International Energy Agency

Energy Conservation in Buildings and Community Systems Programme

A new Annex – Annex 41

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

Adapted from the proposal by Hugo Hens, K.U.Leuven, Laboratory of Building Physics, Belgium

Background

The heat and moisture flows generated by building usage, the heat, air and moisture flows that traverse the enclosure and those 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 so 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.

Objectives

A better knowledge is needed 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. This became apparent during the research efforts of annexes 14, 24 and 32. 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 pa-

In this issue:

rameter, 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 HAM-performance.

The new annex has two main objectives:

First, a detailed exploration of the complex physics involved in whole building heat, air and moisture response (HAM-response). 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 such as build, mock up testing, field testing and validation by inter-comparison of models through common exercises and confrontation with measured data.

This 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.

Scope and Means

As functional and sustainability demands on buildings increase, there is a growing need to better understand and explore the whole building HAM-response and its effect on comfort, energy consumption and enclosure durability. To facilitate this, the annex will forward a fully holistic view of the heat, air and moisture transfer between the outside, the enclosure, the indoor air and the HVAC systems. Such a holistic view is a key element to an energy-efficient and cost-effective control of the three flows.

To materialize that scope, the project will include both research work and promotion. Promotion should increase the designers' and occupants' awareness of HAM-issues and their impact. It will be done through an internet site, a newsletter and reports. Theoretical research will be conducted at the modeling level, while experimental research will be done at the material, room and building level. At the material level, moisture storage in building and finishing materials will be studied. At the room and building level, the impact on indoor climate, energy consumption and durability of adventitious airflow, 3D thermal effects, humidity storage and moisture accumulation in envelope parts will be analyzed. Since HAM-transfer at the enclosure and room level is a complex issue, several models and several experimental test facilities will be used to assess various simplifications of the phenomena, needed for application in building analysis, and to evaluate proposals for a better performance.

Relevance

The scientific relevance of the annex proposal lies in the fact that it's the necessary next step towards a full understanding of the HAM-reality. Research efforts are still focusing on HAM-transport in envelope parts. During the last decade, one- and two-dimensional HAM-models which include moisture sources such as wind-driven rain, rising damp, initial moisture, interstitial condensation and surface condensation and which consider all hygrothermal consequences for the envelope parts have been developed. Although several questions are still open, the one-dimensional models are in the process of becoming standardized procedures (CEN/TC 89 and ASHRAE SPC160).

These envelope-related models however consider the indoor climate (temperature, relative humidity, air pressures) to be a fixed boundary condition. This of course is not true. The indoor climate is a direct consequence of the whole building and HVAC HAM-balance. Moving from the envelope to the building and the HVAC-

The ECBCS Mission

"To facilitate and accelerate the introduction of energy conservation and environmentally sustainable technologies into healthy buildings and community systems, though innovation and research in decision-making, building products and systems, and commercialization"

system will allow consideration of that relationship in full depth.

The societal relevance of the annex proposal lies in its direct relation to human comfort, energy and durability. Good comfort is part of every building user's satisfaction, with relative humidity as one of the four parameters that fix global comfort. As everyone spends up to 80% of their time in buildings, the whole society benefits when comfort conditions are optimal. Durability impacts sustainability. A long service life in fact economizes on material usage, embodied energy and embodied pollution. Moisture especially threatens durability, with wind driven rain and airflow driven moisture ingress as the main sources which an enclosure faces. The second is a direct consequence of the random air pressure differences that develop indoors and that force moist air to move through leaky enclosures. Energy also benefits sustainability. Air in- and exfiltration related heat recovery diminishes the energy used for ventilation. Humidity changes, termed as latent energy, are very significant in warm moist regions, where the latent load often makes up over 50% of the annual cooling load. Optimal passive energy and moisture storage solutions may reduce that percentage. The result is a net saving in energy resources and less CO_2 produced, not only now but increasingly in the future when the desire for well-controlled indoor environments will further increase, in developing countries as well.

Means

Subtasks

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

Subtask 1: Modeling Principles and Common Exercises

Subtask 2: Experimental Investigations

Subtask 3: Boundary Conditions

Subtask 4: Long Term Performance and Technology Transfer

3.1.1 Operating Agent

The proposed operating agent is: Hugo Hens. Four subtask leaders will also be appointed.

Time Schedule

The Annex will run for four years, starting at the end of 2003 and ending at the end of 2007. The first year is considered to be a preparatory one. A fifth year will be used to finish the reports.

Email:
hugo.hens@bwk.kuleuven.ac.be

Results and End Products

Deliverables

1. Establishment of an internet site, preparation of an annex newsletter

2. Report on whole building HAM modeling and the integration of humidity transfer in building simulation packages. Appendix discussing the common exercises

3. Report documenting the experimental investigations, including the development and verification of experimental test facilities and a database of moisture storage properties of building and finishing materials and furnishings.

4. Report on indoor and outdoor boundary conditions for whole building HAM simulation

5. Report on long term performances in relation to comfort, durability and energy, demonstrating the benefits of a well controlled whole building HAM response, included the moisture storage benefits

All reports will be published in printed form and on CD-ROM.

