EBC

Energy in Buildings and
Communities Programme

Annual Report 2012

International Energy Agency

EBC Annual Report 2012

Energy in Buildings and Communities Programme

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Cover picture: Energy refurbishment of a historical building.
Source: Andreas Eckmanns

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Contents

Chair's Statement

The appearance of this latest edition of the EBC Annual Report may differ compared to what you may have expected. In fact, during my first year as Chair, the EBC Executive Committee has taken a number of fundamental decisions to update the identity of the EBC Programme. We started by changing our logo, which had dated from 1977 when EBC (then ECBCS) was founded, and ended up revising our name too. Our former name was thought to be too long and difficult to remember. Thus, a new name was created to enhance communications. We are now the IEA 'Energy in Buildings and Communities' Programme, or EBC for short. These changes have been rounded off by re-designs of our website, newsletter and report formats. Not only do I hope that you like our new look and name, but also that this makes your life easier when talking and writing about the IEA 'Energy in Buildings and Communities' Programme – It is now simply EBC.

I am pleased to announce that in June 2012 Dr. Takao Sawachi has been elected as the EBC Vice-Chair. In this capacity, he is leading the renewal of our Strategic Plan for the coming five years period. During the past year, the Executive Committee visited Spain and Switzerland. At both locations, well organized conferences were held to encourage scientific exchanges between the EBC Programme and the national research communities. In the reporting period, three new international collaborative projects have been started. They are on the topics, 'New Generation Computational Tools', 'Deep Energy Retrofit' and 'Ventilative Cooling'. You can find introductions to these within this Annual Report. No projects were completed during the reporting period, but several are now close to publication of their final reports. Among the project proposals that have recently been under discussion by the EBC Executive Committee, there is a clear trend towards research and development of tools and implementation of strategies for energy efficient communities.

The actual economic and political boundary conditions with currently low fossil fuel prices and the preference of many countries to step out of nuclear power generation are challenging in view of reaching energy reduction and climate change mitigation goals. Reliable and cost effective technologies for transforming the built environment into an energy efficient and low carbon state are needed more than ever. So, to provide solutions in this field has become even more urgent. EBC is making strong contributions to address these challenges by convening targeted international collaborative research work.

Andreas Eckmanns
EBC Executive Committee Chair

New Research Projects

VENTILATIVE COOLING

DEVELOPMENT & DEMONSTRATION OF FINANCIAL & TECHNICAL CONCEPTS FOR DEEP ENERGY RETROFITS OF GOVERNMENT OR PUBLIC BUILDINGS & BUILDING CLUSTERS

NEW GENERATION COMPUTATIONAL TOOLS FOR BUILDING & COMMUNITY ENERGY SYSTEMS BASED ON THE MODELICA & FUNCTIONAL MOCKUP INTERFACE STANDARDS

Ventilative Cooling

ANNEX 62

The current trend in building energy efficiency towards nearly zero energy buildings creates a number of new challenges for building design and construction. One of the major challenges is the increased need for cooling in highly insulated and airtight buildings, which is not only required in summer and mid season periods, but can also be needed in winter, particularly in office buildings. Most of the post-occupancy studies of high performance buildings in European countries show that the temperature levels are the most often reported problem, especially in residential buildings.

Ventilative cooling is the application of ventilation air flow to reduce the cooling loads in buildings. It utilizes the cooling and thermal perception potential of outdoor air. Ventilative cooling can be an attractive and energy efficient solution to reduce the cooling load and avoid overheating of both new and renovated buildings. However, before ventilative cooling is considered, internal gains from equipment and solar radiation are assumed to be reduced to a reasonable level. Ventilation is already present in buildings through mechanical and/or natural systems. It can remove both excess heat gains, as well as increase air velocities and thereby widen the thermal comfort range. As cooling also becomes necessary outside the summer period, the possibilities of using the cooling potential of low temperature outdoor air increases considerably. To address the cooling challenges of buildings the project research will focus on development of design methods and compliance tools related to predicting, evaluating and eliminating the cooling need and the risk of overheating in buildings, and on development of new attractive energy efficient ventilative cooling solutions.

Shading (to reduce solar gains) and ventilation should be applied to reduce cooling loads and avoid overheating.

Objectives

The objectives are to:

- analyse, develop and evaluate suitable design methods and tools for prediction of cooling need, ventilative cooling performance and risk of overheating in buildings;
- give guidelines for integration of ventilative cooling in energy performance calculation methods and regulations, including specification and verification of key performance indicators;
- extend the boundaries of existing ventilation solutions and their control strategies and to develop recommendations for flexible and reliable ventilative cooling solutions that can create comfortable indoor conditions under a wide range of climatic conditions;
- demonstrate the performance of ventilative cooling solutions through analysis and evaluation of well documented case studies.

Meetings

A workshop took place in Copenhagen, Denmark on 8th - 9th October, 2012.

Project duration
2012–2017

Operating Agent
Per Heiselberg, Aalborg University, Denmark

Participating countries (provisional)
Austria, Belgium, P.R. China, Czech Republic, Denmark, Finland, France, Germany, Greece, Italy, Japan, The Netherlands, Norway, Switzerland, Spain, Sweden, United Kingdom, USA

Further information
www.iea-ebc.org

Development & Demonstration of Financial & Technical Concepts for Deep Energy Retrofits of Government or Public Buildings & Building Clusters

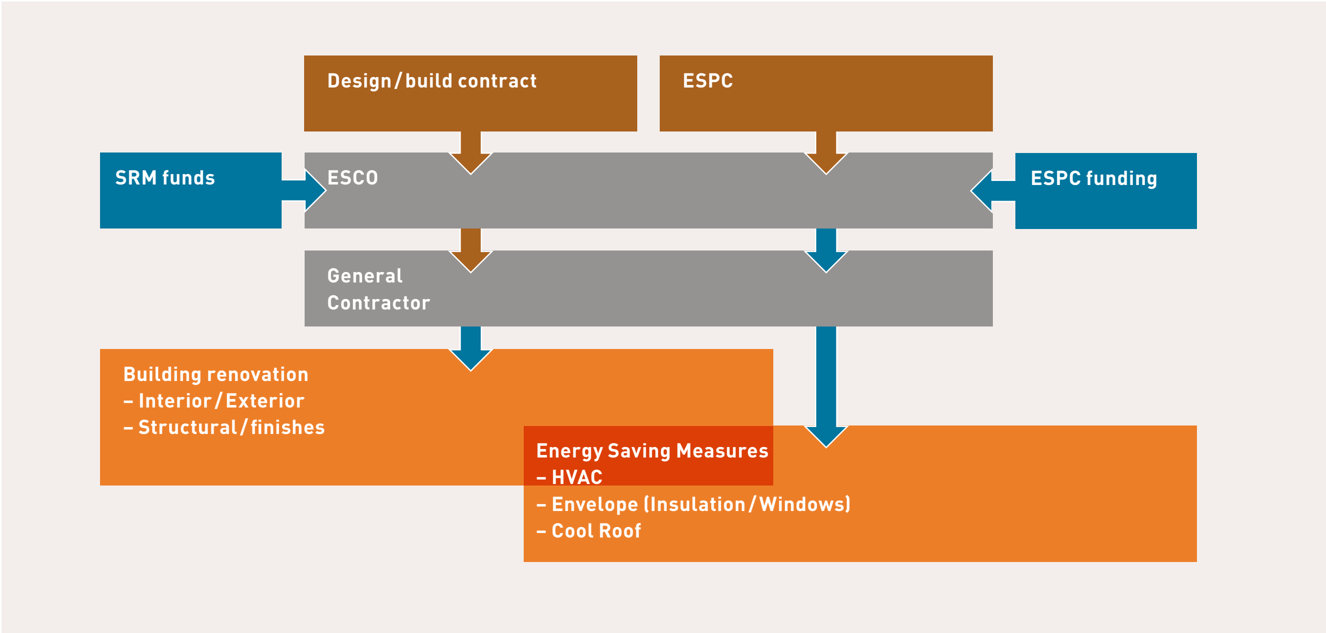
ANNEX 61

Stringent targets for reductions in energy use in government or public buildings are now becoming more common in many industrialised countries. However, the funding and 'know how' (applied knowledge) available for owner-directed energy retrofit projects has not kept pace with new requirements to increase the number of energy retrofits and to improve the energy efficiency of existing buildings. In recent years, the Energy Savings Performance Contract (ESPC) has proven to be a very energy and cost efficient tool in some countries. Nevertheless, in many countries the number of projects funded by ESPCs do not form a significant part of the total investment budgeted by public institutions for energy retrofits. This project aims to increase the acceptance of ESPCs, and to broaden the implementation of deep energy use reduction through refurbishment of existing buildings using ESPCs.

To date ESPCs have been used primarily as instruments for retrofitting heating, ventilating, and air-conditioning (HVAC) systems, lighting systems and controls. Implementation of certain individual measures (for example building envelope insulation and improved airtightness, or co-generation) results in significant reductions in building heating and cooling loads or minimization of energy waste, but requires significant investments with long paybacks. However, when different technologies are implemented together, or are 'bundled', they can result in significant energy use reductions, require smaller investments, and consequently have faster paybacks. Such bundles of energy saving measures are seldom applied when buildings and building clusters are retrofitted. Decision makers and energy service companies (ESCOs) often lack of knowledge about the synergies of different energy saving measures available to them, or about the efficiencies and return on investment that such bundles of measures could yield.

Residential building renovation in Karlsruhe, Germany.

