Introduction to Panel 8 Buildings technologies and systems beyond energy efficiency

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Introduction

The latest report by the International Energy Agency states that in 2018 the building sector represented 28 % of global CO_2 emissions. In the past decade, there has been a strong uptake of energy efficiency measures in the newly constructed building stock, mainly supported by the provisions of the Energy Performance of Buildings Directive. Energy saving measures such as extensive thermal insulation and high efficiency glazing have become mainstream for newly constructed buildings. An important challenge however remains in upgrading a big proportion of the building stock, which is still largely energy inefficient and in need of deep retrofits.

Apart from traditional energy efficiency measures, novel technological advancements can spur the performance of the building stock, both existing and new. Smart controls can bring further energy and carbon reductions, but also additional benefits such as increased comfort and flexibility towards smart energy grids. Finally, measurements and behavioural data allow for the evaluation of designs and the performance gap to be addressed. This panel looks beyond traditional energy efficiency technologies and systems.

Energy management in education buildings

Buildings in university campuses can often form a test-bed for field studies. The uniformity in terms of energy supplier, energy management and financial management allows the exploration of additional challenges when implementing energy efficiency measures. Fonseca et al. (8-100-19) describe the steps and the challenges in achieving a nearly zero energy building in one of the buildings in the University of Coimbra in Portugal, after installing a PV system to cover the annual electricity demand. Svendsen & Riis Christiansen (8-144-19) describe barriers and challenges in implementing energy management in the University of Copenhagen, highlighting the need for the organisation to be capable to make decisions regarding both energy saving measures and financial matters, as well as having access to data and the building management system (BMS). Lopes & Amaro (8-158-19) describe the implementation of energy efficiency measures in a part of the Polytechnic Institute of Coimbra. Measured data are compared with the modelled predictions and further evaluation in terms of potential knock-on effects (deployment and uptake of further energy efficiency projects) are presented.

Building commissioning and performance monitoring

Recent advances in monitoring equipment have allowed the collection of high-resolution data in homes and this now plays a significant role in evaluating building designs in terms of energy performance. Östin & Nair (8-187-19) report on extensive measurements and evaluations of the most northerly built passive house preschool in Sweden. The monitoring reveals that the controls of the ventilation system and shading are not properly set-up, resulting in unnecessary energy consumption and the occurrence of discomfort. Gupta et al. (8-315-19) present evidence on the magnitude and extent of the difference between predicted and measured energy performance of over 50 low energy dwellings in the UK. The results showed that energy use was higher than predicted by 60 % on average but in some cases by more than 100 % and up to 240 %. Findings suggest that in new builds, the probability of an energy performance gap in space heating can be over 80 %, with the

pattern of occupancy having the largest impact. Webborn et al. (8-113-19) present a project that will provide a secure channel for researchers to access energy data from UK smart electricity and gas meters, and link it to relevant contextual data (e.g. socio-demographics, building characteristics, weather data etc.) and discuss the challenges for setting up such platform in a secure and reliable way.

Urban energy modelling and design

Buildings are an integral part of a complex urban system that often can play a significant role in the energy used and produced within its boundaries. Haase (8-279-19) discusses the concept of Positive Energy Districts, and how a systemic use of indicators that address the interaction and integration between buildings, the users (consumers and producers) and the larger energy system can spur new business models. Pagliano & Erba (8-360-19) present a matrix of interactions between building and district design with a focus on the emerging issue of summer comfort under a warming climate. The authors argue that the energy savings from easy access to facilities such as cycling, walking and line drying can in many cases be more relevant than the pure technical efficiency that is often the subject of energy policies. The research paper by Johari et al. (8-362-19) reflects on the use of energy simulation tools for Urban Building Energy Modelling (UBEM) and assesses four different tools and their modelling procedures and checks the validity of the outcomes against thermal energy measured data from a neighbourhood including 32 district-heated buildings in Sweden. The results showed that the predicted annual heat demand can deviate between -16 % to +18 %.

