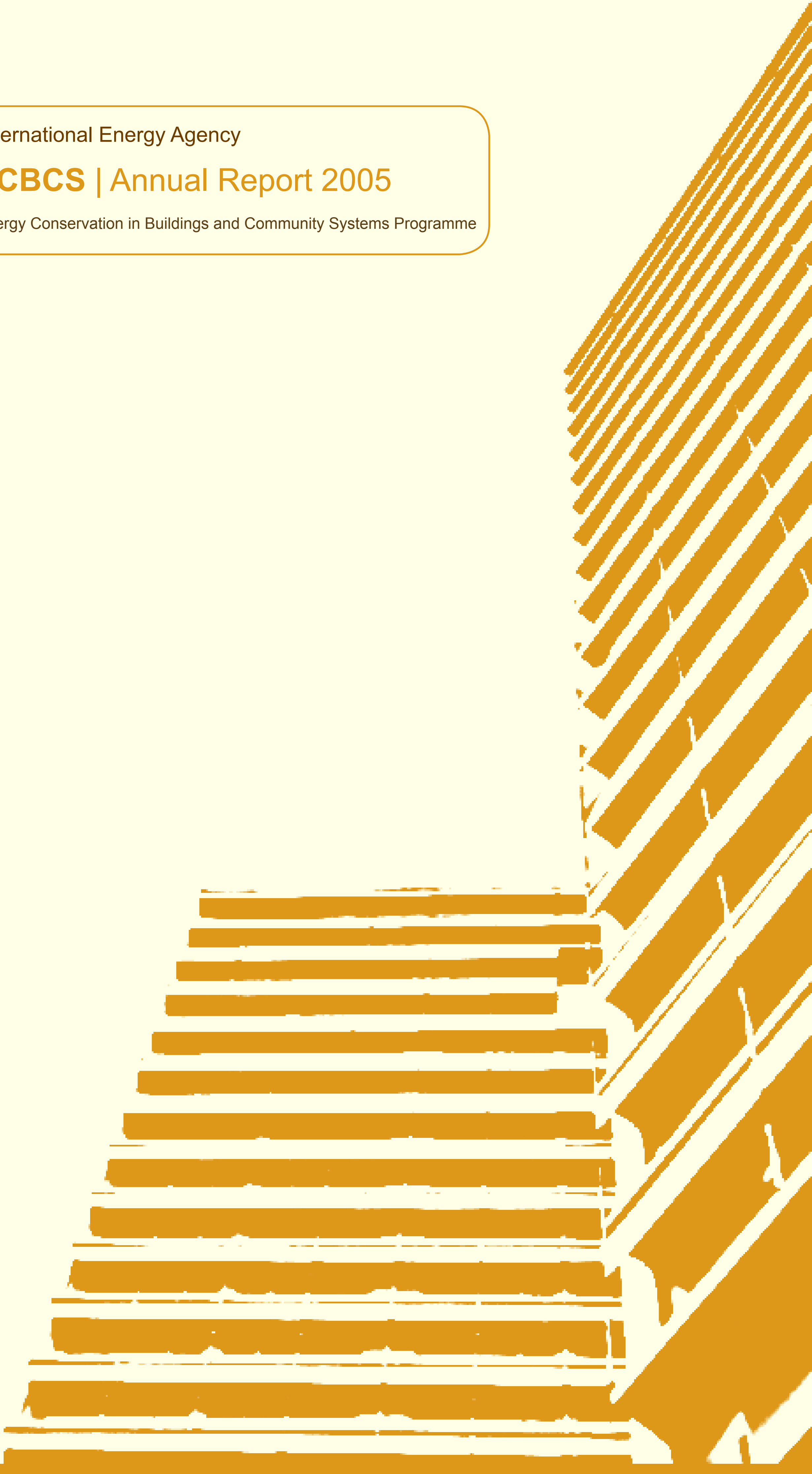
International Energy Agency

# ECBCS | Annual Report 2005

Energy Conservation in Buildings and Community Systems Programme



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# Preface

## International Energy Agency

The International Energy Agency (IEA) was established in 1974 within the framework of the Organisation for Economic Co-operation and Development (OECD) to implement an international energy programme. A basic aim of the IEA is to foster co-operation among the twenty-four IEA participating countries and to increase energy security through energy conservation, development of alternative energy sources and energy research, development and demonstration (RD&D).

## Energy Conservation in Buildings and Community Systems

The IEA sponsors research and development in a number of areas related to energy, through a number of Implementing Agreements (IA's). The mission of one of those Implementing Agreements, the ECBCS - Energy Conservation for Building and Community Systems Programme, is 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. The objectives of collaborative work within the ECBCS R&D program are directly derived from the on-going energy and environmental challenges facing IEA countries in the area of construction, energy market and research. ECBCS addresses major challenges and takes advantage of opportunities in the following areas:

- exploitation of innovation and information technology;
- impact of energy measures on indoor health and usability;
- integration of building energy measures and tools to changes in lifestyles, work environment alternatives, and business environment.

## The Executive Committee

Overall control of the program is maintained by an Executive Committee, which not only monitors existing projects but also identifies new areas where collaborative effort may be beneficial. To date the following projects have been initiated by the executive committee on Energy Conservation in Buildings and Community Systems (completed projects are identified by (*) ):

1: Load Energy Determination of Buildings (*)
2: Ekistics and Advanced Community Energy Systems (*)
3: Energy Conservation in Residential Buildings (*)
4: Glasgow Commercial Building Monitoring (*)
5: Air Infiltration and Ventilation Centre
6: Energy Systems and Design of Communities (*)
7: Local Government Energy Planning (*)
8: Inhabitants Behaviour with Regard to Ventilation (*)
9: Minimum Ventilation Rates (*)
10: Building HVAC System Simulation (*)
11: Energy Auditing (*)
12: Windows and Fenestration (*)
13: Energy Management in Hospitals (*)
14: Condensation and Energy (*)
15: Energy Efficiency in Schools (*)
16: BEMS 1- User Interfaces and System Integration (*)
17: BEMS 2- Evaluation and Emulation Techniques (*)
18: Demand Controlled Ventilation Systems (*)
19: Low Slope Roof Systems (*)
20: Air Flow Patterns within Buildings (*)
21: Thermal Modelling (*)
22: Energy Efficient Communities (*)
23: Multi Zone Air Flow Modelling (COMIS) (*)
24: Heat, Air and Moisture Transfer in Envelopes (*)
25: Real time HEVAC Simulation (*)
26: Energy Efficient Ventilation of Large Enclosures (*)
27: Evaluation and Demonstration of Domestic Ventilation Systems (*)
28: Low Energy Cooling Systems (*)
29: Daylight in Buildings (*)
30: Bringing Simulation to Application (*)
31: Energy-Related Environmental Impact of Buildings (*)
32: Integral Building Envelope Performance Assessment (*)
33: Advanced Local Energy Planning (*)
34: Computer-Aided Evaluation of HVAC System Performance (*)
35: Design of Energy Efficient Hybrid Ventilation (HYBVENT) (*)
36: Retrofitting of Educational Buildings (*)
37: Low Exergy Systems for Heating and Cooling of Buildings (LowEx) (*)
38: Solar Sustainable Housing
39: High Performance Insulation Systems (*)
40: Building Commissioning to Improve Energy Performance (*)
41: Whole Building Heat, Air and Moisture Response (MOIST-ENG)
42: The Simulation of Building-Integrated Fuel Cell and Other Cogeneration Systems (COGEN-SIM)
43: Testing and Validation of Building Energy Simulation Tools
44: Integrating Environmentally Responsive Elements in Buildings
45: Energy Efficient Electric Lighting for Buildings
46: Holistic Assessment Tool-kit on Energy Efficient Retrofit Measures for Government Buildings (EnERGo)
47: Cost-Effective Commissioning for Existing and Low Energy Buildings
48: Heat Pumping and Reversible Air Conditioning
49: Low Exergy Systems for High Performance Buildings and Communities
50: Prefabricated Systems for Low Energy / High Comfort Building Renewal

Working Group - Energy Efficiency in Educational Buildings (*)

Working Group - Indicators of Energy Efficiency in Cold Climate Buildings (*)

Working Group - Annex 36 Extension: The Energy Concept Adviser (*)

(*) - Completed

# Introduction

This Annual Report for 2005 reviews the latest achievements of the IEA Energy Conservation in Buildings and Community Systems Programme, which I am very pleased to introduce. I hope it will encourage your interest in the Programme. It is my particular wish you will be able to take the time to understand the findings of our projects and to apply them in your work.

Throughout 2005, the Programme has been carrying out a series of research, development and demonstration projects and we have continued to pursue the objectives set out in our current Strategic Plan. We aim to bring the results from these projects to the attention of our target audiences by focused outreach and deployment activities.

*Research, development and demonstration projects*

In the past year, we have initiated four new projects, while we have completed three of the existing projects. A further eight projects are still ongoing.

*Those started in 2005 are:*
- Cost Effective Commissioning of Existing and Low Energy Buildings
- Heat Pumping and Reversible Air Conditioning
- Low Exergy Systems for High Performance Buildings and Communities
- Prefabricated Systems for Low Energy / High Comfort Building Renewal

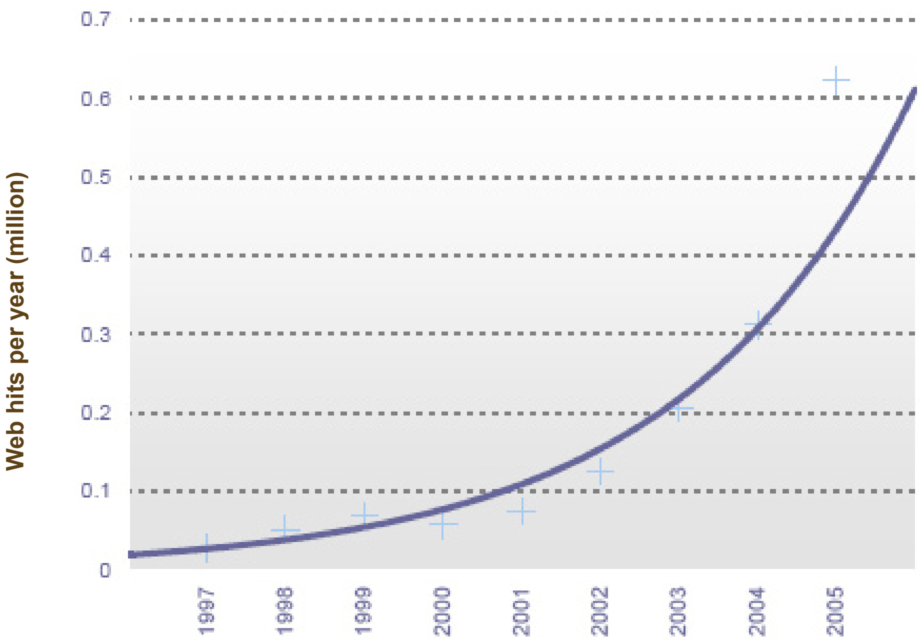
*The projects completed in 2005 are:*
- A project extension for Retrofitting of Educational Buildings - An Energy Concept Adviser for Retrofit Measures
- High Performance Thermal Insulation
- Commissioning of Building HVAC Systems for Improved Energy Performance

**Outreach and deployment**

The largest benefits arising from participation in ECBCS are those gained by national programmes: In general, countries lacking knowledge can benefit from the experiences of those with more expertise, thereby avoiding duplicated research efforts. At an individual level, the Programme allows researchers funded by national programmes and industry to pool their collective expertise to produce high quality project outputs. By taking part in the projects, they create and reinforce their own technical networks, the benefits of which remain long after the particular project has formally ended. This does not happen quickly, but over the course of 3 to 5 years, these networks of expertise become established as excellent international channels of communication.

