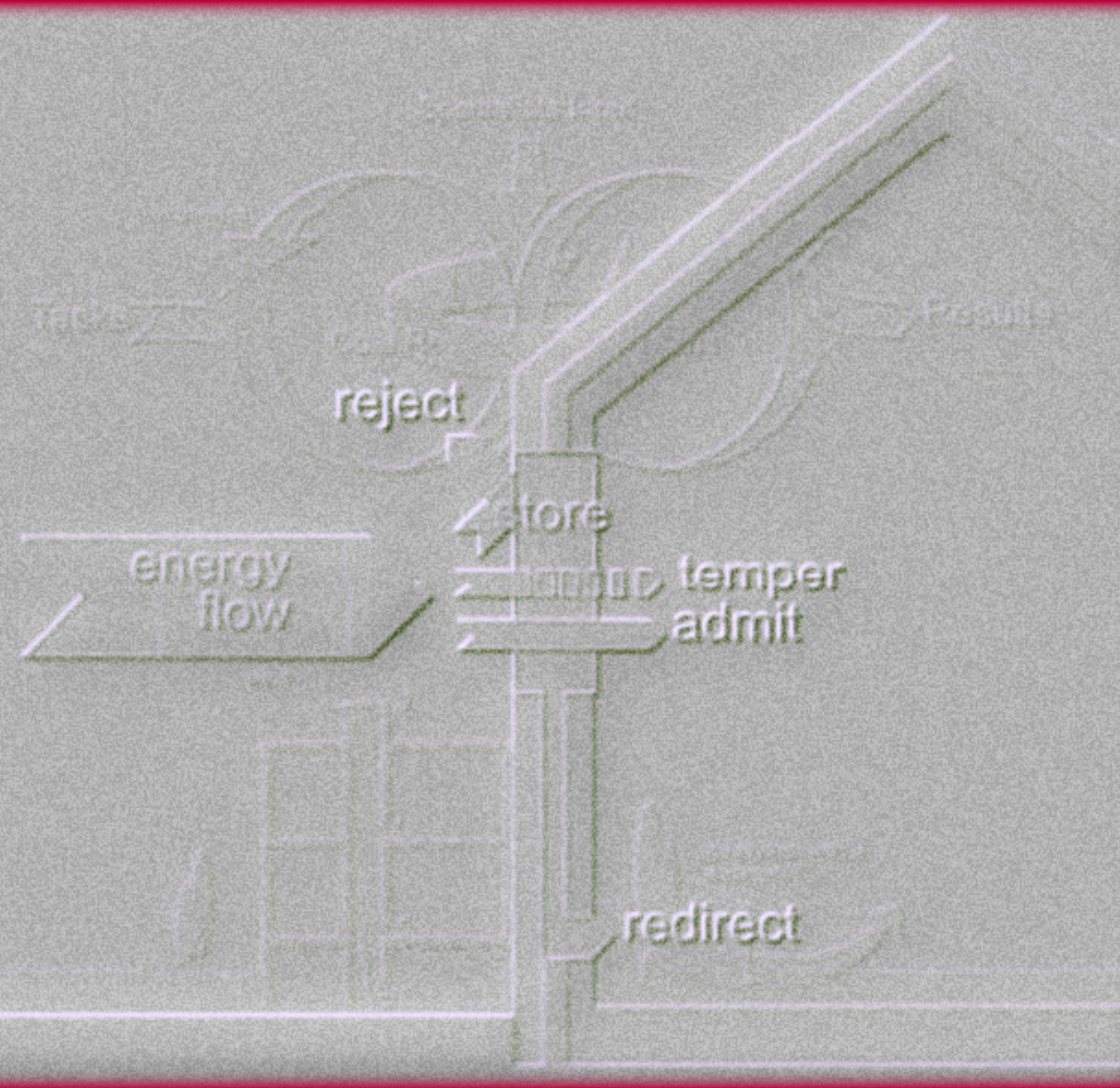
International Energy Agency

ECBCS Annual Report 2009

Energy Conservation in Buildings & Community Systems Programme



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Participating countries in ECBCS: Australia, Austria, Belgium, Canada, P.R. China, Czech Republic, Denmark, Finland, France, Germany, Greece, Italy, Japan, Republic of Korea, the Netherlands, New Zealand, Norway, Poland, Portugal, Spain, Sweden, Switzerland, Turkey, United Kingdom and the United States of America.

Contents

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 co-ordinates 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:

Our Mission

"To develop and facilitate the integration of technologies and processes for energy efficiency and conservation into healthy, low emission, and sustainable buildings and communities, through innovation and research."

Research and Development Strategies

Derived from research drivers, national programs within IEA countries, and the IEA Future Building Forum, the R&D strategies represent a collective input of the Executive Committee members to exploit technological opportunities to save energy in the building sector, and to remove technical obstacles to market penetration of new energy conservation technologies. The R&D strategies apply to residential, commercial, and office buildings, and will impact the building industry in three aspects:

1. Design and Business Environment
2. Building Technologies and Systems
3. Outreach and Commercialisation

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 act 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 Renovation of Residential Buildings**
51. *** Energy Efficient Communities**
52. *** Towards Net Zero Energy Solar Buildings**
53. *** Total Energy Use in Buildings: Analysis & Evaluation Methods**
54. *** Analysis of Micro-Generation & Related Energy Technologies in Buildings**
55. *** Reliability of Energy Efficient Building Retrofitting - Probability Assessment of Performance & Cost**

Working Groups

- * Energy Efficient Communities
- Energy Efficiency in Educational Buildings
- Indicators of Energy Efficiency in Cold Climate Buildings
- Annex 36 Extension: The Energy Concept Adviser

* Ongoing projects

Introduction

Many ECBCS member countries are in the process of implementing policies to target very low or zero carbon and energy buildings. This target is reflected in the collective vision of the ECBCS Programme in our current Strategic Plan, which is for “near-zero primary energy use and carbon emission solutions to have been adopted in buildings and communities, in which energy is produced on demand”. It is therefore appropriate that current ECBCS projects are investigating different technical aspects of how this can be achieved. To this end, a project is being run jointly by ECBCS with the IEA Solar Heating and Cooling Programme to better understand how such buildings perform in reality and how their design can be improved:

- Towards Net Zero Energy Solar Buildings

An important, but as yet unresolved issue about energy use in buildings is that terminology and definitions are not created and applied consistently. Related to this, more knowledge is required about how different factors influence energy use in buildings, particularly occupant behaviour. To resolve these issues, we are conducting the research project:

- Total Energy Use in Buildings: Analysis & Evaluation Methods

Consideration about practical operation of real buildings is the primary concern for an ECBCS project nearing completion:

- Cost Effective Commissioning of Existing and Low Energy Buildings

The work being performed in this project will help to ensure that buildings operate in practice at least as well as they are designed. Final reporting for this work is in progress.

A new project has been initiated within the last year to continue the theme of earlier ECBCS work. The previous work has provided a sound basis for modelling small scale co-generation systems, underpinned by extensive experimental validation. The current project will use this as a basis for exploring how such systems may be optimally applied.

- Micro-generation and Related Energy Technologies in Buildings

Further ECBCS projects are nearing completion. These are examining how ‘environmentally responsive’ building components can be best integrated into buildings and how reversible air conditioning may be more widely applied to further recover heat from buildings.

- Integrating Environmentally Responsive Elements in Buildings
- Heat Pumping and Reversible Air Conditioning

How community scale energy systems should be designed to operate most efficiently to fully integrate with the buildings they serve is the subject of two major areas of ECBCS work. One of these focuses on improving technical design, while the other is producing tools to assist decision-makers:

- Low Exergy Systems for High Performance Buildings and Communities
- Energy Efficient Communities - Case Studies and Strategic Guidance for Urban Decision Makers

The major challenge in the coming years will to refurbish the existing building stock to substantially reduce energy use. ECBCS is therefore particularly active in this area, with three ongoing projects:

- Prefabricated Systems for Low Energy Renovation of Residential Buildings
- Holistic Assessment Toolkit on Energy Efficient Retrofit Measures for Government Buildings
- Reliability of Energy Efficient Building Retrofitting - Probability Assessment of Performance and Cost

The first two of these projects are now entering their final reporting phases, while the latter is beginning its preparation phase.

