your weak points
3.1.4 Recommendations - insulation - planning	3.1.5 Recommendations - heating system and heat supply	3.1.6 Recommendations - lighting, ventilation and electricity	3.1.7 useful information on EU level

The building sector is crucial for achieving the EU's energy and environmental goals.

Buildings are responsible for approximately 40% of EU energy consumption and 36% of the CO2 emissions. Buildings are therefore the single largest energy consumer in Europe.

At present, about 35% of the EU's buildings are over 50 years old and almost 75% of the building stock is energy inefficient. At the same time, only about 1% of the building stock is renovated each year – more or less efficient - with often lost opportunities for a long time.

For example, to compensate a gas consumption of 100.000 kWh per year, you need to plant 1760 trees

- comprehensive measures are necessary to protect climate, take advantage of your potentials!

Renovation of existing buildings can lead to significant energy savings, up to real 70% of existing consumption.

The goals are renovations towards nearly zero energy buildings. The FEEDSCHOOLS project aims to provide local authorities with new solutions, both technical and financial, which will help them to implement ‘nearly Zero Energy Building’ (NZEB) renovation activities in schools.

3.1.2 Typical measures in buildings and potentials

3.1.2 objective

Typical measures for renovating buildings are listed

To reach the CO2 reduction goals you have several typical measures in the building sector, especially in schools and public buildings:

- **insulation** of the exterior surface (walls, ceilings) and **new windows** (potential 20 – 80 %)
- **hydraulic optimization** of the heating distribution system and thermostatic valves (potential 10 – 20 %)
- **changing the heat and power source** towards CO2-friendly sources like biomass, solar energy and heat pumps
- new **LED lighting** (potential 50-80% of lighting consumption)
- ventilation with efficient **heat recovery**
- **efficient pumps**, insulation of pipes, effective and **optimized control** – potentials depending on existing conditions
- **energy management and control**, **behavioural change**

