CATALOGUE OF LOW-

AND NO-COST MEASURES

Project Title: **EmBuild** - Empower public authorities to establish a long-term strategy for mobilizing investment in the energy efficient renovation of the building stock

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1. About the project

EmBuild is a coordination and support project implemented by a consortium of ten institutions based in eight countries throughout Europe under the Horizon 2020 research and innovation Programme. Overall coordination rests with the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ).

The main objectives of EmBuild are to increase the capacity of public authorities at regional/municipal level to collect the necessary data to prepare ambitious, sustainable and realistic renovation strategies for public buildings, analyse and identify cost-effective approaches to renovations, guide investment decisions and facilitate private sector involvement. EmBuild is supporting municipalities and towns in Bulgaria, Croatia, Germany, Romania, Serbia and Slovenia. In addition, the project will focus on analyzing policies and implemented measures that stimulate cost-effective deep renovation of buildings and identify best practices in 6 partner countries.

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CONTENT

1. Introduction: Why no-cost and low-cost measures?

It is widespread knowledge that the European Union's climate and energy targets can only be reached, if the energy consumption of Europe's building stock is significantly reduced. Buildings are responsible for 40% of energy consumption and 36% of CO_2 emissions in the EU[1] (see figure 1). New rigid policies and legislation has been passed at EU and national level that demands new dwellings to fulfil highest energy efficiency standards. The biggest challenge however lies with the existing building stock.
According to Eurostat, about 2/3 of buildings in the EU were constructed before 1980 and less than 10% of today's buildings were built in the 21st century.

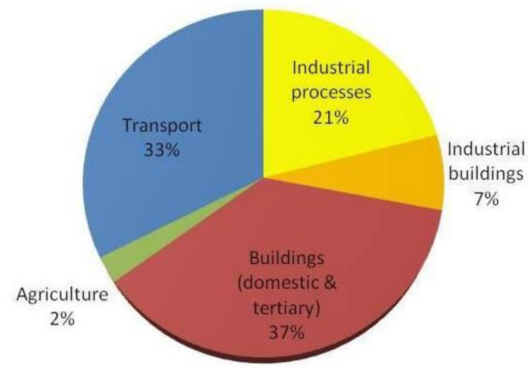

Figure 1 Share of total EU energy consumption (Eurostat)

Renovating the many million buildings that were constructed with low energy efficiency standards is a massive undertaking. The UK Chartered Institution of Building Services Engineers (CIBSE), for instance, calculated that for the next 40 years every minute one home would have to be refurbished to ensure that the entire existing building stock of 24 million homes would be up to modern standard[2].

The EED sets a 3% annual renovation target for public buildings owned and occupied by its central government from the beginning of 2014 onwards. "Deep" renovation implies a minimum of 75% energy savings. Currently however the rate is nowhere near the aspired 3%. For residential buildings – the majority of buildings in Europe – no figures are available.

There is no shortage of literature that confirms the massive economic stimulus that could arise if renovation activities picked up. It is also common knowledge that retrofitted buildings not only consume less energy and thus lead to reduced energy bills. They also often have a more enjoyable in-door climate which leads to various health, education and economic benefits.

- However, there are also many explanations why the saving potential is currently not utilized:
- There is no financial benefit for energy-saving behavior of the building users;
- The building users don`t know the cost for energy;
- The share of the energy costs are not in the focus within the overall operating costs;
- The know-how and abilities of the maintenance workers is sometimes unutilized;
- The existing technical infrastructure is old, broken or defective;
- No budget for energy saving measures available; and
- Low energy prices.

The good news however is that many low and no-cost measures exist that can be applied without major investment and without major interruption of the building use. There is no or only little planning necessary, no tenders or public procumrement processes have to be started. Most of the measures described can be implemented with the assistance of energy experts. The reduction in energy use that could be achieved by applying

[1] https://ec.europa.eu/energy/en/topics/energy-efficiency/buildings

[2] http://www.cibse.org/getmedia/707278aa-a14d-4ff9-b8ff-deae312ebfd3/South-Wales-Nov-2010-Seminar.pdf.aspx

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such measures could be significant. In Germany, for instance, the average cost for heating and electric energy for municipal buildings is about €30 per citizen and year. Thereof, approximately 30% could be saved. Half of this could be saved with low- and no-cost measures only, ie €4.50 per citizen per year! The savings that the small steps generate will improve the financial situation in the municipalities and may trigger deeper renovations.

Which low and no-cost measure can be applied in a specific building depends on the construction material, the way energy is used and how the building and its equipment are maintained. This, of course, varies from building to building and from country to country. In general however, one could think of three major categories:

1. Energy monitoring and controlling;
2. Optimization of the technical infrastructure; and
3. “Non-technical” measures, like awareness raising.

This catalogue summarizes typical no and low-cost measures. Depending on the specific context, the type of buildings and the technology available, some of these measures will be more applicable than others. EmBuild’s approach will be as follows: the catalogue presented below will be published on EmBuild’s website and continuously updated. Simultaneously, national EmBuild partners will extract those measures that will be most applicable by their focus municipalities and publish them in an appropriate format.