Many current and former researchers from ECBCS projects are often directly involved in formulating standards, regulations and codes and will use the knowledge gained in their work to inform and improve them. A current example of this is provided by the recently approved ASHRAE Standard 140-2004 'Standard Method of Test for the Evaluation of Building Energy Analysis Computer Programs', which is underpinned by many collective years of work within ECBCS Annexes 21 and 43 and Tasks 12, 22 and 34 of the IEA Solar Heating and Cooling Programme. This indirect form of deployment can be one by which the Programme has a strong impact.

While carrying out research or demonstration projects, issues and solutions of general relevance often come to light. These can sometimes be generalised to form policy best practices. We are now working with the IEA



Energy End Use Working Party and the IEA Secretariat to understand how to best capture these to assist policy makers from national governments. In this way the Programme would be able to influence both policies and the regulatory frameworks by which they are put into practice as discussed above.

Each year ECBCS sponsors a number of key events and conferences. Aside from the 18 working meetings of the ongoing ECBCS projects, we have carried out a number of outreach activities. In particular, during 2005 we have:

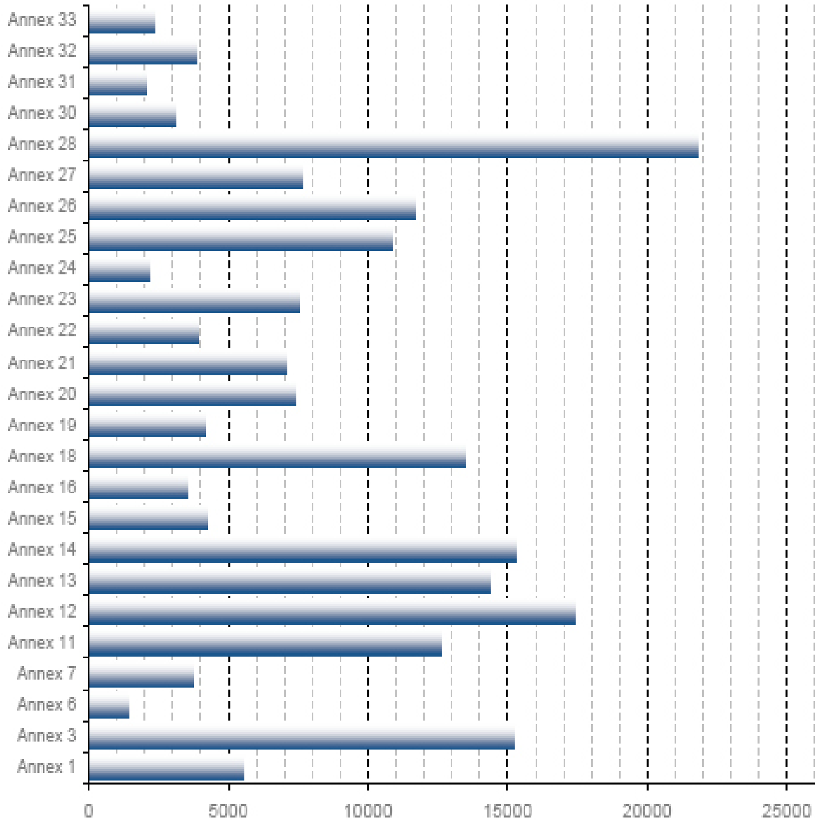
- Cost-Effective Commissioning for Low-Energy Buildings International Workshop, held March 2005, Germany
- Co-sponsored FBF Workshop on Low E3 Building Systems - Low Energy – Low Exergy – Low Environmental Impact, held April 2005, Italy
- Co-sponsored 9th International Building Performance Simulation Association Conference held August 2005, Canada
- 26th AIVC AnnualConference, “Ventilation in relation to the energy performance of buildings”, held September 2005, Belgium
- Co-sponsored Sustainable Buildings Conference, held October 2005, Japan
- Co-sponsored FBF Workshop on Prefabricated Systems for Low Energy / High Comfort Building Renewal, held October 2005, Switzerland
- Life Cycle Cost of Sustainable Construction International Workshop, held December 2005, Czech Republic

The 26th AIVC Annual Conference has been organised by the Air Infiltration and Ventilation Centre, which continues to lead the world as a source of information and analysis.

The AIVC is a continuing highlight of the Programme.

We are maintaining our efforts to improve deployment of the project outcomes, including attempting to quantify the impact of the Programme. A recent initiative has demonstrated the ongoing worldwide demand for knowledge about energy conservation in building and communities, with over 200 thousand downloads of earlier project reports from the Programme website over a six month period from late 2005 to early 2006. We will take note of the areas of interest which have been revealed through this action when developing the Strategic Plan for our next operating period during the coming year.

*Dr Morad Atif, Chairman, ECBCS Executive Committee*




**Number of Annex reports downloaded**

# New Research Projects Initiated in 2005

Cost Effective Commissioning of Existing and Low Energy Buildings (Annex 47)

Heat Pumping and Reversible Air Conditioning (Annex 48)

Low Exergy Systems for High Performance Buildings and Communitie (Annex 49)

Prefabricated Systems for Low Energy / High Comfort Building Renewal (Annex 50)

# Cost Effective Commissioning of Existing and Low Energy Buildings

## Annex 47

Commissioning methods and tools are essential to ensure that advanced components and systems reach their technical potential and operate energy-efficiently. Likewise, these methods and tools should be designed to improve the energy efficiency of conventional and advanced existing buildings beyond merely the design intent. The goal of this new project is to enable the effective commissioning of existing and future buildings in order to improve their operating performance. The project will address three questions:

1) What can be done for (the design of) future buildings to enable cost-effective commissioning?

The focus is set on the concept, design, construction, acceptance, and early operation phase of buildings. 'Integrated Commissioning' could be a good expression in accordance with 'integrated design'.

2) What can be done for existing buildings and systems to conduct a cost-effective commissioning?

The focus here is set on existing buildings where the conditions for commissioning need to be afforded without documentation and limited means for integrated commissioning.

3) How can the cost-benefit situation of commissioning be represented?

Key answers will be provided by developing international consensus methods for evaluating commissioning cost-benefit and persistence. These methods will be implemented in on-line cost-benefit and persistence databases using field data.

The related and recently completed ECBCS project, "Commissioning of HVAC Systems for Improved Energy Performance", was aimed at developing tools and guidelines for commissioning HVAC systems. It clarified the commissioning process on an international basis and developed tools for its implementation in conventional HVAC systems with a focus on functional testing and occupancy. This international effort removed many barriers to commissioning. However, documented commissioning methods are currently only available for conventional HVAC systems and do not address the advanced systems and system combinations that are important for low energy buildings (LEB), such as building scale combined heat and power, integrated control of lighting, blinds and HVAC, and cooling techniques such as evaporative cooling and natural ventilation.

Without suitable methods and tools to ensure the correct interaction between components and systems, their performance in the field can be expected to fall significantly short of what is intended.

New construction commissioning is focused on achieving design intent. However, often the energy efficiency of the design can be improved. Similarly, retro-commissioning may not have an energy focus if the commissioning provider is called in mainly to solve nagging comfort problems. The proposed work focuses on the application of engineering principles to the operation of buildings specifically to achieve energy savings, rather than as a possible side effect. In addition, the commissioning techniques developed through this research will help transition the industry from the intuitive approach that is currently employed in the operation of buildings to more systematic operation that focuses on achieving significant energy savings.

The usual practice when commissioning buildings is to attempt to make the building work as designed. However, the "as-built" and "as-used" building virtually always differs from the original design. Hence new buildings can often operate using 5% - 10% less energy if they are optimized based on actual use and occupancy rather than using only the information available to the designer. Evidence emerging from a study of LEED certified buildings performed by NREL and from a number of European studies strongly suggests that it is even more critical that low energy buildings be commissioned to optimize operation based on actual occupancy and use than for conventional buildings.

"new buildings can often operate using 5% - 10% less energy if they are optimized based on actual use and occupancy rather than using only the information available to the designer"

# Cost Effective Commissioning of Existing and Low Energy Buildings

It is generally recognized that demonstrating cost-effectiveness, including the persistence of commissioning measures will remove a major barrier to the wider market acceptance of commissioning. Economic benefits beyond the energy savings include fewer change orders and call-backs for installers, fewer service calls and fewer complaints from occupants.

**Objectives**

The goal of the project is to enable the effective commissioning of existing and future buildings in order to improve their operating performance.

The aim is to advance the state-of-the-art of building commissioning by:
- Extending previously developed methods and tools to address advanced systems and low energy buildings, utilizing design data and the buildings' own systems in commissioning
- Automating the commissioning process to the extent practicable
- Developing methodologies and tools to improve operation of buildings in use, including identifying the best energy saving opportunities in HVAC system renovations and open reporting methods for the energy performance of buildings in support of the "EU Energy Performance of Buildings Directive"
- Quantifying and improving the costs and benefits of commissioning, including the persistence of benefits and the role of automated tools in improving persistence and reducing costs without sacrificing other important commissioning considerations

The output will include methods and tools for commissioning advanced systems and low energy buildings, methods and tools for field application and information on the costs and benefits that can be used to promote the wider use of commissioning.

Project Period: 2005 - 2009

Operating Agents (joint): Natural Resources Canada: CANMET Energy Technology Centre and National Institute of Standards and Technology, USA

Participating Countries (to be confirmed): Belgium, Canada, Germany, Japan, Norway, USA, others to be confirmed

Participating Organisations (to be confirmed):
- KaHo St-Lieven, Belgium
- NRCAN, Canada
- Ebert Eng., Germany
- IGS, Germany
- ISE, Germany
- Kyoto U, Japan
- Chubu U, Japan
- Kyushu Electric Power Co. Inc, Japan
- NTNU, Norway
- NIST, USA
- CMU, USA
- Johnson Controls, USA
- TAMU, USA
- PECI, USA

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## Annex 48

Substituting a boiler with a heat pump may save more than 50% of primary energy, if electricity is produced by a modern gas-steam power plant and even more if some of that electricity is produced from a renewable source. 'Heat pumping' is probably today one of the quickest and safest solutions to save energy and to reduce CO2 emissions. The aim of this project is to promote the best heat pumping techniques applicable in air conditioning of commercial buildings. This project hopes to make air conditioning as reversible as possible so it can be used in heat pumping mode and intends to make the best use of the currently available technology. The specific characteristics of the building, of the occupancy and of the climate will be carefully taken into account. Guidelines about where and how to use each type of equipment will then be established. Optimal control strategies will be also identified. A selection of new and existing building types will be established during the preparation phase, according to priorities expressed by the participants and to specific expertise available.

Participants will carry out research and development in the framework of the following six Subtasks:

**Subtask 1:** Analysis of building heating and cooling demands;
**Subtask 2:** Performance analysis and comparisons among the different components and systems available;
**Subtask 3:** Design;
**Subtask 4:** Global performance evaluation and commissioning methods;
**Subtask 5:** Case studies and/or demonstration;
**Subtask 6:** Dissemination.

Deliverable 1: Identification tool

This deliverable will help practitioners and decision makers to identify the most "interesting" buildings, among existing ones and also among new projects. Good "candidates" are supposed not to offer too many problems, in order to make realistic the option of reversible heat pumps. The analysis will be based on H/C demands; it will very probably start from classical sizing calculation and also from "as built" files and from actual consumptions in case of existing building. This tool should be operational at end of 2006.