3.1.3 First step – get to know your weak points

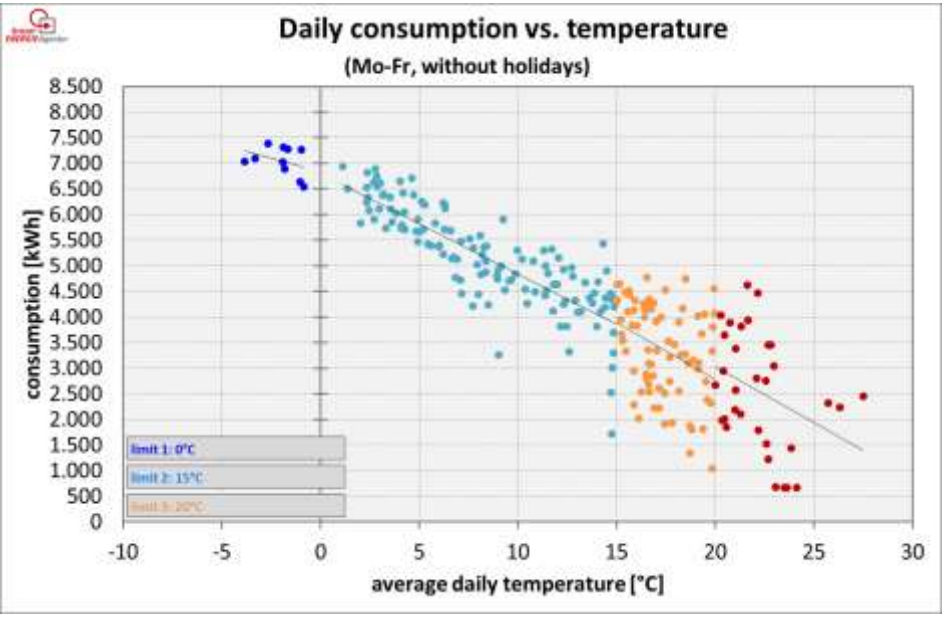
3.1.3 objective

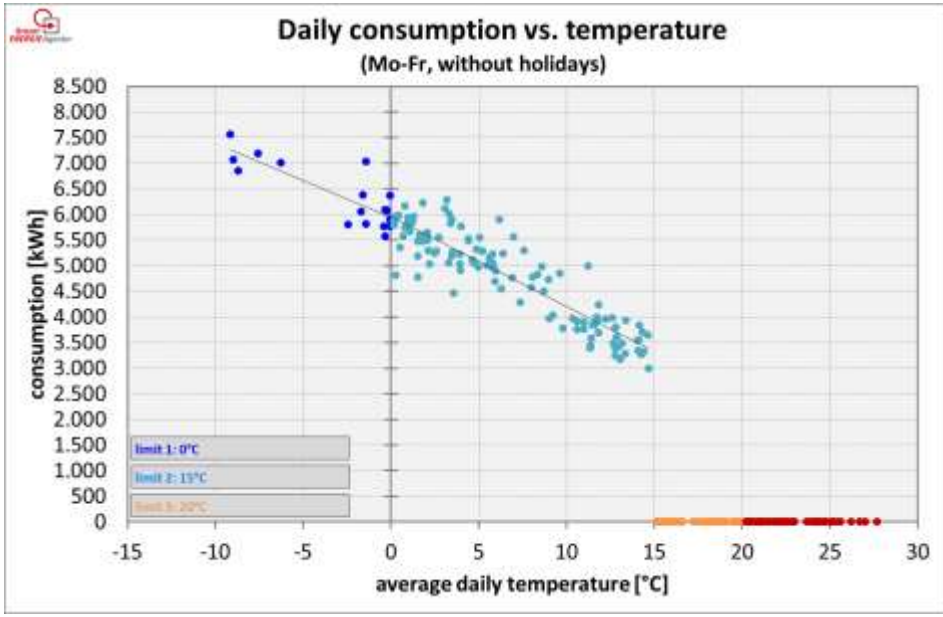
The first step to find measures is to get to know the weak points of your building. You learn about some methods to find the weak points.

The first step is to analyse your current situation as accurate as possible. The perfect instruments are:

- Use the **tools of FEEDSCHOOLS** (ERE app and financial tool)
- **Meter the consumptions** in detail – 15min intervals are recommended, smart meters help you!
- **Analyse** your energy performance certificate and existing consumption and equipment – make an entire **energy audit**
- **Compare** the proportion of real heat consumption and climatic conditions
- Use **thermographic analysis**
- Measure the buildings **air tightness**, make blower door tests (in combination with thermographic analysis)

it will show your potentials...

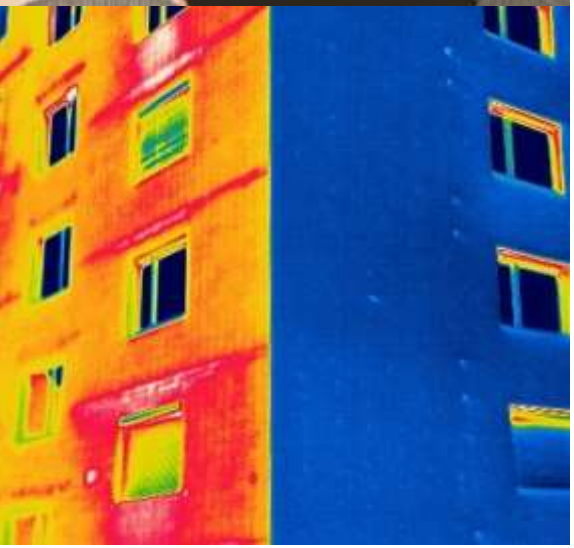




1) Meter your consumptions and outer temperature at least daily
2) Compare the daily consumptions with the climate conditions

<u>left picture:</u> high mean variation, not optimal control of the heating system, it even runs in summer

<u>right picture:</u> optimal control of the heating system, the system is turned off at 15°C average temperature, savings 30%!

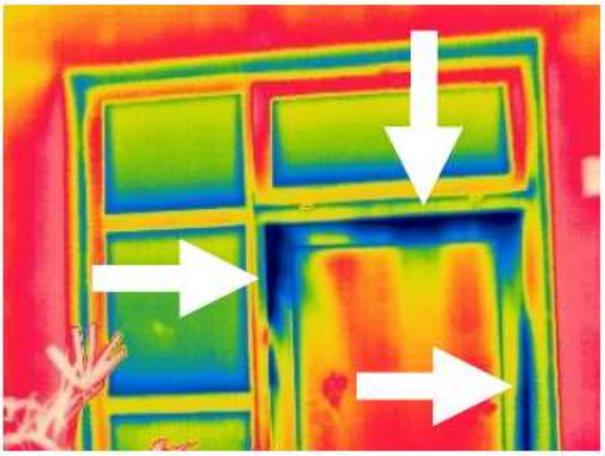


without insulation! with

Infrared pictures of your building show you in a clear way the thermal bridges and weak points of your buildings.

