



Project EIE-06-189 ClearSupport

**Clearinghouse Facilitation:
Paving Way for Better Energy Building Performance
in Europe**

Regional and local Impact of RUE Measures in Buildings

Prepared by

ENERGY NSULTING NETWORK

In coordination with partners of the ClearSupport project

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1 Introduction

This report is a result of the work conducted as a part of work package 4 (WP4) of the project “Clearinghouse Facilitation - Paving the Way for Better Energy Building Performance in EU Less Developed Regions. The project acronym is ClearSupport and the project is based on the EC’s intentions for establishing a clearinghouse for promotion of small and medium scale sustainability energy projects as stated in the EU Green Paper on Energy Efficiency. The technology focus is on RUE in building measures.

WP4 is dedicated to bring in front rational use of energy (RUE) in buildings. The main focus is on building retrofitting, and to a minor extent also designing for RUE in new buildings. A wide range of measures exists for RUE building retrofitting and must be made operational for the operation of project service facilities (PSF) and thus shall facilitate ClearingHouse penetration in general.

Latvia, Lithuania, Poland, Czech Republic and Crete have a PSF in place. Slovenia is participating as observer. The role of each PSF is to provide practical assistance to project owners on project identification, documentation and financing. Project owners include housing associations, municipalities and building project developers having the possibility to implement increased rational use of energy in larger building stocks.

The overall goal for WP4 is to develop standardised solutions of key type of RUE in building measures. The objectives of the work are:

- To collect and prepare structured information on technical issues within building retrofitting for the use in the PSFs
- To ensure an adequate RUE level for new buildings
- Evaluate the impact of RUE building retrofitting
- To generate a RUE package for PSF operation

- Extraction of the replication value of the performed activities of relevance for other EU less developed regions.

This leads to the following four deliverables D4.1 - D4.4:

No:	Deliverable title
D.4.1	Report on cost and energy savings for RUE initiatives in buildings
D.4.2	Report on regional/local impact of RUE initiatives in buildings
D.4.3	Report on EU wide energy saving potential due to RUE initiatives
D.4.4	RUE Technology guide / catalogue for Project Service Facilities

The aim of this Report is to report on the regional and local impact on RUE measures in buildings identified by the partners of the ClearSuport project during implementation.

This report focuses on the impact of RUE measures in buildings and the target group is municipalities, housing associations, local and central authorities and the house owners or tenants with a specific interest in setting up Project Service Facilities in there region or municipality.

2 Regional and local impact of RUE measures in buildings

2.1 Introduction to energy saving measures in the building sector

Executing measures for improved energy efficiency of buildings may seem a purely technical task. But, whenever we talk about energy efficiency or energy saving measures in buildings, there are always other aspects present, which are closely connected to these actions:

- environmental impacts,
- socio-economical influences,
- market development,
- productivity,
- health and general well-being,
- and many more.

It is thus important to investigate possible results of our moves in a broader framework.

In general, we could talk about three levels of problems or concerns related to energy efficiency in buildings. The first one addresses existent building stock. As it is usually not in correspondence with modern trends of energy efficiency there is a need to renovate it into a less energy-consuming condition, which concerns primarily heating, cooling, ventilation, hot water preparation and electricity. To assess to what extent (financially and technically) this should be done (according to the building age, condition and its predicted remaining life time) requires expert knowledge and careful analyses.

The second one addresses new construction, which shall be planned and executed following not only minimum legislative requirements (basic entry point), but preferably latest state-of-the-art criteria and techniques to assure acceptable operational and maintenance costs through the largest possible part of the building's life cycle. This is to avoid that new buildings would soon become "existing buildings with poor characteristics".

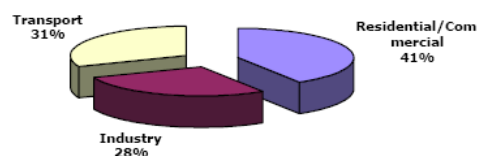
The third one is of a non-technical nature, but often crucially influences the possibility to fulfil expectations based on planning and calculations: occupants and their behaviour, i.e. patterns of building “use”. No matter how advanced the solution for a building renovation is, energy figures will mostly depend on the end-user, his or her knowledge and appreciation of energy efficiency principles, and preparation to modify old patterns of use (to omit the “business-as-usual” practice).