In the face of ambitious energy efficiency objectives it will be necessary to provide integrated solutions and corresponding business models to the market. ESPCs, for example, are not yet the chosen vehicle for integrated retrofit projects that include the building thermal envelope. Research in the project would improve the decision making process to achieve deep energy retrofits of government/public buildings (office/administrative buildings, dormitories/barracks, educational buildings, and so on). The starting point is the determination of effective bundles of technologies and corresponding business models using combined public and private funding. While some countries have demonstrated successful renovation projects that reduced energy use by up to 70% in pilot projects subsidized by the government, penetration of such retrofit concepts into privately (co-)funded retrofit projects is limited, or in some locations non-existent. Experiences from individual countries would be analyzed for applicability in other participating countries.



The application of an energy savings performance contract (ESPC) alongside a design/build contract to introduce energy saving measures during building renovation.

Objectives

The objectives are to

- provide a framework and selected tools and guidelines to significantly reduce energy use (by more than 50%) and improve indoor environment quality in government and public buildings and building clusters undergoing renovation;
- gather and, in some cases research, develop, and demonstrate innovative and highly effective bundled packages of energy conservation measures for selected building types and climatic conditions;
- develop and demonstrate innovative, highly resource-efficient business models for retrofitting/refurbishing buildings and building clusters using appropriate combinations of public and private funding such as ESPCs and other concepts to be developed together with the building owners;
- support decision makers in evaluating the efficiency, risks, financial attractiveness, and contractual and tendering options conforming to existing national legal frameworks;
- engage building owners and other market partners in the proceedings and work of the project.

Meetings

In 2012, two preparation meetings took place in:
Karlsruhe, Germany, 2nd–3rd May, 2012
Paris, France, 18th October, 2012.

Project duration
2012–2016

Operating Agents
Alexander Zhivov, US Army Engineer Research and Development, USA, and Rüdiger Lohse, KEA- Climate protection and energy agency of Baden- Württemberg GmbH, Germany

Participating countries (provisional)
Austria, Belgium, Denmark, Finland, France, Germany, Portugal, Sweden and USA

Further information
www.iea-ebc.org

New Generation Computational Tools for Building & Community Energy Systems Based on the Modelica & Functional Mockup Interface Standards

ANNEX 60

Connections from individual buildings and district energy systems will become increasingly integrated within smart grids to reduce energy and peak power and to increase occupant health and productivity. This poses new challenges for building simulation programs to support decision making during product development, building design, commissioning and operation. This situation leads to new functional requirements on computational tools for buildings that are not addressed by existing building simulation programs. In the meantime, other engineering sectors have been making large investments in next generation computing tools for complex dynamic engineered systems. The aim of the project is therefore to transfer these developments to the buildings industry. For buildings and community energy systems it will coordinate currently fragmented developments on next generation computing tools based on two open, non-proprietary standards, the Modelica modelling language, and the Functional Mockup Interface.

Based on these, the project aims to share, further develop and deploy free open source contributions of currently uncoordinated activities in modelling and simulation of energy systems in buildings and communities. It will create and validate tool chains that link building information models to energy modelling, building simulation to controls design tools, and design tools to operational tools. Invention and deployment of integrated energy-related systems and performance based solutions for buildings and communities will be accelerated by extending, unifying and documenting existing Modelica libraries. They will also be improved by linking existing building performance simulation tools with Modelica through the Functional Mockup Interface standard. The technology will allow optimized design, analysis and operation of multi-domain systems as posed by building and community energy systems. It will also allow the use of models across the whole building life cycle to ensure realization and persistence of design intent.

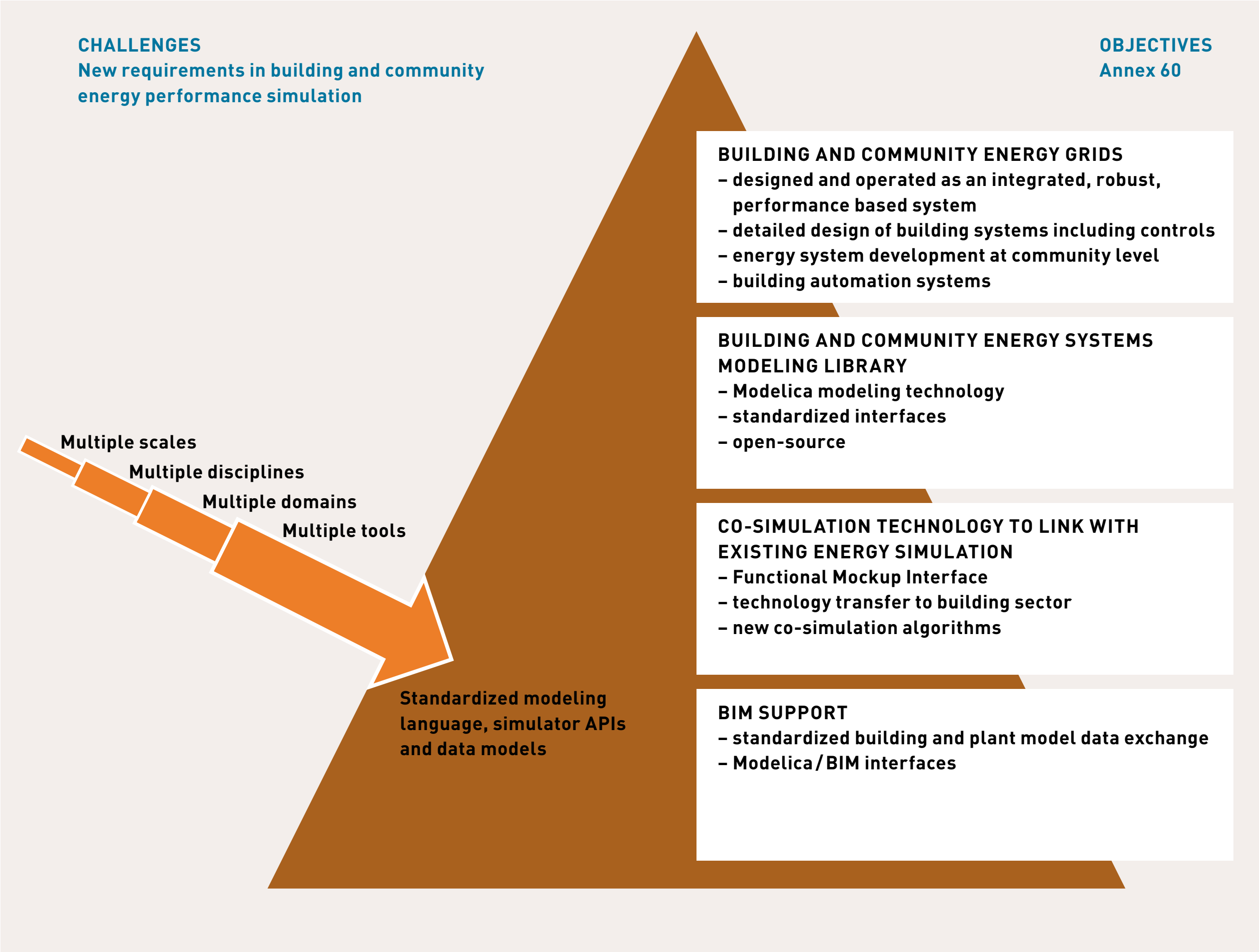
Objectives

The objectives are to develop and demonstrate next-generation computational tools that allow building and energy grids to be designed and operated as integrated, robust, and performance based systems.

Deliverables

- Validated and documented models that can be used by designers, manufacturers, controls providers, researchers and students with multiple open source and commercial Modelica simulation environments.
- New algorithms, implemented in existing building simulation programs and in co-simulation middleware, which allows efficient co-simulation and model exchange through the Functional Mockup Interface standard.
- Interfaces that allow designers to configure Modelica models from a building information model (BIM) compatible CAD system.
- Case studies that demonstrate to designers the co-design of building energy and control systems taking into account system dynamics (energy storage and controls), uncertainty and variability.
- Case studies that demonstrate to urban planners and utilities the integration of buildings into a community-level energy grid.
- Software and case studies that demonstrate to designers, control providers and students how to use models to assist in the operation of buildings.

A guidebook will explain how these technologies can be used in applications that are beyond the capabilities of traditional building simulation programs. Applications include rapid virtual prototyping, design of local and supervisory control algorithms, and deployment of models in support of commissioning and operation.



Interrelationships between technical challenges and planned project outcomes. These challenges will be addressed through the use of a standardized modelling language, standardized Application Programming Interfaces (API) and standardized data models.

Meetings

Two teleconferences took place in 2012.

Project duration
2012 – 2017

Operating Agents
Michael Wetter, Lawrence Berkeley National Laboratory, USA, and Christoph van Treeck, RWTH Aachen University, Germany

Participating countries (provisional)
Austria, Belgium, P.R. China, France, Germany, Ireland, The Netherlands, Sweden, Switzerland, USA

Further information
www.iea-ebc.org

Ongoing Projects

HIGH TEMPERATURE COOLING & LOW TEMPERATURE HEATING IN BUILDINGS

RELIABLE BUILDING ENERGY PERFORMANCE CHARACTERISATION BASED ON FULL SCALE DYNAMIC MEASUREMENT

EVALUATION OF EMBODIED ENERGY & CO2 EMISSIONS FOR BUILDING CONSTRUCTION

COST EFFECTIVE ENERGY & CARBON DIOXIDE EMISSIONS OPTIMIZATION IN BUILDING RENOVATION

RELIABILITY OF ENERGY EFFICIENT BUILDING RETROFITTING – PROBABILITY ASSESSMENT OF PERFORMANCE & COST

INTEGRATION OF MICRO-GENERATION & RELATED ENERGY TECHNOLOGIES IN BUILDINGS

TOTAL ENERGY USE IN BUILDINGS – ANALYSIS AND EVALUATION METHODS

TOWARDS NET ZERO ENERGY SOLAR BUILDINGS

ENERGY EFFICIENT COMMUNITIES:
CASE STUDIES & STRATEGIC GUIDANCE FOR URBAN DECISION MAKERS

AIR INFILTRATION & VENTILATION CENTRE AIVC

High Temperature Cooling & Low Temperature Heating in Buildings

ANNEX 59

This project presents a new perspective and concept for analysing heating, ventilation and air conditioning (HVAC) systems in buildings. High temperature cooling and low temperature heating would be achieved by reducing temperature differences in heat transfer and energy transportation processes.