Keep in mind:

- The pictures do not replace an energy performance certificate
- The pictures are a snapshot and have to be made and interpreted by experts
- Choose the right outer conditions (winter, in the night, no rain and snow, high temp. difference in/out...) when taking the pictures and a high quality IR-camera



A Blower Door test shows the air tightness of the building

Why is this important?

- Unknown leakages can cause problems with the building physics and can harm your buildings
- Unwanted leakages can be responsible for a significant higher heat consumption and dry air in winter in the rooms
- A tight building envelope is also necessary for buildings with ventilation systems

3.1.4 Recommendations

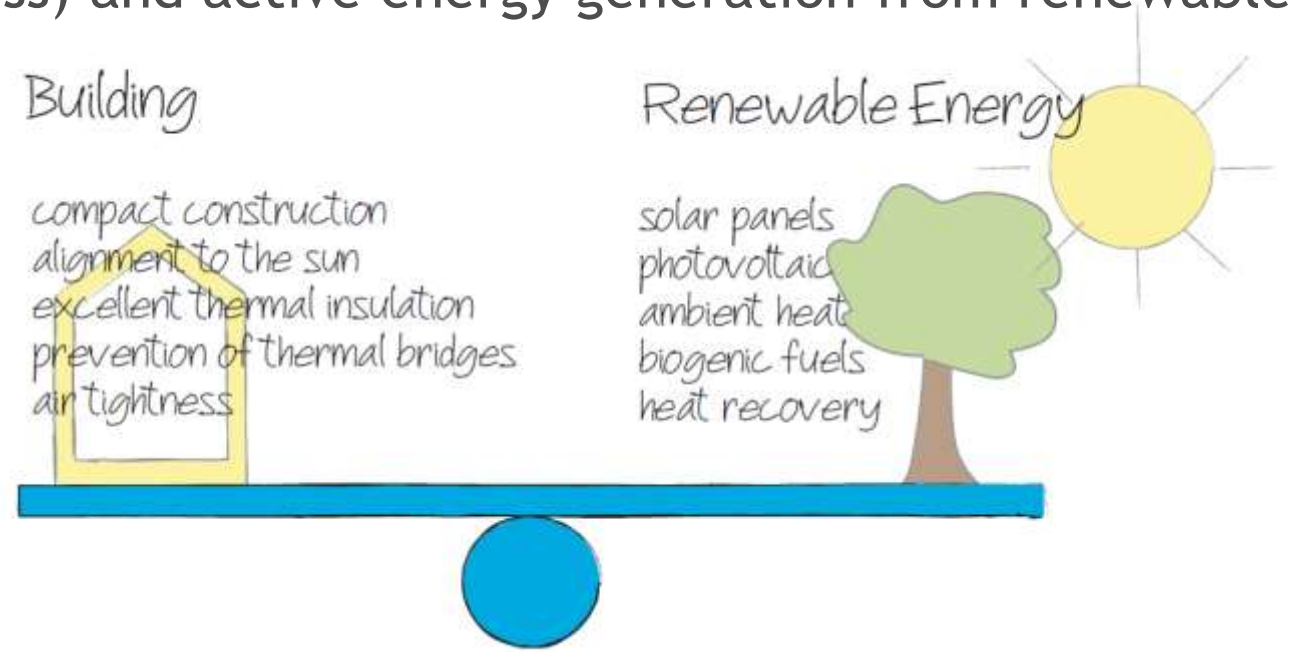
- insulation
- planning

3.1.4 objective

You get some recommendations for planning of insulation measures.