2.2 EU framework and potential

There are several well-known facts available regarding the EU building stock and related energy consumption. The buildings sector is – with around 40% of the final energy consumption – one of the largest energy consumers in the European Union. At the same time this represents also the largest source of environmental pollution (CO₂ and other emissions, but also waste). The main fields of energy consumption here are heating, cooling, hot water supply, ventilation, and electricity.

In addition to reduction of the energy demand of existing buildings, new building design strategies must show the way towards significant decreases in building energy demand. The structure of energy consumption varies depending on the building type. For example, office buildings usually can have higher electricity consumption but lower heat demand than residential buildings.

Energy Demand in 2000 in the European Union



Source: Towards Energy Efficient Buildings in Europe, EuroACE, June 2004

International Energy Agency (IEA) estimates the long-term energy savings potential for new build at 70-75 %, and this without additional costs or with very limited additional costs for owners. The total feasible potential for energy savings by renovation and refurbishment is estimated at 55-80% depending on the building type and region.

These figures are useful when we are talking about the general situation in EU. But, if we would be to simply say that they represent uniform average conditions, a certain dose of caution must be present. Variations from country to country can be quite substantial, and this can originate from many reasons. So, coming from the general EU to national or regional boundary conditions, using only average EU values to describe the existent state can in some cases mean a serious overestimation and in others a substantial underestimation.

2.3 Benchmarking

To add to the above, there are usually significant differences to be found also within the building stock in a particular country or region. This depends on several influential factors, among other climate zone, building type, and building age (i.e., physical characteristics).

It is very useful if one is able to compare the existent state of an individual building to figures typical for the same category of buildings (“benchmarking”). In this way a qualitative description is possible, for example, “consumption below average”, “consumption twice the average”, and similar, which helps to roughly estimate already beforehand the extent of renovation measures needed. But, this can be done only if and when a reliable databases exist, which comprise comparable buildings.

An example of such categorisation could be: multi-storey residential buildings, massive construction, built between 1945 and 1960, in the moderate climate zone. Of course, weighting of data (“normalisation”) on the climate basis can also be done, for example with help of degree-days, to make comparisons possible in an even wider sense.

Another advantage of this approach is in the possibility to conceive sets of “typical” or “recommended” energy renovation measures (which still have to be checked for each individual case) according to categories. Comprehensive databases of this kind allow preparation of even broader strategic plans and estimation of achievable savings and required financing on a local, regional or national level.

2.4 Future prospects and plans – common EU level

As said, conditions of the existent building stock can depend on many historical, economical and technological foundations. In a country where the building stock is generally in poor condition the saving potential is of course substantial. In the same time, looking from the perspective of a national economy, the financial sources needed for a thorough upgrade are usually quite high, too. Also, the overall process can take a significantly long time, which should be estimated realistically. One of the keys to success is formation of a firm technical, logistical and financial basis for implementation of sustainable renovation works. This was for example one of the aims of the ClearSupport project and subsequent establishment of Project Service Facilities.

By cutting the energy use in buildings by about 30 %, Europe's energy consumption would fall by 11%, more than half of the 20-20-20 target (20% less carbon dioxide by 2020, with 20% renewable in the energy mix). It is of course important to acknowledge that the execution of these measures would also have already mentioned multiple other positive effects.

The building stock in the EU amounts to 21 billion m². The annual production of new buildings is 1%, demolition rate about 0.5%, and retrofit about 1.8 %. At that rate it will take a very long time to improve energy efficiency. A comprehensive and aggressive approach will be needed to reach the above mentioned target of 30%.

EU has so far prepared many strategic documents and directives aimed also at improving energy efficiency in the building sector. The most relevant one is the Directive on energy performance of buildings (EPBD; 2002/91/EC). This Directive requires all EU countries to enhance their building regulations and to introduce energy certification schemes for buildings. All countries are also required to have inspections of boilers and air-conditioners. EPBD contains a range of provisions aimed at improving energy performance of residential and non-residential buildings, both new-build and existing.

In 2010 a recast of the EPBD is to be adopted, in which requirements for further strengthening of national legislative criteria for buildings will be set. Member states will again have to adjust their legislation. All this is in adjustment with EU Commission policy, which calls upon member states to

develop and perform urgent actions also to boost renovation of existing renovation building stock.