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1.1 Step 1: Energy monitoring and controlling

1.2 Energy controlling

An accurate monitoring of the consumption of heat, electric energy and water is the basis for an effective energy controlling. It is recommended to read the meters on a monthly basis.

Usually, buildings have at least one electric meter installed: Buildings with central heating have a heat meter, while those heated on natural gas have a gas meter. Buildings heated by liquid or solid fuel, as it is not a rare case in the Balkans, a measuring device for the consumed fuel is often missing. In this case the quantity of the fuel used can be determined by following the changes of the volume of the fuel in the storage and calculating the quantity.

Having the data about the quantity of the consumed fuel is of great importance for determining the precise energy consumption of the building. For thisto know low heating value of the fuel (LHV), as well as other characteristics of the fuel delivered: moisture, debris, stable carbon, volatiles. This information can be obtained from certificates of fuels that power manager should require suppliers of solid and liquid fuels at every delivery and suppliers of natural gas - once a month.

Other important parameters which must be monitored are also external and internal temperature. Internal temperature is desirable to measure at least at one representative room, which support different temperature conditions (eg offices, corridors, staircases). Best option is to use temperature sensors with loggers programmed to record temperature at regular intervals, for example every hour.

For an energy controlling the following steps are required:

- Data collection on site: energy meters, surface area, technical infrastructure;
- Mapping of the meters with an energy management software;
- Creating a “base-year” as a baseline for comparison;
- Readings of the meters on fixed periods not longer than monthly;
- Climate correction;
- Analysis of the readings and creation of periodical reports.

The main energy saving effect is twofold. On one hand, the building users will be sensitized and they will act differently if they know that their energy consumption is observed. On the other hand, higher consumption caused by defects of technical infrastructure will be recognized quickly and can be repaired. No exceeded consumption for a longer time can occur.

With the data collected, specific reference values can be generated and compared to other buildings of the same category. With this, a quick overview of the energetic performance of the building is possible. Furthermore, energy passports can be issued or an annual report can be created.

1.3 Climate correction

For the heat consumption, a climate correction is necessary. To achieve the correct and comparable results using dimensionless "heating degree days" (DD). The basic idea is, that the energy consumption for heating is calculated that would have arised in the same period, at the same place with a longtime climate. The heating degree days sums up the difference between the room temperature (20°C) and the outside air temperature of all day with an average temperature below 15°C. It is a correction-factor to compare the energy consumption of different years / periods.

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An example of the calculation of the degree days over a period of time is performed as follows:

- Heating limit: 15°C; If the outside temperature reaches 15°C, the heating system will stop.
- Average temperature of a day: 5°C (e.g. 25th October, depending on the weather)
- Degree day $_{15}$ = heating limit (15°) – average temperature (5°) = 10° K
- Sum up all the degree days of a period / year: DD = ($Q_{av.indoor}$ – $Q_{av,outdoor}$).t

Data for the annual consumption of energy for heating in the building should be adjusted by multiplying it to the DD in the comparative (basic) year divided by DD for the current year. The basic year is usually represented by the average of 30 years (1961-1990).

Kempten Gradtage (DD 20/15) VDI 3807	long-period average 1961-1990	2008	2009	2010	2011	2012	2013
Jan.	686	573	725	735	651	612	629
Febr.	591	515	602	589	524	744	648
March	551	532	548	536	473	441	589
April	420	401	298	357	298	364	356
May	278	179	160	294	167	177	305
June	150	82	126	115	114	91	152
July	86	61	53	40	129	46	0
August	110	40	32	107	52	20	60
Sept.	204	229	166	255	126	190	193
Oct.	376	346	356	398	369	365	305
Nov.	526	516	420	482	487	466	519
Dec.	656	645	634	700	548	608	594
Total	4.635	4.119	4.119	4.606	3.936	4.124	4.350
Factor	1,000	1,125	1,125	1,006	1,178	1,124	1,066

e.g.: heat consumption gym „Allgäu Sporthalle“ 2013:
411 MWh x 1,066 = 438 MWh heat consumption with climate correction

1.4 Benchmarks

With a relation between heat / electric energy / water consumption and a determining factor, the energetic performance of a building can be detected. For buildings, the annual energy consumption is put into relation to the floor area. The heated floor space [m²] is defined as the sum of all heatable building areas. According to the VDI 3807 the outside dimensions (including exterior walls) is used for the calculation of the floor space.

Reference values for energy are used for the assessment of the energetic performance of a building, for the monitoring of the operatoin of the building and the evaluation of energy saving measures.

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The norm VDI 3807 „Characteristic consumption values for buildings" is the basis and describes the correct modus to calculate reference values:

- Specific heat consumption = (annual consumption heat / heated floor space) x (DD 20/15)
- Specfic electric consumption = annual consumption electric energy / heated floor space
- Specific water consumption = annual consumption water / heated floor space

For the comparison of the reference values, there are various benchmarks with average and target values for different building types available. Te values may vary from country to country.