Reducing energy used for electric lighting of buildings is a global priority. It is thus timely that the final preparations are underway for the publication of a major new design guidebook, researched and written by the ECBCS project on:

- Energy Efficient Future Electric Lighting for Buildings

In the penultimate year of the current Air Infiltration and Ventilation Centre operating period, their long-term work has continued to promote energy efficient ventilation of healthy buildings. AIVC outputs during this period have included publication of four editions of the AIR newsletter, the 30th Annual AIVC Conference, development of online databases and additions to their series of reports.

Knowledge generated in research activities must be better disseminated to enable effective transfer to end users. The Programme is continuing to improve how this takes place. During the past year we have revised the presentation and approach to content for both our website and newsletter. Further, we have initiated a series of factsheets to provide a stand-alone introduction to each of our projects. The intention is that these initiatives should help to widen interest in the outcomes of ECBCS projects.

Dr Morad R. Atif
ECBCS Executive Committee Chair

New Research Projects

Micro-Generation & Related Energy Technologies in Buildings

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

Micro-Generation & Related Energy Technologies in Buildings

Project duration: 2009 - 2013

Given the rapidly increasing numbers of micro-cogeneration installations around the world there is the pressing need for further research to enable informed choices to be made on where and when the installation of micro-cogeneration is appropriate. The previous ECBCS project 'The Simulation of Building-Integrated Fuel Cell and Other Cogeneration Systems' undertook work on the modelling of fuel cells and other micro-cogeneration systems and proved to be highly successful in terms of its research achievements. However, resource and time restrictions limited the scope of its activities, and consequently substantial research opportunities remain. The current project is undertaking work following on from the previous ECBCS project, although the focus is shifted from model development and experimentation towards a more expansive analysis of micro-generation and associated technologies. The scope of activities will encompass:

- multi-source micro-cogeneration systems, polygeneration systems (i.e. integrated heating / cooling / power generation systems) and renewable hybrid systems (collectively termed micro-generation);
- the integration of micro-generation, energy storage and demand side management technologies at a local level (integrated systems);
- customised and optimum control strategies for integrated systems;
- analysis of integrated systems performance when serving single and multiple residences along with small commercial premises;
- analysis of the wider effects of micro-generation on the power distribution system.

Research areas

- Simulation studies of integrated micro-generation systems operating in many different situations will be carried out to create an extensive portfolio of performance studies, which will include 'optimised' systems demonstrating the potential of the technology. The performance assessments will be synthesised with a view to developing general guidelines on the effective deployment of micro-generation to inform a wide stakeholder audience including investors, technology developers and all levels of government.
- To support the simulation studies the development of new models (including battery storage and demand side management) will be undertaken using data from field trials and laboratory tests on up-to-date devices and systems. Algorithms will be developed and tested for the optimum control of micro-generation systems, featuring single and multiple energy sources. Moreover, collection of data relating to electrical and hot water loads will also be undertaken.
- Market diffusion strategies for the mass deployment of micro-generation-related technologies will be developed. This activity will be informed by a regulatory and market review along with data emerging from the technical analysis.

"Market diffusion strategies for the mass deployment of micro-generation-related technologies will be developed"

Expected Outcomes

- An update on occupant related DHW and electric load profiles
- Component models and their implementation in building simulation tools
- Review of best practice in the operation and control of integrated micro-generation systems
- Control algorithms to maximize the performance and value of micro-generation
- Experimental data sets for the calibration and validation of device models
- Performance assessment methodologies
- Country specific studies on the performance of a range of micro-generation systems
- Studies of the viability of micro-generation systems in different operational context and of the impacts of micro-generation on the wider community and the potential benefits, in particular for the electricity network
- An investigation of interactions between technical performance and commercialization / regulatory approaches for micro-generation
- Compilation of case studies of the introduction of micro-generation technologies

Meetings

Two preparatory teleconferences were held in July and October 2009.

Operating Agent: Evgueniy Entchev, CANMET Energy Research Centre, Natural Resources Canada

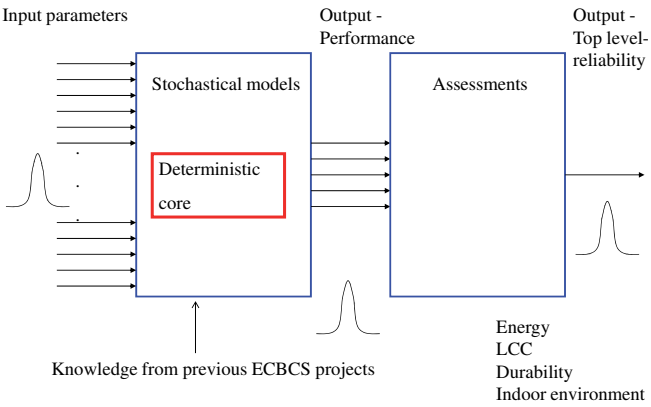
Participating Countries (provisional): Belgium, Canada, P.R.China, Denmark, Finland, Germany, Italy, Japan, The Netherlands, Norway, Switzerland, UK, USA

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

Project duration: 2010 - 2014

Nowadays energy and durability issues are worldwide some of the most important topics. Even though considerable progress has been achieved concerning new buildings (low energy, passive houses, zero energy and so on) and advanced building services, the building sector still accounts for the largest share of CO_2 emissions (including emissions associated with electricity use in buildings). The percentage of the total energy used in non-industrial buildings varies from country to country and ranges between 30% to 50%. In many developed countries, new buildings are made every year corresponding to approximately 1% of the existing building stock, while often more than 50% of the building stock dates from before the first energy crisis in the seventies. Hence, a large potential for energy savings - and consequently a large reduction of greenhouse gas emissions - is presently available in the existing building stock.

Retrofit measures is therefore of utmost importance for upgrading the building stock. Many consumers are only interested in the first cost and it is rare that life-cycle thinking is required. Looking at actual risks that are taken, both in performance and cost, will highlight the need for life cycle thinking and support the demand for methods and demands in this area. Probability assessment in life-cycle economy of solutions supports sound decision making relating to investments. Customer relationship is based on future expectations and confidence; this will be supported by proper probability assessment.



The project will contribute towards the dissemination of improved methods and tools for integrated evaluation and optimization of retrofitting measures, including energy efficiency, life cycle cost and durability. It will demonstrate to decision makers, designers and end users the benefits of the renewal of the existing building stock and how to make reliable solutions. Probability assessment supports the development of robust solutions without surprises. The RAP-RETRO mission is to answer the following question:

> *How do we design and realize robust retrofitting with low energy demand and life cycle costs, while controlling risk levels for performance failure?*

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

- Develop knowledge and tools that support the use of probability based design strategies in retrofitting of buildings to ensure that the anticipated energy benefits can be realized. The intention is to give reliable information about the true outcome of retrofitting measures regarding energy use, cost and functional performance.
- Develop a common framework for probabilistic assessment of energy retrofitting measures.
- Develop and validate probabilistic tools for energy use, life cycle cost and hygrothermal performances.
- Collect and analyze data in order to create stochastic data sets.
- Apply and demonstrate probabilistic methodology on (at least) five real life case studies, with a focus on residential buildings.

"How do we design and realize robust retrofitting with low energy demand and life cycle costs, while controlling risk levels for performance failure?"

Meetings

A start-up meeting took place in March 2009 in Gothenburg, Sweden, which gave a good basis for planning the project.