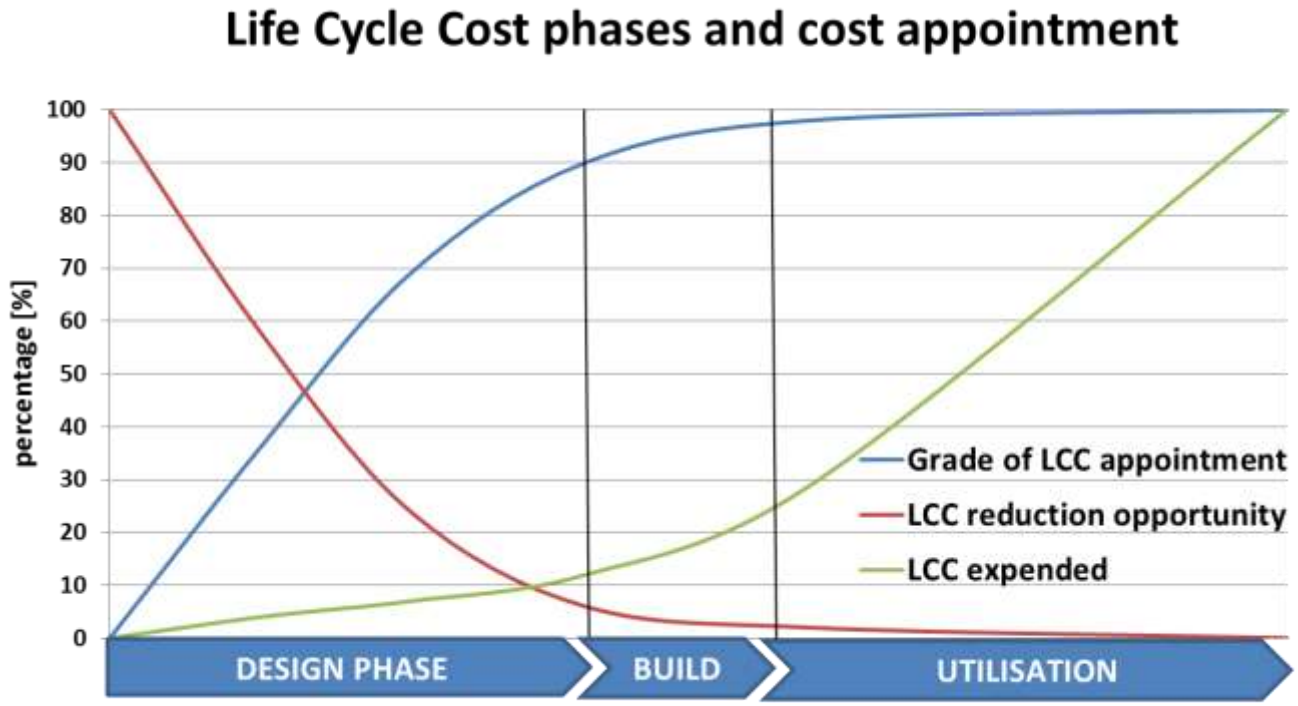
Planning Phase – Integral planning:

- Choose the right balance between building and energy source! A nearly zero-energy house combines very good insulation standards, a high-quality building envelope (no thermal bridges, airtightness) and active energy generation from renewable sources



Planning Phase – Integral planning:

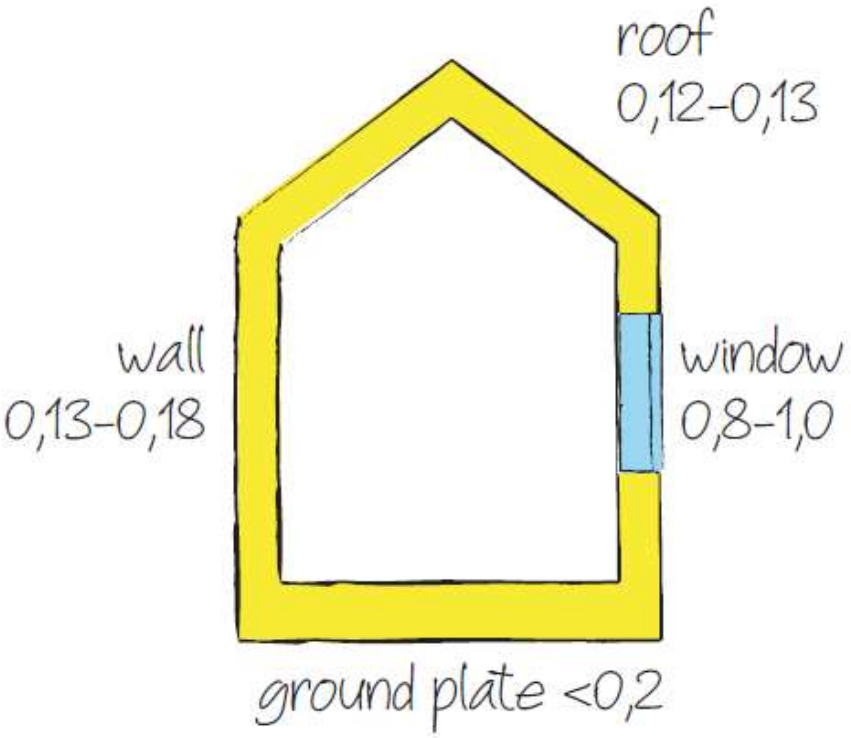
Integral planning is a holistic planning approach that takes into account all relevant success factors of sustainable and life cycle-oriented construction.