Deliverable 2: Design guide

This design guide will help the designers and decision makers, first of all, to preserve future possibilities, by not making irreversible choices in new buildings and by not to making new mistakes. With the help of simple simulations models, it will also help decision makers to judge the projects acceptability. This tool should be operational at end of 2007.

Deliverable 3: Typification and selection guide

This guide will help practioners to make a rational choice among existing HVAC technologies, in view of the most efficient combination between heat and cold productions. It will include technical files, components, simulation models and examples of systems design. This tool should be operational at end of 2008.

Deliverable 4: Commissioning and optimal operation guide

This guide will help the designers, installers and operators to run the system in optimal conditions, to verify the actual performances, to detect all possible malfunctions and to make a correct maintenance. Focus is given here on the heat pumping system, with great attention to the thermal storage optimal management. One of the critical issues is the optimal management of the boreholes field when the ground is used as heat source and cold storage.

A first part of this deliverable (D41: commissioning guide lines) should be available in June 2008. The second part (D42: optimal operation tool) is expected in June 2009.

Deliverable 5: Documented case studies

This deliverable will consist in a set of fully documented case studies. It will be proposed as reference and illustration on how to use the other deliverables. Successful case studies will be made usable as demonstration projects. A first part of this deliverable (D5.1: first set of case studies) will be available at the end of 2007. The second part (D5.2: second set of case studies and monitoring guide lines) will be available in June 2009.

Project Period: 2005 - 2009 Operating Agent: University of Liège, Belgium

Participating Countries (to be confirmed): Belgium, Canada, Chile, China, France, Germany, Hungary, Italy, Romania

Participating Organisations (to be confirmed):
- University of Liège, Belgium
- CEA-Grenoble Greth, France
- TEB GmbH KE, Germany
- IEG Fachhochschule of Nürnberg, Germany
- IKE University of Stuttgart, Germany
- Institut für Energie Fachhochschule beider Basel, Switzerland
- University of Concepcion, Chile
- University of Tsinghua, Beijing, China:
- Technical University of Bucarest, Romania
- Concordia University, Canada
- Technical University of Budapest, Hungary
- Politecnico di Torino, Italy

Contact: Jean Lebrun (j.lebrun@ulg.ac.be)

## Annex 49

Exergy expresses the quality of an energy source and quantifies the potential for work extraction from a system. The exergy content required to satisfy the demands for heating and cooling of buildings is very low. Nevertheless, high quality energy sources like fossil fuels are commonly used to satisfy these small demands for exergy. The aim of this project is to promote rational use of energy by means of facilitating and accelerating the use of low-valued and environmentally sustainable energy sources for heating and cooling of buildings.

The main objective is to use exergy analysis as a basis for providing tools, guidelines, recommendations, best-practice examples and background material for designers and decision makers in the fields of building, energy production and politics. Another important objective is to promote possible energy/exergy- and cost-efficient measures for retrofit and new buildings, such as dwellings and commercial/public buildings, and their related performance analyses viewed from a community level.

As a consequence of the Kyoto protocol and the needed reduction in CO2 emissions, a huge effort must be made in the future to conserve high quality or primary energy re-sources. There will be a new dimension to this problem if countries with fast growing economies continue to increase their energy consumption of fossil energy sources in the same manner as they do now. Even though we still have considerable energy saving potential in the building stock, the results of the recently finished ECBCS Annex 37 - Low Exergy Systems for Heating and Cooling of Buildings - show that there is an equal or greater potential in exergy management. This implies working with the whole energy chain, taking into consideration the different quality levels involved, from generation to final use, in order to significantly reduce the fraction of primary or high-grade energy used and thereby minimise exergy consumption. New advanced technologies have to be implemented. At the same time, as the use of high quality energy for heating and cooling is reduced, there is more reason to apply an integral approach which includes all other processes where energy/exergy is used in buildings. In recent years we have made substantial progress in the development of new and integrated techniques for improving energy use, such as heat pumps, co-generation, thermally activated building components, and methods for harvesting renewable energy directly from solar radiation, from the ground or from various waste heat sources. Some of these issues and others have been dealt with in various annexes and task groups within the IEA.

The results obtained in Annex 37 were promising, and elucidated a huge potential for introducing new components, technologies and system solutions to create low exergy buildings. The exergy conversion (e.g. heat or electricity production) plays a crucial part in possible future activities in the overall system optimisation of the entire energy system within a building. The target should be to establish a holistic approach for an affordable, comfortable and healthy buildings, while obtaining a minimum input of exergy, and implementing a substantial amount of renewable energy sources into the energy supply of buildings.

As a result of the completed Annex 37, the International Society of Low Exergy Systems in Buildings (LowExNet) was founded in September 2003. The members have continued and expanded their work on issues related to Annex 37, and have been organising workshops and seminars to present their results and findings. Examples of LowExNet workshops include those held in May 2004 in Stockholm, in September 2004 in Eindhoven, and the latest one in April 2005 in Padova, which was visited by more than 250 participants and sponsored by a number of Italian organisations. Following this meeting in Padova, a Future Building Forum was held at the same location to discuss a possible future international collaborative venture. As a result of the discussions at the meeting and with the encouragement of ExCo members, the LowExNet group was handed the initiative to propose new Annex collaborative work.

“The Low Exergy (LowEx) approach entails matching the quality levels of exergy supply and demand, in order to streamline the utilisation of high-value energy resources and minimise the irreversible dissipation of low-value energy into the environment.”

### The Exergy Concept and the LowEx Approach

Exergy is a concept which helps us distinguish between two parts of an energy flow: exergy and anergy. Only the exergy part of any energy flow can be converted into some kind of high-grade energy such as mechanical work or electricity. Anergy , on the other hand, refers to the part of the energy flow which cannot be converted into high-grade energy (e.g. low-grade waste heat from a power plant). Exergy can be regarded as the valuable part of energy, while anergy designates the low-value portion.

# Low Exergy Systems for High Performance Buildings and Communities

Unless a suitable use for it is found (e.g. waste-heat utilisation in buildings), the low-value part of the original energy flow will eventually dissipate into the environment and be irreversibly lost. Such unalterable dissipation is designated as irreversibility. The exergy content of a given flow of energy depends on the attributes (e.g. temperature, pressure, and chemical composition) of both the substance carrying the energy (energy carrier) and the surrounding environment. The more different the attributes of the energy carrier and the environment are, the higher the exergy content of the energy car-rier is. For example, high-pressure steam required for electric power generation has a higher exergy content than warm water needed by a dishwasher.

The Low Exergy (LowEx) approach entails matching the quality levels of exergy supply and demand, in order to streamline the utilisation of high-value energy resources and minimise the irreversible dissipation of low-value energy into the environment.

Project Period: 2005 - 2009

Operating Agent: Fraunhofer Institute for Building Physics, Germany

Participating Countries (to be confirmed): Canada, Denmark, Finland, Germany, Italy, The Netherlands, Poland, Sweden

Participating Organisations (to be confirmed):
- Natural Resources Canada, Canada
- Technical University of Denmark, Denmark
- VTT, Finland
- Development Center for Finnish Building Services (TAKE) Ltd., Finland
- Technical University of Berlin, Germany
- Fraunhofer Institute for Building Physics, Germany
- Politecnico di Milano, Italy
- University of Padova, Italy
- University of Warmia and Mazuryl, Poland
- KTH, Sweden
- Cauberg-Huygen, The Netherlands
- SenterNovem, The Netherlands
- Energy Research Team, The Netherlands

# Prefabricated Systems for Low Energy / High Comfort Building Renewal

## Annex 50

The potential for energy conservation is largely dominated by existing buildings. At the current renewal rate and with conventional policies, between one and four centuries will be necessary to improve the building stock to the energy level of current new construction. This project aims to develop and demonstrate innovative whole building renovation concepts for typical apartment buildings comparable to new advanced low energy buildings based on: prototype, prefabricated roof systems with integrated HVAC, hot water and solar systems; highly insulated envelopes with integrated new distribution systems for heating, cooling and ventilation. The advantages of these prototypes include:

- Achieving energy efficiency and comfort for existing apartment buildings comparable to new advanced low energy buildings,
- Optimised constructions and quality and cost efficiency due to prefabrication,
- Opportunity to create attractive new living space in the prefabricated attic space and by incorporating existing balconies into the living space,
- A quick renewal process with minimised disturbances for the inhabitants.

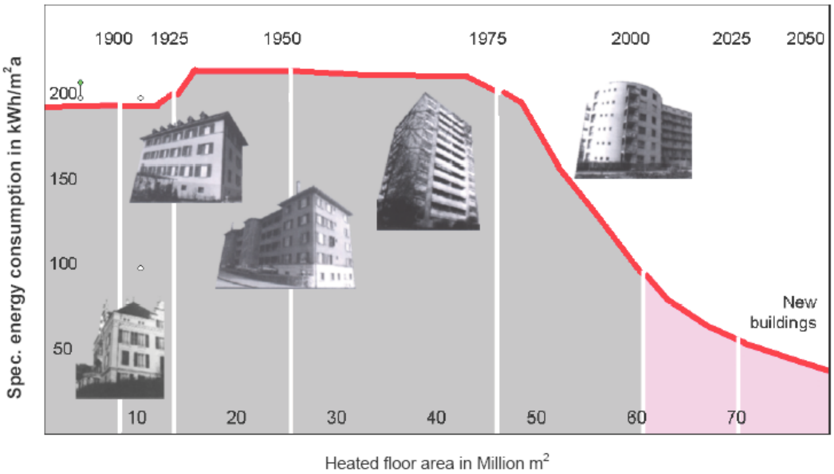
It is obvious that in most industrialized countries the energy consumption is largely dominated by the existing building stock. The energy consumption of new buildings has been drastically reduced during the last decades. Legislation such as the European Building Performance Directive (EBPD) will further improve the energy efficiency of new buildings throughout Europe. A closer look at the energy consumption of domestic buildings shows the importance of the existing building stock. The expected increase of the energy consumption due to new buildings to be built during the next 50 years will be less than 10% of what is already consumed by the existing building stock (see Figure 1).

A large part of the existing building stock was built between 1950 and 1980. These buildings have often a strong need for renovation and offer a large energy saving potential. Accordingly, building renovation has a high priority in many IEA countries and it plays an important role in the building related IEA R&D programmes. The Solar Heating and Cooling Programme has initiated a new task on Advanced Housing Renovation by Solar & Conservation (Task 37). The new SHC Task will develop a solid knowledge base on how to renovate houses to a very high energy standard and will develop strategies that support the market penetration of these renovations. SHC Task 37, Advanced Housing Renovation by Solar & Conservation, will address both technical R&D and market implementation. The Task is scheduled to begin in July / August 2006 and will be completed in December 2009.

Annex 50 is more technically oriented. Most present building renovations address single building parts as roofs, façades or heating systems only. This often results in inefficient and finally expensive solutions, without an appropriate long term energy reduction. The project aims to adapt successful concepts and technologies for the retrofitting of existing buildings. An increasing level of prefabrication should substantially enhance the quality and cost effectiveness of renovation work. Advanced measuring technologies will allow new quality standards in prefabrication. The project will develop and demonstrate advanced renovation packages that will be based to a large extent on industrial construction processes. The project focuses on typical apartment blocks representing approximately 40% of the European dwelling stock. It concentrates on:

- Minimising the primary energy consumption (in the range of 30 kWh/ (m² year) – 50 kWh/(m² year) for heating, cooling and hot water, per gross floor area),
- Optimising the integration of solar energy use,
- Increasing living comfort by better space use,
- Assuring good thermal and acoustical comfort, good indoor air quality and daylighting conditions,
- Assuring a fast, high quality and cost-effective construction process.

