EBC
Energy in Buildings and Communities Programme

EBC NEWS

Issue 65 | June 2017

03 ENERGY AND GHG POLICY, TARGETS AND RESEARCH FOR UK BUILDINGS
06 EMBODIED ENERGY AND CARBON DIOXIDE FOR BUILDINGS
08 CHARACTERIZING SUPER-INSULATION MATERIALS
10 ENERGY FLEXIBLE BUILDINGS
12 IN-SITU ENERGY MEASUREMENTS
13 NEW EBC PROJECTS

IEA Strengthens Energy Efficiency Leadership

Dear Reader,

In November 2016, I was honoured to address the National Energy Efficiency Conference held in Sydney, Australia, for which EBC provided international speakers and delegates to help to share knowledge on energy efficiency in buildings. The IEA recognises the critical role of clean energy in all aspects of energy policy, and is strengthening its leadership in this area, particularly in energy efficiency. As part of the modernisation of the IEA, our vision is to become the global hub for analysis and expertise on energy efficiency. The breadth of the analytical expertise in the IEA Technology Collaboration Programmes is a unique asset to the global transition to a cleaner energy future. EBC has led important research on the key themes of building design, systems, envelope, data and community scale that support global energy efficiency action through the IEA network. Research on embodied energy, lifecycle impacts and net zero energy communities are enabling an improved global dialogue on how buildings can help to achieve energy and climate targets. This in turn is feeding into partnerships such as the Global Alliance for Buildings and Construction, which has developed a roadmap that considers embodied energy. With investigations into the long-term performance of key building technologies, the EBC research is providing the industry with clarity on the energy efficiency potential benefits and risks. Research on occupant behaviour, adaptive thermal comfort and energy flexible buildings are creating new ways to manage user and building energy demands. The data collection for energy epidemiology and performance assessments is helping to create the evidence base that is key to how we make decisions on energy use in buildings. Each of these and the other research projects create a fundamental base that will enable our long-term energy efficiency aspirations. This kind of underpinning knowledge base is essential for the global energy efficiency agenda. We recognize and value the work of the EBC as a very important element of driving energy efficiency action globally for everyone's benefit.

Dr Brian Motherway, Head of Energy Efficiency, IEA

Cover picture: The Marks and Spencer retail store at Cheshire Oaks, one of the best performing buildings in the Innovate UK BPE programme.
Source: Marks and Spencer

Published by AECOM Ltd on behalf of the IEA EBC Programme. Disclaimer: The IEA EBC Programme, also known as the IEA Energy in Buildings and Communities Programme, functions within a framework created by the International Energy Agency (IEA). Views, findings and publications of the EBC Programme do not necessarily represent the views or policies of the IEA Secretariat or of all its individual member countries.

EBC Executive Committee Support Services Unit (ESSU), c/o AECOM Ltd
The Colmore Building
Colmore Circus Queensway
Birmingham B4 6AT
United Kingdom
+44 (0)121 262 1920
newsletter@iea-ebc.org

Online version (ISSN 1754-0585): available from www.iea-ebc.org

Energy and GHG Policy, Targets and Research for UK Buildings

Paul Ruyssevelt

Evidence based research is strengthening policies for buildings with 2030 reduction targets, following good progress in lowering power sector greenhouse gas emissions.

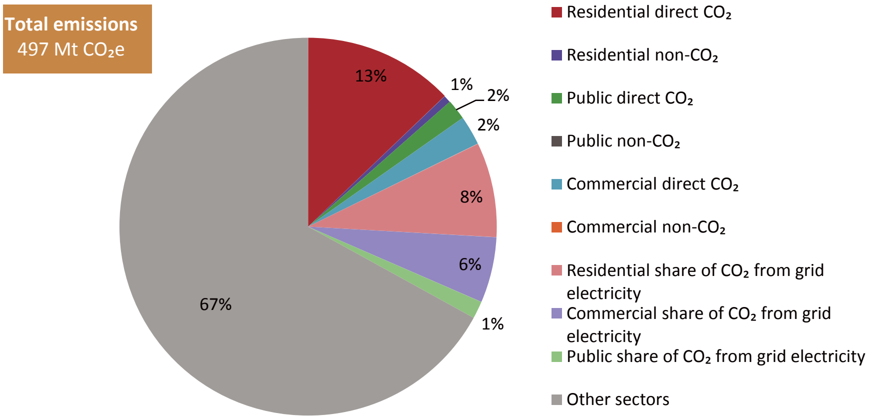
The Climate Change Act 2008 in the United Kingdom established a statutory target to achieve at least an 80% reduction in national greenhouse gases (GHG) by 2050 against a 1990 baseline, to be attained by meeting five-yearly 'Carbon Budgets'. In 2016, the Government accepted the Committee on Climate Change (CCC) recommendation that the Fifth Carbon Budget should be set to achieve at least a 57% reduction greenhouse gas emissions by 2030 against the 1990 baseline. The UK also has a legally binding renewable energy target of 15%, as part of the European Union's overall target of 20% renewables by 2020.

In fact, UK GHG emissions had by 2015 already fallen by 13% over a three year period to a total of 38% below 1990 levels. However, most of the drop in emissions has been in the power sector, as a result of reduced use of coal and increased generation of electricity from renewables and thus the CCC has proposed that new and improved policies are required to continue the good progress to date and to broaden this reduction to other sectors.

The Fifth Carbon Budget shows that GHG emissions associated with buildings need to fall by a further 22% between 2015 and 2030, with options to be developed to support near-zero emissions by 2050. The CCC 2016 Progress Report makes it clear that this requires:

– Clear, consistent and credible policies to drive deployment of heat pumps and district heating, including: immediate action to address barriers (for example upfront cost, low awareness) alongside the Renewable Heat Incentive and development of a more comprehensive policy package to drive the higher uptake needed in the long run.

