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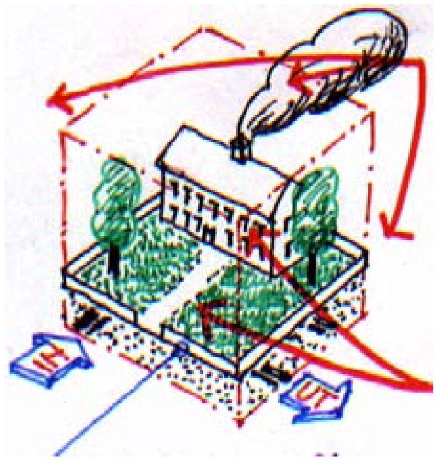
Energy Research in Sweden

Conny Rolén, The Swedish Reseach Council Formas

In conjunction with the 61st ECBCS Executive Committee Meeting in Abisko in the north of Sweden an ECBCS Technical Day was held on the 18th of June 2007. The Technical Day contained presentations on Swedish energy policy, energy statistics and key energy projects together with presentations of ECBCS projects. Representatives from governmental authorities, research institutes and universities were invited to speak on policy, programs, projects and results for the ECBCS Executive Committee and the ECBCS project managers. The main topic for the seminar was Energy Efficiency, New Technologies, Incentives and Regulations for a Sustainable Built Environment. After introductions to the Implementing Agreement by Morad Atif, Canada, chairman of ECBCS and Markku Virtanen, Finland, Vice Chair the following topics were addressed in the presentations:



- The National Framework for Energy Efficiency and Energy Policy in Sweden
- The Swedish National Energy R&D Program
- The Swedish Implementation of the European Directive on Energy Performance in Buildings
- The Program for Passive and Low Energy Buildings – a Swedish Implementation program
- The Dialogue Project Building, Living and Property!

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The National Framework for Energy Efficiency and Energy Policy in Sweden

On behalf of the Swedish Government, Conny Rolén from the Swedish Research Council Formas presented the Swedish energy policy. Sweden is a low carbon economy which can be explained by e.g.

- Fossil-free electricity production
- Energy-efficient industry
- High thermal standards in buildings
- CO_2 taxes and other policy incentives

The energy supply in Sweden in 2005 was about 640 TWh. More than one third of that is fossil fuel based, one third is nuclear power and a little less than 30 % is renewable energy. A little more than 50 % of the renewable energy is bio fuel and approximately 45 % is hydro power.

Swedish Energy Policy has the overall objectives to secure a reliable supply of energy at internationally competitive prices, and to create conditions for efficient and sustainable energy use and cost-effective energy supply with minimum negative impact on health, environment and climate.

New policy instruments in Sweden are:

- Emissions trading
- Green certificates
- Eco-taxes
- Long-term agreements
- Phasing-out of subsidies
- Information and education

CO_2-tax to reduce the use of fossil fuels was introduced in 1991 and a green tax shift with a strong focus on CO_2-tax in 2001. Emissions trading started in 2005.

Sweden's new government since October 2006, has put up the following objectives:

- Make it possible to break the link between economic growth and increased use of energy and raw materials
- Continued liberalization of energy markets
- Aiming at creating stable conditions for the longer term
- Increasing focus on international co-operation (Nordic region, EU, IEA, bilateral collaboration agreements)
- Buildings continue to be a prioritised area

The government has also expressed the need for

- Investment in climate related energy R&D
- A system perspective on energy
- Environmental technology export
- Support for energy saving measures within industry and implementation of a program for energy efficiency in existing buildings will be implemented

In June 2006, the Swedish Parliament approved a governmental bill National Program for Energy Efficiency and Energy-Smart Building that stated that the total use of energy, per heated floor area, shall decrease. The decrease should be 20% to the year of 2020 and 50% to the year of 2050, in comparison to the reference year of 1995 and that the dependence on fossil fuels for use in the building sector shall be broken by the year of 2020. During the same time the use of renewables shall continuously increase.

The Swedish National Energy R&D Program

Michael Rantil from the Swedish Energy Agency presented the Swedish National Energy R&D Program. The Government Energy RD&D Bill from 2006 states that Swedish Energy Research should:

1) Build the scientific and technological knowledge and competence that is needed to realise a transition to a sustainable energy system in Sweden (research)
2) Support the development and commercialisation of new energy technologies and services (innovation)

The Bill calls, among other things, for increased focus of the efforts, increased involvement of stakeholders in the strategic planning of

the energy research programme, emphasis on commercialisation and deployment of results and technology platforms for strategic planning.

The Swedish Energy Agency is responsible for Swedish energy research and development in all areas. The Agency is the third largest public research funder in Sweden, and covers all aspects of research, from basic research to implementation. The funds per year (2006) are 88 Million €. There are some 40 programmes and about 700 projects running. Approximately 50 % of the funding goes to universities and a little more than 20% to research/trade organisations and companies. Five percent goes to international research activities.

Six areas are prioritized as focus areas of Swedish energy research:

- Energy System Studies
- Buildings as Energy Systems
- Transport Sector
- Energy Intensive Industry
- Electricity Generation and Distribution
- Bioenergy, Including CHP

Examples of RDD programs directed or related to the building sector is

- Passive house and low energy buildings
- Procurement programs
- Electricity use in buildings
- Energy Technology programs

A new program is the Center for Energy- and Resource Efficient Construction and Housing Management, CERBOF with an overall budget €15 Million over 3 years. The program is technical as well as "soft issues – behavior, processes and policies". Active participation from private sector is required.

Swedish researchers and research funding organisations are taking part in international collaboration in e.g. EU and IEA.

The Swedish Implementation of the European Directive on Energy Performance in Buildings

Mari-Louise Persson from the National Board of Housing, Building and Planning presented the Swedish strategy for implementation of the European Directive on Energy Performance in Buildings. The objectives of the directive are to promote sustainable development, to obstruct a negative influence on health and climate, and to improve the energy performance of buildings.