“develop and demonstrate advanced renovation packages that will be based to a large extent on industrial construction processes.”




*The diagram shows the specific energy consumption of domestic buildings and the constructed floor area in different time periods. It shows that a lot of energy is consumed by the large building stock constructed between 1950 and 1975. These buildings offer the largest saving potential whereas the new buildings expected to be built till 2050 will only consume an additional 10% (Domestic buildings of the canton of Zurich, approximately 60 million m² in the year 2000).*

# Prefabricated Systems for Low Energy / High Comfort Building Renewal

Project Period: 2007 - 2010 (prep. phase 2006)

Operating Agent: EMPA, Switzerland

Participating Countries (to be confirmed): Austria, Belgium, Czech Republic, Denmark, France, Germany, Portugal, Sweden, Switzerland

Participating Organisations (to be confirmed):

- AEE - Institute for Sustainable Technologies, Austria
- Arcelor Research Centre Liege , Belgium
- ENVIROS s.r.o. , Czech Republic
- VELUX A/S, Denmark
- Saint-Gobain Insulation, France
- Fraunhofer-Institute for Building Physics, Germany
- Variotec Sandwichelemente GmbH & Co.KG, Germany
- University of Minho, Portugal
- Porto University, Portugal
- Lund tekniska högskola, Sweden
- Holzbau Renggli AG, Switzerland
- Hochschule für Technik+Architektur Luzern, Switzerland
- Swiss Federal Laboratories for Materials Testing and Research EMPA , Switzerland

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# Research Projects Completed in 2005

Retrofitting of Educational Buildings - An Energy Concept Adviser for Retrofit Measures (Annex 36 Working Group)

High Performance Thermal Insulation - HiPTI (Annex 39)

Commissioning of Building HVAC Systems for Improved Energy Performance (Annex 40)

# Retrofitting of Educational Buildings - An Energy Concept Adviser for Retrofit Measures

## Annex 36 Working Group

An extension Working Group to the completed Annex 36 Project has been initiated to test the Energy Concept Adviser on real buildings, to produce national versions, and to translate it into languages other than the original English. National versions are being produced in German, Italian, Greek, Danish, French, Polish and Finnish.

**Operating Period: 2004 - 2005**

Operating Agent: Ove Mørck, Cenergia Energy Consultants, Denmark

Participating Countries: Denmark, Finland, France , Greece, Italy, Poland, USA, United Kingdom

Working Group Observers: Germany, Russia

- Cenergia Energy Consultants, Denmark
- VTT: Technical Research Centre - Building Technology Facility Management, Finland
- VTT: Technical Research Centre - Communities and Infrastructure, Finland
- ENTPE: École Nationale des Travaux Publics de l'État, France
- National Technical University of Athens, Greece
- ENEA: National Agency for New Technology, Energy and the Environment, Italy
- Norwegian Building Research Institute, Norway
- Poznan University of Technology, Poland
- Silesian University of Technology, Poland
- U.S. Department of Energy, USA
- Department for Education and Skills - Architects & Building Branch, UK

The following are participating as observers:

Fraunhofer Institute for Building Physics, Germany

- University of Stuttgart, Germany
- Saratov State Technical University, Russia

## Annex 39

The general objective of Annex 39 is to develop reliable components for buildings based on high performance thermal insulation (HiPTI). They are known as HiPTI systems (e.g. façade element, door, and water heater). The successful developments should lead to competitive products that are available on the market. The main technology to be used in the Annex is vacuum insulation panels (VIP). They consist of a microporous core material, packed in a gas tight envelope, evacuated to a pressure of about 0.1 mbar.

Three subtasks will be carried out in order to reach the objectives:
- **Subtask A:** Basic concepts and materials
- **Subtask B:** Application and system development
- **Subtask C:** Demonstration and information dissemination

### Results

#### Thermal conductivity

Independent measurements of thermal conductivities of VIP's have been made. They showed the expected thermal conductivities in the centre of the panels, i.e. VIP's have a ten times lower value than conventional fibre insulations. When edge effects are considered too, the kind of envelope film used is of great importance concerning the heat conductivity. There are today basically two kinds of films, with distinct heat bridge effects:
- Type A: Aluminium foil based films (aluminium layer of 8 micrometres)
- Type B & C: Polymer based metallised films (aluminium layer of 0.09 - 0.30 micrometres)

The edge effect of Type C films (aluminium foil based) leads to a heat conductivity which is 65% higher than with Type A films (metallised). The edge effect can be reduced by applying a layer of insulation material on both sides of Type C film panels. It was calculated, that in case of two layers of glass wool of 5 mm thickness each, the edge effect is reduced from 65% to 41%.

#### Service Life

The service life of a VIP ends, when the internal pressure reaches a certain level. For a VIP with a fumed silica core, it is about 100 hPa. For building applications there is a need for service life durations of at least 20 years up to more than 50 years.

Pressure rise is mainly caused by penetration of water vapour, but also by air. The results of the Annex show that penetration rates depend largely on two factors:
- Envelope film
- Environmental conditions (temperature and humidity)

The currently available films for VIP are in a rapid development process and are being improved all the time. Development effort is focused basically on metallised films. The quality of what is on the market today varies in a quite broad range. Based on preliminary results, it can be said, that there are films available today, which meet the needs of building applications.

VIP constructions

VIP have a very low thermal conductivities in comparison to all other materials used in building constructions. Heat bridges, as shown for the films, are therefore of high importance for whole VIP-based construction. To get an overall satisfying result, heat bridges must be calculated very carefully.

Operating Period: 2001 - 2004

Operating Agent: Markus Erb and Hanspeter Eicher, Dr Eicher and Pauli AG, Switzerland

Participating Countries: Canada, France, Germany, Netherlands, Sweden, Switzerland
- NRC: National Research Council Canada, Canada
- CSTB: Centre Scientifique et Technique du Bâtiment, France
- Fraunhofer Institute for Process Engineering and Packaging Germany
- ZAE-Bayern, Germany
- TU Delft: Technical University of Delft, The Netherlands
- KTH: Royal Institute of Technology, Sweden
- EMPA: Swiss Federal Laboratories for Materials Testing and Research, Switzerland
- FHBB: Fachhochschule beider Basel, Switzerland
- Dr. Eicher+Pauli, Switzerland

# Commissioning of Building HVAC Systems for Improved Energy Performance

## Annex 40

The primary goal of building commissioning, from an energy perspective, is to verify and optimise the performance of energy systems within a building. The objective of the Annex is to develop, validate and document tools for commissioning buildings and building services that will help facilitate the achievement of this goal. These tools include guidelines on commissioning procedures and recommendations for improving commissioning processes, as well as prototype software that could be implemented in stand-alone tools and/or embedded in building energy management systems (BEMS).

The work performed in the Annex focused on HVAC systems and their associated control systems. Five subtasks were identified to address specific technical and/or organisational issues. These subtasks are:

**Subtask A:**
Commissioning Process

**Subtask B:**
Manual Commissioning Procedures

**Subtask C:**
BEMS Assisted Commissioning Tools

**Subtask D:**
Design Models And Commissioning

**Subtask E:**
Commissioning Projects

Operating Period: 2001 - 2004

Operating Agent: Jean Christophe Visier, CSTB, France

Participating Countries: The Netherlands, Japan, France, Canada, Belgium, Switzerland, Sweden, USA, Germany, Norway, Finland

Observers: Korea, China, Hungary

- University of Liège - Laboratoire Thermodynamique, Belgium
- FUL: Fondation Universitaire Luxembourgeoise, Belgium
- Marbek, Canada
- Natural Resources Canada - CEDRL, Canada
- Semaattikainteistot, Finland
- VTT: Technical Research Centre, Finland
- Tampere University, Finland
- ADEME: Agence de l'Environment et de la Maitrise de l'Energie, France
- Cenergie, France
- EDF, France
- CSTB: Centre Scientifique et Technique du Bâtiment, France
- Ebert-Ingenieure, Germany
- IMI Indoor Climate, Hungary
- Cold Region Housing And Urban Research Institute, Japan
- Yamatake, Japan
- Kyoto University, Japan
- Kyushu University, Japan
- Kajima, Japan
- NESTEC: Nakahara Laboratory, Environmental Syst.-Tech., Japan
- Tonets, Japan
- Korean Institute of Energy Research, Korea
- Cauberg-Huygen R.I, the Netherlands
- NOVEM, Netherlands
- TNO, Netherlands
- NTNU: Norges Teknisk-Naturvitenskapelige Universitet, Norway
- KTH: Royal Institute of Technology, Sweden
- AF VVS-Projekt, Sweden
- SP: Sveriges Provnings- och Forskningsinstitut, Sweden
- Elyo Cylergie, Switzerland
- Enerconom, Switzerland
- Delta Controls, USA
- Texas A & M University, USA
- Lawrence Berkeley National Laboratory, USA
- NIST: National Institute of Standards and Technology, US
- Iowa Energy Center, USA
- Johnson Control, USA

# Ongoing Research Projects

Air Infiltration and Ventilation Centre - AIVC (Annex 5)

Solar Sustainable Housing (Annex 38)

Whole building heat, air and moisture response - MOIST-ENG (Annex 41)

The Simulation of Building-Integrated Fuel Cell and Other Cogeneration Systems - COGEN-SIM (Annex 42)

Testing and Validation of Building Energy Simulation Tools (Annex 43)

Integrating Environmentally Responsive Elements in Buildings (Annex 44)

Energy Efficient Electric Lighting for Buildings (Annex 45)

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

## Annex 5

Annex 5, The Air Infiltration and Ventilation Centre, is a long established (since 1979) and highly regarded joint project within ECBCS. Since it's inception, the AIVC has maintained a technical information service to policy makers, practitioners and researchers. It operates both technical and information dissemination programmes within its remit. The primary objective of Annex 5 AIVC is to provide a high quality international technical and information forum covering the areas of ventilation and infiltration in the built environment with respect to efficient energy use, good indoor air quality and thermal comfort. The main drivers for this work are the national and international concerns in the areas of sustainable development and responses to climate change impact. The overall grouping of activities is divided into the following key functions:

- to act as a technical forum for all relevant international and national ventilation and related activities;
- to undertake technical evaluations and analyses so as to synthesise leading edge research information into industry focused products;
- to provide synthesised information to the research community, policymakers, and industry with emphasis on the end users and practitioners.

A further objective is to provide advice on cost effective measures available to achieve energy efficient buildings with good indoor climate conditions.

**Technical Programme**

A major new report has been published by AIVC in the past year. This is a Technical Note "Parameters for the design of demand controlled hybrid ventilation systems for residential buildings".

**Information Dissemination**

Alongside the Annex 5 technical programme, the information dissemination activities are equally valued. During the past year, the Air Information Review (AIR) has continued to be distributed to over 3000 persons and organisations every month. On the AIVC website, all the publications produced by the AIVC since its foundation in 1979 can be found as well as information from many ventilation related activities.

Airbase: Airbase, the AIVC's bibliographic database now contains over 17000 records. It is updated every 3 months (about 150 new references every 3 months). Some 1800 documents in pdf-format are attached to AIRBASE.

*AIVC Conference Attendees Brussels - September 2005*

- 250 participants from 27 different countries attended the conference, which spanned three days and consisted of more than 100 paper and poster presentations.

AIVC Web Site (www.aivc.org): The AIVC website averaged about 8600 visitors per month in 2005. For most of the time, the AIVC is the first reference in 'Google' when searching for 'ventilation', although there are some 3.5 million references.