Greenhouse gas emissions from buildings in the context of total UK emissions in 2015



Direct emissions from buildings accounted for 85 $MtCO_2$-equivalent (MtCO2e) (18%) of UK greenhouse gas emissions in 2015, mainly from use of fossil fuels for heating. Direct CO_2 building emissions are split between homes (75%), commercial buildings (15%) and the public sector (10%). In 2015 electricity consumption in buildings was 204 TWh and this contributed a further 76 $MtCO_2e$ (15%) to UK emissions. Source: Meeting Carbon Budgets - 2016 Progress Report to Parliament, Committee on Climate Change

- Standards to ensure new-build properties are highly energy efficient and use low-carbon heating systems by default.
- A stronger policy framework to drive residential energy efficiency improvement by addressing gaps and strengthening existing policies, including: addressing behavioural factors for the able-to-pay, increased funding for fuel poor households, an effective approach to the private-rented sector.
- More progress on improving the energy efficiency of non-residential buildings, including: a consolidated reporting mechanism for commercial and public buildings, new emissions reduction targets for the public estate, new policies to support SMEs in England.

Buildings research

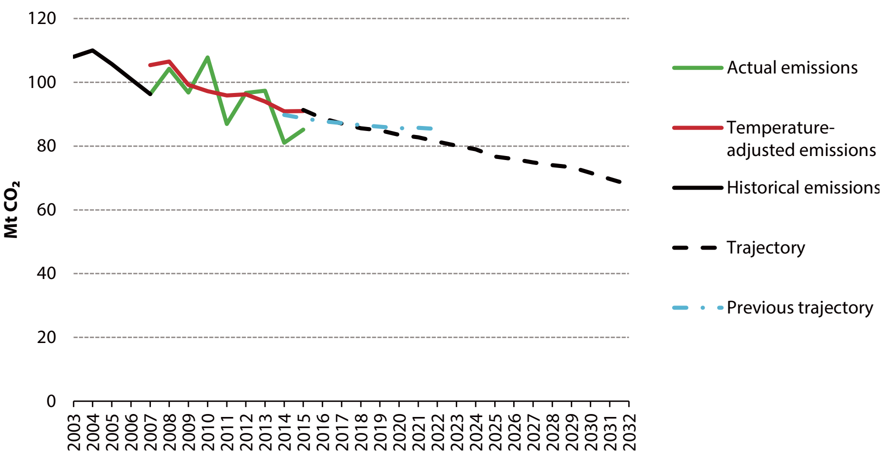
In recent years the UK Research Councils have committed considerable funding to analyse energy demand in buildings and identify cost-effective means of reduction. Approximately £30 million has been spent to set up six End Use Energy Demand (EUED) Centres, four of which address energy use in buildings:

- The Dynamics of Energy, Mobility and Demand Centre starts from the perspective that energy is not used for its own sake, but in the course of carrying out social practices at home, work and transport.
- The RCUK Centre for Energy Epidemiology links data from energy suppliers with data about buildings and people from other sources to build a clearer picture of how people use energy, and whether taking certain energy saving actions is effective.
- The Centre on Innovation and Energy Demand, uses a 'socio-technical' approach to look at the impact of new technologies, social arrangements and modes of behaviour on reducing energy demand.
- The Interdisciplinary Centre for Storage, Transformation and Upgrading of Thermal Energy look at a range of innovative tools for use in domestic and industrial central heating, air conditioning and storage.

The EUED Centres focus for the most part on residential energy use. Hence, a complementary programme was established to support research in 'Energy Management in Non-Domestic Buildings', which has provided £3 million for six projects.

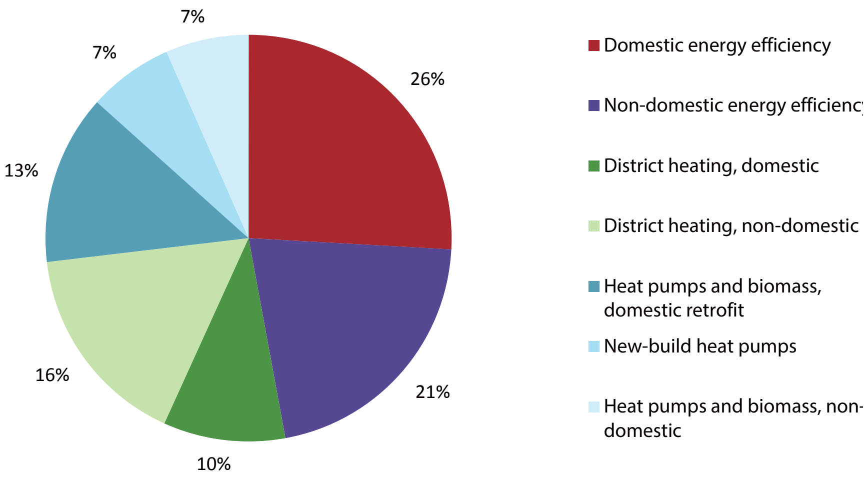
Two major programmes of near market research have been funded since 2011 by Innovate UK (formerly the Technology Strategy Board). The first, a £17 million programme to fund innovation in residential building retrofit, the Retrofit for the Future Programme, provided part-funding for over 100 projects to retrofit existing social housing to achieve an 80% cut in carbon emissions. The dataset relating to this programme is available online through the EMBED platform. Whilst only a small number of these projects achieved the full 80% emissions reduction target, most made significant reductions in excess of 50% and many useful lessons were learned towards implementing deep energy reduction retrofits. The second programme, Building