The implementation of the directive will give the building owner information on cost effective measures and the potential for the building in decreasing the energy usage. It will also lead to more energy-conscious tenants and the possibility to compare energy efficiency for similar buildings.

An energy certificate will be issued for each building. Data about the building and the energy use of the building will be collected by an independent energy expert. The declarations will be collected by the National Board of Housing Building and Planning that will issue the certificate. A copy of the certificate will be placed in the entrance of the building. The certificate will be valid for 10 years.

The certificate will among other things include information on energy performance of the building, if radon has been measured, possible cost effective measures and reference values.

The certified energy expert is required to have special knowledge about energy use and indoor environment, and will have the task to inspect the building if necessary, to establish the energy certificate and to suggest measures.

The Program for Passive and Low Energy Buildings – a Swedish Implementation program

Lars Janhammar from IVL Swedish Environmental Research Institute presented a Swedish program on Passive and Low Energy Buildings.

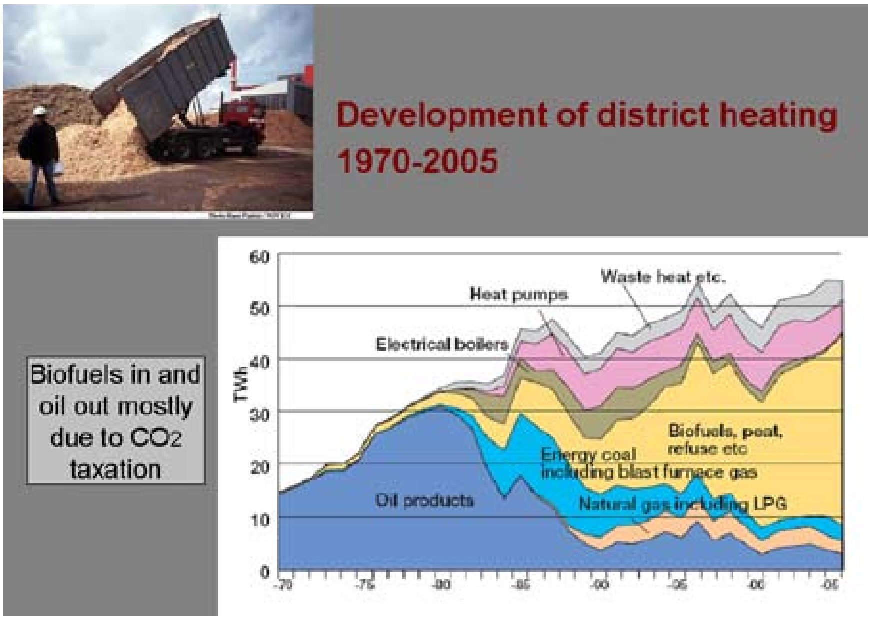
The objective of the program is to "contribute to establishing know-how capacity among property developers, architects, technical consultants and contractors regarding passive houses and low energy buildings, in new construction and renovation. All in order to halve the energy demand within the Swedish residential sector by year 2050".

A draft Swedish standard for passive houses is developed where the requirements are adapted to Swedish conditions and should be possible to achieve in a Nordic climate (two climate zones). The standard minimises supplied energy for heating to obtain the requested indoor climate with required hygienic air flow. The standard also has additional demands for efficiency to reduce total energy (including electricity, DHW and heating).

- Maximum power for heating, 10/14 W/m^2
- Maximum total energy, 45/55 kWh/m^2 (excluding electricity)
- Maximum air leakage, 0.3 l/s m^2
- Energy efficient windows, 0,9 W/(m^{2}K)

There are a lot of pilot passive house projects of different building types in Sweden, but they have to be verified. Each demonstration project supported by the Swedish Energy Agency includes a detailed evaluation program. Seminars and training are to be held to disseminate the results.

A National Forum for Energy Efficient Buildings – FEBY is formed by research organisations together with consultants. A growing market for passive houses opens new business opportunities.



The Dialogue Project Building, Living and Property! - Management for the future

Yogesh Kumar from the National Board of Housing, Building and Planning presented the Dialogue Project Building, Living and Property! The aim is to use dialogue between industry, municipalities and government as a compliment to legislation.

The Dialogue project includes 15 companies, 4 municipalities and the Government and is carried out in the form of agreements, commitments and projects. The main aims are to enhance industry's environmental efforts and to collect supporting data for political decisions on strategies and instruments. The strategies are partnership and voluntary agreements by means of State initiatives and sector initiatives. The first Agreement was signed in 2003. A new agreement was signed in May 2007

Prioritized areas are:

- Efficient use of energy
- Efficient use of resources
- Healthy indoor climate

The goals include more than 50 % renewable energy sources for buildings by 2015, purchased energy 30 % lower in 2025 than in 2000, hazardous material and structures will be excluded, all new buildings and 30% of existing buildings will have been issued with an environmental declaration and been classified by 2009, by 2005, the quantity of deposited waste will decrease by more than 50%, compared to the 1994 level.

Initiatives are taken within seven strategic areas:

- Sustainable community planning
- System selection and procurement with a life cycle perspective and a holistic view
- Quality and efficiency in the building and property management processes
- Property management for a better environment in buildings
- Classification of residential and commercial premises with regard to energy, environment and health
- Use of best available technology (BAT) and need for R&D for good environmental and energy solutions
- Information/implementation of sustainable solutions

Environmental Assessment of Buildings in Sweden

Mauritz Glaumann from the University of Gävle presented work on the environmental assessment of

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State of the Art of Annex 44 "Integrating Environmentally Responsive Elements in Buildings"

Per Heiselberg,

Operating Agent, Aalborg University, Denmark

Introduction

Research into building energy efficiency over the last decade has focused on efficiency improvements of specific building elements like the building envelope,including its walls, roofs and fenestration components, and building equipment such as heating, ventilation, air handling, cooling equipment and lighting. Significant improvements have been achieved, and whilst most building elements still offer opportunities for efficiency improvements, the greatest future potential lies with technologies that promote the integration of responsive building elements and communication among building services.