Participation: In the past 12 month, TNO Building and Construction, has become a member organisation of the Operating Agent, INIVE eeig.

Current Project Period: 2004 – 2007, (Annex established in 1979)

Operating Agent: Peter Wouters, INIVE eeig, Belgium

Participating Countries: Belgium, Czech Republic, France, Greece, the Netherlands, Norway, and the United States of America

**Organisations participating in the Operating Agent, INIVE eeig:**

- BBRI: Belgian Building Research Institute, Belgium
- CETIAT: Centre Technique des Industries Aérauliques et Thermiques, France
- CSTB: Centre Scientifique et Technique du Bâtiment, France
- Fraunhofer Institute for Building Physics, Germany
- NBI: Norwegian Building Research Institute, Norway
- NKUA: National & Kapodistrian University of Athens, Greece
- EMPA: Swiss Federal Laboratories for Materials Testing and Research, Switzerland
- ENTPE: École Nationale des Travaux Publics de l'État, France
- TNO Built Environment and Geosciences, Building and Construction - Netherlands

**Organisations participating in Annex 5:**

- BBRI: Belgian Building Research Institute, Belgium
- Technical University of Brno, Czech Republic
- Ministry of Industry and Trade, Czech Republic
- ADEME: Agence de l'Environment et de la Maitrise de l'Energie, France
- NKUA: National & Kapodistrian University of Athens, Greece
- TNO - Building and Construction Research, Netherlands
- NBI: Norwegian Building Research Institute, Norway
- Lawrence Berkeley National Laboratory, USA

## Annex 38

Annex 38 has been initiated in conjunction with the IEA Solar Heating and Cooling Programme. The goal of Annex 38 is to help achieve significant market penetration of sustainable solar housing in the participating countries by the year 2010 by providing homebuilders and institutional real estate investors with:

- A website: 'Model Solar Sustainable Housing' which illustrates built projects, exemplary in design, living quality, low energy demand and environmental impact.
- A book: 'Marketable Sustainable Solar Housing: Plans, Details and Performance' which describes and analyses recently built housing. It will include a checklist and advice from the experience gained from these projects to help planners develop marketable designs.
- A handbook: 'Marketable Sustainable Solar Housing: A Design Handbook' with guidelines, graphs and tables derived from building monitoring, lab testing and computer modelling.
- Demonstration Buildings with press kits for articles and brochures in local languages to increase the multiplication effect beyond the local region.
- Workshops after the Task
- conclusion presenting the results of the Task.

Recently, Annex 38 have published a series of case study brochures on:

- SIS demonstration housing project, Freiburg, Germany
- Demonstration house, Monte Carasso, Switzerland
- Demonstration houses, Kassel, Germany

Demonstration houses, Hannover-Kronsberg, Germany

- Zero energy house, Kanagawa, Japan
- Sunny Eco-House, Kankyokobo, Japan

The Annex has also identified a number of marketing success stories, including:

- Dewees Island Development, South Carolina, USA
- The WWF sells sustainability in housing in the Netherlands
- Energy Saver Fund, New Zealand

Operating Period: 2000 - 2005

Operating Agent: Robert Hastings, Architecture Energy & Environmental GmbH, Switzerland

Participating Countries: Australia, Austria (through IEA SHC), Belgium, Brazil (through IEA SHC), Canada, Finland, Germany, Italy, Japan, the Netherlands, Norway, Sweden, Switzerland, United Kingdom.

- University of Adelaide - Department of Architecture, Australia
- University of Queensland - Department of Architecture, Australia
- Ingenieurbüro Hofbauer, Austria
- Natur & Lehm, Austria
- Schöberl + Pöll OEG, Austria
- Architektbüro Sture Larsen, Austria
- TB Christian Steininger, Austria
- University of Klagenfurt – IFF, Austria
- Université Catholique de Louvain - Architecture et Climat, Belgium
- UFMG: Federal University of Minas Gerais, Brazil
- Arise Technologies, Canada
- Danish Technological Institute, Denmark
- VTT: Technical Research Centre - Building and Transport, Finland
- Ecofys, Germany
- Fraunhofer Institute for Building Physics, Germany
- Fraunhofer Institute for Solar Energy Systems, Germany
- Ingenieurbüro Morhenne, Germany
- Marburg University - Solar Energy Research, Germany
- Niedrigenergie-Institut, Germany
- Passivhaus Institut, Germany
- University of Essen, Germany
- University of Siegen - Building Physics & Solar Energy, Germany
- Politecnico di Milano, Italy
- PRAU, Italy
- University La Sapienza of Rome, Italy
- Miyagigakuin Women's College, Japan
- Org. Akita Prefectural University - Dept. of Arch. & Env. System, Japan
- Tokyo Metropolitan University - Department of Architecture, Japan
- MoBius Consult, Netherlands
- Enova SF, Norway
- Norwegian State Housing Bank, Norway
- SINTEF - Civil & Environmental Engineering, Norway
- Sunlab, Norway
- ABB Miljo, Norway
- Göteborg Energi, Sweden
- LTH: Lund University – Department of Construction and Architecture, Sweden
- Vattenfall Utveckling, Sweden
- AMENA, Switzerland
- Architektur Energie & Umwelt, Switzerland
- Basler & Hofmann, Switzerland
- CUEPE Université de Genéve - Instit. d'Architecture, Switzerland
- EMPA: Swiss Federal Laboratories for Materials Testing and Research - Energy Systems / Building Equipment Laboratory, Switzerland
- Hochschule Technik+Arch.Abt. HLK, Switzerland
- Renggli, Switzerland
- SUPSI - DCT - LEEE, Switzerland
- Viriden + Partner, Switzerland
- Robert Gordon University - Faculty of Design, United Kingdom

# Whole building heat, air and moisture response (MOIST-ENG)

## Annex 41

The heat and moisture flows generated by building usage, the heat, air and moisture flows that traverse the enclosure and the heat, air and moisture flows injected by the HVAC system are in a permanent balance. Designers try to master that balance for good reasons. The airflows that randomly distributed air pressure differences inside the building generate impact the ingress of gasses such as radon and change the heat and moisture response of the envelope. Resulting moisture deposits in the envelope negatively affect energy consumption. Moisture from inside and heat and moisture from outside also attack the envelope's durability. While the HVAC control system continuously corrects the injected heat as to keep the indoor temperature at comfort level, it leaves the indoor relative humidity in many cases free floating as it is considered to be less important than temperature. Research, however, has shown that relative humidity affects thermal and respiratory comfort. It impacts perception of indoor air quality (IAQ) and the energy consumed for conditioning. High relative humidity also favours dust mites, moulds and bugs.

### Annex Objectives

**Key points of interest of the project are:**

- Sorption and its impact on the indoor conditions.
- Air movement from building to envelope and vice versa.
- Wind driven rain.
- The overall consequences of the whole building heat, air and moisture balances, which affect energy consumption through changes in sensible and latent heat load.

A better knowledge of the whole building heat, air and moisture balance and its effects on indoor environment, on energy consumption for heating, cooling, air humidification and air drying and on the envelope's durability is needed. This was already clear at the time of the Annexes 14, 24 and 32. The whole building heat, air and moisture balance has a direct impact on the microclimate that promotes mould growth, as was studied in Annex 14. In Annex 24, the indoor environment was handled as an input parameter, although measurements showed numerous effects of adventitious air flows and humidity storage on the indoor humidity conditions. Annex 32 repeatedly underlined the linkages between envelope and whole building heat, air and moisture (HAM) performance.

**The Annex has two main objectives:**

First, a detailed exploration of the complex physics involved in whole building heat, air and moisture response (HAMresponse). That objective includes basic research, a further development of existing and new models, measurement of the moisture storage function of materials, measurement of the air permeance of envelope parts as build, mock up testing, field testing and validation by inter-comparison of models through common exercises and confrontation with measured data. That first objective should foster a basic understanding of transient moisture storage in different finishing materials and moisture exchange with the indoor air. For that purpose material storage properties will be measured. It should help develop numerical models and back experiments that link the heat and moisture storage and HAM-transfer in enclosures to the performance of the building and the HVAC system. Mock up and field measurements must prove the effectiveness of moisture storage under different weather conditions (cold, warm and dry, warm and humid and maritime).

Second, an analysis of the effects of the whole building HAM-response on comfort, enclosure durability and energy consumption. A literature review should increase the awareness for these effects. Simultaneously, measures should be studied to moderate possible negative impacts on comfort, enclosure durability and energy consumption, with air-tightness, moisture management, thermal insulation and humidity storage as some of the measures projected.

The following four subtasks will be carried out in order to reach the objectives:

**Subtask 1:** Modelling principles and common exercises

**Subtask 2:** Experimental Investigations

**Subtask 3:** Boundary Conditions

**Subtask 4:** Long Term Performance and technology transfer

Moisture buffering may be seen as a passive way of indoor relative humidity control. The average value will go on depending on the vapour sources present and the ventilation flows activated. Controlling it is only possible with active means. Anyhow, if the average is 'normal', which is the case in most moderate climates, than the peaks and valleys, linked to changes in vapour release, changes in ventilation flows and changes in outdoor partial water vapour pressures, will be flattened quite effectively by 'enough buffering'. There is anyhow one pitfall: most buffering materials are porous and therefore sensitive to foiling and difficult to clean. A normal gesture thus is to protect them with a nice finish, such as paint, wall paper and so forth. This may deteriorate the buffering function quite substantially. Anyhow, books, newspapers and periodicals are never painted. They prove to be nice buffering volumes.

Project Period: 2003 - 2007 Operating Agent: Hugo Hens, K.U.Leuven, Belgium

Participating Countries (to be confirmed): Belgium, Canada, the Czech Republic, Denmark, Finland, France, Germany, Japan, Netherlands, Norway, Portugal, Sweden, Switzerland, UK, USA

# Whole building heat, air and moisture response (MOIST-ENG)

Observers (to be confirmed): Austria, Brazil, Estonia, Slovakia

- Centre de Thermique de Lyon, France
- Concordia University Montreal, Canada
- CSTB: Centre Scientifique et Technique du Bâtiment, France
- Chalmers Tekniska Högskola, Sweden
- Danmarks Tekniske Universitet, Denmark
- EMPA: Swiss Federal Laboratories for Materials Testing and Research, Switzerland
- Fraunhofer Gesellschaft, Germany
- Glasgow Caledonian University, UK
- Kinki University, Japan
- Katholieke Universiteit Leuven, Belgium
- Kyoto University Japan, Japan
- LTH: Lund University, Sweden
- NRC: National Research Council Canada, Canada
- NTNU: Norges Teknisk - Naturvitenskapelige Universitet, Norway
- Oak Ridge National Laboratory, United States
- Pontificia Universidade Catolica Do Parana, Brazil
- Slovenska Akademia Vied, Slovakia
- SP: Sveriges Provnings- och Forskningsinstitut, Sweden
- Technion Israel Institute of Technology, Israel
- Tohoku University, Japan
- Tallinna Tecnikaülikool, Estonia
- Tampereen Teknillinen Yliopisto, Finland
- Technische Universität Dresden, Germany
- Technische Universiteit Eindhoven, Netherlands
- Technische Universität Wien, Austria
- University College London, UK
- Universidade Da Coruña, Spain
- Universidade Federal de Santa Catarina, Brazil
- Universiteit Gent, Belgium
- Université de La Rochelle, France
- University of Saskatchewan, Canada
- Universidade do Porto, Portugal
- VTT: Technical Research Centre, Finland

# The Simulation of Building-Integrated Fuel Cell and Other Cogeneration Systems (COGEN-SIM)

## Annex 42

Residential cogeneration is an emerging technology with a high potential to deliver energy efficiency and environmental benefits. The concurrent production of electrical and thermal energy from a single fuel source can reduce primary energy consumption and associated greenhouse gas (GHG) emissions. Reductions in combustion by-products such as nitrogen oxides and hydrocarbons are also a possibility. The distributed generation nature of the technology also has the potential to reduce electrical transmission and distribution inefficiencies and alleviate utility peak demand problems. Leading contenders for residential building cogeneration include fuel cells, stirling cycles, and internal combustion engines. The effective exploitation of the thermal output for space heating, space cooling, and/or heating domestic hot water is critical to realizing high levels of overall energy efficiency and the associated environmental benefits. Designing and operating a building-integrated cogeneration system that delivers useful thermal output, however, is a complex task due to the strong coupling between the cogeneration unit, other HVAC components, and the building's thermal and electrical demands. Therefore the system might include some storage device to hold the thermal energy until a demand exists. Consequently, it is believed that building-integrated cogeneration will not deliver the potential benefits outlined above without detailed building simulation tools that consider the full complexities of this interconnected thermodynamic system.

