EBC
Energy in Buildings and Communities Programme

EBC NEWS

Issue 60 | November 2014

EBC is a programme of the International Energy Agency (IEA)

iea Energy Technology Network

Signing off, an innovative path is forecast

Dear Reader,

Looking back at the 22 years in which I have had the honour of representing the USA in the IEA's R&D Programme on Energy in Buildings and Communities (EBC), I leave the Executive Committee with feelings of pride, satisfaction and fulfilment. The work accomplished, the people I have met and the contributions to a better world developed under this Programme's purview, all add up to time well spent and a job well done. It's been a great run.

When I first joined, the Programme focused on individual building technologies, such as roofs, windows and HVAC systems. As we progressed, we broadened our outlook to systems-related work, including advancing whole building ventilation and creating energy simulation tools to represent buildings as complete and complex entities. And we maintained an awareness of community; buildings give rise to communities and their combined effects affect many aspects of our lives. Beyond this, we considered how buildings impact on the overall environment.

During my term, I was privileged to be elected Executive Committee Chair, taking over from Dr Sherif Barakat of Canada and tried to maintain the course he had set for us. Having headed the Committee for six years, I was succeeded by Dr Morad Atif, also of Canada, and was pleased to see how he led our work to new and progressive levels of cooperation, pushing us to strive for ambitious goals.

Now, our present Chair, Andreas Eckmanns of Switzerland, has set in place an innovative and futuristic path to traverse, keeping the Programme at the forefront of R&D: The current Strategic Plan requires the development and dissemination, through international collaborative research and innovation, of knowledge and technologies for near-zero primary energy use and CO_2 emissions solutions to be adopted in new buildings and communities, along with a wide range of reliable technical solutions for application to the existing building stock. To achieve this, it is vital for the Committee to continue applying the expertise housed within each member country's national framework and to synergistically strive to create solutions for all to embrace.

Richard Karney

Andreas Eckmanns, EBC Executive Committee Chair (left) thanks Richard Karney, retiring EBC Executive Committee Member for the USA (right)

Cover picture - Building energy simulation on a mobile phone
Source: Olli Stenlund and Janne Porkka, VTT

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Print version (ISSN 1023-5795): printed on paper with 100% recycled content

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

Future Low Carbon Pathways for Finland

Miimu Airaksinen and Markku J. Virtanen

A target for 2050 has been fixed to reduce Finland's greenhouse gas emissions by 80%. So, for buildings and communities robust research, development and demonstration for clean energy technologies are needed now.

By 2050, Finland aims to achieve an 80% reduction in greenhouse gas (GHG) emissions relative to 1990 levels, reflecting a common policy agreed by the Member States of the European Union (EU). With this in mind, assessing the technological implications for reducing these emissions was one of the aims of the national 'Low Carbon Finland 2050' project. Significant opportunities and challenges relating to buildings and communities have emerged from this work.

The project has analysed the implications of three contrasting future scenarios: 'Tonni' (meaning 'tonne' in Finnish), 'Inno' (derived from the Finnish word for 'innovation') and 'Onni' (meaning 'happiness'). These scenarios each assumed an 80% GHG emissions reduction would be achieved by 2050, but realised by alternative pathways. For each of these, the analysis included systematic modelling and assessments of the whole energy supply chain, including fuel and energy production, energy infrastructures and end use in buildings, transportation and industry. These scenarios also took into account the policy measures implemented to date.

In addition, a fourth 'Baseline' scenario was produced as a point of reference, which imagined the future assuming a continuation of current trends and policies. This included Finland's 2020 targets, as agreed across the EU, and the energy policy implementation measures currently in place. For this scenario, a continuation of the present situation was assumed to provide a fair representation of future heat consumption for buildings. Due to the extreme northerly climate, buildings in Finland are already well insulated and all new buildings have heat recovery from ventilation. They presently consume about 40% of end-use energy.

Tonnes of innovation makes for happiness

In the Tonni scenario, the present mode of construction would improve at a relatively slow rate. Existing buildings would be renovated and their energy efficiency would be improved at a modest pace. This scenario is representative of a reasonable extrapolation of past development. But, in each of the Inno and Onni scenarios a faster pace of improvement is anticipated, but with differing underlying drivers.

In the Inno scenario, this would be due to technological development, whereas in the Onni scenario this would be strongly influenced by heightened environmental awareness. The Inno scenario focuses on the most radical technological breakthroughs by 2050. On the other hand, the Onni scenario includes analysis of more non-technical behavioural and consumption related factors, such as environmental awareness and the characteristics of regional development. In-depth multidisciplinary research, however, is needed to integrate such techno-economic with socio-economic scenarios.