It can often happen that certain predictions and plans turn out to be not feasible, be it from financial, technical, or schedule-related reasons. In such cases it is important to identify weak spots in time and to re-assess the possibilities.

A recent example is the European Energy Efficiency Action Plan from 2006. In October 2009 a draft document titled »7 Measures for 2 Million New EU Jobs« came into public discussion. In fact it represents a simplification of the above mentioned Action Plan, as it has become clear that EU would not succeed to reach own targets (20-20-20 until 2020; see above).

Seven measures are presented, which could help to at least get close to these targets. Recent analyses have shown that a reduction of energy consumption alongside current trends would reach only 11% instead of planned 20%. The core of the problem lies in the fact that energy use in EU could stabilize until 2020 (although for the same period a GDP growth of 28% is predicted), but not decrease sufficiently.

One of the seven measures covers the existent building stock. An energy renovation of 15 million buildings in EU is anticipated until 2020, which would not only reduce CO₂ emissions by 66 tons per year, but also generate 300.000 direct and 1,1 million indirect work jobs.

2.5 Greening the actions

“Green procurement” is a motto, which is most vital also for the building field. Relevant EU and national legislation deals with public sector, but the main principles and actions can logically and effectively be transposed to the private sector, too. When planning renovation and upgrade of buildings (or, new construction) these principles can be described as getting proper value for money with consideration of long-term effects (maintenance and operational costs) instead of just initial investment, while simultaneously reducing negative impacts on the environment.

It is most recommendable to prepare criteria for calls for tender among other also on the basis of recognised national or international energy labels. Special guides, calculation tools and performance sheets already exist to help purchasers define their needs and assess offers: for public

authorities see for example www.procuraplus.org (ICLEI Europe), and for private and public sector www.buy-smart.info (an EIE project started in 2009 by a consortium of eight EU partners).

2.6 Basic building stock characteristics in ClearSupport partner countries and EU

In the previous text it has already been stated that noticeable differences in the composition and quality of the building stock can occur regarding particular EU regions and individual countries.

The following table represents an extract from the Study on the Energy Savings Potentials in EU Member States, Candidate Countries and EEA Countries (2009; consortium coordinated by Fraunhofer-Institute for Systems and Innovation Research):

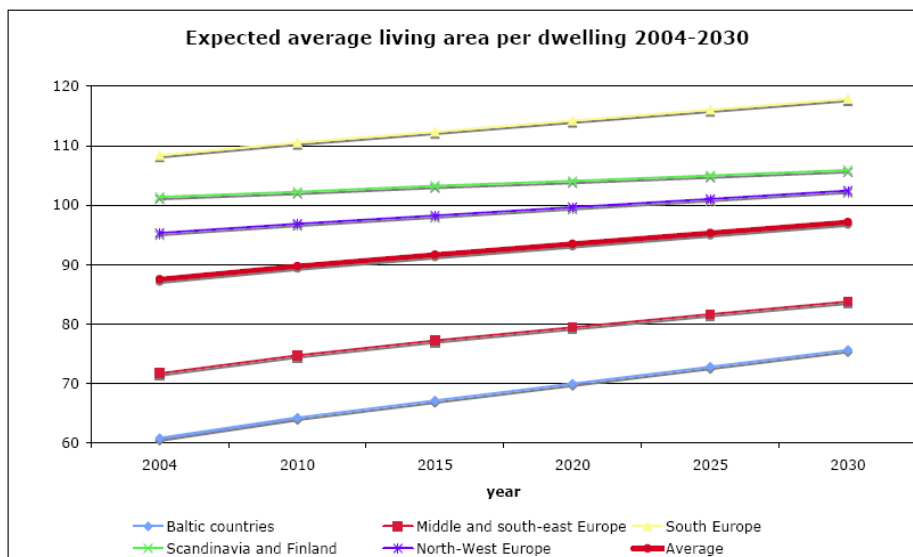
Residential building stock in 2004, ClearSupport partners:

In % of all residential dwellings	Built before 1975	Built between 1975 and 2004	% of single-family buildings	% of multi-family buildings
Belgium	79	21	70	30
Czech Republic	33	67	42	58
Denmark	72	28	59	41
Germany	81	19	47	53
Greece	55	45	43	57
Lithuania	64	36	25	75
Latvia	64	36	25	75
Poland	47	53	33	67
Slovenia	69	31	36	64