**Annex Objectives:** The objectives of Annex 42 are to develop simulation models that advance the design, operation, and analysis of residential cogeneration systems, and to apply these models to assess the technical, environmental, and economic performance of the technologies. This will be accomplished by developing and incorporating models of cogeneration devices and associated plant components within existing whole-building simulation programs. Emphasis will be placed upon fuel cell cogeneration systems and the Annex will consider technologies suitable for use in new and existing single and low-rise-multi-family residential dwellings. The models will be developed at a time resolution that is appropriate for whole-building simulation.

The Annex research is organized into three related Subtasks.
**Subtask A :** Cogeneration system characterization and characterization of occupant-driven electrical and domestic hot water usage patterns. Subtask A will produce a general description of the cogeneration technologies that will be modelled within the Annex. Although this will not be an extensive description of the technologies, it will be sufficient to lend credibility to the models developed in Subtask B.
**Subtask B :** Development, implementation, and validation of cogeneration system models. Subtask B will focus on the development, implementation, and validation of cogeneration system models for use in integrated building simulation. To leverage against previous significant research investments, efforts will be focussed on the development of models and their implementation into existing building simulation tools rather than on the development of new simulation programs. Where appropriate, existing models will be adapted.
**Subtask C :** Technical, environmental, and economic assessment of selected cogeneration applications**.** Subtask C will apply the models produced by the Annex to selected case studies. This effort is intended to demonstrate the potential of the models developed by the Annex and to investigate the suitability of cogeneration systems in applications that are of interest to the Annex Participants.

Project Period: 2003 - 2007
Operating Agent: Ian Beausoleil-Morrison, Natural Resources Canada
Participating Countries (to be confirmed): Belgium, Canada, Finland, Germany, Italy, Netherlands, Switzerland, United Kingdom, USA

- University of Liège, Belgium
- COGEN Europe, Belgium
- Natural Resources Canada - Building Simulation Team, Canada
- Natural Resources Canada - Integrated Energy Systems Group, Canada
- University of Victoria - Department of Mechanical Engineering, Canada
- NRC: National Research Council Canada - Institute for Research in Construction, Canada
- VTT: Technical Research Centre - Building and Transport, Finland
- ENEA: National Agency for New Technology, Energy and the Environment, Italy
- ECN: Energy Research Centre of the Netherlands - Renewable Energy in the Built Environment, Netherlands
- NBI: Norwegian Building Research Institute, Norway
- EMPA: Swiss Federal Laboratories for Materials Testing and Research - Energy Systems / Building Equipment Laboratory, Switzerland
- EPFL: Swiss Federal Institute of technology - Laboratory for Industrial Energy Systems, Switzerland
- Sulzer Hexis, Switzerland
- Siemens Building Technologies, Switzerland
- University of Strathclyde - Energy Systems Research Unit, United Kingdom
- Cardiff University - Welsh School of Architecture, United Kingdom
- Penn State University - Energy Institute, USA
- Texas A&M University - Department of Architecture, USA
- NIST: National Institute of Standards and Technology, USA
- NREL: National Renewable Energy Laboratory, USA

# Annex 43

Annex 43 has been initiated in conjunction with the IEA Solar Heating And Cooling Programme. The goal of this Annex is to undertake pre-normative research to develop a comprehensive and integrated suite of building energy analysis tool tests involving analytical, comparative, and empirical methods. These methods will provide for quality assurance of software, and some of the methods will be enacted by codes and standards bodies to certify software used for showing compliance to building energy standards. This goal will be pursued by accomplishing the following objectives:

- Create and make widely available a comprehensive and integrated suite of IEA Building Energy Simulation Test (BESTEST) cases for evaluating, diagnosing, and correcting building energy simulation software. Tests will address modelling of the building thermal fabric and building mechanical equipment systems in the context of solar and low energy buildings.
- Maintain and expand as appropriate analytical solutions for building energy analysis tool evaluation.
- Create and make widely available high quality empirical validation data sets, including detailed and unambiguous documentation of the input data required for validating software, for a selected number of representative design conditions.

This Annex will investigate the availability and accuracy of building energy analysis tools and engineering models to evaluate the performance of solar and low-energy buildings. The scope of the Task is limited to building energy simulation tools, including emerging modular type tools, and to widely used solar and low-energy design concepts. Activities will include development of analytical, comparative and empirical methods for evaluating, diagnosing, and correcting errors in building energy simulation software. The audience for the results of the Annex is building energy simulation tool developers, and codes and standards (normes) organizations that need methods for certifying software. However, tool users, such as architects, engineers, energy consultants, product manufacturers, and building owners and managers, are the ultimate beneficiaries of the research, and will be informed through targeted reports and articles.

The objectives shall be achieved by the Participants in the following Subtasks:

**Subtask A: Comparative Tests**
In Subtask A, the Participants shall expand the SHC Task 12 and Task 22 BESTEST-type comparative / diagnostic evaluation tests to include:

- ground-coupled heat transfer with respect to floor slab and basement constructions
- multi-zone buildings
- buildings with double-skin facades

Analytical verification tests for evaluating basic heat transfer and mathematical processes in building energy analysis tools will be included where possible.

**Subtask B: Empirical Validation**
In Subtask B, the Participants shall expand the SHC Task 22 empirical validation tests and data sets to include validation of models for:

- Thermal and solar/optical performance of windows and shading
- Solar impacts on room heating/cooling loads
- Illuminance calculations
- Interaction between natural (day-lighting), shading, and electrical lighting and HVAC systems
- Control strategies required to increase efficiency of heating and cooling plants, and especially control models for components such as: chillers, boilers, fans and pumps in the context of solar and low energy buildings.
- Ground Coupled Floor Slab and Basement Comparative Tests
- Multi-Zone Heat Transfer Comparative Tests
- Shading/Daylighting/Load Interaction Empirical Tests
- Radiant Heating and Cooling (Thermally Activated Building Systems, Low Temperature Heating and Cooling System) Comparative and Empirical Tests
- Heat Pump Comparative Tests
- Systems, Components, and Controls Empirical Tests
- Double-Façade Empirical Tests

Project Period: 2003 - 2007
Operating Agent: Ron Judkoff, National Renewable Energy Laboratory, USA

Participating Countries (to be confirmed): Australia, Belgium, Canada, the Czech Republic, France, Germany, Greece, Italy, Japan, Netherlands, Sweden, Switzerland, United Kingdom, USA

- Arup, Australia
- CSIRO, Australia
- University of Liège, Belgium
- PHYSIBEL, Belgium
- Natural Resources Canada - CANMET Energy Technology Center, Canada
- Technical University of Brno, Czech Republic
- CVUT: Czech Technical University in Prague, Czech Republic
- Aalborg University, Denmark
- CSTB: Centre Scientifique et Technique du Bâtiment, France
- EDMP: Ecole des Mines de Paris, France
- Université de La Réunion, France
- Fraunhofer Institute for Building Physics, Germany
- TUD: Technische Universität Dresden, Germany
- Universita di Palermo, Italy
- Miyagi National College of Technology, Japan
- NIES: National Institute for Environmental Studies, Japan

- YNU: Yokohama National University, Japan
- TNO - Building and Construction Research, Netherlands
- ACHSL Consultoria, Spain
- LTH: Lund University, Sweden
- EMPA: Swiss Federal Laboratories for Materials Testing and Research, Switzerland
- HTAL: Hochschule Technik+Arch. Abt. HLK, Switzerland
- University of Strathclyde - Energy Systems Research Unit, United Kingdom
- Cardiff University - Welsh School of Architecture, United Kingdom
- Iowa Energy Center, USA
- NREL: National Renewable Energy Laboratory, USA
- GARD Analytics, USA
- TESS, USA

## Annex 44

The greatest future potential for increased energy savings lies with technologies that promote the integration of active building elements and communication among building services. Responsive building elements are defined as building construction elements that assist in maintaining an appropriate balance between optimum interior conditions and environmental performance by reacting in a controlled and holistic manner to changes in external or internal conditions and to occupant intervention. Examples include façade systems (double skin facades, adaptable facades, dynamic insulation), roof systems (green roof systems), foundations (earth coupling systems, embedded ducts), storage (active use of thermal mass, materials such as concrete or massive wood, core activation, phase change materials).

The development, application and implementation of responsive building elements are considered to be a necessary step towards further energy efficiency improvements in the built environment. The Annex will address the following objectives:

- define state-of-the-art of responsive building elements, of integrated building concepts and of environmental performance assessment methods;
- improve and optimise responsive building elements;
- develop and optimise new building concepts with integration of responsive building elements, HVAC-systems as well as natural and renewable energy strategies;
- develop guidelines and procedures for estimation of environmental performance of responsive building elements and integrated building concepts.

Three subtasks will be carried out in order to reach the objectives:

**Subtask A. Responsive Building Elements**
The subtask will aim to improve responsive building element concepts , including assessment of the advantages, requirements and limitations. The subtask will focus on systems that have the potential to be successfully integrated with integrated building concepts. Such integration has a number of important advantages:

- Integration of responsive building elements with HVAC-systems will lead to substantial improvement in environmental and cost performance.
- It enhances the use and exploit the quality of energy sources (exergy) and stimulates the use of renewables and low valued energy sources (like waste heat, ambient heat, residual heat etc.)
- It will further enable and enhance the possibilities of passive and active storage of energy (buffering).
- It will integrate architectural principles into energy efficient building concepts.
- Responsive building elements lead to a better tuning of technologies to each other and in relation to the integrated building concept and the building users.
- It enhances the development of new technologies and elements in which various functions are combined in the same active building element.
- It will lead to a better understanding of integrated design principles among architects and engineers.

**Subtask B. Integrated Building Concepts**
The subtask will focus on development of integrated building concepts where responsive building elements, energy systems and control systems are integrated into one system to reach an optimal environmental performance.

**Subtask C. Implementation and Dissemination**
The focus of the subtask will be to guide, collect, packet, transform and disseminate the findings generated in Subtasks A and B. The main target groups are manufacturers of building elements, contractors, designers (architects and engineers), but also end-users and building owners.

