

project BRITA in PuBs

23 partners
9 countries
8 demo projects

retrofit design
guides

BIT information
tool

quality control
toolbox

e-learning
module



project Demohouse

16 partners
7 countries
6 demo projects

common evalu-
ation protocol

state-of-the-art-
in-renovation
report



2nd EU FP6 Ecobuildings Symposium – City Hall Stuttgart, April 2008
Towards an energy efficient European building stock beyond national requirements

ECO-Culture

6 partners
3 countries
3 demo projects

thermoactive slabs

aquifer energy
storage

building
integrated PV

cultural
buildings as
ecobuildings

project ECO-Culture



15 partners
8 countries
7 demo projects

instant replicability
potential

integrated BMS
& monitoring

shared solutions
and interests

technical advice
and support

project SARA

Imprint

Editor:

Jürgen Görres
Landeshauptstadt Stuttgart
Amt für Umweltschutz
Gaisburgstrasse 4
70182 Stuttgart

Hans Erhorn
Fraunhofer-Institut für Bauphysik
Nobelstr. 12
D-70569 Stuttgart

Markus Kratz
Projektträger Forschungszentrum Jülich GmbH
D-52425 Jülich

Print:

Grafische Betriebe des Forschungszentrums Jülich GmbH

Disclaimer:

The reports contained in this book represent the opinions of the individual authors and do not necessarily reflect those of the editor. The authors and the European Commission are not liable for any use that may be made of the information contained therein.

© 2008 – Forschungszentrum Jülich GmbH

Ecobuildings: Answers to an Immense Challenge

THE CHALLENGE IS IMMENSE: HOW TO COPE WITH DWINDLING FOSSIL FUEL RESERVES AND CLIMATE CHANGE? THE PUBLIC AND POLITICAL FOCUS IS OFTEN CONCENTRATED ON THE NEGATIVE EFFECTS OF TRAFFIC. NOTHING WRONG WITH THAT, HOWEVER, OTHER POSSIBILITIES TO COPE WITH THE PROBLEM ARE SOMETIMES OVERLOOKED. TAKE THE BUILDING INDUSTRY: THE ENERGY SAVING POSSIBILITIES HERE ARE IMPRESSIVE IN NUMBER AND EFFECTS. THIS SECTOR IS AT PRESENT RESPONSIBLE FOR MORE THAN 40% OF THE EU'S ENERGY CONSUMPTION. ACCORDING TO SEVERAL STUDIES AND OFFICIAL EU POLICY DOCUMENTS, THE SECTOR OFFERS THE LARGEST INDIVIDUAL POTENTIAL FOR IMPROVING THE ENERGY EFFICIENCY.

IN THE BUILDING SECTOR THERE ARE TECHNOLOGIES AVAILABLE AND UNDER DEVELOPMENT, WHICH COULD SUBSTANTIALLY IMPROVE THE ENERGY PERFORMANCE IN BUILDINGS. THEY REDUCE CONVENTIONAL ENERGY DEMAND IN NEW AND EXISTING BUILDINGS AND SUBSTANTIALLY CONTRIBUTE TO REDUCE ENERGY INTENSITY, THROUGH COMBINED MEASURES OF RATIONAL USE OF ENERGY AND INTEGRATION OF RENEWABLE ENERGY TECHNOLOGIES. THERE IS A WIDE RANGE OF SOLUTIONS, INDICATION OF THE VARIOUS POSSIBILITIES AS REQUIRED IN THE EUROPEAN PERFORMANCE OF BUILDINGS DIRECTIVE (EPBD).

IN ORDER TO CREATE THE MEETING POINT OF SHORT-TERM DEVELOPMENT AND DEMONSTRATION TO SUPPORT LEGISLATIVE AND REGULATORY MEASURES FOR ENERGY EFFICIENCY AND ENHANCED USE OF RENEWABLE ENERGY SOLUTIONS WITHIN THE BUILDING SECTOR, THE EU-ECOBUILDINGS INITIATIVE WAS STARTED. THIS INITIATIVE AIMS AT A NEW APPROACH FOR THE DESIGN, CONSTRUCTION AND OPERATION OF NEW AND REFURBISHED BUILDINGS, BASED ON THE BEST COMBINATION OF THE DOUBLE APPROACH: ON THE ONE HAND THE SUBSTANTIAL REDUCTION, AND IF POSSIBLE, AVOIDANCE OF THE DEMAND FOR HEATING, COOLING AND LIGHTING. ON THE OTHER HAND SUPPLYING THE NECESSARY HEATING, COOLING AND LIGHTING IN THE MOST EFFICIENT WAY AND BASED AS MUCH AS POSSIBLE ON RENEWABLE ENERGY SOURCES AND POLYGENERATION.

THE 4 ECO-BUILDINGS PROJECTS UNDER THE FP 6 CALL ARE COMING TO AN END. ALL OF THEM SHOW IN A DIFFERENT WAY, THAT ECOBUILDINGS PROJECTS CAN IMPROVE SUBSTANTIALLY THE ENERGY PERFORMANCE OF BUILDINGS AT A LARGE SCALE, CAN HELP TO TRANSFER SCIENTIFIC KNOWLEDGE INTO STANDARDS AND INDUSTRIAL CODES AND TO BRING THE RESULTS OF SOCIO-ECONOMIC RESEARCH ON INTEGRATED PLANNING AND BEHAVIOUR OF USERS INTO PRACTICE. ALL PROJECTS GO CLEARLY BEYOND THE REQUIREMENTS OF EXISTING LEGISLATION AND THUS CONTRIBUTE TO A FURTHER DEVELOPMENT OF REGULATORY ISSUES IN THIS SECTOR. THE INITIATIVE HAS SHOWN THAT THIS NEW APPROACH MAY AIM TO A NEW AGE AND STAGE IN THE EUROPEAN BUILDING STOCK, THE BUILDING ENERGY EFFICIENCY AGE.

THIS SYMPOSIUM WILL GIVE A CONTRIBUTION TO THIS MOVEMENT, BUT ALL THE RELEVANT PLAYERS HAVE TO CONTRIBUTE TO A CONTINUATION OF THIS PROCESS. POSSIBLY THE ECOBUILDINGS INITIATIVE COULD SERVE AS EUROPEAN-WIDE PLATFORM. THE PARTICIPANTS OF THE 4 PROJECTS ARE LOOKING FORWARD TO SUPPORT THIS PROCESS. WE ARE AWAITING A FAST GROWING COMMUNITY OF ECOBUILDINGS FELLOWS.

ON BEHALF OF THE SYMPOSIA ORGANIZERS AND ECOBUILDINGS COORDINATORS

HANS ERHORN
FRAUNHOFER INSTITUTE FOR BUILDING PHYSICS

CONTENT

Keynotes

Challenge and vision in the building sector	3
Harald N. Røstvik, Sivilarkitekt Harald N. Røstvik AS / SunLab, Norway	
Energy performance of buildings in the EU Member States	8
Kirsten Englund Thomsen, Danish Building Research Institute	
Roadmap for Energy Efficiency Measures in the Existing Building Stock	13
Jean-Christophe Visier, CSTB, France	

Ecobuildings in Progress

Bringing Retrofit Innovation to Application - BRITA in PuBs	21
Hans Erhorn, Fraunhofer Institute of Building Physics, Germany	
Energy Efficient Renovation of Dwellings: Lessons Learned	29
Frans Koene, Henk Kaan, Energy research Centre of the Netherlands	
Participative Decision-Making for Energy Efficient Renovation and Project Development	34
Evert Hasselaar, TU Delft, The Netherlands	
Sustainable architecture applied to replicable public-access buildings – SARA	40
Mike Barker, Universitat de Barcelona, Spain	
ECO-Concepts for High Performance European Cultural Buildings – ECO CULTURE	45
Mogens Krighar, COWI A/S, Denmark	
Eco Building/Bioclimatic Concept versus Passive House	52
Aleš Krainer, Mitja Košir, University in Ljubljana, Slovenia	

Tools for Supporting Ecobuildings

BRITA in PuBs WP 2: Retrofit Design Guidelines	59
Kari Thunshelle, Norwegian Building Research Institute	
BRITA in PuBs WP 3: Quality Control Toolbox	64
Timo Kauppinen, vtt, Finland	

BRITA in PuBs Information Tool – Case Studies, Retrofit Measures and Performance Rating to Find the Best Retrofit Concepts for Public Buildings	69
Heike Erhorn-Kluttig, Fraunhofer Institute of Building Physics, Germany	
Integrating BMS and Simulation Tools for Monitoring and Performance Analysis	73
Ursula Eicker, Dirk Pietruschka, Stuttgart University of Applied Sciences, Germany	
Post Occupancy Evaluation and Adaptive Control Algorithms	78
Manuel Fuentes, Maita Kessler, Oxford Brookes University, United Kingdom	
DST, Decision Support Tool to facilitate energy-efficient renovation of buildings	83
Irena Kondratenko, Energy research Centre of the Netherlands	
Educate the Actors	
Improving the user behaviour - the BISHes	89
Ove Mørck, Cenergia Energy Consultants, Denmark	
BRITA in PuBs Facility Manager's Training	93
Gilbert Snook, City College Plymouth, United Kingdom	
E-Learning Module for BRITA in PuBs Project	97
A. Kaklauskas, A. Mickaityte, M. Seniut, Vilnius Gediminas Technical University, Lithuania	
Adapting Information to Reach the Target Audience	104
Christoph Peters, Institut Català d'Energia, Spain	
The Added Value of Expert Technical Advice During the Design Process	109
Anita Preisler, Arsenal Research, Austria	

Keynotes

CHALLENGES AND VISIONS IN THE BUILDING SECTOR

Harald N. Røstvik
Sivilarkitekt Harald N. Røstvik AS / SunLab
Kirkegt 3, 4006 Stavanger Sentrum, Norway
Tel.: +47 51861925 / Mob + 47 92226710
E-Mail: hnr@netpower.no

1 Background

In most graphs showing sector-by-sector energy use, buildings do not appear to have the most dominating role. But it has. Contrary to this, buildings probably account for almost half of the global energy use and greenhouse gas emissions, if we include the production of building materials, the energy needed during the building process, the life span energy use of buildings and the energy demanding demolishing phase.

As a result, the building sector will be put more and more in the centre. The pressure on the building sector to develop a smarter energy system will increase. At its core will be energy efficiency or rational use of energy, offering the same service using a fraction of energy in buildings, industry and transportation, supplemented by renewable energy.

One of the most challenging themes is the irresponsible use of huge glass areas as an architectural trend. It is documented that the weak point in the building envelope is the window. In cold climates a window is like a hole in the wall in an energy leakage context and we have to react accordingly by reducing the window, the glass area and introduce higher insulation quality windows.

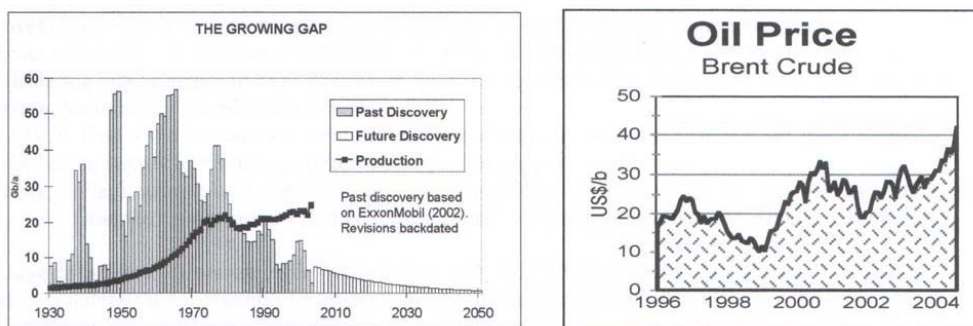


Figure 1: Global oil production, extraction 1930 – 2008 – 2050 and oil price 1996 - 2004. (Source: ASPO.) When the Brita project started, the oil price was 40USD/b. Now it is 110. The gap between the lack of identification of new oil fields and the growing speed of exploring the oil fields mainly found between 1950 and 1990, the so called “growing gap”, will lead to higher prices. In Europe the UK shelf’s oil fields are practically empty. The Norwegian shelf’s oil production has fallen by 25 percent since the peak in 2000. It will fall another 50 percent points the next five or seven years. “Drop like a stone” is a proper phrase. This will not be compensated by increased natural gas production on the shelf.

1.1. Design strategy - energy

There is no "quick innovative fix" in the building sector yet, as regards reducing energy need dramatically or find innovative new sources. It is still the fundamentally simple approach of area efficiency, better insulation values, careful glass sizing, well founded shading solutions that works best.

A five-step design strategy could look like this (Source: Husbanken/SINTEF) :

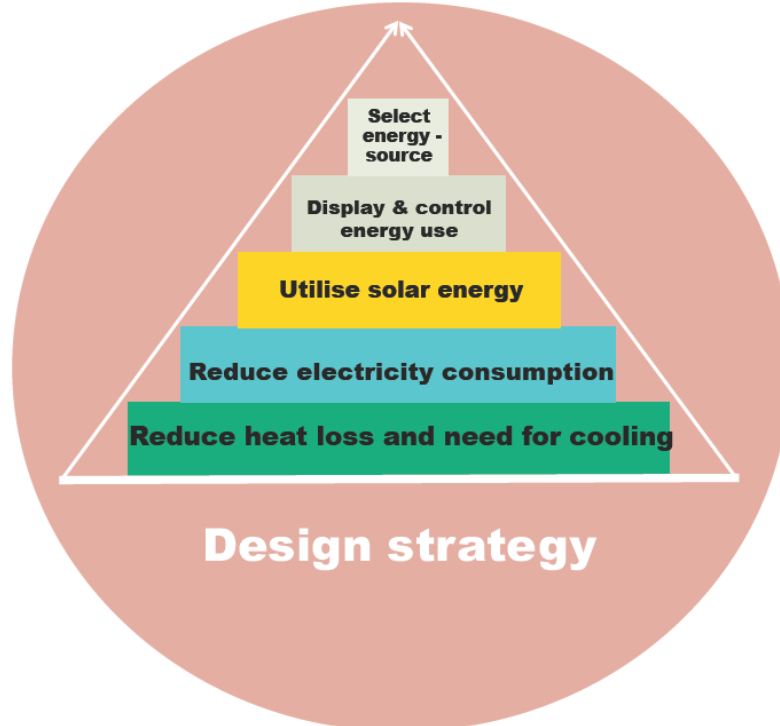


Figure 2: Design strategy pyramid. At its base the basic issues like increasing insulation levels, reducing the need for cooling and for electricity, using solar thermal and applying proper controls. Finally, when all these basic steps are taken, select energy source.

•**Step 1 :**

Careful positioning of the building on site. Minimize the built area and the floor area.
Reduce the heat loss by reducing the building envelope area.

•**Step 2 :**

Selection of a balanced ventilation system with heat exchanger.
If you want to try natural ventilation fight for it, but expect resistance.

•**Step 3 :**

Consider the possibility for controls (timer/sensor/shading etc).

•**Step 4 :**

Consider the possibility of installing energy efficient equipment and lights.

•**Step 5 :**

Finally and not earlier : Consider the issue of choice of energy source.

1.1.1 Basic principles still valid

Several challenges arise from this: How do we avoid poor indoor air quality as the building envelope gets more and more air tight ? In spite of advanced ventilation systems we often find that indoor air quality can be below minimum standards.

Technology does not always solve all problems. This has also been learnt in the motorcar sector where even fairly new cars due to an unfortunate relationship between humidity and temperature levels combined with poor maintenance results in fungi growth in the system. We must hence always keep a critical eye on the negative consequences of new technology.

Modern building designers can still be making extensive use of several basic principles in design to bring down the need for bought energy. Among these are:

- Shading by vegetation or mechanical means.
- Proper massing with some heavy materials inside the building to avoid indoor temperature from jumping up and down with every sunray that penetrates the building.
- Not overdoing the glass area in proportion to well-insulated wall area.
- Good routines and strategies for control of energy use in the building.

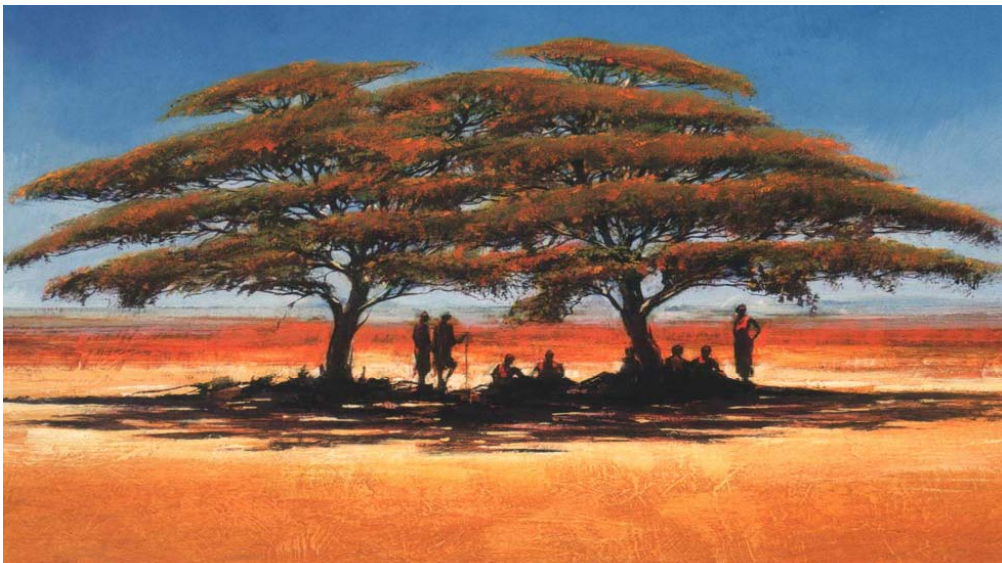


Figure 3: Natural cooling, natural ventilation, daylight and other methods found in nature can be a suitable idea bank for reducing the heating and cooling load of most buildings.
Old principles still applies.

1.1.2 Alternatives to basic principles ?

Over the last years we have seen a great number of buildings been marketed globally as good examples of sustainable buildings. Some of these get a lot of attention, not least so if there is a new technology (an object) involved that is eye catching and/or can be communicated as innovative and hence seen as breaking new ground.

What we often find, however, is that some of the best-published buildings have got an undeserved good reputation in such a context. There are numerous examples of so called solar buildings where solar PV is “flagged” as innovative and a key feature of the building, in spite of the system perhaps being the largest PV installation in the building sector in that country, it only delivers a tiny one percent of the annual energy need in the building. As a result few discuss where the remaining 99 percent are delivered from and what kind of energy sources are involved in that.

Several high profiled “well-sold” so called energy efficient buildings have proved to be energy wasters since the basic principles of designing energy efficient buildings have been neglected and traded for a symbol, a huge PV system or a wind mill which offers fancy pictures for the glossy magazines, whilst the facts show that the building do not offer energy supply of a magnitude which is even worth mentioning.

Luckily there are also examples - more and more so - of serious building sector actors that now manage to design and build energy efficient buildings where the use of even modestly sized technology like solar PV means a lot to cover the needed energy supply, as percentage of overall energy need, since the building is quite energy efficient.

1.1.3 Related sectors : Transportation and food

Several challenges appear when we realise that where we live versus where we work, in other words overall planning decisions, to a great extent make up and decide our daily transportation need and the resulting energy need and emissions arising from transportation. When planning buildings, communities, cities and nations, functional localisation will have to be taken more into account in the future.

We already see some fairly large scale city developments in Asia, North Africa and even in the USA where communities and cities are being developed based on public transport only. We also see buildings that become hosts to huge crop growing fields on the roofs.

Such optimistic attempts, however, are fast being overwhelmed by the facts like:
Every day 1000 new motor vehicles are put on the roads in China.

Similar developments occur in India and low priced private cars are now being presented as something positive in the individual's need for transportation.

Perhaps all traffic has to come to a standstill before we all understand the pitfalls of such development that already have taken place in the Western world for half a century. It now seems the majority of the people in the emerging markets are not at all interested in learning from our mistakes.

We might have to see a total collapse symbolised by road congestion and increasingly health damaging and more and more visible pollution before we all realize that there are perhaps other solutions that might be better for all concerned.



Figure 4: Is this the way roofs will be used in the future ? Heavy mass consisting of soil and vegetation to cool the building, combined with using the roof for food production.

In an energy need, emission and water need context a vegetarian diet is far more ecological than meat production. So if we are concerned about energy and environmental challenges, perhaps a more holistic approach could be applied. The facts show that to get one calorie of protein from beef production, the fossil fuel need is 39 times higher than that of producing the same 1 calorie of protein from a vegetarian soybean production.

1.1.4. Conclusion

While we wait for revolutionary innovative new concepts – that might not even appear - the best we can offer is probably to keep on using the basic, well tested and extensively applied methods within the building, transportation and food production sectors.

Perhaps, when we see all of these sectors together, the synergies between them appear and can be applied to the best advantage of all sectors.

ENERGY PERFORMANCE OF BUILDINGS IN THE EU MEMBER STATES - main challenges for the EPBD now and in the future

Kirsten Engelund Thomsen
Danish Building Research Institute
Dr. Neergaards Vej 15, DK-2970 Hørsholm
Tel.: +45-4586 / 5533, Fax: +45-4586 / 7535
E-Mail: ket@sbi.dk

1 Introduction

The EU Member States (MS) have been gradually transposing and implementing the Energy Performance of Buildings Directive (EPBD) into their own national legislation since the Directive was adopted in January 2003. The EPBD is the most significant measure adopted so far by the EU to reduce greenhouse gas emissions from buildings.

A main objective of the EPBD is to improve the energy performance of the European building stock. The EPBD proposes certain measures that encourage energy efficiency improvements existing large buildings. Furthermore, an energy certificate scheme has become the central element of the Directive, and this will be compulsory for all European Member States from 2009 at the latest. As a consequence, it is possible that knowledge about the energy performance of buildings in all Member States will have to be collected in databases. Afterwards, this knowledge might be made available to the construction and property sectors to promote the energy performance of buildings. Additionally, the databases might be of high value for future surveys of energy-saving potentials, for compiling energy-saving measures, for benchmarking buildings and for policy making. In the long run the accumulated knowledge will facilitate more systematic generation of energy savings with a more solid basis, especially if the quality of the building stock knowledge attained by implementing energy certificates is of high quality.

2 Building stock knowledge and energy-saving potentials in Member States

It is clear that large energy savings can be obtained in the existing building stock. In the ENPER-EXIST project the main purpose was to support the take off of the EPBD for existing buildings. The project was initiated and coordinated by the CSTB in the framework of the Intelligent Energy Europe (IEE) programme. It involves partners from seven countries on the topic of energy performance standardization and regulation.

Building stock knowledge regarding detailed energy issues in Europe exists at very different levels of detail in the different Member States. There is general knowledge about the number of buildings, built-up areas, and conditioned floor area, but when it comes to more detailed information like energy consumption per floor area or division of buildings into different energy classes, there is a general lack of information. One area which particularly lacks information is non-residential buildings.

In general there is more information available for the residential sector compared with the non-residential sector. However, in the case of electricity consumption, more information is available for the non-residential sector. Some countries, like Denmark, have a lot of information on all kind of buildings, mainly because they have had mandatory energy certification schemes since 1997.

Knowledge about the existing building stock is available at both national and European levels. The most detailed knowledge is found in national statistics. For a general view however, some European Statistics can contribute with relevant knowledge. Additionally knowledge is found in separate databases created in connection with specific EU projects or other sources. In the EU EPA-NR project, a large investigation concerning the non-residential sector was carried out. With regard to European Statistics, both Eurostat and the European Environment Agency are in possession of statistics for buildings.

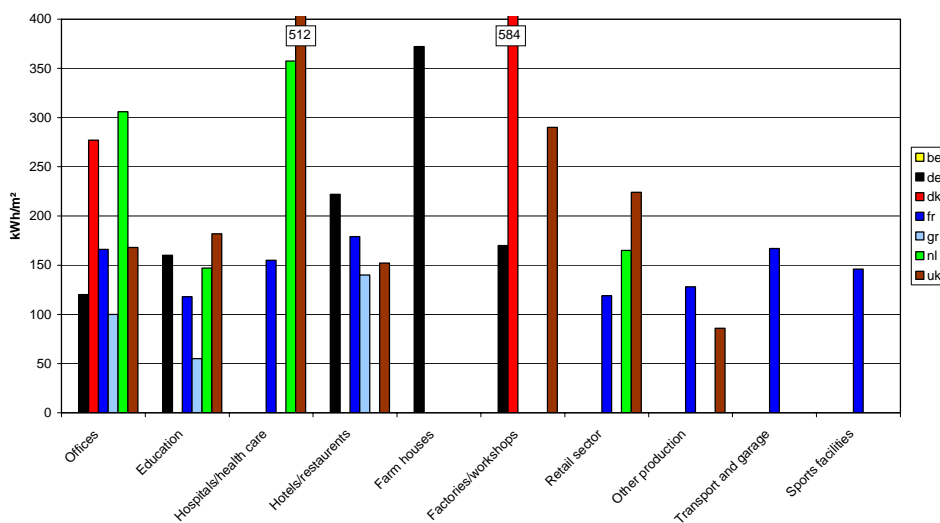


Figure 1. Energy consumption for space heating per heated floor area in non-residential buildings in ENPER-EXIST countries

In the Brita-in-PuBs project, energy consumption for space heating, electricity consumption and the water consumption were selected for public buildings in 9 Member States. These consumptions have been used in the IEA Annex 36 benchmarking Energy Concept Advisor tool.

To investigate how to gain improved knowledge of the building stock and information on possible energy savings, Danish experience from the existing certification scheme can be used as an example. A comprehensive investigation based on data from the Danish energy certification schemes was carried out in order to obtain knowledge about the potential for saving heating in housing. The potential for energy savings for space heating in housing is about 30 PJ per year (0.55 PJ per 1000 inhabitants), or one-third of the total amount of energy currently used to heat the dwellings.

In The Netherlands a local survey *Energy savings in the existing building stock* (EBM-Consult 2006) was conducted, with special focus on the different owner situations in the housing sector. The building stock was thus divided into three categories: social sector rented housing, other rented housing and owner-occupied housing. In these categories there was an estimated energy saving potential of 2933 / 726 / 3768 PJ respectively, or 0.46 PJ per 1000 inhabitants.

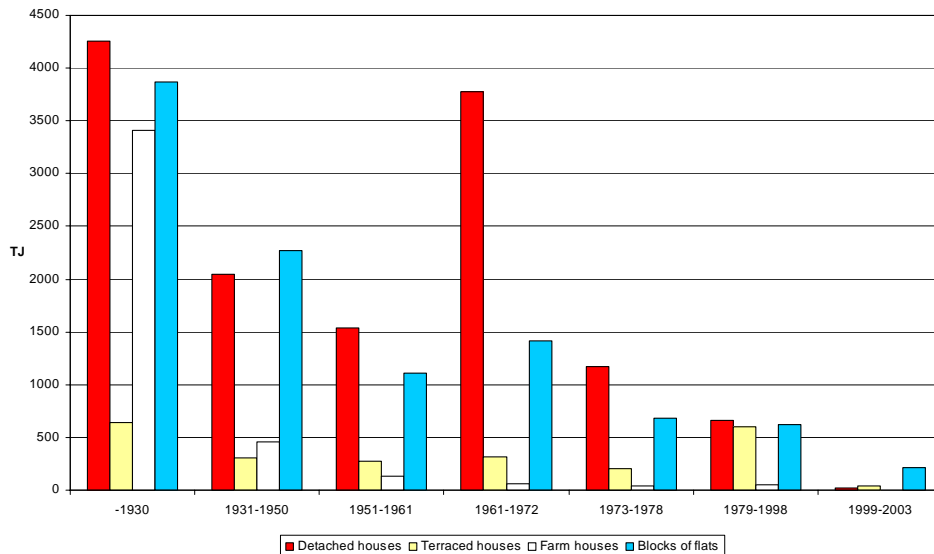


Figure 2. Potential heating savings in Danish residential housing, based on more than 200,000 issued energy certificates, and extrapolated to the entire Danish building stock.

Based on these surveys a table can be elaborated that lists the recommended minimum information that should be recorded in energy certification schemes (with calculated energy consumption) related to different parts of the building:

Building:

- Built-up area and heated floor area, number of floors.
- Construction year and year of major renovations.
- Location of building (climate zone).
- Recorded energy – analysed by type of energy - and water consumption (for comparison with calculations).

Thermal envelope:

- Type, area and U-value for each opaque construction type.
- Area, U-value and solar energy transmission factors for each transparent element including any shading objects.
- Thermal bridges (length/size, transmission coefficient).
- Thermal storage capacity of the building.

Systems:

- Primary and secondary heating system (including efficiencies and location).
- Ventilation system including an estimate of the natural and mechanical ventilation rate.
- Cooling system (including efficiencies and location).
- Heating and cooling distribution systems (pipe length, insulation level, location).
- Domestic hot water production (including location and distribution).

Default values:

- Internal loads (no. of persons, equipment, lighting, etc).
- Domestic hot water consumption (based on no. of persons and/or floor area).

3 Concerted Action I and II (CA-EPBD I and II)

3.1 CA-EPBD I

To support the transposition of the EPBD into the Member States, the EPBD Concerted Action project was approved within the scope of the 2003 Intelligent Energy Work-programme. The project started on January 1, 2005, and it was completed by 30 June 2007.