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

Participating Countries (provisional): Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Japan, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, UK, USA

Ongoing Research Projects

Air Infiltration & Ventilation Centre

Integrating Environmentally Responsive Elements in Buildings

Energy Efficient Future Electric Lighting for Buildings

Holistic Assessment Toolkit on Energy Efficient Retrofit Measures for Government Buildings

Cost Effective Commissioning of Existing & Low Energy Buildings

Heat Pumping & Reversible Air Conditioning

Low Exergy Systems for High Performance Buildings & Communities

Prefabricated Systems for Low Energy Renovation of Residential Buildings

Energy Efficient Communities

Towards Net Zero Energy Solar Buildings

Total Energy Use in Buildings: Analysis & Evaluation Methods

Air Infiltration & Ventilation Centre

Project duration: 1979 - present

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

The popular annual conference provides an opportunity for researchers and practitioners from around the world to exchange ideas and present their latest findings. The proceedings and conference report are available at the AIVC website.

The present operating period for the Air Infiltration and Ventilation Centre will end in May 2010. There is clearly a need for further international collaboration on energy efficient building ventilation, but it is proposed to have a more focused approach and a fundamental change in operational mode.

New Products in 2009

- **New Ventilation Information Papers**
  VIP 31 Humidity controlled exhaust ventilation in moderate climates
- **Technical Reports**
  TN 65 Recommendations on Specific Fan Power and Fan System Efficiency, 2009
- **Contributed Reports**
  CR 12 Indoor air quality in French dwellings
- **AIVC Conference Proceedings**
  30th Annual Conference 'Trends in High Performance Building and the role of Ventilation', held 1st - 2nd October 2009, Berlin, Germany
- **AIVC Newsletter: 'Air Information Review'**
  March 2009, June 2009, September 2009, December 2009

The website (**www.aivc.org**) is regularly updated.

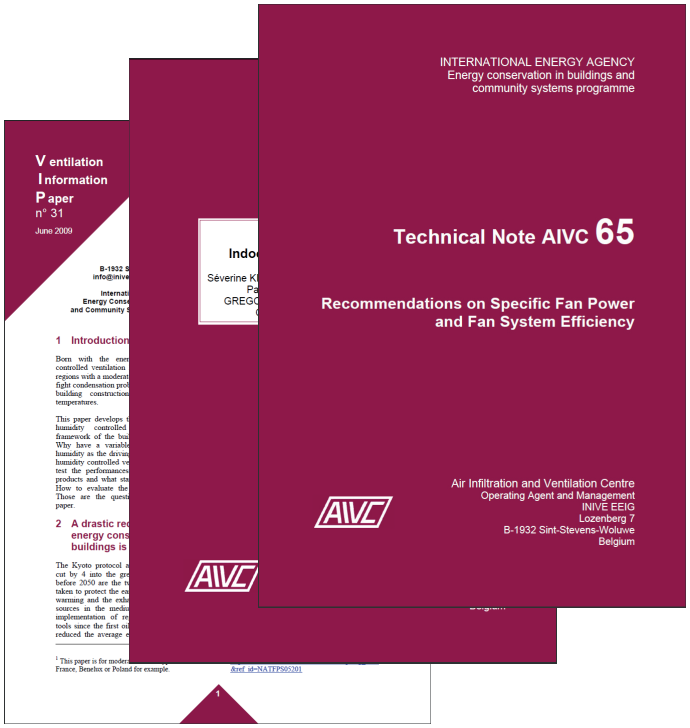
Meetings

A workshop on the topic of "Trends in national markets for summer comfort and cooling" was held in Barcelona, Spain, in March 2009 and "Trends in national markets regarding compliance with regulations" was held in Brussels, Belgium, in September 2009. The second workshop was focused on the impact, compliance and control of energy legislation.

The 30th AIVC Conference was held in October, 2009 in Berlin, Germany in conjunction with the International Conference on Building and Ductwork Airtightness.

Operating Agent: Peter Wouters, INIVE eeig

Participants: Belgium, Canada, Czech Republic, Denmark, France, Greece, Japan, Republic of Korea, Netherlands, Norway, USA

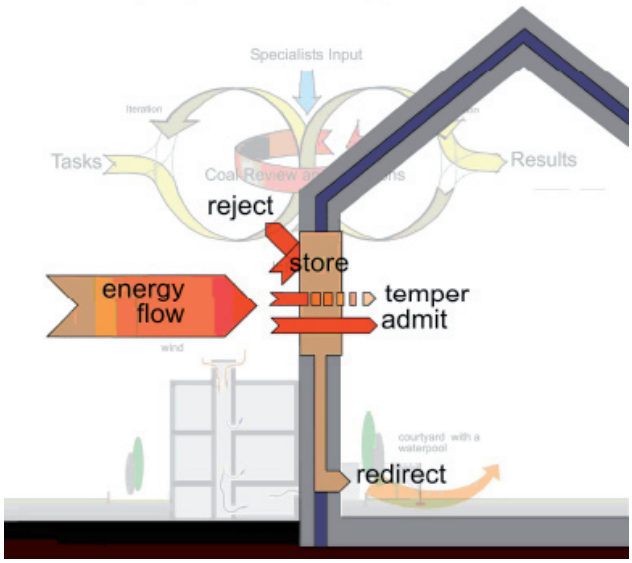


Integrating Environmentally Responsive Elements in Buildings

Project duration: 2004 - 2009

Energy usage for room heating, cooling and ventilation still accounts for more than one third of the total, primary energy demand in the industrialised countries. To successfully achieve the targets set out in the Kyoto protocols it is necessary to identify innovative energy technologies and solutions for the medium and long term which facilitates the implementation and integration of low carbon technologies, such as renewable power generation devices within the built environment. Deployment of low carbon technologies still faces major barriers in the built environment especially in relation to costs, building logistics, technological challenges, lack of understanding and knowledge and absence of requisite skills. Moreover, there is worldwide growing concern about the type of energy used for different purposes.

The greatest future potential lie with technologies that promote the integration of responsive building elements with the building services and renewable energy systems. Responsive in this context means ability to dynamically adjust physical properties and energetic performance according to changing demands from indoor and outdoor conditions. This ability could pertain to energy capture (as in window systems), energy transport (as air movement in cavities), and energy storage (as in building materials with high thermal storage capacity). With the integration of responsive building elements, building services and renewable energy systems, building design completely changes from design of individual systems to integrated design of responsive building concepts, which should allow for optimal use of natural energy strategies (daylight, natural ventilation, passive cooling, etc.) as well as integration of renewable energy devices.



"The greatest future potential lie with technologies that promote the integration of responsive building elements with the building services and renewable energy systems."

The objectives of the project are to collect information about the performance of buildings that utilize responsive building systems, improve and optimise such system and address the following objectives:

- Define state-of-the-art of responsive building elements
- Improve and optimise responsive building elements and technologies
- Develop and optimise new building concepts with integration of responsive building elements, building services as well as natural and renewable energy strategies
- Develop tools for the early assessment of the impact of responsive building elements on the environmental performance of buildings
- Develop guidelines for procedures and tools for detailed simulation of environmental performance of responsive building elements and integrated building concepts

The official publications for this project are:

- **State of the Art Report** of responsive building elements, integrated buildings concepts and integrated design methods and environmental performance assessment tools (aimed at researchers)
- **Experts' Guide Part 1,** giving detailed information regarding design and analysis of responsive building elements, integration strategies of responsive building elements and HVAC systems and optimum use of simulation methods and tools to assess environmental performance and robustness of integrated building concepts (aimed at engineers)
- **Experts' Guide Part 2**, for the development, optimisation and performance assessment of responsive building elements including examples of application in integrated building concepts (aimed at manufacturers and engineers)
- **Basic Design Guide**, describing the principles of responsive building elements and HVAC systems (aimed at architects, building owners, developers and end users)

Operating Agent: Per Heiselberg, Aalborg University

Participating Countries: Austria, Canada, China, Denmark, France, Italy, Japan, Norway, Portugal, Sweden, Netherlands, UK, USA

Energy Efficient Future Lighting for Buildings

Project duration: 2004 - 2009

This project is known as 'E^3 Light'. The 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.