Operating Period: 2004 - 2008
Operating Agent: Per Heiselberg, Aalborg University, Denmark

Participating Organisations:

- AEE INTEC, Institute for Sustainable Technologies, Austria
- Concordia University, Canada
- The University of Hong Kong, China
- Aalborg University, Denmark
- Technical University of Denmark
- Politecnico di Torino, Italy
- Università Politecnica delle Marche, Italy
- NILIM: National Institute for Land and Infrastucture Management, Japan
- BRI: Building Research Institute, Japan
- Tokyo Polytechnic University, Japan
- University of Tokyo, Japan
- SINTEF - Civil & Environmental Engineering, Norway
- NTNU: Norges Teknisk- Naturvitenskapelige Universitet, Norway
- LNEC: National Laboratory for Civil Engineering, Portugal
- UTL: Technical University of Lisbon, Portugal
- Cauberg-Huygen R.I, the Netherlands
- TU Delft: Technical University of Delft, The Netherlands
- Brunel University, United Kingdom
- Buro Happold, United Kingdom
- Aberdeen University, United Kingdom
- Purdue University, USA
- Participation to be confirmed:
- ENTPE: École Nationale des Travaux Publics de l'État - LASH, France
- University of La Rochelle - LEPTAB, France
- CSTB, France
- Cracow University of Technology, Poland
- SP: Sveriges Provnings- och Forskningsinstitut, Sweden
- University of Gävle, Sweden

## Annex 45

Overview

Lighting-related electricity production for the year 1997 was 2016 TWh of which 1066 TWh was attributable to IEA member countries. Global lighting electricity use is distributed approximately 28 % to the residential sector, 48 % to the service sector, 16 % to the industrial sector, and 8 % to street and other lighting. For the industrialized countries national lighting electricity use ranges from 5 % to 15 %, while in developing countries the value can be as high as 86 % of the total electricity use. The corresponding carbon dioxide emissions were 1775 million tonnes, of which approximately 511 million tonnes was attributable to the IEA member countries.

More efficient use of lighting energy would limit the rate of increase of electric power consumption, reduce the economic and social costs resulting from constructing new generating capacity, and reduce the emissions of greenhouse gases and other pollutants. At the moment fluorescent lamps dominate the office lighting. In domestic lighting the dominant light source is still the more than a century old, inefficient incandescent lamp. New aspects of desired lighting are energy savings, daylight use, individual control of light, quality of light, emissions during life cycle and total costs.

> “For the industrialized countries national lighting electricity use ranges from 5 % to 15 %, while in developing countries the value can be as high as 86 % of the total electricity use.”

The goal of Annex 45 is to identify and to accelerate the widespread use of appropriate energy efficient high-quality lighting technologies and their integration with other building systems, making them the preferred choice of lighting designers, owners and users.

The aim is to assess and document the technical performance of existing promising, but largely underutilized, innovative lighting technologies as well as future lighting technologies and their impact on other building equipment and systems (ie: daylighting, HVAC). These novel lighting system concepts have to meet functional, aesthetic, and comfort requirements of building occupants.

The Annex intends to reach its objective by means of four Subtasks:

**Subtask A : Targets for energy performance and human well-being**

The objective is to document the effect of design on energy use, lighting quality and human performance and give examples of good practice. The objective is to assess barriers preventing the adoption of energy-efficient, human friendly lighting design.

**Subtask B Innovative technical solutions**

The objective is to identify, assess and document the performance, energy and economical criteria of existing promising and innovative future lighting technologies and their impact on other building equipment and systems. Purpose is to reduce the used energy in buildings by applying information on concepts and products and their effect on energy consumption and performance to consultants, public authorities and building owners.

**Subtask C Energy-efficient controls and integration**

The task will focus on controls that enable the occupant and facility manager to modify the electric lighting according to personal needs and preferences, within acceptable building operative requirements. Based on modern communication technology, personalisation and integration of these controls with other building systems will be an important part of the subtask.

**Subtask D Information dissemination**

The objective is to positively affect on the current lighting practices in a manner that accelerates the use of energy efficient products, improves overall building performance and enhances occupant’s environmental satisfaction. The main target groups of deliveries are designers and end-users/owners. The results are disseminated also by delivering information to standards and recommendations and by providing educational material to educational institutions in order to positively affect future lighting professionals.

Operating Period: 2004-2008

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Website: www.lightinglab.fi/IEAAnnex45

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- Zumtobel Staff, Austria
- Belgian Building Research Institute, Belgium
- CSTB: Centre Scientifique et Technique du Bâtiment, France
- ENTPE: École Nationale des Travaux Publics de l’État, France
- Fraunhofer Institute for Building Physics, Germany

- Technische Universität Berlin, Germany
- NTNU: Norges Teknisk- Naturvitenskapelige Universitet, Norway
- SINTEF, Norway
- Silesian University of Technology, Poland
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- Miloni Lichtplanung, Switzerland
- EPFL: Ecole Polytechnique Fédérale de Lausanne - Solar Energy and Building Physics Laboratory, Switzerland
- Lawrence Berkeley National Laboratory, USA
- National University of Singapore, Singapore
- NRC: National Research Council Canada - Institute for Research in Construction, Canada
- China National Institute of Standardization, China
- Fudan University, China
- Tokai University, Japan

“to identify and to accelerate the widespread use of appropriate energy efficient high-quality lighting technologies and their integration with other building systems,”

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

Annex 46

## Overview

The scope of the Annex is the decision making process for energy retrofitting of Government non-residential buildings: e.g., office buildings, hospitals, large one-storey production facilities and maintenance shops and speciality warehouses.

The Annex is meant to influence the decision making process that determines the use of energy-saving measures in building retrofits. This decision making process must improve if it is to successfully cope with the challenges of increasing energy costs and climate change, and if it is to avoid "locking in" long-term commitment to energy inefficiencies by adopting sub-optimal renovations. Consequently, the target group consists of all actors involved in this decision making process, specifically executive decision makers and energy managers of Government buildings, performance contractors and designers. The IT-tool-kit EnERGo, supplemented by guidelines and best practice examples, will support these different user groups, and facilitate communication between them.

**The objectives of this Annex are:**

- To provide tools and guidelines for decision makers and energy managers, performance contractors and designers to improve the working environment of Government buildings through energy-efficient retrofitting projects. Though the focus of this Annex is on Government buildings, many results can be applied to similar private sector buildings;
- To provide recommendations on how to operate the retrofitted buildings;
- To promote energy- and cost-efficient retrofit measures by providing successful examples;
- To support decision makers in evaluating the efficiency and acceptance of available concepts;
- To find improved ways of using Energy Performance Contracts (ESPC's) for Government buildings retrofit measures.

To accomplish these objectives, Participants will carry out research and development in the framework of the following three Subtasks and one joint working group:

**Subtask A:** Develop an energy assessment and analysis methodology/protocol and a tool "Energy Assessment Guide for Energy Managers and ESCO's ";

**Subtask B:** Develop a database of "Energy Saving Technologies and Measures for Government Building Retrofits" with examples of best practices;

**Subtask C:** Develop "Best Practice Guidelines for Innovative Energy Performance Contracts;

**Subtask D:** Develop IT-Toolkit "EnERGo".

Status: Ongoing (2005-2008)

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- Fraunhofer Institute for Building Physics, Germany
- University of Stuttgart, Germany
- TEKES, Finland
- National University of Singapore
- IEA Demand Side Management Programme
- (Others to be confirmed)

# ECBCS and the IEA

The International Energy Agency (IEA) was established as an autonomous body within the Organisation for Economic Co-operation and Development (OECD) in 1974. Its purpose is to strengthen co-operation in the vital area of energy policy. As one element of this programme, member countries take part in various energy research, development and demonstration activities that are instituted through a series of Implementing Agreements. There are numerous advantages to international energy technology RD&D collaboration through the IEA, including:

- Reduced cost and 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
- Harmonized technical standards
- Strengthened national RD&D capabilities
- Intellectual property rights protection

More information may be found at:
www.iea.org/textbase/papers/2005/impag_faq.pdf

- About ECBCS
- Objectives and Strategy
- Mission Statement
- Nature of ECBCS Activities
- ECBCS Participating Countries
- Coordination with other Bodies
- Collaboration with IEA Building-Related Implementing Agreements
- Collaboration with the IEA Solar Heating and Cooling Programme
- Collaboration with other IEA Activities
- Non-IEA Activities
- Collaboration with the European Commission

## About ECBCS

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 carbon dioxide production. 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 building. Overall, these are aimed at reducing energy consumption by between 15% - 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, the International Energy Agency has established an Implementing Agreement on Energy Conservation in Buildings and Community Systems (ECBCS). The function of ECBCS 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 by means of annexes to the ECBCS 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 Conservation in Buildings and Community Systems (ECBCS) 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 ECBCS 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 ECBCS programme are:

- To support the development of generic energy conservation technologies within international collaboration
- To support technology transfer to industry and to other end-users by dissemination of information through demonstration projects and case studies
- To contribute to the development of design methods, test methods, measuring techniques, and evaluation/assessment methods encouraging their use for standardisation
- To ensure acceptable indoor air quality through energy efficient ventilation techniques and strategies
- To 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:

- Environmental impacts of fossil fuels
- Business process to meet energy and environmental targets
- Building technologies to reduce energy consumption
- Reduction of Green House Gas emissions
- “Whole Building” performance approach
- Sustainability
- Impact of energy measures on indoor health, comfort and usability
- Exploitation of innovation and information technology
- Integrating changes in lifestyles, work and business environment

### Mission Statement

The mission of the IEA Energy Conservation for Building and Community Systems Programme is as follows:

**"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"**

### Nature of ECBCS Activities

a) Formal co-ordination through shared tasks: This represents the primary approach of developing the work of ECBCS. The majority of Annexes are task shared and involves a responsibility from each country to commit manpower.

b) Formal co-ordination through cost shared activities: ECBCS currently supports one cost shared project, Annex 5, the Air Infiltration and Ventilation Centre (AIVC). In recent times, Annex 5 has sub-contracted 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 co-ordination or initiation of activities by participants: Many organizations and groups take part in the activities of ECBCS including government bodies, universities, non-profit making research institutes and industry.

d) Information exchanges: Information about associated activities is exchanged through the ECBCS and through individual Annexes. The ECBCS Web Site (www.ecbcs.org), for example, provides links to associated research organizations. Participants in each Annex 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 ECBCS Newsletter, which, for example, carries regular reports of energy policy development and research activities taking place in various countries.

ECBCS Participating Countries

- Australia
- Austria
- Belgium
- Canada
- Czech Republic
- Denmark
- Finland
- France
- Germany
- Greece
- Israel
- Italy

"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"

- Japan
- New Zealand
- Netherlands
- Norway
- Poland
- Portugal
- Sweden
- Switzerland
- Turkey
- United Kingdom
- United States of America

There are now twenty one IEA participating countries and two non-IEA countries in the Agreement. During the last operating period, the Czech Republic joined both the IEA and this Agreement. IEA countries that are not participants in the Agreement are Hungary, Ireland, Korea, Luxembourg, and Spain. It is anticipated that Singapore and Korea will soon become member countries of the programme.

### Coordination with Other Bodies

In order to achieve high efficiency in the R&D program and to eliminate duplication of work it is important to collaborate with other IEA building-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. The duty of the chairs of the Executive Committees is to keep the others informed about their activities, seeking areas of common interest.

### Collaboration with IEA Building-Related Implementing Agreements

The ECBCS Programme continues to co-ordinate its research activities, including Annexes and strategic planning, with all BRIA's (Building-Related Implementing Agreements) through collaborative Annexes and through the BCG (Buildings Coordination Group), constituted by:

- District Heating And Cooling (DHC) Executive Committee Chair
- Demand Side Management (DSM) Executive Committee Chair
- Energy Conservation in Buildings and Community Systems (ECBCS) Executive Committee Chair
- Energy Conservation through Energy Storage (ECES) Executive Committee Chair
- Heat Pumping Technologies (HPT) Executive Committee Chair
- Photovoltaic Power Systems (PVPS) Executive Committee Chair
- Solar Heating and Cooling (SHC) Executive Committee Chair
- Energy End Use Working Party (EUWP) Vice Chair for Buildings

Beyond the BCG meetings, ECBCS meets with representatives of all building-related IA's at Future Buildings Forum (FBF) Think Tanks and Workshops. It is planned the outcome from the Future Buildings Forum Think Tank will be used strategically by the various IEA buildings-related Implementing Agreements to help in the development of their work programmes over the next five years.