All buildings direct emissions - updated indicator trajectory to 2032



The emission reductions in buildings to date and the trajectory which is a realistic pathway for buildings consistent with meeting future Carbon Budgets, for which the starting point is temperature-adjusted emissions in 2014.
Source: Meeting Carbon Budgets - 2016 Progress Report to Parliament, Committee on Climate Change

Direct emissions abatement in 2030 in buildings, CCC central scenario



Breakdown of the measures that will need to be applied to achieve the 22% reduction greenhouse gas emissions associated with buildings between 2015 and 2030. Source: Sectoral Scenarios for the Fifth Carbon Budget, Committee on Climate Change, 2015

Performance Evaluation, provided £8 million to fund the evaluation of 101 contemporary projects which aimed to deliver best practice energy and environmental performance. Fifty three projects involved residential developments, with 350 homes in total, and 48 projects involved non-residential buildings. The full dataset for these projects is also online at the Building Data Exchange. The research encompassed analysis of the design and construction process, operational performance, energy and environmental performance and occupant response. The programme highlighted many successful projects and identified important lessons associated with these successes.

Learning from successful building operation

One such building performance evaluation project is the Marks and Spencer store at Cheshire Oaks (shown on the front cover) that demonstrates high levels of occupant satisfaction alongside good energy performance. At the project inception stage, a target was set to achieve 30% energy reduction with 35% lower carbon emissions compared to a similarly sized store operated by the same retailer. In reality, the store achieved a 42% energy reduction and 40% carbon emissions reduction over the comparator store. The Cheshire Oaks store incorporates a combination of innovative and tried and tested technologies, including earth mounding to help stabilise indoor temperatures, free cooling delivered through a displacement ventilation system, a biomass boiler which, together with heat recovery, provides 70% of the space heating, good natural lighting with daylight control of the sales floor lighting and LED car park lighting. Schemes like this one, which draw on previous operational experience and include effective performance monitoring, point the way for a new generation of successful low carbon buildings in the UK.

Further information

The Carbon Plan:
www.gov.uk/government/publications/the-carbon-plan-reducing-greenhouse-gas-emissions--2
Meeting Carbon Budgets:
www.theccc.org.uk/publication/meeting-carbon-budgets-2016-progress-report-to-parliament/
Sectoral Scenarios for the Fifth Carbon Budget:
www.theccc.org.uk/publication/sectoral-scenarios-for-the-fifth-carbon-budget-technical-report/
EUED: www.eueduk.com
Retrofit for the Future: www.retrofit.innovateuk.org
EMBED: www.getembed.com
Building Performance Evaluation:
www.connect.innovateuk.org/web/building-performance-evaluation
Building Data Exchange:
www.buildingdataexchange.org.uk

Paul Ruyssevelt is Professor of Energy and Building Performance at the Energy Institute, University College London.

Embodied Energy and CO_2 Equivalent Emissions

Completed Project: EBC Annex 57

Tatsuo Oka

The findings of an EBC research project on reducing embodied energy and carbon dioxide for building construction can be widely deployed for the greatest impact.

As a personal reflection on the outcomes of our recently completed major EBC research project, 'Annex 57: Evaluation of Embodied Energy and CO_2 Equivalent Emissions for Building Construction', I am privileged to offer a number of recommendations for consideration by policy and decision makers. I have based these on some of the extensive scientific research findings created by the experts from our 17 participating countries.

Background

The embodied energy consumption (EE) and embodied energy-related carbon dioxide emissions (EC) associated with building construction are defined respectively as the fossil fuel energy used by the whole building construction process, along with the related CO_2 emissions. In fact, EC has been estimated to currently account for about 20% of total annual CO_2 emissions worldwide (J. Civil Engineering and Architecture, 9, 2015, 300-307). EE and EC are influenced by a number of stages within the entire process, including: extracting and processing of raw materials; manufacturing of construction materials and products; transportation of materials and products; construction of the building.

Further, other greenhouse gases are used in the manufacture of certain insulation materials and in the manufacture and operation of chillers, particularly fluorocarbons, and their impacts can be converted to equivalent CO_2 emissions, and used to adjust evaluations of EC accordingly. Embodied total greenhouse gases can be quantified in terms of the sum of EC and the equivalent CO_2 emissions from other greenhouse gases, with the total written as EC_{eq}.

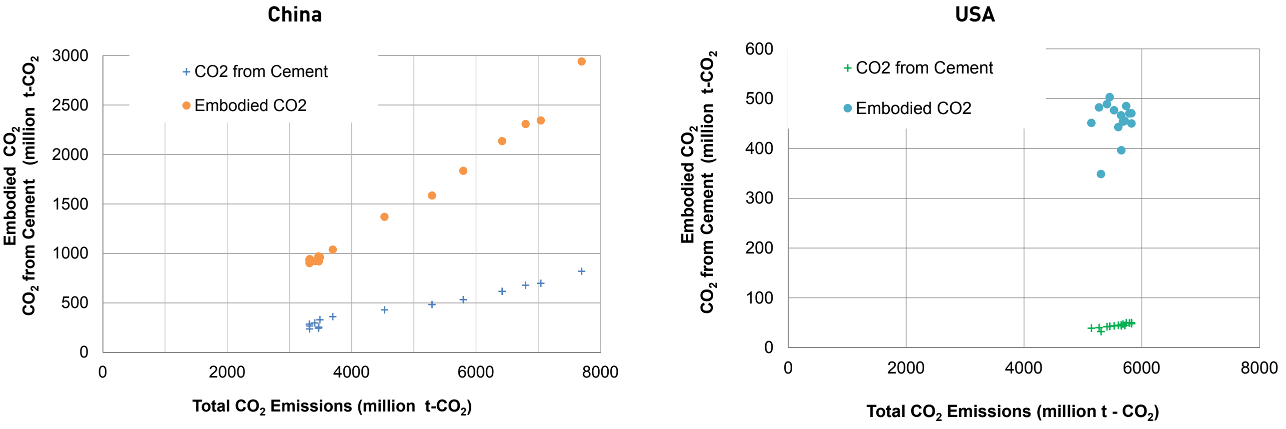
In industrialised countries, buildings are generally constructed to high quality standards. So, while it might be supposed there is little room to reduce EE or EC_{eq} for building construction in such countries by improved architectural and engineering design, our project outcomes imply this is actually not the case.