In this perspective, integrating Building Concepts are defined as solutions where responsive building elements together with building services are integrated into one system to reach an optimal environmental performance in terms of energy performance, resource consumption, ecological loadings and indoor environmental quality. Responsive Building Elements are defined as building construction elements which are actively used for transfer of heat, light and air. This means that construction elements (like floors, walls, roofs, foundation etc.) are logically and rationally combined and integrated with building service functions such as heating, cooling, ventilation and energy storage. The development, application and implementation of responsive building elements are considered to be a necessary step towards further energy efficiency improvements in the built environment. With the integration of responsive building elements and building services, building design completely changes from design of individual systems to integrated design of "whole building concepts".

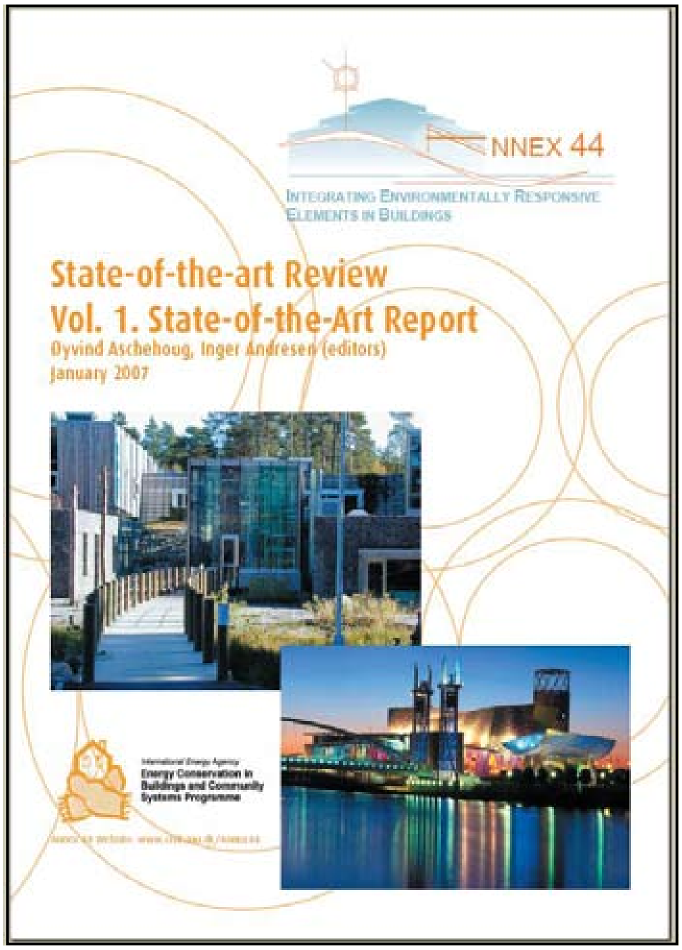
IEA-ECBCS Annex 44: "Integrating Environmentally Responsive Elements in Buildings" runs for 4 years from 2005-2008 and involves about 25 research institutes, universities and private companies from 14 countries around the world. The Annex has the following objectives:

- State-of-the-art review of responsive building elements, of integrated building concepts and of environmental performance assessment methods
- Improve and optimise responsive building elements
- Develop and optimise new building concepts with integration of responsive building elements, HVAC-systems as well as natural and renewable energy strategies
- Develop guidelines and procedures for estimation of environmental performance of responsive building elements and integrated building concepts

The first deliverable, the State-of-the Art Report, will be available from June 2007 from the Annex website. The following sections highlight the main topics covered in the report.

Responsive Building Elements

The work in Annex 44 focus on five specific responsive building elements (RBE), whose perspective of improvement and widespread implementation in the building sector seems to be promising. The state-of-the-art of these five different types of RBE is presented and discussed including analysis of the



working principles, design criteria and typical application fields as well as the "claimed" benefits and limitations are highlighted. Examples of application of RBE in existing buildings is examined and barriers to their widespread application discussed, focusing the attention on lack/availability of design tools and of experimental procedures to assess their performances. The five RBE´s are described shortly in the following.

- An Advanced Integrated Façade (AIF) is a building envelope that exhibits adaptive characteristics that are in tune with both the physical/ climatic conditions of a particular location and the indoor environment requirements. An AIF provides the basic functions of shelter, security and privacy, while minimizing energy consumption.
- Thermal mass (TM) is defined as the mass of the building that can be used to store thermal energy (for heating/cooling purposes). Components typically adopted when the TM concept is applied include: the building envelope, the interior partition, the furnishing, or even the building structure. A relatively new approach, is represented by a combination of TM and the radiant heating/ cooling of the buildings.
- The basic principle of the Earth Coupling (EC) is to ventilate air to the indoor environment through one or several buried ducts, in order to exploit the seasonal thermal storage ability of the soil. Frequently, this technology is also addressed as "Earth To Air underground Heat Exchangers
- The concept of Dynamic Insulation Walls (DIW) combines the conventional insulation and heat exchange characteristics of an outer wall, in order to effectively pre-heat the ventilation air. One of the most promising existing technologies is represented by the so called "Breathing Wall" (BW), which let an air transfer through a permeable insulation layer and act as a contra-flux mode heat exchanger.
- Phase Change Materials are suitable materials characterized by the fact that they undergo a phase change in a range of temperatures around the ambient temperature. The basic principle is to exploit their considerable capacity of accumulating heat at temperatures close to their melting point. This property can be used as a means of increasing the thermal inertia of the building components and, therefore, to smooth the cooling/heating loads.