Annex beneficiaries

The Annex beneficiaries should be

- The building research community

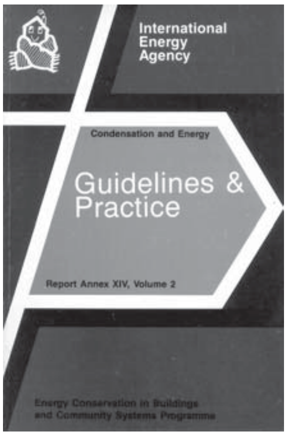
- Engineering offices that focus on building physics, energy, HVAC and sustainable construction

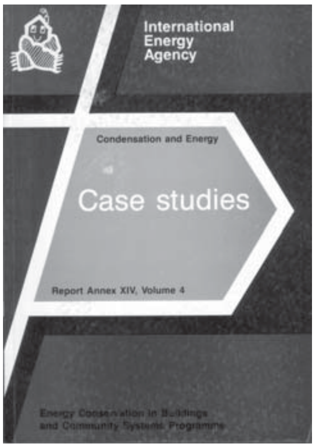
- Material and building system developers and corporations with an interest in high performance systems

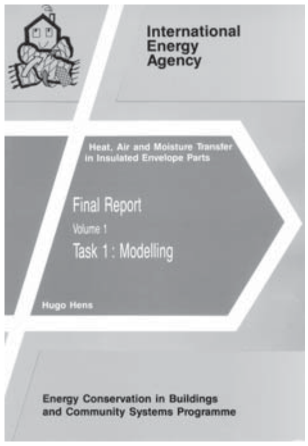
- Building designers

- Educational institutions

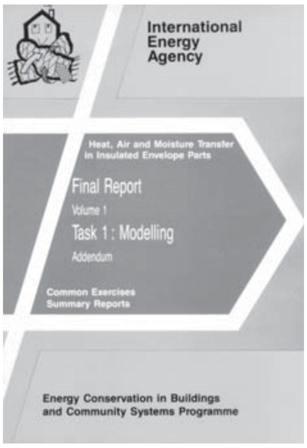
Heat Air and Moisture Reports from Earlier Annexes

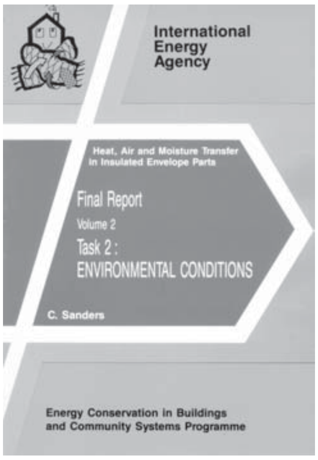


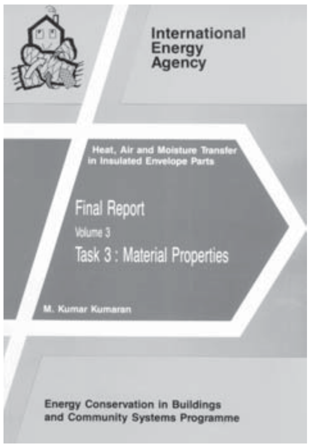


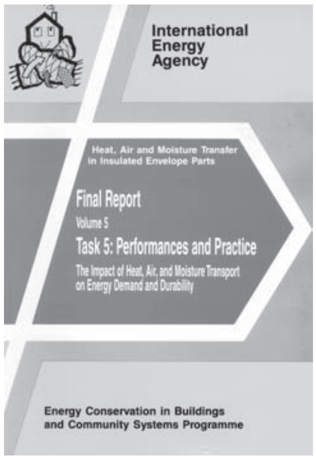


Annex 14: Condensation and Moisture

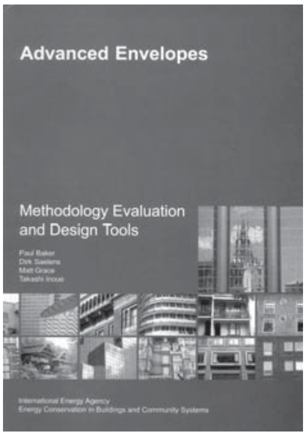


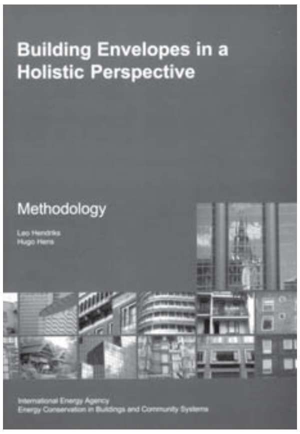


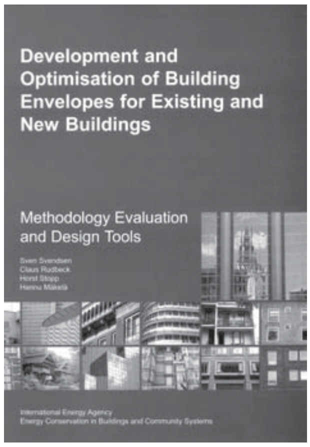




Annex 24: Heat Air and Moisture Transport in Insulated Envelope Parts







Integral Building Envelope Performance Assessment

Testing and Validation of Building Energy Simulation Tools

Annex 43/SHC Task 34 (in Conjunction with the IEA Solar Heating And Cooling Programme)
(adapted from the Draft Annex Text, 20 May 2003)