Embodied CO_2 emissions in 2000 for major building construction materials in China and Japan

Material	China	Japan	Emissions ratio China to Japan
Wood (kg CO_2 / m^3)	115	40.3	2.8
Steel (kg CO_2 / kg)	4.03	1.10	3.7
Cement (kg CO_2 / kg)	0.42	0.18	2.3

The embodied CO_2 emissions of major building construction materials in China and Japan differs between a factor of 2 to 3. In Japan, comparing the EC of major construction materials between 1975 and 2000 (not shown), there were also differences of between a factor of 2 to 3. The EC of construction products and materials can be reduced by improving their quality and production efficiency. Source: Journal of Civil Engineering and Architecture, 9, 2015, 300-307

Total embodied CO_2 emissions from building construction versus embodied CO_2 emissions from cement production in China and USA for the years between 1995 and 2009



Each point plotted shows EC for cement versus the total EC for building construction for a particular year. In general, EC emissions in developing countries continue to grow year by year, while those in developed countries tend to be stable. Focusing on developing Asian countries is a high priority for reducing embodied energy and greenhouse gas emissions.
Source: Oka T. et al, Introduction of Annex 57 - Evaluation of Embodied Energy and Carbon Dioxide Emissions for Construction Worldwide, Barcelona SB14, October 2014

The general project outcomes

From our research work, we have found that in general EE and EC_{eq} can be successfully reduced by combining one or more of the following measures:

1. Choose construction products and materials in the architectural and engineering design process using available environmental product declaration data to identify low EE and EC_{eq} materials.
2. Choose recycled materials in the architectural and engineering design process, noting this issue is affected in addition by economic and social factors.
3. Promote long life buildings, which depends on criteria concerning the design specifications, choices of materials, quality of building construction, and life cycle maintenance and replacement.
4. Reduce the use of fluorocarbons and other greenhouse gases, which is greatly influenced by the design specifications relating to chillers and insulation materials.

Recommendations for policy and decision makers

Our project has shown that it is technically feasible to reduce total embodied energy and greenhouse gas emissions, especially by designing and constructing long life buildings and reducing the use of fluorocarbon gases in chillers and insulation materials. The role of policy makers and decision makers is essential in promoting and requiring these two measures and this forms our main recommendation for them. Also based on our findings, I would like to propose two further specific recommendations, as explained below.

Implement reduction measures in developing countries: Embodied energy and greenhouse gas emissions are vast in developing countries, with many rapidly and poorly constructed buildings. So, promoting and requiring long life buildings in developing countries by improving their strength and quality will reduce EE and EC. EC is notably increasing in many developing countries in Asia, which reinforces the need for the main project recommendation described above.

Improve the quality of construction materials and products and increase production efficiency: Embodied energy and greenhouse gas emissions can be reduced by improving the quality of construction materials and products, along with production efficiency. These depend on the production efficiency within a country, which varies over time. The energy intensities of extraction and transportation of raw materials, which also vary over time, differ greatly depending on their countries of origin and destination.

Further information

www.iea-ebc.org

Thermal Characterization of Super-insulation Materials

Current Project: EBC Annex 65

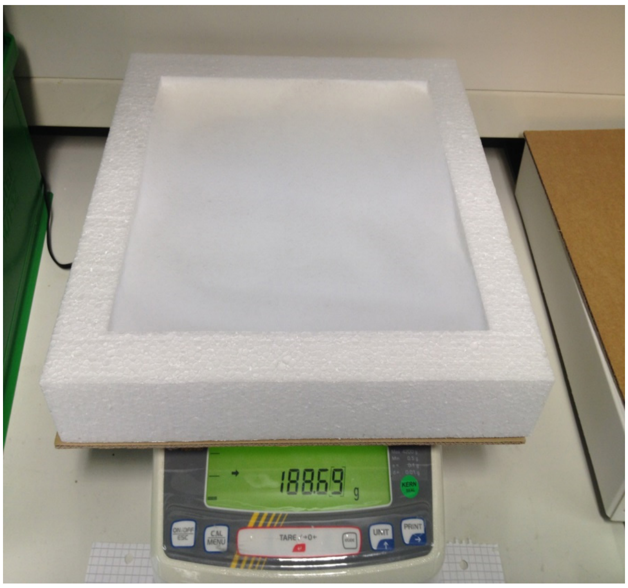
Daniel Quenard, Christoph Sprengard
and Sebastian Treml

Investigations of the long term performance of newly developed super-insulation materials and systems are revealing their benefits and risks, leading to guidelines for their optimal design and reliable use.

Introduction

The structures and microstructures of super-insulation materials (SIMs) are completely different to traditional insulation materials (mineral wools and cellular polymers), and so SIMs cannot be compared directly with them. Specifically, vacuum insulation panels (VIPs) have composite structures, while advanced porous materials (APMs) have nano-porous microstructures. But, worldwide uptake of SIMs would be improved if their thermal properties could be declared transparently and in a reproducible way. Therefore, methods of characterization currently applied to traditional insulation materials must be adapted, or new methods must be developed to measure thermal properties of SIMs. This is the main goal of part of the current EBC research project 'Annex 65: Long-Term Performance of Super-Insulating Materials in Building Components and Systems'.