It is important to minimise temperature differences in HVAC systems, because high differences result in reduced efficiencies and therefore increased energy use. The project is thus focusing on temperature differences throughout HVAC systems, as well as in indoor spaces and on how these can be minimized in highly energy efficient buildings. Temperature differences within HVAC systems can be classified into three types, arising from:

- heat and moisture exchange,
- heat transmission through fluid media, and
- thermal mixture loss in indoor spaces due to different types of indoor terminal devices.

The beneficiaries of the project outcomes and deliverables will be designers and industrial manufacturers, such as manufacturers of chillers, radiant and supply air terminals. The outcomes will contribute to the further improvement of new HVAC terminal devices.

Objectives

The main project objectives are to:

- establish a methodology for analysing HVAC systems from the perspective of reducing mixture and transfer losses,
- propose novel designs for indoor terminals and novel flow paths for outdoor air handling equipment, and
- develop high temperature cooling and low temperature heating systems in buildings with fully utilized heat and cold sources, high efficiency transportation and appropriate indoor terminals.

Deliverables

- A guide book on a new analysis method for HVAC systems
- Novel designs for indoor terminals in high temperature cooling and low temperature heating systems
- Novel flow paths for outdoor air handling equipment and their application in high temperature cooling and low temperature heating systems
- A design guide for high temperature cooling and low temperature heating systems with applications
- Real-time test results for high temperature cooling and low temperature heating systems in typical office buildings under different climatic conditions

Progress

During 2012 the following activities took place:

- a new parameter, 'entransy' - defined as heat transfer ability - was introduced and several examples of the application of entransy analysis in HVAC systems were examined, including heat exchangers, heat exchangers in series, indoor cooling processes and heat storage,
- experimental and modelling studies were carried out for assessing the thermal performance of various radiative and convective terminals,
- experimental tests were conducted on the performance of desiccant systems with various desiccants,
- dehumidification methods were compared, and
- the 'Bayer Diegem' building in Belgium and 'Xi'an Airport T3 Terminal' in China were chosen as case studies for real-time testing.

Meetings

The 1st project meeting was held in Aalborg, Denmark, on 30th April and 1st May, 2012.
The 2nd project meeting was held in Zhuhai, China, on 1st–2nd November, 2012.

Project duration
2012–2015

Operating Agent
Yi Jiang, Tsinghua University, P.R. China

Participating countries (provisional)
Belgium, P.R. China, Denmark, Finland, Italy, Japan, USA

Further information
www.iea-ebc.org

Reliable Building Energy Performance Characterisation Based on Full Scale Dynamic Measurement

ANNEX 58

To reduce the energy use of buildings and communities, many industrialised countries have imposed stringent requirements for new developments. In most cases, evaluation and labelling of the energy performance of buildings are carried out at the design phase. Several studies have showed, however, that the actual performance after construction may deviate significantly from this theoretically designed performance. As a result, there is a growing interest in full scale testing of components and whole buildings to characterise their actual thermal performance and energy efficiency. This full scale testing approach is not only of interest to study building (component) performance under actual conditions, but is also a valuable and necessary tool to deduce simplified models for advanced components and systems to integrate them into building energy simulation models. The same is true to identify suitable models to describe the thermal dynamics of whole buildings including their energy systems. Characterising the dynamic behaviour of buildings is an essential and very valuable input, for example when optimising energy grids for building and communities.

It is clear that quantifying the actual performance of buildings, verifying calculation models and integrating new advanced energy solutions for nearly zero or positive energy buildings can only be effectively realised by in situ testing and dynamic data analysis. But, practice shows that the outcome of many on site activities can be questioned in terms of accuracy and reliability. Full scale testing requires quality during all stages of research, starting with the test environment, such as test cells or real buildings, accuracy of sensors and correct installation, data acquisition software, and so on. It is crucial that the experimental setup (for example test layout or imposed boundary conditions for testing) is correctly designed, and produces reliable data. These outputs can then be used in dynamic data analysis based on advanced statistical methods to provide a characteristic with reliable accuracy intervals and final use of the results. As soon as the required quality is not achieved at one of the stages, the results become inconclusive or useless.

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.

Objectives

- Develop common quality procedures for dynamic full scale testing to realise better performance analysis
- Develop models to characterize and predict the effective thermal performances of building components and whole buildings

Expected outcomes

- A report on the state of the art of full scale testing and dynamic data analysis, including a survey of existing full scale test facilities for the benefit of the building industry, engineers and consultants
- Guidance on how to perform reliable full scale dynamic testing, intended for the building industry and building research community
- A description of the methodology to perform dynamic data analysis and performance characterisation, intended for the building research and associated communities
- A summary report (white paper) on full scale dynamic testing and data analysis to characterise building energy performance, intended for the building research and associated communities
- A few, well-documented dynamic data sets that can be used for developing dynamic data analysis procedures and for validation purposes, aimed at software developers and the building research community
- A synthesis report, demonstrating the applications of the developed framework, intended for building designers and industry, government and other authorities

Progress

The following activities took place in 2012:

- The survey of full scale test facilities was almost completed.
- A scale model of a building (a round robin test box) was built and was moved around the world for in situ characterisation under different climatic conditions.
- A first concept was developed for a decision tree to guide and optimise full scale testing.
- Common exercises on dynamic data analysis and performance characterisation were run.
- A close collaboration with Dynastee (www.dynastee.info) was set up to ensure a long lasting network of excellence on full scale testing and dynamic data analysis.

Meetings

In 2012, two experts meetings took place in:
Bilbao, Spain, in April 2012
Leeds, UK, in September 2012.

Project duration
2011–2015

Operating Agent
Staf Roels, University of Leuven, Belgium

Participating countries
Austria, Belgium, P.R. China, Czech Republic, Denmark, Finland, France, Germany, Italy, Japan, The Netherlands, Norway, Poland, Spain, United Kingdom, USA

Further information
www.iea-ebc.org

Round robin test box used for in situ characterisation under different climatic conditions.

Evaluation of Embodied Energy & CO_2 Emissions for Building Construction

ANNEX 57

The total energy used by a building during its whole life cycle includes both embodied and operational energy. Embodied energy is 'embedded' in construction materials during all production processes, on site construction, renovation and demolition and final disposal, while operational energy is used for supplying services within a building.

The accuracy of operational energy use and related carbon dioxide (CO_2) emissions prediction methodologies has been improved in recent years, resulting in more energy efficient building designs. As operational energy use is so reduced, the embodied energy and CO_2 emissions become proportionally more significant.

The project is investigating methods for evaluating embodied energy and CO_2 emissions of buildings, to develop guidelines to further practitioners' understanding. The intention is to assist them to find better design and construction solutions for buildings with less embodied energy and CO_2 emissions.

Objectives

- Collect existing research results concerning embodied energy and CO_2 emissions due to building construction, and summarize these results within a state of the art report.
- Develop guidelines for methods for evaluating the embodied energy and CO_2 emissions due to building construction.
- Develop guidelines for measures to design and construct buildings with less embodied energy and CO_2 emissions.

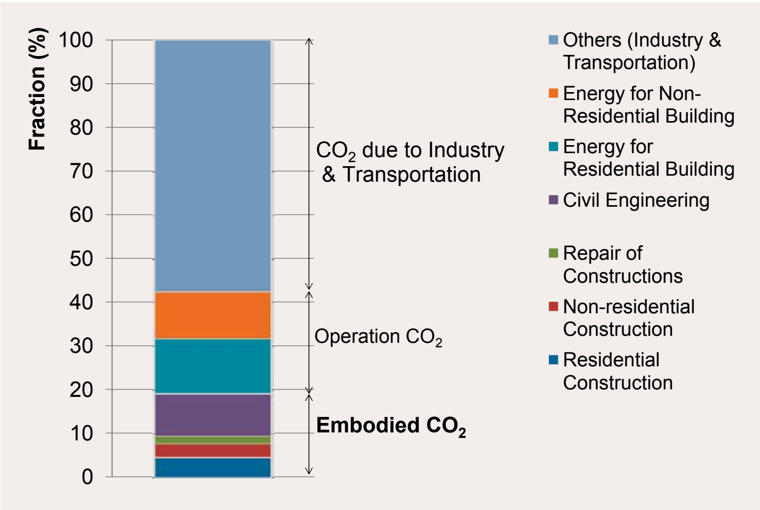
Deliverables

- A state of the art overview of methods for evaluating the embodied energy and CO_2 emissions due to building construction.
- A database and benchmarks for intensities of embodied energy and CO_2 emissions
- Guidelines for evaluation methods for embodied energy and CO_2 emissions for building construction.
- Guidelines for design and construction methods for buildings with low embodied energy and CO_2 emissions.

Progress

During 2012, the following work was undertaken:

- Definitions of key concepts and technical terms related to embodied energy and CO_2 emissions during building construction were refined.
- Review of methodologies used in existing calculation tools for embodied energy and CO_2 assessment and databases.
- Energy use in supply chains relating to building materials was clarified to differentiate between the characteristics of databases based on ISO standards (on which life cycle assessment procedures rely) and input-output (IO) analysis.
- Since the quantity of materials used in buildings is important, the dominant materials have been expressed as benchmarks and the weight of buildings in the participating countries has been reported.
- Embodied energy and CO_2 emissions under various building design conditions were approximately estimated to find out the principal factors, before starting more detailed and more extensive evaluations. Prolongation of building life was found to be an effective measure to reduce embodied energy and CO_2 emissions, although the quantity of materials in the building structure would need to increase to a certain extent.
- It was agreed to create a user friendly database of various building materials aggregated into construction elements to permit more straightforward design.