The Member States decided to hold a forum to discuss the available and best alternatives and to agree on at least some critical principles that should be common across the whole EU in order to allow for some degree of relative comparability between results provided by different Member States. The first Concerted Action (CA-EPBD I) is recognized as having been an important tool to help in the implementation of the EPBD in Europe.

3.2 CA-EPBD II

CA EPBD II is the continuation of the first Concerted Action. This continuation became necessary due to the delay in the implementation of Directive.

The objectives of the CA EPBD II are to:

- enhance and structure sharing of information and experience from national implementation and promote good practice in activities required of Member States for implementation of the EPBD
- create favourable conditions for faster convergence of national procedures on EPBD-related matters;
- supplement the work of the Energy Demand Committee (Article 14 of the EPBD) and its ad-hoc group on CEN standards and certification exercises.

As a secondary benefit, the conclusions of CA-EPBD II will be useful to the Commission in their evaluation of the EPBD, especially as the 2007 "Energy Action Plan" announced that it would be revised in 2009. Finally, CA EPBD II will also contribute to producing up-to-date information for market players and stakeholders.

In order to optimise the available resources and to maximise synergetic effects with other activities initiated by the EC, it is envisaged that an effective collaboration will be set up with the Buildings Platform (see chapter 4) and that all the useful information produced will be fully exploited within the various finalised or ongoing SAVE projects e.g. the ASIEPI project.

4 The Buildings Platform

The EPBD Buildings Platform is a European Commission initiative in the framework of the Intelligent Energy - Europe (2003-2006) programme, which provides information services for practitioners and consultants, experts in energy agencies, interest groups and national policy makers in the European Member States to help implementation of the EPBD.

The Buildings Platform is in the process of publishing country status reports about EPBD implementation. The underlying philosophy is to have relatively short reports (2-4 pages), in which the major elements of the national implementation strategy are described. There is close collaboration with the CA-EPBD. All the country reports can be found on the website of the EPBD Buildings Platform.

5 Future revision of the EPBD with focus on achieving more realised savings

Work completed by most Member States up until the end of the CA-EPBD towards transposition of the EPBD has been substantial. This has primarily involved:

- Revising national building regulations, with updated and more detailed calculation models, as well as more demanding energy efficiency requirements;
- Setting up certification schemes as well as schemes for inspections of boilers and air-conditioning systems, with all their legal and logistical implications;
- Training experts to carry out certification and inspections, including all the concerns for ensuring quality control and monitoring of results.

Revision of the EPBD should focus on the major challenge in improving the energy efficiency of the existing building stock.

6 Further information

Directive 2002/91/EC of the European Parliament and of the Council on the energy performance of buildings. Available at <http://www.managenergy.net/products/R210.htm>

ENPER-EXIST: Applying the EPBD to Improve the Energy Performance Requirements to Existing Buildings. Available at <http://www.enper-exist.com>

Thomsen K.E. et al (2006). Applying the EPBD to improve the Energy Performance Requirements to Existing Buildings – ENPER-EXIST. WP3 – Building stock knowledge. June 2007. Available at http://www.ENPER-EXIST.com/pdf/reports/ENPER-EXIST_WP3_Report%20Final_28_06_07.pdf

EPA-NR: Energy Performance Assessment of existing Non-Residential buildings. Available at <http://www.epa-nr.org>

BRITA-in-PuBs: Bringing Retrofit Innovation to Application in Public Buildings". Available at <http://www.brita-in-pubs.eu/>

IEA ECBCS Annex 36 - Retrofitting of Educational Buildings REDUCE Energy Concept Adviser for Technical Retrofit Measures Available at <http://www.annex36.com/>

Concerted Action, European Building Performance Directive Concerted Action: an instrument to improve implementation of the Directive. Available at <http://www.epbd-ca.org>

EPBD Buildings Platform: your information resource on the Energy Performance of Buildings Directive. Available at <http://www.buildingsplatform.org/cms/>

Council of the European Union, "Energy Action Plan", May 2007, 7224/1/07 REV 1. Available at http://www.consilium.europa.eu/uedocs/cms_Data/docs/pressdata/en/ec/93135.pdf

ASIEPI: ASsessment and Improvement of the EPBD Impact (for new buildings and building renovation). Available at <http://www.asiepi.eu/home.html>

ROADMAP FOR ENERGY EFFICIENCY MEASURES IN THE EXISTING BUILDING STOCK

Jean-Christophe Visier
Centre Scientifique et Technique du Bâtiment (CSTB)
84 Avenue Jean Jaures, 77447 Marne la Vallée Cedex 2
Tel.: +33-1-64 68 82 94
E-Mail: visier@cstb.fr

Xavier Loncour, Peter Wouters, Luk Vandaele
Belgian Building Research Institute

Heike Erhorn-Kluttig
Fraunhofer Institute for Building Physics

1 Background

The roadmap for energy efficiency measures in the existing building stock was developed within the framework of the European Intelligent Energy Europe programme or more precisely in the project ENPER-EXIST, which started in January 2005 and ended in June 2007. The project can be summarised as follows:

The Energy Performance of Buildings Directive (EPBD) set a series of requirements specifically dedicated to existing buildings. But the Member States were facing difficulties to implement some of them. The main objective of the ENPER-EXIST project was to support the take off of the EPBD in the field of existing buildings. This was achieved by working on three main issues which were faced by Member States in the application of the Directive:

- lack of coordination of technical work on existing buildings
- lack of coordination of work on non-technical issues especially the impact of certification on the market, the human capital and the national administration
- insufficient knowledge of the building stock

ENPER-EXIST used an intensive networking of existing national and international projects to defragment efforts to solve these three issues. In addition the project defined a roadmap for future actions regarding existing buildings.

2 Why a roadmap for energy efficiency measures?

Energy efficiency is becoming a very important topic in Europe and around the world. Among the different sectors where energy savings can be realised, the European action plan for energy efficiency of the European commission has identified the building sector as a top priority. Huge cost-effective energy savings can be realised in existing buildings. The action plan for energy efficiency states a potential by 2020 of 27% to 30% according to the building type. Realising this potential will not be done by itself and a set of accompanying measures should be developed and implemented by different actors.

The roadmap and the underlying report give first an indication of the short, medium and long-term challenges regarding the energy efficiency of buildings. Then, attention is paid to the specific characteristics of the existing building stock. It then gives an overview of

possible legal measures and other types of measure that can be implemented. The status of the existing measures allowing the improvement of the energy efficiency of buildings in seven European countries is explained. At the same time, examples of national long-term vision about building energy efficiency are given. The report gives also indications (including pro's and con's) about the possibilities to enlarge the scope of the Energy performance of buildings directive.

The primary target audience of the report are policy makers and persons interested in policy issues regarding energy efficiency of buildings. The emphasis lies on the achievement of substantial medium and long-term improvements of the energy performance of the existing building stock.



Figure 1: The seven countries participating in the ENPER-EXIST project: Belgium, Denmark, France, Germany, Greece, the Netherlands and the United Kingdom.

3 Segmentation of the building stock to help identify measures for improving energy efficiency of buildings

In principle, energy savings could be realized in nearly every building, although some specific situations are more relevant than others. These represent either high potential energy savings, or a limited number of decision-makers being involved that therefore make it easier to implement the measures. Some building markets are more difficult to address because of the lack of motivation of those concerned actors. The most relevant building markets to be addressed in terms of priority, can be country specific, because of the peculiarities encountered in that country's building stock. In order to identify the most interesting situations, a segmentation of the building stock is proposed in this chapter. This segmentation is arranged according to the following criteria: the building type, the specific building situation (type of works/transaction realised) and the actors and their motivations. The situations below have been analysed in detail:

1. Social housing managed by public bodies
2. Residential sector - lack of enthusiasm and invisibility of energy saving measures
3. Residential sector – owners with no financial means
4. Apartment buildings – problems of co-ownership and decision-making among apartment owners and the way in which heating costs are distributed
5. Rented office buildings
6. Educational buildings
7. Public buildings

The following text summarises the situation for the public buildings:

Public buildings are interpreted as buildings owned by the public, e.g. by communities, the state, or similar. As the ownership strongly influences the type of barriers inhibiting energy-

efficient retrofits, buildings with public access (often also interpreted as public buildings) are not considered here. The total number of public buildings is very high. In Germany for instance, there are about 100,000 buildings in the public sector. However, these buildings are owned by various communities, which have greater restrictions on their financial limits regarding investment in energy-efficient renovations. Furthermore, the structure of the administration might differ between countries (and even between the different communities within the same country). Renovations are usually carried out because of building defects or damage and sometimes also because the function of the building has been changed. This type of renovation work does not initially focus on energy efficiency and is usually managed by the planning department of the local community. In some community administrations there is a special department dealing with energy consumption and environmental impact. If this department (or a similar group within the planning department) gets involved in at least the design phase, then the energy efficiency will be included as a renovation by-product. The section has been written from German and Dutch perspectives. The complete text can be found in the appendix to the report.

4 Overview of the existing measures and actions

Some of the measures described can be classified into several of the categories already identified. The measures described are generic measures. The application in a specific country must always take the specific situation into account. The efficiency of each measure will also depend on the national context. In some European countries (e.g. eastern part of Germany), about 60% of the dwellings are rented, and in others such as Spain, about 80% of the dwellings are owner-occupied. Such differences require that the instruments are adapted and that the application of the subsidiarity principle is necessary. The measures are classified according to the following categories:

1. The regulatory measures
2. The financial levers
3. Non-governmental activities
4. Research / demonstration and development projects
5. Promotional measures / increase public awareness

5 Examples of national long-term visions

Many measures exist in order to improve the energy efficiency of the existing building stock. Improving the existing building stock requires important efforts and long-term planning. In the context of the Kyoto commitment, and the preparation of the post-Kyoto discussions, most European countries are developing such long-term strategies relative to the reduction of the CO₂ emissions in general, and the improvement of the energy efficiency of buildings in particular. Discussions about ambitious measures are ongoing, and some of them are under development in the different member states. The long-term strategies in the European countries participating in the project have been summarized in a set of documents that can be found in appendix. A short introduction to these appendices is given below.

5.1 Belgium

In Belgium, the Flemish Climate conference was started in June 2005. This conference addresses all energy consuming sectors, including the building sector. One of the major recommendations of this climate conference is to develop a large scale renovation

program for existing dwellings. In the framework of the Flemish Climate policy plan 2006 – 2012, a feasibility study for an energy renovation program for existing dwellings has been announced. The purpose of this study is to identify which combination of measures is the most appropriate for a substantial improvement by 2020 of all the existing housing stock. The general strategic objective for an energy renovation program in the housing sector, is formulated as follows: “By 2020 there will no longer be energy-inefficient dwellings in the Flemish Region”. A list of possible accompanying measures is under development.

5.2 Denmark

Since 2005, three long-term political announcements have been presented in Denmark. These are, Energy Strategy 2025, Action plan for renewed energy savings measures (2005) and the government's new draft energy proposal entitled "A visionary Danish energy policy" published in January 2007. The plans, all of them passed by parliament, are increasingly firm in their pronouncements and in their proposals for action. Both plans and the visionary policy, also refer to higher levels of efficiency in the building stock. Thus most of the proposals of the Action plan, which is incidentally a fulfilment of the EPBD, have been transformed into action to a great extent. Recently however, many politicians from all parts of the world have changed their minds about global climate change and environmental issues. The policy presented in, 'A visionary Danish energy policy', stated in January 2007 by the Danish government, can be seen as a result of exactly that global change of attitude. Nonetheless, it now seems clear that energy efficiency within the existing building stock is a much more important issue.

5.3 France

In France, two main documents are used for long-term actions planning:

- the French climate plan as defined in 2004
- the Energy orientation law published on July 15th 2005 (EOL)

These two documents deal with energy in all sectors; the one selected here contains the actions which are applicable to existing buildings. Building renovation constitutes a large part of the climate plan 2004. This plan is a clear roadmap for the various actors, and especially public-related bodies. The Energy Orientation Law is the legal vehicle which enables the government to implement many of the actions defined within the climate plan.

5.4 Germany

The German government has set up a long-term strategy for the improvement of the energy efficiency of all buildings, which foresees a yearly rate of renovation of 5 % of the building stock over the next 20 years. Currently the German government is developing a new holistic energy policy concept. The announcement of this concept is planned for the second half of 2007. Therefore the long-term vision can only be based on the publications available from the government, the responsible ministries and the results of the so-called energy summits. With regard to the energy efficiency of the German building stock, a set of specific goals have been planned, including:

- Accelerated realisation of the significant energy saving potential in the existing building stock
- Introduction of the energy efficiency as major factor in the real estate market
- Significant reduction of the energy consumption of public buildings
- Use of the presidency of the European Union in order to boost energy efficiency at the international level

The level of scope and the supporting measures should both be announced soon.

5.5 The Netherlands

Energy saving in existing buildings has already been in the picture in the Netherlands over the last ten years, and a base has been made for future long-term plans. It started out by using a voluntary method along with an instrument to calculate the energy performance of existing dwellings (EPB, later EPA) as an initiative of EnergieNed (the umbrella-organisation of energy companies). The Dutch national government picked up on this initiative and over several years a subsidy scheme (EnergiePremie, EPR) was linked to it. Then a new method and tool was also developed for non-residential buildings. The calculation of the Energy Performance Certificate is based on EPA. This is one of the pillars of the Dutch energy efficiency policy over the longer term. Intensification of the energy efficiency policy in the construction environment was announced in December 2006. The following tools have been announced:

- Energy saving targets will be imposed on energy companies.
- The application of stimulating tools to overcome investment restrictions for building owners and users.
- Knowledge transfer for building owners and users, e.g. concerning user behaviour, cost and benefits of energy saving measures and new technologies and measures.

Additional policies and tools are also under development.

5.6 The UK

The UK Government set out its policy to deliver a secure, low carbon energy mix for the UK on 23 May 2007 when it published its Energy White Paper, "Meeting the Energy Challenge". Looking ahead to 2020, the White Paper announced specific measures that will ensure that individuals, businesses and the government reduce their carbon emissions and save energy:

- Helping more people save energy by proposing to double energy suppliers' current obligation to provide customers with energy efficiency measures through a new 'Carbon Emission Reduction Target' from 2008-2011.
- A mandatory national scheme – the 'Carbon Reduction Commitment' (CRC) – to require large non-energy intensive commercial organisations (e.g. banks, supermarkets, hotel chains, etc.), government departments and local authorities to reduce their emissions.
- A requirement for new meters to come with a real-time display from 2008 and a short term offer of free displays from energy providers for households to 2010. The government expects everyone to have a smart meter with a display within 10 years.

The UK's long-term energy policy is to achieve a 60% reduction in CO₂ emissions by 2050. Buildings are responsible for about 50% of total emissions, and may well need to deliver cuts greater than this. The government recently announced that new buildings should be zero-carbon by 2016 and has promised proposals for the decarbonisation of existing buildings later this year.

6 The Roadmap Toolbox

Besides the report, that includes also suggestions for the EPBD revision with pro's and con's and features various appendixes (national current situation, short-term and long-term visions) the project has also developed a so-called roadmap toolbox that provides links to the various parts of the report and to the appendixes. The included tables provide an overall view of the contents of the reports, and the hyperlinks allow direct consultation to the information requested, see Figure 1.

Type of measure							
1. The regulatory measures							
1.1 Legal requirements (technical)							
1. Adoption and/or reinforce requirements							
a. Building level - overall energy performance		exist	exist	exist	exist	ud	exist
b. Building level - subset performance		exist	exist	exist	exist	no	no
c. Component level		exist	exist	exist	exist	exist	exist
d. Enlarge the application field of the requirements		exist	exist	no	exist	ud	no
2. Adaptation of energy and environment standards		no	no	no	exist	exist	no
3. Visible meters in the building		no	exist	exist	no	no	ud
4. Requirements compliance check		exist	exist	no	no	no	no
5. Public / governmental buildings							
a. Stricter requirements for governmental buildings		no	exist	exist	exist	no	exist
b. Integration of the energy performance of buildings in public procurement procedures		exist	exist	exist	exist	no	exist
c. Retrofitting of public buildings		exist	exist	exist	exist	no	no
1.2 Other legal supporting measures							
1. Energy certification scheme							
a. Way certificates are communicated / displayed		exist	exist	exist	exist	exist	exist
b. Towards the mandatory realisation of the recommendations enclosed into the energy certificates		no	exist	no	no	no	no
c. Base the development of adapted supporting tools on the knowledge of the building stock gained by the collection of energy certificate		ud	exist	no	ud	ud	no
d. Linking incentives to energy performance certification		ud	ud	no	exist	no	exist
2. Encourage reconstruction instead of heavy renovation works		ud	no	exist	no	no	ud
3. Adaptation of the renting level							
a. Right for the owner to charge energy investments in renting level (agreed procedure)		no	no	no	exist	no	no
b. Right for the tenant to deduct energy efficiency investments in rent paid to owner (agreed procedure)		no	no	no	no	no	no
4. Adaptation of the legislation concerning co-ownership							
a. Reduced majority level to decide to implement measure proven to be energy efficient		no	no	exist	no	no	no
b. Reduced majority level to decide to implement measure proven to be energy efficient and cost efficient		no	no	exist	no	no	no
c. Requirement regarding the constitution of financial reserve for energy efficiency measures in co-owned buildings		no	exist	no	exist	no	no
d. Rules to transfer cost savings on all co-owners or financial reserve when							

Figure 1: Roadmap toolbox for energy efficiency measures in the existing building stock; here: overview on existing measures and measures under development (screenshot).

7 Literature

Loncour, X., Wouters, P., Vandael, P. (edit.), (2007), Roadmap for energy efficiency measures/policies in the existing building sector. Final report. European Intelligent Energy Europe programme project Applying the EPBD to improve the Energy Performance Requirements to Existing Buildings – ENPER-EXIST, available at www.enper-exist.com

Loncour, X., et ali, (2007), Roadmap Toolbox for energy efficiency measures/policies in the existing building sector. European Intelligent Energy Europe programme project Applying the EPBD to improve the Energy Performance Requirements to Existing Buildings – ENPER-EXIST, available at www.enper-exist.com

8 Acknowledgements

The project has received funding from the Community's Intelligent Energy Europe programme under the contract EIE/04/096/S07.38645.

The content of this document reflects the authors' view. The authors and the European Commission are not liable for any use that may be made of the information contained therein.

Ecobuildings in Progress

BRINGING RETROFIT INNOVATION TO APPLICATION IN PUBLIC BUILDINGS - BRITA IN PUBS

Hans Erhorn
Fraunhofer Institute for Building Physics
Nobelstr. 12, 70569 Stuttgart
Phone: +49 (0)711/ 970-3380, Fax: +49 (0)711/ 970-3399
E-Mail: hans.erhorn@ibp.fraunhofer.de

1 Project summary

The BRITA in PuBs project (Bringing Retrofit Innovation To Application in Public Buildings) aims at increasing the market penetration of innovative and effective retrofit solutions to improve energy efficiency and implement renewables, with moderate additional costs.

In the first place, this is realised by the exemplary retrofit of 8 public demonstration buildings in the four participating European regions (North, Central, South, East). The general aim of the retrofits at the demonstration buildings is to reduce the primary energy demand for heating, ventilation, cooling and domestic hot water by factor 2 and to improve the user satisfaction also by factor 2. Secondly, the research work packages include socio-economic research such as the identification of real project-planning needs and financing strategies, the assessment of retrofit design guidelines, the development of an internet-based knowledge tool on retrofit measures and case studies, and a quality control-tool box to secure the good long-term performance of the building and the systems. The training and dissemination work includes blackboard information sheets, an Eco-buildings e-learning module, architectural student courses, and a facility managers training based on the results of the demonstration projects. The project website (www.brita-in-pubs.eu) includes a building diary with updated information on the current status of the demonstration projects.

2 The demonstration buildings

Public buildings are natural locomotives for the introduction of energy efficiency, energy conservation and renewable energy into the building sector. They are often visited by many people on a daily basis; they are often architecturally significant and have an outstanding location in the city. All groups of age and social origin meet in public buildings, a greater penetration of society and influence on their values is not possible with other building types. Renovation projects on public buildings enjoy the immediate interest of the local residents and will thus receive media attention. The state and local authorities are expected to take a lead position in the implementation of the European Directive on the Energy Performance of Buildings. These facts make public buildings the obvious choice for "Ecobuildings" demonstration projects. All in all, conducting demonstration projects on public buildings has the potential for a large replication effect.

The choice of the buildings was made with the intention to cover the whole sector of public buildings. From Table 1 you will see that with these 8 demonstration buildings each type (habitation, social facilities, education and research, cultural facilities and services) is represented at least twice in different climatic zones. By this the results can be

generalised. The building type 'transport' has not been covered, because these buildings are rarely or never heated.

Table 1: Public building types covered by the BRITA in PuBs demonstration buildings.

Region	Demonstration buildings	Habitation	Social facilities	Education and research	Cultural facilities	Services	Transport
Central North	Nursing home Filderhof Stuttgart	X	X				Mostly un-heated or heated at a lower temperature
	City College Plymouth			X			
	Borgen Community Centre		X	X		X	
	Hol Church				X		
	Proevehallen, Copenhagen				X		
South	Evonymos Library Athens				X	X	
East	Brewery University Brno	X	X			X	
	Main Building University Vilnius			X			

2.1 Nursing Home Filderhof, Stuttgart

The challenge in this project was to show how the primary energy demand in an old nursing home can be reduced by minimum 50 % without changing the historical view. The Filderhof is located in an urban area in the south of Stuttgart. The building was originally built as a hotel in 1890, got an extension in 1952 and since 1967 it has been used as a nursing home for old people and people with dementia. It consists of 4 storeys and has a total net floor area of 2,875 m². There exist about 18000 similar buildings in Europe. All the windows and entrance doors were retrofitted. The new windows have high-efficiency triple-glazing with a U-value of 1.0 W/m²K and thermal spacers to minimize the thermal bridges at the glazing edges. In order to maintain the architectural expression of the building, only internal insulation has been used in most parts of the old building. Mineral-fibre wool of various thickness has been used with an individual construction frame (aluminium profile frame planked with sheetrock) masked with a vapour barrier. About 20 % of the front wall got an external insulation. To reduce the heat losses through the roof a 14 cm thick thermal insulation layer was fixed between the rafters, an additional 5 cm insulation layer was fixed below the rafters. The upper ceiling of the building was insulated with 16 cm of mineral fibre between the rafters, and 5 cm insulation panels were laid on top of the ceiling. The use of some basement rooms was changed, so they will be heated now. Thus, the thermal insulation had to be modified as well. The heated areas, which are used as kitchens and as dressing rooms, get insulation at the base floor and inside surfaces of the wall. In the other cellar rooms the ceiling is insulated. The old constant-temperature heating system has completely been replaced. The new heating plant consists of two gas condensing boilers, a combined heat and power unit and a thermal solar plant. The new system temperature of the radiators is 60° C flow and 40° C return flow. The two gas condensing boilers have a thermal power of 150 kW each, and the combined heat and power unit has a thermal power of 32 kW and 17 kW of electrical power. To extract the humidity from the new bathrooms and to ventilate the kitchen rooms, two independent ventilation systems were installed. The heat recovery rate of both systems is higher than 80 %. Furthermore, a thermal solar plant was applied for domestic hot water. The collectors have a surface of 60 m² and can provide appr. 32 % of the

domestic hot water demand. A photovoltaic system with a surface of 105 m² was installed. The maximum power of the plant amounts to 12.6 kWp and the 90 monocrystalline modules produce some estimated 12,615 kWh per year. This means a reduction of the greenhouse gas CO₂ of around 8.7 tons per year.

2.2 City College Plymouth

The challenge of this project was to upgrade the external façades and remodel internally to modernise the building, but adopting a whole range of energy saving technologies. The institute building dating from 1972 had only been partially refurbished since that time. As a result it has a dated feeling suffering severe solar gain, drafts and inadequate heating. The aim of the project was to have a significant impact on the large student population that passes through the college. The building has a reinforced concrete frame, non insulated cavity wall construction and single glazed vertical sliding windows. There are about 300000 similar buildings in Europe.

A holistic retrofit concept was developed, but not yet realized. This includes the upgrade of the external façades to significantly reduce energy loss and the internal remodelling to create a modern environment using innovative measures to control heating, cooling and lighting and the working environment. The heating would be upgraded with three high efficiency modulating boilers. Heat emitters will be replaced with high efficiency radiators served from a zoned distribution system. Heating would be further improved by the addition of a combined heat and power unit. It is also intended to supplement the domestic hot water system through the addition of solar thermal units. Room ventilation will be based on a natural system. High level louvers in each room will provide the inlet and outlet air for the ventilation strategy. The upgraded BMS controls will open the louvers at night to permit night time cooling and by day to maintain the required air change rates and comfort. Opening windows will also be included. High frequency electronic controlled gear and T5 lamps are to be provided in all rooms. Lighting will include automatic controlled both by occupancy and light levels.

Two 6 kW wind turbines have been installed adjacent to the Tower Block to help reduce energy demand of the site.

2.3 Borgen Community Centre

The challenge was to implement a comprehensive renovation of a combined elementary/secondary school building built in 1971, transforming it into a secondary school incorporated in a local community centre. The overall goals were:

1. Best possible quality classification for: environment - resources - indoor climate.
2. Reduce total energy consumption for heating, ventilation and lighting by 50% or better.
3. Utilize renewable energy resources.

Across Europe there are about 6000 similar buildings.

The concept was to reuse all construction elements that could satisfy Norwegian building requirements: foundations, prefab concrete pillars and beams, concrete floor slabs, drainage and sewage pipes. In order to meet the new requirements for snow loads, roof elements were replaced. Roof insulation was increased to an average thickness of 300 mm which resulted in a U-value of 0.13 W/m²K. Walls were rebuilt with 8" wood framework and brick cladding. 200 mm insulation gives a U-value of 0.2 W/m²K. New windows have wooden frames with outside aluminium cladding. Glass is high quality double glazing with low emissive coating. The U-value is 1.1 W/m²K. Existing floor slabs were given a new 100 mm insulation layer underneath a new concrete floor slab. To optimise the use of renewable energy, a geothermal heat pump was chosen. Heat is

pumped from 44 energy wells in the ground, average depth about 150 m. The heat pump produces low temperature hot water, 45 to 50 °C. Heat is distributed by water to radiators under the windows. It is also used to preheat domestic hot water to about 40 °C and the temperature is then lifted to 75 °C by electric heating. When using heat pumps, it is mandatory to have a backup system, and two oil boilers are installed. The heat pump is dimensioned to 60 % of total needs. Under normal conditions this is enough and the oil burners will kick in only a few days during the winter. The main ventilation is based on a natural hybrid system. Since this was an existing building, air culverts had to be built outside along the foundations. The massive construction of the culverts helps to cool the air in the summer and preheat during winter. Air flow is regulated by temperature and CO₂ sensors in each room and adjusted to the actual need. Exhaust towers are equipped with fans that are activated when natural driving forces are insufficient. A heat recovery system supplies heat to the preheating unit in the culverts. The shape of the building made it necessary to improve daylight conditions. Central areas of the roof were raised to install windows and skylights. To optimize the effect of daylight, all electrical lights are adjustable and automatically regulated by light sensors. An advanced Building Energy Management System (BEMS) has been installed to control the heating and ventilation systems.

2.4 Hol Church

The challenge in this church project was to show how energy efficient solutions could be applied to a listed building under the authority of protective antiquarian wings, which means that in principle not any structural change will be allowed.

Across Europe there are approx. 180000 similar public buildings.

After having received refusal from the Antiquarian Authorities (AA) for insulation works, appeals have led to compromises. The floor was insulated from below through the crawl space, which indeed was a difficult job. A similar refusal/acceptance procedure was carried out for the flat part of the roof. The ceiling was insulated from above. The windows and doors were adjusted to close properly and they were equipped with rubber gaskets. The existing heating system was a typically Norwegian one. Due to the huge hydropower production, electric resistance heating is common. The system has a total capacity of 70 kW and heaters are positioned under the benches. Due to the draughts, it took three days to reach a comfortable temperature in wintertime. This happened every time again with typical activities like approximately 21 services a year, 15 funerals, 5 weddings and 10 choir and other cultural events. The heating solutions sought can be split into three main categories:

- Insulation reducing heat loss through the envelope, coupled with improved gaskets to avoid drafts from windows and doors. This has proven to raise the comfort level..
- A vertical two metres high, 75 cm diameter round air canon of 4,200 m³/hour (drawing only 160 W) 'shoots' unheated air upwards to replace the heated air under the ceiling. This process is normally started an hour before the service and it moves the warm air from under the ceiling down to where people are seated. It has proven to be an efficient comfort measure that improves the feeling of comfort.
- In this region of Norway, when it is cold, it is normally sunny and not windy. There is also a lot of white reflective snow in this region. That's why an air based solar thermal system has been selected. The air is moved through the solar absorber and from the absorber to the church by two small fans connected to a solar PV system that starts, stops and regulates air speed depending on how bright the sunshine is.

These improvements reduced the necessary pre-heating time from three days to a bit more than one day. Since the church has a very simple energy system, a complicated

Building Energy Management System (BEMS) was not necessary to control the heating systems. Instead, a close dialogue, analysis and discussions with the caretaker have proven to be valuable in taking measures, checking routines and improving routines while continuously supporting the caretaker. In order to bridge the huge distance between the caretaker's home and the church (25 km) an automated 'Ring the church warm' system has been installed. Before, the caretaker always had to drive to the church each time to turn the heat on, days before a major church activity took place.