SIMs, such as APMs and VIPs, are characterized by lower thermal conductivities, typically 5 mW/(m·K) to 15 mW/(m·K), in comparison to traditional insulation materials, typically 30 mW/(m·K) to 40 mW/(m·K). Because of such properties, the experimental methods for thermal characterization of SIMs may be affected by higher measurement uncertainties and reduced reliability. This is mainly due to the low thermal flux through the sample material during experimental testing. The project aim includes verifying the accuracy of existing testing methods when applied to SIMs, to show their drawbacks and limits, and proposing possible correction criteria and guidelines to provide reliable data (properties and durability) for manufacturers and designers. This research work is being shared with the European standardization (CEN) groups working on measurement methods for the ageing process of VIPs. In a near future, thanks to this EBC project, a further CEN working group on the development of a standard for APM's is anticipated to be established.



A specimen holder for loose-filled granulate, constructed from an expanded polystyrene frame, provided as an accessory from the manufacturer of thermal conductivity testing apparatus.
Source: German Aerospace Center (DLR), 2017

Measuring the initial thermal and ageing properties of SIMs

Due to the characteristics of SIMs, the existing thermal characterization methods have had to be adapted, or in some cases even new methods developed. Therefore, an inter-laboratory testing programme was developed in the project to check for differences in thermal conductivity measurements, determination of linear thermal bridge effects, determination of internal pressures and ageing effects.

As a common exercise between the participants, a survey of the available test methods was initially carried out. Before starting the testing campaign, all of the participants agreed that the purpose of the round robin tests was to investigate the measurement techniques themselves, rather than to discuss materials performance and quality. Finally, twenty laboratories have taken part in the testing, with most of them measuring the thermal conductivity of SIMs. The principle of the test programme was to first allocate the VIPs and APMs supplied by manufacturers and next to test these materials at several laboratories. To encourage support from the manufacturers, confidentiality was ensured by distribution of anonymised materials. Moreover, each laboratory provided extensive information about their methodology for the measurements.

Consistent data exchange

To ensure consistent data exchange in practice, several Excel templates were developed for collecting data, the necessary information about the test methods, and the values obtained. More than 100 tests have been performed and analyzed. The results have then been screened for any differences and double-checked with the description of the measurement process to work out the critical parts of methodology that have to be considered to provide reproducible testing. Beside this practical approach, an extended error calculation for both guarded hot plate and heat flow meter methods has also been developed.

Based on this model, the general error of thermal conductivity measurements has been calculated and compared to the level of confidence for conventional insulation materials. Also, a sensitivity analysis has been carried out for the relevant measurement tasks to define if there is any change needed in minimum requirements for measurement accuracy, compared to the relevant standards.

Extra layers of 10 mm thick rubber for measurement of vacuum insulation panels.
Source: Istituto nazionale di ricerca metrological, 2017

Artificial ageing tests

SIMs can offer considerable advantages. However, potential drawbacks should be fully understood and addressed in the planning process to optimise their development and to avoid unjustified negative publicity, which could be detrimental to this emerging sector. For this reason, ageing tests have been defined according to the conditions in use (temperature, moisture, pressure, load, and so on). One objective of artificial ageing is to understand potential degradation processes that could occur. The durability of the hydrophobic treatment is one such process that is also being investigated.

VIPs particularly show time- and condition-dependent ageing behaviour, due to the unavoidable permeation of dry gases and water vapour through their barrier films. On the one hand, the measurements of the initial performance of SIMs by the different laboratories present low discrepancies, but on the other, the measurements after ageing are widely dispersed. The analysis of all of the measurement results are currently being concluded.

Further information

www.iea-ebc.org

Energy Flexible Buildings

Current Project: EBC Annex 67

Søren Østergaard Jensen, Daniel Aelenei
and Glenn Reynders

The energy flexibility of a building is the ability to manage its energy demand and generation according to local climatic conditions, occupant needs and grid requirements.

Renewable energy sources such as wind and solar power have an intrinsic variability that can seriously affect the stability of the electricity networks if they account for a high percentage of the total generation. Therefore, future high penetration of variable renewable energy sources would force a transition from generation on demand to consumption on demand to match the instantaneous energy generation. In practice, this means that the energy consumption needs to become flexible.

In most industrialised countries, the energy use in buildings accounts for 30% to 40% of total consumption. The energy is used for space heating, domestic hot water, cooling, ventilation, and lighting, as well as for appliances. A large part of the energy demand of buildings – such as the energy for space heating, cooling, or kitchen appliances – may be shifted in time, and thus it may significantly contribute to increase the flexibility of the demand from energy grids.

Buildings are expected to play a central role in this transition, in which consumers and 'prosumers', for example buildings with PV, become energy flexible to satisfy the generation and storage needs of energy grids, either as single buildings or as clusters of buildings. This is the research topic of the current EBC project, 'Annex 67: Energy Flexible Buildings'.

Options for energy flexibility

One option for creating energy flexibility is to make use of the thermal mass that is embedded in all building fabric and structures. Depending on the amount, distribution, speed of charging / discharging, and so on, of the thermal mass, it is possible to shift the heating or cooling demand in time for a certain period without jeopardizing thermal comfort in the building. Typically, the time constant of a building varies between a few hours to several days depending on the amount and exploitability of the thermal mass together with the heat losses, internal gains, occupancy pattern and the actual climatic conditions. In addition, many buildings use different kinds of distributed energy storage (for example water tanks, or electrical batteries), which may add to their energy flexibility. One such typical type of storage is the domestic hot water tank, which can be pre-heated to excess in anticipation of a low energy supply level situation. The excess heat may be used for space heating, but can also be used for white goods, such as hot-fill dishwashers, washing machines and tumble dryers to decrease and time shift their electricity needs.

