Introduction to Panel 2
Making buildings more energy efficient

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HARDLY ANY OTHER SECTOR HAS such great prospects in energy saving as the building sector. In industrial countries space heating and cooling are the main "consumers" of energy (globally mainly fossil fuel is used). In the early years of the 21st century, the energy use in the built environment in the European Union (EU) accounted for more that 40% of the total energy use. This means that buildings, in contrast to popular belief, contributed more greenhouse gases than traffic (approx. 31%) and industry (approx. 28%). According to the Japan Ministry of Economy, Trade and Industry "Energy supply-and-demand actual result in 2002 fiscal year" the corresponding figures for Japan are: buildings 27%, traffic 24% and industry 49%.

It has been possible to build comfortable built environments anytime and anywhere by using energy-consuming technology, not only for heating and ventilation but also for air conditioning and lighting systems. The building designers have many choices when designing houses. There is a challenge to achieve a comfortable indoor environment with good air quality by using energy efficient technologies.

Cost-effective technologies exist that could reduce the energy use in buildings by 22% in the EU. This would help to minimise greenhouse gas emissions. One of the greatest opportunities in conserving energy is to reduce heat transfer through the building envelope (walls, roofs, floors, windows, etc.) by improved thermal performance (better insulation, better windows and air tightness). These measures are suitable for both new and existing buildings and have a strong linkage to a sustainable development. There is also a great opportunity to reduce cooling demand by improved thermal insulation, especially in attics and roofs, and by using different solar shading devices.

It should be stressed that the greatest environmental effect of a building does not occur during its construction, but later, during the usage of the building, through heating, cooling, hot water, lighting, and so forth.

A large amount of this energy use is unnecessary. Using modern technology, it is now possible to reduce the energy needs of buildings substantially.

Under the Kyoto protocol, the EU committed itself to reduce the emissions of greenhouse gases (GHG) by 8% in the period 2008 to 2012, compared to the level in 1990. Regrettably, not all industrial countries have signed the Kyoto protocol. The emissions of carbon dioxide (CO_2), the most important greenhouse gas, are mostly linked to the combustion of fossil fuels. Therefore, increases in energy efficiency are expected to contribute considerably to the achievement of the GHG emission reduction goals.

Our call for papers has resulted in a large number of very interesting papers and posters. The contents cover a wide range of aspects connected to energy efficiency in buildings. In Europe, the on-going implementation of the EU-Directive on the energy performance of buildings resulted in much work in all member states. Methods for energy certification of buildings are under development in many countries and many researchers and consultants are involved in that work. Development of new EN-standards to determine, calculate and express the energy use in buildings is under way. Case studies presented in the papers always give useful results that need to be shared and taken into account when developing new tools and when Member States have to set new minimum energy requirements on new buildings and for buildings that are under-going renovations.

The selected papers in Panel 2 cover four main topics: energy performance and certification of buildings, bringing

down cooling demand, low energy buildings and proper building management. In addition to these there are also some papers dealing with more strategic questions like the planning processes.

ENERGY PERFORMANCE AND CERTIFICATION OF BUILDINGS

Under this topic several aspects on implementation of the energy performance directive and the energy certification of buildings are given. Maes *et al*'s results show both important advantages and problems for future public acceptance of the procedure for certification outlined in the directive. Schilken and Magnin discuss methods to display the energy use in buildings and compare with methods for classifications used for household appliances. Methodologies for successful implementation of new building energy efficiency passive technologies are demonstrated in projects in Australia by Macfarlane and Szental.

Sunikka presents an analysis of the consequences of the energy performance directive regarding the renovation of existing buildings. As the breakpoint for renovation is buildings larger than 1 000 m^2, the effectiveness of the directive will be very limited. A combination of taxes and energy certificates could be more promising.

In the Netherlands, a survey has been done in order to evaluate the effect of the energy performance coefficient which is used in the Dutch building regulations. In practice there are many deviations from what has been explained for the building permit, but the deviations result in both better and worse buildings. Incorrect use of the installations is often reason for higher energy use than expected. Influence of behaviour is a well-known reason for deviations in energy use in similar houses. A Dutch analysis (Boerakker and Jeeninga) show on the other hand that stricter norms lead to corresponding energy saving. One problem is that the consumers want to have larger dwellings, which result in increasing energy use even if the houses are built more energy efficient.

BRINGING DOWN COOLING DEMAND

A main focus of the summer study is summer comfort and cooling requirements. Motivation for this important topic could not have been put better than by Henderson's paper "How much energy would we use, if we became more like American households". This general outlook will be completed by the interesting data of Dupont and Adnot. They address the possible consequences of the EU Building Directive, especially inspection and auditing of air conditioning facilities. Okamoto *et al* underline the significance of the cooling problem for the Japanese market, with a special focus on the summer peak load reduction, stimulated by a governmental programme for gas cooling. To complete the global journey around the "cooling markets", Edwards and Marnay identify Californian regions for promising and economically feasible implementation of absorption chillers by the modern means of a GIS-based method. The session will be completed by the very useful reminder of Kinney, that cooling can be simply and effectively provided by using simple natural mechanisms such as the chilling effect of evaporating water.