Integrated Building Concepts

The state-of-the art report includes descriptions of 22 case study buildings with integrated building concepts. The buildings include office buildings, residential buildings, school buildings, and other public buildings, located in different climates in 8 different countries. This review provides descriptions of the buildings and their contexts, a description of the integrated energy systems, and the overall performance of the building with respect to energy, indoor environment and costs, where available. Also, barriers towards implementation and lessons learnt from the projects are summarized.

Integrated Design Methods and Tools

The state-of-the art report also includes an review of different integrated design methods and tools. Three methods can be described as process focused methods. They describe how to work during the design, what issues to focus on in what stages of design, how the issues may be organised, how they interact, etc. The Eco-Factor Method, is mainly focused on design evaluation. The method consists of a set of assessment criteria that may be used to evaluate a specific design scheme and compare it to a benchmark or to another alternative scheme. Three methods present a way to structure the technological design measures. These all stem from the Trias Energetica approach .They are based on the philosophy that the order of measures should be similar the "reduce-reuse-recycle" –principle, i.e. passive measures first, then renewable technologies, and at last efficient use of non-renewable resources.

The review also includes descriptions of 5 different computer based tools that members of the IEA Annex 44 have been involved in developing.

The methods may be organised into two main categories: design support tools and design evaluation tools. The design support tools are typically used in the early stages of the design to get an idea of what approaches and design schemes are the most promising for the given project. The design evaluation tools are typically used later in the design process to check the performance of a given design concept. There is no sharp border between the two types of tools. The design support tools may in some case also be used as design evaluation tools, and vice versa. The available computer simulation tools for predicting energy use and indoor climate are typically used as design evaluation tools, but may also be used as design support tools. In fact, in order to succeed in creating effective integrated building concept, it is very useful to apply advanced computer simulation tools in the early design stages.

In addition, the review includes a short overview of computer simulation tools that may be used to predict the performance of integrated building concepts and responsive building elements and at last, the chapter gives a description of uncertainty modelling in building performance assessment.

Further information

www.civil.aau.dk/Annex44

Holistic Assessment Tool-kit on Energy Efficient Retrofit Measures for Government Buildings (EnERGo).

An update of Developments in ECBCS Annex 46

Dr. Alexander Zhivov, USACE Engineer R&D Center, Champaign, IL, USA

Analysis of non-residential building structures shows that many government buildings are characterized by high energy consumption. Still, decisions to retrofit are often made without sufficient consideration of the many energy saving options available to retrofit designers, and energy saving measures are seldom applied when these buildings are retrofitted. In fact, such considerations can be facilitated by the use of some simple tools. An international group of researchers and engineers from Canada, Denmark, Finland, France, Germany, Italy, Poland, Russia, United Kingdom, and the United States are developing EnERGo, an interactive IT-tool-kit that will help executive decision makers, energy managers, performance contractors, suppliers, and designers, and different user groups to make informed decisions on government building energy retrofits. The objectives of this project (www.annex46.org) are:

- To provide tools and guidelines to identify energy conservation opportunities in Government and Public buildings and to improve the indoor environment of these buildings in energy-efficient retrofitting projects.
- To support decision makers in evaluating the efficiency and acceptance of available energy concepts.
- To promote energy- and cost-efficient retrofit measures by providing successful examples.
- To find improved ways of using Energy Performance Contracts (EPCs) for Government and Public buildings retrofit measures.

To accomplish these objectives, Annex 46 participants are conducting research and development in the framework of the following four Subtasks:

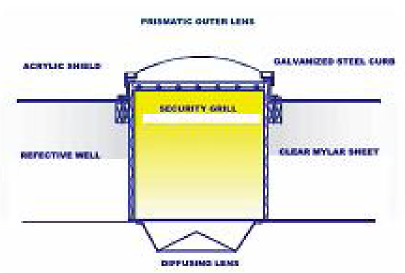
A: Develop an energy assessment and analysis methodology/protocol and the “Energy Assessment Guide for Energy Managers and ESCOs”

B: Develop a database of “Energy Saving Technologies and Measures for Government Building Retrofits” with examples of best practices and case-studies

C: Develop “Best-Practice Guidelines for Innovative Energy Performance Contracts”

D: Develop IT-Toolkit “EnERGo.”

The objectives of the Subtask A are to develop an energy assessment and analysis methodology/protocol and the “Energy Assessment Guide for Energy



(a) schematics of a modern skylight installation

(b) typical commercial application

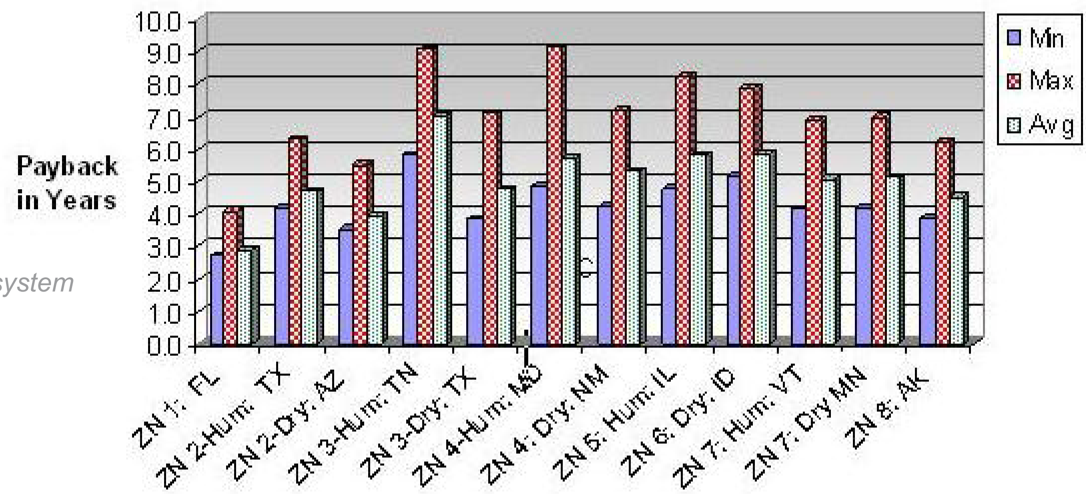


Figure 1. Daylighting system

(c) estimated payback shown for high, medium, and low energy rates.