2.5 Cultural Centre Proevhallen

The challenge in this project was to show how energy efficient solutions can be used in turning an old factory building into a modern low energy and multifunctional cultural house. The site is an old industrial area, which is being completely reshaped, modernised and made into a new neighbourhood with its own identity. The building, Proevhallen ('The test hall') was part of an industrial complex for porcelain production. Proevhallen is an old open hall building constructed in the 1930s in 1 floor. However, the height of the building is the same as that of a 5-floor building. There are about 3000 similar buildings across Europe.

Originally, it was the intention to insulate the external walls on the inside in order to maintain the architectural expression of the old brick walls. However, it turned out that for fire protection reasons this would require quite substantial and extremely costly treatments of the metal-beam load-supporting parts of the wall. Therefore it was decided to insulate the wall externally. This has no economical consequences for the project and from a technical point of view it is a clear advantage, as external insulation is better at preventing thermal bridges than internal insulation. The basic heating system selected for Proevhallen is a standard hydronic radiator system. The air supply in the mechanical ventilation system is preheated - if needed - by a heating coil. This is supplied also from the hydronic system. The building is ventilated by a combination of natural ventilation – at the upper floor – and mechanical ventilation at the lower floors, where also a bathroom and toilets are located. The windows will be demand-controlled according to CO₂ and temperature. An efficient air-to-air heat exchanger is used for the mechanically ventilated part of the building. This balanced ventilation system keeps a minimum low ventilation for the toilets and it supplies additional ventilation when the CO₂, humidity (in the bathrooms) and temperature sensors indicate that there is a demand for additional air exchange. Two kinds of PV plants are installed at Proevhallen: one at the gable (19 kWp), which is made with an artistic expression and one innovative PV-T plant (6 kWp), which also delivers heat by cooling by a heat pump. The cooling raises the efficiency of the PVs. The produced electricity is used in the building or sold to the electricity grid. A Building Energy Management System (BEMS) has been designed and installed to control the heating and ventilation systems.

2.6 Ecological Library Evonymos, Athens

The challenge in this project was to renovate a listed building, constructed in 1895 - 1905, using energy conservation and renewable energy systems. Besides it had to be converted into an ecological library devoted to demonstration, education, and dissemination of low energy and environment friendly technologies in building construction and renovation. This will include traditional and modern techniques of energy and water conservation, ecological building materials, renewable energy systems, and recycling of water, paper etc. There are about 4000 similar buildings across Europe.

The interior of the building will be completely renovated. A key feature of the renovation is the addition of new useful spaces, that is: a mezzanine between the ground and 1st floor, in order to take advantage of the double height of the ground floor, the conversion of an existing veranda on the first floor into an open reading area, the conversion of the terrace into a sitting area. The outdoor spaces have been designed to ensure high quality thermal and visual comfort for the users in all seasons.

The following energy conservation measures were realised at the library building:

- External insulation of walls and roofs: 4 cm insulation thickness - all external architectural decorative elements will be dismantled for the placement of insulation and then replaced or reconstructed.
- Air-tight low-E double glazing and night insulation (insulated aluminium rollers).
- Reduction of infiltration with window stripping and tight window frames.
- Shading varying according to the orientation of openings (horizontal, and vertical shades made of thin wooden openable fins).
- Shading of the South and Southwest façades with wooden pergolas supporting PV modules and sliding cloth shades.

The measures for renewable energy integration, efficient energy supply and ventilation include:

- Integration of two sunspaces on the verandas/terraces with openable vertical and tilted glazing to eliminate any increase of the building cooling load.
- PVs integrated on the sunspace roofs as shading devices.
- Solar collectors for domestically heated water.
- Gas fired water boiler system for heating, fuelled from the natural gas city network. The required size of the boiler is 82 kW. A fourway valve is necessary at the boiler outlet to significantly lower the water temperature to the level needed by fan coil units. Pumps will be driven by Variable Frequency Drivers (VFD).
- Efficient hybrid ventilation: ceiling fans and earth pipes. A centrifugal fan (fan section type) with VFD drivers will assist natural ventilation.
- Innovative solar chimney/ light duct elements.
- Hybrid night ventilation for the warm months.

2.7 Social Centre Brewery, Brno

The Brewery is the oldest building in the BRITA in PuBs demonstration project, dating back from 1769. The retrofitting of very old buildings, which involves the change of use, can be full of surprises. No drawings of a building are usually available at the beginning and some energy saving measures suggested at an early stage of retrofit design may not eventually be applicable. Success can therefore only be achieved by a flexible, iterative approach. The retrofitting of the Brewery involved a complete change of use. The industrial type building had to be transformed into a modern social and cultural centre for students and academics. Many building structures had to be rebuilt or reinforced during the retrofit and all the building systems had to be designed from scratch. There exist about 1000 similar buildings in Europe.

The Brewery has heavy, one meter thick brick walls and the foundation pressure exceeded the nominal bearing capacity of the soil. The foundations were in a really bad condition and their reinforcement was necessary in order to avoid a demolition order. New windows with the glazing U-value of 1.1 W/m²K replaced the old ones. Some external walls were thermally insulated with 100 mm of mineral wool. The floors adjacent to the ground were insulated with 60 mm of polystyrene, and the ceilings under the unheated lofts with 160 mm of mineral wool. The roof of the two-storey building was insulated with 160 mm of

mineral wool. A hydronic heating system with different types of radiators and convectors is installed in the building. The wall-mounted radiators are used in most of the rooms. Floor convectors placed in grill-covered cavities are used in some rooms in order not to disturb the historical appearance of the rooms. Air handling units of the mechanical ventilation system are fitted with heating and cooling coils (water-to-air heat exchangers) and they can be used for heating and cooling. Since the building has a tremendous heat storage mass the mechanical ventilation systems can be employed for night cooling. A heating plant with two condensing gas boilers provides hot water for the heating system and air-handling units. A cooling plant with two chillers prepares chilled water for the cooling loop. A variable refrigerant volume (VRV) air conditioning system is installed in the guest rooms. The system can be used for both cooling and heating. A grid-connected PV system with the peak output of 13 kW is installed on the roof. The main objective of incorporating the PV system into the energy retrofit measures was the reduction of the load to the power grid in summer months when mechanical cooling is needed. A good match between the output of the PV system and the cooling loads is expected due to the orientation of the system. The Building Energy Management System (BEMS) is integrated into the Building Management System (BMS) of the whole campus of the Faculty of Information Technologies.

2.8 Main Building Vilnius Gediminas Technical University

The challenge in this project was to show how energy efficient solutions can be achieved in applying the methodology of multi-variant design and multiple criteria analysis of a building refurbishment by forming thousands of alternative versions. This methodology allowed to determine the strongest and weakest points of the Vilnius Gediminas Technical University (VGTU) main building refurbishment project and its constituent parts. Across Europe there exist about 5000 similar buildings.

Keeping in mind that the building has now been in use for more than thirty years, the following measures were suggested: renovation of facades, replacement of windows, renovation of the roof, replacement of entrance doors, a slight optimisation of the renovated thermal unit and complement of the automatic part, renovation of the heating and ventilation system. This includes a new, fully automated heating system with automated compensation valves, a new closing reinforcement, the installation of thermostatic valves for heating equipment, a change of trunk pipelines. Also, the current ventilation system was replaced by a new, fully automated mechanical ventilation system with up to 70 % recuperation. In addition, new pipelines of air supply/removal and equipment have been installed.

During the renovation of the thermal unit, an electromagnetic indicator for heat and water quantity was installed. With the help of the indicator the heat quantity, the quantity of flowing water, instantaneous debit, initial and recursive temperature, initial and final pressure are determined. Data recorded by the indicator can be transmitted by Internet and the indicator can be managed by computer programs.



Figure 1: Photos of the BRITA in PuBs demonstration buildings after the retrofits.

3 Literature

Citterio, M. et al. (2008), 8 Reports on the Realisation and Validation Analysis of the Demonstration Buildings in BRITA in PuBs, EU 6FP Integrated Project Bringing Retrofit Innovation to Application - BRITA in PuBs, soon available at www.brita-in-pubs.eu.

4 Acknowledgements

The project has received funding by the European Commission within the 6th Framework Programme under the contract no. TREN/04/FP6EN/S07.31038/503135.

The content of this document reflects the authors' view. The authors and the European Commission are not liable for any use that may be made of the information contained therein.

Project Partners:



ENERGY EFFICIENT RENOVATION OF DWELLINGS: LESSONS LEARNED

Frans Koene, Henk Kaan
ECN, Energy research Centre of the Netherlands
Energy in the Built Environment Unit
P.O. Box 1, 1755 ZG Petten
Tel.: +31 224 564585 Fax: +31 224 568966
E-Mail: koene@ecn.nl

1 Introduction

An analysis of the energy consumption of the built environment in Europe shows that the main challenge to achieve substantial energy reductions in this sector lies in improving the energy efficiency of the existing stock rather than in designing and building energy efficient new dwellings. This challenge is especially pungent when taking into account the building stock of former Eastern European countries, where energy efficiency was never a great issue and where investments in energy efficiency are difficult to find.

This is area where the EU - funded project Demohouse is focusing on. In this project, partners from Austria, Denmark, Greece, Hungary, the Netherlands and Spain are working together to develop, implement and demonstrate solutions to reduce the heating demand by at least 30% compared to present 'business as usual' renovations. The advantage of the European dimension of the project is that participating countries learn through sharing their experience and solutions.

2 The renovation projects.

The Demohouse project started in 2004 with 18 partners, and 8 building projects, of which 7 renovations and 1 new build. In the very first phases of the project, 2 renovation projects were withdrawn and one more followed in January 2007. Finally another project, in Hungary, was withdrawn in November 2007. Since the latter participated in most of the analyses and provides some useful lessons learned, it is nevertheless presented in this paper. Pictures of the 5 projects and the main architectural characteristics are summarized in Table 1 and Table 2 below.

All projects began with reducing the energy need for space heating by a good thermal insulation and air tightness of the building skin. Ventilation losses are reduced by applying a heat recovery unit or applying demand controlled ventilation, using CO₂-sensors.

For all projects, the renovation is compared to a 'business as usual' or 'standard' renovation. For all buildings, including the Greek building, this is a theoretical exercise, where the building is 'virtually' renovated according to the national or local building code.

Originally, a biomass fired CHP (Combined Heat and Power) plant was planned in the Austrian renovation project, but in the end, this did not appear to be economically feasible. Figures for the case with CHP and without CHP are shown in Table 3.

Table 1: Pictures of the 5 projects.

		
The Spanish Demonstration building, after renovation	The Austrian Demonstration building, after renovation	The Danish Demonstration buildings, before renovation
		
The Greek Demonstration building, newly built	The Hungarian Demonstration building, before renovation	

Table 2: The main architectural characteristics of the 5 projects.

Country, City	Year of construct.	Characteristics	Main energy saving measures
Spain, Bilbao	1910, partly renov 1960	Old Town, historical area, 4-storey, brick walls, tiled roof	Insulation of building envelope Solar collectors + PV Building Management System
Austria, Graz	1975-76	Two blocks of flats, Social housing District heating	Insulation of building envelope Biomass-CHP-plant Quality control (e.g. IR-photography)
Denmark, Copenhagen	1965-1969	3 (of 12) building blocks, Prefab concrete District heating	Insulation of building envelope Air tightness Heat recovery unit each apartment
Greece, Athens	2005-2007	Newly Built, Concrete structure, Brick walls	Insulation of building envelope Ground heat exchangers for cooling Demand controlled ventilation (CO ₂)
Hungary, Budapest	1955-1960	Former military building 3 (of 11) blocks of 3 storey building bricks/concrete	Insulation of building envelope Solar collectors + PV Rooftop apartment

Table 3 shows that the simple Pay Back Time (PBT), calculated as the ratio of investment and the savings in operational cost (both compared to a standard renovation) ranges from

8 to 30 years. The first figure, from the Austrian project, is for the scenario without the biomass CHP.

Table 3: Investments and savings of the 5 projects.

	net floor area [m ²]	simple PBT [yrs]	renovation cost [€/m ²]	Space heating + DHW [kWh/m ² a]	CO ₂ -savings [%]
Spain	496	26	1463	80	64%
Austria	9860	14	130	102	52%
Austria, no CHP	9860	8	118	102	22%
Denmark	2880	21	218	40	50%
Greece	2787	17	115	46	48%
Hungary	6300	30	117	22	73%

The total cost of the renovation ranges from 115 to 220 €/m², except for the Spanish building. The structural reinforcement that was necessary (see below) made this renovation particularly costly.

Model calculations for the heating demand, including space heating and DHW (Domestic Hot Water) show figures in the range of 22 to 100 kWh/m²a, with the low figure presenting a challenge to reach this in practice. CO₂ savings compared to a standard renovation range from 22% for the Austrian project without CHP to 73% for the Hungarian project, again, a challenge to achieve in practice.

3 Barriers for Energy Efficient Renovation

For most of the projects, the financial barrier appeared to be the most important one. In Spain, local subsidies from funds to revive the neighbourhood were found to help overcome this barrier. In all countries, lack of low cost solutions for large scale implementation of energy saving measures was a barrier. In particular, implementation of a heat recovery unit in the ventilation system requires a substantial investment. In fact, this is the reason why such system was not implemented in the Austrian renovation project.

With the aid of EU-funding some important quality oriented R&D work was carried out to overcome this barrier. In the Danish project, a cost effective heat recovery unit with high thermal efficiency, low noise and energy efficient fans was developed. The Austrian partners as well as the Spanish expressed great interest in the product, but the development came too late for application in their renovation projects.

Another example is the development of a prefab lightweight and energy neutral rooftop apartment, also by the Danish partners. The sale of such apartments, generally at a good price because of the location, will partly cover the extra investment needed for an energy efficiency renovation of the remaining building. Roof top apartment were also planned in the Hungarian project, prior to its withdrawal.

In Austria, Hungary and Spain, introduction of an EPC (Energy Performance Contracting) model was considered to overcome the split-incentive problem, where the party investing in the renovation (the owner) is not the one to profit from the energy savings (the tenants). For various reasons, the EPC concept was not implemented in these projects.

Unfamiliarity of stakeholders with energy savings was also encountered in a number of countries. A good cooperation between builders, consultants and housing association proved very valuable in the Danish project. In Austria, unfamiliarity of tenants with an energy saving concept is thought to be solved by gradual introduction of the concept with tenants of good social background.

In Spain, an architectural barrier was related to the building being of historic value where the façade had to be preserved, implying the application of thermal insulation internally. Also, the building was in a dilapidated condition, requiring extensive and expensive structural reinforcements, resulting in a substantial renovation investment (see Table 3).

In Hungary, subsidised gas prices decrease the feasibility of application of Rational Use of Energy (RUE) measures and Renewable Energy Sources (RES). Here, the subsidy system is in need of revision, but this is outside the scope of the project.

4 The renovation process, what went well and what didn't

In general, raising awareness with the stakeholders (housing association, tenants, and local authorities) went very well. In Spain, contacts with local government like EVE (Basque Energy Board) and IHOBE (Public Society for Environmental Management) resulted in cooperation on developing energy policies and guidelines /legislation. In Denmark, tenants appeared to be very pleased with the application of the low cost heat recovery unit, also because it was very silent. In Greece, its success worked against the builders: future owners asking for additional sustainable measures caused some delays.

Setbacks different from project to project. In the Spanish project it was the bad condition of the building, aggravated by the lack of information about building in general and the foundations in particular. In the Austrian project, it was the increase of the price of vegetable oil by 60% since the start of the project in 2004, rendering the application of a biomass powered CHP (Combined Heat and Power) plant economically unfeasible.

In Denmark, renovations had to be approved by a majority of the tenants. The process of reaching consensus caused delays in the renovation. As a result, roof-top apartments could not have been applied in the Demohouse project, as its application could no longer fit the time frame of the latter. The roof top apartment will however be applied in the rest of the Danish renovation project. In Greece, the cost of the BMS (Building Management System) was higher than foreseen. In Hungary, in the end, lack of support from the local authorities, both financially and cooperatively, caused the project to be withdrawn.

5 Monitoring

An important aspect, often overlooked both in renovation and new build, is the monitoring of the building after the building process is completed. Too often, contractors build what they are supposed to build and don't look back at what they did. Monitoring the building after completion can provide information to what extent the targets with respect to energy savings, indoor environment etc. were achieved.

Monitoring will be carried out according to the so-called Common Evaluation protocol, which includes measurements of energy consumption for space heating and DHW for one year and single measurements of e.g. thermal and visual comfort and indoor air quality.

The protocol also includes a methodology (the energy signature) to compare expected and achieved energy savings.

So far only limited monitoring results are available. Instructive however is the case of the Austrian renovation project. The expected energy savings of approx. 65% (compared to pre-renovation state) that were calculated using sophisticated modelling tools were not achieved at first. In the first winter (2005-2006) of monitoring, with about half of the apartments renovated, the energy consumption of the building was reduced by approx. 5%. At the same time, it was observed that windows were opened more often than before. It appeared that the control of the heating system had to be adjusted to the different thermal behaviour of the building. Also, the tenants, unaccustomed to a well insulated building envelope, will have to be instructed anew on how to operate the heating system.

6 Lessons Learned

The reason for not applying energy saving measure in renovation is often unfamiliarity of the stakeholders with the approach and the consequences, and fear of extra costs. Demonstration of successful renovations therefore is crucial. Financial solutions can be found in the availability of low-cost components (such as the heat recovery unit developed in the Demohouse project), finding local subsidy funds, applying new financing models e.g. EPC or placing prefab rooftop apartments. Also, a good cooperation with and support by local authorities (preferable including financial support) is imperative.

Quality control in the course of the renovation appears to be very important in order to achieve the targets set. In the Austrian project, IR (Infrared) photography revealed missing parts of insulation of the building envelope, which the contractor could be forced to repair. In the Danish project, repeated blower door tests in the course of the renovation proved very useful to correct failures in achieving the air-tightness required.

The price of these quality control techniques is a fraction of the building cost. IR-photography for instance will cost in the order of 1000 €, giving the opportunity to correct cold bridges, air leakages, missing insulation etc.

After care also seems an important lesson. Check that the expected energy savings are indeed achieved and analyse the reasons if they don't. Too often, this stage is omitted in the process. The energy signature method can help to compare expected and achieved energy consumptions. Include the opinion of the tenants in the evaluation.

It is important to disseminate research carried out, the knowledge gained and lessons learned in order to achieve wide spread energy efficient renovation of buildings. For this reason, a Decision Support Tool was developed (Kondratenko et. al., April 2008). This instrument should facilitate decision makers on energy efficient and otherwise sustainable renovation. The DST focuses on the initiative phase of renovations since it is at this stage that the decisions about the ambition level of a renovation are taken. The DST also includes information on quality control during the renovation process and after care (e.g. the energy signature).

7 Literature

Kondratenko et. al., (April 2008), DST, Decision Support Tool to facilitate energy-efficient renovation of buildings

PARTICIPATIVE DECISION-MAKING FOR ENERGY EFFICIENT RENOVATION AND PROJECT DEVELOPMENT

Evert Hasselaar
OTB Research Institute of Delft University of Technology
Jaffalaan 9, 2628BX Delft, the Netherlands
Tel.: +31 15 2787871, Fax: +31 15 2783450
E-Mail: e.hasselaar@tudelft.nl

1 Introduction

In European demonstration projects the main interest is in new technologies and in how to spread the application of best practices. Strategies to manage processes and to involve stakeholders are less developed. When technologies fail to have the calculated energy performance, then occupant behaviour is mentioned as the unknown variable. Often the occupants are viewed as a problem group rather than the starting point for innovations.

It is possible to develop projects bottom up and to reach high performance quality nonetheless. A strategic approach for a bottom up design process for new buildings and for renovation projects will be presented. The information is based on discussions in workshops with stakeholders in the EU supported Demohouse project.

2 Methods

Participative decision-making was discussed during workshops on socio-economic aspects, held in three cities where Demohouse demonstration projects were executed: Copenhagen, Bilbao, Budapest and Athens. Workshop participants came from partner organisations including universities, local architects, consultants and in Bilbao also product- and service suppliers. The results are used as a starting point for practical guidelines for organising involvement of citizens, probably the most difficult element of participative decision making. Rather than giving a blue-print, the paper presents the conditions, strategies and ways to solve dilemmas. The ideas are based on practical experience with participative planning procedures and on the workshop results.

3 Results

3.1 Conditions

In contemporary decision making on housing, a top-down tendency is observed, which excludes the potential users of dwellings from influence on decision making. We propose the participative process where the (future) occupant can explain the preferences and needs. This involvement can increase the user oriented quality of the design and can help in achieving optimum occupant performance through operating the house. In the context of the Demohouse project the goal is to achieve energy efficient dwellings that sometimes include new technologies. Because building is never a pure technological procedure but includes the relation between technical quality and user perception and behavior, learning by involvement and feedback on the 'learnability' of a product must be included in the design process (Ornetzeder 2005). Direct user tests are possible through pilot houses as

realistic prototypes of new products, or through evaluation of existing projects. The organisation of participative decision making depends on the type of project, the scale and the stakeholders involved. A private home owner can take all relevant decisions, but with more dwellings in a house agreements with the large majority (70% up to 100% of occupants) are required. For new dwellings one active individual can build a private house, a group can commission the execution of partly collective and partly individual designs. Other approaches are: a contractor builds a basic dwelling and the occupant decides about individual extensions. Also, the local community, a housing association or developer can buy land, take initial investments and support the design and construction for the future buyers or tenants. For these procedures a participation procedure is quite possible.

3.2 Participative design context

Direct citizen participation emerged from the Greeks, but re-emerged over and over again in history, for instance in the 1960's during the civil rights movement with its push for participatory democracy. Citizen participation in the Netherlands had its roots in the democratic movements of the 1960's and showed also the onset of the movement towards a sustainable environment. Participation procedures of the 1970's in the Netherlands were learning by doing-tactics: citizens were supported in drawing alternative plans and in playing an advisory role in the official planning process. A new kind of democratic experimentation has been taking place in the context of local Agenda 21, starting in the late 1990's (Jamison 1999). New information techniques have changed the role of representative policy makers. The gap between natives and aliens and between the rich and the poor demand for new strategies, that "empower" the people in the neighborhoods to turn social decline and to offer opportunities for jobs, good education and a healthy environment. Participative decision making is essential in urban restructuring, in which social and economical changes go together with improvement of the physical environment. But participative decision making is also a means to increase the user friendly quality of products and the relation between needs and market products.

3.3 Principles

Stakeholder analysis

It is important to know the important stakeholders. Missing the involvement of important stakeholders, for instance the occupants, cannot guarantee that the process will be supported and the product will satisfy the relevant needs.

Discussion about goals

At the start of a project the goals will be defined and the planners will be provided with a brief of the performance requirements of the building or renovation project. The question will arise: do we have to accept for instance the functions, the sizes, the differentiation, the price level of the projected buildings? It is important to define the goals with all stakeholders involved. This phase tends to proceed in harmony and with enthusiasm about the ambitions and the cooperation. Because in later phases the consequences may differ for individuals, for instance because a service for all creates traffic noise or parking problems for a few, it is important to have strong dedication to the goals, but a great flexibility in taking the interests of different groups into account.

Accessible information

One of the most difficult aspects of participative decision making is the difference in expert knowledge. The first problems to be solved are the lack of access to information and the

lack of transparency of how it is used. Accessible information requires a moderator who has access to all information and translates it into information that is useful for the citizen group. Citizens do not replace the experts, but must be able to build a reciprocal relationship of receiving information and giving feedback. Citizens are experts as users and they are the main partners in performance evaluation. The demands on professional experts are high: they need to make their work transparent, their proposals must be conveyed well to other stakeholders and the feedback must be clear and relevant. Also, the experts must meet exact deadlines for decision making. By organizing the design process in 5 or 6 steps, with clear goals or requirements per step, all stakeholders involved know when to come up with advice or alternative plans.

Decision making procedure

Groups in power can speed up or delay the process and manipulate decisions. Citizens who are actively involved in the design process, have limited time and want to contribute to precise actions and well formulated decisions. A clear step by step design approach with definite decisions per step is essential for successful procedures. Also, decisions must have official backup from the local council, or those in charge. This quality requires a contract about the process and the status of decisions. This contract needs to be "empowered" at a high level in the power structure and must allow the experts and representatives sufficient free play to take decisions when they are needed in the process with other stakeholders. This leads to some dilemma's that need to be clarified: choice or voice, representation or direct involvement and majority rules or consent principle.

Participative decision making is about voice by giving advice rather than choice between alternative plans. Also, representation by a few for many may lead to isolation and loss of trust between the citizens and the representatives. Therefore a horizontal approach is suggested, in which every citizen is allowed to become involved or otherwise accept the decisions taken by others. Different approaches have been successful. One approach is to invite all stakeholders for all meetings and keep all informed, but have the decisions taken by those present at the meeting. A different approach is to set criteria for "relevancy of involvement" and apply the criteria to select a "user group". A third approach is to follow a parallel design process with citizens and have the proposals presented by persons who have the support from the group of citizens. This representation dilemma brings the next suggestion: not to take decisions by majority vote (consensus), but on the basis of consent. Consent means to accept a proposal rather than to agree. Consent means that a stakeholder can live with the decision. Consent highlights objections, while consensus may overrule these objections and this could cause frustration and loss of commitment in a later phase. Because the process becomes more complex in later phases and conflicts may arise, it is useful to agree on a problem solving protocol.

3.4 Framework

The framework of decision making about projects considers technical, financial and organizational aspects. Organizational includes social aspects and project management. These themes and phases present a framework. See Figure 1. Indicators that mark the success of the decision making process can be selected and they are used in the preparation phase of a project to guide the making up of a cooperation agreement.

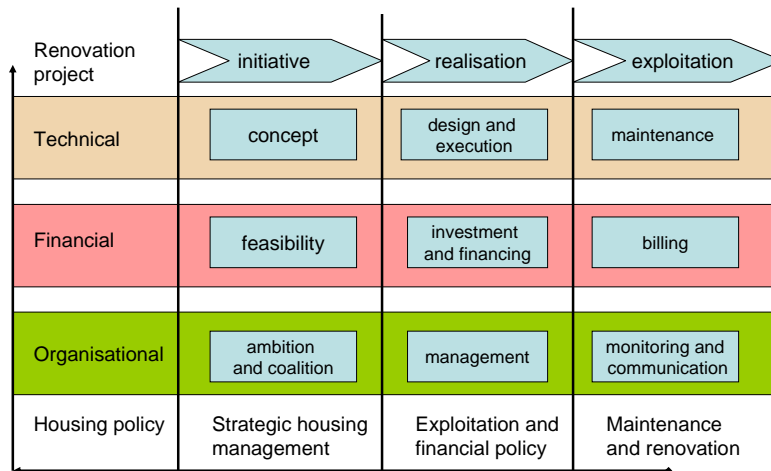


Figure 1. Framework of phases and topics of a renovation (or new construction) project

3.4.1 Phases and topics

The first step is to prepare a “startup” document. The architect works in a number of workshops on the design: location study, functional plan, details of materials and installations, cost consequences, user and maintenance aspects. The architect translates ideas of participants and reports to the owner. The owner is responsible for final decisions and contracting. Aspects to be considered are (Ravesloot 2005):

Initiative and strategy

- Workshop on Vision and Ambition to find support from key stakeholders
- Preliminary guarantees of the feasibility in relation to ambition
- Coalition forming for a design team with proper position for the occupants
- Information available on technical concepts of integrative solutions
- Procedures and time table for decision making

Realisation

- Guarantee of good progress in Tendering, and Funding
- Relevant tools and information for the selection of materials and components
- Testing performance and user friendliness in a pilot application
- Temporary relocation of occupants during renovation with high standard
- Integration of the contribution of many disciplines: quality control of all chains

Exploitation

- Instruction how to use the dwelling: instruction and user friendliness
- Complaint handling and communication about maintenance
- Monitoring of actual performance.

Table 1. Steps, involvement and methods in the participation procedure

Participative process		
steps	involvement	methods
1.collect information	Introduction of experts by neighborhood representative	Checklist for problem identification
2.social map, housing needs	Face-to-face meeting in own house	Semi-open questionnaire
3.stakeholder quality agreement	Input into contract by representatives, open access of meetings	Owner acknowledges conditions for user oriented participation procedure, information
4.architectural brief	Open access, involvement, direct input of ideas, learning process	Installations tested for user friendliness, pilot renovation of one dwelling
5.project contract	Relocation options, time schedule, representation, moderator support	Independent investigation of needs of neighborhood and of owner
6.design process	Steps: area plan, envelope, systems, lay out, details, decorations, rent level	Open access, fixed decision making steps, feedback, teamwork, accessible information
7.benchmarking	Evaluation, calculations	Workshops, questionnaires, focus groups
8.final decisions, rent, subsidies	Local community controls outcome, feedback, go-no go	Rules of how input will be reviewed, double-check by experts, information
9.individual deals per household	Individual discussion with owner (representative) until deal is reached	Home visits, fixed dates for execution, fixed plan, rent, subsidies, support in relocation
10. execution	Social support when moving out, personal tour at delivery	Direct communication occupants and project leader
11. (re-)use	Do-it-yourself task,	Social team
12. post-occupancy evaluation	Independent evaluation, results open to all for feedback	Focus group meetings, brochure, finalization party / ceremony

4 Discussion

For energy efficient project development, a participative decision-making method has potential of selling the dwellings in an earlier stage, which can minimise the financial risk for the developer. Also, participative decision making is likely to speed up the design and construction process, which is cost efficient. When clients are involved and turn into prospective buyers, they will prefer a short period of commissioning and construction. The moment to sell the planned development is after the completion of the plans and when a reliable construction price can be set. This method supports short turnover periods, client-oriented designs and social involvement. Additionally, participative decision-making is a way to promote user friendly designs and direct involvement of occupants can help to develop occupant behaviour that is more adapted to the needs of sustainable housing.