Introduction

The IEA Solar Heating and Cooling (SHC) Programme Tasks 12 and 22 created a number of procedures for testing and validating building energy simulation programs. These procedures are now being used by software developers to diagnose and correct errors in building energy simulation computer programs throughout the world. Some of these procedures have been, or are in the process of being, adopted by international codes and standards organizations for certification of software. ANSI/ASHRAE Standard 140 codified the original IEA-BESTEST as a standard method of test for software [1], and CEN used BESTEST to check their reference cooling load and cooling energy calculation methods based on the requirements of prEN 13791 and 13792 [2]. The recently issued Energy Performance Directive (EPD) of the European Union [3] emphasizes performance-based standards and requires certification of software used to show compliance with energy performance standards (normes). This is a very positive development because with true performance-based normes, renewable energy technologies in buildings are encouraged and not constrained by prescriptive requirements. However, the modeling of complex solar and low energy buildings is challenging, and existing methods for testing such software are not yet comprehensive enough. In this context the work proposed for this new IEA task may be thought of as "pre-normative" research. For example, at the recent Task Definition Workshop in Delft, participants established that the reference calculation methods under development by CEN will work for the vast majority of conventional buildings, but will not be adequate for innovative solar and low energy buildings. Therefore, the work proposed under this new IEA Task is meant to ensure that the software for modeling solar and low energy buildings can be tested, validated, and certified in accordance with the needs of those organizations responsible for promulgating and enforcing building codes and standards.

Description

This Task 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 Task 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.

Objectives

The goal of this Task 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 modeling 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.

Means

The work will be divided into two subtasks:

(1) Subtask A: Comparative Tests

In Subtask A, the Participants will expand the IEA 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 mathematic processes in building energy analysis tools will be included where possible.

(2) Subtask B: Empirical Validation

In Subtask B, the Participants will expand the IEA 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 (daylighting), 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.

Results

The products of work performed in this Annex will be designed for use by building energy analysis tool developers, and standard making organizations that need software certification protocols. Products from Tasks 12 and 22 are already being used, or considered for use by a number of such organizations including CEN, ISO, ASHRAE, and ANSI among others. In addition, the Energy Performance Directive (EPD) of the European Union requires development of software certification methods. The Dutch Energy Diagnosis Reference (EDR) [4], which adapted IEA BESTEST (from Task 12) [5] for loads analysis certification, is an example of a national response to the EPD that may be a model for other member countries. The EPD is comprehensive, and will require further development of software test protocols as proposed in this new task.

The results of this Task are planned as follows:

Subtask A: Comparative Testing

(a) Usable BESTEST-type test specifications - including equivalent inputs that can accommodate a variety of computer programs - that can be incorporated into codes and standards used for certifying building energy simulation computer programs. The test procedures will address the Subtask A topics listed in the preceding section. Analytical solutions will be included where possible.

(b) Along with the test specifications described in "(a)", final reports will also include: benchmark simulation results, modeler reports, enumeration of bugs found and/or corrected in simulation software, and improvements to the test procedure resulting from international field trials.

Subtask B: Empirical Validation

(a) An expanded set of empirical validation test procedures and data sets based on highly instrumented test facilities or buildings, addressing the Subtask B topics listed in the preceding section.

(b) A report or series of reports on the results of evaluating widely used building energy simulation tools with the empirical data sets.

Products of all subtasks will also include technical papers or articles presented at international congresses or in professional journals throughout the course of the Task. Such papers will include assessments of the impact of improved building energy analysis tools in the areas being studied.

Time Schedule

September 2003 December 2006.

Operating Agent

US Department of Energy

Participants Countries

Australia, Canada, France, Germany, Japan, Netherlands, Sweden, Switzerland, United Kingdom, United States

References

1. ANSI/ASHRAE Standard 140-2001. "Method of Test for Evaluation of Building Energy Analysis Computer Programs." Atlanta, Georgia, US: American Society of Heating, Refrigerating, and Air-Conditioning Engineers. 2001.

2. J.-R. Millet. Paris, France: Centre Scientifique et Technique du Batiment. Personal Communications at IEA SHC Task Definition Workshop, April 24-25, 2003, Delft, Netherlands.

3. Directive 2002/91/EC of the European Parliament and of the Council of 16 December 2002 on the energy performance of buildings. Distributed prior to the Task Definition Workshop, April 24-25, 2003, Delft, Netherlands by W. Maassen of TNO-Bouw, Delft, Netherlands.

4. J.J.N.M. Hogeling. "Advanced energy management in buildings with EDR: Why and How." Rotterdam, Netherlands, ISSO. Distributed prior to the Task Definition Workshop, April 24-25, 2003, Delft, Netherlands by W. Maassen of TNO-Bouw, Delft, Netherlands.

5. R. Judkoff and J. Neymark. "International Energy Agency Building Energy Simulation Test (BESTEST)

and Diagnostic Method." Golden, Colorado, US: National Renewable Energy Laboratory. NREL/TP-472-6231. 1995.

Project Plans from Task Definition Workshop, April 24 -25, 2003 at The Netherlands Organization (TNO Bouw), Delft, Netherlands

Five project (or work) plans are included for:

- Shading/Daylighting load interaction
- Double Façade
- Ground Coupling
- Multi-zone
- Control Strategies and Mechanical Equipment

Completed Annex: Annex 31 Energy Related Environmental Impact of Buildings

Introduction

The IEA Annex 31 is a project established under the auspices of the International Energy Agency's (IEA) Agreement on Energy Conservation in Buildings and Community Systems (ECBCS). Overall, the project reports include a directory of current tools, a description of tool theory and methods, case studies of tool applications and research reports on how tools perform.

Participating Countries and Organisations

Fourteen countries participated in Annex 31, each supplying one or more experts to the Annex 31 meetings, and by supporting the on-going research work and writing undertaken by these experts and their colleagues, within their national organizations and agencies. Participating countries include: Australia, Canada (Operating Agent), Denmark, Finland (Resources), France (Theory), Germany (Web Site), Japan, Netherlands (Applications), New Zealand, Norway, Sweden (Reference Materials), Switzerland, United Kingdom, and the USA (Case Studies).