The most common used benchmark in the Germany:

- VDI 3807 Blatt 2 (Beuth Verlag)
- AGES-Studie (Gesellschaft für Energieplanung und Systemanalyse m. b. H.)
- Bekanntmachungen der Regeln für Energievebrauchskennwerte und der Vergleichswerte im Nichtwohngebäudebestand (Bundesministerium für Wirtschaft und Energie)

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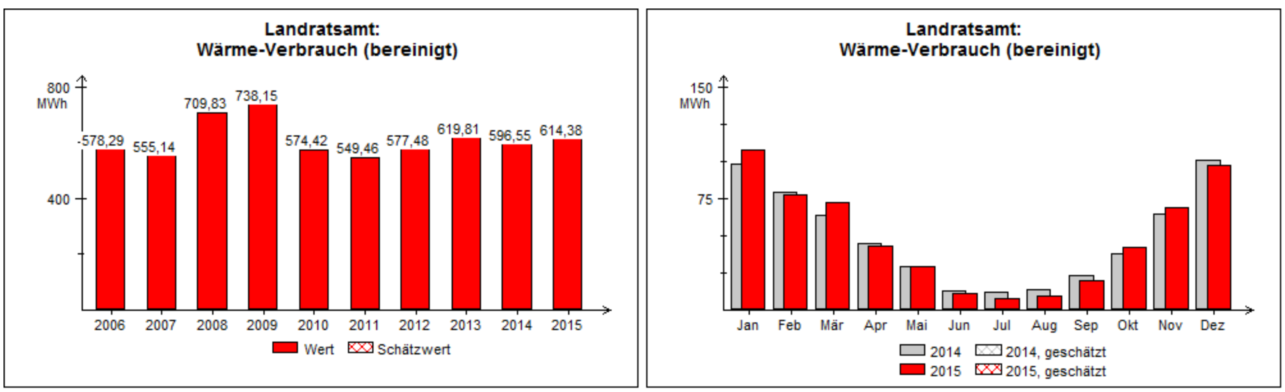
1.5 Reporting

With the energy monitoring, the municipality keeps track of the energy consumptioin and the energy costs of the building stock. The information can be used either for the information and motivation of the building users and it can be used for budget-planning within the administration. Together with the benchmark, which gives information about the enery performance of the buildings, it is a basic tool for the elaboration of a long-term renovation strategy.
Another side effect is: if the frequent meter readings are analysed thoroughly, consumptions higher than average will promptly be recognised. If they are caused by defects, they can be quickly repaired.

A prompt and targeted analysis of the measured data can provide:

- proper operation of technical installations;
- rapidly detect faults / failures in technical installations;
- possibility timely to request specialized support for troubleshooting;
- reduction of energy consumption;
- documentation and evaluation of energy saving measures.

Example for a monthly Report on energy consumption of a municipal building



Heat consumption

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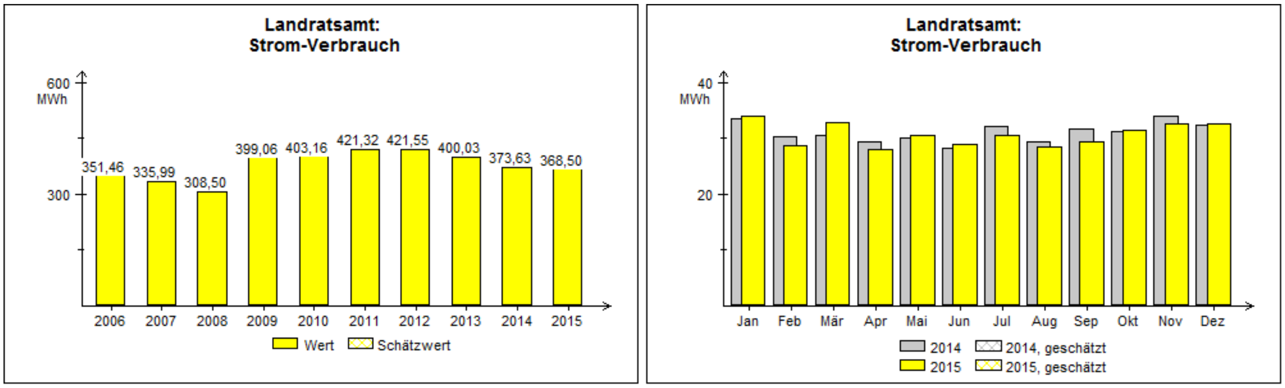
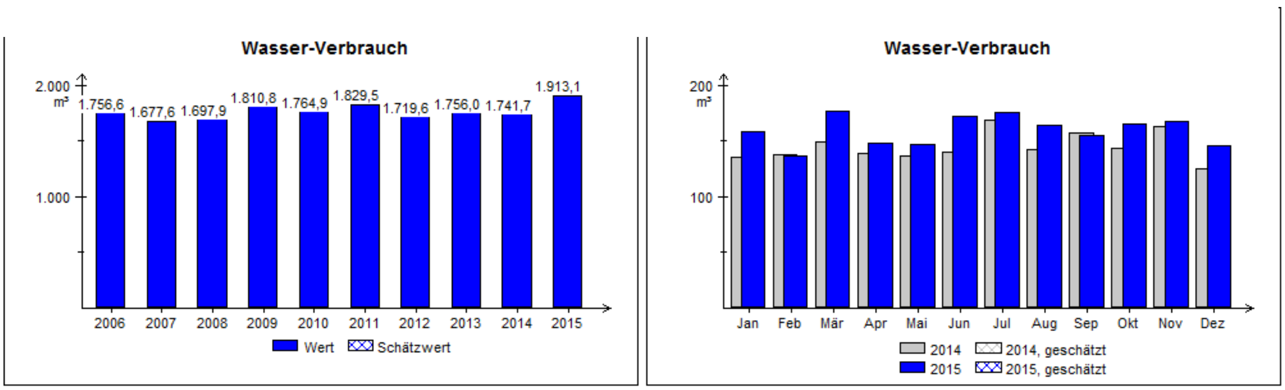