Taking stock of renewal

The Baseline and Tonni scenarios are identical in respect of building stock development area and urban form, and these would follow today's development expectations. In the Inno scenario, urbanization would be more rapid, and people would occupy living space more efficiently. In the Onni scenario, people would want more space and nature around them, so urban sprawl would increase. Under these circumstances, large single family houses would become the predominant form of housing, with rapid growth occurring in the residential stock. People would tend to work from home, and some would even aim at partial self-sufficiency with small-scale farming, leading to a smaller size in the industrial and commercial building stocks. Since people would be living close to nature, the number of summer cottages or other leisure homes would be low compared to Inno and Tonni. In the Onni scenario, the assumptions regarding the specific heating energy consumption per building type are close to those in the Inno scenario. Also in the Onni scenario, the high renewal rate of single-family houses would be achieved by replacing the old stock with new very energy-efficient buildings. Single-family houses would then consume roughly 30% of the energy of the building stock. As a result of the high number of new houses, the energy efficiency of the building stock would improve.

Electric stock

The energy consumption of the Finnish building stock is currently dominated by space and domestic hot water heating. But, it is anticipated that by 2050 half of the building stock will be newly constructed or will have undergone major renovation since 2010. Thus, the average specific space heating energy consumption will decrease, although due to increasing housing area per person, absolute consumption will not drop as rapidly. In passive and other very low energy houses, electricity already accounts for between 30% to 40% of the total building energy use. Electricity consumption will also increase slightly due to an expected increased number of appliances and devices, even though the specific electricity consumption per device will have decreased dramatically. So, for these reasons, the relative importance of electricity use is expected to increase in future.

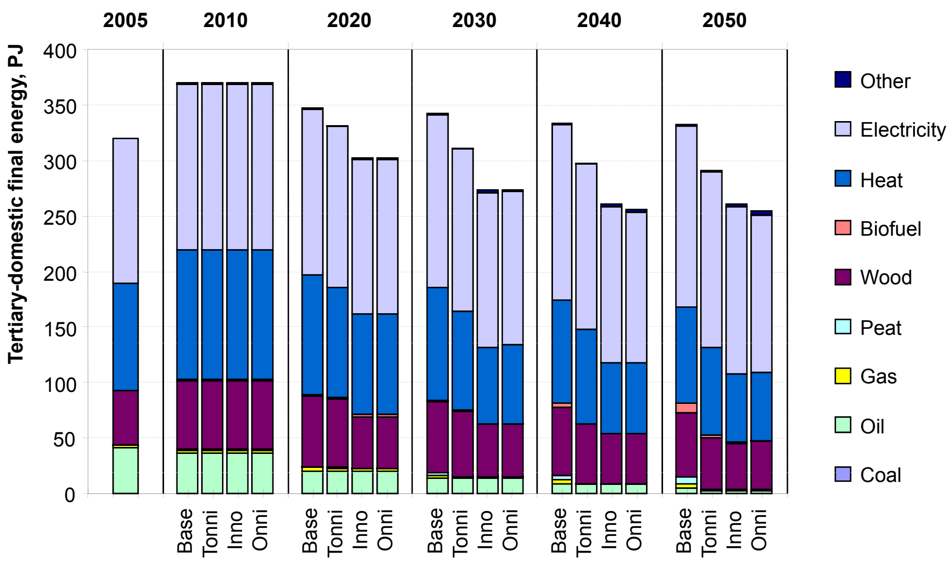
Smart buildings and smarter networks

As part of the EU, Finland has established a target to achieve close to zero energy new buildings by 2020. To realise this, well designed interactions between different parts of the energy infrastructure will be crucial, based on intelligent communications between energy supply and consuming systems.

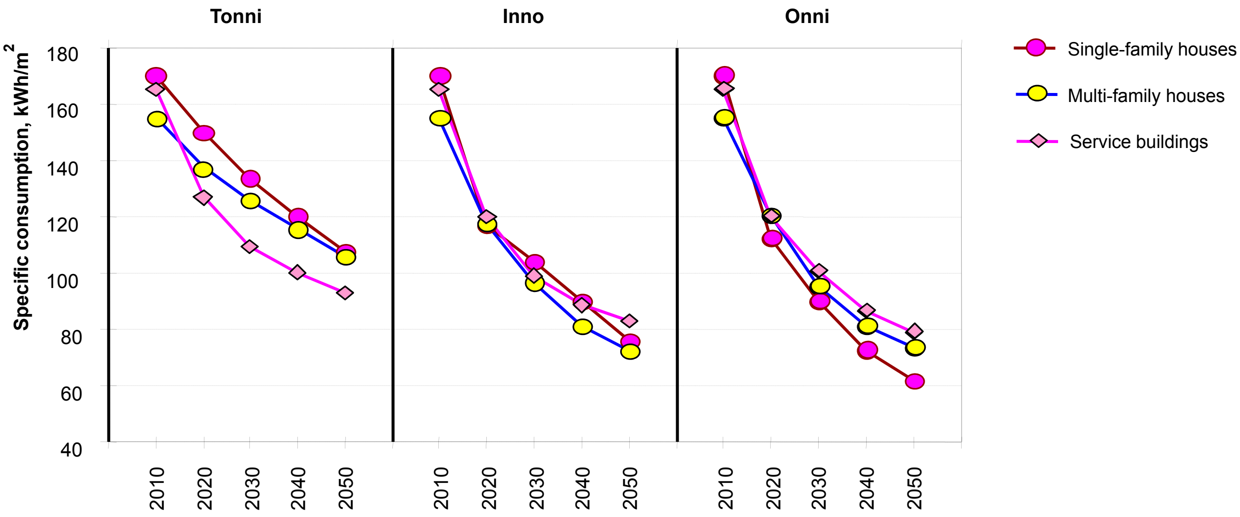
Renewable localized energy production technologies may considerably influence the direction of future developments. Until now, local power generation in the cold climate has been limited by the following factors:

- the efficiency of local power generation tends to be lower than that achieved in large power plants, and
- current distribution networks cannot manage heat produced by large scale local power generation.