Managers and ESCOs." Since the beginning of the Annex 46, Subtask A team members have analyzed best practices and procedures for identifying energy conservation opportunities in retrofitted Government and Public buildings. The opportunities relate to the building envelope, lighting, internal loads, HVAC, and other mechanical and energy systems. Disaggregating the information on energy consumption in the building or within the building stock is an important task in the assessment process where the energy use, demand, or costs are divided into components.

The results are illustrated in the form of a Sankey diagram, which shows the relative size of associated components (e.g., with the different building systems) or potential inefficiencies related to energy usage as done e.g. in the protocol for industrial buildings. It was agreed that the use of Sankey diagrams adds visual value to an assessment and can provide a basis for a graphical user interface that implements a hypertext type guide. The first Energy Assessment Protocol focused on industrial buildings, and was published by U.S. Army Corps of Engineers in October 2006. It has been reviewed and tested during energy assessments at some U.S. Army installations in Germany and the United States in 2006 and 2007. The protocol helped streamline the energy audit process and reporting, increase the scope and effectiveness of energy assessments, and reduced their costs. Experiences gained in these field tests will be used to improve Energy Assessment Protocol for industrial buildings and to further develop the Protocol for non-industrial buildings. New showcase assessments in Germany, Italy, Korea and the United States to be conducted by international teams have been planned for 2008.

The Subtask B team is developing a database of promising energy saving technologies and measures. These include technologies/measures that relate to building envelope, internal load reduction, lighting, HVAC systems, energy consuming processes in the building, supplemental energy systems (e.g., compressed air, steam system), etc.

The computer programs ESPr and Energy Plus have been identified to screen selected candidate technologies/measures– referred to as ECM's (=energy conservation measures). Three representative base case buildings have been defined for, respectively: offices, industrial buildings, and barracks/dormitories. Thirty representative climate locations for participating countries were selected and respective building characteristics were specified for base case buildings in these climates. The templates for technology and case study descriptions – including the results from the screening analyses have been developed and agreed to. The first set of 20 industrial ECM's has been developed using these templates, showing energy savings and payback analyses for 12 U.S. climatic conditions. Figure 1 shows a sample daylighting technology information included in these templates.

The objective of Subtask C is to identify and document the approaches countries have used to implement successful EPCs projects at government facilities in their countries, and to develop a set of consensus recommendations that can be used to improve existing EPCs programs, and to implement new programs in countries that currently lack them. These recommendations will be compiled in a Best Practices Guide for Innovative Energy Performance Contracts. This guide will be translated as necessary into other languages for use by participating countries. Country reports had already been prepared by Germany, the United States, Finland, and Denmark. The team is currently working on the outline for the Best Practices Guide.

Subtask D will develop an electronic interactive source book (IT-Toolkit "EnERGo"). A central database will include all project results and will allow users to obtain extensive information, according to their individual focus of interest: energy saving opportunities, design inspirations, design advice, decision tools, design tools, commissioning methods, long-term monitoring systems and measures that require no financial investment. Subtasks A, B, and C will provide their results as input to this joint activity. The IT Tool-kit "EnERGo" will be based on the Energy Concept Adviser (ECA) tool developed in Annex 36 (www.annex36.com). All participating countries have agreed to use the German standard DIN V 18599 as the calculation code for the part Retrofit Concept Development with the following national databases to be provided by the national representatives: climate, fuel data, age-dependent components/systems, standard user profiles, alternative efficiency figures (screenings or national experience), costs. Two calculation tools were defined to make validation tests for the IT-Toolkit: ESP-r and RETSCREEN. In case the DIN V 18599 cannot calculate some of the defined energy conservation measures (HVAC) either the results of the screening or additional available energy efficiency figures can be used.

Since its beginning, seven Annex 46 sponsored workshops were organized in Canada Finland, France, and the United States. As a part of ECBCS Program activity, a special Annex 46 workshop was organized during the EPIC 2006 Conference, sponsored by AIVC in Lyon, France in November, 2006. Workshop presentations and discussions promoted and gained support to the Annex 46 from the international industry experts. The next Annex 46 sponsored workshop Energy Efficient Technologies for Government Buildings - New and Retrofits is planned to take place in New York, USA on January 16-18, 2008.

Further information

www.annex46.org/workshops_seminars/fourth_workshop

Vision and Research Roadmap for Future Sustainable Buildings and Communities

Future Building Forum

The FBF workshop on Future Sustainable Buildings and Communities was organized to develop an R&D roadmap and increase and strengthen the co-operation of various experts in the scope of sustainable buildings and communities and related technologies within IEA. It took place on March 21st to 22nd, 2007 in Espoo, Finland.

The aim of the workshop was to identify R&D needs and new business opportunities in the scope of sustainable buildings and communities. The expected outcome of the workshop was a vision and a roadmap towards the vision concerning the energy system and the most important components of this system. The timeframe for the outlook is up till 2030.

Background

The building and construction sector is one of the key sectors for sustainable development. The construction, use and demolition of buildings generate substantial social and economic benefits to society, causing at the same time serious environmental impacts created by the use of energy, water and other natural resources, by land use and by waste generation. To achieve a sustainable community, these impacts have to be minimised. Any sustainable solution needs to fulfil the demands of ecological and economic as well as social sustainability.

