Introduction to Panel 5A Cutting the energy use of buildings: Projects and technologies

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Introduction

Buildings account for 40 % of Europe's energy use. Still, energy efficiency has not lead to a decrease of total energy consumption yet. But at least it avoided further increase. Despite financial crisis and rising energy prices several developments counteract efficiency improvements. Private households are one example: a growing number of smaller households (one- and two-person-households) living in bigger flats, kept at warmer temperature, using more electrical appliances more often. So the focus on buildings still is of particular importance when it comes to energy efficiency. The eceee Summer Study responds to it by splitting the buildings panel, offering double the presentations.

Panel 5A mainly focuses on single projects, measures or aspects of energy use and energy efficiency improvement in buildings. The papers presented can be grouped into five thematic areas:

- efficiency standards and building codes,
- interdependencies between efficiency and financial, social and other aspects,
- the ESCO market,
- electricity use in buildings,
- and several examples and projects from different European countries.

Efficiency standards and building codes

To categorise efficiency in buildings different codes and standards have been and are currently developed. Some standards have clear requirements as the "passive house standard" in Germany. Others as yet are to be negotiated, e.g. the "nearly zero-energy building" that is required for all new buildings in the European Performance of Buildings Directive (EPBD) from 2020. Existing codes and standards cannot be easily spread worldwide as different climate zones, construction patterns, building materials, etc. influence energy demands.

Christopher Anthony Moore et al. show possible ranges and definitions of energy performance for different climate zones worldwide in paper 5A-426-13 ("A global strategic approach to energy efficiency in the building sector"). Jingjing Zhang and Lars J. Nilsson on the other hand focus on one, namely the passive house standard. In paper 5A-275-13 they compare from a Technological Innovation Systems perspective how the passive house diffused (and still is diffusing) from its niche onto the markets of Germany, Sweden and China ("Comparative analysis of energy efficient technology innovation in buildings: the case of passive houses in Germany, Sweden and China"). Rajan Rawal et al. summarizes two important initiatives taken up in India for making energy code implementation and enforcement easier "ECOnirman & third party assessors: innovative approaches to energy code compliance and enforcement in India" (5A-518-13). Rajat Gupta et al. discusses how efficient low/zero carbon houses actually are and how to close the gap between design intent and actual performance (5A-483-13, "Tackling the performance gap between design intent and actual outcomes of new low/zero carbon housing").

But as we know the rate of new buildings is rather low in Europe and it is not enough to build energy efficient new houses. To reach the targets of lower energy consumption and reduced CO_2-emissions in the building sector existing buildings need to be renovated to low energy levels as well. But how far can we get with the existing building stock as we find a wide range of obstacles here? Peter Mellwig et al. have analysed current "Technical restrictions on retrofit insulation of buildings" in Germany (paper 5A-228-13). The result shows the demand for heating energy that cannot be refurbished away.

Financial, social and other effects of energy efficiency

Energy efficiency in buildings has more effects than "only" saving energy, as there are e.g. lower energy bills, higher comfort levels and improved indoor climate coming along with positive effects on inhabitants' health. In paper 5A-098-13 Jaryn Bradford et al. report about positive effects like higher comfort levels and lower costs as well as about difficulties in understanding new technologies ("Retrofit for the Future: reducing the carbon emissions of the UK's housing stock"). Jean-Michel Cayla and Dominique Osso take a closer look on financial effects as they ask: "Does energy efficiency reduce inequalities? Impact of policies in residential sector on household budget" (paper 5A-309-13). In paper 5A-397-13 Farshid Bonakdar et al. analyses the potential final energy savings and cost-effectiveness of different energy efficiency measures for a Swedish multi-story residential building ("Implications of energy efficiency renovation measures for a Swedish residential building on cost, primary energy use and carbon dioxide emission").

As energy efficiency measures can have broader effects in social, financial and other ways there are interdependencies vice versa, too. Karin Engvall et al. had a look at the "Interaction between building design, management, household and individual factors in relation to energy use for heating in residential buildings in Stockholm" (paper 5A-325-13). And Erica Löfström and Åshild Lappegard Hauge surveyed in paper 5A-428-13 seven renovation projects to find out if participation of residents can support the integration of energy efficiency and general upgrading. ("Participation as a driver for energy efficiency and universal design: learning from case studies of ambitious upgrading of post-war multi-residential buildings").

Energy efficiency markets

In Europe extensive refurbishment will be needed to reach the 2020 targets. To boost the market for energy-efficient heat recovery systems for apartment blocks, five local housing companies in Sweden, in conjunction with the Swedish Association of Public Housing Companies and the Swedish Energy Agency, announced a technical procurement project for systems (5A-104-13 Åsa Wahlström et al., "Technical procurement of heat recovery systems in existing apartment blocks in Sweden").