Annual fraction of embodied CO_2 of total emission in Japan

Meetings

- The 2nd expert meeting took place in Porto, Portugal in June 2012
- The 3rd expert meeting took place in Cambridge, UK in October 2012

Project duration
2011–2015

Operating Agent
Tatsuo Oka, Utsunomiya University, Japan

Participating countries
Australia, Austria, China, Czech Republic, Denmark, Finland, Germany, Japan, Republic of Korea, The Netherlands, Norway, Portugal, Sweden, UK, Brazil (Observer)

Further information
www.iea-ebc.org

Cost Effective Energy & Carbon Dioxide Emissions Optimization in Building Renovation

ANNEX 56

In recent years, various standards and regulations for energy consumption in buildings have emerged that specify greatly improved levels of energy efficiency in comparison with earlier requirements. However, these mainly focus on new buildings and do not respond effectively to the numerous technical, functional and economic constraints of the existing stock. It is common that requirements for existing buildings, which are generally targeted at energy efficiency measures, result in expensive processes and complex procedures, seldom accepted by occupants, owners or developers. These procedures can be simplified if onsite generation of renewable energy is considered during the renovation process, potentially reducing the amount of work needed for energy efficiency measures.

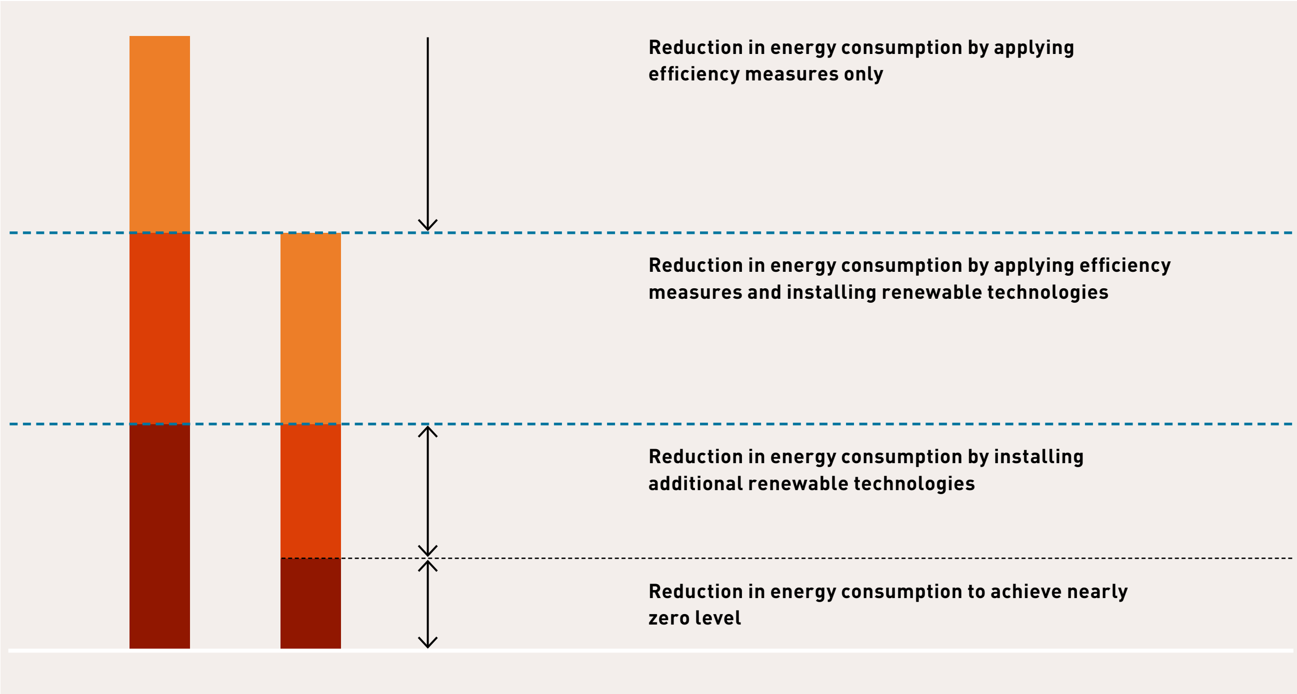
Effectively, within the overall objective of slowing down climate change by reducing carbon dioxide (CO_2) emissions, renewable energy supply measures can sometimes be at least as cost effective as energy efficiency measures, if not more so. Therefore, in existing buildings, the most cost-effective renovation solution is often a combination of energy efficiency and renewable energy supply measures. So, it is important to investigate where the balance point lies between these two types of measures from a cost-benefit perspective.

This involves determining how the best performance (in terms of less energy consumption, less CO_2 emissions and other benefits) would be achieved with the least effort (in terms of financial investment, depth and duration of interventions and disturbance of occupants). Therefore, a new methodology for energy and carbon emissions optimized building renovation is being developed to be used by interested private entities helping them in their renovation decisions, as well as by governmental agencies for the definition of regulations and their implementation. The outcomes are intended to serve as a basis for future standards.

Objectives

The project objectives are to:

- define a methodology for establishing cost optimized targets for energy consumption and CO_2 emissions in building renovation,
- clarify the relationship between CO_2 emissions and energy targets and their eventual hierarchy,
- determine cost effective combinations of energy efficiency and renewable energy supply measures,
- highlight additional benefits achieved in the renovation process,
- develop tools to support decision makers in accordance with the developed methodology,
- select exemplary case studies to encourage decision makers to promote efficient and cost effective renovations.



Achieving nearly zero energy consumption by applying efficiency measures and renewable technologies.

Deliverables

The following project deliverables are planned:

- the report, 'Methodology for Cost Efficient Energy and Carbon Emissions Optimized Building Renovation',
- the report, 'Integration of Embodied Energy and LCIA into the Assessment of Renovation Measures',
- the report, 'Added Values of Building Renovation: Integration into Assessment and Promotion of Renovation Measures',
- supporting tools for decision makers,
- the 'Shining Examples' brochure,
- the report, 'Detailed Case Studies', and
- the 'Renovation Guidebook', including a summary for policy makers.

Progress

During 2012, the following main activities were carried out:

- First results were produced to demonstrate the viability of the developed methodology, based on different packages of energy renovation measures.
- Data were collected about typical buildings and renovation measures in the participating countries.
- Development of the ‚Shining Examples' brochure was progressed, with the objective of demonstrating building renovation examples to motivate and inspire a general, non-technical audience.

Meetings

- The 2nd meeting of the working phase took place in Venice, Italy in April 2012
- The 3rd meeting for the working phase took place in Oslo, Norway in September 2012

Project duration
2010–2015

Operating Agent
Manuela Almeida, University of Minho, Portugal

Participating countries
Austria, P.R.China, Czech Republic, Denmark, Finland, Italy, The Netherlands, Norway, Portugal, Spain, Switzerland, Sweden

Further information
www.iea-ebc.org

Reliability of Energy Efficient Building Retrofitting – Probability Assessment of Performance & Cost

ANNEX 55

Nowadays building energy use and durability issues are some of the most important topics in industrialised countries. Even though considerable progress has been achieved concerning new buildings (low energy, passive houses, zero energy, and so on) and advanced building services, the buildings sector still generally accounts for the largest share of energy-related carbon dioxide (CO_2) emissions. While in many industrialised countries, new buildings are constructed every year corresponding to approximately 1% of the existing building stock, often more than 50% of the building stock dates from before the first energy crisis in the 1970s. Hence, a large potential for energy savings and consequently a large reduction of CO_2 emissions is presently available in the existing building stock.

Retrofit measures are therefore of the utmost importance for upgrading the building stock. But, many building owners are only interested in the initial capital cost. Looking at actual risks in performance and the costs incurred highlights the need for life cycle thinking. Applicable calculation methods are therefore required in this area. For this purpose, probability assessment in life cycle costing of solutions supports sound decision making relating to investments. For industry, customer relationships are based on future expectations and confidence: These will be supported by proper probability assessments.

A project common exercise on economic assessment using the Swedish 'cold attic' model. Participants are determining the most cost effective renovation measure for a neighbourhood of 237 dwellings.

The project is improving methods and tools for integrated evaluation and optimization of retrofitting measures, including energy efficiency, life cycle cost and durability. It will demonstrate to decision makers, designers and practicioners the benefits of the renewal of the existing building stock and how to make reliable solutions.

Objectives

The scope of the project is to develop and provide decision support data and tools for energy retrofitting measures. The tools are being based on probabilistic methodologies for prediction of energy use, life cycle cost and functional performance. The objectives are to:

- develop and validate probabilistic methods and tools for energy use, lifecycle cost and functional performance, and
- apply and demonstrate probabilistic methodologies on real life case studies, and
- create guidelines for practitioners, including assessment of common retrofitting techniques.

Deliverables

The deliverables from the project will be:

- a methodology for probability based assessment of energy retrofitting measures,
- analyses of case studies to show how to apply probability analyses to enhance energy savings, secure performance and apply cost analyses, and
- a report and electronic database for stochastic inputs, validation data, and guidelines for practitioners.

Progress

During 2012 the following activities took place:

- Stochastic data were collected and methodologies to analyse and present the data were established.
- The reporting phase started.
- Various probabilistic methods were investigated for performance evaluation. A common task on probabilistic assessment of life cycle cost for attic retrofitting was completed.
- The framework for the risk assessment of retrofitting measures was evaluated and established.
- A survey to list frequently used retrofitting building technologies was carried out, along with associated benefits and risks in the participating countries.