The common view of the FBF Workshop participants was that, to reach this goal, the emphasis has to shift from technology development to market development. Many technologies are ready for the market, but the market is not ready for the new technologies! New thinking is required to move from the current way of making first-cost-based-business towards life-cycle-performance-based business. This will benefit both the consumer and the environment as well as the industry. There is still room for technological development, too.

Vision and Research Roadmap

The FBF Workshop resulted in the following vision statement:

 "By the year 2030, powerful and enlightened consumers surrounded by a culture of energy and environmental awareness will be able to select appropriate spaces provided by a business partner offering life-cycle performance based services in a low-energy-consuming built environment that produces carbon free energy according to demand."

There are currently several things working for the introduction of more sustainable buildings and communities, but still many barriers obstruct the way and must be tackled before a real breakthrough.

Taking into consideration these drivers and barriers, roadmaps towards the target (research priorities) were

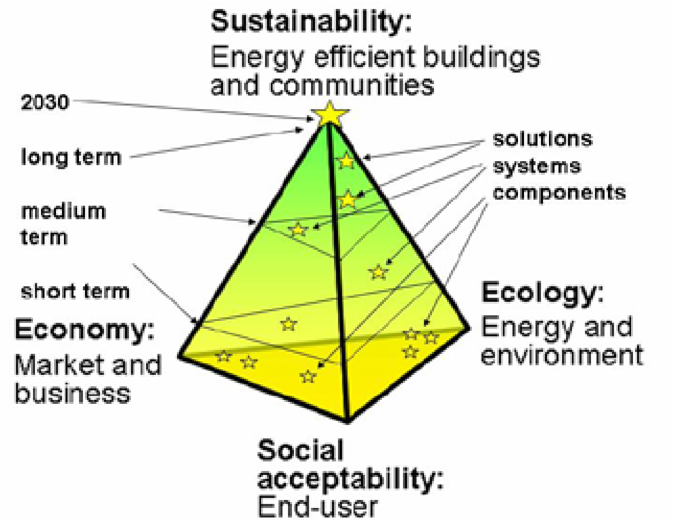


Figure 1. The development of the three aspects of sustainability towards the vision.

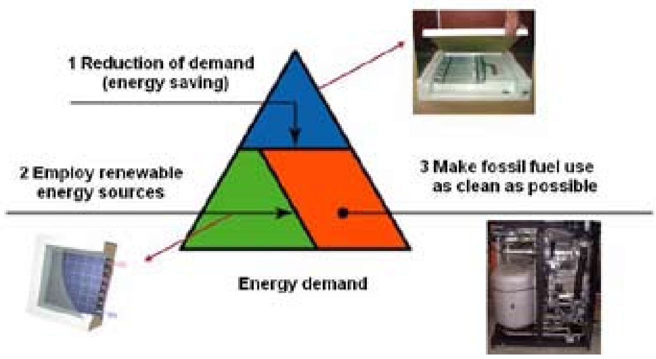


Figure 2. Energy impact of the applied methods can be described with the energy pyramid (adapted from Ivo Opstelten)

presented for four important areas of attention:

- **end-users:** this area describes sustainability from a social point of view
- **energy and environment:** this area describes sustainability from an ecological point of view; the focus in the roadmap is on energy issues
- **market and business:** this area describes sustainability from economical point of view
- **solutions:** different products and solutions are placed differently according to their ability to fulfil the three criteria. The final goal is a solution that fulfils all three criteria in a balanced way.

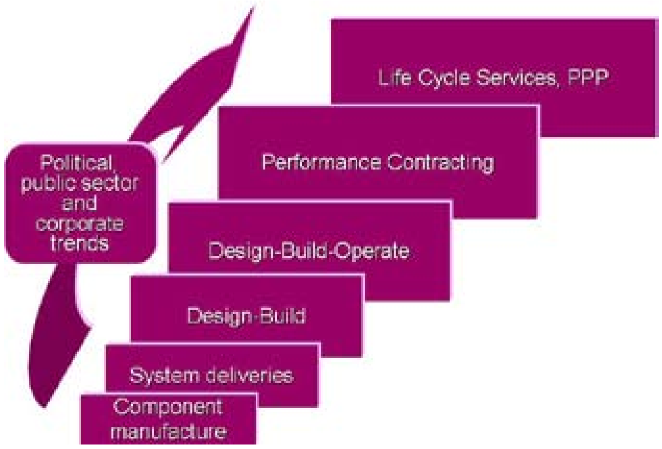


Figure 3. A vision about how added-value business-models could accelerate the change towards life-cycle optimised, service based business)adapted from Ilari Aho)

Future Scenarios

Many enabling technologies already exist to realise an economic solution for an energy efficient community that operates according to owners' expectations and users' needs. Some technologies still need to be developed, but the emphasis needs to be shifted towards market development. The building and construction industry still operates mainly on the basis of minimising the first-cost. Also, many consumers are only interested in the price. In some rare occasions life-cycle services are offered or required. Especially in the residential sector life-cycle thinking is virtually non-existent. People are usually not aware of the impacts of buildings on the environment. Local renewable and waste energy sources are rarely used optimally to supply the energy needs of the community. Partial and independant optimisation is the normal standard in both construction and energy design.

The current situation is represented with the bottom level of the tetrahedron in Figure 1, and the development has to move towards the top of the tetrahedron in all the three aspects. The solutions are represented by points inside the tetrahedron. There is a need to harvest the full potential of the designed concepts by taking advantage of all sides: business process, building and services process and the end-user's behaviour.

To move towards an energy efficient and environmentally sustainable building and community, some technologies still need to be developed, especially for compact, building-integrated storage of heat, cold and electricity. In the design of energy efficient communities, three actions are imperative, and should be used in the following order (see also Figure 2):

1. Reduce the heating, cooling and lighting loads to a minimum
2. Use the exergy of renewable and waste energy sources as effectively as possible.
3. Make fossil fuel use as effective and clean as possible.