Experts participating in Annex 31 were typically architects, engineers or scientists. All have brought to the work both a practical and academic understanding of buildings and environmental issues. Many have been involved with the development of methods and tools within their organizations and countries.

Description of the Annex

Mission

Through collaborative research and communications Annex 31 will encourage development and application of appropriate tools and assessment methods for improving the energy-related environmental impact of buildings.

Mandate

The mandate of Annex 31 is to provide information on how to improve the Energy-Related Environmental Impact of Buildings. Specifically, Annex 31 has focused on how tools and assessment methods might improve the energy-related impact of buildings on interior, local and global environments.

Tools stimulate communication, make energy and environmental efficiency quantifiable and ultimately make it possible to set goals and monitor performance. The ultimate objective is to promote energy efficiency of buildings by increasing the use of appropriate tools by practitioners.

Audience

Annex 31 reports may be of interest to users of tools, to groups engaged in tool design, and to anyone establishing policy and guidelines for promoting better decision-making within the building sector. Specifically, this includes:

- Policy developers, regulatory Groups and others who may wish to encourage or mandate the use of tools and methods;

- Educators, researchers and students;

- Practitioners, including design professionals;

- Tool developers.

Dissemination of Results

Dissemination of the Annex 31 research results and report is important and will be accomplished through several venues. Key deliverables and dissemination methods are planned as follows:

- Annex 31 Website

The full Annex 31 report will be available on the annex31.org website, with links to it from the ECBCS and Canada Mortgage and Housing Corporation (CMHC) websites.

- Annex 31 Tools Directory cross-linked to the US DOE website

The Tools Directory report of the Annex 31 website will be cross-linked to the US Department of Energy (DOE) web-based database of Building Energy Software.

- Annex 31 Tools Directory available on the SBIS

All the tools listed in the Annex 31 Tools Directory are included in the Methods and Tools section of the international Sustainable Building Information System (SBIS) database developed by the International Initiative for a Sustainable Built Environment (iiSBE). The SBIS will be updated on a continuous basis by iiSBE.

- Annex 31 Report Highlight

A printed report highlight summarizing the work of Annex 31 will be printed and distributed to all Annex 31 participants. Copies of the highlight report will be deposited with the ECBCS Executive Committee Support and Service Unit (ESSU) and available from the ECBCS bookshop.

- Annex 31 CD-ROM

The full Annex 31 report will be available on a CD-ROM and included with the Annex 31 Report Highlight booklet.

- ECBCS newsletter and Summary Report

Annex 31 report completion article in the ECBCS newsletter and production of an ECBCS project Summary Report.

Program Plan

Process Actions since November 2002 ExCo Meeting

- All final documents edited, reformatted and cleaned up stylistically to present a clear and consistent package of information.

- Developed an Annex 31 highlight report that summarizes the research and results of Annex 31, which combined with the CD-ROM of complete Annex 31 research, provides an accessible overview and complete record of the project.

- Website format and structure improved for clearer navigation through Annex 31 material.

- The iiSBE engaged to provide the host server for the Annex 31 website, contracted and managed by CMHC on behalf of the Annex 31 participants.

Previous Annex 31 Process Summary

- Completed development of review of all Annex 31 reports by designated ExCo members.

- Changed name of Annex 31 “Summary Reports” to “Core Reports” to not cause confusion with IEA nomenclature for produced project reports.

- All the tools listed in the Annex 31 Tools Directory have been included in the Methods and Tools section of the international Sustainable Building Information System (SBIS) database developed by the International Initiative for a Sustainable Built Environment (iiSBE).

'Outline of Annex 31' Report

The main information of the Annex 31 project report is categorized into six sections.

A project overview is provided in the **About Annex 31** report. A series of four **Core Reports** provide the main body of information. This information is supplemented by detailed reference documents in the seven **Background Reports**.

A **Directory of Tools** presents an overview of international tools used for evaluating the environmental impact of buildings, with links to ongoing databases of building assessment tools (DOE and SBIS). Also included is a **Glossary** of key terminology used in the reports in several languages, and a **Links** section presenting all the participants and agencies that contributed to Annex 31.

- About Annex 31
- Core Reports
- Background Reports
- Directory of Tools
- Glossary
- Links

ABOUT ANNEX 31

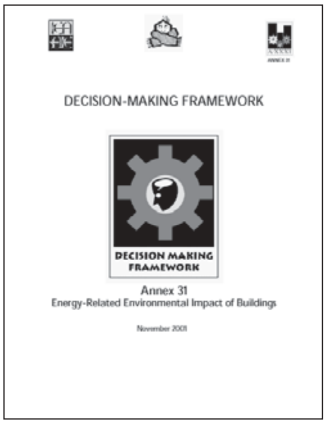
About Annex 31 provides a mandate and content overview with an introduction to the IEA and the Annex 31 project and report format. It includes an overview of the Annex 31 Mandate, Participants, Audience, Process, and a summary of all Research reports.

CORE REPORTS

The main outputs of the Annex 31 project research are the Core Reports. These consist of four reports that provide a comprehensive introduction to the theory of tool design and application.