Meetings

In 2012, two experts meetings took place:
Vienna, Austria, in April 2012
Leuven, Belgium, in October 2012

Project duration
2010–2014

Operating Agent
Carl-Eric Hagentoft, Chalmers University of Technology, Sweden

Participating countries
Austria, Belgium, Canada, Denmark, Finland, Germany, The Netherlands, Portugal, Sweden, UK, USA

Observers
Brazil, Slovakia, Estonia

Further information
www.iea-ebc.org

Integration of Micro-Generation & Related Energy Technologies in Buildings

ANNEX 54

Micro-generation consists of technologies for providing energy using small scale systems of up to around ten kilowatts, typically with photovoltaic systems or micro-wind turbines. The combined production of heat and power (CHP) in a single small scale process is called micro-cogeneration (μCHP). This can be extended to a micro-trigeneration system, if cooling power is also produced.

Activities within this project encompass multi-source micro-cogeneration systems and renewable hybrid systems, including energy storage and demand side management technologies at a local level. Customised and optimum control strategies for integrated systems are being investigated, serving single and multiple residences along with small commercial premises. In addition, the effects of micro-generation on power distribution systems are being analysed.

Research Areas

- Development of technical models for different micro-generation technologies as cogenerators with combustion engines, fuel cells or Stirling engines, photovoltaic systems, thermal and electrical storage and balance of plant components. The models are being validated using data from laboratory and field measurements.
- Simulations are being used to develop an extensive library of performance assessment studies covering different combinations of technology types, performance in different countries and with different end users. Simulation work initially concentrated on improving and optimising the performance of basic, but realistic micro-generation systems. Subsequent work is featuring a wider range of system components, system functions and end users.
- Dissemination strategies for the mass deployment of micro-generation-related technologies are being investigated. This activity is being informed by a regulatory and market review, along with data emerging from technical analyses and performance assessment studies.

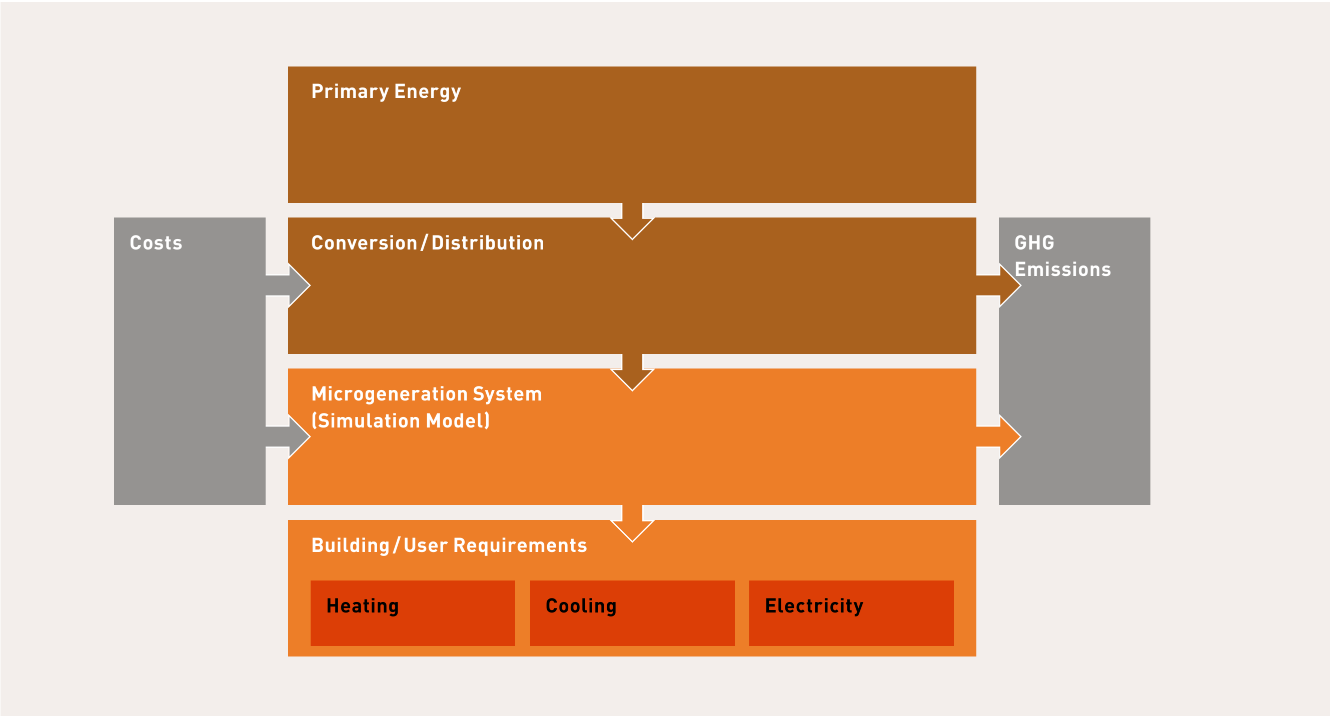
Expected Outcomes

- Component and system models implemented in building simulation tools, such as TRNSYS or ESPr
- Review of best practice in the operation and control of integrated micro-generation systems and control algorithms to maximize the performance and value of micro-generation
- Performance assessment methodologies
- Country specific studies on the technical, economic and environmental performance of micro-generation systems and the potential benefits for electrical distribution networks in particular

Progress

The following activities took place in 2012:

- The existing models were extended to simulate complete micro-generation systems. This was done based on a collection of measured laboratory and field data.
- National performance assessment studies of micro generation technologies were progressed.
- Country specific data such as standards, regulations, energy-related and economic parameters were collected and analysed.



The 3-E analysis process covering energy, environment and economics.

Meetings

- The 5th expert meeting was held in Ottawa, Canada in April 2012
- The 6th expert meeting was held in Tokyo, Japan in October 2012

Project duration
2007 – 2013

Operating Agents
Evgueniy Entchev, Natural Resources Canada, Canada and Peter Tzscheutschler, Technische Universität München, Germany

Participating countries
Belgium, Canada, Denmark, Finland, Germany, Italy, Japan, Republic of Korea, The Netherlands, UK, USA

Further information
www.iea-ebc.org

Total Energy Use in Buildings – Analysis and Evaluation Methods

ANNEX 53

One of the most significant barriers for achieving a substantial improvement of building energy efficiency is a lack of knowledge about the factors determining energy use. In fact, there is often a significant discrepancy between designed and real total energy use in buildings. The reasons for these discrepancies are generally poorly understood, and often have more to do with the role of human behaviour than the building design. In fact, building energy use is mainly influenced by six factors:

- Climate
- Building envelope
- Building services and energy systems
- Building operation and maintenance
- Occupants' activities and behaviour
- Indoor environmental quality

In general, much current research focuses mainly on the first three factors (climate, building envelope, building services and energy systems). However, the latter three factors related to human behaviour can have an influence at least as significant as the three former ones. Detailed comparative analysis of building energy data, concerning the six factors mentioned above, would provide essential guidance in identifying energy saving potentials and opportunities.

The project is working to improve understanding of how the six factors combine to influence building energy use, with particular emphasis placed on occupant behaviour. It also aims to improve the treatment of these factors within the building energy field, and to more closely relate this to the real world. Hence, the intention is to have a better understanding of how to robustly predict total energy use in buildings, so enabling the improved assessment of energy saving measures, policies and techniques.

Research Areas

Five distinct areas of research have been established:

- Definitions and energy reporting
- Case studies and data collection
- Statistical analysis
- Energy performance evaluation
- Occupant behaviour analysis

Deliverables

- Models for predicting total building energy use (statistical and analytical methods)
- Reports of building case studies, measurement methods and total energy use data

Progress

- Reporting was progressed on terminology, indicators and influencing factors for energy use.
- Definitions were developed for energy boundaries, building energy use terms and conversion factors.
- Definitions were developed of the influencing factors and energy performance indicators at three levels of complexity for residential and office buildings, with two case studies used to expound the definitions.
- Case studies were selected for the project.
- Case study material for four building types was collated for use in simulations.
- A literature review was completed and a state of the art review prepared for inclusion in the final report.

Meetings

5th project meeting, held in Rotterdam, The Netherlands in April 2012

6th project meeting, held in Yokohama, Japan in October 2012

Analysed single family residential case study building from Japan.

Analysed multi-dwelling residential case study building from Austria.

Project duration
2008–2013

Operating Agent
Hiroshi Yoshino, Tohoku University, Japan

Participating countries
Austria, Belgium, Canada, P.R. China, Denmark, Finland, France, Germany, Italy, Japan, The Netherlands, Norway, Portugal, Spain, USA

Further information
www.iea-ebc.org

Towards Net Zero Energy Solar Buildings

ANNEX 52

Several industrialised countries have recently adopted a vision of so called 'net zero energy buildings' as long-term goals of their energy policies. However, what is missing is a clear definition and international agreement on the measures of building performance that could inform 'zero energy' building policies, programmes and industry adoption around the world.

The objective of the project is to study current net zero, near net zero and very low energy buildings and to develop a common understanding, a harmonized international definitions framework, tools, innovative solutions and industry guidelines. A primary means of achieving this objective is to document and propose practical net zero energy building (NZEB) demonstration projects, with convincing architectural quality. These exemplars, supported by a sourcebook, guidelines and tools, are viewed as essential for industry adoption.