Interesting aspects of desired lighting are energy savings, daylight use, individual control of light, quality of light, emissions during life cycle and total costs. The demands for the new light sources are: higher efficiency, ecological, lower costs, better light quality, longer lifetime, suitability for dimming, control and other value added features. Objectives of the project are:

- Identify and accelerate the use of energy efficient high-quality lighting technologies and their integration with other building systems
- Assess and document the technical performance of existing and future lighting technologies
- Assess and document barriers preventing the adoption of energy efficient technologies and propose means to resolve these barriers.

The final report will be a **Guidebook on Energy Efficient Lighting**. The Guidebook will be available as a printed version (Summary Report), CD version and on the internet. This will include chapters on:

- Lighting Energy in Buildings
- Lighting Quality Criteria
- Lighting and Energy Standards and Codes
- Lighting Design
- Lighting Technologies
- Lighting System Control
- Commissioning of Lighting Systems
- Case Studies
- Technical Potential for Energy Efficient Lighting and Savings
- Proposals to Upgrade Recommendations and Codes

"Interesting aspects of desired lighting are energy savings, daylight use, individual control of light, quality of light, emissions during life cycle and total costs."

Recent Published Papers

Papers related to this project have been presented at various conferences, workshops and journals. The following papers have been published in 2009:

- Halonen, Tetri: Needs and challenges for energy efficient lighting in developed and developing countries. Light & Engineering, Vol. 17, No. 1, pp.5-10, 2009
- Halonen, Tetri: Lighting Efficiency and LED Lighting Applications in Industrialized and Developing Countries. The 5th International Conference ILUMINAT 2009, Sustainable Lighting. Cluj-Napoca, Romania, 20 February 2009
- Newsletter 9, May 2009

Operating Agent: Liisa Halonen, Helsinki University of Technology

Participating Countries: Australia, Austria, Belgium, Canada, China, Finland, France, Germany, Italy, Japan, Netherlands, Norway, Poland, Sweden, Switzerland, Turkey, UK, USA

Observers: Russia and Singapore

Holistic Assessment Toolkit on Energy Efficient Retrofit Measures for Government Buildings

Project duration: 2005 - 2009

Research has shown that many government buildings are characterised by high energy consumption. Since government buildings are constructed similarly in many countries, experience gained with retrofitting such buildings with energy saving technologies should be widely applicable on an international scale.

Older, energy inefficient buildings represent about 80% of the building stock. Therefore, this project focuses exclusively on the energy retrofit in selected building categories that represent a substantial part of the non-residential building stock: office / administrative buildings, large one-story production facilities, and maintenance shops. Though the focus is on Government buildings, many results can be applied to similar private sector buildings. The objectives of this project are:

- Provide tools and guidelines for decision makers and energy managers, performance contractors and designers;
- Improve the working environment of government buildings through energy-efficient retrofitting projects;
- Provide recommendations on how to operate the retrofitted buildings;
- Promote energy- and cost-efficient retrofit measures by providing successful examples;
- Support decision makers in evaluating the efficiency and acceptance of available concepts;
- Find improved ways of using Energy Performance Contracts (ESPC's) for government buildings retrofit measures.

Products

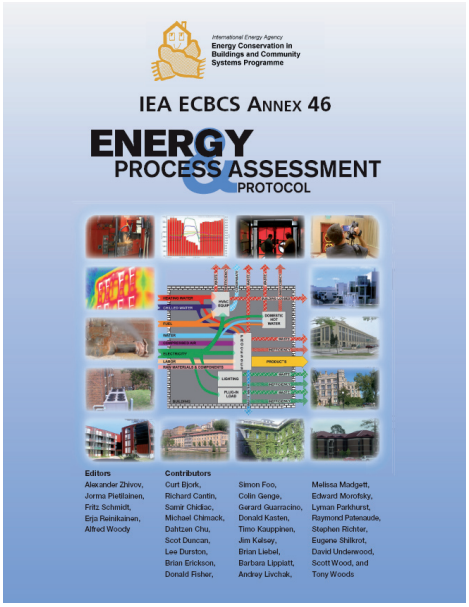
The products of this project will be as follows:

- **Energy Assessment Guide** for Energy Managers and ESCOs, and results of pilot studies conducted to apply and test the Guide
- A database of **'Energy Saving Technologies and Measures for Government Building Retrofits'**, with technology description, results of the screening analyses and case studies.
- **Best Practice Guidelines** for innovative energy performance contracts
- **IT Toolkit 'EnERGo'** – an electronic source book, to be supplemented by guidelines, best practice and case studies. A database will include all project results and will allow users to obtain extensive information, according to their individual focus of interest: energy saving opportunities, design inspirations, design advice, decision tools, design tools, commissioning methods, long-term monitoring systems, and measures that require no financial investment.

Progress

The final draft of the **Best Practice Guidelines for Using Energy Performance Contracts to Improve Government Buildings** report was completed in 2009.

The **Energy and Process Assessment Protocol** was published in 2009 and a 'beta version' of the electronic version was being finalized and incorporated in



the IT Tool-kit **Energy Efficient Retrofit for Government Buildings 'EnERGo'**. For the electronic version a special online database has been compiled supporting searching, sorting, viewing and selection of energy conservation measures. Case studies have been added and the new database for the energy conservation measures is now integrated.

Meetings

In 2009 three Experts' Meetings took place and were hosted by McMaster University, Canada in October 2009, by Engineer Research And Development Center (ERDC) and Construction Engineering Research Laboratory (CERL), USA (January 2009), and VTT (St. Petersburg, Russia, 2009). All Experts' Meetings were preceded by major workshops.

Operating Agent: Alexander Zhivov, Energy Branch US Army Corps of Engineers

Participating Countries: Canada, Denmark, Finland, France, Germany, Italy, UK, USA

Observer: Russia

Cost Effective Commissioning of Existing & Low Energy Buildings

Project duration: 2005 - 2009

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 optimised based on actual use and occupancy rather than using only the information available to the designer.

Commissioning methods and tools are required to ensure that advanced components and systems reach their technical potential and operate energy efficiently. Likewise, commissioning methods and tools should strive to improve the energy efficiency of conventional and advanced existing buildings beyond just the design intent. 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. 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.

"Commissioning methods and tools are required to ensure that advanced components and systems reach their technical potential and operate energy efficiently. "

The goal of this project is to enable the effective commissioning of existing and future buildings in order to improve their operating performance. 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 project will also exchange information on commissioning practices in different countries and disseminate relevant information to national practitioners.

Design, construction, commissioning, and operation and maintenance are typically done by different people and even different companies. By changing the players within a project, knowledge that would be helpful or even important for future tasks is often lost. Due to the difficulty of maintaining consistent information representation, not all data available in the previous phase is made available when transitioning to subsequent phases. Design intent information is no longer kept in working drawings and design specifications, the complete design specifications are no longer available in the commissioning report, and O&M manuals rarely contain information about the insights gained during commissioning. Therefore, information rapidly atrophies during these transition points (e.g., 'Real scope of information') and has to be subsequently recovered. The objectives of this project are to:

- Extend existing methods and tools to address advanced systems and low energy buildings, utilizing design data and the buildings' own systems in commissioning.
- Automate the commissioning process to the extent practicable.
- Develop methodologies and tools to improve the operation of buildings in use.
- Quantify and improve 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 key outputs of this project include:

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

Progress

The reports on **Commissioning Overview** and **Commissioning Tools for Existing and Low Energy Buildings** are being prepared ready for publication. The drafts of the reports on **Commissioning and Persistence Database** and **Flow Charts and Data Models for Commissioning Advanced and Low-Energy Buildings** have been reviewed.

Meetings

The 8th project meeting took place in Ottawa in Canada in May 2009 and a workshop was held to focus on testing of self-configuring control systems in the HVAC domain.