Smarter distribution grids, control and monitoring technologies, energy storage and improvements in small-scale renewable energy technologies can improve the efficiency of local power generation at district and building levels. In addition, water heating



Development of final energy consumption in the residential and service sector. Buildings may have nearly 100% carbon-free total energy consumption by 2050.



Development of the average specific heating energy consumption for space heating and domestic hot water in buildings. Considerable reductions in specific consumption can be realized by low energy building concepts and smart control technologies.

systems with energy storage may become a valuable asset, because controllable electricity consumption across Europe will have added value due to price volatility caused by an increased share of variable wind and solar power generation. In addition, heating and cooling systems that can use low quality (low exergy) heating and cooling sources, for example waste heat, might become very attractive in energy efficient buildings and also benefit the energy network.

Heating halved and cooling checked

In the Tonni, Inno and Onni low carbon pathways, the assumptions concerning the development of the building stock were tailored according to the projected urban structure and density, as well as consumer lifestyles and preferences. These differences are directly reflected in the results for final energy consumption. However, although urban planning does have an impact on energy efficiency, the results indicate that new low energy building technologies and concepts are even more important with respect to future energy consumption.

According to the results of the scenario based analysis, total energy consumption in buildings would be reduced by 17% to 30% by the year 2050, and the total demand for heating, including hot water consumption, would be reduced by 25% to 50%. Almost equally high savings would be achieved in both the Inno and Onni scenarios, in which the total heating energy requirements would be roughly halved.

For buildings in the Finnish climate with a need for cooling, the use of solar energy has been demonstrated to perfectly match supply and demand. On the contrary, cooling demand might increase in future buildings for comfort reasons. To overcome this, innovative technologies such as phase change materials can provide alternatives to mechanical cooling.

Trends for tomorrow

The key implications for building and communities that the Low Carbon Finland 2050 project has revealed are:

- Smart technologies and solutions will make everyday life easier. Automated controls enable energy savings independent of occupancy patterns. Two-way networks for electricity and heating will enable local energy production and implementation of positive energy houses.
- The potential for improving the energy efficiency of buildings is large, but its realisation may not be fast enough due to their slow renewal rate.
- The fastest energy savings can be achieved by using intelligent control strategies and by improving the envelope, ventilation and heating systems and sources.
- Improvements in communications technology will help people to avoid unnecessary travel and, if needed, enable dispersed living.

Further information

www.vtt.fi/lowcfin

Embodied Energy and Carbon in Construction

Current Project: Annex 57

Tatsuo Oka

Embodied CO_2 due to construction accounts for around one fifth of global emissions, so it is crucial to reduce this along with the causal energy use. Producing guidelines for reliable calculation methods and reduction strategies for buildings are essential means to this end.

The embodied energy consumption (EE) and carbon dioxide emissions (EC) associated with building construction are defined respectively as the fossil fuel energy used by and the related CO_2 emissions from the whole process of building construction including:

- extracting and processing of raw materials,
- manufacturing of construction materials and products,
- transportation of materials and products, and
- construction of the building.

A hurdle to reducing both embodied energy and CO_2 (EE-EC) in construction is that a variety of methodologies and supporting materials databases already exist, but these have based on differing definitions of EE-EC. Furthermore, some databases include non-CO_2 greenhouse gases quantified as 'embodied carbon equivalents'.

The purpose of the current EBC project 'Annex 57: Evaluation of Embodied Energy and CO_2 Emissions for Building Construction' is therefore to develop guidelines for:

- reliable and comparable methods for evaluating EE-EC due to building construction, and
- measures to design and construct buildings with reduced EE-EC.

Embodied carbon made material

The EC associated with construction accounts about one fifth of global CO_2 emissions. The EC levels in Asian countries are relatively high, and are believed to account for between 20% to 35% of the entire CO_2 emissions in this region. In many Asian countries, EC is larger than the CO_2 emissions due to building operation, whereas in Europe EC levels are relatively low, accounting for only about 5% to 10% of the entire CO_2 emissions.

Reduction strategies

The main strategies for reducing EE-EC in building fabric, structure and services include:

- increasing the lifespan of buildings using seismic countermeasures and preventing concrete degradation,
- extending building lifespan by renovation,
- using building materials with lower EE-EC (including reuse and recycling processes),
- using renewable construction materials, such as wood, and
- reducing use of non-CO_2 greenhouse gases in heat pumps, air conditioning equipment and insulation materials.