One of the most determining obstacles for energy efficiency being implemented in buildings more widely are high investment costs. Energy Service Companies (ESCO) that invest into efficiency measures and get paid back through energy savings are one solution to overcome investment obstacles. ESCOs offer services for different target groups and in different sectors, for industries as well as in the residential sector. Next to its clients ESCOs differ in share of investments and risks. Therefore, Laziza Rakhimova et al. suggest a "Typology of the energy performance-based contractual models for comprehensive refurbishment in the buildings sector" (paper 5A-012-13).

Though the idea of ESCO services is convincing and good practice can be found in many European countries, the market is developing rather slow. In paper 5A-524-13 Wolfgang Irrek et al. survey existing barriers and suggest some new ideas how to stimulate the ESCO market ("ESCOs for residential buildings: market situation in the European Union and policy recommendations").

Electricity use in buildings

In the paper of Richard Bull et al. ("Are people the problem or the solution? A critical look at the rise of the smart/intelligent building and the role of ICT enabled engagement", 5A-079-13) the role of technology versus human behaviour is discussed. Also the role of social media and digital technology is discussed as a means to influence behaviour and to in crease energy efficiency.

J Richard Snape and Peter Boait's paper (5A-162-13) "Enhancing energy efficiency through smart control: paths and policies for deployment" illustrates the potential for smart controllers to alter demand patterns over time both with and without distributed generation. They show the effect of order of adoption of devices at the householder level on the energy consumption of their building, but also on consumption at a larger scale and highlight issues for policy makers designing policies intended to incentivise a transition towards smart control of energy demand.

Nicholas DeForest et al. (5A-204-13) present a simulation study of a large office building in four distinct geographical contexts: Miami, Lisbon, Shanghai, and Mumbai. In the simulation thermal storage is modelled as an alternative for capital intensive expension of grid required due to the peak load caused by air conditioners. Thermal storage, in the form of ice or chilled water, may be one of the few technologies currently capable of mitigating this problem cost effectively and at scale. Cold storage capacity allows a building to meet its on-peak air conditioning load using electricity purchased off-peak. In this way, cold storage has the potential to fundamentally alter consumption dynamics and reduce impacts of air conditioning ("Thermal energy storage for electricity peak-demand mitigation: a solution in developing and developed world alike").

On markets where feed-in support for PV has declined, or is not yet in place, home energy management systems (HEMS) and batteries could be interesting for increasing the value of on-site PV power generation. These systems typically provide scheduling of programmable appliances. In their paper ("Evaluating the benefits of a solar home energy management system: impacts on photovoltaic power production value and grid interaction" 5A-237-13) Joakim Widén and Joakim Munkhammar investigate how HEMS perform in Swedish detached single-family buildings equipped with PV systems. The main conclusion is that these systems have a potential for improving the PV self-consumption and production value by a few percent, but unless extensive battery storage is introduced, they are unlikely to have any marked impact on distribution system management.

Luis Munuera et al. (5A-099-13) describe the crucial role of energy efficiency in mitigating the cost of decarbonizing heat. They state that this role has been gravely underestimated in system-level modeling studies that drive current EU energy policy.

The analysis demonstrates that beyond fuel and cost savings, energy efficiency has a crucial role in mitigating the cost of decarbonising heat – a role that has been gravely. The analysis provides the foundation for more robust future studies of the role of energy efficiency and electrification in the decarbonisation of heat ("The role of energy efficiency in decarbonising heat via electrification").

Efficiency measures and new technologies influence and modify the energy market: demand as well as the supply side. But to expand renewable energies, develop smart control systems and energy storage further it is necessary to know what amount of energy is needed when and where not only today but in future as well. In paper 5A-206-13 Tobias Boßmann et al. have a look at the development of electricity demand in Germany ("The German load curve in 2050: structural changes through energy efficiency measures and their impacts on the electricity supply side").

Building and practicing energy efficiency

When it comes to energy efficiency measures some of the first questions are usually: Which measures shall I take? And how much energy can I save? Which ones are most cost-effective and beneficial for me? These questions were addressed inter alia in a project called HOMES. Olivier Cottet et al. present findings in paper 5A-373-13: "Optimising buildings energy performance with a new perspective – lesson learned by HOMES programme: possible savings up to 50 % with short payback possible".

In paper 5A-025-13 Davide Calì et al. present findings from monitoring three identical buildings that have been renovated with different materials, technologies and building elements to compare the energy savings reached ("Holistic renovation and monitoring of residential buildings").

Geoffrey Stevens and Jaryn Bradford (5A-338-13) reports on the largest UK field trial to monitor the in-situ performance of solid walled properties and retrofit solid wall insulation (93 dwellings in England). The field trial has gathered building performance data including: environmental conditions; wall surface temperature; and gas and electricity usage all at 5 minute intervals. Thermal imaging, u-value and air tightness measurements have also been carried out, and all measurements have been taken before and after insulation ("Do U-value insulation? England's field trial of solid wall insulation").

Paper 5A-179-13 takes into account that public building owners are supposed to serve as good example in terms of implementing the EPBD. Gerhard Hofer et al. describe the development of an energy efficient building stock by "Introducing (energy) design processes into Austria's largest public real estate company".