Consumption of electric energy



Water consumption

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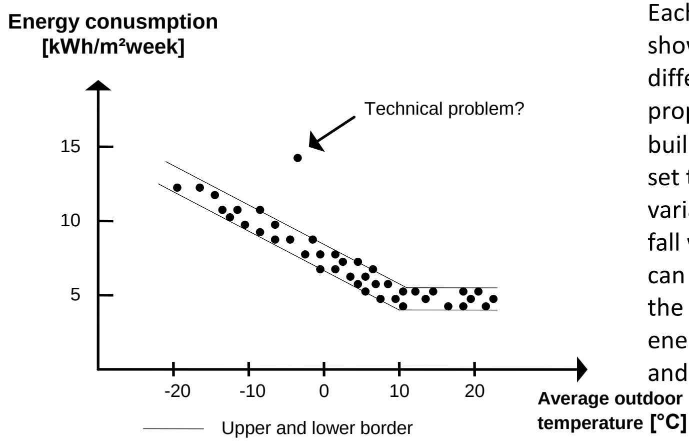
1.6 Further Analysis: Energy temperature curve

A suitable analytical tool is the Energy-Temperature curve (ET-curve). It could be constructed by registering the measured energy consumption and the average outdoor temperature for a certain period of time, for example once a week. The horizontal axis reflects the average ambient temperature for the week (GM / week) and the vertical axis the specific energy consumption of the heated area in the same week (kWh / m2 / week).



Each building has its own unique ET-curve that shows what should be the energy consumption at different outside temperatures, in the case of proper operation of technical systems of the building. Lower and upper limit (eg ± 5%) can be set to the ET-curve of the building. Normal variations caused by solar radiation, wind, etc., fall within these limits. Deviations from ET-curve can report technical problem or deviation from the normal people's behavior related to the energy consumption. This should be investigated and to take the necessary service activities.

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2. Step 2: Optimization of the technical infrastructure

2.1 Ventilation

General Advice:

- Ventilation systems should only be activated, if they are necessary for the specific usage of the room.
- Doors and windows should be closed during the operation of the ventilation system.
- Ventilation flaps and dampers should be closed when system is not in operation.
- To heat up rooms with air heating, recirculation air operation should be used.
- Sunscreens and blinds should be used to prevent the building from overheating in summer.
- Air condition and cooling may only be used, if room temperature is higher than 27°C

2.2 Adequate air volumes

"Starting porsition":
Building users need fresh air. CO_2, water vapor, fine dust and odors accumulate indoors and have to be brought outside of the building. Clean and sufficient air is essential for the health and well-being of the residents.

What`s the problem?
Ventilation systems in non-residential buildings are often planned to existing laws and norms. The air-change rate is often projected according to the size of the room (m^2), not to the real demand, which is the number of persons.

Recommendation:
Check the air volumes of the mechanical ventilation system. If possible, reduce the inlet air volume to 20-30m^3 per hour and person. If the system is equipped with a CO_2-sensorset it to 1.000 ppm (parts per million).

Applicable for:
Buildings with a mechanical ventilation system e.g. office buildings, financial institutions, gyms

2.3 Adequate room temperatures

"Starting point":
A pleasant room climate creates an essential condition for wellbeing and health, as well as good performance at work. Temperature, humidity and personal constitution influence the feeling and well-beeing of the persons inside the premises.

What`s the problem?
In order to feel well, "thermal comfort" should prevail. This is a state, which is given when persons are satisfied with the air temperature, the air humidity, air movement and radiant heat in the room.

Recommendation:
One factor that can easily be influenced is the air temperature. Energy consumption of a building is mainly influenced by the room temperature: a temperature increase of one degree causes a 6% higher consumption. The humidity should match the temperature to meet the comfort zone (see following AHREA comfort zone diagram).