Proposals for new research projects are discussed in co-ordination with these other Programmes to pool expertise and to avoid duplication of research. Co-ordination with SHC is particularly strong and joint meetings are held between the Programmes every two years. Both ECBCS and the Solar Heating and Cooling (SHC) programmes focus primarily on buildings and communities.

**Collaboration with the IEA Solar Heating and Cooling Programme**

While there are several IEA programs that are related to the building sector, the ECBCS and the Solar Heating and Cooling (SHC) programmes focus primarily on buildings and communities. Synergy between these two programmes occurs because one program 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 greenhouse gas emissions. The areas of responsibility of the two programs were reviewed and agreed. ECBCS 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 every two years. At these meetings matters of common interest are discussed, including planned new Tasks, program 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 program, 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 programs 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:

- ECBCS 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 Program - 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:

1. Technology development via international collaboration
2. Information dissemination to target audiences
3. Enhancing building standards
4. Interaction with developing countries

The other objectives are different. The ECBCS 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 building sector and are committed to continue their coordinated approach to reducing the use of purchased energy in building sector markets.

There are currently two SHC – ECBCS joint projects:

- Annex 38 - Solar Sustainable Housing, and
- Annex 43 - Testing and Validation of Building Energy Simulation Tools.

**Non-IEA Activities**

A further way in which ideas are progressed and duplication is avoided is through co-operation with other building related activities. 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),
- The American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE), and
- International Initiative for a Sustainable Built Environment (iiSBE).

CIB: This organization, sponsored by individual groups, has its main area of interaction in sponsored workshops, conferences and publications. ECBCS has a formal memorandum of understanding with CIB to assist in the dissemination of results and avoidance of duplication of effort. The Secretariat of CIB periodically attends ECBCS ExCo meetings.

EC: Collaboration with the European Commission has been formally established and they are a Contracting Party to the ECBCS Implementing Agreement. The EC Framework Program sponsors research, primarily within the European Union. Typically half the project funding comes from EU resources so it can be more attractive than IEA participation. IA's provide opportunity for a wider range of country participation and hence a broader knowledge base. There is, however, much cross-pollination of ideas between the IEA and EU.

International Standards Organization: This group sets standards that can be adopted by individual countries or communities. ISO interacts with ECBCS and its information for developing standards is drawn from many sources including output from IEA activities.

iiSBE: This is the international initiative for Sustainable Built Environment. iiSBE is an international non-profit organization whose overall aim is to actively facilitate and promote the adoption of policies, methods and tools to accelerate the movement towards a global sustainable built environment. Its specific objectives include the following:

- Map current activities and establish a forum for information exchange on SBE initiatives for participating organizations, so that gaps and overlaps may be reduced and common standards established; and
- Increase awareness of existing SBE initiatives and issues amongst non-participating organizations and in the international user community;
- Take action on fields not covered by existing organizations and networks. ECBCS is involved with iiSBE design and information dissemination.

# Recent ECBCS Annex

### ECBCS
- ECBCS News, ECBCS ExCo Support Services Unit, 1984 onwards, newsletter published every 6 months.

### Annex 5 - Air Infiltration and Ventilation Centre (AIVC)
- AIR Newsletter published every 3 months

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

### Technical Notes
- Reducing Indoor Residential Exposures to Outdoor Pollutants, 2003, Sherman M and Matson N, TN 58
- Parameters for the design of demand controlled hybrid ventilation systems for residential buildings, 2005, Dorer V, Pfeiffer A, Weber A, TN 59
- Efficacy of Intermittent Ventilation for Providing Acceptable Indoor Air Quality, Sherman M H, TN 60, 2006

### Annotated Bibliographies
- Review of Airflow Measurement Techniques, 2003, McWilliams J, BIB 12

### AIVC Conference Proceedings
- Ventilation, Humidity Control and Energy, 2003, Washington, USA, CP 24
- Ventilation and Retrofitting, 2004, Prague, Czech Republic, CP 25
- Ventilation in Relation to the Energy Performance of Buildings, Brussels, Belgium, CP 26

### Ventilation Information Papers
- Airtightness of ventilation ducts, 2003, Delmotte Ch, VIP 01
- Indoor Air Pollutants – Part 1: General description of pollutants, levels and standards, 2003, VIP 02
- Natural ventilation in urban areas, 2004, Santamouris M, VIP 03
- Night ventilation strategies, 2004, Santamouris M, VIP 04
- Displacement ventilation, 2004, Schild P G, VIP 05
- Air to air heat recovery in ventilation systems, 2004, Schild P G, VIP 06
- Indoor air pollutants – Part 2: Description of sources and control/mitigation measures, 2004, Levin H, VIP 07
- Airtightness of Buildings, 2004, Dorer V, Tanner C, Weber A, VIP 08
- Energy performance regulations: which impact can be expected from the European Energy Performance Directive? 2004, Wouters P, VIP 09
- Sheltering in buildings from large-scale outdoor releases, 2004, Chan W R, Price P N, Gadgil A J, VIP10
- Use of Earth to Air Heat Exchangers for Cooling, 2006, Santamouris M., VIP 11

See www.aivc.org for details of Annex 5 publications.

### Annex 19 – Low Slope Roof Systems
- Technical Synthesis Report: Annex 19 Low Slope Roof Systems, Palmer J, 2003

### Annex 22 & 33 Advanced Local Energy Planning
- Technical Synthesis Report, ESSU, 2005

### Annex 32 - Integral Building Envelope Performance Assessment
- Technical Synthesis Report: Annex 32 Integral Building Envelope Performance Assessment, Warren, P, 2003

### Annex 34 - Computer Aided Evaluation of HVAC System Performance
- Technical Synthesis Report, ESSU, 2005

### Annex 35 - Control Strategies for Hybrid Ventilation in New and Retrofitted Office Buildings (HYBVENT)
- Technical Synthesis Report, ESSU, 2005

### Annex 36 - Retrofitting in Educational Buildings: Energy Concept Adviser for Technical Retrofit Measures
- Retrofitting of Educational Buildings - Case Study Reports, edited by Morck O, 2003
- Energy Concept Adviser, 2005 - www.annex36.com

### Annex 37 - Low Exergy Systems for Heating and Cooling of Buildings
- Low Temperature Heating Systems - Increased Energy Efficiency and Improved Comfort, brochure, 2002 (see www.vtt.fi/rte/projects/annex37)
- Lowex Guidebook - www.lowex.net/english/inside/guidebook.html

### Annex 38 - Solar Sustainable Housing
- Sustainable Solar Housing: Marketable Housing For A Better Environment Brochure, 2003
- SIS demonstration housing project in Freiburg, Germany, 2003
- Demonstration house in Monte Carasso, Switzerland, 2003
- Demonstration houses in Kassel, Germany, 2003
- Demonstration houses in Hannover- Kronsberg, Germany, 2003
- Zero energy house, Kanagawa, Japan, 2003
- Sunny Eco-House, Kankyokobo, Japan, 2003

See www.iea-shc.org/task28 to download.

### Annex 39 High Performance Thermal Insulation Systems (HiPTI)
- Vacuum Insulation in the Building Sector: Systems and Applications, 2005
- Vacuum Insulation Panels: Study on VIP-components and Panels for Service Life Prediction of VIP in Building Applications, 2005
  - download from www.vip-bau.ch

### Annex 40 Commissioning of Building HVAC Systems for Improving Energy Performance
- Commissioning Tools for Improved Energy Performance: Results of ECBCS Annex 40, 2005
  - download from www.commissioning-hvac.org

### Annex 42 The Simulation of Building-Integrated Fuel Cell and Other Cogeneration Systems (COGEN-SIM)
- Residential Cogeneration Systems: a Review of The Current Technologies, 2005
  - download from www.cogen-sim.net

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# List of Abbreviations

| | |
|---|---|
| **AIVC** | Air Infiltration and Ventilation Centre (IEA) - www.aivc.org |
| **AIR** | Air Information Review (ECBCS AIVC) |
| **ALEP** | Advanced local energy planning (IEA) - www.ecbcs.org/Annexes/annex33.htm |
| **ASHRAE** | American Society of Heating, Refrigerating and Air-conditioning Engineers - www.ashrae.org |
| **BCG** | Buildings Coordination Group (IEA) |
| **BEMS** | Building energy management system |
| **BESTEST** | Building Energy Simulation Test (IEA) |
| **CADDET** | Centre for the Analysis and Dissemination of Demonstrated Energy Technologies (IEA) |
| **CIB** | Conseil International du Bâtiment, International Council for Building - www.cibworld.nl |
| **ECBCS** | Energy Conservation in Buildings and Community Systems Programme (IEA) - www.ecbcs.org |
| **EETIC** | Energy and Environmental Technologies Information Centres (IEA) - www.etde.org/abtetde/eetic.html |
| **ESSU** | ExCo Support Services Unit (IEA) - www.ecbcs.org/SupportServices.htm |
| **ETDE** | Energy Technology Data Exchange (IEA) - www.etde.org |
| **EU** | European Union |
| **ExCo** | Executive Committee (IEA) ExCo Executive Committee (IEA) |
| **FBF** | Future Buildings Forum (IEA) www.ecbcs.org/Futurebuldforum.htm |
| **GHG** | Greenhouse gas GREENTIE Greenhouse Gas Technology Information Exchange (IEA) |
| | - www.greentie.org |
| **HAM** | Heat, air and moisture |
| **HiPTI** | High performance thermal insulation (IEA) - www.ecbcs.org/Annexes/annex39.htm |
| **HVAC** | Heating, ventilation, air conditioning |
| **Hybvent** | Hybrid ventilation - www.ecbcs.org/Annexes/annex35.htm |
| **IA** | Implementing Agreement (IEA) |
| **IEA** | International Energy Agency - www.iea.org |
| **iiSBE** | International Initiative for Sustainable Built Environment - www.iisbe.org |
| **ISO** | International Standardization Organization - www.iso.org |
| **LCA** | life cycle analysis |
| **LCC** | life cycle costing |
| **LowEx** | Low exergy (IEA) - www.ecbcs.org/Annexes/annex37.htm |
| **OECD** | Organisation for Economic Co-operation and Development - www.oecd.org |
| **R&D** | Research and development |
| **RD&D** | Research, development and demonstration |
| **SBE** | Sustainable built environment |
| **SHC** | Solar Heating and Cooling Programme (IEA) - www.iea-shc.org |
| **VIP** | Vacuum insulated panel |
| **WG** | Working Group (IEA) |

The International Energy Agency (IEA) Energy Conservation in Building and Community Systems Programme (ECBCS)

The International Energy Agency (IEA) was established as an autonomous body within the Organisation for Economic Co-operation and Development (OCED) in 1974, with the purpose of strengthening co-operation in the vital area of energy policy. As one element of this programme, member countries take part in various energy research, development and demonstration activities. The Energy Conservation in Buildings and Community Systems Programme has sponsored various research Annexes associated with energy prediction, monitoring and energy efficiency measures in both new and existing buildings. The results have provided much valuable information about the state of the art of building analysis and have led to further IEA sponsored research.

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