5 Conclusions

Housing managers and occupants are key stakeholders in the process, but the managers have to decide about the initiative to follow a participative decision making process. Performance criteria are a social contract, accessible information, horizontal cooperation and transparency in decision making. The procedure can speed up the process and can result in better user performance and cost efficiency. Participatory design procedures require communicative skills and well performing experts. Procedures may require support from the local community council.

6 Literature

Jamison A., ed., Public Engagement and Science and Technology Policy Options (PESTO), Final Report, March 1999;

Ornetzeder M., Rohracher H., ed., Nutzererfahrungen als Basis für nachhaltige Wohnkonzepte, Wien, März 2001;

Ravesloot C.M., 2005, Rombo Tactiek. (Organisational Method for the Realisation of Energy-neutral-dwellings in the Netherlands), Dutch, PhD Thesis, University of Eindhoven.

SUSTAINABLE ARCHITECTURE APPLIED TO REPLICABLE PUBLIC ACCESS BUILDINGS – SARA, WWW.SARA-PROJECT.NET



Mike Barker

Universitat de Barcelona, Dep.t de Física Aplicada i Òptica

Av. Diagonal 647, 5è [510], 08028 Barcelona

tel: +34 934 034 528 / fax: +34 934 039 219

email: mbarker@ub.edu

1 Introduction

SARA aims to construct sustainable, cost effective, high energy performance, public-access eco-buildings that are immediately replicable at large scale in many locations. The objective is to surpass the requirements of the European Directive on Energy Performance in Buildings demonstrating CO₂ reductions of 30% with an overcost of no more than 5% compared to conventional public buildings in each country.

The key aspects of the project are public-access, innovative yet cost effective and replicable results, consideration of end users and an interdisciplinary team working on Research and Technological Development (RTD) activities that have focussed on expert design advice and integration of simulation and BMS data to improve control of the buildings and future simulations. The demonstration sites include integrated project planning, active and passive solar design, low energy construction, including sustainable materials and components and including renewable energy technology and building energy management systems. Dissemination and training activities are also key to the project and are all visible and publicly available via the project web site.

SARA initially involved the demonstration of 8 sustainable and replicable Public-access buildings in 7 EC Member States (Austria, France, Italy, Poland, Slovenia, Spain and the UK) and 1 New Independent State (Uzbekistan). An important German research centre is also involved. Of these eight, four new buildings are now complete (03/2008), the two refurbishment projects are still in progress and two sites have withdrawn from the project.

The project is near enough to its conclusion (31/5/08) for preliminary results and conclusions to be drawn. Other contributions to this symposium will offer details of certain RTD and training aspects of the SARA project. This presentation aims to compliment these detailed contributions with an overall balance of results from the perspective of project management. It should be stressed that the overall result of the project is very positive and, perhaps for this reason, some less positive results are shared here in order to enable other organisations to learn from and build on the SARA experience in future projects.

2 Demonstration Activities

2.1 ☺ New buildings completed (3 public sector, one private sector)



Figure 1 Primary School (La Tour de Salvagny, France) , opened 9/2004

All three new, public-sector buildings involved in the project were completed without significant delays or difficulties. The private sector client-led development, a shopping centre was also constructed very quickly (in less than 1 year) after delays in the planning procedures. These four successful buildings are illustrated below.

The buildings are apparently well liked by users, according to post occupancy evaluation by Oxford Brookes University on the UK building (see elsewhere in the proceedings) and anecdotal evidence from other sites.



Figure 2 Student Services Building (University of Southampton, UK), opened 12/2004

The buildings have also achieved publicity based demonstration objectives as measured by the extensive media interest in and site visits to the buildings during the course of the SARA project. They have also provoked replication of the innovation beyond the scope of the SARA project. For example, the Catalan health service now apply RUE/RES criteria in the design brief for all new buildings and are now building a new hospital building on the SARA experience and going further, including a geothermal based heating and cooling system. The Catalan energy agency (ICAEN) have also started an ongoing monitoring programme in other primary health care centres as a result of the SARA project.

It is still too early to have reliable monitoring data from the buildings. The project included, as part of its innovation, the ambitious objective of using data from the Building Management System as the basis for detailed monitoring and performance comparisons with design based simulation data. Due to construction delays in Ljubljana and Barcelona, data is only now becoming available. A lack of after sales support for the BMS system installed in the Tour de Salvagny means that no data is available from this site, so energy performance is now being calculated by more traditional means such as energy meter readings and climate data. The experience has been most



Figure 3 Primary Health Care Centre (Catsalut, Spain) – opened 9/2007



Figure 4 Supermarket (Mercator, Slovenia) – opened 12/2007

complete in Southampton. Here a three stage process has involved (i) identification of nonsense data due to hardware connection errors and defects, (ii) detection of anomalous readings due to calibration or parameter definition problems leading to (iii) collection and monitoring of data to measure performance and identify scope for improvement. More information is reported in the symposium by the SARA RTD task leader Zafh.net.

2.2 ☒ Buildings not completed

2.2.1 Delays in refurbishment



Figure 5 Restoration of the facade in Naples, Italy

Refurbishment of the historic building in Naples is proceeding and has achieved significant results. The approved plans demonstrate how renewable energy technology and rational use of energy criteria can be compatible with the restoration of historic and listed buildings. The RTD work on site has shown how the existing structures can form part of an intelligent energy strategy when working with thermal mass, inertia and passive solar gains. The project has suffered significant delays compared to the original plan and only one section of the building will be completed within the SARA project timescale. This limits the demonstration work although the involvement in the SARA project has been of fundamental value to pushing forward with the innovative aspects of this ambitious restoration project.

The lesson to be learnt for European projects is that working with historic and listed buildings is complicated and that possible delays must be estimated with a large margin of security.



Figure 6 Restoration work in Bukhara, Uzbekistan

The refurbishment of the historic building in Uzbekistan is currently paralysed due to geo-political tensions and consequent financing problems for this cooperation project. Despite these difficulties with the demonstration aspect of the work, the SARA participants Association Tessellatus and Arsenal Research have been able to make progress with a training workshop and know-how exchange based field work in the course of the SARA project. This has resulted in bidirectional learning and training.

The lessons to be learnt here are that even where there are apparently insurmountable difficulties, it is possible to make progress and added value can be found.

2.2.2 Withdrawals from the project

The proposed Office building (Poland) withdrew at the beginning of the project due to change of management in the Dutch parent of the property development company and a

change of investment criteria due to this change and the economic climate in Poland at that time.

The proposed office / laboratory building (Austria) withdrew after 2 years due to financial difficulties of the developer/promoter.

The difference between these two building projects and the four successful SARA new-build sites is that these two were speculative development and, although promising, there was no client with a demonstrated demand for or commitment to the building. The logical conclusion is that this is a risk to be avoided in the development of future project proposals.

3 Dissemination and training

The dissemination aims of the project are to amplify the effect of the demonstration activity thus further contributing to the achievement of EU energy performance in building targets by provoking replication of good practice, by facilitating knowledge transfer and by influencing the behaviour of building users and decision makers.



Figure 7 Examples of SARA Posters for display in the Barcelona SARA building

The channels used for dissemination have been:

- Interfaces in the foyers of completed buildings displaying project information and real-time energy performance information).
- Additional printed information for building users and for sites visits / guided tours
- the project web site
- periodic electronic and printed paper bulletins
- posters for permanent display and for use at events
- presentation of the project and results at conferences
- collaboration with other Eco-buildings projects (periodic newsletters, website, brochure and 2 symposia)

The results are considered positive due to the interest generated and responses received. The dissemination materials developed are available for download from the project web site and may be of use either directly or indirectly as inspiration for other projects.

The first training activity of the project was aimed at construction workers and involved the development of a series of posters for display on site to illustrate the significance of their work in relation to energy performance. These posters then formed the basis for on-site training of construction staff during construction of the Barcelona and Ljubljana buildings.



Figure 8 Examples of Sara on-site training posters

Now work involves using material from the project in courses aimed at university students and also in a good practice guide for building energy managers. These results are in their final stage of development and will be published in spring 2008.

More details can be found on the project web site: www.sara-project.net

4 Acknowledgements

The SARA project is supported by the European Commission within the Six Framework Programme for Research and Development as part of the SARA demonstration project (2004-2008), Contract number: TREN/04/FP6EN/SO7.31838/503183.

The Sara participants are:

Organisation	Country	Acronym
Universitat de Barcelona *	Spain	UB
Institut Català d'Energia, Generalitat de Catalunya	Spain	ICAEN
Departament de Medi Ambient i Habitatge, Generalitat de Catalunya	Spain	DMA
Departament de Sanitat i Seguretat Social, Generalitat de Catalunya / CATSALUT	Spain	DSSS
Arsenal Research (Österreichisches Forschungs- und Prüfzentrum Arsenal Ges.m.b.H)	Austria	ARS
University of Southampton	UK	SOTON
Oxford Brookes University	UK	OBUS
Poslovni sistem Mercator	Slovenia	MERCATOR
University of Ljubljana, Faculty of Civil and geodetic Engineering	Slovenia	ULFGG
Mairie de la Tour de Salvagny	France	TSALV
HESPUL	France	HESPUL
Comune di Napoli	Italy	NAP
Association Tessellatus	France	TESSEL
Zentrum für angewandte Forschung nachhaltige Energietechnik	Germany	ZAFH.NET

SARA is an official partner of the European Sustainable Energy Campaign



ECO-CONCEPTS FOR HIGH PERFORMANCE EUROPEAN CULTURAL BUILDINGS - ECO-CULTURE

Mogens Krighaar
COWI A/S
Parallelvej 2, 2800 Kongens Lyngby, Denmark
Tel.: +4545972211, Fax: +4545972212
E-Mail: mgk@cowi.dk

1 Eco-Culture: focus on high performing cultural buildings

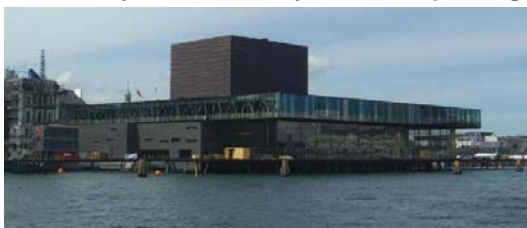
The Eco-Culture project has been set up to demonstrate the use of energy efficient technologies integrated into new built high-performing cultural buildings. The reason is obvious as there is a need for knowledge about the various ways to improve the environmental performance of these types of cultural buildings across Europe. Three remarkable buildings are included in this project:

- The Royal Danish Playhouse, Copenhagen, Denmark.
- The new Public Library, Amsterdam, The Netherlands.
- The new Opera House Oslo, Norway.

Focus is on investigations, demonstration and testing of the following technologies which have been selected out of the integrated ECO-concepts as being especially innovative and contributing to further development:

- Energy Storage.
- Heat Pumps.
- Natural ventilation.
- PV systems.
- Advanced Building Energy Management
- Systems (BEMS).

2 The Royal Danish Playhouse, Copenhagen, Denmark



2.1 Context

The new Playhouse for the Danish Royal Theatre on the Copenhagen waterfront will open in February 2008. The Playhouse consists of a main stage with 650 seats, a second stage called 'Port scene' with 250 seats and a small studio stage with 100 seats, together with

rehearsal rooms, recording studio, costume workshop, restaurant, café, library offices, facilities for staff and artists and a large public square in front of the building with a view of the harbour area. The main stage has horseshoe-shaped galleries and is inspired by the northern Italian renaissance theatre. The 'Port scene' reflects the fact that the large, gate-like doors in the northern wall can be opened to draw the stage and activities out onto the pier.

2.2 Energy Objectives

To reduce energy consumption and environmental impact:

- Reduction of energy consumption and CO₂ emission related to cooling by 75%.
- Heat consumption and energy for ventilation related CO₂ emission reduced by 50%.
- Through environmental friendly concrete a reduction of CO₂ emission by 26%.

2.3 Solutions

2.3.1 Use of renewable energy sources

An innovative energy concept has been developed for the new Playhouse. The energy concept contains thermal-active structures with energy storage, seawater cooling with heat pump and demand-controlled ventilation. The aim is to optimize the energy system by the use of surplus heat generated during theatre performances in interaction with the building integrated energy storage, and further to optimize the overall efficiency of the systems by implementing seawater cooling and reversible and interruptible heat pump. This use of renewable energy sources and surplus energy will be controlled by the intelligent BEMS.

2.3.2 'Climate belt' energy storage using thermo-active slabs

The thermo-active slabs are linked to the overall energy concept because of the temperature levels close to the room temperature: 5-10°C temperature difference. This means that the system can be used as low-temperature heating and as 'little-high-temperature' cooling, depending on the demand in the building. Water filled tubes embedded in the concrete slabs are functioning as both heat and cooling system in the Playhouse. During winter, excess heat from lighting and the audience is stored in the thermal active constructions until the next day. During summer, the building is cooled during the night (free cooling) in order to be ready for use the next day.

2.3.3 Data for one block

The accumulation inertia of the thermal active slabs means that heating or cooling can be stored in the concrete slabs during night, when the price for electricity for pumps is low (outside peak production period for the power plants), i.e. the use of thermo-active will contribute to the reduction of peak power production, which will improve the efficiency of the electricity production.

2.3.4 Seawater cooling and optimized heat pump

Due to the location of the Playhouse at the waterfront, it is natural to use seawater for cooling the building. Further by connecting a heat pump to the system, the seawater can be utilized optimally for heating in spring and autumn as well.

2.3.5 Ventilation

Wherever it has been possible, the Playhouse is ventilated with natural ventilation, which saves energy. Ideal area for natural ventilation is the large foyer and the offices. In the auditoriums, demand-controlled mechanical ventilation is used, in order to assure the amount of fresh air necessary for ensuring the desired level of comfort and quality.

2.3.6 Environmental friendly ('green') concrete

Environmental friendly concrete has been used for the 'climate belt' and will underline the energy savings of the climate belt/seawater solution. ECO buildings should always be built of environmental friendly materials. Denmark is the European leader within the development of environmental friendly concrete, also known as 'green concrete'. The environmental concrete has not been used in buildings before, but has been tested - in a slightly different format - at a highway bridge in Denmark. The environmental friendly concrete will reduce the embodied energy of the concrete as well as reduce the CO₂ emission.

2.4 Energy data and additional results

For The Royal Theatre the contribution to the overall energy savings are:

- **Thermo-active slabs**
 - Heat recovering from heat from stage tower: Savings = 57 MWh/year.
- **Heat pump and seawater cooling**
 - Heat pump, Heating: Saving = 250 MWh/year.
 - Heat pump, Extra electricity: Increased consumption = 56 MWh/year.
 - Seawater cooling, electricity: Savings = 300 MWh/year.
 - Annual saving of CO₂: 76%.
- **Intelligent controlled ventilation system – BEMS**
 - Heating: Savings = 347 MWh/year.
 - Electricity: Savings = 125 MWh/year.
 - Annual saving of CO₂: 49%.
- **'Green concrete'**
 - CO₂ saving: 26%.

2.5 Economic data

The construction cost of the ECO culture parts are:

- Thermo-active slabs: €280,000.
- Seawater cooling and heat pump: €890,000.
- Intelligent ventilation including BEMS: €500,000.
- Environmental concrete: €570,000.

Thus are the total cost is for the ECO culture parts: €2,240,000.

3 The new Public Library, Amsterdam, The Netherlands



3.1 Context

The Oosterdokseiland (Eastern Dock Island) lies to the east of Amsterdam's Central Station and borders on the historic city centre. The island is a component of the large-scale project to develop the Zuidelijke IJ-oever (the south bank of the IJ-inlet). The shift of port functions westward from this part of the city has presented new opportunities to support city-centre functions. Amsterdam wants to transform the area into an intensive urban area, providing residential, commercial, recreational and public functions in as mixed an environment as possible. It can therefore accommodate functions that are forced to leave the city centre because of a lack of space. These principles are reflected in the Oosterdokseiland Zuiddeel urban plan that was released in January 2002. A tract of land covering approximately 48,000 m² on the south side of the Oosterdokseiland is being transformed into a new urban area with a built programme of about 225,000 m². The new main branch of the Openbare Bibliotheek (Public Library) and the Conservatorium (Amsterdam Conservatory) is located here. Towards the east the plots become wider, allowing for large-scale buildings such as the conservatory and the library.

3.2 Energy Objectives

To reduce:

- Energy consumption and CO₂ emission related to cooling by 75-80%.
- Heat consumption and related CO₂ emission by 35-50%.
- Energy for ventilation and related CO₂ emission by 35-50%.

To use:

- Renewables; ground water (i.c.w. heat and cold storage) and solar energy.
- Intelligent control for maximised utilisation of the used technologies.

3.3 Solutions

3.3.1 Long-term energy storage (LTES) in an aquifer

The buildings at the Oosterdoks location will all be connected to a central cold and heating system. The distribution system comprises two rings, cold and warm, that will supply the connected buildings with heat and cold. In total there are three times two wells (cold and

warm). Via heat exchangers the groundwater cold respectively the heat will be transferred to two circular underground pipes (two rings), the distribution system. The wells will be charged during winter respectively summer in such way that the system is in energy balance. Innovative is that all buildings will have both access to the cold and warm well at the same time. Excess cold or heat will be stored in the buffer rings. Due to the fact that not all buildings have the same pattern of heat and cold demand the buildings can use the residue heat or cold of each other. For peak loads a bio-oil fired boiler is used. When extra cold is needed this will be produced by a heat pump. The excess warmth will be stored in the buffer ring. The heating system of the building is a low temperature heating system. There are no negative environmental effects of this system.

3.3.2 Ventilation system

The ventilation system of the library is designed to have a high temperature air inlet into the building with a temperature range of 18 to 21°C. This means that a long period over the year outside air can be used without heating. The ventilation system will be controlled by minimum CO₂ levels. The CO₂ levels of the exhaust air are measured. In this way an efficient use of energy for ventilation will be achieved. Between incoming and outlet air a heat recovery system is placed.

3.3.3 Solar façade and roof

Two photovoltaic solar energy systems are realised in the building of the library. Together with the architect an integrated façade system has been designed. The use of this type renewable energy on a highly visible location where per year a lot of visitors will come enhances the awareness of renewable energy systems and the ECO-building concept. A PV roof system of 75 kWp is installed for a more efficient power generation.

3.3.4 Building Energy management system (BEMS)

A building energy management system controls the ventilation and the heating/cooling system. All levels of heat and/or cold usage are monitored. The electricity production of the photovoltaic energy system is also connected to the system.

3.4 Energy data and additional results

The maximum allowed energy consumption of the library that the municipality of Amsterdam wants to achieve is 606 MJ/m₂ or 168 kWh/m₂. The contributions to the overall energy savings are:

3.4.1 Long term energy storage (i.c.w. heat pumps)

- LTES heating (heat pump): Saving = 814 MWh/year.
- LTES cooling, electricity: Savings = 106 MWh/year.
- Annual saving of CO₂ for heating: 23%.
- Annual saving of CO₂ for cooling: 67%.

3.4.2 Photovoltaic system (roof and façade)

- Roof system, extra generated electricity = 56,250 kWh/year.
- Façade system, extra generated electricity = 6,000 kWh/year.
- Annual saving of CO₂: 36 tons

3.4.3 Intelligent controlled ventilation system – BEMS – Lightning

- Electricity: Savings = 306 MWh/year.
- Annual saving of CO₂: 13%.

4 The new Opera House, Oslo, Norway



4.1 Context

The Opera House will accommodate nearly 1,000 rooms and will be the workplace for over 600 people. The building is composed of three main elements: the front of the house, the back of the house and the 'roofscape'. The 'roofscape' describes the building's sloping roof surface, which rises directly from the sea level, and is surrounding the stage tower and technical tower which are breaking up the vast platform from the sea to the uppermost levels - all of which will be accessible to the public. The 'roofscape' will be clad in white marble. The front of the house incorporates all the public areas, located in the building's western section, with access from the nearby central train station. These public areas include the main foyer, a large performance auditorium with 1,350 seats and a small auditorium with 400 seats. The large auditorium is designed in classical form with a horseshoe-type plan and a high ceiling height, providing high quality natural acoustics and good sight lines to the stage. Under the main stage, there is also an under-stage area to allow lowering of the 4 stage podiums when they are replaced by the rotating stage moving in from back stage area. The small auditorium will have considerable flexibility in both stage and seating arrangements. The foyer will be a grand, open room with a variety of lighting conditions and views to the surrounding city and fjord. The space will be characterized by its simple use of materials and minimal details. A tall undulating wooden wall will define the separation between foyer and auditoriums. The production areas of the building are those termed 'back of the house'. Here one will find all the workshops, storage areas, rehearsal rooms, changing rooms, offices, and every facility necessary to produce an opera or ballet. This part of the building has four floors and one basement. The architecture and the use of materials are functionally appropriate, with the exterior façade being composed of metal panels. As the opera house is to be situated partly on land and partly over water, there has been put much effort into the foundation design, handling of polluted soil, control of moisture and the building's water tightness. To create a stable and dry working environment, the construction requires some 12,000m² of steel sheet piling around the perimeter of the site. The foundations require 28,000m² of piles to act as

supporting elements for the building above. The piles vary in length and can reach up to 55m below the water surface before meeting stable bedrock.

The project started in February 2003 and will be completed in April 2008.

4.1.1 Energy Objectives

To reduce:

- Energy consumption and CO₂ emission related to cooling by 75-80%.
- Heat consumption and related CO₂ emission by 35-50%.
- Energy for ventilation and related CO₂ emission by 35-50%.

To use:

- Renewables; sea water, ground water and solar energy.
- Intelligent control for maximised utilisation of the use technologies.

4.1.2 Solutions

Demand controlled and energy efficient distribution of ventilation, including humidity control. This results in a high maximum ventilation rate and a long running time for the plants. The users are highly sensitive to poor indoor climate and require humidity control of the air.

4.1.3 Control strategies for glass façade, light, ventilation, heating and cooling

An integrated bus system will be developed, which works on the shading, light, heating, cooling and ventilation system. The design will be developed to maximise the use of daylight, and reduce the cooling, heating and ventilation demand. The Building Energy Management System (BEMS) will be linked directly to the internet for dissemination purposes.

4.1.4 A south facing glass façade with solar cells

The Opera House has a large glazed south facing façade in the foyer. This façade causes over-heating without shading. A 400 m² solar cell grid integrated in the façade can provide both shading and electricity. With the exposed location, it will also be a demonstration of the technology to a large audience. The façade will have a great exposure to the south, the sea and the public.

4.2 Energy Data

Theoretical calculated total energy consumption is calculated to be 217 kWh/m². Without the techniques from the EC project it is calculated that it would have been 266 kWh/m². This means 49 kWh/m² savings.

ECO BUILDING/BIOCLIMATIC CONCEPT VERSUS PASSIVE HOUSE

Aleš Krainer, Mitja Košir
Faculty of Civil Engineering, University in Ljubljana
Jamova 2, SI-1000 Ljubljana, Slovenia
Tel.: +386 61 176 8604, Fax: +386 61 125 0688
E-Mail: akrainer@fgg.uni-lj.si

1 Summary

The paper deals with the concept of passive house in relation to the inside environment and compares passive house and bioclimatic design. Bioclimatic design is an integral part of eco building oriented interventions in the built environment. The main goal of the passive house is to reduce heating energy consumption to less than 15 kWh/m² per year. To reach this goal triple glazing is needed and consequently daylighting illumination is reduced. But the concept of alienating people from the natural environment is according to many studies harmful to health and consequently to productivity. The external environment is not by definition hostile to human beings; on the contrary, it can have stimulative effects on body and mind. Daylight provides quality lighting, stimulates the sense of sight and is an important communication mode between the internal and external space. The constant change of light improves concentration and responsiveness. The same holds true for acoustic environment, aural perception and sense of smell. The bioclimatic concept is based on simultaneous adaptation to the external conditions as well as internal needs and requirements. The closer the building is able to follow these two profiles and the better the communication coordination between them, the more efficient it is. The adaptive model of the built environment system represents the dynamic structure which performs in real time conditions. The objective of the above described interventions in the framework of bioclimatic design is healthy living and working environment with the lowest possible energy use, and not the lowest energy use based on the physiological minima.

2 Introduction

Lately we have been witnessing apparently incomprehensible development of events connected with the world's climate conditions. It seems that the climate change trends are causing changed conditions in living and working environment and are influencing the health of faunae and flora. Part of this system is also human beings. These changes have been caused by unbalanced exploitation of material and energy.

Care for sustainable development is explicitly defined as an important strategic task of EU and its member states. It must find its place in the development orientation of all sectors, including construction sector. Passive house is declared as what we call sustainable construction in the embrace of politically popular expression „sustainable development“. Being put in force in the Rio Declaration on Environment and Development, it means complete balance of economic, social, environmental and health development aspects.

Contemporary passive house focuses on the economy and partly environmental components while the social and health view are intentionally or unintentionally left out. Considering the studies which scientifically prove negative influences of diminished daylight, insufficient ventilation based on physiological minima with planned large amount of expected nonsatisfied occupants, we can define passive houses as distinctly nonsustainable. "Nonsustainable are all human activities which have negative influence on the environment, health and life of people and can not be performed in the future. If it is

estimated that human activity is nonsustainable in the future it must be sustained and can not be executed." [1]

According to Selkowitz from Environmental Energy Technologies Division, Lawrence Berkeley lab, there is an interesting relation between the yearly energy costs for an employed person per m² which is USD 20, and the expense for an employed person per m², which is USD 2000. [2] Even a small improvement of productivity or reduction of absence owing to illness is much more cost efficient than energy saving which is expressed either in lower or higher temperatures and daylight illumination disturbances.

Bryan [3] presented the case where a 0.5% higher productivity covers all expenses for heating and a 6.6% higher productivity covers all expenses for the whole building.

3 Health

Cardiovascular health requires periodical exercises where human body is frequently exposed to considerable physical discomfort. Stoops [4] maintains that short-term pain and discomfort have in long-term positive influence on health. He is asking whether too much bounded standards for thermal comfort have not in fact in long-term negative influences on human health. To define thermal comfort and satisfaction it is definitely not enough to say this is something which is neither like this nor like that, as used in Fanger's thermal comfort scale: neither cold nor warm! Parts of free-time activities are connected with physical discomfort: skiing in low temperatures in the winter, roasting in the sun in the summer. The same holds true also for other kinds of perception from visual to audible environment. While people expose themselves to thermal discomfort, which does not happen accidentally or because of some kind of masochistic inclinations, some experts believe that it is necessary to assure in buildings, in living and working environment, such temperatures that decrease the percentage of thermal discomfort or to assure thermally neutral environment. This fits perfectly with simplified steady state thermal analyses. A study by the American Medical Association and the US Army (1990) revealed that the consequences of health problems caused by poor internal air quality (IAQ) cost USD 150 M in work days per year and USD 15.000 M in lost productivity per year.

Apparently similar case is ventilation rate. Here the lowest rate is required in practically all legal interventions, based on the quantity of CO₂ in the air. This is a very grateful parameter for the calculations of thermal requirements and everybody is using custom lowest required value of $n = 0.5$ to 0.7 as default value. Unfortunately there is a catch, since this value is not accepted by 30% of users who feel under this condition neither good nor neutral but bad! Such instrument can not be a measure of energy efficiency in the built environment. Basically, CO₂ control can be an efficient mode for ventilation control. But washing of air and other kinds of air treatment with the intention to reduce energy use are not acceptable in normal outside conditions. What is necessary is to assure and maintain clean and fresh air. If the trends do not change we will get, because of "economic" reasons, gas masks, and "energy efficiency" promoters will use all kinds of feints to convince crowds that this is the best solution.

4 Daylight

Daylight is, compared to other lighting sources, the most energy efficient source of illumination. The right to light was settled already in Roman Law. In the industrial revolution the limitation of this right arose as collateral damage and today its limitation found the excuse in the market iconography. The argument for efficient use of daylight is not only energy saving but first of all health and visual comfort, higher productivity and connection with sky dynamics. Psychologists and experts for performance efficiency have

long ago discovered that something as simple as daylight assists to more efficient work, to learn more, to diminish absence from work because of ill-health and to increase sales in shops.

The first contribution of daylight is reduction of energy use. Early studies in the USA in late 70ties reveal possible savings between 15 and 20%. As an example an average shop in LA can save USD 16.000 per year or USD/m² 3.2, typical elementary school USD 7.500 per year or USD 3.2 per m², air-conditioned office building with intensive illumination USD 7.5 per m². In Costco Store the installation of skylights on 5% of 15.000 m² caused annual energy saving of 0.15 kWh/m² per year or USD 23.000 per year.

The average sale with daylight lighting can rise from USD 0.2 per m² to USD 0.26-0.29 per m². Heschong Mahone Group determined 40% average increase in sales in daylit stores in their study of sales performance performed for 108 stores (2/3 daylit, 1/3 not).