These include:

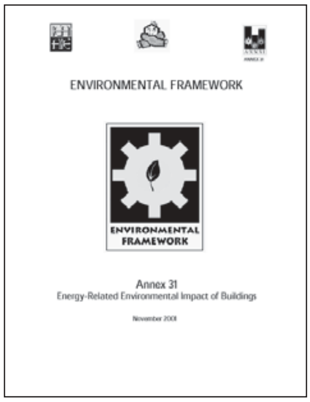
- The Environmental Framework;
- The Decision-Making Framework;
- Types of Tools;
- Life Cycle Assessment (LCA) Methods for Buildings.



The core reports have been written for an informed and technical reader familiar with the building sector. However, no specialized knowledge of environmental assessment methods or tools is required.

Environmental Framework

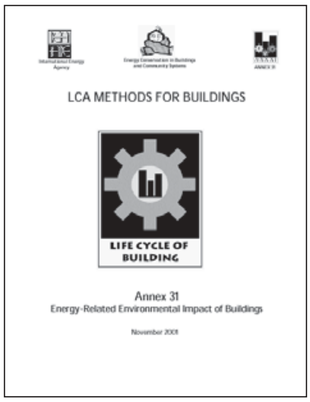
An *environmental framework* is the foundation to any analysis of the energy-related environmental impact of buildings. The environmental framework provides a consistent and comprehensive system for describing the physical interactions arising throughout the life cycle of buildings. This report provides a detailed description of the concepts and methods used to analyse the technical systems that affect the environment, including the cause and effect chains.



Decision-Making Framework

A *decision-making framework* is required in order to effectively design and develop environmental assessment methods and tools. This report serves to clarify how and when specific actors become involved in decisions, at each stage in a building's lifecycle. The Framework defines the scope of each decision, and the types of evaluation criteria and decision-support tools that may be beneficial.

Types of Tools



Tools inform the decision-making process by helping actors understand the consequences of different choices. Tools are the interface between the environmental framework and the decision-making framework. To be effective, they must be tailored to the planning phase, the knowledge base of the user, and the concerns of the actors – including the applicable assessment criteria and standards. This report describes every category of environmental assessment tool, and their information requirements. The report identifies key features that make tools effective.

LCA Methods for Buildings

Life Cycle Assessment (LCA) is a technique for assessing the environmental aspects and potential impacts throughout a product's life – from raw material acquisition through production, use and disposal.

This report begins by summarising how to apply the basic LCA method to building products, single buildings and groups of buildings. The report then examines six problem areas encountered when LCA methods are used for buildings. Suggestions are made about how to adapt the LCA method and overcome specific problems.

BACKGROUND REPORTS

Seven background reports have been prepared for Annex 31 and provide experts and tool developers with additional detail and technical information on key aspects of tool design and use.

Context and Methods for Tool Designers

The art of tool design is evolving in concert with the sophistication of users, improved information technology and increased market demand for green buildings. The Context and Methods report provides an overview of the most important issues currently facing tool developers. It includes topics of building lifetimes, energy flows, occupant behaviour, user needs and presentation of results. Many of the critical assumptions about building lifetimes, energy flows and occupant behaviour are addressed. The needs and motivations of actors are carefully analysed. Methods for connecting tools with users are discussed, and examples are given for how tool developers can best present results.

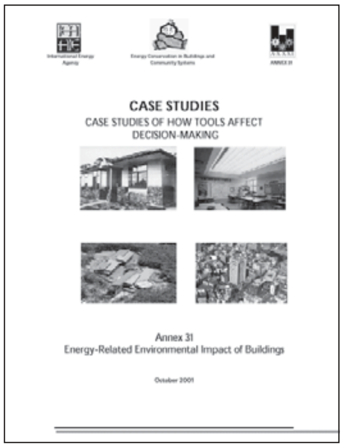
Comparative Applications: A Comparison of Different Tool Results for Similar Residential & Commercial Buildings

This report describes the results of the Annex 31 research project in which the environmental impact of both a single dwelling and an office building were assessed with tools from the participating countries. All the tools were intended to assist in quantifying or qualifying the environmental profile of a building, or to assist decision-makers in improving the environmental performance of a building design. The research was designed to address a large number of questions about the similarities and differences between tools.

The results indicate that transparency of a tool is one of the most important characteristics. Significant differences in outputs between tools occurred as a result of differences in data infrastructure (e.g. energy mix), system boundaries, data allocation and weighting factors.

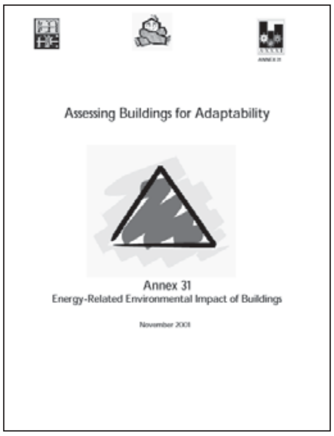
Case Studies of How Tools Affect Decision-Making

The intent of this report is to explore how life-cycle assessment tools have had an impact on the design and environmental performance of buildings. Six countries were asked to submit case studies of building projects where tools were intentionally used to create more efficient and environmentally friendly building or building stock. Each case study includes information on the site and project, the energy and environmental features, the assessment tool and the results.



Data Needs and Sources

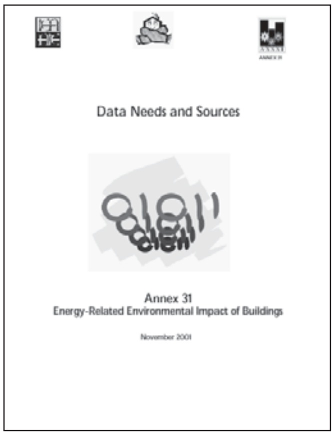
In this report a more detailed examination is conducted of data require-



ments and sources. An attempt is made to inventory as exhaustively as possible the data needed for a complete detailed assessment of impacts at any aggregation level.