Case studies

One of the objectives of the EBC project is to analyze various methods for reducing EE-EC in a quantitative manner through case studies. Six of the case studies analysed in the project are shown below, including the methods applied to reduce EC and their impacts. In future, more practical and highly effective reduction methods may be developed.

Further information

www.iea-ebc.org

Six of the case studies analysed in the project

(1) Zero energy building residential concept (Norway)

Reference period (years)	60
EC (kg-CO_2/m^2 year)	7.2

In ZEBs, EC from photovoltaic power generation panels (PV) accounts for approximately 32% of the total. Offset by the increase in EC, it was found that the CO_2 emissions from operation could be completely eliminated.

(2) Long-life and low carbon office (Japan)

	Standard	Resilient
Reference period (years)	50	100
EC (kg-CO_2/m^2 year)	22	12

The strength of the structure was increased by 30% to be more resistant to earthquakes. This reduced EC due to longer service life, effectively cutting down the annual EC by about 40%.

(3) Long-life office building with an atrium (Denmark)

	Standard	Resilient
Reference period (years)	50	100
EC (kg-CO_2/m^2 year)	7.9	4.8

This office building was constructed using concrete, steel and aluminum accounting respectively for 42%, 37% and 8% of EC. A reduction was achieved by increasing service life, with the annual EC reduced by approximately 40%.

(4) Comparison of wooden lightweight timber frame and reinforce concrete (RC) buildings (Korea)

	Wooden	RC
Reference period (years)	50	50
EC (kg-CO_2/m^2 year)	8.3	16.8

The EC for a wooden lightweight timber frame dwelling was compared with 60 units located in a reinforced concrete multi-family block. The floor area of was 165 m^2 for the dwelling and 80 m^2 for each unit. The results show that wooden construction contributes to an EC reduction of approximately 50%.

(5) Comparison of using new and reused materials (Czech Republic)

	New	Reuse
Reference period (years)	60	60
EC (kg-CO_2/m^2 year)	6.4	6.1

Reduced EC due to the reuse of building materials was relatively low, the effect of which is only about 5%. The impact was not as much as expected since steel and concrete are already reused by industry. Most of the reused material was bricks.

(6) Reduction of EC by reviewing the building design (Sweden)

	Original	Final
Reference period (years)	50	50
EC (kg-CO_2/m^2 year)	3.3	2.9

The reduction in EC was attempted at the initial stage of design, which resulted in 12% reduction. However, structural materials were not included in the review, which might increase the EC reduction up to 79%.

Computational Tools for Energy Systems

Current Project: Annex 60

Christoph van Treeck and Michael Wetter

Modelling and simulation technology can rapidly test the performance and operation of new efficient systems leading to very low energy building and community energy systems.

With increased use of renewable energy systems, the real-time interactions between buildings, distribution networks and community energy systems become more important. To adjust to this change and to ensure proper operation, buildings need to act as active systems, for example taking into account occupant behaviour and grid interaction, using technologies such as demand side management, model predictive control, or fault detection and diagnosis.

Planning and operation of such energy systems requires deep knowledge and understanding of system dynamics and interplay. Information technology is essential for planning, measuring, monitoring, simulating and managing their performance. Today's building energy simulation technology has reached a solid level and is applicable for modelling and predicting the energy performance of buildings, but at the same time is generally limited to simulating building physics and HVAC-related issues.

Assess detail and scale, more or less

In the context of modelling and simulation, 'multi-level' refers to simultaneous representation of the same system at different levels of detail, typically for different purposes, while 'multi-scale' refers to systems containing important characteristics that need to be captured at different temporal or spatial scales. These become relevant if, for example, the interactions between multiple buildings and centralized or decentralized energy systems at a community level are addressed, while at the same time the dynamics of different thermal, hydraulic, gas and electrical networks need to be considered.

However, required aspects of multi-level and multi-scale modelling and simulation are at present either not supported for building and community energy systems, or are still undergoing research and development. To solve this issue, modelling and simulation need to perform at different levels of detail, involving model- and data-based coupling processes between software tools.

This concern is being addressed in the current EBC project 'Annex 60: Computational Tools for Building and Community Energy Systems', by developing tools that allow users to:

- add new physical models at different levels of detail to building simulation programs and share these models between tools,
- couple tools with other existing software tools, and
- embed algorithms into hardware, such as advanced building control systems for model-based operation.

Linking libraries

For the systems and controls modelling, the platform independent object-oriented modelling language Modelica is used as a common basis for the project. Prior to the start, several participating organisations had already independently developed their own Modelica model libraries. Not only was this a duplication of effort, but also the individual libraries had limited scope and were incompatible. It was therefore decided to jointly develop a new combined library based on these.

The project team has now developed the core of an open-source library, containing more than 100 models and have successfully tested semi-automatic integration for three of the existing libraries. This combined library is designed to allow models to work with the updated EnergyPlus simulation environment and with other tools, such as IDA-ICE.