What is of most interest is the influence of daylight on health and directly or indirectly on productivity. According to Lorna Rosenberg [5], daylight increases the productivity by almost 7% and personal control of temperature by 3.6%. In schools the results of tests are 20% better, in offices the productivity is increased by 2-16% and there is 15-40% less absences from work. Between USD 12.000 and 125.000 M can be saved by improving worker performance through enhancing the thermal environment and the lighting. The above mentioned Heschong Mahone Group studied the effects of daylight on students' performance. In classrooms with the most daylighting students progressed 20% faster on math tests and 26% faster on reading testes, and the test scores were 7-8% higher. In classrooms with the largest window area the students were 15% faster in math and 23% faster in reading, in classrooms with well-designed skylight students improved 19-20% faster and in classrooms with windows that could be opened they progressed 7-8% faster. The conclusion of the study was that "the effect of daylighting on students' performance in schools is consistently positive and highly significant, and that daylighting can only add to a child's educational experience".

5 Case study

In European technical specifications exclusively the documentation of energy consumption is requested as restrictive measure, while for example USA Energy LEED gives priority to healthy and comfortable environment before energy saving.

To find out what is the relation between thermal and daylight balance a comparative analyse was made. [6] First the variation of energy for heating was compared to the changes in illumination level in 27 randomly selected buildings. The results and variables are shown on Figure 1. Because of the improvement of thermal insulation of windows from 1.4 to 0.6 W/m².K, average energy use in 27 buildings for heating was reduced by 15% but at the same time the share of daylight illumination was reduced by 25%.

The influence of double and triple glazing on specific annual energy use for heating and daylighting was treated also on a sample building. The structure of double glazing by U value of opaque part of the envelope 0.15 W/m²K and air change n=1 was: glass 4 mm + argon 15 mm + glass 4 mm, U=1.12, g=61%, τ_v = 76%, and the structure of triple glazing: glass 4mm + argon 12 mm + glass 4mm + argon 12 mm + glass 4mm, U = 0.74, τ_v = 66%, g = 50%. For the treated types of glazing Pilkington Spectrum v02.01.01 application was used which considers for the calculation of U, τ_v and g standards EN 673, and EN 410.

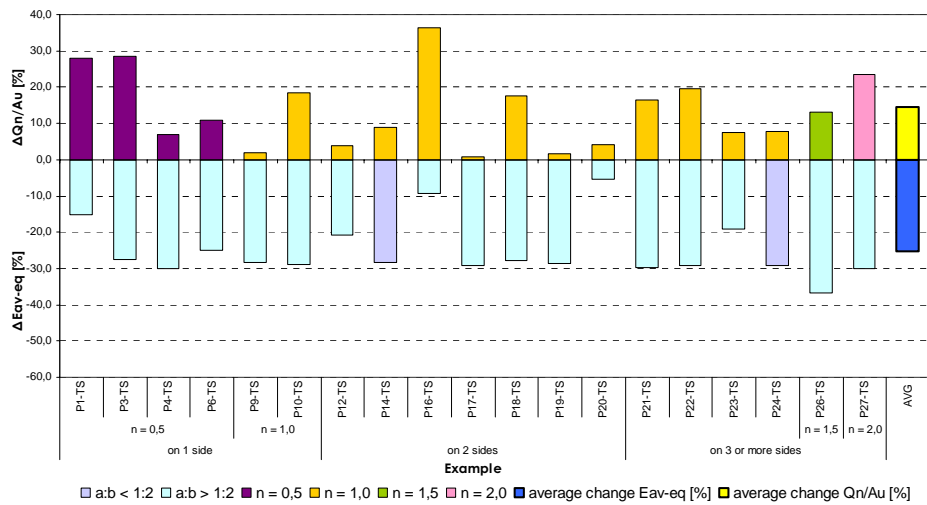


Figure 1: Comparison of heating energy reduction (+ %) and consecutive daylight reduction (- %) between windows with $U = 1.4 \text{ W/m}^2\text{K}$ and $g = 0.65$ and windows with $U = 0,6 \text{ W/m}^2\text{K}$ and $g = 0.5$ in 27 randomly selected buildings.

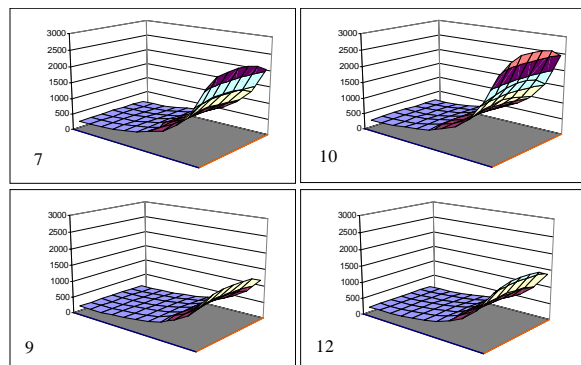


Figure 2: Comparison of daylight illumination, window 42% of room floor area:
 7 - Triple glazing, clean glass, incidence angle 90° , 10 - Double glazing, clean glass, incidence angle 90° , 9 - Triple glazing, dirty glass, real incidence angle, 12 - Double glazing, dirty glass, real incidence angle.

It must be stressed that the data presented in the technical documentation material are valid for normal (90°) incidence and clear glass. The factor for the reduced transmittance in an urban environment on account of angle of incidence is 0.8 and for the influence of dirt also 0.8. According to the available data there is no glazing system available with g-value higher than 0.5 together with U-value between 0.58 and 0.78 $\text{W/m}^2\text{K}$, as defined in one of the basic Passive House requirements. The comparison of illumination levels using ideal and reduced data is presented in Figure 2.

The specific energy use for heating was in the case of the smallest permitted window, according to Slovenian regulation, opening with double glazing 68.33 kWh/m².a and in case with triple glazing 67.80 kWh/m².a. Practically for the same quantity of needed energy, in both cases the only result of the replacement of double glazing by triple glazing was that the average level of daylighting was reduced by 13-15% with all the related consequences. Under such circumstances any "economic" analysis is absurd!

In the case with the largest window opening the specific energy consumption for heating was with double glazing 59 kWh/m².a and with triple glazing 55 kWh/m².a, i.e. reduction by 7%. But at the same time annual average daylight illumination was reduced by 14% in ideal conditions presented by glass producers with clean glass and incidence angle of solar radiation of 90°. In real time conditions, where factors of dirtiness on glass and incidence angle of solar radiation were taken into the account, daylight illumination is reduced by 38%. (Figure 1.)

6 Conclusion

Our primeval conceptions about shelter are threatened when an excluding system is used in the design of living environment and where the goal - hidden or unhidden - is maximal restriction of communications of thermal and light flows, of visual and sonic communications in order to reduce thermal energy use. Architectonic active spaces and constructional functional zones are more than a sum of physical parts, they are interconnected and dependent whole.

Interventions for the reduction of window's U value have no sense at the momentary technology level of glazing because the amount of the transferred daylight is disproportionally reduced in comparison with the reduction of energy for the heating. This holds true even more if we take into account collateral consequences on health and productivity. Bioclimatic principle is connected by the self sufficiency, decentralisation and autonomy, awareness of limited resources and enjoyment of natural da-sein.

The use of calculation of single parts of interactions between the inner and the outer environment as the only criterion in the process of building design can have absurd influence on architecture and is unacceptable. The envelope as an interface must enable positive communications between these two. It can not be a closed box whose purpose is prevention of any kind of communication, but it must be an active system, regulator of changes between the natural and artificial environment, changes which are unavoidable, desirable, encouraging and numerous.

7 Literature

- [1] Towards Sustainability: a European Community Programme of Policy and Action in Relation to the Environment and Sustainable Development, 1992,
- [2] **Peyton, C.**, 1999, Sunlight could perk up kids' grades, store profits,
- [3] **Bryan, H.**, 2007, Solar Today, American Solar Energy Society,
- [4] **Stoops, J.L.**, 2004, A possible connection between thermal comfort and health, Lawrence Berkeley National Laboratory, University of California,
- [5] **Rosenberg, L.**, 2003, Health Benefits of Green Buildings, US Environmental Protection Agency,
- [6] **Krainer, A., Košir, M., Kristl, Ž.**, 2006/2007, 27 students: seminar Building, Environment, Energy, Faculty of Civil Engineering, University in Ljubljana.

Tools for Supporting Ecobuildings

BRITA IN PUBS WP2: RETROFIT DESIGN GUIDELINES

Kari Thunshelle
Norwegian Building Research Institute
P o Box 124 Blindern, 0314 Oslo
Tel.: +47 22 96 55 30, Fax: +47 22 69 94 38
E-Mail: kari.thunshelle@sintef.no

1 Background

Innovative technologies and low energy solutions in the building industry are well known, but are often not preferred in refurbishment of public buildings. Lack of knowledge, cost and maintenance are some of the known restraints.

The BRITA in PuBs project is an EU-supported integrated demonstration and research project that aims to increase the market penetration of innovative and cost-effective retrofit solutions to improve energy efficiency and implement renewable energy in public buildings all over Europe. The project demonstrates the solutions by exemplary retrofit of eight demonstration public buildings in four European regions. The research issues include a socio-economic research study identifying real project-planning needs, financing strategies, the development of design guidelines, the development of an internet-based knowledge tool on retrofit measures and case studies and a quality control-tool box to secure a good long-term performance of buildings and systems.

The ECO-BUILDING concept is expected to be the meeting point of short-term development and demonstration in order to support legislative and regulatory measures for energy efficiency and enhanced use of renewable energy solution within the building sector, which go beyond the Directive of the Energy Performance of Buildings (EPBD).

In order to provide right and exact information about retrofitting innovation in public buildings to the actors of the decision process, the BRITA project has developed a set of guidelines. The guidelines are designed to support the decision-makers in the choice of energy efficient and sustainable solutions.

2 Another set of guidelines – what is different?

2.1 Socio-economic study

The guidelines are based on results from the socio-economic analysis on barriers and needs performed in the Brita in PuBs WP1. A central focus in the study was to identify who the real decision makers are, and then identify the most valuable information in order to accomplish innovative solutions in refurbishment of public buildings.

2.2 Experience

The Brita guidelines are based on experience from the Building Research Design Guides, the national knowledge base for the whole building industry in Norway. This knowledgebase is developed through the last 50 years, and the leader of WP2 is experienced on this kind of work.

2.3 Literature study

Before starting out writing the guidelines, a literature study was performed. What does already exist of guidelines on similar subjects, and how are their approach compared to the results from the socio-economic study were important questions. What are good ideas to bring further, and where are the needs for changes? Based on these results content, form and structure were worked out for the Brita guidelines.

2.4 Practice

The guidelines also include examples on how to use low energy and renewable technologies and experience from operation and maintenance. The examples are from the demo buildings in the Brita projects or other best practice examples.

3 Titles and content

3.1 Titles



Figure 1: Examples on the final guidelines

The Guidelines are written as individual pamphlets on different technologies and overall themes:

- 0 Introduction chapter
- 1 Interdisciplinary approach to sustainable build environments
- 2 Energy simulation tools for buildings
- 3 LCA Guidelines in the building sector
- 4 Innovative insulation
- 5 Advanced energy efficient windows
- 6 Passive solar heating
- 7 Reduction of overheating –passive strategies
- 8 Hybrid ventilation
- 9 Improved day lighting
- 10 Solar thermal systems
- 11 Solar heating and cooling of buildings
- 12 Integration of PV in the build environment
- 13 Heat-pumps

The introduction chapter include short description of each of the other guidelines, how to read the guidelines, and an overview of the usability of the solutions in different type of buildings.

3.2 Content

The idea is to provide right and to the point information to the persons involved in the decision process to help them chose energy efficient and sustainable solutions.

The introduction chapter include short description of each of the other guidelines, how to read the guidelines, and an overview of the usability of the solutions in different type of buildings.

The guidelines on interdisciplinary approach, Energy simulation tools and LCA are all more overall and general guidelines. Other guidelines are written technology by technology. Generally the guidelines are structured as follows:

- Introduction – why use this technology?
- Requirements in regulations and standards
- Current practise
- Overview of different types of innovative solutions, including sketches
- Advantages/disadvantages
- Costs and Energy saving potential
- Maintenance and service
- Best practise examples
- Calculation guidelines, tools
- Reference to further reading.

4 High quality guidelines

4.1 Review

The first drafts of the guidelines were ready already by the 18 month milestone of the project. Each of the guidelines is then reviewed by 2-3 international experts on the subject. This to ensure that the quality of the content is at a high scientific level and frontline information is included.

4.2 Easy understandable

The guidelines are also reviewed by demo partners in the Brita project or other real project partners. This to ensure the guidelines are easy understandable, include to the point information and is not written in a too scientific language.

4.3 Usable solutions

The guidelines do not only describe front edge solutions, they also include information about usability of the solutions. Experience from best practice examples in demo buildings, therein advantages/disadvantages and operation/maintenance is included. Each of the solutions in the guidelines has been assess by the authors upon usability for different type of buildings. The overview is included in the introduction chapter.

5 Publication and use of the guidelines

5.1 Web site

The Guidelines are published on the Brita web-site www.brita-in-pubs.eu. The guidelines are written as individual pamphlets and can be downloaded as PDF files.



Figure 2: Guidelines available as PDF's at www.brita-in-pubs.eu

5.2 Newsletters

The guidelines have been published in groups over the last year. 4 newsletter articles have been written to give short presentations on each guidelines. The articles are published and distributed through the Brita newsletter and information channels.

5.3 Input to other Brita WP's

The finished guidelines are used in several of the other work packages (WP's) in the Brita projects. PDF's and questions with answers developed for each guideline are used in e-learning systems and student courses developed within the project. The PDF's are also used in the Brita knowledge based internet tool, the BIT.

6 Literature

Thunshelle, K et al.: "Socio-economic analysis on barriers and needs". EU 6FP Bringing Retrofit Innovation to Application in Public Buildings – BRITA in PuBs (TREN/04/FP6EN/S.07.31038/503135). Report D5 (2005). Available at www.brita-in-pubs.eu

Thunshelle, K. et al : "Handbook of design guidelines, tools and strategies for low energy refurbishment of public buildings" EU 6FP Bringing Retrofit Innovation to Application in Public Buildings – BRITA in PuBs (TREN/04/FP6EN/S.07.31038/503135). Report D16 (2008). Available at www.brita-in-pubs.eu

Guidelines included in the D16 Handbook of design guidelines:

- Thunshelle, Kari; Erhorn, Hans** Introduction chapter
- Buvik, Karin et al** Interdisciplinary approach to sustainable build environments (2007)
- Beccali, Marco** Energy simulation tools for buildings (2007)
- Ardente, Fulvio et al:** LCA Guidelines in the building sector (2007)
- Erhorn-Kluttig, Heike** Innovative insulation (2007)
- Thomsen, Kirsten Engelund** Advanced energy efficient windows (2007)
- Buvik, Karin; Hestnes, Anne Grete:** Passive solar heating (2007)
- Triantis, Euphrosyne** Reduction of overheating –passive strategies (2007)
- Jicha, Miroslav** Hybrid ventilation (2007)
- Athanassakos, Eva** Improved day lighting (2007)
- Ferrari, Simone; Adhikari, Rajendra** Solar thermal systems (2007)
- Beccali, Marco** Solar heating and cooling of buildings (2007)
- Fuentes, Manuel** Integration of PV in the build environment (2007)
- Kaklauskas, Arturas et al** Heat-pumps (2007)

BRITA IN PUBS WP 3: QUALITY CONTROL TOOLBOX

Timo Kauppinen
VTT
PO Box 1100, FI-90571 Oulu Finland
Tel.: +358 20 722 2013, Fax: +358 20 722 2090
E-Mail: timo.kauppinen@vtt.fi

1 Introduction

The objective of this work package was to develop a quality/performance control tool-box model – a concept from design to post construction life long management, using also BEMS/REMS-type procedures and prevailing methods. Quality control toolbox concept is based on previous studies on commissioning of performance characteristics and energy efficiency of buildings. All major stages of a renovation project has described, which are put into practice by using new auditing tools e.g. **review or checking lists**.

In the quality control toolbox concept all the stages of construction process are considered. The early stages are emphasized on the owner's and users' needs and requirements, which are also considered through the whole process. After setting up system goals, implementing the goals and verifying the performance, indoor climate and energy consumption are managed and monitored as a long term basis for the whole life cycle of the building.

2 Objectives of the work packages

The energy efficiency of the buildings should be confirmed in all major stages of a renovation project (figure 1):

1. Planning and design
2. Implementation and
3. Use, operating and maintenance

The objective of WP3 was to develop:

A quality/performance control toolbox – a concept from design to post construction life long management. The toolbox is to be developed in internet based form. The toolbox includes preliminary risk-management and energy/life-cycle cost calculations model for the design and planning stage, commissioning and quality control procedure for implementation stage,) and a web-based energy and facility monitoring system, both energy audit model for ascertaining the performance of the buildings

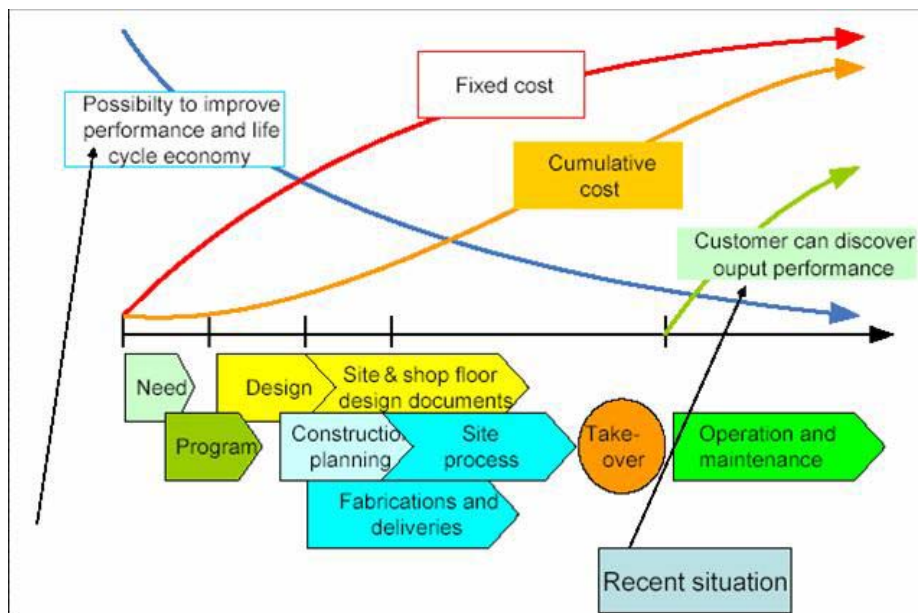


Figure 1: - Building performance vs. energy efficiency

Deliverables:

Documentation of the quality control toolbox including:

- Risk analysis and life cycle cost concept/model
- Energy audit procedure with recommended measurements
- Concept for operation and service manual
- Facility management tool covering energy benchmarking, design, monitoring and quality control procedures.

3 Building commissioning (Cx)

The basic idea of the new quality control toolbox concept is to ensure that owner's and users' needs and requirements are met as agreed. First, at the beginning of the renovation project goals are established and the owner's and users' needs are determined. Second, the system requirements are set with the help of design procedures. Third, the goals are implemented and performance is verified in the elaboration and construction phases. Finally, indoor climate and energy consumption is managed with new building automation and online reporting systems. The basic phases (red diamonds 1-7) of the quality control toolbox concept are described in figure 2

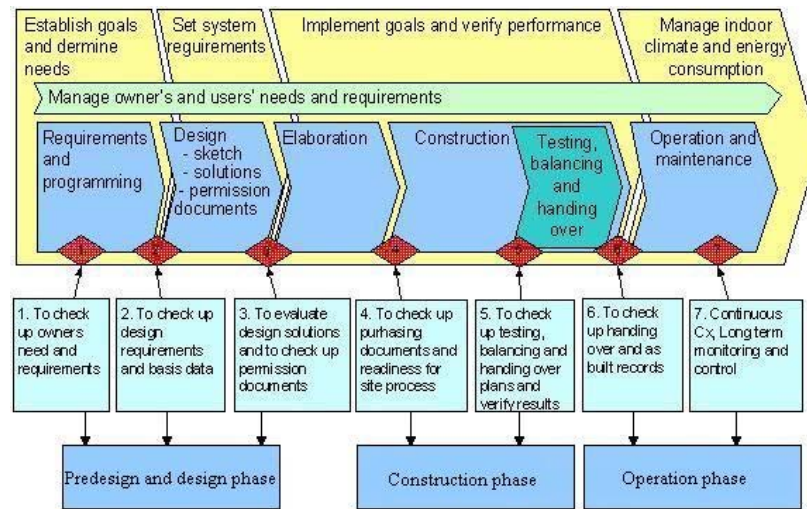


Figure 2: The basic stages of Quality Control Toolbox

3.1 Checklists

The purpose of the performance and energy efficiency checklists is to support and be a tool for quality control and commissioning agent when planning commissioning and quality control actions and subproject specific checking lists.

The aim is to confirm and verify the integration of various systems in terms of indoor air quality, thermal comfort and energy efficiency.

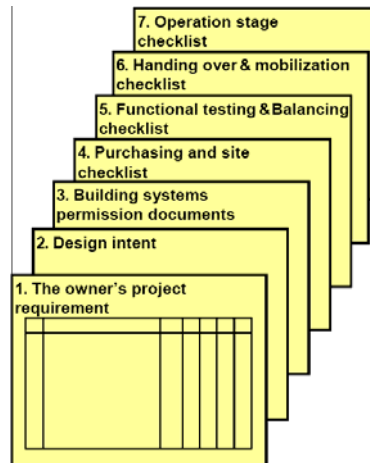


Figure 3: - Example on the checklists

3.2 Operation and maintenance manual

Maintenance manual can be determined as a file of detailed documents and information that are needed in maintaining a building or a real estate during its lifetime. There are several advantages that can be reached by creating good quality maintenance manual and using it regularly.

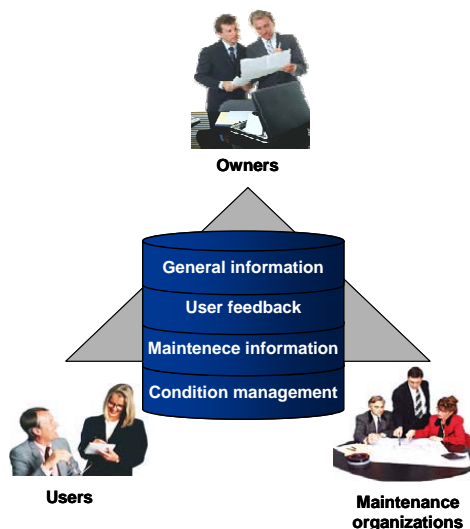


Figure 4: - Modern facility maintenance databank can be utilized in real time by different facility interest groups. Data available for different interest groups can be determined and restricted.

3.3 Life cycle costs

Life cycle costs of a building are regarded to consist of the following elements:

1. Acquisition costs
2. Operation and maintenance costs
3. Repair and replacement costs

Acquisition costs include all the costs caused by the acquisition of a new building or a renovation/refurbishment of an old building.

An example of the results of renovated school building life cycle cost estimation is shown in *table 1*.

Table 1. An example of the results of life cycle cost calculation for renovated school building (present value). Economic lifetime of the building 40 years and interest rate 6%. Residual value has been left out of the calculation.

Acquisition costs	Operation and maintenance costs	Repair and replacement costs of building parts	Total life cycle costs
1 300 €/m2	1 100 €/m2	200 €/m2	2 600 €/m2
(50 %)	(42 %)	(8 %)	(100 %)

3.4 Risk evaluation

In this concept model the focus will be mostly to technical risks dealing with energy performance of renovated buildings using s.c. risk-number method:

The drawbacks of a system will be estimated using the following criteria (table 2).

Seriousness, S	Numerical value	Probability of detection, Pd	Numerical value	Probability of occurrence, Po	Numerical value
No influence (Category 1)	1	Drawback always detected	1	Occurrence of drawback improbable	1
Category 2	2,3	Category 2	2,3	Category 2	2,3
Category 3	4,5,6	Category 3	4,5,6	Category 3	4,5,6
Category 4	7,8,9	Category 4	7,8,9	Category 4	7,8,9
Health risk	10	No detection of drawback	10	Very probable	10

Table 2. Criteria of the drawbacks

3.5 Energy audit procedures

The energy audit model is based on the procedure created by MOTIVA that is public organization under Ministry of Trade and Industry. MOTIVA controls the energy audits in Finland. Before energy audit a benchmarking study can be carried out - comparison between the analysis target and the statistics based on the results of benchmarking, one can make conclusions if energy audit is needed or if only some targeted measurements or checking's must be done.

4 Literature

Pietiläinen, J, Kauppinen, T, Kovanen, K, Nykänen, V, et al. 2007. ToVa-käsikirja (Building Commissioning Handbook). Rakennuksen toimivuuden varmistaminen energiatehokkuuden ja sisäilmaston kannalta. Espoo:VTT. (VTT Research Notes 2007)

THE BRITA IN PUBS INFORMATION TOOL – CASE STUDIES, RETROFIT MEASURES AND PERFORMANCE RATING TO FIND THE BEST RETROFIT CONCEPTS FOR PUBLIC BUILDINGS

Heike Erhorn-Kluttig
Fraunhofer Institute for Building Physics
Nobelstraße 12, 70569 Stuttgart
Tel.: +49-711/970-3380, Fax: +49-711/ 970-3399
E-Mail: hk@ibp.fraunhofer.de

1 Background

The BRITA in PuBs Information Tool is being developed within the EU 6th Framework integrated project “Bringing Retrofit Innovation to Application in Public Buildings - BRITA in PuBs”. The project has its main focus on the design, realisation, monitoring and documentation of eight demonstration buildings. All of the demonstration buildings are public buildings that have been energy retrofitted beyond national requirements. The retrofit concepts foresee that the energy demand of the building will be reduced by factor 2 due to the retrofit. This aim was realised by applying thermal insulation, improving the energy efficiency of the building systems and by integrating renewable energy. At the same time, the user satisfaction rate shall be significantly improved.

Besides the demonstration, the project has smaller parts on socio-economic research and training and dissemination. All tasks within the project are inter-connected, so for example the BRITA in PuBs Information Tool is based on the results and lessons learned from the demonstration buildings; moreover, it also offers information material (such as the retrofit design guidelines) that was developed in other work packages. The tool is available for download on the project website www.brita-in-pubs.eu. Currently the β -version of the tool is being presented there, which already gives very good insights in the tool structure and the different information types that will be available. With the completion of the project phase end by the of April 2008, the final version of the tool will become available. The tool is a further development of an IEA project result, namely the ECBCS Annex 36 “Energy Concept Adviser” that dealt with educational buildings (www.annex36.com).

The tool is targeted to assist decisions makers and their technical support in public administrations. It will provide information and give inspiration to facilitate the decisions to be taken, namely which buildings to select for retrofitting and what measures to include in the retrofit concept.

2 The different types of information offered

The tool's title page is presented in Figure 1. The tool is structured in the following three main parts:

- the case studies with descriptions and reports of more than 40 retrofitted demonstration buildings
- the retrofit measures with descriptions and design guidelines for different types of energy saving measures
- the performance rating, which offers the possibility to compare the energy consumption of a particular building to those of similar buildings within your country.

Additionally the contributors to the tool are specified in the contact list. The case studies and retrofit measures are presented in a clearly arranged matrix that shows which retrofit measures have been applied to which demonstration building. The matrix is presented in Figure 2 and can be sorted by country and retrofit measure type.

2.1 The Case Studies

More than 30 case studies have been summarised in the same, uniformly structured manner in the IEA Annex 36 project “Retrofitting of Educational Buildings”. The 8 demonstration buildings of the BRITA in PuBs project have been added accordingly. For all case studies the following headers have been filled out with information:

- general data (project address, project summary and retrofit features)
- site and typology
- before retrofit (building construction, heating, ventilation, cooling and lighting systems, problems, damages)
- retrofit concept (general, building construction, heating, ventilation, cooling and lighting systems)
- energy savings (heating and electrical energy)
- user evaluation
- renovation costs
- lessons learned and resulting design guidance
- additional information (references such as reports, acknowledgements, links)

Photos of the buildings taken before, during and after the retrofit, of details and building systems, floor plans and schemes visualise the projects, supplemented by tables specifying U-values comparisons before and after retrofitting and tables on energy savings and costs. Figure 3 presents one page extract of the case study community centre Borgen in Norway. The realised and analysed demonstration projects described shall give insights in successful energy saving retrofits, but also present the lessons learned including occurring problems during and after the retrofit. By summarising the energy savings, the costs and the user evaluation the reader gets the complete picture of the project. More extensive information is given in pdf-reports.

2.2 The Retrofit Measures

Besides the information on realised projects, different types of retrofit measures are explained in the part ‘Retrofit Measure Viewer’. The measures are grouped according to the following types:

- building envelope (windows, doors, insulation material, walls, roofs, ceilings/basements)
- heating systems (heating, domestic hot water, energy sources, controls)
- ventilation systems (natural ventilation, mechanical ventilation, hybrid ventilation, control & information)
- solar control and cooling systems (shading and glare protection, cooling systems, air-conditioning, control systems)
- lighting (lighting systems, electrical appliances, daylighting technologies, control systems)
- renewables (biomass, heat pumps, photovoltaics, solar thermal)
- management (energy auditing, commissioning, education & training, non-investment)

All retrofit measure types include an introduction and an innovation part with new developments in the respective field. Similar to the case studies, the text information is accompanied by photos, graphics and tables. Further information can be obtained by

reading the pdf-reports out of Annex 36 and by studying the offered relevant retrofit design guidelines developed within BRITA in PuBs.