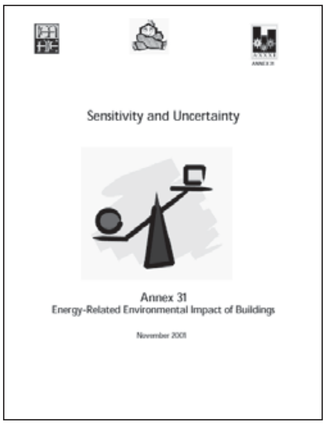
The data needed to assess the energy related environmental impact of buildings depends strongly on the type of tool used and, among others, on the aggregation level considered (i.e. product/building/stock).

Assessing the Adaptability of Buildings



This report examines all aspects of adaptability in buildings, from principles to strategies to specific features. Evaluation methods and potential benefits are discussed. Adaptability refers to the capacity of buildings to accommodate substantial change. Over the course of a building's lifetime, change is inevitable, both in the social, economic and physical surroundings, and in the needs and expectations of occupants. All other things being equal, a building that is more adaptable will be utilized more efficiently, and stay in service longer, because it can respond to changes at a lower cost. A longer and more efficient service life for the building may, in turn, translate into improved environmental performance over the lifecycle.

Sensitivity and Uncertainty



This report describes how to undertake sensitivity and uncertainty analysis, and includes examples of how such exercises can improve decisions. The key purpose of sensitivity analysis is to identify and focus on key data and assumptions that have the most influence on a result – thereby simplifying data collection and analysis without compromising the results. A parallel to sensitivity analysis is uncertainty analysis.

Experience shows that uncertainty related to an LCA inventory can be significant, and must be considered when performing comparative LCA's. Sensitivity and uncertainty analysis can be used at many stages throughout the assessment of energy related environmental impacts from buildings.

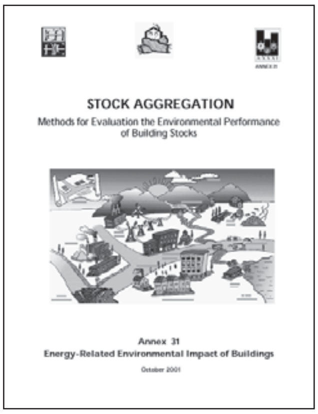
Stock Aggregation

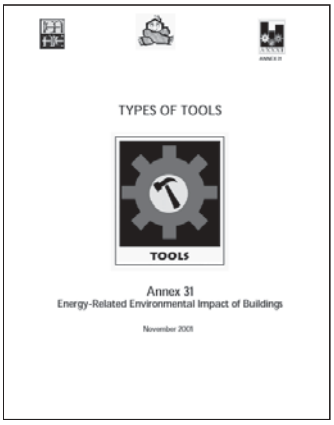
Stock Aggregation refers to the process of evaluating the performance of a building stock using environmental assessments of components of the stock. For example, total energy use by a stock of buildings can be estimated by adding up (or 'aggregating') the energy estimates for all the individual buildings within the stock. Or for less effort, a subset of representative buildings can be analyzed, and the results then factored in proportion to the total number of such buildings in the stock. This report explains why Stock Aggregation is frequently the best method for assessing stocks. Examples are given of how stock aggregation can assist in policy development at the local and regional scale. The method is also shown to offer significant benefits for planners, businesses in the building sector, and utilities.

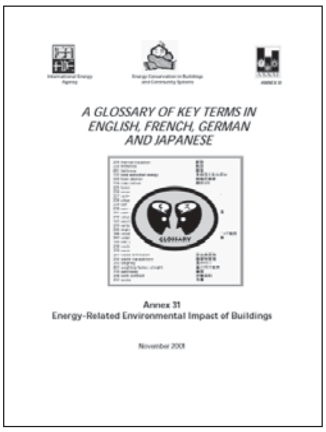
DIRECTORY OF TOOLS

The next main section of the Annex 31 project report is the Directory of Tools. Improving the environmental performance of buildings and building stocks is best accomplished using tools as decision-making aids. Many countries now have a variety of tools that have been tailored for use by specific users and to fill particular analytical needs. Annex 31 has completed an international survey of tools, and has used the survey to create a directory of tools that is accessible on the Annex 31website.

The purpose of the Directory is to provide a quick overview of the tools that are currently available or soon to be released. Each tool is described in terms of its functions, audience, users, software application & tech support, data requirements, strengths,







availability and contact information. The directory includes a broad array of decision making tools including a Survey of LCA Tools, Assessment Frameworks, Rating Systems, Technical Guidelines, Catalogues, Checklists and Certificates.

Plus, collaboration was developed and links have been established between the Annex 31 Directory of Tools and the US Department of Energy (DOE) web-based database of Building Energy Software Tools (http://www.eren.doe.gov/buildings/tools_directory/).

Tools in the Annex 31 Tool Directory are now also listed in the Method and Tools section of the Sustainable Building Information System (SBIS) database. The SBIS is a newly created international database designed to provide users with general but broad information about sustainable building and links to detailed sources of information. The SBIS provides data and a search mechanism for eight categories of information that include Technologies, Method and Tools, Policies and Programs, Research and Development Projects, Buildings, Documents, People, and Events. Building upon the directory created in Annex 31, the SBIS database will provide a current and updateable information source on sustainable design Tools.