When referring to energy flexibility in terms of consumer demand, there are two main approaches, which meet the need to shift the energy demand: storage of electrical energy / heat and demand flexibility. Storage of heat is based on the use of thermal mass, or water tanks, whereas storage of electrical energy relies on dedicated batteries, or electric vehicles. Storage of heat can be achieved efficiently in a number of ways, and heat pumps and hot water tanks are most commonly used. Demand flexibility (response) is achieved when the electricity consumption of controllable equipment or devices (HVAC, washing machines, dishwashers, tumble dryers, electric vehicles, and so on) is shifted from

The SOLAR XXI Building at LNEG, Lisbon, Portugal is one of the project case study buildings. This office building has South façade-integrated photovoltaic panels (12 kW_p) optimised for winter generation, and a further photovoltaic roof system at a nearby car park (12 kW_p) optimised for summer generation. As both systems work together to meet the building's energy demands, the year round performance is also optimised. Load shifting strategies to improve the energy flexibility of the building are being considered, for instance to shift power loads for laptop computer charging and other devices from low renewable generation periods to between 12 midday and 2PM, when there is typically high renewable generation.
Source: National Laboratory of Energy and Geology (LNEG)

their normal consumption patterns in response to changes in the price of electricity, to respond to periods of high renewable generation, or to alleviate electricity grid capacity issues.

Although various investigations of buildings in the smart grid and smart energy context have been carried out, research on the relationships between energy flexibility in buildings and future energy grids is still in its early stages. Currently, there is little consensus about how much energy flexibility different types of building and their usage may be able to offer to future energy systems.

Building stakeholders

When applying energy flexibility in buildings, the comfort and whole life costs of the buildings are influenced. If the owner, facilities manager, or occupants of a building are not interested in providing energy flexibility to nearby energy grids in practice, the extent of energy flexibility of the building does not matter, as it will not be an asset for the energy grids. It is, therefore, very important to investigate and understand which barriers exist for building stakeholders and how they may be motivated to allow their buildings to support the stabilization of future energy grids with energy flexibility. Strategies to benefit both the total energy system and building stakeholders are therefore being explored.

Terminology and flexibility indicators

As energy flexibility in buildings is a rather new research area, there is a need for new terminology. This should be easily understood by both the buildings and energy grid communities, who should respectively provide energy flexibility and apply it to stabilize energy grids. There is a common need for applicable flexibility indicators that characterize buildings in such a way that it is possible to determine how a building, or clusters of buildings, may provide flexibility services to grids. Literature reviews on terminology and flexibility indicators have already been carried out within the project ready for publication. In the meantime, flexibility indicators and the available energy flexibility of single buildings and clusters of buildings are being investigated by using simulation, test facilities and case studies in real buildings.

Further information

www.iea-ebc.org

Energy Performance Based on In-situ Measurements

New Project: EBC Annex 71

Staf Roels

More attention needs to be paid to the real as-built performance of buildings, otherwise we will not reach our global energy reduction goals.

Energy performance requirements for new and renovated buildings are becoming progressively more stringent in many industrialised countries. And improved fabric performance and more efficient heating systems, lighting and appliances are increasingly common practice.

Several studies have shown that despite policy implementation and regulatory enforcement, the actual as-built energy performance of buildings can differ significantly from the requirements. This can be due in part to compliance checks being carried out in the design phase, based on calculating the theoretical energy use. But, at present there is limited as-built quality assurance and a general lack of knowledge about real building operation.

The research being undertaken in the new EBC project, 'Annex 71: Building Energy Performance Assessment Based on In-situ Measurements', is founded on the premise that the intended large energy savings can only be achieved if more attention is paid to the actual energy performance of buildings. It is focusing on residential buildings and is combining optimised in-situ measurements with dynamic data analysis techniques to develop characterisation and quality assessment methods, on the level of individual dwellings, as well as for building communities.

Techniques for dynamic data analysis and quality assessment

Previous EBC work in this field has made a great deal of progress, notably in the recent project 'Annex 58: Reliable Building Energy Performance Characterisation Based on Full Scale Dynamic Measurements'. The scope of that project was limited to the thermal performance of the building envelope, making use of rather intrusive tests on scale models and test buildings. The current project is focusing on in-use monitoring of buildings and defining the minimum data sets needed for reliable energy performance characterisation. In general, it is relying on existing (non-intrusive) monitoring systems and available databases.

The project is making a distinction between dynamic data analysis techniques to develop characterisation methods and techniques for quality assessment. Characterisation methods translate the dynamic behaviour of a building into a simplified model that can be used in model predictive control, fault detection, optimisation and design of district energy systems, and so on. Quality assessment methods intend to pinpoint the most relevant physical parameters, such as the overall heat loss coefficient, the energy efficiency of a system, and so on, to compare them with the design values.

Within the project an expert group is being established, consisting of participants with strong links to industry, government, and other representatives, who will be asked to evaluate the practical applicability of the methods developed. In particular, this will closely link the project with certification bodies, government and practitioners in the field.

Further information

www.iea-ebc.org

EBC International Projects

New Projects

Annex 72: Assessing Life Cycle Related Environmental Impacts Caused by Buildings

Contacts: Rolf Frischknecht,
frischknecht@treeze.ch

The project is focusing on the assessment of different types of building, both new and retrofit during their entire life cycles. A building's embodied and operational impacts from cradle to grave are being considered. When including information on environmental impacts in investment decisions for buildings, efforts can be either focused on embodied, or on operational impacts. This gives rise to the question of the environmental optimum between gross zero operational energy buildings and minimal insulation buildings. Is it sensible to try to reduce energy use for heating and cooling to a level close to zero, or do the environmental impacts of the additional materials and equipment outweigh the reduced environmental impacts during operation? Guidelines will be derived defining optimal ratios between investments in building materials and equipment and operational costs in the use stage. Furthermore, methods will be established for the development of specific environmental benchmarks for different types of buildings. Case studies will also be developed to establish further empirical benchmarks and to validate regionally differentiated benchmarks defined based on these methods. These are intended to assist architects and planners, policy advisers, building owners, and investors.