Sweden	71	29	43	57
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Source: WI calculations based on Boverket, MMR (2005); MIIR, FIHF (2007) and EURIMA, Ecofys (2005a)

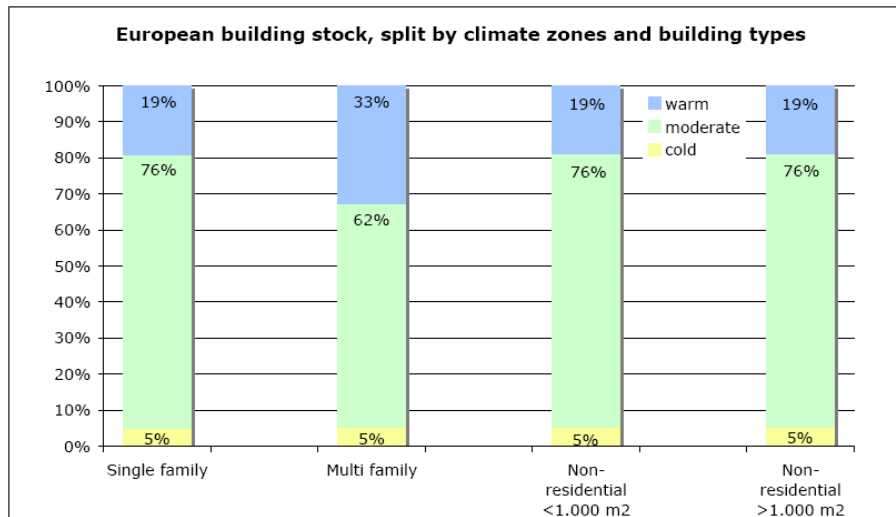
According to the cited study the total amount of living area will grow by 2030. It is projected that in general the total number of households will grow but the number of inhabitants per household will decrease by 2030 due to the demographic and social changes. The total increase of the floor space is 29 % between 2004 and 2030, and an increase of average living area from 88 m² up to 97 m² per dwelling in 2030 is projected:



Source: WI calculations based on Primes, Odyssee and Eurostat

It is expected that the trend differs between the countries by 2030. Especially in the Baltic countries and in Poland an increase of approx. 25 % of the average living area per dwelling is expected, whereas in North-West Europe and in Scandinavia, France and Germany the average increase is about 5 to 7 %.

Thermal characteristics' levels and additional investments in energy efficiency vary also regarding climate zones. Study on the Energy Savings Potentials brings the following picture of EU area:



source: WI calculations based on ECOFYS 2005b; WI 2000

So, energy standard of buildings can be classified accordingly:

			U-values in Wm ² K
	Old		Intermediate (IM)
	Built before 1975 not refurbished	Built before 1975 already refurbished	Built 1976 - 2000
Cold Climate Zone			
Roof	0.50	0.20	0.18
Facade	0.50	0.30	0.25
Floor	0.50	0.20	0.19
Windows	3.00	1.60	1.60
Moderate Climate Zone			
Roof	1.50	0.50	0.45
Facade	1.50	1.00	0.75
Floor	1.20	0.80	0.65
Windows	3.50	2.00	2.75
Warm Climate Zone			
Roof	2.46	1.00	0.65
Facade	1.97	1.40	0.90
Floor	2.50	1.00	0.68
Windows	4.70	3.50	3.85

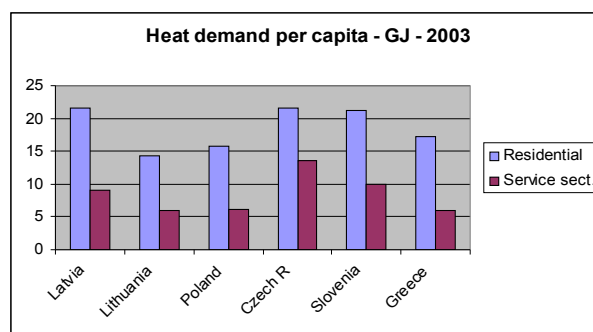
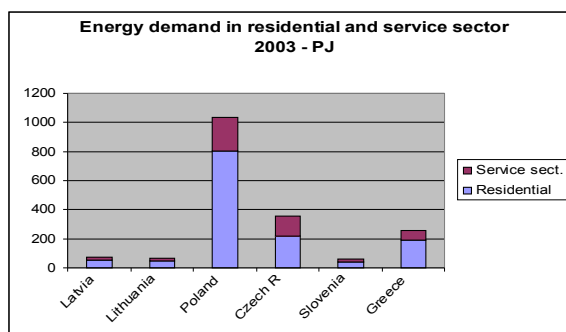
Source: WI calculations based on EURIMA, Ecofys (2005b); WI (2000); IWU (1994); ISIS