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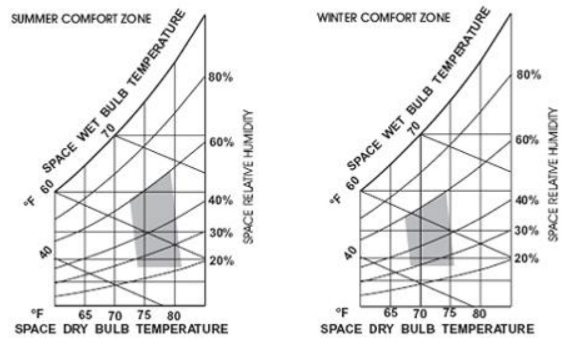
room	temperature
common room	20° C
changing room	22 – 24° C
lavatory	22 - 24° C
toilets	15 – 17°C
office spaces	20° C
workshops, service stations	12° C
stairways	12 – 15° C
garage	5° C

recommended room temperatures



ASHREA Comfort Zones

Applicable for:
All buildings with devices for temperature regulation (central & decentral).

2.4 Maintenance of mechanical ventilation systems

“Starting point”:
Mechanical ventilation systems can always provide us with fresh air in a building. But even simple technical systems have a lot of components that need attention.

What`s the problem?
From inside the building and from the outside, dust and pollutants can get into the air-ducts, the dampers and outlets. This may be a hygenic problem and with increasing pollution of the components, the energy consumption for the transport of the fresh air will rise. Dust and fibers in the dampers and filters, as well as in the pipeline network causes resistance. To override the resistance, more energy for the engines is needed.

Dust in air heater causes low effectiveness

If a building e.g. a gym is only heated with air, the premises might not get warm enough if the dampers and registers are soiled.

Reccommendation:
Damper registers should be cleaned at regular intervals and filters must be replaced. Maintenance intervals are recommended as follows:

functional part	activity	interval
heat recovery	check function, clean check for defects or corrosion	minimum each 3 months
air flaps for fresh-air and exhaust-air	check function	minimum each 6 months
fan belt	check condition and slip	minimum each 3 months

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Applicable for:
All buildings with mechanical ventilation systems; with exhaust air, supply air, systems with heat recuperation etc.…

3. Cold and hot water

3.1 Save water!

“Starting point”:
The share of the costs for warm in municipal buildings is ca. 5% of the total costs for energy (heat, electricity and water). In a normal office building - without special infrastructure – the main share of water consumption is caused by toilet and urinal flushing.

What`s the problem?
Water is used decentralised in a building, so the user has a huge influence on the water consumption. Caused by technical defects, the water consumption can significantly rise without being noticed. This can cause high costs that could be avoided.

Reccommendation:
Water taps, toilets and urinals should be checked regularly for tightness. Defect parts should be replaced immediately. In the case of refurbishment, water-saving taps should be installed.
The installation of waterless urinals or the use of rainwater is also ecologically worthwhile.
The flow rate of showers and washbasins should be checked and adjusted to maximum flow rates:

device	flow rate	time
shower	10 l/min.	20 sec.
washbasin	5 l/min.	5 sec.
toilet	6 l per flushing	

Applicable for:
For all buildings with water installations; water taps, toilets, urinals, kitchens…

3.2 Adequate temperature for warm water

“Starting point”:
Some non-residential buildings have central systems for hot water generation. The production, storage and distrisbution of warm water consumes energy. The efficiency factor for central hot water generation is approximately around 3-5%

What`s the problem?
The higher the temperature of the warm water, the more energy is needed for generation, storage and distribution. …??

Reccommendation:
An adequate temperature of hot water is 60°C at the outlet of the hot-water boiler. The temperature should not be lower to prevent legionnaires’ disease.
Pipes for warm water and circulation should be insulated to reduce the energy losses. Depending on the

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temperature, a power loss of 20-50 Watt per meter arises. The energy losses can easily be calculated in kWh: power loss [W/m] * length [m] * operating hours per year/1000 [h/a] = x kWh/a

Applicable for:
All buildings with domestic hot water generation, especially with central warm water tanks.

3.3 Decentralised hot water

"Starting point":
In offices, warm water is only needed in kitchens. The efficiency factor of central hot water generation systems in administrative buildings are approx. 2-3%. Therefore, it may be the best solution, to decommission the central hot water-supply and equip the kitchens with electronic water heaters.

What`s the problem?
Flow-type heaters are more efficient than storage heaters, for there are no storage losses. Only the required amount of hot-water is heated and the water is heated to the desired temperature accurately. The energy consumption for the generation of hot water can be calculated as follows:
volume cold water [m³] * ΔT [K] * 1,163 kWh/m³K = x kWh

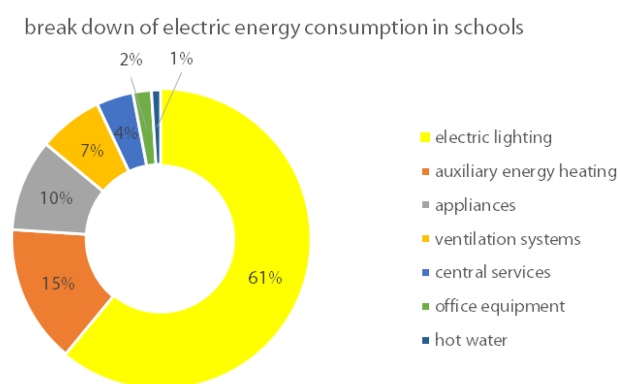
Reccommendation:
Decomission central hot water and install electronic water heaters. Additionally, you can begin to turn off the hot water at the wash-basins in the toilets. Inform the building users, that not the temperature of water is crucial when washing your hands but how careful hands are washed.