The project aims to cost effectively equalize the small annual energy needs of such buildings through building integrated heating and cooling systems, power generation and interactions with utilities. It is learning from recent industry experiences with net zero and low energy solar buildings and the most recent developments in whole building integrated design and operation. This joint international research and demonstration activity is addressing concerns of comparability of performance calculations between building types and communities for different climates. The goal is to produce solution sets that are attractive for broad industry adoption.

The scope includes major building types (residential and non-residential), new and existing buildings in various climatic zones represented by the participating countries. The work is linked to national activities and is focusing on individual buildings, clusters of buildings and neighbourhoods. It is based on analysis of existing examples, which leads to the development of innovative solutions to be incorporated into national demonstration buildings.

Objectives

- establish an internationally agreed understanding of NZEBs, based on a common methodology,
- identify and refine design approaches and tools to support industry adoption,
- develop and test innovative, whole building net zero solution sets for cold, moderate and hot climates with exemplary architecture and technologies that would be the basis for demonstration projects and international collaboration, and
- support knowledge transfer and market adoption of NZEBs at a national and international level.

The NZEB Map has been established, which presents net zero-energy and energy-plus buildings from around the world.

Solar Siedlung Vauban Freiburg, Germany.

Progress

- Development continued on the NZEB Definition Evaluation Tool (Excel based).
- A study was carried out of power grid interactions, time dependent energy mismatch and exergy balance.
- Development continued on Volumes 2 and 3 of the Source Book on net zero energy buildings.
- The NZEB Map was completed (www.enob.info/en/net-zero-energy-buildings/map). This presents and provides links for sample projects of net zero energy and energy plus buildings from around the world along with basic supporting data.

Meetings

7th experts group meeting was held in Naples, Italy on 8th–11th May, 2012

8th experts group meeting was held in Barcelona, Spain on 1st–3rd October, 2012

Project duration
2008–2013

Operating Agent
Josef Ayoub, CanmetENERGY, Natural Resources Canada, Canada

Participating countries
Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Republic of Korea, New Zealand, Norway, Portugal, Singapore, Spain, Sweden, Switzerland, United Kingdom, USA

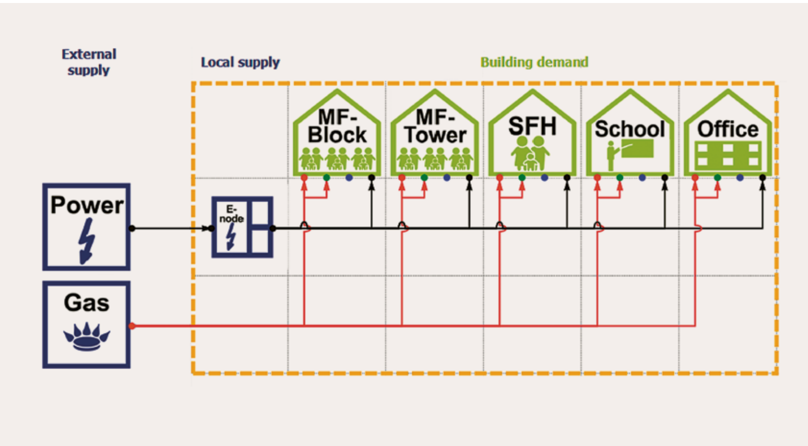
Further information
www.iea-ebc.org
www.iea-shc.org

Energy Efficient Communities: Case Studies & Strategic Guidance for Urban Decision Makers

ANNEX 51

Energy planning for community level systems is of increasing political importance in a number of industrialised countries. Consequently, ambitious targets for the reduction of energy-related carbon dioxide (CO_2) emissions are often set by municipal administrations, but with only a limited understanding of the means necessary to achieve them. Often the appropriate technology exists, but difficulties in deploying it are caused by insufficient know how for strategic planning, management ability during the implementation process, or availability of tools and instruments for decision making, planning and monitoring.

This project is providing practical guidance for urban planners, decision makers and stakeholders on how to achieve ambitious energy and CO_2 reduction targets at local and urban scales. It is addressing small units, such as neighbourhoods or quarters, as well as whole towns or cities. The project is generating the necessary knowledge and means to be able to define reasonable goals in terms of energy efficiency, energy conservation and CO_2 abatement at the community level.



Community energy systems need to meet demands from multiple building types.

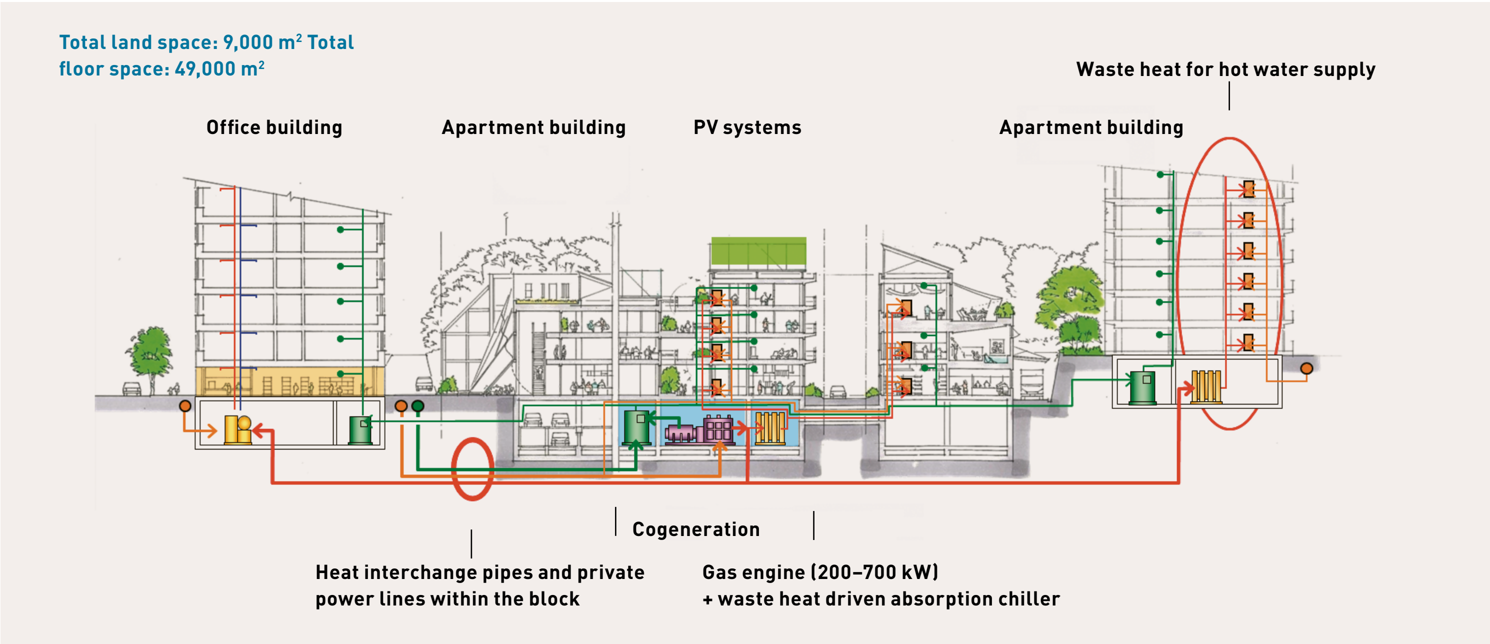
While current methods and tools useful for local energy planning form part of the case study evaluations, which are of interest to both urban and energy system planners, the primary audiences addressed by this project are local decision makers and stakeholders. Hence, the legal frameworks and different approaches found within the participating countries are being considered according to their comparative suitability to enable innovative approaches for successful urban energy policies.

Research Areas

- Existing organisational models, implementation instruments and planning tools for local administrations and developers are being assessed in a 'state of the art' review.
- Case studies on energy planning and implementation strategies for neighbourhoods, quarters and municipal areas. This involves both refurbishment of existing building stock and planning and development for new 'green' settlements.
- Case studies on the preparation of integrated energy and CO_2 abatement concepts for towns or cities and corresponding implementation strategies.
- Instruments for a successful community energy policy. This includes the preparation of a guidebook to successful urban energy planning, a community energy concept adviser and dissemination activities.

Deliverables

- The 'Guidebook to Successful Urban Energy Planning' is aimed at decision makers in urban administrations, developers and urban planners. The document is based on the findings of the state of the art review, an evaluation of the case studies, and is presented such in a way that users will be able to apply the guidebook directly to their own work.



Rebuilding and renovation of facilities in a commercial/residential block as an integrated community energy system.
Source: Tokyo Gas Company

– The 'District Energy Concept Adviser' is an electronic tool to support municipal administrations and urban planners faced with the task of developing and comparing different alternatives for integrated energy systems for neighbourhoods, either for new developments or for retrofit projects.

Progress

During 2012 the following project activities took place:

– the evaluations of case studies on energy planning and implementation strategies for neighbourhoods, quarters and municipal areas were finished;
– development work on the District Energy Concept Adviser was completed;
– work on the 'Guidebook to Successful Urban Energy Planning' was progressed;
– 'Description of the state-of-the-art of energy efficient projects on the scale of neighbourhoods' was published, presenting international case studies for energy efficient communities;
– the 'Case Study – Energy Efficient City Ludwigsburg' was published. The aim of this study was to show how energy efficiency can be achieved at a municipal level and how it can be implemented into the political decision making process by similarly structured administrations;
– a website for the project was created providing information on the project objectives, participants and periodic newsletters.

Meetings

During 2012 two project meetings took place:
7th meeting, held April 2012, in Sophia Antipolis, France
8th meeting, held October 2012, in Salzburg, Austria

Project duration
2007 – 2013

Operating Agent
Reinhard Jank, Volkswohnung GmbH, Germany

Participating Countries
Austria, Canada, Denmark, Finland, France, Germany, Japan, The Netherlands, Sweden, Switzerland, USA, Brazil (Observer)

Further information
www.iea-ebc.org


Aerial view of the neighbourhood covered by the Karlsruhe-Rintheim Case Study.