Further information

www.iea-ebc.org

Annex 73: Towards Net Zero Energy Public Communities

Contacts: Alexander Zhivov,
Alexander.M.Zhivov@erdc.usace.army.mil,
Rüdiger Lohse, ruediger.lohse@kea-bw.de

The project is developing straightforward guidelines and tools to support the planning of net zero energy resilient public communities. It is establishing benchmarks, energy targets and constraints. It is also summarizing conventional and the state-of-the-art technologies and concepts for community-wide energy master planning for power, heating and cooling needs. Furthermore, it is advancing the integration of various new energy master planning tools and strategies by standardizing data models and developing new software services for meeting current and future energy efficiency (site and source) and energy security goals. It is researching and integrating innovative energy supply and energy distribution strategies including information on their performance and costs, which will culminate in a complete community energy modelling tool. An energy master planning tool will allow selection of different scenarios based on a community's heating, cooling, and power load profiles and comparing them based on specific resiliency needs and operational constraints and economics. Energy master planning guidelines and enhancements of modelling tools, best practices and case studies will support the target audiences for the outcomes. These include participants in the decision-making process, specifically planners, building owners, architects, engineers and energy managers of public-owned and operated communities.

Further information

www.iea-ebc.org

EBC International Projects

New Projects

Annex 74: Energy Endeavour

Contacts: Peter Russell,
peter.russell@solardecathlon.eu
Karsten Voss, kvoss@uni-wuppertal.de

The Solar Decathlon is an international competition for students based on an initiative by the U.S. Department of Energy, and was established in 2000. In this competition, universities from all over the world are challenged to design, build and operate small, experimental solar powered houses. Each competition includes 10 entrants, hence the basis for the name 'Decathlon'. Twelve competitions have so far been conducted worldwide with a wide range of experiences. New events in Dubai, China and Morocco are already scheduled and the next one for Europe is under preparation with the 'Call for Cities' announced in January 2017. The project is serving as a knowledge platform linking experiences with such competitions worldwide and is working towards evolving the Solar Decathlon, as well as encouraging new formats that might address issues such as dense urban living, existing buildings and communities. The major objectives are to: increase the role of university competitions as testing grounds for innovative methods, tools and systems; link the competition format to the scientific and education communities; raise public visibility of energy policy towards climate neutral habitation; provide case studies at the building and district levels; strengthen the IEA dissemination activities concerning buildings-related R&D; offer a test bed for new methodologies in energy efficiency and life cycle analysis.

Further information

www.iea-ebc.org

Annex 75: Cost-effective Building Renovation Strategies at District Level using Energy Efficiency and Renewables

Contact: Manuela Almeida,
malmeida@civil.uminho.pt

The transformation of existing buildings in cities into low greenhouse gas emissions and low-energy buildings is challenging. However, there are also opportunities to develop district-level solutions at urban scales. In this context, the project is clarifying the cost-effectiveness of various approaches combining both energy efficiency and renewable energy measures at district level. At this level, finding the balance between renewable energy and energy efficiency measures is a complex task with many research questions remaining. In this context, the project has the following objectives: investigate cost-effective strategies for reducing emissions and energy use in buildings in cities at district level, combining both energy efficiency measures and renewable energy measures; provide guidance to policy makers, companies working in the field of the energy transition, as well as building owners, on how to cost-effectively transforming existing urban districts into low-energy and low-emission districts. It is also producing guidelines for policy makers and energy-related companies on how to encourage market uptake of cost-effective strategies combining energy efficiency measures and renewable energy measures and guidelines for building owners and investors about cost-effective renovation strategies, including district-based solutions.

Further information

www.iea-ebc.org

EBC International Projects

Current Projects

Annex 5: Air Infiltration and Ventilation Centre
The AIVC carries out integrated, high impact dissemination activities with an in depth review process, such as delivering webinars, workshops and technical papers.
Contact: Dr Peter Wouters
aivc@bbri.be

Annex 56: Cost-Effective Energy and CO_2 Emissions Optimization in Building Renovation
The project is delivering accurate, understandable information and tools targeted to non-expert decision makers and real estate professionals.
Contact: Dr Manuela Almeida
malmeida@civil.uminho.pt

Annex 60: New Generation Computational Tools for Building and Community Energy Systems
The project is developing and demonstrating new generation computational tools for building and community energy systems using the Modelica modelling language and Functional Mockup Interface standards.
Contact: Dr Michael Wetter, Christoph van Treeck
mwetter@lbl.gov, treeck@e3d.rwth-aachen.de

Annex 61: Business and Technical Concepts for Deep Energy Retrofit of Public Buildings
The project aims to develop and demonstrate innovative bundles of measures for deep retrofit of typical public buildings to achieve energy savings of at least 50%.
Contact: Dr Alexander M. Zhivov, Rüdiger Lohse
alexander.m.zhivov@erdc.usace.army.mil,
ruediger.lohse@kea-bw.de

Annex 62: Ventilative Cooling
This project is addressing the challenges and making recommendations through development of design methods and tools related to cooling demand and risk of overheating in buildings and through the development of new energy efficient ventilative cooling solutions.
Contact: Prof Per Heiselberg
ph@civil.aau.dk

Annex 63: Implementation of Energy Strategies in Communities
This project is focusing on development of methods for implementation of optimized energy strategies at the scale of communities.
Contact: Helmut Strasser
helmut.strasser@salzburg.gv.at