Applicable for:
Buildings with low demand of hot / warm water like office buildings, schools, town halls etc.

4. electric lighting

"Starting point":
In public buildings like schools, administration buildings, the share of the electric lighting, compared to the total consumption is around 60%.

What`s the problem?
In many buildings, the installation is old and inefficient. There is no centralised control systems, the lights are switched on or off decentrally by the building users.



Data source: KlimaNet, Klimaschutz macht Schule

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Recommendation:
A major contribution to save electric energy can be brought by the users of a building by correct and intelligent use of the lights:

- Switch off lights when leaving the room or daylight is sufficient.

- Clean lamps and reflectors regularly.
- Sun-shading should be used in a way, that no additional electric lights are necessary
- Install signs and information signs "switch off the lights" in infrequently used rooms like toilets, storage rooms, kitchens.
- Install motion sensors or timers in corridors and halls
- Replace old bulbs and filament lamps with efficient lamps - e.g. led retrofit lamps.

The room should be illuminated according to the requirements and the use of the rooms. Surplus lamps should be avoided and in case, removed. Unnecessary lights should to be switched off.

type of room	illuminance level
common room	200 lux
changing room	100 lux
lavatory	100 lux
toilets	100 lux
office spaces with daylight	300 – 500 lux
office spaces	500 – 1.000 lux
workshops, service stations	500 lux
stairways	100 lux
garage	30 – 100 lux

Recommended illuminance levels

5. heat generation

General advice:

- Control and regulation systems must be checked regularly for functioning. The parameters like the heating times and heating curve must be adjusted to the building use and the building standard.
- At the end of the heating period, heating system without centralised hot water generation should be turned off. Furthermore, the burner should be switched off, the heat exchanger of district heating systems should be cut-off. For electric heaters, the electric connection should be unplugged. The heating pumps should be turned off manually – control systems should be kept in operation.
- Let a specialist check the heating system regularly. Only when all the maintenance is done regularly, the heating system will work optimally. In addition, maintenance is a good opportunity to examine the regulation of the system and to seek individual advice on possible improvements by an expert.
- For timer clocks, the change to daylight-saving-time must be observed.

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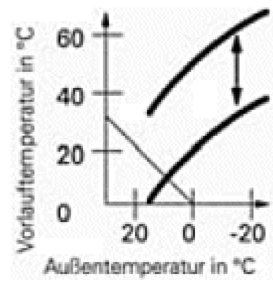
5.1 Heating curve

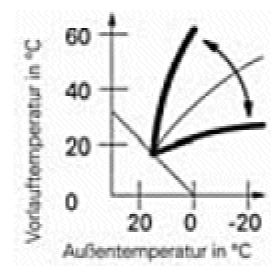
"Starting point":
The correct adjustment of the heating curve is essential, for the energy efficient operation of the heating system on the one hand and for the satisfaction and well-beeing of the building users on the other hand.

What`s the problem?
A weather-compensated heating control ensures that the temperature of the heating system is adapted to the actual heat demand of the building. For this, the control system measures outside air temperature and determines the inlet temperature for the heating devices according to the desired room temperature. The relationship between outdoor and inlet temperature is described by the heating curve.

Reccomendation:
Adjust the heating curve according to building standard. The curve slope determines how much the flow temperature will be changed when the outside air temperature is changing. The inclination that has to be set, depends on the thermal insulation of the house and the type of heating surfaces (radiators, floor heating etc.). The level of the heating curve is the factor for the desired room temperature. For the basic setting "0", a desired room temperature of 20° C is assumed. If a higher temperature is desired, the level must be increased.



Level of the heating curve



Slope of the heating curve

slope according to the building standard	slope
new building with good insulation, radiators	1,0 – 1,2
new building with good insulation, floor heating	0,3 – 0,5
old building, poor insulation, radiators	1,4 – 1,6

Level adjustment according to the room temperature	
always too cold	increase level
too cold, esp. on cold days	increase slope
in changing of the seasons too cold, ok on cold days	increase level and decrease slope
in changing of the seasons too warm, ok on cold days	decrease level and increase slope

In general, the temperature the night setback can be activated in residential buildings between 22:00 and 6:00 h; in non-residential (office) buildings from 17:00 to 06:00 h and on weekends. For the night setback a room temperature of 15°C is recommended. If the temperature is lower, much more time and energy will be needed to re-heat the building.