2.3 The Performance Rating

How does a specific building rate against buildings of the same type in the same country? Which of the many buildings a community owns has the biggest need to be retrofitted? The performance rating section within the BRITA in PuBs information tool offers a valuable comparison tool to answer these questions. By selecting one's own country (from among the Czech Republic, Denmark, Finland, Germany, Greece, Lithuania, Italy, Norway and the UK) and choosing the relevant building type out of 19 different possibilities, the tool gives benchmarks for the comparison of the heating energy, electricity and water consumption of public buildings. The tool visually contrasts the inserted consumptions with the national average, just like high and low consumptions of similar buildings. The underlying data for this has been provided by the national participant in BRITA in PuBs. The exact source is indicated in the tool. Figure 5 shows a screenshot for a comparison of Finnish hospital data.

2.4 Info & Contact

Information on the experts and organisations from 9 different countries who participate in the project is given in the 'Info & Contact' part, along with their contact e-mails.

3 Literature

Erhorn-Kluttig, H. et al, (2008), The BRITA in PuBs Information Tool, EU 6FP Integrated Project Bringing Retrofit Innovation to Application - BRITA in PuBs, available at www.brita-in-pubs.eu

Erhorn, H.: et al, (2004), The Energy Concept Adviser, IEA Annex 36 Retrofitting of Educational Buildings, available at www.annex36.com.

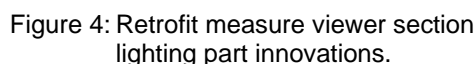
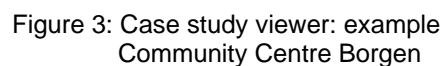
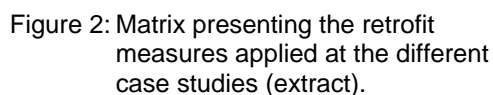
Citterio, M. et al, (2008), 8 Reports on the Realisation and Validation Analysis of the Demonstration Buildings in BRITA in PuBs, EU 6FP Integrated Project Bringing Retrofit Innovation to Application - BRITA in PuBs, soon available at www.brita-in-pubs.eu.

Thunshelle, K. et al, (2008), The BRITA in PuBs Retrofit Design Guidelines, EU 6FP Integrated Project Bringing Retrofit Innovation to Application - BRITA in PuBs, available at www.brita-in-pubs.eu.

4 Acknowledgements

The project has received funding by the European Commission within the 6th Framework Programme under the contract no. TREN/04/FP6EN/S07.31038/503135.

The content of this document reflects the authors' view. The authors and the European Commission are not liable for any use that may be made of the information contained therein.



INTEGRATING BMS AND SIMULATION TOOLS FOR MONITORING AND PERFORMANCE ANALYSIS

Ursula Eicker, Dirk Pietruschka
University of Applied Sciences, HfT Stuttgart
Schellingstrasse 24, D-70174 Stuttgart, Germany
Tel +49.711.8926.2831, Fax +49.711.8926.2698
ursula.eicker@hft-stuttgart.de

1 Introduction

Control related problems significantly contribute to high energy consumption in office and commercial buildings. Today, building management systems (BMS) are commonly designed to control the technical building equipment in order to reach comfortable climatic conditions in the controlled spaces. This setpoint orientated control strategy does normally not contain any active supervisory instruments to control the energy consumption of the building. As a consequence, no error messages will occur as long as the setpoints are reached, sometimes even if in the worst case the cooling and heating system are working against each other. Furthermore, standard BMS control algorithms are only able to detect abrupt changes in the conditions of e.g. HVAC-Systems, but they do not offer significant fault detection and diagnostic information and are unable to detect gradual degradations in system performance (Buswell R.A. et. al., 2003 and others). On the other hand, dynamic simulation tools are so far only used during the planning phase for the building design and the dimensioning of the technical equipment like the heating and cooling system. Control algorithms are then well developed under consideration of simulation results and the planned equipment, but the implementation is later normally done by system engineers of the chosen BMS company. Due to information losses interpretation and implementation errors are nearly unavoidable and lead to suboptimal system control. To reduce such problems new strategies are required to directly implement well tested control algorithms from simulation programs into the building control system. During building operation the simulation tools can then e.g. be used in the energy management system for online simulation and control, e.g. to check the control actions and measurement data against the simulation results (Clarke, J.A. 2004; Gouda M.M. 2003; Hao, X. 2005 and others). Using the means of information technology, control and simulation actions can also take place at different locations, so that there are apart from usable software interfaces no additional requirements on site for the building automation system.

2 Innovations in building management systems

2.1 Energy consumption control

Building management systems are commonly used for the control of the building and its energy supply systems and only in some cases additionally for the monitoring of the cooling and heating energy consumption of the building. Since the energy consumption depends strongly on the outside conditions like temperature and solar irradiation, a simple monitoring provides no detailed information whether the system and the building control works properly and energy efficient. If a standard energy management system is installed, at least the yearly or even monthly energy consumptions of the building are compared to historical energy consumption data using degree day normalisation methods. However, since only historical data of long time periods are analysed, this is more a passive than a real active energy management tool.

2.2 Model based control

For the implementation of an active energy management system the monitoring data of the building and plant performance should be compared to predicted values in daily, hourly or even shorter time periods calculated by simulation models under consideration of the real operation conditions like weather data and time schedules for the utilisation of rooms or the building itself. Instead of a comparison of measured and predicted energy consumption, the models can also be used for the active control of the building and the heating, cooling and ventilation systems. Such applications are for example:

- Optimisation of heating up / cooling down periods after night time or weekend energy saving time or for partly used rooms under consideration of the internal building mass.
- Energy optimised strategies for the control of the sunshading system in order to increase solar gains and to prevent overheating under consideration of the building envelop properties und internal mass.
- Control of passive or hybrid cooling systems during the night time using the ventilation system or automated window openings.
- Control of solar driven absorption /adsorption cooling systems using weather forecast data. Cooling of rooms below a certain setpoint (to e.g. 22 °C instead of 24°C) if the weather conditions are optimal for a solar cooling system.

For the implementation of such a model based control system, online simulation models of the building and the plants have to be developed and validated against measurement data. The main question which has to be considered and clarified is the necessary level of modelling detail to meet the required accuracy for the planned control implementation. Do we need in all cases dynamic models, how simple can a dynamic model be, which time steps are required for the planned control action etc.. In case of the building detailed static calculation methods according to DIN EN 832 or DIN V 18599 can be used for the calculation of the energy demand of the building in monthly or with small adjustments in the calculation methods even daily mean values. For shorter time periods in time steps of one hour the building dynamic caused by the internal mass has to be considered in order to reach comparable result for the cooling and heating energy demand. This requires more or less detailed dynamic building simulations. In a first approach a simple model, based on an extension of the steady state calculation methods, will be developed and tested.

2.3 Communication infrastructure for the implementation of model based control systems

For the implementation of a model based control system a software interface to the installed BMS is required. The proposed system runs on a PC separately from or parallel to the BMS and can be located on site or centrally in the office of an energy management agency. In any case, the measured data and setpoints collected by the BMS need to be transferred to the model based control system. The possible solutions for the data transfer strongly depend on the installed BMS and the available interfaces. In the easiest case the BMS provides an interface which transfers the measured data directly on a DataSocket/OPC or ftp server. If the BMS provides only an interface which writes the measured data into a database on the PC, an additional database reader and writer software is necessary to read the necessary data from the database and write it on a DataSocket/OPC or ftp server. For the transfer of measured data to the online simulation models, a DataSocket/OPC or ftp client (reader) and a corresponding server have to be installed (software installation) on the PC which is connected to the BMS-System and to an internet/modem connection. DataSocket/OPC or ftp clients (reader and writer) have to be

installed on a PC of the energy management agency as well. The reader client reads the necessary measurement data via internet or modem connection from the DataSocket/ OPC or ftp server running on the PC who is directly connected to the BMS on site and passes them to the online simulation tools running on the PC of the energy management agency. The simulation results are then written back to the server running on the PC on site. Additionally, the calculated output performance is compared with the measured performance of the building. If the deviation between measurement and simulation exceeds a certain threshold, additional warning messages and control actions can be written back to the DataSocket or OPC Server running on the PC on site. DataSocket and OPC are provided by National Instruments amongst others.

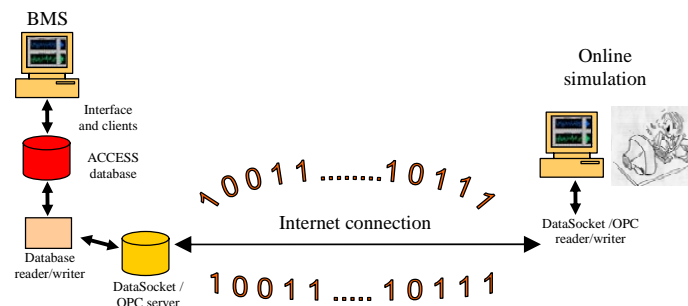


Fig. 1: Communication structure for model based fault detection scheme

3 Applications within the SARA project

3.1 The project and buildings analysed

The project SARA involves the demonstration of 7 sustainable buildings with different public functions, two training centres, one in France and one in Uzbekistan, a supermarket in Slovenia, a healthcare centre in Barcelona, an educational office building in the UK, a municipality office building in Italy and a office building with exhibition halls in Austria. Within the SARA project the main tasks of the zafh.net research centre in Stuttgart are the analysis and improvement of the implemented BMS control strategies and the development and integration of intelligent online simulation tools. These simulation tools focus on the energy demand of the buildings and on parts of the integrated energy



supply equipment like PV-generators, ventilation and cooling systems, geothermal systems (heat pipes, earth collectors etc.). Interfaces to different types of BMS have been developed together with the producers of the systems. The simulation models runs centrally on a zafh.net PC in Stuttgart with data transfer from/to the demonstrations sites via internet connection. The calculated energy demand/production from the online simulation tools is used for monitoring and shown in parallel to the real energy consumption/production. This will helps to detect and improve hidden control mismatches or system faults. Furthermore, the online simulation tools are used for the development and testing of new intelligent control strategies which are then implemented in the BMS. The development of more advanced online simulation tools with some active control tasks are currently under development for the ventilation and cooling system of the health care centre in Barcelona.

3.2 Energy consumption observation of the building in Southampton

Fig. 2 shows the communication structure for the transfer of the building performance data via ftp to the energy consumption observation system at zafh.net. The on site measured weather data and the room temperature set points etc. are transferred to a dynamic simulation model of the building running on a PC of zafh.net in Stuttgart, which calculates the expected heating energy consumption and compares the simulation results with the measured data. Two detected control problems are shown in Fig. 3. The upper carpet plots show the volume flow status of the installed air handling units and the lower carpet plots show the resulting heating energy consumption required to heat up the supply air. At the beginning of march 2007 the office air handling unit was operated due to an control error at full air flow during day and night time and therefore caused additional heating energy consumption. The atrium air handling unit was always operated at full load during the summer period. The aim of this control was to use the cold air for night time cooling. However, the control was not sufficient to avoid additional heating energy demand for too low ambient temperature conditions. A new optimised control strategy will be implemented for the summer period 2008.

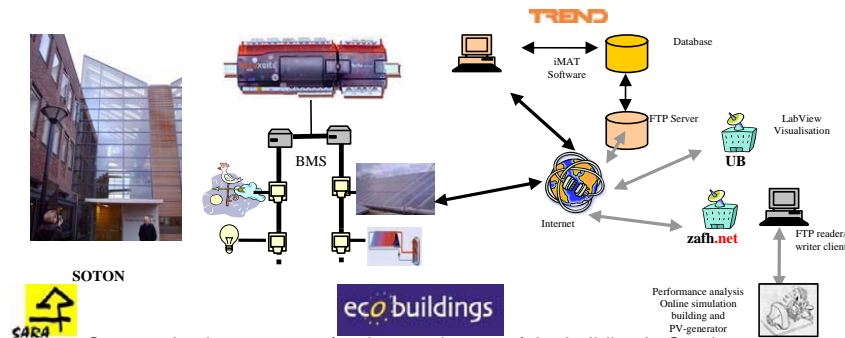


Fig. 2: Communication structure for data exchange of the building in Southampton

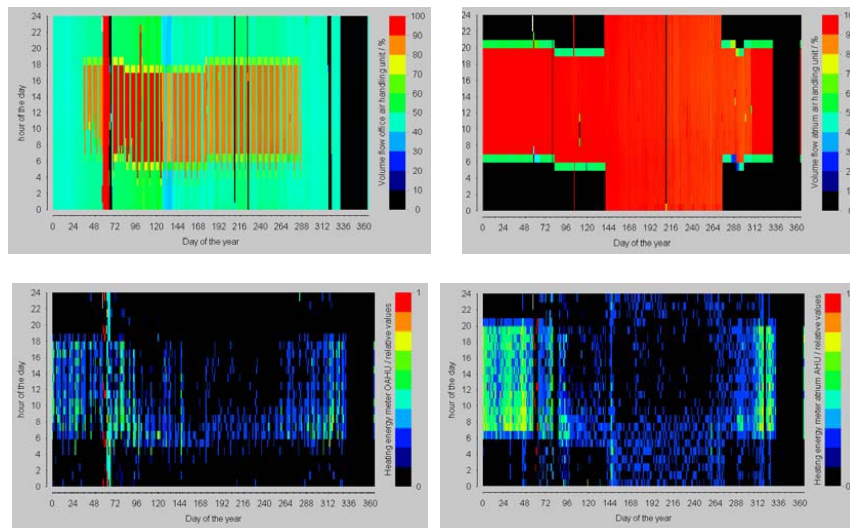


Fig. 3: detected control problems of the installed ventilation systems in the offices (left) and atrium (right).

3.3 Simulation based monitoring and control of photovoltaic power plant using online simulation

The PV generator of the Southampton building shown in Fig. 4 with a nominal power of 11.4 kWp consists of 63 semi transparent glas-glas modules divided into seven strings which are connected to four inverters, three Fronius multi string inverters IG 30 and one Fronius IG 15 inverter. The monitoring of the PV generator is also connected to the detailed monitoring and data transfer system described in paragraph 3.2 and collects all the data from the inverters, the module temperature and the solar irradiation on the tilted module area in 15 min mean values. A detailed simulation model of the PV generator has been developed with direct access to the monitoring data. This simulation model is used as online simulation and system observation tool with an implemented fault detection routine. The results are published on an interactive webpage accessible via form the SARA homepage. The graphs in Fig. 4 show detected sensor errors and a detected 25% too low performance of the modules connected to inverter 3, which was not noticed by the operator for over a year.

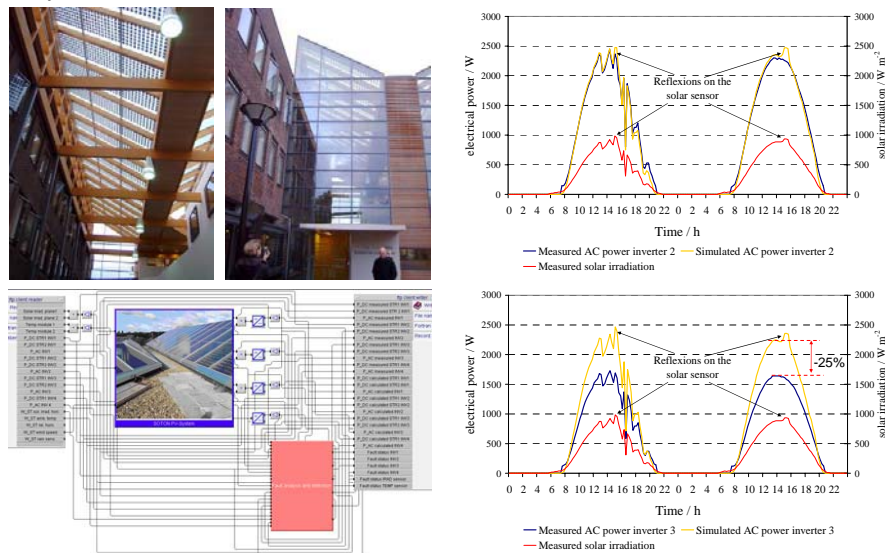


Fig. 4: Online simulation tool for the semi-transparent PV installation on the atrium roof of the Educational Office Building of the University of Southampton, UK

4 References

- Buswell, R.A.**, Haves, P., Wright, J.A. "Model-based conditioning monitoring of a HVAC cooling coil sub-system in a real building", Building Serv. Eng. Res. Technol. 24,2 pp103-116, 2003
- Clarke, J.A.**, Conner, S., Fujii, G., Geros, V., Jöhanesson, G., Johnstone, C.M., Karatasou, S., Kim, J., Santamouris, M., Strach, P.A. "The rule of simulation in support of internet-based energy services", Energy and buildings, 36, pp837-846, 2004
- Doppelintegral GmbH**, INSEL Version 7.0, 2008, [www.insel.eu]
- Gouda, M.M.**, Underwood, C.P., Danaher, S. "Modelling the robustness properties of HAVAC plant under feedback control", Building Serv. Eng. Res. Technol. 24,4 pp271-280, 2003
- Hao, X.**, Zhang, G., Chen, y. "Fault-tolerant control and data recovery in HAVAC monitoring systems", Energy and buildings, 34, pp933-940, 2002
- Shah, R.**, Rasmussen, B.P., Alleyne, A.G. "Application of a multivariable adaptive control strategy to automotive air conditioning systems", International Journal of adaptive control and signal processing, 18, pp 199-221, 2004

POST OCCUPANCY EVALUATION AND ADAPTIVE CONTROL ALGORITHMS

Dr. Manuel Fuentes, Maita Kessler
Oxford Centre for Sustainable Development, Oxford Brookes University,
Headington Campus, Gipsy Lane, Oxford OX3 0BP, UK
Oxford Brookes University
Tel.: +54-1865483615
E-Mail: mfuentes@brookes.ac.uk

1 Abstract

A Post Occupancy Evaluation was performed in the Administration and Student Services Building (ASSB) in Southampton University as part of the European project *Sustainable Architecture Applied to Replicable Public-Access Buildings* (SARA). This building was finished in the spring of 2006, and the staff has been asked to comment on its performance over the first summer and winter. This POE was developed according to previous research done by Oxford Brookes University for the British Research Establishment and other European projects.

An adaptive control algorithm was also installed at the BMS level affecting this building in an attempt to show the potential for reducing energy consumption based on setting up a comfort temperature using the adaptive thermal comfort approach. The impact of these two actions are discussed in this paper

2 Introduction

The International Standard for indoor temperatures favours the provision of constant temperatures in buildings. This follows from the way in which such standards are based on steady-state experiments in climate chambers and the necessity to specify clothing and metabolic rates of building occupants in order to predict the effects of the environment. However there is an increasing realization that such methods may be inappropriate and restrictive, particularly for variable conditions such as may be found in naturally ventilated (NV) buildings. Research analyzing field work throughout the world has shown that the temperature which people find comfortable varies with season and climate.

Recent work^[1] has suggested that the comfort temperature indoors can be defined by a time-series of the outdoor temperature. This means that comfort can be achieved using less energy because the indoor temperature follows that outdoors. It also means that well designed buildings can fall within the range of temperatures which are comfortable without the use of air conditioning.

The work presented here shows an algorithm for the prediction of comfort temperatures in buildings using the outdoor temperature. This algorithm has been tested for UK conditions using dynamic thermal simulations and was also tested in actual buildings. The comfort algorithm has two components

- A definition of the indoor temperature which is to be controlled in terms of the globe temperature and the air velocity
- A formula relating the desired value of the indoor temperature to the exponentially weighted running mean of the outdoor temperature.

The algorithm requires a calculation of the running mean of the outdoor temperature. The required indoor temperature is then calculated from the daily mean and the running mean of the outdoor temperature. In air conditioned (AC) buildings this is used as the set-point temperature^[2]

3 Developing the adaptive algorithm

Using statistical techniques on the results of the comfort surveys an appropriate algorithm can be developed^[2]. The result is an adaptive algorithm which is the basis for the development of adaptive controls. This algorithm can then be used to define comfortable indoor conditions and can be used to control air conditioning systems or assess whether naturally ventilated buildings will provide comfortable indoor temperatures.

3.1 The control algorithm

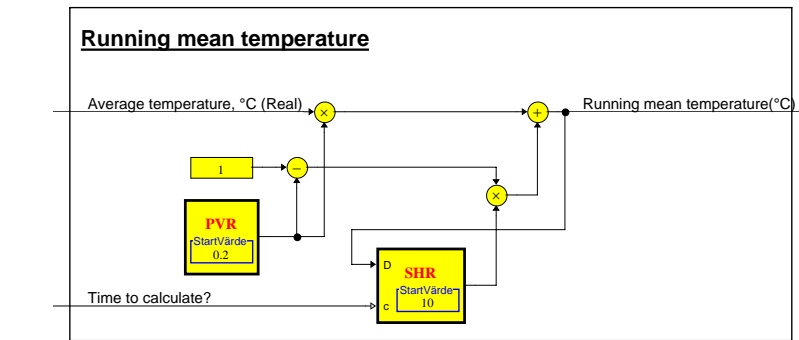
The control algorithm is used to calculate the comfort temperature setpoint at the BMS level depending on the historical outdoor temperature in a very specific way explained elsewhere^[2]. The comfort temperature setpoint is then used to control the indoor temperature. What has to be implemented at BMS level is the following:

1. The actual outdoor temperature is measured once every hour, added up, and the average outdoor temperature is calculated once every day at 7 o'clock (no adjustment for daylight saving time).
2. The Running mean temperature is calculated as:

T_{RM} = Running mean temperature

T_{DM} = Actual average temperature

$T_{RM}^n = c * T_{DM}^{n-1} + (1-c) * T_{RM}^{n-1}$ where the constant c is set default to

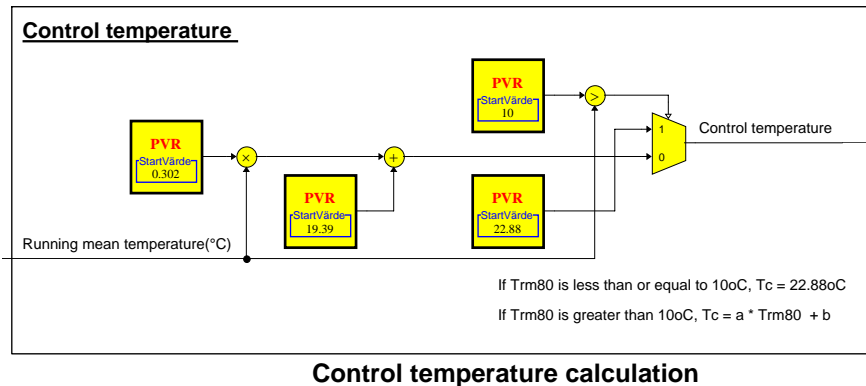


0.2.

Running mean temperature calculation

3. The Control temperature is calculated as
 - If the running mean temperature is below 10 °C, the Control temperature is set to a fixed value of 22.88 °C.
 - In other cases, the Control temperature is:

$$T_c = a * T_{RM} + b$$
 where $a = 0.302$ and $b = 19.39$



This algorithm was implemented at the BMS level in December 2007 and it is running in part of the building.

4 Post Occupancy Evaluation

The Post Occupancy Evaluation (POE) studies of buildings involve systematic collection and evaluation of information about the performance of a building in use. Data collected can include measured information such as energy consumption, temperatures, lighting levels, acoustic performance etc., and survey data from the perspective of the occupants regarding issues such as comfort, aesthetics, occupant satisfaction, management, etc^[3].

Crucial, therefore, to the likely success of any building in being comfortable are the *adaptive opportunities* it provides. Adaptive opportunities are those features of the building which allow the occupants to adapt themselves to the building or to adapt the environment in the building to their own requirements^[3].

According to this, the control of one's environment is a key factor in the perception of thermal comfort and should inform the survey's structure,.

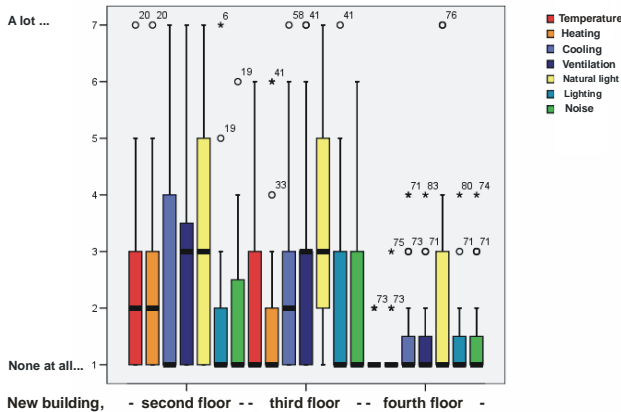
A POE survey then will put its emphasis on measuring the physical characteristics of the environment (temperature etc) at the time of the evaluation, looking for adaptive opportunities. It should provide information about how is the building behaves accordingly to the users and how are the users dealing with the building



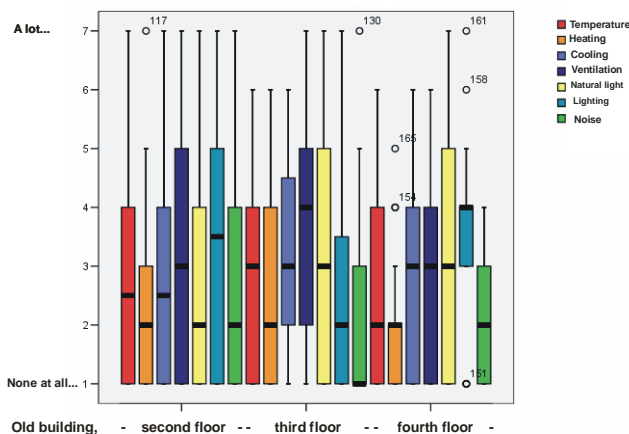
Photo 1 - Showing new atrium linking old (left) and new (right) buildings.
 (photo M. R. Kessler)

The questionnaire^[2] developed to carry out this survey is divided in four main sections. The first one describes the scene at the office space. The second part will show the user's perception about the amount of control he/she has over the environment. The third part is designed in order to help the user to describe his/her environment. This section is also divided in four areas and will give the researcher an idea of the internal environment through the user's feelings about the temperature, the quality of the air, the quality of the natural and the artificial lighting and any acoustic problems. The fourth part relates to productivity and, again, provides the user with choices that will give him/her the possibility to ponder about his/her own ability to work *vis a vis* their office environment.

How much control do you feel that you have over the following aspects of your environment?



How much control do you feel that you have over the following aspects of your environment?



Graph. 1 & 2: Showing perceived control during the winter. Summer results were very similar in this question.

All the environmental questions are in the form of semantic differentials, giving extremes of possible answers and asking users to give their reply as a tick in the appropriate box between those two extremes. There are seven possible boxes for each question. In addition users will be asked to give any comments they have on the subjects covered in the questionnaire.

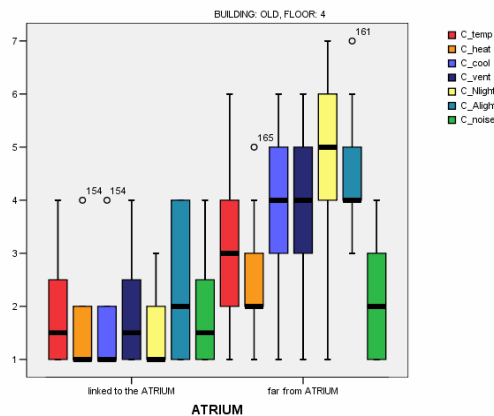
This information, together with the monitoring of the internal environment, will help the researcher to analyze the answers within a context.

The ASSB was finished in the spring of 2006, and the staff has been asked to comment on its performance over the first summer and winter.

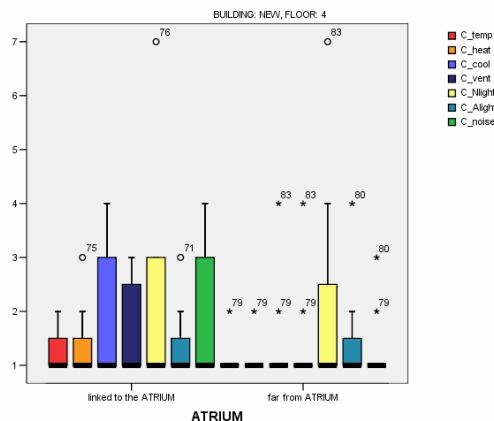
Overall comments from staff show a good acceptance of the new building. Occupants appreciate the design and express tolerance of the open-plan offices layout: *"it is difficult to please everybody..."*

The results also show that there is a perception of lack of control on all floors of the new and the old building (graphs 1 & 2).

As shown in the graphs, the fourth floor has highest levels of complaint. In the old building, the most negative feedback comes from the area near the atrium – the area worst affected during the period of construction, with offices that lost direct access to outside light (graph 3). Those findings are similar to those of in Dr. AbuBakr S. Bahaj presented in the CIBSE National Conference in 2006^[4]. This floor has potential for better natural lighting and ventilation, ventilation has to be fine-tuned in several places and the eternal equation between glare - natural light - artificial light, especially in the western side of the building, could promote better understanding for the window design.