- Invest more in planning – especially in early planning phases!
- Define exact energetic and **environmental goals** (e.g. NZEB standard) and responsibilities
- **Integrate all specialists** as well as the users and operating personnel **from beginning on**, **focus on the operating phase**
- Define **quality control** standards and measures (e.g. thermographic analysis after renovation)
- All economic analyzes are based on **life cycle cost considerations**.

Integral planning combines economic, ecological and societal-social aspects in all phases of the life cycle from the first idea to planning, implementation, commissioning, operation until dismantling.

Recommended U-values [W/m²K] for a nearly zero-energy building



Source: Styrian Energy Agency; http:\www.ea-stmk.at

3.1.5 Recommendations - heating system and heat supply

3.1.5 objective

You get some recommendations for heating systems and heat supply.

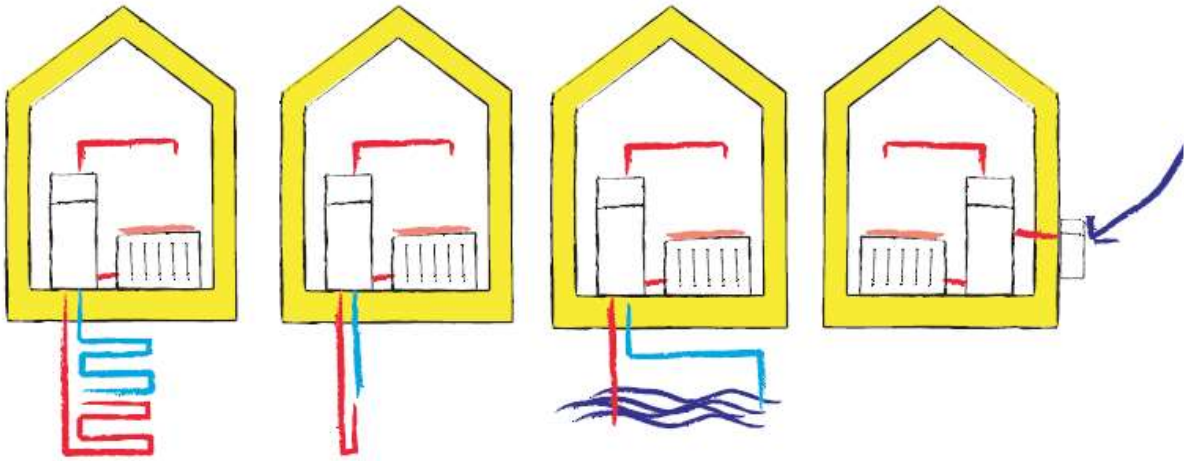
obviously its time to renew the heating system...