PROPER BUILDING MANAGEMENT

Energy efficiency in buildings cannot only be reached by technical investments. Much more focus should be set on the building operation and the "human factor". Planning an energy optimised building is one question, operating and managing seems to be a different one. "Are predicted energy savings still realized after several years of use?" is the consequent question of Eijadi *et al*. "Yes, if the operation staff is integrated in the planning process", answer Aune and Bye. They use a social approach to get a better understanding of the role of building operators.

As buildings are not always as properly designed as intended, as they are not always as properly operated as designed, as money is not always available as wanted, some people make business out of the human failures: energy services can systematically turn down energy consumption by more than 20%, as a growing number of successful projects in the public building sector demonstrates. But can this success story be transferred to the private building sector? asks Grim. Hawkes *et al* also identify a new challenge for energy services using grid-connected micro-combined Heat and Power and a time-of-use electricity tariff. Vermeulen *et al* investigate the diffusion of energy innovations among project developers, using a sophisticated and theoretical model of the decision-making process.

LOW ENERGY BUILDINGS

Making existing buildings more energy efficient is a real challenge for the near future. Hermelink presents an interesting combined research and demonstration project on how to make an integrated eco-efficient renovation of large residential buildings in Eastern Europe. All flats are owner occupied while the retrofit measures are carried out. Active facades that can change thermal performance by using sun shading devices lower the energy use. (Koene *et al*). Four different active facades are studied in a special test facility and a building simulation program is used to assess the potential of the energy savings of the different facades constructions. Cler and Kinney discuss the use of insulating shutters for improvement of thermal insulation and thermal comfort.

The energy bill in offices is often very small compared to other costs in the office. Therefore energy efficiency in offices is rarely taken into account. Guertler *et al* argue for the benefits in property valuation, addressing the investment criteria of increased rental return and future investment worth. The authors point out that without stronger legislation or higher energy prices, energy use in commercial buildings will become ever more important than the cost of tea and biscuits.

Much energy is used for lighting in commercial buildings. More use of daylight is emphasised in recommendations for energy saving. Vaidya *et al* present results from studies where the expected savings have not been provided. There exist several opportunities for mistakes when designing advanced daylight passive technologies. The authors propose methods and use of checks to increase the chances of success.

Neumann *et al* identify in their paper some recent low consumption non-residential buildings around Europe, which have been operated for a while. The success strongly

depends on the motivations, experiences and incentives of all players involved. The paper discusses ways to motivate the building owners to invest in low energy non-residential buildings.

Implementation of low energy houses can be problematic, if energy sales and thus long-term-investments in district heating infrastructure are touched. Späth describes the decision making process of municipal stake holders and inhabitants of the low-energy district.

For good success in erecting energy efficient buildings, it is very important that all actors involved in the building process work with the same goal. Poel presents the development of an integrated design process that makes sure that energy efficiency, the use of renewable energy and wishes of the owner/user are integrated in the design of buildings from the very first moment. He presents demonstration projects with good results.

POSTER SESSION

A lot of interesting research has been done all over the world, especially covering technical developments for low energy houses, organisational improvements in building management and motivational campaigns for better understanding of the energy consumption in buildings.

On low energy houses and technical improvements

In our poster session Bagge and Lindstrii will present interesting results of a long-term evaluation of two low-energy houses in Sweden. They are very clear on the fact that technical design is one part, and the other part is the appropriate behaviour of inhabitants and operation of the equipment.

In Denmark, an investigation of the potential of energy savings potential in existing buildings has been made. Dyrböl *et al* present that profitable savings of energy used for heating of 60% can be achieved in the building stock if the energy performances are upgraded when buildings are renovated. In year 2050 a cost effective savings potential of 82% is identified.

Steinbock *et al* explain the experiences of designing a zero-energy-building in Minnesota. The designed building – a science house at the Science Museum – utilizes passive solar design, daylighting, ground source heat pump and photovoltaic as the major design strategies. The predicted and actual monitored performance is documented in the poster.

In Norway a building network was established in 1996 as a measure to promote rational use of energy. Ettestöl presents the energy use in different types of buildings by energy source and type of end use. The changes in energy use from year to year in the period 1996-2003 are described.

In a poster Guertler and Smith present good practice case studies of high rise residential refurbishment from across Europe. High rise buildings have often poor energy efficiency. The benefits of energy efficiency investments is increased thermal comfort, potentially improved health and quality of life and avoided investment in supply infrastructure

On better building management

Verdict and Wei present both the technical and the business case for the operation scheme of 'continuous commissioning' and show its successful application on the campus of Alamo Community College District.

On motivational and informational campaigns

An initiative from the Wuppertal Institute to enforce the international recommendations into practice is presented by Wallbaum *et al*. The project has set up a common platform by which realisation of new project ideas can be supported and information of successful examples spread.

On decentralised generation

Aspects of decentralised generation are covered by Zhou *et al*: they give a simulation for different Japanese building types and show the potential of peak load reduction, if combined heat and power generation would be employed in combination with absorption chillers. Also aiming at decentralised generation Archibald presents results of an UK funding programme with a special focus on PV systems.