Air Infiltration & Ventilation Centre AIVC

ANNEX 5

The primary objective of the EBC information centre, 'Air Infiltration and Ventilation Centre (AIVC)', is to be the international centre on research and development in the fields of air infiltration and ventilation. Thus, the specific objective is to provide a high quality international technical and information forum covering the areas of ventilation and air infiltration in the built environment with respect to efficient energy use, good indoor air quality and thermal comfort. The mission of AIVC is to be the reference portal for information on ventilation in buildings to improve the wellbeing of people through development and dissemination of ventilation knowledge.

Since the beginning of 2011, the AIVC has been operating with a new approach, which is approved for the period through to 2013. A key ambition of the new AIVC is to convene integrated and combined activities (called 'projects'), resulting in different information tools, for example webinars, workshops, position papers, technical papers, and so on. These are supported by a review process and result in an increased information dissemination impact. The projects identified are:

- Development and applications of air leakage databases
- Philosophy and approaches for airtightness requirements
- How tight and insulated ducts should be
- Testing, reporting and quality schemes for building airtightness
- Durability of building airtightness
- Improving the quality of residential ventilation systems
- Ventilative cooling – Use of natural or mechanical ventilation strategies to cool indoor spaces
- Ventilation and health

For projects and events in relation to airtightness and ventilative cooling, AIVC is joining forces with the two information platforms TightVent Europe and venticool. TightVent is focusing on airtightness of buildings and ductwork and was launched in January 2011. Venticool is focusing on ventilative cooling and was launched in September 2012. TightVent Europe's and venticool's main goals are to:

- raise awareness of airtightness and ventilative cooling issues, which are relevant concerns for a wide range of buildings and may even be critical in nearly zero energy buildings;
- provide appropriate support tools and knowledge transfer to ease market transformation.

In 2012, the 33rd AIVC Annual Conference has once again provided an opportunity for over 160 researchers and practitioners from around the world to exchange ideas and to present their latest findings. The theme for the conference was 'Optimising Ventilative Cooling and Airtightness for [Nearly] Zero-Energy Buildings, Indoor Air Quality (IAQ) and Comfort'. The very positive evaluation of the event by participants – 72% rated the conference as meeting their expectations very well or extremely well – shows the quality of the programme and organization.

Given the converging interests of AIVC, TightVent Europe and venticool, the AIVC Board and the Steering Committees of both platforms have agreed to collaborate among other things on:

- the organization of the 2013 conference, which will be held in Athens on the theme of 'Energy conservation technologies for mitigation and adaptation in the built environment: the role of ventilation strategies and smart materials'
- the joint management of five of the projects mentioned above.

NEW PRODUCTS

Technical Notes

Technical Note 66: 'Building air leakage databases in energy conservation policies: analysis of selected initiatives in 4 European countries and the USA'

Technical Note 67: 'Building airtightness: a critical review of testing, reporting and quality schemes in 10 countries'

AIVC Conference Proceedings

33rd Annual Conference, 'Optimising Ventilative Cooling and Airtightness for [Nearly] Zero-Energy Buildings, IAQ and Comfort', held on 10th–11th October 2012, Copenhagen, Denmark.

Contributed reports

Contributed report 14: 'Methods and techniques for airtight buildings'

Contributed report 15: 'Development and evaluation of a new test method for portable air cleaners'

AIVC Newsletter

July 2012

WEBINARS

- 'The need for structured air leakage databases in energy conservation in buildings policies', held 25th May 2012.
- 'Demand-Controlled Ventilation in the European context: approaches in 4 countries and at EU level', held 26th November 2012. This attracted around 150 participants.

Project duration
1979–present

Operating Agent
Peter Wouters, INIVE eeig, Belgium

Participating countries
Belgium, Czech Republic, Denmark, France, Germany, Greece, Italy, Japan, Republic of Korea, The Netherlands, New Zealand, Norway, Portugal, Sweden, USA

Further information and reports
www.iea-ebc.org
www.aivc.org

Background Information

EBC & THE IEA

RECENT PUBLICATIONS

EBC EXECUTIVE COMMITTEE MEMBERS

EBC OPERATING AGENTS

PAST PROJECTS

EBC & the IEA

THE INTERNATIONAL ENERGY AGENCY

The International Energy Agency (IEA) was established in 1974 within the framework of the Organisation for Economic Cooperation and Development (OECD) to implement an international energy programme. A basic aim of the IEA is to foster cooperation among the twenty eight IEA member countries and to increase energy security through energy conservation, development of alternative energy sources and energy research, development and demonstration (RD&D). The current framework for international energy technology RD&D cooperation was approved by the IEA's Governing Board in 2003. More information about the energy technology RD&D framework can be found at: www.iea.org/textbase/techno

This framework provides uncomplicated, common rules for participation in research programmes, known as 'Implementing Agreements', and simplifies international cooperation between national entities, business and industry. Implementing Agreements are legal agreements between countries that wish to pursue a common programme of research in a particular area. In fact, there are now over 40 such programmes. There are numerous advantages to international energy technology RD&D collaboration through the IEA Implementing Agreements, including:

- Reduced cost and avoiding duplication of work
- Greater project scale
- Information sharing and networking
- Linking IEA member countries and non-member countries
- Linking research, industry and policy
- Accelerated development and deployment
- Harmonised technical standards
- Strengthened national RD&D capabilities
- Intellectual property rights protection

ABOUT EBC

Approximately one third of primary energy is consumed in non-industrial buildings such as dwellings, offices, hospitals, and schools where it is utilised for the heating and cooling, lighting and operation of appliances. In terms of the total energy end-use, this consumption is comparable to that used in the entire transport sector. Hence the building sector represents a major contribution to fossil fuel use and related carbon dioxide emissions. Following uncertainties in energy supply and concern over the risk of global warming, many countries have now introduced target values for reduced energy use in buildings. Overall, these are aimed at reducing energy consumption by between 5% and 30%. To achieve such a target, international cooperation, in which research activities and knowledge can be shared, is seen as an essential activity.

In recognition of the significance of energy use in buildings, in 1977 the International Energy Agency has established an Implementing Agreement on Energy in Buildings and Communities (EBC-formerly known as ECBCS). The function of EBC is to undertake research and provide an international focus for building energy efficiency. Tasks are undertaken through a series of 'Annexes', so called because they are legally established as annexes to the EBC Implementing Agreement. These Annexes are directed at energy saving technologies and activities that support technology application in practice. Results are also used in the formulation of international and national energy conservation policies and standards.

OBJECTIVES AND STRATEGY

The objectives of the collaborative work conducted by the Energy in Buildings and Communities (EBC) Implementing Agreement are derived from the major trends in construction and energy markets, energy research policies in the participating countries and from the general objectives of the International Energy Agency (IEA). The principal objective of the EBC is to facilitate and accelerate the introduction of new and improved energy conservation and environmentally sustainable technologies into buildings and community systems. Specific objectives of the EBC programme are to:

- Support the development of generic energy conservation technologies within international collaboration;
- Support technology transfer to industry and to other end users by the dissemination of information through demonstration projects and case studies;
- Contribute to the development of design methods, test methods, measuring techniques, and evaluation/assessment methods encouraging their use for standardisation;
- Ensure acceptable indoor air quality through energy efficient ventilation techniques and strategies;
- Develop the basic knowledge of the interactions between buildings and the environment as well as the development of design and analysis methodologies to account for such interactions.

The research and development activities cover both new and existing buildings, and residential, public and commercial buildings. The main research drivers for the programme are:

- The environmental impacts of fossil fuels;
- Business process to meet energy and environmental targets;
- Building technologies to reduce energy consumption;
- Reduction of greenhouse gas emissions;
- The 'whole building' performance approach;
- Sustainability;

– The impact of energy reduction measures on indoor health, comfort and usability;
– The exploitation of innovation and information technology
– Integrating changes in lifestyle, work and business environments.

MISSION STATEMENT

The mission of the IEA Energy in Buildings and Communities Programme is as follows: 'To facilitate and accelerate the introduction of energy conservation and environmentally sustainable technologies into healthy buildings and community systems, through innovation and research in decision making, building assemblies and systems, and commercialisation'

NATURE OF EBC ACTIVITIES

a. Formal coordination through shared tasks: This represents the primary approach of developing the work of EBC. The majority of Annexes are task-shared and involve a responsibility from each country to commit manpower.

b. Formal coordination through cost shared activities: EBC currently supports one cost shared project, Annex 5, the Air Infiltration and Ventilation Centre (AIVC). In recent times, Annex 5 has subcontracted its information dissemination activities to the Operating Agent, by means of a partial subsidy of costs and the right to exploit the Annex's past products.

c. Informal coordination or initiation of activities by participants: Many organizations and groups take part in the activities of EBC including government bodies, universities, nonprofit making research institutes and industry.

d. Information exchange: Information about associated activities is exchanged through the EBC and through individual projects. The EBC website (www.iea-ebc.org), for example, provides links to associated research organizations. Participants in each project are frequently associated with non IEA activities and can thus ensure a good cross-fertilization of knowledge about independent activities. Information exchange additionally takes place through regular technical presentation sessions and 'Future Buildings Forum' workshops. Information on independent activities is also exchanged through the EBC newsletter, which, for example, carries regular reports of energy policy development and research activities taking place in various countries.