GLOSSARY

The Annex 31 Glossary section has been designed to standardise the many specialized terms used for describing the environmental performance of buildings in a number of languages including English, French, German and Japanese. The glossary emerged as a result of ongoing communication difficulties experienced within Annex 31.

Academics and researchers in the 14 participating countries used different English terms interchangeably. Varying translations compounded this problem. The solution was to carefully review the use of all terminology, with special reference to terms used in international standards, and then to translate a standard set of English terms into the other languages commonly used within the Annex.

LINKS

Annex 31 benefited from the participation of many individuals and agencies from the member countries. Names and contact information are listed in the Links to Participants and Agencies section.

Each of the participants in Annex 31 contributed valuable material to the final reports, over an extended period of time, and their effort is greatly appreciated. Completion of the final reports, CD-ROM and web site were managed by Thomas Green (Canada, Operating Agent), with coordination support from Nils Larsson (Canada), project work led by Sebastian Moffatt (Canada), and web site construction by Thomas Lützkendorf (Germany). Substantial research, writing and review efforts were undertaken with great dedication by many participants, and many Annex members were involved in commenting on the completed work.

Next Steps

The final steps for Annex 31 project work include:

- Completion of the Annex 31 website and loading the final project onto the annex31.org server;

- Installation of links between Annex 31 website and the ECBCS website;

- Production of the Highlight Report and CD-ROM and distribution to ECBCS ESSU and all Annex 31 participants.

Note: final draft Annex 31 materials on interim website at http://www.annex31.com/

Proposed New Annexes Under Consideration

Integrating Environmentally Responsive Elements in Buildings

Energy Efficient Electric Lighting For Buildings

Heat Pumps and Reversible HVAC

Sustainable Building Information System on the Web from iiSBE

By Nils Larsson, Executive Director, iiSBE

The website at <*www.sbis.info*> is the home of the Sustainable Building Information System, or SBIS. There is much to be found of interest in the site.

The system has been launched by the International Initiative for a Sustainable Built Environment (iiSBE), with the support of several organizations around the world. The goal of the system is to allow users all over the world to gain access to a rich body of information related to sustainable building in several languages.

Several linked files will provide relational access. The individual files include:

- Advanced Technologies
- Methods and Tools
- R&D Projects
- Policies and Programs
- Buildings
- People
- Events
- Documents
- Relevant websites

All of the files contain individual records related to the file subject for browsing by SBIS users, either live on the web or on a CD, to be issued quarterly. The Documents file will also allow SBIS users to download PDF-format documents that have been contributed by individuals or organizations.

The CD version includes some features (illustrations and a multi-lingual interface) that will migrate to the web version over time. Also, the whole system is being continuously augmented. Feedback from users in this regard is warmly welcomed.

Members of iiSBE will also obtain the CD version on request. If you wish to learn more about iiSBE or join to help support this project, use the following contact details. Annual cost for individuals is $75 CAD, or less than 50 Euros.

International Initiative for a Sustainable Built Environment
130 Lewis Street
Ottawa, K2P 0S7, Canada

Tel: 1 613 769-1242
Fax: 1 613 232-7018

email: *larsson@greenbuilding.ca*
http://iisbe.org
http://www.sbis.info

New to the ECBCS Bookshop - Latest Publications

Technical Synthesis Report for Annex 19 - Low Slope Roof Systems

by John Palmer

The need for energy efficiency has increased the amount of insulation required, and for well-insulated low-slope roofs this has increased the demand for information on design, installation, and maintenance needs. A primary purpose of this Annex was to assess and report on the current roofing practices in the context of an accumulating database on performance.

Annex 19 'Low-slope roof systems' completed its work with a report entitled 'A Guidebook for Insulated Low-slope Roof Systems', published in February 1994. The objective of the report was to describe available information and good practice when working with highly energy efficient low-slope roof systems. The report describes the various types of low-slope roof and the insulating materials that may be used. The requirements of the various construction methods and insulation combinations are discussed on the context of possible modes of failure. Examples of successful methods are provided.

Price £20.00 plus postage.

Technical Synthesis Report for Annex 32 - Integral Building Envelope Performance Assessment

by Peter Warren

A good envelope design should be the result of a systematic approach, checking all relevant elements. A new approach to consider the building and the envelope quality is the "performance concept". The performance of an envelope includes all aesthetic and physical properties to be fulfilled by that envelope, integrated into the function of the building as a whole.

The objective of Annex 32 was to develop a methodology for performance assessment that will support the integral design and the evaluation process of building envelopes, with the aim of realising significant energy saving along with environmental and indoor comfort benefits.

Although the envelope in itself is a crucial element for the overall performance of the building, the interaction with other building components, and the climatic control systems is of equal importance. Therefore, the emphasis of the Annex was on the overall performance of the building seen from the perspective of the envelope. While the focus is on energy efficiency, a high quality was aimed at with respect to aspects such as durability, comfort, acoustics, moisture.

The work of the Annex was divided into two principal Subtasks:

Subtask A: Development of a comprehensive assessment methodology, including performance criteria, leading to a rational strategy for optimising building envelopes, based on an integral performance approach.

Subtask B: Testing and evaluating the developed methodology by applying it on selected case studies. The case studies are ranked in three thematic groups: retrofitting, advanced envelopes and performance testing. concentrating on both evaluation and improvement of design tools, assessment methodology, performance criteria and practical experience.

Price £20.00 plus postage.