Information exchange in chains

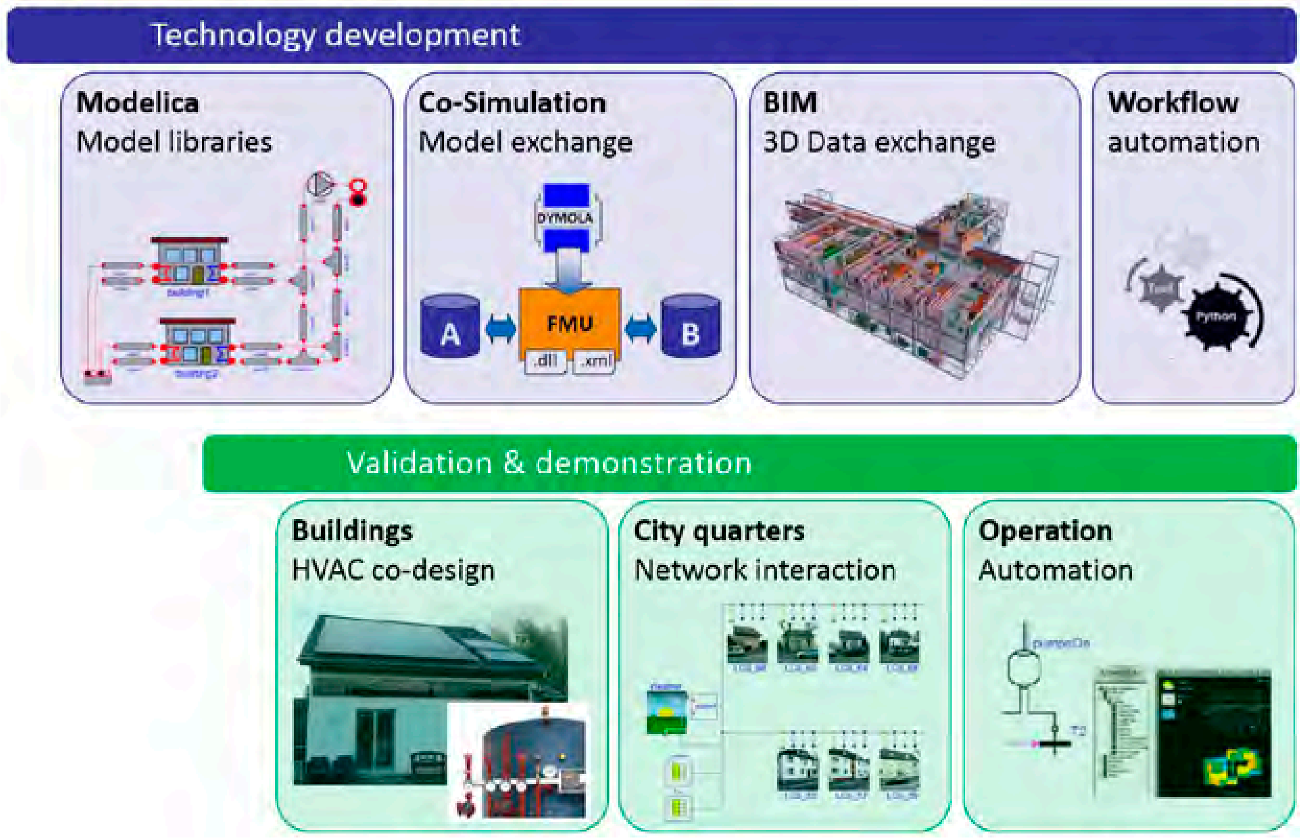
The Modelica approach is supported by the so-called 'co-simulation' technology using the Functional Mockup Interface standard to exchange models among different simulation tools and control systems and to perform run-time coupling of existing solvers. Consequently, the technology can be applied to and coupled with existing simulation software for building and community energy systems. The co-simulation activities in the project are also coupling native Modelica models intended for simultaneous performance assessments.

In another part of the project, the translation process from Building Information Modelling (BIM) to obtain a building simulation model is addressed. For this purpose, a common data representation model has been developed that contains all relevant data for creating a building performance simulation model in Modelica. To support the BIM process, an existing XML-based data representation format specification was selected and has been extended.

The outcomes of the project are validated tool-chains that link BIM to energy modelling, building simulation to controls design tools, and design tools to operational tools. The use of these tools is being verified and demonstrated through case studies that optimize design and operation of building and community energy systems.

Further information

www.iea-ebc.org



How simulation technology development, validation and demonstration are being carried out within the project.

Deep Energy Retrofit as a Business Opportunity

Current Project: Annex 61

Alexander Zhivov and Rüdiger Lohse

To meet ambitious energy savings policy targets, the number of building refurbishments must be rapidly increased using deep energy retrofits. This provides a substantial business opportunity, but needs highly effective bundles of measures to be demonstrated.

What is deep energy retrofit?

Since the energy crisis of the 1970s, energy requirements pertaining to new construction and building renovation have significantly improved in many industrialised countries. For example, from the 1980s new building energy-use requirements in the United States have improved by more than 50%. Therefore, it is now usually technically feasible to reduce existing building energy use by more than 50% using technologies readily available on the market by simply adapting current minimum requirements for new buildings to the specific requirements for refurbishment.