EBC PARTICIPATING COUNTRIES

Australia
Austria
Belgium
Canada
P.R. China
Czech Republic
Denmark
Finland
France
Germany
Greece
Italy
Ireland
Japan
Republic of Korea
New Zealand
The Netherlands
Norway
Poland
Portugal
Spain
Sweden
Switzerland
Turkey
United Kingdom
United States of America

COORDINATION WITH OTHER BODIES

In order to achieve high efficiency in the R&D programme and to eliminate duplication of work it is important to collaborate with other IEA buildings-related Implementing Agreements. The coordination of strategic plans is a starting point to identify common R&D topics. Other actions are exchange of information, joint meetings and joint projects in areas of common interest. It is a duty of the Chairs of the respective Executive Committees to keep the others informed about their activities and to seek areas of common interest.

COLLABORATION WITH IEA BUILDING-RELATED IMPLEMENTING AGREEMENTS

The EBC Programme continues to coordinate its research activities, including Annexes and strategic planning, with all IEA Building-Related Implementing Agreements through collaborative projects and through the BCG (Buildings Coordination Group), constituted by the IEA Energy End Use Working Party (EUWP) Vice Chair for Buildings and the Executive Committee Chairs of the following IEA research programmes:

– District Heating And Cooling (DHC)
– Demand Side Management (DSM)
– Energy in Buildings and Communities (EBC)
– Energy Conservation through Energy Storage (ECES)
– Heat Pumping Technologies (HPT)
– Photovoltaic Power Systems (PVPS)
– Solar Heating and Cooling (SHC)
– Energy Efficient Electrical Equipment (4E)

Beyond the BCG meetings, EBC meets with representatives of all building-related IA's at Future Buildings Forum (FBF) Think Tanks and Workshops. The outcome from each Future Buildings Forum Think Tank is used strategically by the various IEA buildings related Implementing Agreements to help in the development of their work programmes over the subsequent five year period.

Proposals for new research projects are discussed in coordination with these other programmes to pool expertise and to avoid duplication of research. Coordination with SHC is particularly strong.

COLLABORATION WITH THE IEA SOLAR HEATING AND COOLING PROGRAMME

While there are several IEA programmes that are related to the buildings sector, the EBC and the Solar Heating and Cooling programmes focus primarily on buildings and communities. Synergies between these two programmes occur because one programme seeks to cost-effectively reduce energy demand while the other seeks to meet a large portion of this demand by solar energy. The combined effect results in buildings that require less purchased energy, thereby saving money and conventional energy resources, and reducing CO_2 emissions. The areas of responsibility of the two programmes have been reviewed and agreed. EBC has primary responsibility for efficient use of energy in buildings and community systems. Solar designs and solar technologies to supply energy to buildings remain the primary responsibility of the SHC Programme.
The Executive Committees coordinate the work done by the two programmes. These Executive Committees meet together approximately every two years. At these meetings matters of common interest are discussed, including planned new tasks, programme effectiveness and opportunities for greater success via coordination. The programmes agreed to a formal procedure for coordination of their work activities. Under this agreement during the initial planning for each new Annex/Task initiated by either programme, the other Executive Committee is invited to determine the degree of coordination, if any. This coordination may range from information exchange, inputting to the draft Annex/Task Work Plan, participating in Annex/Task meetings to joint research collaboration.
The mission statements of the two programmes are compatible in that both seek to reduce the purchased energy for buildings; one by making buildings more energy efficient and the other by using solar designs and technologies. Specifically, the missions of the two programmes are:
- EBC programme – to facilitate and accelerate the introduction of energy conservation and environmentally sustainable technologies into healthy buildings and community systems, through innovation and research in decision making, building assemblies and systems, and commercialization.
- SHC programme – to facilitate an environmentally sustainable future through the greater use of solar designs and technologies.

The two programmes structure their work around a series of objectives. Four objectives are essentially the same for both programmes. These are:
- Technology development via international collaboration;
- Information dissemination to target audiences;
- Enhancing building standards;
- Interaction with developing countries.

The other objectives differ. The EBC programme addresses life cycle environmental accounting of buildings and their constituent materials and components, as well as indoor air quality, while the SHC Programme addresses market impacts, and environmental benefits of solar designs and technologies. Both Executive Committees understand that they are addressing complementary aspects of the buildings sector and are committed to continue their coordinated approach to reducing the use of purchased energy in buildings sector markets.

NON-IEA ACTIVITIES

A further way in which ideas are progressed and duplication is avoided is through cooperation with other building related activities. Formal and informal links are maintained with other international bodies, including:
- The International Council for Research and Innovation in Building and Construction (CIB),
- The European Commission (EC),
- The International Standards Organization (ISO), and
- The American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE).

Recent Publications

Air Infiltration & Ventilation Centre (AIVC) - Annex 5

Database

AIRBASE – bibliographical database, containing over 17,000 records on air infiltration, ventilation and related areas, Web based, updated every 3 months

Technical Notes

- TN 67 Building airtightness: a critical review of testing, reporting and quality schemes in 10 countries, 2012
- TN 66 Building air leakage databases in energy conservation policies: analysis of selected initiatives in 4 European countries and the USA, 2012

Ventilation Information Papers

- VIP 34 Needs and methods for ductwork cleaning in France, 2010
- VIP 33 CO_2 as indicator for the indoor air quality – General principles, 2010
- VIP 32 Hybrid Ventilation, 2010

AIVC Conference Proceedings

- 2010 Korea – Seoul, Low Energy and Sustainable Ventilation Technologies for Green Buildings,
- 2011 Belgium – Brussels, Towards Optimal Airtightness Performance
- 2012 Denmark – Copenhagen, Optimising Ventilative Cooling and Airtightness for (Nearly) Zero-Energy Buildings, IAQ and Comfort

Integrating Environmentally Responsive Elements in Buildings - Annex 44

- Project Summary Report, Per Heiselberg, 2012
- Designing with Responsive Building Elements, Ad van der Aa, Per Heiselberg, Marco Perino, 2011

Energy-Efficient Future Electric Lighting for Buildings - Annex 45

- Project Summary Report, Liisa Halonen, Eino Tetri, and Pramod Bhusal, 2012
- Guidebook on Energy Efficient Electric Lighting for Buildings, Liisa Halonen, Eino Tetri & Pramod Bhusal (editors), 2010
- Guidebook on Energy Efficient Electric Lighting for Buildings – Extended Summary, Liisa Halonen, Eino Tetri & Pramod Bhusal (editors), 2010

Holistic Assessment Tool-kit on Energy Efficient Retrofit Measures for Government Buildings (EnERGo) - Annex 46

- EnERGo IT-Toolkit, 2011
- Best Practice Guidelines for Using Energy Performance Contracts To Improve Government Buildings, John Shonder, Ed Morofsky, Fritz Schmidt, Ove Morck, Mervi Himanen, 2010

Cost Effective Commissioning of Existing and Low Energy Buildings - Annex 47

- Commissioning Overview, Edited by Chloé Legris, Natascha Milesi Ferretti and Daniel Choinière, 2010
- Flow Charts and Data Models for Initial Commissioning of Advanced and Low Energy Building Systems, Edited by Ömer Akin, Natascha Milesi Ferretti, Daniel Choiniere and David Claridge, 2010
- Commissioning Tools for Existing and Low energy Buildings, Edited by Christian Neumann, Harunori Yoshida, Daniel Choinière and Natascha Milesi Ferretti, 2010
- Commissioning Cost-Benefit and Persistence of Savings, Edited by Hannah Friedman, David Claridge, Daniel Choinière and Natascha Milesi Ferretti , 2010

Heat Pumping and Reversible Air Conditioning - Annex 48

- Analysis of Building Heating and Cooling Demands in the Purpose of Assessing the Reversibility and Heat Recovery Potentials, Edited by Pascal Stabat, Philippe Andre, Stéphane Bertagnolio, Marcello Caciolo, Pierre Yves Franck, Corinne Rogiest, Laurent Sarrade, 2011
- Analysis of Building Heating and Cooling Demands in the Purpose of Assessing the Reversibility and Heat Recovery Potentials: Annexes, Edited by Pascal Stabat, 2011
- Review of Heat Recovery and Heat Pumping Solutions, Edited by Stéphane Bertagnolio, Pascal Stabat, Marcello Caciolo, David Corgier, 2011
- Simulation tools: Reference Book, Edited by Stéphane Bertagnolio, Samuel Gendebien, Benjamin Soccal, Pascal Stabat, 2011
- Design Handbook for Reversible Heat Pump Systems with and without Heat Recovery, Edited by Wolfram Stephan, Arno Dentel, Thomas Dippel, Madjid Madjidi, Jörg Schmid, Bing Gu, Philippe Andre, 2011
- Overview of Cases Studies and Demonstrations of Heat Pump Systems for Tertiary Buildings, Edited by Marco Masoero, Chiara Silvi, Jacopo Tonolio, 2011

Low Exergy Systems for High Performance Buildings and Communities - Annex 49

- Exergy Assessment Guidebook for the Built Environment, Summary Report, 2011
- Detailed Exergy Assessment Guidebook for the Built Environment, Guidebook, 2011

Prefabricated Systems for Low Energy Renovation of Residential Buildings - Annex 50

- Project Summary Report, Mark Zimmermann, 2012
- Retrofit Strategies Design Guide, Peter Schwehr, Robert Fischer, Sonja Geier, 2011
- Retrofit Module Design Guide, René L. Kobler, Armin Binz, Gregor Steinke, Karl Höfler, Sonja Geier, Johann Aschauer, Stéphane Cousin, Paul Delouche, François Radelet, Bertrand Ruot, Laurent Reynier, Pierre Gobin, Thierry Duforestel, Gérard Senior, Xavier Boulanger, Pedro Silva, Manuela Almeida, 2011
- Building Renovation Case Studies, Reto Miloni, Nadja Grischott, Mark Zimmermann, Chiel Boonstra, Sonja Geier, Karl Höfler, David Venus, 2011

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