Applicable for:
All buildings with a centralised control and regulation systems with outside air temperature sensors (e.g. Siemens, Honeywell…)

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6. heat distribution

6.1 Insulation of heating pipes

Missing insulation of heat distribution pipes

"Starting point":
Everything strives for balance. Hot pipes in a cold cellar will loose energy towards the cold room, where the energy can not be used.

What`s the problem:
The pipe network of a central heating system must bei insulated in order to reduce the energy losses in cellar / basement rooms. These rooms are warm then, but it is not the main purpose of the heating system to heat up secondary or seldomly used rooms. The heat should efficently be delivered to the rooms that are really used in the building.

Recommendation:
Insulate the heat distribution and hot water pipes of the heating system. Uninsulated pipes lose a lot of heat on the way between the boiler and radiators. You can carry out the work for yourself, but make sure that the insulation is according to norms and regulations (e.g. Law on energy efficiency in Germany). The fittings have to be insulated without voids, too. The thickness of the insulation has to be equivalent to the diameter of the pipe. The thermal conductivity of the insulation material has to be at least λ = 0,035 W/(mK).

Applicable for:
All buildings with a central heating and a heat distribution and warm water pipe network.

6.2 Efficient heat distribution pumps

"Starting point":
Four out of five heating pumps in Germany are outdated.

What`s the problem?
Old, unregulated heating circuit pumps are always working with the same speed and therefore often make more power available than is needed. With an annual operation time of 6,000 hours, an old circulation pump has an annual electricity consumption of 400 to 600 kilowatthours. New high-efficiency pumps, however continuously adapt their output to the actual needs of the building - and therefore consume much less electricity - up to 80 percent.

Recommendation:
Replace old inefficient, unregulated heating circuit pumps. Before installing new high-efficient pumps with electronic control, check for the correct dimension of the new pump. The power of the pump is depending on the size of the floor area, they supply with hot water.

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Applicable for:
All buildings with a central heating and a heat distribution and warm water pipe network.

6.3 Hydraulic balancing

“Starting point”:
With the hydraulic balancing is, each heating element within a heating installation is adjusted to a certain flow of hot water. With this, it is ensured that heating devices are exactly supplied with the amount of hot water that is required to reach the desired room temperature and the recirculation of each heating devices have the same low temperature.

What`s the problem?
Without hydraulic balancing, heating devices that are close to the boiler, are better provided with hot water, heating devices (radiators, floor heating etc.) that are far from the boiler are undersupplied. Radiators in the upper floor levels will not be warm enough. This is caused by the flow resistance in the pipe network.

Indicators for a missing hydraulic balancing:

- single radiators are not warm enough, while other parts of the system are
- pulsing operation of the boiler
- noise in the radiators and the pipe network
- heating system is operated with a high flow temperature to heat distant rooms
- the recirculation temperature is high

Recommendation:
For the hydraulic balancing, the distribution of heating water is regulated with adjustable valves. With these, the desired amount of water is reduced and presetted according to the size of the radiator and it`s position in the heating system. After the hydraulic balancing, the power of the heating circuit pumps and the flow temperature can be reduced.

Hydraulic balancing by adjusting the flow-rate of the valve

Applicable for:
All buildings with a double pipe network with radiators and convectors. If the valves are not adjustable, they can be replaced.

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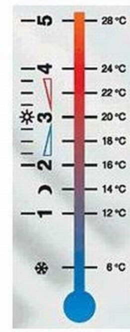
7. heat delivery

7.1 Correct use of thermostats



28° Swimming pools

24° bathrooms
22° office, childrens room
20° living room
18° kitchen, hallways
16° bedrooms

“Starting point”:
For the temperature regulation for the single user, thermostats are installed at the radiators. This gives the user the possibility to adjust the room temperature to its personal liking.

What`s the problem?
A thermostat is a valve that mechanically controls the temperature. Depending on the ambient temperature, the valve will open or close, so that the temperature in the room will be matched. The setting of the thermostat will determine, at which room temperature the valve will be closed. A setting to 3 will result in a room temperature of 20°C. A setting to 5 will not cause a faster heating-up of the room. On the contrary, it will result in an over-heating of the room, for the valve will be closed at a temperature of 28°C.

Recommendation:
Inform the users of the building on how to correctly use a thermostat. The users have to find the position of the thermostat that matches their personal heat demand or their well beeing temperature. This is dependent on the physical status (male, female), the clothing and of coursse the building (passive house or old castle). The thermostat can remain in that position, the central control unit of the heating system will regulate the flow temperature. Only when the users open the windows to get fresh air, they shoul close the thermostat (set it to *). After closing the window, they should set it back to their “personal” position.
In less often used rooms like hall-ways, storage rooms and toilets, room temperature can be lower. The thermostats can manually be limited and locked to a setting of 1 or 2. So the building users (especially in public buildings and schools) cannot manipulate the temperature in these minor rooms.

Applicable for:
Buildings with central heating system with radiators, convectors with thermostats.

8. Electricity

8.1 Reduce Stand-By consumption

“Starting point”:
Modern technical devices often go to a stand-by modus and can be easily activated with a remote control.