The Energy Performance of Buildings Directive Recast (EPBD 2010), requires buildings to 'be refurbished to a nearly zero-energy condition' and states that 'Member States shall not be required to set minimum energy performance requirements that are not cost-effective over a building's estimated economic lifecycle.' In the USA, the 'Massachusetts Save Energy Retrofit Builder Guide' refers to deep energy retrofit (DER) as the 'retrofit of the building enclosure and other building systems in a way that results in a high performance building.'

The current EBC project 'Annex 61: Business and Technical Concepts for Deep Energy Retrofit of Public Buildings' is developing this topic. Based on experiences in different countries, it was decided for the purposes of this project that DER status would be achieved if the site energy has been reduced by more than 50% compared to the pre-renovation baseline.

Cost effective technologies

Results from a survey conducted by the project, and also discussed with ASHRAE Technical Committee 7.6 'Federal Buildings', have been used to generate a list

Examples of buildings with energy use reduced by more than 50% from pre-renovation baseline

Building name, location	Building type	Size m²	% Under baseline	Baseline	Measured or estimated	Project completion
Home on the Range, USA	Office	772	79%	ASHRAE 90.1-1999	Measured	2006
Pringle Creek Painter's Hall, USA	Office, Assembly	335	68%	Other	Measured	2009
Johnson Braund Design Group, USA	Office	744	51%	Other	Measured	Ongoing
Heedegards School, Denmark	School building	3850	73%	National code	Estimated	2012
School campus, Germany	School campus	4179	66%	WSVO 77 and before	Measured	2012
Office building, Germany	Office	1931	75%	Before WSVO 77	Measured	2012
Housing block, Austria	Residential building	2845	80%	Other	Measured	2012

The proposed core bundle of technologies for deep energy retrofit (DER)

Category	Name	Specification
Building Envelope	Roof, wall and slab insulation	Level to be defined through modelling
	Windows and doors	
	Thermal bridge remediation	Planned DER Guide
	Airtightness	0.76 l/(s m^2) at 75 Pa; 0.6 ach - 1.0 ach at 50 Pa
	Vapour barrier	Planned DER Guide
	Building envelope quality assurance	Planned DER Guide
Lighting and Electrical Systems	Lighting design, technologies and controls	USACE Lighting Guide
	Advanced plug loads, smart power strips and process equipment	Top ten (Europe, USA), FEMP Designated, etc
HVAC	High performance motors, fans, furnaces, chillers, etc	ASHRAE Std 90.1 2013, EN, EU efficiency classifications
	Dedicated outdoor air systems	Planned DER Guide
	Heat recovery (dry and wet)	>80% efficient
	Duct insulation	ASHRAE Std 90.1 2013, EN 13180, EN 13403
	Duct airtightness	EN 14239 Class C, DIN 18955
	Pipe insulation	ASHRAE 90.1 2013, EN 12828, DIN 18955

of energy efficient technologies. This 'core bundle of technologies' is being used for technical and economic analyses by simulating representative buildings in different climate zones. Modelling is being conducted for representative climates in the participating countries, including for all 17 climate zones in the USA. To take into account the circumstances of the participating countries, the analysis assumes that gas prices range from 2.7 US c/kWh to 9.7 US c/kWh and electricity from 8.0 US c/kWh to 35 US c/kWh. The modelling process covers four different stages, including the pre-renovation baseline:

1. according to the building codes existing at the time of construction of the building,
2. according to today´s building code levels for refurbishment of buildings,
3. according to DER targets, and
4. assuming different national targets for end- or primary energy.

In addition to the core bundle of technologies, various building type and climate specific technologies can be used in the modelling process. Some of the listed energy efficiency measures are costly and can have long payback periods when used individually. To become cost effective, DER must exploit the effects of synergy between different demand- and supply-side measures in an innovative and integrated design approach. Different non-energy-related measures that contribute to the cost effectiveness of the DER are also being assessed. These additional measures include, for instance, the implementation of quality assurance and quality control processes that specify the areas of major concern to be addressed and checked during the design, construction, and post-occupancy phases.

The synergies between the different measures are being assessed as they pertain to downsizing and investment cost reduction. For example, the specification of a high-performance building envelope in the retrofit project can significantly reduce the size and the cost of heating and cooling plant. Specification of an advanced lighting design can also significantly reduce both electrical consumption and the cooling load on the HVAC system. The evaluation is considering the extent to which the reduction of investment cost will compensate for any increased construction costs resulting from the DER.

Further information

www.iea-ebc.org

Reducing Overheating Risk using Ventilative Cooling

Ongoing Project: Annex 62

Per Heiselberg

The current trend towards nearly-zero energy buildings has led to an increased risk of overheating throughout the year. Use of the cooling potential of outdoor air can be an energy efficient passive solution to this.