In the ClearSupport project all types of climate zones were represented:

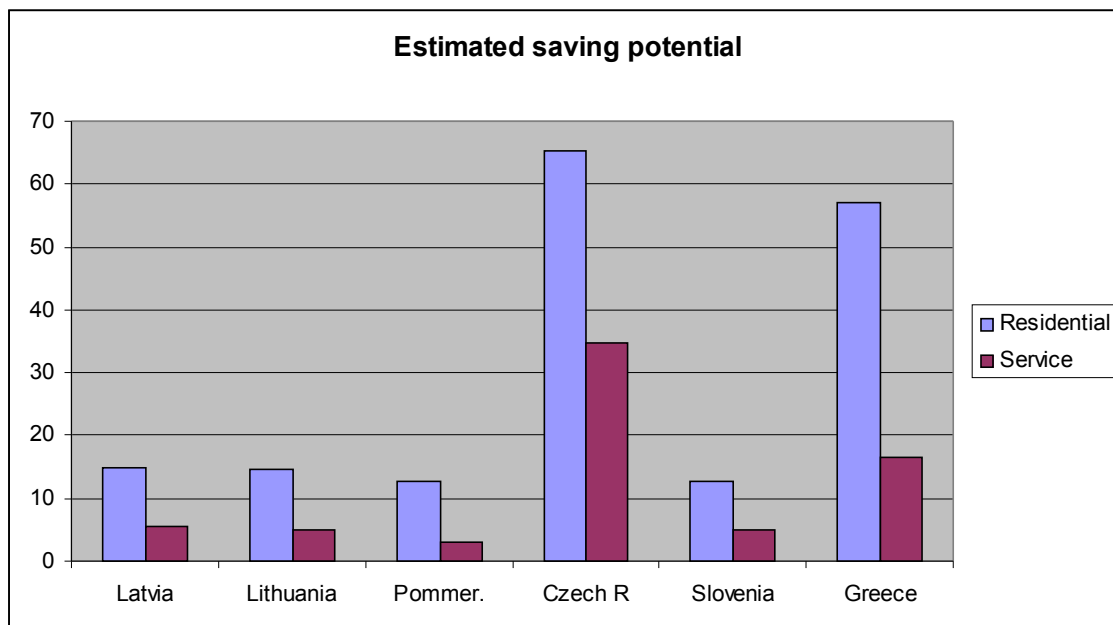
Name of region	Countries	Description	Degree days
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Baltic Sea Region	Latvia, Lithuania and Poland	Cold climate	> 3700
Central Europe	Czech Republic, Slovenia	Moderate climate	2700-3700
Southern Europe	Greece (Crete)	Warm climate	< 2700

In Work Package 4 some valuable information about current situation in PSF countries was collected (for details see report Cost and Energy Savings for RUE measures in buildings).



The PSF's (note: in Poland only the Pomeranian region is partner and in Greece only Crete) have each estimated the saving potential for residential buildings and buildings in the service sector: 20-50% for the residential sector and at least 25% in the service sector. An average estimate of 30% for the residential sector and 25% for the service sector gives a saving potential of 406 PJ in the residential sector and 125 PJ in the service sector:



2.7 General path to energy efficiency in buildings

We spend most of our time living and working in buildings. In EU the number of people occupying buildings in one or another way is coming close to half of a billion. It is thus vital to ensure suitable indoor comfort as well as acceptable investment, operational and maintenance costs.

As buildings normally have a substantial technical and constructional lifetime, it is important to distinguish between components with a shorter technical lifetime, which can be replaced or upgraded without major interventions into building structure (for example, boiler, solar collectors, etc.), and components, for which any intervention would require more substantial work and higher additional costs (for example, additional thermal insulation, new windows, not to mention load-bearing construction, etc.).

So, we could very roughly speak about the following terms:

- installed and
- built-in components.