Photo: MichaelGaida at PIXABAY

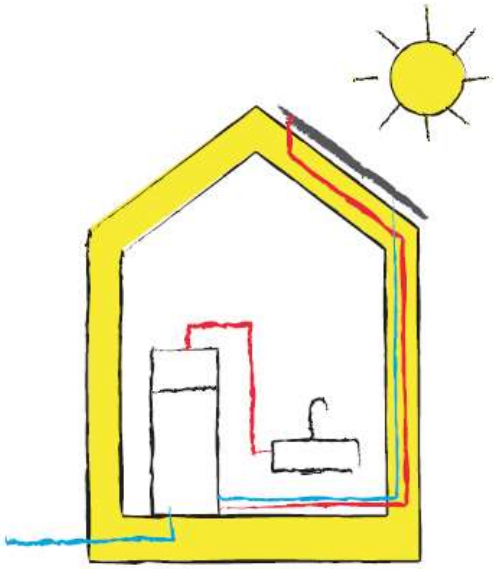
The renewed heating system

- ✓ has energy efficient circulation pumps (efficiency class A)
- ✓ insulated pipes (at least the thickness of the pipe)
- ✓ needs hydraulic balancing
- ✓ has thermostatic valves
- ✓ has a modern control system (and at its high end predictive control)
- ✓ uses renewable resources
- ✓ takes care of not to high temperatures in the rooms each 1 °C saves about 5% of heat consumption

Gain your energy from the environment or biomass!



Schematic of a heat pump with geothermal heat collectors (1), depth drilling (2), usage of well water (3) and air (4) as heat sources



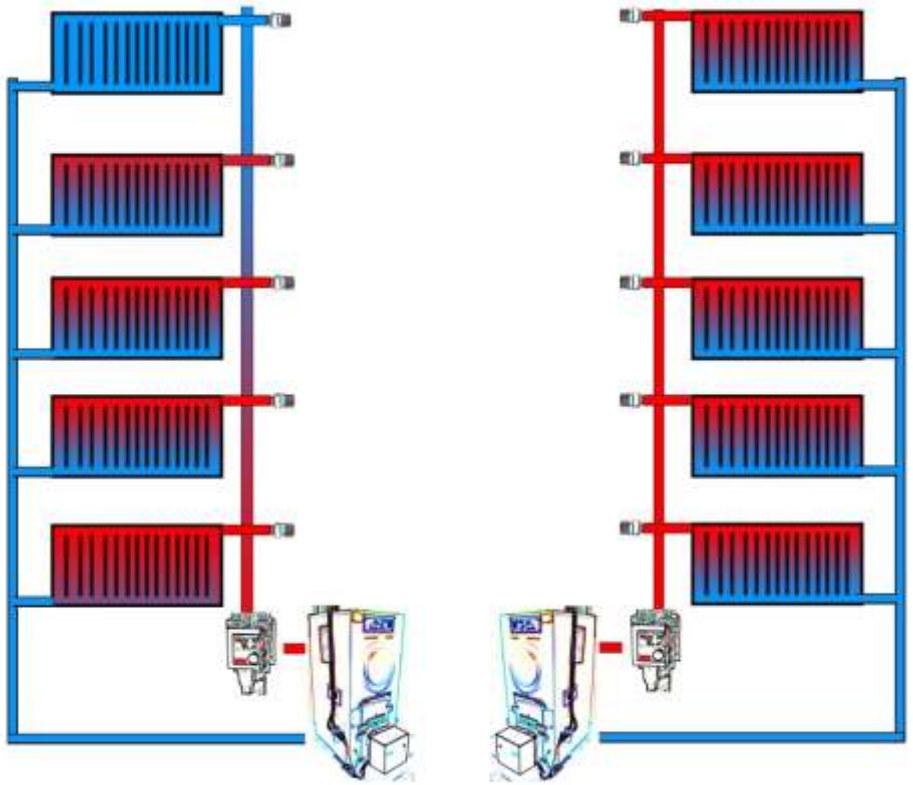
Schematic of a solar system

Source: Styrian Energy Agency; http:\www.ea-stmk.at

Hydraulic balancing

For a heating system to work perfectly, the radiator must contain exactly the right quantity of hot water. This is not something that just happens. It requires exact hydraulic balancing.

Faulty hydraulic balancing can lead to malfunction as ell as increased fuel and pump energy demand. Savings up to 15% and more are possible.



picture (c) Ra Boe / Wikipedia (https://commons.wikimedia.org/wiki/File:Hydraulischer_Abgleich_by-Ra_Boe-1.jpg), „Hydraulischer Abgleich by-Ra Boe-1“, https://creativecommons.org/licenses/by-sa/3.0/de/legalcode

3.1.6 Recommendations - lighting, ventilation and electricity

3.1.6 objective

You get some recommendations for lighting, ventilation and electricity.