Evaluating and eliminating cooling need and the risk of overheating in buildings are required to address the increasing cooling challenges posed by new and renovated buildings, in moderate as well as in more extreme climates. Therefore, the current EBC project, 'Annex 62: Ventilative Cooling', is focusing on development of design methods and compliance tools to meet these objectives. It is also cooperating with the international *venticool* platform for dissemination of research results. The project is developing innovative energy efficient ventilative cooling solutions through three research tasks:

– 'Methods and Tools' is analysing, developing and evaluating suitable design methods and tools for predicting cooling need, ventilative cooling performance and risk of overheating in buildings. This part is also providing guidelines for integration of ventilative cooling in energy performance calculation methods and regulation, including specification and verification of key performance indicators.
– 'Solutions' is investigating the cooling performance of existing mechanical, natural and hybrid ventilation systems and technologies and typical comfort control solutions as a starting point for extending the boundaries for their use. Based upon these investigations, it is developing recommendations for new kinds of flexible and reliable ventilative cooling solutions that can create comfort under a wide range of climatic conditions.
– 'Case studies' is demonstrating the performance of ventilative cooling through analysis and evaluation of well-documented case studies.

What is ventilative cooling?

Ventilative cooling refers to the use of natural or mechanical ventilation strategies to cool indoor spaces. This effective use of outside air reduces energy used by mechanical cooling, while giving a comfortable thermal environment. The most common technique is the use of increased daytime ventilation airflow rates and night ventilation, but other technologies may also be considered. Ventilative cooling can be an attractive and energy efficient passive solution to avoid overheating because:

– ventilation is already provided in most buildings through mechanical and / or natural systems using opening windows,
– ventilative cooling can remove excess heat gains and increase air speeds, so improving the thermal environment, and
– the possibilities for using the free cooling potential of low temperature outdoor air increases considerably as cooling becomes required outside of the usual summer period.

The causes of overheating

In recent years, the risk of overheating in buildings in many industrialised countries has increased as an unintended consequence of efforts to reduce energy demand by improving insulation and airtightness levels. In very well-insulated buildings, only solar gains or heat gains from people, appliances or equipment are often needed to provide comfortable conditions. But, high insulation levels can result in increased sensitivity to internal heat gains. If the rate of these gains

is much greater than losses through ventilation and fabric conduction, then overheating can result.
In very well-insulated and airtight buildings the heating and cooling demands depend less on the outdoor temperature, and more on solar radiation. This naturally gives better potential for use of ventilative cooling, because there can be a cooling need, not only in the summertime, but actually all year round.

Overheating in the real world

Many post occupancy studies of zero energy buildings have reported elevated temperature levels during the whole year. In these studies, it has been found that an overheating problem may occur not only in the summer, but also during the heating season.

Dwellings

The risk of overheating is an increasing problem in high performance residential buildings both in cold and moderate climates. The reasons for this are that only a few standard solutions are presently available, which might not be well adapted for practical application, and also occupants have only limited experience of dealing with overheating problems. If technologies such as solar shading and ventilative cooling are applied, it is critical to use an appropriate control and operation strategy, taking into account occupant behaviour, to make sure that they work successfully.

Offices

Office buildings often have high heat loads and therefore there is commonly a requirement for cooling during occupied hours. This need is not new, but it is increasing and systems that are sufficiently efficient to achieve demanding future energy reduction targets are yet to be developed. Application of the free cooling potential of outdoor air is already widely used in mechanical ventilation systems, while the use of natural and hybrid ventilation system is still limited in many countries.

What is the state-of-the-art?

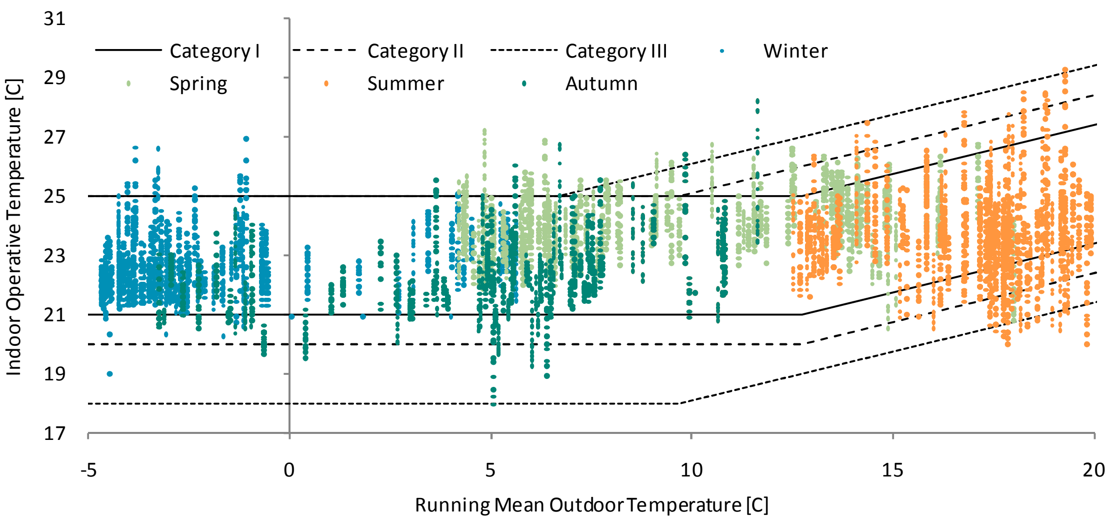
The first project outcome (due in 2015) is an overview and state-of-the-art report on ventilative cooling. This covers the following topics:

- potential and limitations of ventilative cooling,
- ventilative cooling in existing energy performance regulations,
- exemplary existing buildings using ventilative cooling,
- existing components and control strategies for ventilative cooling, and
- existing methods and tools.