The latter ones should be designed and chosen in such a way that their characteristics allow normal and efficient functioning of a building as long as possible. For this reason national regulations usually provide already initial high-performance criteria for example for the elements of the outer building envelope.

When it comes down to new buildings or renovation of existing ones, modern requirements in regulations are often at the so-called low-energy or low-carbon levels. Nevertheless, already at early planning stages attention must be put upon operational and maintenance costs. The building sector is one of the major examples where analyses of life-cycle costs (LCC) for possible solutions show most valuable long-term effects.

2.8 When and how

There is virtually never a bad time to plan and execute energy efficiency measures. The important thing is to analyse and identify the type and extent of measures, which are logical and feasible in a certain situation. It is strongly recommended not to simply copy-paste successful “recipes” from other buildings, as initial state and boundary conditions may be significantly different. Of course, as a source of inspiration and information it is always profitable to make a research about good practice examples (see for example relevant ClearSupport reports).

Types of measures

Energy efficiency measures can be in a range from simplest to most complex ones. One categorisation can be made with regard to regular or interventional maintenance work:

- anyway (non-energy) measures, and
- specific (energy) measures.

(Note: the term “anyway” is taken from Ecofys report PBENDE084668, 2009)

Namely, in several cases total investment costs for energy renovation include costs, which would occur in any case, i.e. certain renovation measures (repairs, replacements) would have to be done anyway. It is important to identify and segregate these partial investments when calculating the pay-back time for energy efficiency measures (i.e. balancing investment costs against energy savings), otherwise non-realistic figures will occur.

However, another important thing to have in mind is that the most appropriate time for execution of energy efficiency measures is when certain renovation/maintenance work is already scheduled. This helps to avoid multiplication of costs.

There are often measures available and feasible, which prove noticeable effects without major financial input. They can be executed separately, without compromising the technical integrity of possible future comprehensive interventions. In this relation we usually talk about:

- no-cost, and
- low-cost measures.

No-cost measures relate especially to change of occupants' behaviour: ventilation patterns, maintenance of suitable internal temperature, rational use of electricity and water, and similar. In some cases with these measures only savings up to several % can be achieved.

Low-cost measures require small technical and financial effort and can often be done on a do-it-yourself basis: adding a layer of thermal insulation to the unheated attic floor, additional sealing of windows, and similar. The pay-back period is quite short, usually not more than two years.

Comprehensive measures require careful planning and comprise sets of preparation and realisation activities. For basic rules see chapter below. They are connected to higher investment costs and require elaborate logistics of planning and execution.

Under comprehensive measures we could count adding thermal insulation, replacing windows and doors, upgrading and replacing heating system, installing ventilation system with heat recovery, installing facilities for

active use of solar energy and other renewable sources, and similar. These measures can often be done (or even require) in conjunction with minor or major reconstruction works, i.e. interventions into building structures.

In the previous it was noted that especially for comprehensive measures reliable benchmarking data can be of much use in planning process. Another important and most helpful tool can be a catalogue of measures, which lists individual measures and their combinations, suitable for different situations. A catalogue of this kind was prepared in the framework of the ClearSupport project to assist building owners and occupants in their decisions. Of course it is not intended only for individuals with less technical knowledge, but also for planners and designers to ease their work.

2.9 Step-by-step approach to a successful project

In his book Introduction to design (1962) Morris Asimow described basic principles to be considered in each project. Even nowadays they can be easily adopted into a process of improving energy efficiency of buildings, for instance first five of them:

- a) defining the need
- b) physical reliability of the project
- c) economic worth-while
- d) financial feasibility
- e) optimality

Here of course the “need” would be treated in a broader meaning, including not only wishes and needs of the investor but also an assessment of existent state and its boundary conditions. As also briefly mentioned in previous chapters of PSF activities, the basis for any sensible further activities is good knowledge of present conditions.

Depending on the subject and extent of planned actions it is necessary to do more or less intensive preparation activities beforehand. For example, reconstruction of buildings can be comprehensive and integral, or gradual and particular, depending on our priorities. One important thing to always have in mind is the complexity of buildings and building-related activities.

Work here does not necessarily start and end with a choice of a particular product.