Graph 3- Showing the level of discomfort near the atrium, Old Building, level 4.



Graph 4 - Showing the level of discomfort far from the atrium, New Building, level 4.

In the new building, the most problematic area is away from the atrium and adjacent to the services block; it has less access to daylight and opportunities for direct ventilation. In summer, there was extensive use of fans; in winter, when the angle of the sun changes dramatically, the blinds were down and the lights on most of the day.

5 Conclusions

We have showed how the POE Research could analyze the interaction between the building and its occupants. We have also shown that it can suggest possible improvements for the building starting from a broad discussion between architects, management and staff in the use of the building.

It is important to remark the participation by staff and designers in decision taking and discussions about the design of natural and artificial lighting would have meant a higher level of engagement with the building's special features.

Regarding the Adaptive Algorithm, data is being recorded in order to document the energy savings due to its implementation. A future POE survey is recommended to understand occupants' comfort levels under the

adoption of the comfort temperature as the temperature setpoint for the building.

6 References

- [1] Nicol F and Raja I: (1996) Thermal comfort, time and posture: exploratory studies in the nature of adaptive thermal comfort, Oxford Brookes University. March 1996
- [2] Deliverables D12 and D13 *Sustainable Architecture Applied to Replicable Public-Access Buildings* (SARA) project. www.sara-project.net
- [3] Nicol, J. F. and Kessler, M.R.B. (1998) Perception of Comfort in Relation to Weather and Indoor Adaptive Opportunities. ASHRAE Transactions vol. 104 (1) 1005-1017 (ISSN 0001 2505)
- [4] Dr. AbuBakr S. Bahaj, School of Civil Engineering and the Environment, University of Southampton (2006), A Climate Envelope Extension of an Office Building, Perception and Reality of the Change in Environmental Condition; CIBSE National Conference 2006 – Engineering the future, 21-22 March, UK

DST, DECISION SUPPORT TOOL TO FACILITATE ENERGY-EFFICIENT RENOVATION OF BUILDINGS

Irena Kondratenko
ECN, Energy research Centre of the Netherlands
Energy in the Built Environment Unit
P.O.Box 1, 1755 ZG Petten
Tel.: +31 224 564346 Fax: +31 224 568966
E-Mail: kondratenko@ecn.nl

1 Background to DST development

The aim of the DEMOHOUSE project is to develop minimum standards and recommendations for energy-efficient and sustainable renovation of social housing estates. Within this, the Decision Support Tool is one of the final results and uses knowledge gathered throughout the DEMOHOUSE project. In many European countries, social housing is owned by housing associations, municipalities or housing co-operations. To facilitate the decision makers in these organisations a simple instrument which helps to select relevant information for making decisions is developed within the DEMOHOUSE project. There are several phases in the process of renovation of dwellings. Main decisions in relation to ambitions of the renovation in energy-efficiency, sustainability, economic feasibility and occupants' participation take place in the first so called *initiative phase*. It is this phase that the DST is focusing on to guide the decision makers, housing managers and home owners associations alike, through decision making process towards achieving energy-efficient and sustainable renovation of dwellings. As any building renovation is a complex process with many stages, the tool also contains practical information and offers guidance and links to further more in-depth information of relevance to other stakeholders for example: architects, energy experts, building contractors, and building users.

2 DST Content

The Decision Support tool contains examples of best practice renovation including the five pilot renovation projects realised within the DEMOHOUSE project. It also includes overview of different improvement technologies and renewable energy technologies, information on low cost technical solutions and catalogue of best available technologies. The DST allows access to relevant existing tools such as: the Energy Signature, for evaluation of energy saving measures, the Green Build Quality Process, the Green Build Questionnaire and the Green Diploma as tools for promoting higher ambition level of sustainability in buildings. Indicators to control building construction quality and performance, for example IR-photography and Blower Door Test are also included as well as appropriate financial mechanisms for affordable energy efficient renovation (such as energy service companies, ESCOs) and indicators for tenants participation in the renovation.

The DST is answering two main questions:

- Why an energy-efficient and sustainable renovation?
- and
- How to do an energy-efficient and sustainable renovation?

Why an energy-efficient and sustainable renovation? This question is presented to decision makers with quality indicators as benefits associated with this type of renovation. The benefits can be considered from several points of view. Firstly, a social housing point of view: Property value (financial benefits), Lettability (energy + rent), Improved building energy labelling (EPBD), Comfort (indoor environment). Secondly, from occupants' point of view: Social status (neighbourhood image) and Lower total living costs. Thirdly, from the Environmental point of view (climate protection and conservation of resources). All indicators are described in a concise manner with further information provided as attached reading documents, easily accessible as pdf documents and / or links to other sources.

Beside the benefits, barriers and opportunities for an energy-efficient and sustainable building renovation are also described categorised as architectural, financial, social, technical and legal. Many of the barriers present in itself opportunities, for example, increased height of investment is regarded as a financial barrier, while increased market value of the building after the renovation at the same time can be an opportunity. Similarly, the financial consequences for the tenants as potential rent increase is a barrier while lower living costs due to energy savings is an opportunity.

The second main question: *How to do an energy-efficient and sustainable renovation?* is addressed through three main aspects categorised as Technical, Financial and Social. The Technical aspect for decision making in an energy-efficient renovation includes general guidelines on energy conservation, different improvement techniques and renewable energy technologies, best available technologies and information on low-cost technical solutions. The technical aspect of the DST also makes reference in regards to benefits of employing construction quality control techniques: IR camera, Blower door test; and the Energy Signature for post-occupancy energy performance. Access is provided to relevant existing tools: the Green Build Quality Process, the Green Build Questionnaire and the Green Diploma. Finally, 'lessons learned' are included from the five DEMOHOUSE building renovation projects.

The Financial aspect of the tool provides managers with information on novel financial models i.e. energy service companies or ESCOs. They can be initiated to do engineering, finance and even do the maintenance and financial administration of renovated buildings. By outsourcing energy efficient installations, the housing association need lower investment and have lower financial risk. Also included is the cost analysis for implementing renovation measures for each of the Demohouse renovation projects, including the energy and CO₂ emission saving potential. Simple pay back time for renovation investments are calculated and compared to pay back times in typical renovations. This analysis was used to identify optimal renovation measures.

The Social aspect of the tool promotes to managers advantages of tenants involvement and participation from early stages of renovation and benefits of providing building users with information on proper energy-efficient house use and maintenance.

Where appropriate, the use is made of other DEMOHOUSE project deliverables. Since the DST is aimed at decision makers of housing renovations (managers), it is not an intention of the tool to provide management or organisational information.

2.1 DEMOHOUSE building renovation projects

Throughout the DEMOHOUSE project different buildings in five European countries, Denmark, Austria, Greece, Spain and Hungary, are being renovating under sustainable criteria. In the DST tool all these renovation projects are presented. The design process and selection of renovation measures assessment is described towards achieving best renovation scenario. The life cycle costs and CO₂ emissions have been calculated in renovation case. The analysis included a comparison to existing building prior renovation and a standard renovation case. The simple pay-back times and CO₂ emission reductions were also calculated and optimal renovation measures in each renovation building identified. This provides decision makers with clear show-cases of energy, CO₂ emissions saved and the cost and pay back times in with renovations.

The energy monitoring programmes undertaken in all Demohouse renovation projects is also presented in the DST. The monitoring programme includes blower door and thermography tests as well as measuring the consumption of heat, electricity and water in renovated buildings. Renovation projects with renewable energy technologies have special programmes for monitoring of the energy production from renewable sources in addition to monitoring the actual energy consumption. Since the monitoring is to start after the on-line launch of the DST, monitoring information and analysis of the energy consumption and building function if it is in accordance with expectations and ambition of renovation will be included in the DST at the time they become available.

3 Validation and Translation

It is intended to test the structure, content, usefulness and user-friendliness of the tool by sending the pilot version of the DST accompanied with a short questionnaire to several potentials users internationally within the network of housing associations decision makers and DEMOHOUSE partners. The feedback will be used constructively to improve the tool.

The DST structure and content (in English) is developed by ECN and will be included onto the DEMOHOUSE project website <http://www.demohouse.net/publications/decision-support-tool/>. In order to reach widespread European audience and potential tool users as well as promote project achievements, the DST will be translated by project partners to their national languages and included on project website with links to related national websites.



Figure 1: DEMOHOUSE renovation buildings in Austria, before and after renovation.



Figure 2: DEMOHOUSE renovation buildings in Spain, before and after renovation.

Educate the Actors

IMPROVING THE USER BEHAVIOUR – THE BISH-ES

Ove Mørck
Cenergia Energy Consultants
Herlev Hovedgade 195 2730 Herlev, Denmark
Tel.: +45-44660099, Fax: +4544660136
E-Mail: ocm@cenergia.dk

1 User behaviour improvement tools

1.1 User behaviour

Many reservations against energy conservation and renewable energies result from lack of knowledge and ignorance on this subject in the different social, age and professional groups. The user behaviour has a strong influence on the energy performance of buildings, it can increase or decrease the energy consumption for heating and lighting by more than 50 %. Additionally it can influence the indoor comfort. A change to better user behaviour is a no-cost measure for the building owner and will therefore be supported by them. WP6 aims at informing, helping to develop a consciousness and therefore improving the user's behaviour on energy questions.

1.2 Building information sheet - BISH

For each target group (occupants like pupils and teachers or office workers/care-takers and maintenance personnel/administration) simple blackboard information sheet have been developed, which informs on positive and negative influence possibilities to the energy consumption and indoor comfort of buildings. Besides showing the energy consumption and/or cost differences they give advice on how to improve the comfort level with no and low-cost measures.

Each participant has collected strategies and material on how to influence the user behaviour in a positive way. The layout of the information sheets were defined and agreed to by the participants and the after the sheets had been developed in English they were translated into the language of each participant in order to reach the highest penetration.

2 The themes of the BISHes

All together the participants identified 8 themes of no-cost measures for improving comfort and reducing energy consumption. The 8 themes were:

- ♦ Daylight
- ♦ Report Defects
- ♦ Monitoring
- ♦ Shading
- ♦ Thermostat
- ♦ Ventilation
- ♦ Instrumentation
- ♦ AC-Windows

To illustrate the design and idea of the BISHes, an example is shown as figure 1, below.

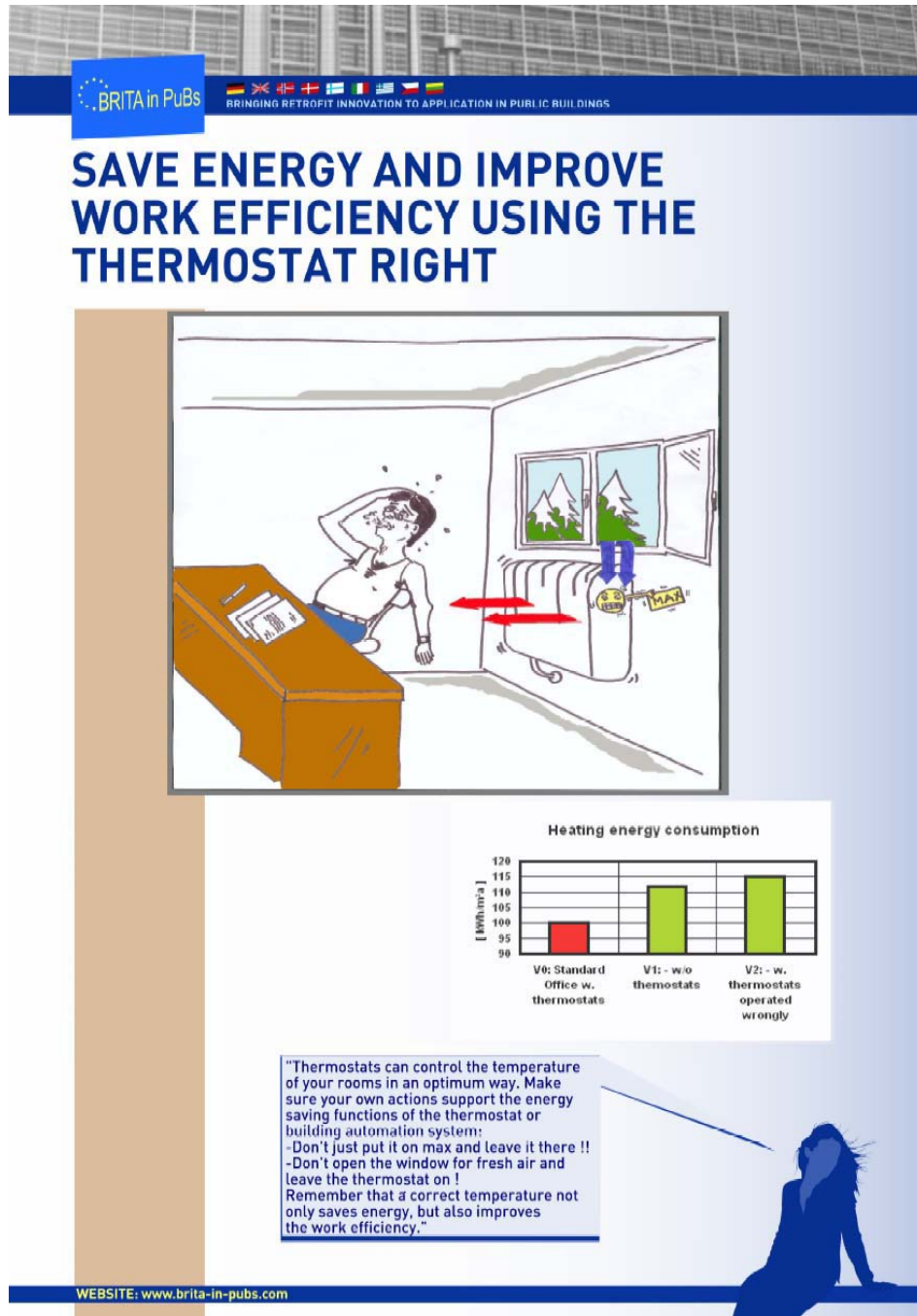


Fig. 1 The BISH developed on the theme of the thermostat.

3 The translated BISHes

As it appears from the list of themes some of them are mostly oriented towards the warm, Mediterranean climates, for example Shading, and some are more directed towards the Nordic climates, for example the Thermostat. To some degree this is reflected in the table below which shows an overview of all the BISH-themes and to which languages they have been translated into. In total around 65 BISHes have been developed.

Table 1: Overview of the BISHes produced in the BRITA in PuBs project

Languages Themes	English	German	Danish	Finnish	Estonian	Greek	Norwegian	Czech	Lithuanian
Daylight Report	x	x		x	x	x	x		x
Defects Monitoring	x	x		x	x			x	x
Shading	x	x	x	x	x	x		x	x
Thermostat	x	x	x	x	x		x	x	x
Ventilation	x	x		x	x	x			x
Instrumentation	x	x	x	x	x		x	x	x
AC-Windows	x	x		x	x	x	x	x	x

4 Distribution

The BISHes have been distributed in a number of ways, First of all they are all placed for free download on the public part of the BRITA in PuBs website: www.brita-in-pubs.eu. Similarly, the translated BISHes have been placed on local websites in the different countries of the participants, see for example: <http://e3portal.vtt.fi>.

The BISHes have been mentioned in the BRITA in PuBs newsletter and likewise information about them has been distributed in each country.

5 Evaluation

The participants of the BRITA in PuBs project have specifically placed the relevant BISHes in a number of buildings, naturally first and foremost in the demonstration project buildings, but also in other relevant buildings, where it has been possible to directly ask for their placement.

For some of these placements of the BISHes an evaluation of their user acceptance has taken place in each country. As an example here is referred to the evaluation conducted in Greece, where the Shading and Ventilation BISH were sent to 9 buildings (one library, 4 office buildings, one electronic laboratory, one higher educational, 2 Public office

buildings). The Greek participant asked the occupants to post them in, at least one, working space and fill in a questionnaire in order to assess the usefulness of the BISH.

The conclusions of the evaluation were that the BISHs' were apprehended and found interesting by all occupants. Most of them used the BISH information and decreased the room's temperature improving thus the working environment. BISH recommendations also made the occupants more conscious on the working conditions, and motivated them to suggest the implementation of such systems/techniques to the building managers.

6 Conclusion

The results achieved by this part of work package 6 of the BRITA in PubS project show that for relatively small means efficient training material for elected target groups can be developed and distributed. After the closing of the BRITA in PuBs the BISHes will still be available at the BRITA in PuBs website for a number of years as they will be on some of the national websites of the participants. Thus the training can continue and the value of the work increase over the years to come.

BRITA IN PUBS - FACILITIES MANAGERS' TRAINING

Gilbert Snook
City College Plymouth
Kings Road
Plymouth
PL1 5QG
UK

Tel: +441752 305302, Fax: +441752 305893

E-Mail: gsnook@cityplym.ac.uk

1. Background

1.1. Depletion of oil reserves and global warming provide significant reasons to improve energy management.

1.2. UK final energy consumption by sector 2001 (Energy Consumption in the United Kingdom DTi)

- Services 18%
- Industry 25%
- Domestic 31%
- Transport 26%

Facilities Managers have direct influence in the Services and Industry Sectors therefore up to 43% of total energy consumption. There is indirect influence into the other sectors since the examples of good energy management at work will overflow into other actions.

1.3. Building performance – what performance? Most existing buildings have very limited design parameters with regard to energy use, perhaps only heat loss and set points for individual pieces of equipment. In the EU 95% of buildings were built before 1980 (Facility and energy management as a tool for energy use). New buildings have good parameters and targets but: -

- Do design teams know or care if they are met? Design teams progress to the next commission often without taking interest in the performance of the new building in comparison to the design parameters.
- Are buildings commissioned properly? Often buildings are occupied quickly after construction or even before completion.
- Is proper monitoring occurring? This requires expertise, controls, metering, software, i.e., investment in time and equipment.
- Are Facilities Managers trained? Training should cover general professional qualifications, continuing professional development and induction to each new building.

1.4. Too often buildings are simply not performing to specification.

2. The Facilities Manager

2.1. Facilities Managers have wide ranging roles. The following is not an exclusive list: -

- Maintenance
- Building improvements
- Cleaning
- Catering
- Transport
- IT/Telecoms
- Furniture
- Security
- Energy Procurement/Management (only a specialist appointment with very large property holdings)

2.2. Different backgrounds

- Facilities Managers come from many different backgrounds therefore with differing levels of experience and training. The range can be from building administrator or caretaker to qualified professional

2.3. Variable senior management support

- Facilities Managers will have differing positions of influence within organisations. Often companies in the past would not invest to save energy. Rising fuel costs are changing this situation. Significant energy cost saving can now be made.

2.4. Facilities Managers clearly have a key role in achieving energy and carbon reduction

3. Facility Manager Training

3.1. BRITA in PuBs research

- Recognition of need to support Facilities Managers including with training.
- The need for computer based monitoring and control systems in energy management.
- An extra Work Package was introduced to develop a Facilities Manager training programme

3.2. Work Package 9. This provides for Facilities Manager Training, 2 day seminar programme, in the following countries:

- Norway
- Lithuania
- Denmark
- Germany
- Greece
- Czech Republic

3.2.1. Day 1

- Background principals from BRITA in PuBs research
 - Facility and Energy Management as a tool for energy use. This module covers building energy performance, EU regulations, prices and energy certification
 - Barriers and limitations to innovative energy saving solutions within public buildings. This module draws on the BRITA research identifying when and why energy saving measures are introduced. Energy saving measures are rarely done for their own sake nor considered a key retrofit measure in isolation. The module also introduces many of the BRITA tools, i.e., Design Guides, the Building Information Tool and Blackboard Information Sheets
 - Life cycle decision making. This module examines the need to take the long view in decision making and project funding. Also the module looks at the need for investment to keep buildings in an acceptable condition together with the use of risk assessment in design decision making.
 - Commissioning and the need for doing this part of the construction process properly. The module also looks at maintenance manuals and building automation systems
 - Monitoring module covering bench marking, data management, condition surveys and energy audits
 - Practical FM experience. The experience of energy management at City College Plymouth, one of the BRITA Demonstration Partners.

3.2.2. Day 2

- National application of the learning from day 1 and including a visit to the BRITA demonstration building

4. Conclusions

4.1. Facilities Managers have a key role both in:

- Energy saving
- Carbon reduction

4.2. Facilities Managers need to be familiar with both:

- Building services engineering.
- IT Systems being the basis for control and monitoring systems.

4.3. Facilities Managers will have to monitor and set targets as a continuous process.

4.4. Much can be done before retrofitting energy saving measures:

- Maintain the building and its equipment, i.e., regular servicing and repairs.
- Operate and monitor the existing controls systems.
- Get occupiers on side with energy saving.

4.5. But what about Facilities Managers' Training?

- Learning has to be a continuous process. Never again should an Facilities Manager say, "But we've always done it this way."
- Rapidly raising energy prices giving the potential to make a difference.

4.6. But is enough being done to support and train Facilities Managers in their key role to reduce energy consumption and carbon production?

Literature

- Energy Consumption in the United Kingdom – Department of Trade and Industry.
- Barriers and limitations for innovative energy saving solutions of retrofitted public buildings – Anne Tolman
- Facility and energy management as a tool for energy use – T. Kauppinen, H. Katajala, J. Ronty
- Life Cycle Costing – J. Ronty, H. Katajala
- Building commissioning, operation and maintenance manuals and the use of building automation as a tool for facility management – T. Kauppinen, K. Kovanen, V. Nykanen, S. Paiho, J. Peltonen, J. Pietilainen.
- Monitoring (benchmarking, data management and analysis), condition surveys, condition assessment, energy audits – T. Kauppinen, J. Pietilainen
- Energy Management Making a Difference a facilities management perspective – G. Snook

E-LEARNING MODULE FOR BRITA IN PUBS PROJECT

A. Kaklauskas, A. Mickaityte, M. Seniut
Vilnius Gediminas Technical University
Sauletekio Ave. 11, LT-10223 Vilnius, Lithuania
Tel.: +12-3456 / 6789, Fax: +12-3456 / 678910
E-Mail: artka@st.vtu.lt

Abstract

Most advantage eco buildings libraries select, organize, retrieve, and transmit tacit and explicit information/knowledge. Different reports contained an explicit criticism of the libraries' focus on their specific collections and a recommendation to focus more on user needs. There is a need to overpass the key limitations in the development of traditional libraries, which have been developed for a particular content and a specific group of learners. We suppose that the future libraries will become a practical knowledge storehouse and will offer intelligent opportunities for people. In order to increase the efficiency and quality of BRITA IN PUBS project activities, an Intelligent Library and Tutoring System for BRITA IN PUBS project (ILTS-BP) was developed. ILTS-BP have the ability to personalize, maximum-reuse, index, analyze and integrate valuable information and knowledge from a wide selection of existing sources in all building life cycle. ILTS-BP is briefly analyzed in the paper.

Keywords: Eco buildings, e-Libraries, e-Learning, BRITA IN PUBS project, Intelligent Systems.

1 Introduction

As digital libraries become more popular, information and knowledge overload has become a pressing required literature searching problem. Problems with search on digital libraries will worsen as the amount of information and knowledge increases. Traditional digital libraries often index words and documents when learners think in terms of topics and subjects. As a result, learners cannot without problems determine how well a particular topic and subject is covered, or what types of searching will provide required information and knowledge.

Search engine rankings have been adopted in the most advanced intelligent libraries (Alexandrov et al., 2003, Gutwin et al., 1999, Hsinchun et al., 1998, Kaklauskas et al., 2006, Ruch et al., 2007, Trnkoczy et al., 2006, J. Wang, 2003) and tutoring systems (Armani et al., 2000, Brusilovsky, 2000, Day et al., 2007, Lucence, 2005, Pouliquen et al., 2005) recently. As part of the ongoing Illinois Digital Library Initiative project, the research proposes an intelligent personal spider (agent) approach to Internet searching, which is grounded on automatic textual analysis, general-purpose search and genetic algorithms (Hsinchun et al., 1998). Pouliquen et al. (2005) use parsing techniques to extract information from the text, and provide a proper semantic indexation which is used by a medical-specific search engine. Day et al. (2007) use the Jakarta Lucene full text indexer to index the full text of the textbook. Jakarta Lucene is a high-performance, full-featured text search engine library written entirely in Java. The technology is suitable for nearly all applications that require full-text search. It is also readily available and has a good API for our needs. ITA (Pouliquen et al., 2005) index the chapters, sections, and subsections of

the textbook. Highlighter is used to highlight the index context. Finally, the ITA provides reading recommendations for students via the chapter similarity function.

However, intelligent libraries (Alexandrov et al., 2003, Gutwin et al., 1999, Hsinchun et al., 1998, Kaklauskas et al., 2006, Ruch et al., 2007, Trnkoczy et al., 2006, J. Wang, 2003) and intelligent tutoring systems (Armani et al., 2000, Brusilovsky, 2000, Day et al., 2007, Lucence, 2005, Pouliquen et al., 2005) with search engine rankings cannot select chapters (sections, paragraphs) of a specific text which are the most relevant to a student, cannot integrate them into learner-specific alternatives of teaching material and cannot select the most rational alternative, i.e. cannot develop alternatives of training materials, perform multiple criteria analysis and select the most effective variant automatically. However, an Intelligent Library and Tutoring System for BRITA IN PUBS project (ILTS-BP) can perform the aforementioned functions. No one thought of above function before, so this attempt is the first (rare). The approach helps students to obtain suitably tailored material for an e-learning course. Above and other improvements are possible by using the ILTS-BP.

The e-learning Master Degree studies Construction Economics, Real Estate Management and Internet Technologies and Real Estate Business were introduced at Vilnius Gediminas Technical University in 1999. There are currently 225 master students from all over Lithuania studying in the e-learning Master's Degree programs. ILTS-BP also is used for these e-learning Master's Degree programs.

This paper is structured as follows: following this introduction, Section 2 describes the application of ILTS-BP for e-learning. Finally, some concluding remarks and future works are provided in Section 3.

2 Intelligent Library and Tutoring System for BRITA in PuBs Project

The intelligent library (library of e-learning modules) in eco buildings sector should have the following functions:

- Customisation and personalization function. Learners are central to the library of e-learning modules and all efforts to develop e-learning modules should be based on the need to provide interesting, practical and innovative knowledge to learners. Customisation and personalization function serves students with various goals and characteristics: to access a steadily expanding amount of digital information and knowledge with the minimum efforts according to explicit and implicit learner requirements; to personalize information access to digital content at the levels of content selection, content presentation, services and content volume.
- Cooperation function. The library of e-learning modules must provide easy communication between students, tutors, researchers, eco buildings industry professionals, etc. on topics that are of mutual interest.
- Maximum-reuse efforts, economy of scale and extensibility function. Within the BRITA IN PUBS Project, the library of e-learning modules should be created by broad variety of participating universities and institutions, which would interconnect modules across Europe and Asia and support for easy sharing and reuse of materials and integrate their contents.
- Integral multimedia function. The library of e-learning modules should manage all multimedia forms (electronic format of textbooks, video, audio as well as computer-software, computer learning systems) integrally.
- Notification function. Notification when new multimedia of importance to the learner is added to a e-learning modules library.
- Function of support of cooperation within communities of best practice.
Some above functions are briefly analyzed as follows.

2.1 Indexing and Multi-variant Design as a Core Component of Module Large-scale Content Integration

Indexing often is used to refer to the automatic selection and compilation of 'meaningful' keywords from e-textbooks into a list that can be used by a search system to retrieve texts. This list is more properly called a concordance. As this procedure involves no intellectual effort indexers distinguish their own work by calling it intellectual indexing, manual indexing, human indexing or back-of-book-style indexing. Indexing also means the intellectual analysis of the e-textbooks to identify the concepts represented in the document and the allocation of descriptors to allow these concepts to be retrieved. During indexing the Indexing Sub-system visit definite BRITA IN PUBS Project modules and collects information/keywords about it. Intelligent copy and paste from many modules with retention of a link/reference to the module can be performed. Development of new module is performed by using a combination of knowledge found with the possibility of easy editing and integrating. Learners can use Indexing Sub-system for computer-assisted extraction of data from text for their own purposes, making their work more efficient. As importantly, these data can then be reused and made useful for a large learners community: they can be incorporated (connected, interlinked) into a large distributed knowledge base.

Figure 1 shows the frequency of each specific keyword in the analysed text. Keyword ranking in modules seeks to determine the level of relevance of chapters and sections for student's needs. The level of relevance to student's needs can be defined by the term "Keyword density and significance" as described by indicators provided in the figure: weight (shows the significance of one keyword over another from a student's perspective in a search for specific learning material), difficulty of a text (the level of difficulty is determined on the basis of previous examination results related to a specific topic) and other indicators (number of pages, words and sentences in the analysed text) which help to determine the keyword's density. Then, information describing the usefulness of the analysed text for a learner's needs is summarised in a Figure 1. Also, the relevance of a text to a student's learning needs is described by the presence of different keywords in one sentence (see Figure 2). The occurrence of several different keywords that are specified by a student in the same sentence shows higher relevance of the text to the learner's needs.

The significance/efficiency (Q_j) of alternatives of the teaching material is determined on the basis of keyword density characteristics (i.e. frequency of each specific keyword, weight, difficulty of a text, number of pages, words and sentences in the analysed text). Significance Q_j of the learning material a_j indicates the satisfaction degree of requirements and goals pursued by the students, e.g. the greater the Q_j the higher the efficiency of the learning material.