What`s the problem:
In the stand-by modus, the funciontality of the device will be limited in order to save energy. The amount of energy that is still consumed by the power supplies and sensors is called the stand-by consumption or power loss. Almost any device with an external power supply, a remote control, a display or a charging station consumes electric energy continuously.

Recomendation:
To detect the power loss you can use a measuring instrument that shows how much energy is wasted. Use switchable power sockets to avoid Stand-by consumption

Applicable for:

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Many technical devices like printer, pc`s, monitors, coffee machines etc.

8.2 check for steady load

“Starting point”:
Energy is power multiplied by time (kWh = KW * h). Not only the power of a device is significant, but also it`s operation time. Even a small load can cause a high consumption if it running for a long time.

What`s the problem:
Some buildings are equipped with technical infrastructure that may consume energy continuously if the controls and regulations are not set properly. Examples for steady loads may be ventilation systems, vending machines or heating elements for buildings in a harsh climate (e.g. electric heating for rain pipes, park decks).

Use switchable sockets to cut off Stnd-By

Recommendation:
To determine steady loads you must monitor the electric consumption: is there a high consumption at night and on weekends? Another possibility is to measure an analyse the load curve of the building. Does it show a base-load and is that explciable?

Applicable for:
All buildings with a higher than average specific consumption of electric energy.

8.3 Avoid electric heating

“Starting point”:
If electric heating devices are used in public buildings, it indicates that there is a problem with the heating system. If remote rooms are heated with additional electric heaters, it may be because the existing heating system – due to hydraulic problems - does not provide sufficient energy there.

What`s the problem?
Electric heating is 2 to 3 times more expensive than heat generation with a central heating system based on oil, natural gas or biomass. And the use of electricity causes more CO_2-emissions than conventional energy carriers.

Electric radiators

Recommendation:
Try to optimize heat distribution in the building with a hydraulic balancing. Inform the users.
But on the other hand, electric heating may be reasonable in some cases, e.g. if it can avoid that the whole building has to be heated. This may be the case if only single rooms or remote rooms for gatekeepers or security have to be warm.

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Applicable for:
All buildings.

9. Small measures for Building envelope

Many insulation measures are expensive and require a longer consultation and planning before they are implemented. But there are some easy measures that can improve the energy performance of a building:

- insulation of the basement ceiling
- insulation of top floor ceiling
- check and improve air tightness of the building
  e.g. window seals, close unnecessary chimneys etc.

Advice:
Roof insulation and wall insulation should be planned with an energy consultant.

10. "Non-technical" measures – Awareness raising

Last but not least, the energy efficiency level of awareness of the mayors/city managers/decision makers is of utmost importance. The project partners have repeatedly come across this issue in their daily work, which can be derived from the discussions and conclusions of several meetings with municipalities and reflected in their reports and publications. The low-cost energy efficiency measures can and should be addressed from the very top (international treaties, national laws) to the bottom (municipal council decisions).

From regional point of view, one field of intervention would be to recommend mentioning the local government dimension in international treaties and programmes. As an example, the Energy Community Treaty does not have a special unit or does not streamline the local energy issues. As it is a treaty between governments, it sets national targets in NEEAPs concerning national targets and often the local energy action plans are not or are little connected to them. Similarly, the indicative targets and binding obligations of the Energy Efficiency Directive are laid down for central governments with a number of references to the regional and local level.

One possible way of influencing the policies is to involve the local government associations in the process. The local government associations within their mandate are the interlocutor between the central and the local governments, and participate in the preliminary debates and legislative process for introducing laws.

Here are some measures that can be introduced for no- and low-cost measures for energy efficiency:

a) information and motivation of the building users to energy efficient behavior:
- heating setpoint (thermostats)
- switching of lights
- switch off utilities (pc`s, printers etc.)
- adequate clothing
- use of natural ventilation – CO_2-alarms
- energy monitors: information on current energy consumption
- manual for the use of typical buildings (Schools, Kindergarten, administration buildings)

b) Increase political and public awareness of potentials and benefits of energy efficiency (EE) application at local level:

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- EE projects in schools, hospitals, public institutions and residential buildings may have a particularly high impact on public education and awareness raising
- Disseminate information on good practice of EE applications in municipalities
- Awareness raising campaigns should be based upon target-group specific argumentation (e.g. focusing on environmental concerns for educated target groups , focusing on economic concerns for poor people)
- Domestic production of adapted EE technologies should have a high priority;
- Alternative forms of financing (PPP, credit, loans, etc.) should be more actively promoted and used for local projects

c) cooperate with government authorities responsible for EE (intergovernmental cooperation both at vertical and horizontal levels)

- Support the development and implementation of municipal joint programmes, campaigns and projects at local, national and international level
- Facilitate technical and financial cooperation of municipalities with national and international partners
- Provide information on and improve access to national and international funding sources for EE

d) contribute to improve the political, legal, institutional and economic framework conditions for EE projects

e) Liaise, cooperate and exchange know-how and experience with existing local, national and international initiatives and networks promoting EE measures in municipalities

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