Operating Agent: Daniel Choinière and Natascha Milesi-Ferretti

Participating Countries: Belgium, Canada, Czech Republic, Finland, France, Germany, Hong Kong / China, Japan, Netherlands, Norway, USA

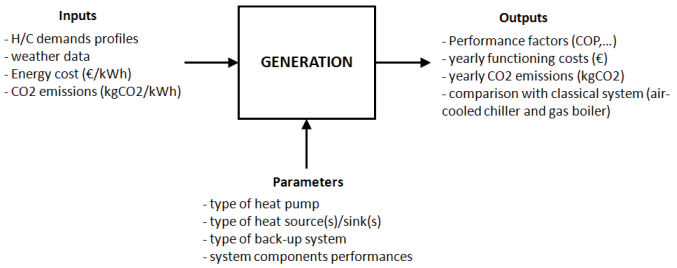
Observer: Hungary

Heat Pumping & Reversible Air Conditioning

Project duration: 2005 - 2009

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 a part 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 carbon dioxide emissions. The aim of this project is to promote the best heat pumping techniques applicable in air conditioning of commercial buildings. Focus is given to the integration of these techniques inside the whole air conditioning system. Specific objectives include:

- This project aims to make air conditioning as reversible as possible.
- It intends to make the best use of the currently available technology.
- Technological information already gathered in previous ECBCS, SHC and HPP projects will be extensively used.
- 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 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 research areas:

- Analysis of building heating and cooling demands and equipment performances;
- Performance analysis and comparisons among the different components and systems available;
- Design;
- Global performance evaluation and commissioning methods;
- Case studies and demonstrations;
- Dissemination.

“A Design Guide ... provides information how to optimise the whole HVAC and heat pump system.”

Four deliverables are expected from this project:

- An **Identification Tool, Typification and Selection Guide**, which helps to make a rational choice between existing HVAC technologies, in view of the most efficient combination of heat and cold production.
- A **Design Guide**, which provides information how to optimise the whole HVAC and heat pump system.
- A **Commissioning and Optimal Operation Guide**, which helps designers, installers and operators in running the system in optimal conditions, in verifying actual performances, in detecting all possible malfunctions and in making correct maintenance.
- **Documented Case Studies**. These case studies are proposed as references and illustrations on how to use the other deliverables. Successful case studies will be usable as demonstration projects.

Progress

The report on analysis of building heating and cooling demands for the purpose of assessing the heat recovery and reversibility potentials has been submitted for final review.

The final version of a review of heat recovery and heat pumping solutions and a draft of assessment tools report were scheduled for December 2009.

Meetings

The 6th Experts Meeting took place in Torino in April 2009 and was preceded by the 2nd Workshop. The 7th Expert Meeting of this working phase was hosted by Ecole des Mines de Paris, in October 2009.

Operating Agent: Jean Lebrun, Université de Liège

Participating Countries: Belgium, China, France, Germany, Italy, Switzerland

Low Exergy Systems for High Performance Buildings & Communities

Project duration: 2005 - 2009

The main objective of this project is to develop concepts for reducing the exergy demand in the built environment, thus reducing the CO_2-emissions of the building stock and supporting structures for setting up sustainable and secure energy systems for this sector. Specific objectives are to:

- Use exergy analysis to develop tools, guidelines, recommendations, best-practice examples and background material for designers and decision makers in the fields of building, energy production and politics
- Develop cost-efficient energy / exergy measures for retrofit and new buildings, such as dwellings and commercial / public buildings
- Develop exergy-related performance analysis of the buildings as seen from a community level

The project is based on an integral approach which includes not only the analysis and optimisation of the exergy demand in the heating and cooling systems but also all other processes where energy/exergy is used within the building stock. In order to reach this aim, the project works with the underlying basics, i.e. the exergy analysis methodologies. These work items are aimed at development, assessment and analysis methodologies, including a tool development for the design and performance analysis of the regarded systems. With this basis, the work on exergy efficient community supply systems focuses on the development of exergy distribution, generation and storage system concepts. For the course of the project, the generation and supply is as interesting as the use of energy/exergy. As a result, the development of exergy efficient building technology depends on the reduction of exergy demand for the heating, cooling and ventilation of buildings.

Tools for Exergy Analysis

To bring the application of the exergy concept within the built environment closer to the broader public, the following tools are being developed:

- A simplified Excel-based tool for steady-state exergy analysis of different building heating systems. The tool is focussed at the building level and allows the combination of several building systems to be analyzed, giving an idea of their exergy performance and suitability in providing heating demands.
- Several models for the dynamic analysis of building systems have also been developed in TRANSYS code. Although compiled into a tool, the models can be combined as modules, allowing for the evaluation of a great variety of building systems.
- A simplified exergy evaluation model has been implemented into the REVIT building design environment. So an evaluation from a CAD drawing of a building is possible
- A simplified tool, also Excel based, is being developed for analyzing exergy performance energy supply structures at the community level. This is meant as a help to municipalities and decision makers involved in the community design process in the planning of optimized energy supply structures. With the help of this tool, a quantitative and qualitative view on potential improvements in such structures can be gained.

Progress

State of the Art Report, **Low Exergy Systems for High-Performance Building and Communities, A framework for exergy analysis at the building and community level** was published in 2009. The report includes an introduction into the use of the exergy concept for the particular case of buildings and building system`s analysis. Particular emphasis is given to the exergy analysis of renewable energy systems for the heating and cooling of buildings. The main outcomes from an extensive literature review on this issue are also included. Finally, several case studies designed according to the LowEx principles, both at community and building levels are presented.

Meetings

In April 2009 ‘The Future for Sustainable Built Environments - Integrating the Low Exergy Approach’ Conference was held in Heerlen, the Netherlands. It was a joint activity with the European COSTeXergy Action. The focus of the conference was the future of sustainable build environments and on providing front-edge results on the field of exergy analysis of buildings and communities. The 5th working phase meeting in April 2009 was hosted by Cauberg-Huygen RI in Maastricht (The Netherlands). The 6th working phase meeting in September 2009 was hosted by VTT Finland and held in Espoo (Finland).

Operating Agent: Dietrich Schmidt, Fraunhofer-Institute for Building Physics, Project Group Kassel

Participating Countries: Austria, Canada, Denmark, Finland, Germany, Italy, Japan, Poland, Sweden, Switzerland, Netherlands, USA

Prefabricated Systems for Low Energy Renovation of Residential Buildings

Project duration: 2006 - 2010

Energy conservation is largely dominated by existing buildings. In most industrialized countries new buildings will only contribute 10% - 20% additional energy consumption by 2050 whereas more than 80% will be influenced by the existing building stock. If building renovation continues at the current rate and with the present common policy, we will need between 100 and 400 years to improve the building stock to the energy level of today's new construction.

"... establish optimised renovation solutions that will reduce the energy consumption by a factor of 5 to 10 ..."

Currently, most building renovations address isolated building components, such as roofs, façades or heating systems. This often results in inefficient, and in the end expensive solutions, without an appropriate long-term energy reduction. Optimal results cannot be achieved by single renovation measures and new problems can arise, including local condensation or overheating. Currently, most building renovations are neither cost effective nor energy effective. This project aims to standardise and prefabricate building retrofits for efficiency and quality.

The project's objective is the development and demonstration of an innovative whole building renovation concept for typical apartment buildings. The aims of the project are to:

- Investigate and promote cost effective low energy renovation strategies for existing apartment buildings;
- Establish optimised renovation solutions that will reduce the energy consumption by a factor of 5 to 10 i.e. to less than 30 - 50 kWh/(m²·year);
- Achieve standardisation of construction details suitable for prefabrication at lower costs.

The focus is on typical apartment blocks, which represent approximately 40% of the European dwelling stock. One of the novel aspects of the project is the integration of a ventilation system into the façade construction. Innovative solutions are studied to integrate the piping system into the insulation layer and to apply vacuum insulation to compensate locally for the additional thermal loss. This concept avoids extensive construction work inside the building and makes it possible for the building to be inhabited during refurbishment.

A special area of the project is dealing with advanced geomatics using laser scanning to obtain an accurate three-dimensional picture of existing buildings.