Further information

www.iea-ebc.org
www.venticool.eu

Temperature distribution in the living room in 'Home for Life', Lystrup, Denmark



The operative temperature in the living room in a zero energy residential building constructed recently in Denmark is shown as a function of the running mean outdoor temperature. The measurements were recorded during the first year of building operation. The results show that operative temperatures in the winter are at similar levels to those in the spring, summer and autumn. Source: Velux

EBC International Projects

New and Completed Projects

Annex 67: Energy Flexible Buildings (new)

Contact: Søren Østergaard Jensens
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Renewable energy sources, such as wind and solar power, have an intrinsic variability that can seriously affect the stability of energy systems if they account for a high percentage of total generation. A transition from generation on demand to consumption on demand is crucial in order to match the instantaneous energy generation. This means in practice that the energy consumption needs to become more flexible. For this reason, energy flexibility in buildings may play an important role in facilitating energy systems based entirely on renewable energy sources. The new EBC project is focusing on:

- increasing knowledge on building energy flexibility and how building services can provide it to energy grids,
- identification of critical aspects and possible solutions to manage the energy flexibility that buildings can provide,
- determination and enhancement of the flexibility potential of buildings, and
- user motivation and acceptance associated with the introduction of energy flexibility in buildings.

Further information

www.iea-ebc.org

Annex 52: Towards Net Zero Energy Solar Buildings (completed)

This is a joint project with IEA Solar Heating and Cooling (Task 40)

Contact: Josef Ayoub
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The main objective of this project has been to study current net-zero, near net-zero and very low energy buildings (residential and non-residential) and to develop a common understanding, a harmonized international definitions framework, tools, and innovative solutions and industry guidelines. The following outputs have been successfully produced:

- a source book 'Definition and Methodologies, Design Tools and Processes, and Solution Sets' based on case studies, databases of over 30 case studies from 19 countries and different climatic conditions, stand-alone technical reports, conference papers, an education network, and the 'NZEB Knowledge Centre' website,
- Source Book Volume 1: Net Zero Energy Buildings: International Projects of Carbon Neutrality in Buildings,
- Source Book Volume 2: Modelling, Design, and Optimization Net Zero Energy Buildings,
- Solution Sets for Net Zero Energy Buildings - Feedback from 30 Net-ZEBs worldwide,
- Life Cycle Analysis report,
- Analysis of Load Match and Grid Interaction Indicators in NetZEBs with high Resolution Data, and
- Measurement and Verification Protocol of NetZEBs.

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 54 Integration of Micro-generation and Related Energy Technologies in Buildings

A sound foundation for modelling small scale co-generation systems underpinned by extensive experimental validation has been established to explore how such systems may be optimally applied.
Contact: Dr Evgueniy Entchev
eentchev@nrcan.gc.ca

Annex 55 Reliability of Energy Efficient Building Retrofitting - Probability Assessment of Performance and Cost

The project is providing decision support data and tools concerning energy retrofitting measures for software developers, engineers, consultants and construction product developers.
Contact: Dr Carl-Eric Hagentoft
carl-eric.hagentoft@chalmers.se

Annex 56 Cost-Effective Energy and CO_2 Emission 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 57 Evaluation of Embodied Energy and CO_2 Emissions for Building Construction

The project is developing guidelines to improve understanding of evaluation methods, with the goal of finding better design and construction solutions with reduced embodied energy and related CO_2 and other GHG emissions.
Contact: Prof Tatsuo Oka
okatatsuo@e-mail.jp

Annex 58 Reliable Building Energy Performance Characterisation Based on Full Scale Dynamic Measurements

The project is developing the necessary knowledge, tools and networks to achieve reliable in-situ dynamic testing and data analysis methods that can be used to characterise the actual energy performance of building components and whole buildings.
Contact: Prof Staf Roels
staf.roels@bwk.kuleuven.be

Annex 59 High Temperature Cooling and Low Temperature Heating in Buildings

The project aim is to improve current HVAC systems, by examining how to achieve high temperature cooling and low temperature heating by reducing temperature differences in heat transfer and energy transport processes.
Contact: Prof Yi Jiang
jiangyi@tsinghua.edu.cn

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 based on the non-proprietary Modelica modelling language and Functional Mockup Interface standards.
Contact: 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 and 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: 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: 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 with the objectives of creating quantitative descriptions and classifications, developing effective calculation methodologies, implementing models within building energy modelling tools, and demonstration using case studies.
Contact: Da Yan, Tianzhen Hong
yanda@tsinghua.edu.cn, thong@lbl.gov

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