The solutions resulting from the above mentioned design procedure should also be intuitive and robust, so that people would automatically be able to use the technology correctly, and not be able to cause fatal defects to the system, even if they fail to use it as it was designed to be used. The goal is to achieve integrated and performance-based solutions for energy efficient and environmentally friendly buildings and communities that support sustainability and produce carbon-free energy according to demand.

To improve the social acceptability of sustainable buildings and communities, information mechanisms have to be improved (e.g. energy issues should be integrated in education, and policy makers should be provided with concise and accurate information). Energy terminology has to be harmonized internationally. Attractive financial credits for sustainable buildings should be introduced. Reporting buildings must be developed by virtualisation and visualisation of energy use and performance with ICT. Demonstration and lighthouse projects act as important information channels.

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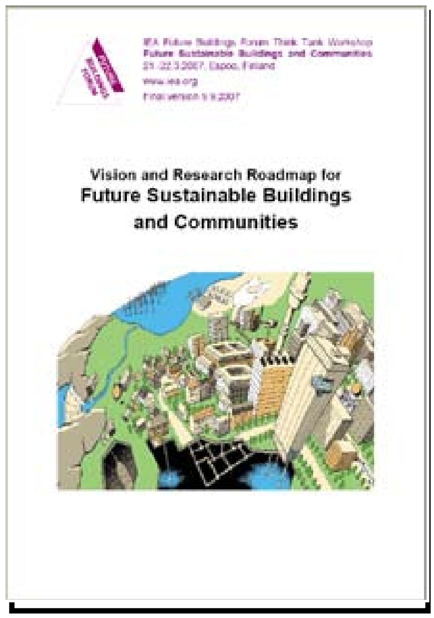

Marking Thirty Years of ECBCS Research

A Task from the Past

This year marks the 30th Anniversary of the signing of the contract formed by the Implementing Agreement for a Programme of Research and Development on Energy Conservation in Buildings and Community Systems by organisations representing 15 member countries of the International Energy Agency. This legal agreement formally established the ECBCS programme. The first ECBCS project, 'Annex 1 Establishment of Methodologies for Load / Energy Determination of Buildings', followed between 1977 to 1980. In this project, representatives from eight countries working with 19 different computer programs assessed the ability of computer models to simulate the thermal load and energy requirements of commercial buildings.

In the intervening years between then and now, ECBCS projects have directly supported the technical basis of many national building codes, standards, and regulations. Present and former researchers from ECBCS projects use the international knowledge they have gained to inform and improve their own national approaches. A current example of this is provided by ASHRAE Standard 140 'Standard Method of Test for the Evaluation of Building Energy Analysis Computer Programs' which was underpinned by many collective years of work developing BESTEST (Building Energy Simulation Test) by ECBCS and its sister programme, Solar Heating and Cooling.

Participants in Annex 1 checked the consistency and accuracy of their computer programs to assess how much confidence government policy makers and engineers could place in computer estimates of building energy requirements. Understanding differences in predictions about building energy use is important to architects and engineers studying the relationships between energy use and building architecture and to public policy makers developing energy performance standards for buildings.

In a second phase, participants compared eleven different computer models to predict the energy flows within the Avonbank office building near Bristol, UK. The results predicted by the models were compared with the performance of the building as determined by monitored data. One of the computer models checked was ESP-r. This had originally been developed by Joe Clarke during his doctoral research between 1974 to 1977. Validation trials for ESP-r began during the working phase of Annex 1 from 1977 to 1980, with funding from the UK Science and Engineering Research Council.

About the early work of Annex 1, one of the UK participants Jeremy Cockroft recalls, *"Joe Clarke and I were reminiscing about the early days of building energy modelling and simulation, and our recollections of the state-of-the-art around the late 1970's. We were both pioneering developers of simulation software, in those heady days long before the global warming debate, when energy conservation, driven by various "oil shocks" was becoming the in- thing. We have seen extraordinary changes over the intervening years; we didn't even dream it would be possible that whole building simulations would run on a 'desktop' computer in seconds, and give you graphical output right there on your screen! Of course some things have not changed so much; FORTRAN code is still alive and kicking, we continue to debate the results of validation studies, and the IEA ECBCS programme rolls on."*

"We remember the first meetings where we would write the results of our simulations on giant wall charts, some in S.I. and others in U.S. customary units (there was always a sizeable U.S. contingent). The spread of results was enormous, and motivated us to start the first of many validation efforts. Who remembers Avonbank, and the Collins building? Of course we started with too much complexity, instead of getting the basics right, and then building up."

"Much has been achieved, largely through the continuing activities of the ECBCS programme participants. Simulation technologies are coming of age. The market for software and consultancy services flourishes, and use of the tools is enshrined in many countries' building standards and codes of

Participants from Annex 1 Conducting a Beer Test (Circa 1980) *practice."*

But who does remember Avonbank? Part of the answer, Clarke, Cockroft and the other Annex 1 participants may be pleased to learn, is that almost 30 years later about 8000 copies of the Annex 1 reports on the multiple simulations of this building are downloaded from the ECBCS website each year.

Although BESTEST procedures were not formalised until ECBCS Annex 21 in collaboration with SHC Task 12 , this initial international collaboration provided an ideal opportunity to investigate possible approaches. As Ron Judkoff (current Operating Agent for ECBCS Annex 43 / SHC Task 34) explains, *"BESTEST evolved from the important lessons learned in the early projects that when conducting validation studies it is vital to start with simple cases and add complexity systematically so that there is a clear diagnostic path for analyzing model to data and model to model differences. Also, when collecting measurements for use in model validation, it should be done in a disciplined way, taking into account the input requirements, underlying assumption and limitations of the models. Annex 1 contributed to the collective understanding of how to better do these things."* Of most significance, many thousands of buildings now constructed world-wide are more energy efficient because they have been simulated using models that have undergone BESTEST evaluations. Without such work, there would be much less confidence in computer modelling as an everyday design tool.