The deliverables of the project are:

- **Building Renovation Guide** documenting typical solutions for whole building renovations, including prefabricated roofs with integrated HVAC components and for advanced facade renovation. The idea is to develop an electronic tool, a type of 'Retrofit advisor' that will allow an internet-based evaluation of suitable renovation strategies.
- **Guidelines for renovation module development** is a guide for system evaluation, design, construction process and quality assurance for prefabricated whole building renovation concepts.
- **Documentation of Renovated Demonstration** provides the case studies.
- **Project Summary Report** for a broad audience, demonstrating the potential of prefabricated retrofit.

Progress

- French and a Swiss building typology have been completed as Annex related national studies.
- **Renovation concept development** based on building typology is ongoing and the reporting phase has started. The final report of building simulations is being prepared.
- **Renovation module development** is mostly completed and focuses on façade, integration of ventilation, roofs and roof spaces. The documentation of this module development is ongoing.
- The investigations on **3-D laser scanning** are completed and the final report is now being prepared.
- **Eight demonstration projects** in Austria and Switzerland are completed; further demonstration projects are ongoing in Sweden and Switzerland.
- The **Retrofit Advisor** has been further developed based on the Swiss building typology with default values available for 9 building types and for various renovation scenarios.

Meetings

The 5th working meeting took place in April 2009 in Grenoble, France. The 6th working meeting was held in Haarlem, Netherlands, October 2009 in conjunction with the IEA Solar Heating and Cooling Programme's Task 37, "Advanced Housing Renovation by Solar and Conservation" final meeting and conference in Antwerpen.

Operating Agent: Mark Zimmermann, Empa

Participating Countries: Austria, Czech Republic, France, Netherlands, Portugal, Sweden, Switzerland

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

Project duration: 2007 - 2011

This area of research is topical at the moment as in several countries public programs on energy politics in communities have either been established recently, or are in preparation. A strong increase of interest in sustainability issues is currently apparent in community administrations as a result of pressure from both national and urban politics. Consequently ambitious targets for the reduction of CO_2 emissions are often set by communities, but with a limited understanding of the means to achieve them. Often the technology is in place, but difficulties are caused by:

- Insufficient know-how on strategic planning,
- Insufficient management ability during the implementation process, and
- Insufficient availability of tools and instruments for decision making, planning and monitoring.

The project aims to provide a practical guide for urban planners, decision makers and stakeholders on how to achieve ambitious energy and carbon dioxide reduction targets on a local and urban scale. Addressing small units such as neighbourhoods or quarters, and towns or cities as well, the project aims to provide urban administrations, urban planners and other urban stakeholders with the necessary knowledge and means to be able to define reasonable goals in terms of energy efficiency, energy conservation and greenhouse gas abatement at the community level.

Local decision makers and stakeholders are primarily addressed by this project, rather than energy planners. Hence the legal frameworks and different approaches found within the participating countries will be discussed according to their comparable suitability to enable innovative approaches for successful urban energy policies.

Research Areas

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

"The project aims to provide a practical guide for urban planners, decision makers and stakeholders on how to achieve ambitious energy and carbon dioxide reduction targets on a local and urban scale."

Deliverables

- Guidebook to Successful Urban Energy Planning based on the findings of the state of the art review, and an evaluation of the case studies, and presented in a way that users will be able to apply the guidebook directly to their own work. Aimed at decision makers in urban administrations, developers and urban planners.
- Community Energy Concept Adviser is a computer-based tools to support municipal administrations and urban planners faced with evaluating and monitoring tasks will be considered with respect to their capability and usability.

Progress

Work on case studies on energy planning and implementation strategies for neighbourhoods, quarters and municipal areas has been started in August 2009 by preparing a Case Study questionnaire and an evaluation plan.

A website for the project as set up providing initial information on the project purposes and participants and a first newsletter. In parallel, work on the District Energy Concept Adviser (D-ECA) has been started. A first proposal on the Guidebook to Successful Urban Energy Planning content was presented in October 2009.

Meetings

The work plan definition Workshop was held in February 2009 in Karlsruhe, Germany. The kick-off meeting was organized by SenterNovem in April 2009 in Sittard, Netherlands. The 2nd Experts Meeting took place in Bad Aibling, Germany, in October 2009 and was preceded by Workshop on community energy systems modelling.

Operating Agent: Reinhard Jank, Volkswohnung GmbH

Participating Countries: Austria, Canada, Denmark, Finland, France, Germany, Japan, Netherlands, Sweden, Switzerland, USA

Towards Net Zero Energy Solar Buildings

Project duration: 2008 - 2013

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

Thus, this joint project with the IEA Solar Heating and Cooling Programme has been initiated to study current net-zero, near net-zero and very low energy buildings and to develop a common understanding, a harmonised international definitions framework, tools, innovative solutions and industry guidelines. To achieve this objective the project will document and propose practical NZEB demonstration projects.

The planned outcome is to support the conversion of the NZEB concept from an idea into practical reality in the marketplace.

"... what is missing is a clear definition and international agreement on the measures of building performance that could inform 'zero energy' ... "

The project will cover major building types (both residential and non-residential), new and existing, for the climatic zones represented by the participating countries.

Research Areas

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

Net Zero Energy Buildings Database

A database is under development to profile net zero energy residential and commercial buildings from around the world, including buildings that were designed to be zero energy and those that actually achieve zero energy. The database is being expanded and interested parties are invited to submit their zero energy residential or commercial building to be included. This will form part of the US Department of Energy's Energy Efficiency and Renewable Energy High Performance Buildings Database, which covers many other projects.

Progress

- Work on a literature review, conducting a survey of definitions and listing projects that meet the definitions, as well as assessing the definitions using some selected projects has been ongoing.
- An online survey of NZEB and low energy building design tool for near or net-zero energy buildings have been conducted.
- Preliminary work has been done on the benchmarking to evaluate the capabilities of tools used to design low energy buildings and or net zero energy solar buildings.
- A buildings data template has been developed to document the top NZEB projects of the participating countries (using agreed definitions) and relevant technical and no-technical information collected to form the database and provide a common basis for comparison of NZEBs between countries.

Meetings

The 1st Experts Group Meeting was held in Montreal, Canada in May 2009. The 2nd Experts Group Meeting in Wuppertal, Germany.

Operating Agent: Josef Ayoub, CANMET ENERGY, Natural Resources Canada

Participating Countries: Austria, Belgium, Canada, Denmark, Finland, Germany, Italy, Republic of Korea, Norway, Switzerland, USA

Participating Countries (to be confirmed): Australia, France, Netherlands, New Zealand, Portugal, Sweden, UK

Total Energy Use in Buildings: Analysis & Evaluation Methods

Project duration: 2008 - 2012

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

- climate,
- building envelope,
- building services and energy systems,
- building operation and maintenance,
- occupants' activities and behaviour, and
- indoor environmental quality provided.

Current research focuses mainly on the first three factors (climate, building envelope, building services and energy systems), however the latter three factors, related to human behaviour, can have an influence as great as or greater than the former three ones. Detailed comparative analysis on building energy data, concerning the six factors mentioned above, would provide essential guidance in identifying energy saving potentials and opportunities.

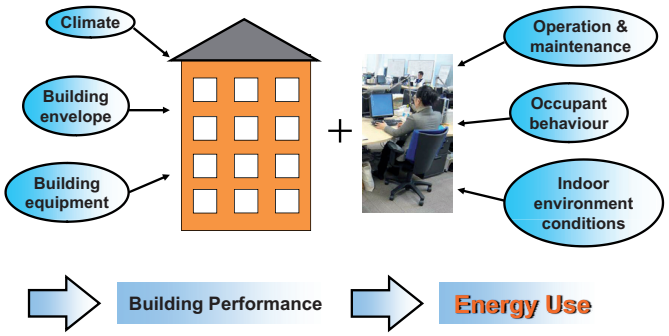
The project is working to improve understanding of how the six factors combine to influence building energy use, with particular emphasis placed on occupant behaviour. It also aims to improve the treatment of these factors within the building energy field, and to more closely relate this to the real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

Deliverables

- Definitions of terminology, indicators and influencing factors for building energy use
- Case studies of energy end use in buildings
- Demonstration of measurement and data acquisition technologies for long term monitoring - planned to be an on-line database
- Illustration of the relationship between the characteristics of the database and the statistical / prediction methods that are best suited to the aims of the analysis
- Methodologies with presentation of case studies
- A methodology for analysis of the effect of the six directly influencing factors on building energy use, by end use
- Demonstrations of the effect of energy saving technologies and occupants' behaviour and lifestyle changes on energy use

Progress

- **Definition and reporting** - A list of items needing definitions has been developed. A comprehensive set of definitions has been agreed.
- **Case Studies and Data Collection** - The cases to be examined under a variety of occupant behaviour patterns have been selected.
- **Statistical Analysis** - Review and analysis of available databases are ongoing. The databases for total energy use in large building samples at global, national, regional level have been selected, as well as the use in individual buildings.
- **Energy Performance Evaluation** - Review and development of analytical models are being conducted with some models already showing good agreement with measured data and so can be used for evaluating the influencing factors.