Keywords/Chapters	Weight	A human rights assessment 1	A human rights assessment 2	A human rights assessment 3	A human rights assessment 4	A human rights assessment 5	A human rights assessment 6	A human rights assessment 7	A human rights assessment 8
Tsunami	0.6	10	10	6	18	14	14	17	8
construction	0.5	0	1	0	7	5	0	0	0
rehabilitation	0.5	7	3	4	3	3	1	3	4
reconstruction	0.7	6	0	1	5	0	2	0	0
Sri Lanka	0.3	2	3	0	7	4	4	5	3
relief	0.4	3	3	5	1	8	5	7	11
human	0.4	18	18	11	4	8	5	4	6
housing	0.4	5	7	3	16	32	0	5	1
international	0.45	11	3	9	1	2	3	1	0
Difficulty:	0.7	0.4	0.6	0.6	0.5	0.6	0.4	0.4	0.6
Number of pages:	0.5	4	4	2	7	10	8	8	5
Number of words:	0.3	839	917	787	2153	3214	1863	2206	970
Number of sentences:	0.4	32	50	41	94	150	89	113	46

Figure 1 Density of specific keywords in the analysed text

Legend - The first column of the figure provides the keywords under evaluation; the second column provides the weight of the keywords. The figure's third column specifies whether the minimising or maximising value is the best. From the fourth column onwards, numbers of paragraphs are provided with references to full texts and the frequency of iterated keywords.

Repetitions	A human rights assessment 1	A human rights assessment 2	A human rights assessment 3	A human rights assessment 4	A human rights assessment 5	A human rights assessment 6
1*	6	12	9	28	29	21
2*	9	11	5	8	10	1
3*	2	2	3	3	6	2
4*	3	0	1	0	0	0
5*	1	0	0	0	0	0
6*	0	0	0	0	0	0
7*	0	0	0	0	0	0
8*	0	0	0	0	0	0
9*	0	0	0	0	0	0

Figure 2 Combinations of analysed keywords in sentences

Legend - The first column of the figure provides the number of iterations in one sentence. From the second column onwards, numbers of paragraphs are provided with references to full texts and the number of iterated different keywords in one sentence.

1* - numbers in the row show the frequency of each specific keyword in the analysed text;
2* - numbers show the frequency of combinations of two different keywords in one sentence in the analysed text;
3* - numbers show the frequency of combinations of three different keywords in one sentence in the analysed text, etc.

The degree of utility N_j of the teaching material a_j indicates the level of satisfying the needs of the actual student. The more learning goals that are achieved and the more important they are, the higher the degree of the teaching material's utility. The degree of the teaching material's utility reflects the extent to which the goals pursued by the student are attained. The greater the Q_j the higher the priority of the teaching material (see Figure 3).

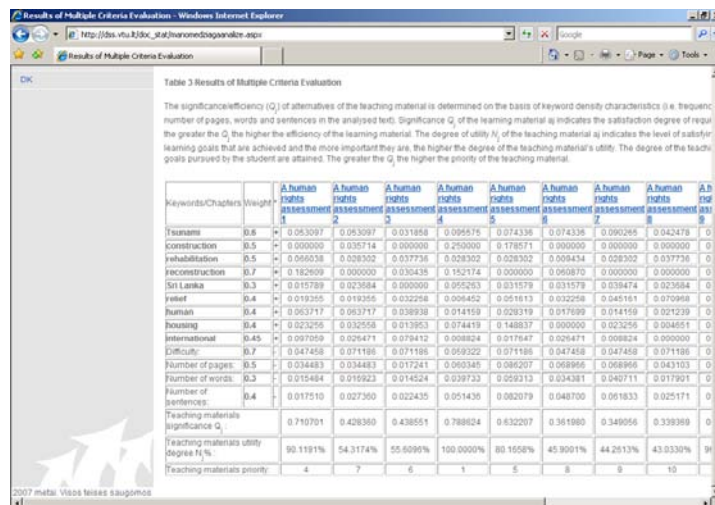


Figure 3 Results of Multiple Criteria Evaluation

ILTS-BP can display previously covered keywords that might be used for search required knowledge. The tutor can add additional keywords to this list. Also the search is possible by any combination of keywords. Using the keywords provided by a student and some criteria delivered by a Tutor and Testing Model, the system formulates a number of alternatives for an optional module. These alternatives are composed from sections or components of many different modules matched in a certain way. The selection of keywords and determination of their importance is not as simple as it seems. Numbers of feasible alternatives can be as large as 100,000. The received information is used for action plans, i.e. *mini curricula* that are used to lead the learner/student to rationally accomplish the learning process. The *Mini Curricula* are adapted to individual learner's needs, depending on their knowledge level, age, study and learning styles and difficulties.

2.2 Customisation and Personalization in Student model

As constantly increasing amounts of information and knowledge in the library of e-learning modules become available to a growing number of learners, it becomes very difficult for students to find the information and knowledge they need. Moreover, different students with different education, objectives, requirements and priorities may expect particular and individualized ILTS-BP behaviour. What distinguishes the personalized ILTS-BP from a traditional eco buildings e-libraries systems is the existence of Student Model that stores data that is specific to each individual learner. These learner profiles let the ILTS-BP adapt its behaviour to the education, objectives, requirements and priorities of learners.

In general, ILTS-BP performance may be adapted, i.e., personalized, at different levels: at the content selection, content presentation (electronic format of textbooks, video, audio, computer-software, computer learning systems), services (life long learning, master degree studies, PhD degree studies, etc.), content volume (i.e. 50, 100 or 250 pages of textbook) or interaction level, taking into account the education, objectives, requirements and priorities of learners. For example, various learners are provided with diverse content according to their requirements and priorities. The same content can be offered to different learners in a summarized or an extended form or in different multimedia. Various

learners may have access to different services, which may be customized according to learner requirements and priorities.

The Student Model stores data that is specific to each individual student. The Student Model is used to accumulate information about the education of a student, his or her study needs, training schedule, results of previous tests and study results.

2.3 Statistical Information Streams and the Tutor and Testing Model

Permanent streams of statistical information (information based on voice analysis of student answers, information on correct and incorrect answer, time distribution on every question, the number of times a student changed an answer to each question of a test, history on interaction between students and tutors) is integrated into the Tutor and Testing Model. The Tutor and Testing Model provides the function to process and integrate permanent data streams and provides access to this data to different stakeholders. ILTS-BP provides appropriate mechanisms for online processing of these aggregated stream data. Statistical aggregated stream data are particularly important in the library of e-learning modules for all stakeholders for later improvement and development of e-library. For example, on the basis of available statistical information, it is possible to determine which topics are the most relevant to learners and what their presentation form should be (e-books, audio, video, etc.). Besides, weaknesses and strengths of existing modules could be determined, and this information could be used as a basis to provide specific recommendations how to improve these modules.

The Intelligent Library presents learning frames to the student. The Tutor and Testing Model provide a model of the teaching process and supports transition to a new knowledge state. For example, information about when to test, when to present a new topic, and which topic to present is controlled by the Tutor and Testing Model model. The Tutor and Testing Model reflect teaching experiences of associate professors and/or professors. The Student Model is used as input to the Tutor and Testing Model so that the Tutor and Testing Model's decisions reflect the differing needs of each student in the optional modules. The Tutor and Testing Model formulates questions at various difficulty levels, specifies sources for additional studies and helps to select literature and multimedia for further studies and a computer learning system to be use during studies.

A student can select the level of difficulty at which the teaching will take place. The Tutor and Testing Model compares the knowledge possessed by a student (test before studies) and knowledge obtained by a student during studies (test after studies) and then it performs a diagnosis based on the differences. By collecting information on the history of a student's responses, the Tutor and Testing Model provides feedback and helps to determine strengths and weaknesses of a student's knowledge, and his/her new knowledge obtained during studies is summarized and then various recommendations and suggestions are provided.

The system provides information on the testing process in a matrix and a graphical form: information on correct and incorrect answer, time distribution on every question, and the number of times a student changed an answer to each question of a test, etc.

3. REFERENCES

- Alexandrov, V. N., Dimov, I. T., Karaivanova, A., Tan, C. J. K.,** (2003), Parallel Monte Carlo algorithms for information retrieval. *Mathematics and Computers in Simulation*, Volume 62, Issues 3-6, 289-295.
- Armani, B., Bertino, E., Catania, B., Laradi, D., Marin, B., Zarri, G.P.,** (2000), Repository Management in an Intelligent Indexing Approach for Multimedia Digital Libraries. *Lecture Notes in Computer Science. Foundations of Intelligent Systems: 12th International Symposium, ISMIS 2000, Charlotte, NC, USA, October 11-14, Proceedings.*
- Brusilovsky, P.,** (2000), Course Sequencing for Static Courses? Applying ITS Techniques in Large-Scale Web-Based Education. *Lecture Notes in Computer Science. Intelligent Tutoring Systems. 5th International Conference, ITS 2000 Montr'el, Canada, June 19-23, Proceedings.*
- Day, M., Lu, C., Yang, J., Chiou, G., Ong, C., Hsu, W.,** (2007), Designing an Ontology-based Intelligent Tutoring Agent with Instant Messaging, http://iasl.iis.sinica.edu.tw/webpdf/paper-2005-Designing_an_Ontology-based_Intelligent_Tutoring_Agent_with_Instant_Messaging.pdf, (Accessed: January 28, 2007).
- Gutwin, C., Paynter, G., Witten, I., Nevill-Manning, C., Frank, E.,** (1999), Improving browsing in digital libraries with keyphrase indexes. *Decision Support Systems*, Volume 27, Issues 1-2, 81-104.
- Hsinchun, C., Yi-Ming, C., Ramsey, M., Yang, C. C.,** (1998), An intelligent personal spider (agent) for dynamic Internet/Intranet searching. *Decision Support Systems*, Volume 23, Issue 1, 41-58.
- Kaklauskas A., Zavadskas E., Ditkevičius R.,** (2006), An Intelligent Tutoring System for Eco buildings. *Lecture Notes in Computer Science*, 4101, 174-181, Springer – Verlag Berlin Heidelberg.
- Lucence, J.,** (2005), "Jakarta Lucene Text search engine in Java", <http://jakarta.apache.org/lucene/docs/index.html>, (Accessed: February 23, 2005).
- Pouliquen, B., Le Duff, F., Delamarre, D., Cuggia, M., Mougin, F., Le Beux, P.,** (2005), Managing educational resource in medicine: system design and integration. *International Journal of Medical Informatics*, Volume 74, Issues 2-4, 201-207.
- Ruch, P., Boyer, C., Chichester, C., Tbahriti, I., Geissbühler, A., Fabry, P., Gobeill, J., Pillet, V., Rebholz-Schuhmann, D., Lovis, C.,** (2007), Using argumentation to extract key sentences from biomedical abstracts. *International Journal of Medical Informatics*, Volume 76, Issues 2-3, 195-200.
- Trnkoczy, J., Turk, Z., Stankovski, V.,** (2006), A grid-based architecture for personalized federation of digital libraries. *Library Collections, Acquisitions, and Technical Services*, Volume 30, Issues 3-4, 139-153.
- Wang, J.,** (2003), A Knowledge Network Constructed by Integrating Classification, Thesaurus, and Metadata in Digital Library. *The International Information & Library Review*, Volume 35, Issues 2-4, 383-397.

ADAPTING INFORMATION TO REACH THE TARGET AUDIENCE

Christoph Peters
Institut Català d'Energia
Av. Diagonal 453, bis, 08036 Barcelona
Tel.: +34-93 / 6220500, Fax: +34-93 / 6220501
E-Mail: cpeters@icaen.gencat.net

Abstract

In the frame of the SARA project – Sustainable Architecture applied to Replicable public Access buildings – the Catalan Energy Institute ICAEN carried out different training and dissemination activities taking advantage of synergies with activities and material from other project partners. Special emphasis was laid on adapting the information conveniently to the different target audiences. The main outcomes are training and dissemination material on both, broad public and energy manager level: a sequence of posters that aim to raise awareness and change habits amongst building visitors, a user guide for staff to help them contribute to high energy performance, and an exhaustive good practice guide for energy managers within the SARA project, but also beyond the project limits for all kind of public access buildings.

1 Introduction

The Catalan Energy Institute ICAEN was mainly involved in two work packages of the SARA project: training and dissemination. At the same time, one of the project's ecobuildings, the "Primary Health Care Center Roger de Flor" in Barcelona, was just around the corner and allowed a direct follow-up of the design, construction and actually operational phase of the building. This made possible to detect and analyse the needs and opportunities for training and dissemination together with all involved stakeholders, being them architects, engineers, construction workers, Health Care Center staff, energy managers or visitors. The coincidence with a Government Agreement approved in May 2007 to make the employment of an energy manager compulsory for all Governmental operated buildings with an annual energy consumption superior to 200,000 kWh, enforced the elaboration of an energy good practise guide for professionals.

2 Dissemination

During the overall project duration dissemination activities were carried out in the frame of traditional presentations on congresses and workshops and by publications on print media and websites. A first approach to easily understandable information on the project objectives and the ecobuilding features of the Primary Health Care Center in Barcelona was developed as a leaflet on the design and energy installation innovations foreseen for the project building. In a common effort with all involved actors, mainly the local SARA partners, technicians and the responsible person in the Health Care Center, a second dissemination level was elaborated in order to attract the attention of the general public visiting the center and the staff itself.

The results are a sequence of posters for the visitors and a small user guide for the staff members and participants of a guided visit of the ecobuilding's innovative energy installations and water saving strategies.

The eight posters present in a very visual and comprehensive manner the highlights of the energy and water management in the center. They are designed in a way, that general information on the specific topics – solar photovoltaic energy, solar thermal energy, thermal insulation, solar protection, water management, lighting, ventilation, and heating and cooling - is given on one hand, and particular information on the implementation of these features in the Primary Health Care Center Roger de Flor is given separately. This approach increases the comprehension for the general public, but also makes the posters easily adaptable to other public access buildings, using the design and main text and completing the specific text field with particular information. Pictograms based on a design idea of the project partner *arsenal research* from Austria try to further ease visual comprehension of the different poster contents.

The posters are framed and exposed on both sides of the unique elevator area in each of the four floors with main public affluence. The location of the posters and the high percentage of photographs will guarantee the attention of the users. Taking into account that probably the same visitors will mainly frequent always the same floor due to separation of services, the posters are supposed to be changed after some time to make the overall information available to everybody and to increase attention.

The user guide continues the same design idea of the posters, but in a handy format of 20x20cm, widening the information on different levels. The technology is getting explained with more detail, as well as its particular implementation in the Primary Health Care Center. At the same time practical recommendations are given, on a comprehensive level, to make the staff aware of the importance of *their* contribution to ensure that the high performance appliances and control mechanisms really lead to a high performance in consumption and to achieve the goals set by administration and planners.

Finally, the poster design and input is also the base of the information displayed on a flat screen placed in the building entrance. Here, general information on innovative design principles and technologies, particular information on the Primary Health Care Center, and specific measured and frequently updated consumption data is mixed to give an overall view of the building's performance.



Figure 1: Posters for broad public (80x80cm)

A first experience – no post occupancy study was carried out – was reported by the director of the Center, who noticed the special attention of the staff members towards the energy performance of the building. Just due to a general poster located in the buildings entrance, the first leaflets on the reception desk and the vague knowledge that the building forms part of a European project, made them ask in several occasions about their possible contribution to the performance of the building. Hopefully, the information about the energy and water consumption given regularly by the Building Monitoring System on the screen in the building entrance and the positive attitude of the director of the Center will strengthen this self-competitive attitude of the staff towards energy efficiency. Another important issue to be taken into account is that the Primary Health Care Center is highly autonomous in its financial and technical management, so that energy and water savings are directly improving the economic balance of the Center.

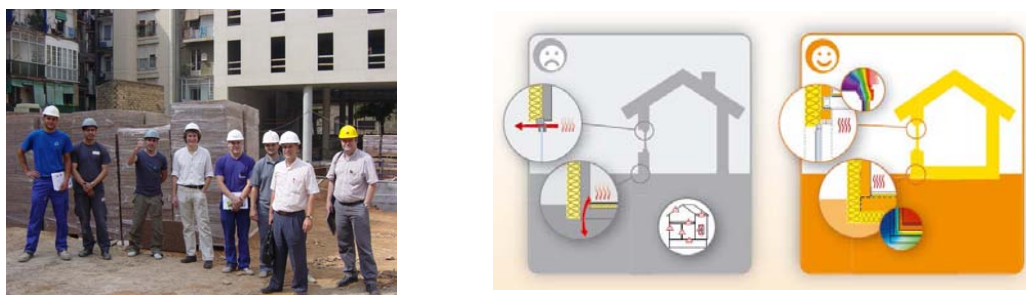


Figure 2: Training group photo and pictograms (thermal bridges)

3 Training

During the construction phase of the ecobuilding in Barcelona, a training workshop was organised for the construction workers at the site in order to make them understand the special objectives of this building and the importance of their good practise in implementing the special design features. The training material was based on the pictograms of *arsenal research* and got widened by a general introduction and particular details for this construction site.

The training counted on the participation of selected key workers of the relevant construction companies, especially from the installation sector. The selective approach to attendance allowed a very interactive session, as participants were able to interrupt and comment questions and possible doubts on the innovative approach of technical solutions in the Primary Health Care Center. The workshop was evaluated as a success and as a very effective tool for awareness building among the construction workers, whose influence on the buildings quality is immense and therefore of tremendous importance.

4 Good practise guide

As part of the training materials, three good practise guides were elaborated by the SARA consortium, as well as an exhaustive documentation on ecobuildings realised by the University of Ljubljana. The guides are dedicated to three different stages of the building process and operation: the first is analysing political and managerial aspects of how to start an ecobuilding initiative, which actors have to get together, which barriers have to be struggled to successfully promote the construction of an ecobuilding; the second guide is focussing on the design phase of energy efficient and low impact buildings; the third, elaborated by the Catalan Energy Institute, is addressed especially to the energy managers of public access buildings, as they are seen as main stakeholders on the way towards more energy efficient building performance, and evidently rare times count on an ecobuilding with latest technology as start point.

The good practise guide for energy managers gives a general overview over the main technologies used in heating, ventilating and cooling, lighting, control and regulation and water management in existing public buildings. It describes the different conventional equipment and its pros and contras, and gives arguments for its substitution with more energy efficient technologies. But as investment decisions may be not in the range of the energy managers competition and his activity may be restricted to propose changes to the directorate, in a special chapter the most important maintenance protocols are listed to ensure at least maximum efficiency in the operation of the conventional existing equipment. The guide gives furthermore a short introduction on upcoming technologies as cogeneration, solar thermal assisted cooling, and ground source heat exchange and shapes at least in Southern Europe innovative energy management approaches by Energy Service Companies and district heating and cooling.

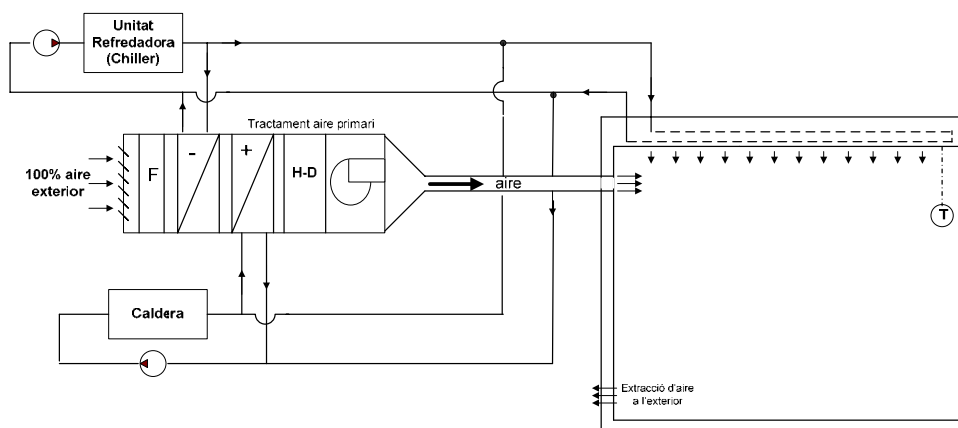


Figure 3: Two tube installation based on radiation: heating and cooling ceiling
(good practise guide for energy managers)

Both guides elaborated by the Catalan partners on designing and running of energy efficient buildings, will be presented to the target groups – planners and energy managers - in the frame of the European Solar Day on 16th of May in a special workshop in Barcelona.

THE ADDED VALUE OF EXPERT TECHNICAL ADVICE DURING THE DESIGN PROCESS

Anita Preisler, Susanne Gosztanyi
Sustainable Energy Systems / arsenal research
Giefinggasse 2, A-1120 Vienna
Tel.: +43-50550 / 6634, Fax: +43-50550 / 6613
E-Mail: anita.preisler@arsenal.ac.at

1 Introduction

The Integrated Project SARA in the 6th Framework Programme of the European Commission (EC) aimed to support the construction of seven sustainable, cost effective, high energy performed public-access eco-buildings which are immediately replicable at large scale in many locations. Therefore, seven demonstration buildings in six EU Member States (A, E, F, I, SI, UK) and one new Independent State (UZ) were selected.

An “Expert Technical Advice Service” (ETAS) provided horizontal knowledge transfer between eco-buildings in order to obtain efficient integration. Other specialised teams of participants were working in parallel on specific Research, Technology Development and Demonstration (RTD) issues related to integration of Building Management System (BMS), monitoring, internet based dissemination, socio-economic studies and training, to exploit synergies of all aspects of the project. The key aspects of the project are public-access buildings, innovative yet cost effective and replicable results, consideration of end users and an interdisciplinary team working on various RTD activities.

2 Method

The ETAS had to facilitate the knowledge transfer between the participants to achieve a high level of innovation that would have been difficult to reach in a conventional planning process. The target was to fulfil the following minimum requirements:

- Optimisation of building and energy concept to reach **30% reduction in energy** demand compared to conventional buildings
- **Replicability** of demonstration buildings
- Preferred use of **ecological building materials**

The actions set for all demonstration sites to reach the set targets can be summarized as following:

- Merge of requirements in the energy performance with the building design
- Low energy demand for heating, cooling and lighting
- Use of renewable energy sources to cover the energy demand of the building
- Use of ecological and regional available building materials

During the project duration many different tasks were asked from ETAS for each demonstration site, here are some examples:

- Co-operation between various experts, including ETAS, consultants, architects and others
- Support in conceptual design by definition of energy performance goals and strategies to achieve these goals
- Use of innovative design tools for simulations, calculations and analyses
- Selection of best options according to results and criteria of experts involved

- Specifying materials and energy efficient components (thermally activated building component systems, indoor comfort, buried air pipes,...)
- Design of renewable energy technology installation (Photovoltaic, Solar Thermal)
- Selection of monitoring and BMS components and systems

3 Results

The actions supported by ETAS can be divided in four sections:








- Energy efficient building envelope & passive solar strategies
- Innovative building constructions
- Energy efficient components
- Renewable energy integration

3.1 Energy efficient building envelope & passive solar strategies

The actions proposed for each demonstration site are listed in Table 1 for:

- Sufficient thermal insulation and efficient glazing
- Shading systems to reduce cooling demand
- Natural ventilation
- Daylight optimisation

Table 1: Energy efficient building envelope and passive solar strategies








	 France	 UK	 Spain	 Austria
Building type	Primary school / new building	Student service centre /new building	Health care centre/ new building	Office building/ new building
thermal insulation/ glazing	HQE requirements	energy certification	low energy optimisation	low energy optimisation
solar shading systems	standard	in-glass blinds, PV integration	fixed and mobile shading devices	external mobile shading
natural ventilation	cross ventilation	night ventilation, cross ventilation	not permitted	night ventilation in transition period
daylight optimisation	orientation of windows optimized	atrium	atrium	standard
	 Italy	 Slovenia	 Uzbekistan	
Building type	Office building/ retrofitting	Supermarket/ new building	Training centre/ retrofitting	
thermal insulation/ glazing	low energy optimisation	low energy optimisation	low energy optimisation	
solar shading systems	PV integration			
natural ventilation	cross ventilation	not permitted	night ventilation, cross ventilation	
daylight optimisation	Glass roof with PV	combination of sun-pipes & direct daylight	standard	

3.2 Innovative building constructions

The actions proposed for each demonstration site are listed in Table 2 for:

- Construction elements
- Ecological building materials

Table 2: Innovative building constructions








	 France	 UK	 Spain	 Austria
Building type	Primary school / new building	Student service centre /new building	Health care centre/ new building	Office building/ new building
construction elements	light-weight structure in wood	massive at office building, light-weight in atrium	pre-fabricated reinforced concrete	mixed construction
ecological building materials	wood, hemp (insulation)	timber panels, lime mortar, bricks	cork insulation, lime mortar, bricks	hemp, cork, reed insulation; innovative materials
	 Italy	 Slovenia	 Uzbekistan	
Building type	Office building/ retrofitting	Supermarket/ new building	Training centre/ retrofitting	
construction elements	massive construction (old)	pre-fabricated mixed construction	massive construction (old)	
ecological building materials	Tuff (traditional)	natural stone	clay, reed insulation	

3.3 Energy efficient components

The actions proposed for each demonstration site are listed in Table 3 for:

- Active ventilation
- Innovative heating & cooling system
- Water recovery

Table 3: Energy efficient components







	 France	 UK	 Spain	 Austria
Building type	Primary school / new building	Student service centre /new building	Health care centre/ new building	Office building/ new building
active ventilation	buried air pipes for pre-heating & cooling, heat recovery	earth air pipes for pre-heating & cooling, heat recovery	mechanical ventilation required, heat recovery	earth air pipes for pre-heating & cooling, heat recovery
innovative heating & cooling system	standard	standard	radiant ceiling system, air/air heat pump	activation of thermal storage mass, ground coupled heat pump
water recovery	rainwater harvesting	rainwater harvesting	rainwater harvesting, storage tank (15 000l)	rainwater harvesting
	 Italy	 Slovenia	 Uzbekistan	
Building type	Office building/ retrofitting	Supermarket/ new building	Training centre/ retrofitting	
active ventilation		mechanical ventilation required, heat recovery	earth air pipes for pre-heating & cooling	
innovative heating & cooling system	radiant floor system	radiant floor system	standard	
water recovery	rainwater harvesting	indirect waste water use for heat utilisation	rainwater harvesting	

3.4 Renewable energy integration

The actions set for the each demonstration site are listed in Table 4 for:

- Photovoltaic
- Solar thermal

Table 4: Renewable energy integration

	 France	 UK	 Spain	 Austria
Building type	Primary school / new building	Student service centre / new building	Health care centre/ new building	Office building/ new building
Photovoltaics	on roof (160m ²) 15kWp	roof integrated atrium (177m ²) 14kWp	on roof (95m ²) on façade (55m ²) 10kWp	on facade (50m ²) 5kWp
Solar thermal	not used	not used	On roof (23m ²) unglazed collectors	On roof (38m ²) flat plate & solar air collectors
	 Italy	 Slovenia	 Uzbekistan	
Building type	Office building/ retrofitting	Supermarket/ new building	Training centre/ retrofitting	
Photovoltaic	roof integrated (750m ²) 72kWp	facade integrated (80m ²) 9,6 kWp	roof integrated, pergola (48m ²) 4,8kWp	
Solar thermal	not used	not used	on roof (43m ²) flat plate collector	

4 Conclusion

Standard buildings are designed mainly to meet the requirements defined in national regulations for thermal insulation and building services. ETAS work made clear that the design of eco-buildings need significant changes in planning process.

The energy performance becomes a central question for design in the initial conceptual design phase. Therefore, building design integrating high energy performance levels (passive solar strategies, integration of renewable energy technologies) requires new approaches in design.

The intention to use photovoltaic as a façade integrated element and the ideas how to realise it, came in each case from the planning team itself. Most of the support provided by ETAS was for the selection and use of energy efficient components, first for setting up

possible concepts and then for dynamic transient simulations or computational fluid dynamic simulations for detailed planning.

One main lesson learnt is that the integration of monitoring as a planning task for evaluation and optimisation must be considered from an early status of planning, at least before realisation. The right time and procedure for implementation of monitoring hardware and software to get the required monitoring data was more crucial than expected. The co-ordination of different responsibilities in that topic, starting from the planners of building services, to the companies that produce and deliver measuring and control instruments and software, to the facility managers, is a task which has to be standardised in some way for future projects.

Generally, the role of the ETAS members in the different planning teams has changed significantly during the project duration from support for building services engineering to an integrated and active member of the planning team.

Ecobuildings

Public awareness, that the building sector is responsible for more than 40% of EU energy consumption and thus takes an important position for active climate change policy, has increased.

Technologies, which could substantially improve the energy performance of buildings, reducing the energy demand in new and existing buildings through combined measures of rational use of energy and the integration of renewable energy, are already available. Further R&D activities are also ongoing.

This booklet presents 4 Ecobuildings projects that were granted funding by the EU within FP6. The Ecobuildings concept is expected to be the meeting point of short-term development and demonstration in order to support legislative and regulatory measures for energy efficiency and enhanced use of renewable energy solutions within the building sector, where these go beyond the [Directive on the Energy Performance of Buildings](#).

The Ecobuildings concept has the potential for becoming a solid foundation for enhancing compliance concerning the essential refurbishment of the EU Building Stock with regards to its energy performance.



Bundesministerium
für Wirtschaft
und Technologie



LANDES-
HAUPTSTADT
STUTT GART