During the completion of Annex 1, various areas were identified where the simulation of building energy transfer processes needed further development. This has led to a series of related projects, all with the common theme of thermal simulation of buildings, including the following major ECBCS studies:

- Annex 10 Building HEVAC System Simulation
- Annex 21 Environmental Performance of Buildings
- Annex 30 Bringing Simulation to Application
- Annex 42 The Simulation of Building-Integrated Fuel Cell and Other Cogeneration Systems
- Annex 43 Testing and Validation of Building Energy Simulation Tools

The Future

For the continuing work of the ECBCS programme on model evaluation, Annex 1 laid solid foundations. In future, engineers will be required to model ever more complex systems. It is likely these will include not just isolated buildings, but community wide energy systems incorporating renewable energy technologies. ECBCS is now in the process of finalising the Strategic Plan for the period 2007 to 2012, which will further develop this theme.

Further information

Reports from many completed ECBCS projects are available from:
www.ecbcs.org/docs

The history of ESP-r can be found at:
www.esru.strath.ac.uk/Programs/ESP-r_tut/history.htm

Additional information about BESTEST:

www.eere.energy.gov/buildings/tools_directory/doe_sponsored_bestest.cfm.

Improving Energy Efficiency in Commercial Buildings (IEECB'08)

Fifth International Conference

Congress Center Messe Frankfurt, Frankfurt, Germany, 10 - 11 April 2008
taking place during the Light+Building Fair

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http://energyefficiency.jrc.cec.eu.int/ Fifth International Conference

Micro-Cogen 2008

First International Conference and Workshop on Micro-Cogeneration Technologies and Applications

April 29 - May 1, 2008

It is our great pleasure to invite you to participate in MICRO-COGEN 2008, the first international conference and workshop on micro-cogeneration systems and applications, which will be held from April 29th to May 1st 2008 in Ottawa, Canada.

MICRO-COGEN 2008 is a forum for presenting the latest research, development and demonstration results in a broad range of small cogeneration technologies including technical and policy analyses, deployment strategies, comparative analysis, and studies on sustainability and societal and environmental impacts.

The conference will also act as a close-out of Annex 42 of the International Energy Agency's Energy Conservation in Buildings and Community Systems Programme, which aimed to develop, validate, and implement models of a variety of cogeneration devices for whole-building simulation programs.

The workshop will bring together researchers, manufacturers, electric and gas utilities, policy makers, regulators, and builders to discuss the current state of microgeneration technologies, future development trends, barriers and opportunities for collaboration for speedy deployment. International experts will share their vision, extensive experience and knowledge gained through modelling, lab and field trials and will discuss the applications of a variety of microgeneration technologies in the residential/ commercial energy sector world wide.

For more details, see www.nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/Events/cogen_2008/index_e.htm.

Conference Topics

Residential/Commercial Microgeneration Systems Sustainability

- National and International Programs and Perspectives
- Environmental Issues
- Economy and Financing
- Social Acceptance

Microgeneration technologies

- Solid Oxide Fuel Cells
- PEM Fuel Cells
- Stirling Engines
- Internal Combustion (IC) Engines
- Thermophotovoltaics (TPV)
- Thermoelectric (TE)
- Others

Building integration and controls

- Balance of plant (BOP) design and operation
- Control strategies

Standards and regulations

- Performance standards
- Safety standards
- Interconnect standards

Field Trials and Demonstrations

Simulation-Based Performance Assessments

Thermal and Electric Load Profiles

IMPORTANT DATES

Conference dates – April 29-30, 2008

Workshop date – May 1, 2008

Further details will be sent out via email.

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Symposium on Building Envelope Sustainability: The Future is in the Balance

Marriott Wardman Park, Washington, DC
April 30 - May 1, 2009

The two-day symposium will focus on evolving philosophies concerning the most cost-effective methods to address construction of sustainable building envelopes. Please e-mail abstracts and/or questions to: CJ Walters, RCI Foundation, 1500 Sunday Drive, Suite 204, Raleigh, NC 27607-5041 (phone: 800-828-1902 / e-mail: cjwalters@rci-online.org).

Continued from page 10

The progress from the current way of making partial-optimised-first-cost-based-business towards life-cycle-performance-based business models could happen through the changes described in Figure 3.

The results are described in the document “Vision and Research Roadmap for Future Sustainable Buildings and Communities”.

Further information

www.vtt.fi/liitetiedostot/muut/fbf_roadmap.pdf

Continued from page 4

sification and needs for the development of such methods.

Regarding the characteristics of assessment tools, an inventory has shown that

- Tools are generally developed as commercial products
- The scientific background is seldom presented
- The topics assessed differ greatly between tools
- There is a lack of agreed methodology for weighting
- A very different result is obtained with different tools for the same building

More scientific examination of assessment tools and debate about approaches, results and interpretations are needed

Different possible indicators can be more or less appropriate for characterising an environmental problem with regard to:

Theoretical aspects:

- Validity (to what extent is the addressed problem measured?)
- Accuracy (how accurately is the addressed problem measured?)
- Repeatability (do repeated measurements produce the same result?)

Practical aspects:

- Influence (to what extent can the owner influence the result?)
- Intelligibility (how easy is it to communicate the indicator?)
- Cost (how costly is it to collect data needed for calculations?)

Indicators need to be systematically evaluated before adoption.

A Swedish project for the development of an environmental classification method was presented discussing the wanted and possible indicators in such a method.

EcoEffect, a Swedish building environmental assessment system that has been developed during the last decade was also presented. EcoEffect is LCA-based and is divided into:

- External impact - emissions and depletion- and covers energy use and materials use
- Internal impacts- health and biodiversity- and covers indoor environment and outdoor environment
- Life cycle costing

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