Meetings

The 1st Experts Group Meeting was held in Liege, Belgium in February 2009, the 2nd Experts Group Meeting was held in Turin, Italy in May 2009 and the 3rd Experts Group Meeting was held in Nanjing, China in November 2009.

Operating Agent: Hiroshi Yoshino, Tohoku University, Japan

Participating Countries: Austria, Belgium, China, Denmark, France, Italy, Japan, Norway, USA

Participating Countries (to be confirmed): Canada, Finland, Netherlands

Past Projects

- Load Energy Determination of Buildings
- Ekistics and Advanced Community Energy Systems
- Energy Conservation in Residential Buildings
- Glasgow Commercial Building Monitoring
- Energy Systems and Design of Communities
- Local Government Energy Planning
- Inhabitants Behaviour with Regard to Ventilation
- Minimum Ventilation Rates
- Building HVAC System Simulation
- Energy Auditing
- Windows and Fenestration
- Energy Management in Hospitals
- Condensation and Energy
- Energy Efficiency in Schools
- BEMS 1- User Interfaces and System Integration
- BEMS 2- Evaluation and Emulation Techniques
- Demand Controlled Ventilation Systems
- Low Slope Roof Systems
- Air Flow Patterns within Buildings
- Thermal Modelling
- Energy Efficient Communities
- Multi Zone Air Flow Modelling (COMIS)
- Heat, Air and Moisture Transfer in Envelopes
- Real time HEVAC Simulation
- Energy Efficient Ventilation of Large Enclosures
- Evaluation and Demonstration of Domestic Ventilation Systems
- Low Energy Cooling Systems
- Daylight in Buildings
- Bringing Simulation to Application
- Energy-Related Environmental Impact of Buildings
- Integral Building Envelope Performance Assessment
- Advanced Local Energy Planning
- Computer-Aided Evaluation of HVAC System Performance
- Design of Energy Efficient Hybrid Ventilation
- Retrofitting of Educational Buildings
- Low Exergy Systems for Heating and Cooling of Buildings
- Solar Sustainable Housing
- High Performance Insulation Systems
- Building Commissioning to Improve Energy Performance
- Whole Building Heat, Air and Moisture Response
- The Simulation of Building-Integrated Fuel Cell and Other Cogeneration Systems
- Testing and Validation of Building Energy Simulation Tools

ECBCS & the IEA

The 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-eight IEA member countries and to increase energy security through energy conservation, development of alternative energy sources and energy research, development and demonstration (RD&D). The current framework for international energy technology RD&D co-operation was approved by the IEA's Governing Board in 2003.

More information about the energy technology RD&D framework can be found at: www.iea.org/textbase/techno/framework_text.pdf

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

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

In recognition of the significance of energy use in buildings, in 1977 the International Energy Agency 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 as 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.

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 buildings. Overall, these are aimed at reducing energy consumption by between 5% and 30%. To achieve such a target, international cooperation, in which research activities and knowledge can be shared, is seen as an essential activity.

In recognition of the significance of energy use in buildings, 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 as 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:

ECBCS & the IEA

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

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

- The environmental impacts of fossil fuels;
- Business process to meet energy and environmental targets;
- Building technologies to reduce energy consumption;
- Reduction of Green House Gas emissions;
- "Whole Building" performance approach;
- Sustainability;
- The impact of energy measures on indoor health, comfort and usability;
- The exploitation of innovation and information technology';
- Integrating changes in lifestyles, work and business environment.

Mission Statement

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

Nature of ECBCS Activities

- 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 involve a responsibility from each country to commit manpower.
- 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.
- 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.
- Information exchange: Information about associated activities is exchanged through the ECBCS and through individual Annexes. The ECBCS website (**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
- P.R. China
- Czech Republic
- Denmark
- Finland
- France
- Germany
- Greece
- Italy
- Japan
- Republic of Korea
- New Zealand
- The Netherlands
- Norway
- Poland
- Portugal
- Spain
- Sweden
- Switzerland
- Turkey
- United Kingdom
- United States of America

ECBCS & the IEA

Coordination with Other Bodies

In order to achieve high efficiency in the R&D programme and to eliminate duplication of work it is important to collaborate with other IEA 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 the IEA Energy End Use Working Party (EUWP) Vice Chair for Buildings and the Executive Committee Chairs of the following IEA research programmes:

- District Heating And Cooling (DHC)
- Demand Side Management (DSM)
- Energy Conservation in Buildings and Community Systems (ECBCS)
- Energy Conservation through Energy Storage (ECES)
- Heat Pumping Technologies (HPT)
- Photovoltaic Power Systems (PVPS)
- Solar Heating and Cooling (SHC)

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 that 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 programme seeks to cost-effectively reduce energy demand while the other seeks to meet a large portion of this demand by solar energy. The combined effect results in buildings that require less purchased energy, thereby saving money and conventional energy resources, and reducing 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 programmes are compatible in that both seek to reduce the purchased energy for buildings; one by making buildings more energy efficient and the other by using solar designs and technologies. Specifically, the missions of the two programmes are:

- 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 programme - to facilitate an environmentally sustainable future through the greater use of solar designs and technologies.

The two programmes structure their work around a series of objectives. Four objectives are essentially the same for both programmes. These are:

- Technology development via international collaboration;
- Information dissemination to target audiences;

ECBCS & the IEA

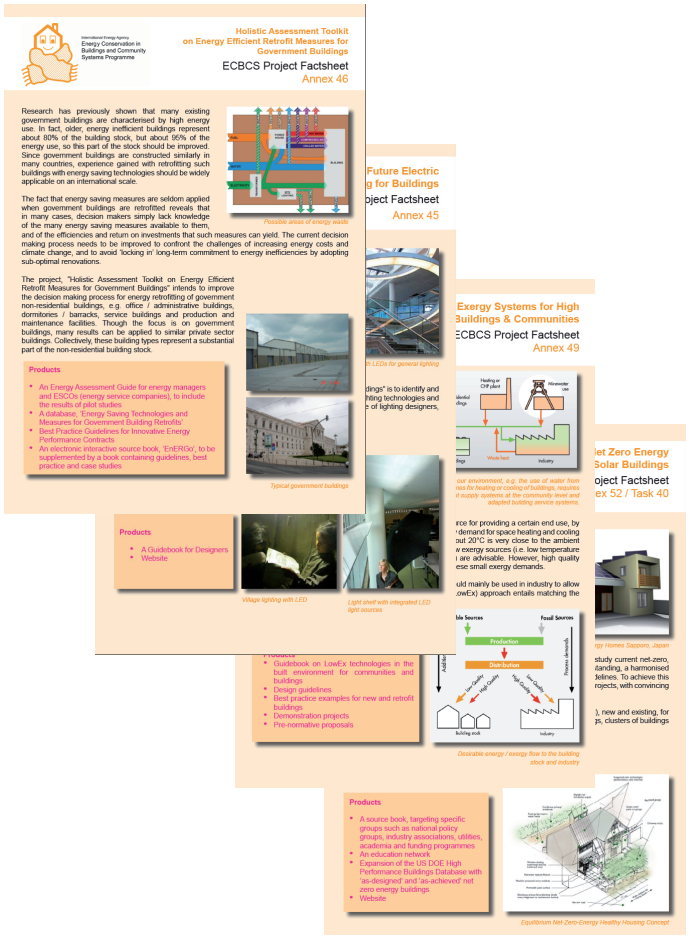
- Enhancing building standards;
- Interaction with developing countries.