Energy efficiency (or, “green”) requirements can be included in the basic item of public and private procurement (“construction of a new building”), in selection of designers, engineers and (sub-)contractors (required particular past experience and references from energy- and environment-conscious design and construction, EMAS practices, etc.), as criteria describing the required overall design level with regard to national technical regulation (detailed technical specifications of particular energy characteristics, maybe even prescription of an advanced calculation methodology, etc.), as criteria for selection of materials (exclusion of certain materials from environmental reasons), through requirements for sustainable production and transport of materials and products, and numerous other options.

Basic rules

1. Carefully assess initial conditions

(range of activities varies with regard to planned actions)

- visit the building
- acquire plans, if available, or make measurements
- interview building manager, housekeeper, building users
- collect data on energy consumption (from bills, from energy book-keeping records etc.)
- assure additional metering of consumption
- conduct a walk-through inspection
- perform an energy audit including various tests (thermograph, blower-door test etc.)
- compare collected information with benchmarking data (if an appropriate database exists)
- prepare a report

2. Define the needed/desired extent of interventions

- minor or moderate upgrade
- thorough renovation/reconstruction
- interventions on building systems and technologies (boiler, radiators, pumps, valves, ventilation systems, lighting etc.
- interventions on building envelope and structures (thermal insulation, windows and doors etc.

3. Define target criteria using principles of green procurement (in relation to the subject)

- qualification criteria for planners, contractors, materials' providers etc.
- target characteristics of construction products and systems
- target heat demand
- target cooling demand
- target delivered energy demand
- target reduction of CO2 emissions
- target indoor comfort level.

4. Make a preliminary assessment of available and potential financial sources

(use respective ClearSupport guidelines)

- own sources
- commercial bank credits
- eco-loans
- third party financing

- revolving funds

5. *Seek professional assistance and guidance for project facilitation at an appropriate early stage*

- use corresponding guidelines and tools, for example the ones prepared in the ClearSupport project
- contact local Project Service Facility
- contact other support, if PSF not existing (energy advisory office, consultants etc.)

6. *Consider and compare different scenarios of measures and validate them to find an optimum solution*

- through possibility of technical realisation
- through energy- and environmental benefits
- through possibility of financing the project (own and outside sources)
- through financial feasibility (initial investment costs and pay-back period)
- through long-term positive technical and financial effects (perform LCC analyses)

7. *Activities after (or in parallel with) execution of measures*

- perform information and education activities for occupants
- appoint and educate a building manager
- introduce energy book-keeping and monitoring of main mechanical systems
- prepare an updated plan for regular maintenance

2.10 Some practical tips and reminders

- Remember that individual procurement decisions in the field of buildings or building components can among other significantly affect - positively or negatively - energy efficiency levels and environmental impact of buildings, but also indoor living and working comfort, costs, and durability and structural integrity of the building structure.
- Always think about possible interactions and influences following realisation of a certain measure, and keep in mind logical running order of provisions.
- For example, improving building air-tightness can result in an increased air humidity and mould growth if not accompanied by measures regarding ventilation. Another example: raising thermal insulation of the opaque envelope to the passive standard does not make much sense if maybe windows from several decades ago are not replaced simultaneously.
- On many occasions it can turn out that upgrading (renovating, refurbishing, reconstructing) of an existing building is technically and financially more demanding than designing and constructing a new one.
- It is important to obtain several (comparable!) tenders. The integrity of the preparatory phase is crucial in order to be able to make a proper decision about the most appropriate offer. That is where we define boundary conditions and set quality and quantity target levels. Additional negotiations are always possible and sometimes a constituent part of the procurement process, but this should be restricted to brushing up details, not to discuss basic requirements.
- It is almost impossible to guess or make at least a remotely accurate out-of-the-head estimation about all short- and long-term impacts and results of various potential procurement decisions in the building field. That is why LCC analyses are an indispensable part of such actions; their results may sometimes be unexpected, but will help you to get appropriate value for your money.

- With the purchase and installation of energy-efficient building materials, components and systems (or even when new construction or an integral renovation of buildings is in question) only one part of saving potentials can be opened up. To a large extent real practical results lie in the hands of building users and building managers. This includes regular maintenance and patterns of use (behavioural aspects). Even technically most advanced building components cannot provide expected (and pre-calculated) results if not used and maintained in an appropriate manner. Only with responsible energy- and environment-conscious behaviour the saving potential can be fully exploited.