The possibilities to optimize the electrical and lighting systems in schools and public buildings are numerous:

- ✓ LED lighting is state-of-the-art and cost optimal
- ✓ Switch off the lights if you leave the room or make automatic controls (daylight, presence)
- ✓ Reduce number of printers, copiers, fridges and vending machines
- ✓ Use timer for electric boilers (hot water)
- ✓ Use switchable power strips for your PCs and IT equipment
- ✓ Buy energy efficient equipment
- ✓ Reduce standby losses
- ✓ Change behaviour, make a game out of it
- ✓ ...

LED lighting:

- ✓ Take care of the right illuminance (EN 12464-1)
  - if the existing illuminance is poor (very often with old lighting systems), savings are lower...
- ✓ Consumption with new lighting should be < 6 kWh/m² and year
- ✓ Use daylight and presence control in classrooms, most new lighting systems are prepared for it
- ✓ Sometimes retrofit solutions reduce costs – take care of technical limitations; very often the whole system should be changed

Photo: LEV

Comfort ventilation system

- Make sure that heat recovery is high and electricity consumption is low.
- When planning the pipe system, make sure the pipes are short and the layout is simple and accessible. Avoid acute angles in the pipe system.
- Adapt the air supply intake (air quantities) to the actual demand depending on the number of persons and their physical presence.
- Change the filter at least once a year. This prevents soiling.

Source: Styrian Energy Agency; http:\www.ea-stmk.at

3.1. 7 useful information

3.1.7 objective

You get some useful information (online links) on EU-level and a contact point to the creator of this module.

FEEDSCHOOLS webpage:

https://www.interreg-central.eu/Content.Node/FEEDSCHOOLS.html

Examples how it works:

https://www.epbd-ca.eu/wp-content/uploads/2011/05/CT5_Report_Selected_examples_of_NZEBs-final.pdf

EU energy performance of buildings directive:
https://ec.europa.eu/energy/topics/energy-efficiency/energy-efficient-buildings/energy-performance-buildings-directive_en

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SELF ASSESSMENT TEST (1)

How many trees do you have to plant to compensate 100.000 kWh (fossil) gas consumption per year

☐ 160 ☐ 1760 ☐ 100000

The saving potential of hydraulic optimization is normally

☐ 5% ☐ 10-20% ☐ 50%

What are the first steps to know the weak points of your energy cosumption?

☐ Meter the consumption in detail (15 min. interval), analyse it

☐ Taking IR-pictures in summer at daylight

☐ Taking a photo of the building with your mobile and sending it to an expert

SELF ASSESSMENT TEST (2)

What is most important to reach an nearly zero energy building?

- ☐ Insulation of the roof
- ☐ A new heating system
- ☐ A combination of very good insulation standards, a high-quality building envelope and energy from renewable sources

What is life-cycle oriented planning?

- ☐ Taking only investments into account
- ☐ Planning a house to live in when you are older and retired
- ☐ Life-cycle oriented planning combines environmental goals, quality control standards, integration of all specialists in early planning phases, taking into account investment- running- and demolition costs as well

SELF ASSESSMENT TEST (3)

What does a renewed heating system need?

- ☐ As much power as you can get to heat the house up to 25°C
- ☐ A good oil filter to get the dirt out of the heavy oil
- ☐ A modern control system, thermostatic valves, hydraulic balancing, highly insulated pipes, renewable energy source

The state-of the art lighting is

- ☐ Compact-Fluorescent bulbs (CFL)
- ☐ LED lighting with automatic control
- ☐ Conventional light bulbs

SELF ASSESSMENT TEST (ANSWERS)

How many trees do you have to plant to compensate 100.000 kWh (fossil) gas consumption per year

- ✓ 1760

The saving potential of hydraulic optimization is normally

- ✓ 10-20%

What are the first steps to know the weak points of your energy cosumption?

- ✓ Meter the consumption in detail (15 min. interval), analyse it

What is most important to reach an nearly zero energy building?

- ✓ A combination of very good insulation standards, a high-quality building envelope and energy from renewable sources

SELF ASSESSMENT TEST (ANSWERS)

What is life-cycle oriented planning?

- ✓ Life-cycle oriented planning combines environmental goals, quality control standards, integration of all specialists in early planning phases, taking into account investment- running- and demolition costs as well

What does a renewed heating system need?

- ✓ A modern control system, thermostatic valves, hydraulic balancing, highly insulated pipes, renewable energy source

The state-of the art lighting is

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