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.

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), and
- The American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE).



- 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: A certain level of co-operation exists between the European Commission and ECBCS. The EC Framework Program sponsors research, primarily within the European Union. 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.

Latest Publications

Air Infiltration and Ventilation Centre

➲ Technical Notes

TN 65 Recommendations on Specific Fan Power and Fan System Efficiency 2009
TN 64 Ventilation in Korea 2008
TN 63 Ventilation in the Czech Republic 2008

➲ Contributed Reports

CR 12 Indoor air quality in French dwellings 2009
CR 11 Air Leakage of U.S. Homes: Model Prediction 2008
CR 10 Ventilation Behavior and Household Characteristics in New California Houses 2008

➲ Newsletters

AIR newsletter (published every 3 months)

➲ Annual AIVC Conference Proceedings

2009 Germany – Berlin, Trends in High Performance Buildings and the role of Ventilation
2008 Japan – Kyoto, Advanced building ventilation and environmental technology for addressing climate change issues

➲ Ventilation Information Papers

VIP 31 Humidity Controlled Exhaust Ventilation in Moderate Climate 2009
VIP 30 An overview of national trends related to innovative ventilation systems 2008
VIP 29 An overview of national trends in envelope and ductwork airtightness 2008
VIP 28 IAQ and ventilation efficiency with respect to pollutants inside automobiles 2008
VIP 27 Trends in the Czech building ventilation market and drivers for changes 2008
VIP 26 Trends in the Korean building ventilation market and drivers for changes 2008
VIP 25 Trends in the Japanese building ventilation market and drivers for changes 2008
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VIP 18 Trends in the Belgian building ventilation market and drivers for changes 2008
VIP 17 Trends in the building ventilation market in England and drivers for change 2008
VIP 16 Air quality in passenger aircraft 2008
VIP 15 Report of the 2nd European BlowerDoor Symposium 2008

Computer-Aided Evaluation of HVAC System Performance

➲ Technical Synthesis Report: Computer-Aided Evaluation of HVAC System Performance
➲ Demonstrating Automated Fault Detection and Diagnosis Methods in Real Buildings

Design of Energy Efficient Hybrid Ventilation (HYBVENT)

➲ Technical Synthesis Report: Control Strategies for Hybrid Ventilation in New and Retrofitted Office Buildings (HybVent)
➲ Hybrid Ventilation: State of the Art Report
➲ Principles of Hybrid Ventilation

Retrofitting of Educational Buildings

➲ Technical Synthesis Report: Retrofitting in Educational Buildings - Energy Concept Adviser for Technical Retrofit Measures
➲ Case Study Reports
➲ Energy Concept Adviser
➲ KULU – a tool for commissioning
➲ State of the Art Overview: Questionnaire Evaluations
➲ Overview of Retrofitting Measures
➲ Calculation Tools for the Energy Concept Adviser
➲ Energy Audit Procedures

Low Exergy Systems for Heating and Cooling of Buildings (LowEx)

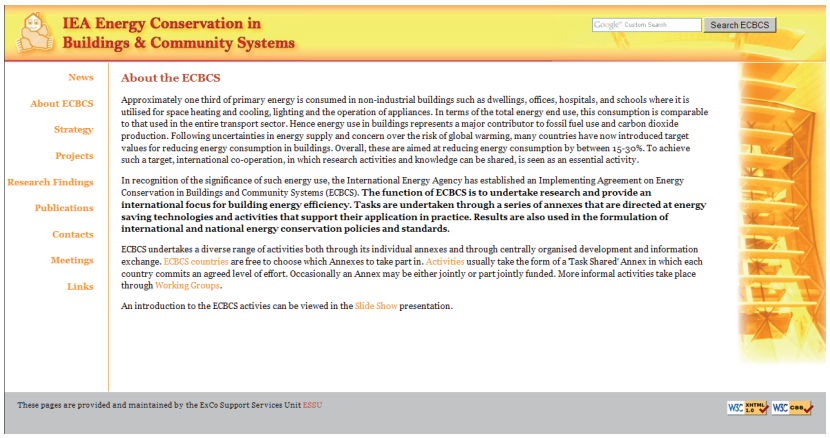
➲ Technical Synthesis Report: Low Exergy Systems for Heating and Cooling of Buildings
➲ Heating and Cooling with Focus on Increased Energy Efficiency and Improved Comfort – Guidebook to IEA ECBCS Annex 37 Low Exergy Systems for Heating and Cooling of Buildings
➲ Guidebook Summary Report
➲ Introduction to the Concept of Exergy - for a Better Understanding of Low-Temperature-Heating and High-Temperature-Cooling Systems
➲ Analysis Tool for the Exergy Chain (Excel Tool)

Solar Sustainable Housing

➲ Sustainable Solar Housing (2 volumes)
➲ Bioclimatic Housing: Innovative Designs for Warm Climates
➲ The Environmental Brief: Pathways for Green Design
➲ Business Opportunities in Sustainable Housing

Latest Publications

- A Marketing Guide Based on Houses in Ten Countries
- Exemplary Sustainable Solar Houses - a set of 40 Brochures



High Performance Insulation Systems

- Vacuum Insulation Panels: Study on VIP Components and Panels for Service Life Prediction of VIP in Building Applications
- Vacuum Insulation in the Building Sector: Systems and Applications
- Vacuum Insulation: Panel Properties and Building Applications - Summary
- High Performance Thermal Insulation Systems - Vacuum Insulated Products (VIP): Proceedings of the International Conference and Workshop
- Building Commissioning to Improve Energy Performance

Commissioning Tools for Improved Energy Performance

- Final Report
- Toolkit CD

Whole Building Heat, Air and Moisture Response (MOIST-ENG)

- Final Report Volume 1: Modelling Principles and Common Exercises
- Final Report Volume 2: Experimental Analysis of Moisture Buffering
- Final Report Volume 3: Boundary Conditions and Whole Building HAM Analysis
- Final Report Volume 4: Applications: Indoor Environment, Energy, Durability

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

- Review of Residential Cogeneration Technologies
- Methodologies for the Performance Assessment of Residential Cogeneration Systems
- Review of Existing Residential Cogeneration Systems
- Performance Assessments and Evaluations
- Residential Cogeneration Systems: A Review of the Current Technologies
- European and Canadian non-HVAC Electric and DHW Load Profiles for Use in Simulating the Performance of Residential Cogeneration Systems
- Specifications for Modelling Fuel Cell and Combustion-Based Residential Cogeneration Devices within Whole-Building Simulation Programs

Testing and Validation of Building Energy Simulation Tools

- In-Depth Diagnostic Cases for Ground Coupled Heat Transfer Related to Slab-on-Grade Construction
- Final Task Management Report - Testing and Validation of Building Energy Simulation Tools
- Empirical Validations of Shading / Daylighting / Load Interactions in Building Energy Simulation Tools
- Double Skin Facades: A Literature Review
- Empirical Validation of Building Simulation Software: Modelling of Double Facades

Integrating Environmentally Responsive Elements in Buildings

- Responsive Building Elements, Integrated Building Concepts and Environmental Performance Assessment Methods: State of the Art Review
- Expert Guide. Part 1 Responsive Building Concepts
- Expert Guide. Part 2 Responsive Building Elements

Holistic Assessment Tool-kit on Energy Efficient Retrofit Measures for Government Buildings

- Energy Process Assessment Protocol

Low Exergy Systems for High Performance Buildings and Communities

- Midterm Report

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www.ecbcs.org

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Total Energy Use in Buildings: Analysis & Evaluation Methods
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Reliability of Energy Efficient Building Retrofitting - Probability Assessment of Performance & Cost
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