Annex 64: LowEx Communities - Optimised Performance of Energy Supply Systems with Exergy Principles
This project is covering the improvement of energy conversion chains on a community scale, using an exergy basis as the primary indicator.
Contact: Dr Dietrich Schmidt
dietrich.schmidt@ibp.fraunhofer.de

Annex 65: Long-Term Performance of Super-Insulating Materials in Building Components and Systems
This project is investigating potential long term benefits and risks of newly developed super insulation materials and systems and to provide guidelines for their optimal design and use.
Contact: Daniel Quenard
daniel.quenard@cstb.fr

Annex 66: Definition and Simulation of Occupant Behavior in Buildings
The impact of occupant behaviour on building performance is being investigated to create quantitative descriptions and classifications, develop effective calculation methodologies, implement these within building energy modelling tools, and demonstrate them with case studies.
Contact: Dr Da Yan, Dr Tianzhen Hong
yanda@tsinghua.edu.cn, thong@lbl.gov

Annex 67: Energy Flexible Buildings
The aim of this project is to demonstrate how energy flexibility in buildings can provide generating capacity for energy grids, and to identify critical aspects and possible solutions to manage such flexibility.
Contact: Søren Østergaard Jensen
sdj@teknologisk.dk

Annex 68: Design and Operational Strategies for High Indoor Air Quality in Low Energy Buildings
This project focuses on design options and operational strategies suitable for enhancing the energy performance of buildings, such as demand controlled ventilation, improvement of the building envelope by tightening and insulating products characterised by low pollutant emissions.
Contact: Prof Carsten Rode
car@byg.dtu.dk

Annex 69: Strategy and Practice of Adaptive Thermal Comfort in Low Energy Buildings
The project provides a scientifically based explanation of the underlying mechanism of adaptive thermal comfort, and is applying and evaluating the thermal adaptation concept to reduce building energy consumption through design and control strategies.
Contact: Prof Yingxin Zhu, Prof Richard de Dear
zhuyx@tsinghua.edu.cn,
richard.dedear@sydney.edu.au

Annex 70: Building Energy Epidemiology: Analysis of Real Building Energy Use at Scale
This project seeks to support decision-makers and investors in their efforts to transform to a low carbon and energy efficient building stock by focusing on developing best practice methods for collecting, accessing, analyzing and developing models with empirical data of energy demand in buildings and communities.
Contact: Dr Ian Hamilton
i.hamilton@ucl.ac.uk

Annex 71: Building Energy Performance Assessment Based on In-situ Measurements
Contact: Prof Staf Roels
staf.roels@bwk.kuleuven.be

Annex 72: Assessing Life Cycle Related Environmental Impacts Caused by Buildings
Contact: Rolf Frischknecht
frischknecht@treeze.ch

Annex 73: Towards Net Zero Energy Public Communities
Contact: Dr Alexander M. Zhivov, Rüdiger Lohse
alexander.m.zhivov@erdc.usace.army.mil,
ruediger.lohse@kea-bw.de

Annex 74: Energy Endeavour
Contact: Prof Karsten Voss, Peter Russell,
kvoss@uni-wuppertal.de,
peter.russell@solardecathlon.eu

Annex 75: Cost-effective Building Renovation Strategies at District Level using Energy Efficiency and Renewables
Contact: Dr Manuela Almeida
malmeida@civil.uminho.pt

Working Group: Cost-effective Building Renovation Strategies at District Level using Energy Efficiency and Renewables
Contact: Dr Takao Sawachi
tsawachi@kenken.go.jp

www.iea-ebc.org

EBC

Energy in Buildings and Communities Programme

EBC Executive Committee Members

CHAIR
Andreas Eckmanns (Switzerland)

VICE CHAIR
Dr Takao Sawachi (Japan)

AUSTRALIA
Stanford Harrison
Stanford.Harrison@environment.gov.au

AUSTRIA
DI Theodor Zillner
theodor.zillner@bmvit.gv.at

BELGIUM
Dr Peter Wouters
peter.wouters@bbri.be

CANADA
Dr Robin Sinha
robin.sinha@canada.ca

P.R. CHINA
Prof Yi Jiang
jiangyi@tsinghua.edu.cn

CZECH REPUBLIC
To be confirmed

DENMARK
Prof Per Heiselberg
ph@civil.aau.dk

FRANCE
Nicolas Doré
nicolas.dore@ademe.fr

GERMANY
Katja Rieß
k.riess@fz-juelich.de

IRELAND
Prof J. Owen Lewis
j.owen.lewis@gmail.com

ITALY
Michele Zinzi
michele.zinzi@enea.it

JAPAN
Dr Takao Sawachi (Vice Chair)
tsawachi@kenken.go.jp

REPUBLIC OF KOREA
Dr Seung-eon Lee
selee2@kict.re.kr

NETHERLANDS
Daniël van Rijn
daniel.vanrijn@rvo.nl

NEW ZEALAND
Michael Donn
michael.donn@vuw.ac.nz

NORWAY
Eline Skard
eska@rcn.no

PORTUGAL
João Mariz Graça
joao.graca@dgeg.pt

SINGAPORE
Tan Tian Chong
TAN_Tian_Chong@bca.gov.sg

SPAIN
Francisco Rodriguez Pérez-Curiel
francisco.rodriguez@tecnalia.com

SWEDEN
Conny Rolén
conny.rolen@formas.se

SWITZERLAND
Andreas Eckmanns (Chair)
andreas.eckmanns@bfe.admin.ch

UK
Prof Paul Ruyssevelt
p.ruyssevelt@ucl.ac.uk

USA
David Nemtzow
david.nemtzow@ee.doe.gov

IEA Secretariat
Brian Dean
brian.dean@iea.org

EBC Secretariat
Malcolm Orme
essu@iea-ebc.org