Load shifting and energy flexibility in buildings

Buildings are not only part of the urban tissue, but also interact with the energy grids. By exploiting the flexibility to shift energy demands in time, the uptake of renewable energy sources can be strengthened and the carbon footprint of buildings can be reduced. This however requires new business models and changes in how buildings and their technical systems are used by the occupants. Hanmer et al. (8-098-19) investigate the daily heating patterns in UK homes that have a hybrid heat pump installed (a heat pump and a gas boiler), operated by smart heating controls. Measured data as well as interviews explore the residents' reactions to the changed heat delivery patterns due to the use of heat pumps. The results show that evening temperatures were adjusted upwards manually and the temperature requirements were strongly linked to the timing of practices taking place in homes. Salzman et al. (8-337-19) provide a new taxonomy for flexible building technologies: flexible timing, flexible efficiency, flexible fuel source, and flexible frequency/voltage regulation. Each of these flexibilities is linked to grid services recognised by electricity markets and analysed in terms of technical potential and optimisation requirements.

High performance systems and technologies

High performance buildings require appropriate technical installations and control strategies. Kolb & Osojnik (8-304-19) present the importance of hydronic balancing in heating and cooling systems and the profitable business cases that this can yield when retrofitting building installations. Tettey & Gustavsson (8-142-19) show that apart from the technical building systems, the building envelope construction methods can also be important. This is showcased by exploring life cycle primary energy implications of different frame construction systems under various climate scenarios. Di Costanzo (8-264-19) discusses the potential roles for fuel cell micro-cogeneration in an increasingly integrated, flexible and low carbon energy system. Azizi et al. (8-227-19) evaluate demand control HVAC and lighting to assess the energy saving potential of upgrading conventional building energy systems – with a specific focus on occupancy detection technologies. Reiter et al. (8-397-19) present the demand cost curves for building related saving measures in the residential sector, focusing on refurbishment of old buildings and the construction of new buildings. By modelling a number of different energy efficiency measures packages and scenarios the authors correct pathways and potential for energy and cost savings. Persson & Larsson (8-150-19) describe how the lack of high-performance heating and ventilation equipment on the market, and the failure of a competition to stimulate innovation, led to a joint development project between housing developers and heating and ventilation equipment manufacturers that resulted in new products with improved indoor air quality and reduced electrical peak load. With the need for cooling increasing in an unprecedented rate across the planet, Kumar et al. (8-240-19) present a study with the aim to establish the energy savings in the use of air-conditioning in India through the adoption of adaptive thermal comfort. The results showed that it is possible to achieve 8–10 % energy savings for every degree °C increase in the set-point (from 22 °C to 27 °C) of inverter room air conditioners.

Enabling energy efficiency

Energy efficiency is mainly associated with technical improvements in buildings and systems, however in many cases the barriers that prevent considerable uptake, are often connected to the occupants and the conditions surrounding their comfort and living. Adisorn & Vondung (8-284-19) report the barriers in the diffusion of Mechanical Ventilation and Heat Recovery (MVHR) systems in Germany. The results showed that there is no such thing as silver bullet measure and that there needs to be concerted action on many different levels to sensitise and incentivise the actors shaping and making MVHR decisions. Nestle et al. (8-115-19) present a gamification based energy management approach that aims to motivate temperature adjustment in rooms or buildings that are not used. The authors suggest a reduction in heating demand by 5–15 % and a payback period of less than 5 years. Gether et al. (8-319-19) report on practical experiences with a 15-year energy and climate performance contract for 11,000 m² of college buildings. The work of Konstantinou (8-384-19) focuses on one of the first deep retrofit projects for multi-story social housing to be carried out in the Netherlands, resulting in a net energy surplus on an annual basis for standardised occupancy. Kooger (8-194-19) describes a project that aims to enable greater uptake of energy efficiency measures in homes by addressing and reducing the hassle factor. The presented approach is a synthesis of the home owner's

perspective on energy efficiency retrofit and practical knowledge of private parties in this field. Löfström et al. (8-368-19) present a study exploring the hypothesis that measurement and communication of odours linked to types of residential ventilation may allow for a new way of evaluating indoor air quality and strengthen arguments for energy efficient ventilation. The authors conclude that a standardised monitoring method with clear definitions is needed before allowing for such a concept to be explored. Boork & Katzeff (8-353-19) present a project that explores the consequences of energy efficient office buildings on the employees' work environment. The authors conclude that there is a lack of research on the interaction between the environmental and the social aspects of the activity-based workplace.