The ECBCS Bookshop - www.ecbcs.org

c/o FaberMaunsell Ltd (Attn: Janet Blacknell),
Beaufort House, 94/96 Newhall Street,
Birmingham B3 1PB Great Britain
email bookshop@ecbcs.org, or janet.blacknell@fabermaunsell.com
Fax: +44(0)121 262 1994

Executive Committee Members

AUSTRALIA
Mr John Murray
37 Flanagan Street
Garran ACT 2605
Tel: +61 2 6282 5575
Fax: +61 2 6282 5544
Email: jmur7464@bigpond.net.au

BELGIUM
Prof Jean Lebrun, Director,
Lab.de Thermodynamique,
Université de Liège
Campus du Sart-Tilman, Bâtiment B49
Chemin des Chevreuils, B 4000 Liège
Tel: +32 43 664801
Tel: (Secretariat) +32 43 664800
Fax: +32 43 664812
e-mail: J.LEBRUN@ULG.AC.BE

CANADA
Morad R Atif (Chairman)
Director, Indoor Environment Research Program, National Research Council,
1500 Montreal Road (M-24)
Ottawa, Ontario K1A 0R6
Tel: +1 613 993 9580
Fax: +1 613 954 3733
email: morad.atif@nrc.ca

CEC
to be arranged

CZECH REPUBLIC
Irena Plockova
Czech Energy Agency
U Sovovych mlynu 9
118 00 Praha 1
Tel: +425 257 532 151
Fax: +425 257 530 478
Email: plockova@ceacr.cz

DENMARK
Mr Jens Windeleff
Head of Section
R&D and JI Division
Danish Energy Authority
Amaliegade 44
DK-1256 Copenhagen K.
Tel: +45 33 92 68 18
Fax: +45 33 11 47 43
email: jew@ens.dk

FINLAND
Markku Virtanen
c/o Nella Jansson
VTT Building and Transport
PO Box 1804
FIN-02044 VTT
FINLAND

Tel:+358 50 596 7690
Fax:+358 9 6959 0666
e-mail: markku.virtanen@take-finland.fi

FRANCE
Mr Pierre Hérant
Bâtiment et Collectivités, Agence de l'Environment et de la Maîtrise de l'Energie
Centre de Sophia Antipolis, 06560 Valbonne
Tel: +33 4 93 95 7947
Fax: +33 4 93 65 3196
e-mail:pierre.herant@ademe.fr

GERMANY
Mr Jürgen Gehrmann
Forschungszentrum Jülich, Projektträger Biologie, Okologie, Energie
Postfach 1913
D 52425 Jülich
Tel: +49 2461 614852
Fax: +49 2461 613131
e-mail:j.gehrmann@fz-juelich.de

GREECE
Mr Dimitrios Nomidis
Head, Energy Saving Division, Ministry of Development, Michalacopoulou str. 80
GR-101 92 Athens
Tel: +30 1 7709100
Fax: +30 1 7717612
e-mail: nomidisd@ypan.gr

ISRAEL
Mr Joseph Nowarski
Director – Energy Conservation
Ministry of National Infrastructure, P O Box 13106 , Jerusalem 91130
Tel: +972 2 5316115
Fax: +972 2 5316081
e-mail: jnow@mni.gov.il

ITALY
Dr Marco Citterio
ENEA SIRE HAB
C.R. Casaccia
Via Anguillarese 301
00060 S. Maria di Galeria
Roma
Tel: + 39 06 3048 3703
Fax:+39 06 3048 6315
citterio@casaccia.enea.it
www.enea.it

JAPAN
Prof Yuichiro Kodama
Kobe Design University, Gakuen-nishi 8-1-1
Nishi-ku , Kobe
Tel/Fax: +81 78 796 2571
e-mail: y-kodama@kobe-du.ac.jp

NETHERLANDS
Mr Piet Heijnen
Account Manager Sector Bouw, NOVEM BV, Swentiboldstraat 21, Postbus 17, 6130 AA Sittard
Tel: +31 46 4 202268
Fax: +31 46 4 528260
e-mail: p.heijnen@novem.nl

NEW ZEALAND
Mr Michael Donn
School of Architecture
Victoria University of Wellington
PO Box 600, Wellington 1
Tel:+64 4 463 6221
Fax:+64 4 463 6204
email: michael.donn@vuw.ac.nz

NORWAY
Dr Jørn Brunsell (Vice Chairman)
Norwegian Building Research Institute
PO Box 123 Blindern, N-0314 Oslo
Tel: +47 22 96 55 46
Fax: +47 22 96 57 25
e-mail: Jorn.Brunsell@byggforsk.no

POLAND
Prof Stanislaw Mierzwinski
Silesian Technical University
Faculty of Environmental and Energy Engineering, Dept of Heating, Ventilation & Dust Removal Technology, ul Konarskiego 20
44 101 Gliwice
Tel: +48 32 2 37 1280
Fax: +48 32 2 37 2559
email: smierzwinski@kowito.polsl.gliwice.pl

PORTUGAL
Prof. Eduardo Maldonado
Faculdade de Engenharia
Universidade do Porto
Rua Dr. Roberto Rrias
s/n 4200-465 Porto
Tel: +351 22 508 14 00
Fax: +351 22 508 14 41
Email: ebm@fe.up.pt

SWEDEN
Mr Conny Rolén
Formas
Box 1206
Birger Jarls torg 5
S-111 82 Stockholm
Tel: +46 8 775 4030
Fax: +46 8 775 4010
email: conny.rolen@formas.se

SWITZERLAND
Mr Mark Zimmermann
EMPA-ZEN, Uberlandstrasse 129
CH 8600 Dübendorf
Tel: +41 1 823 4178
Fax: +41 1 823 4009
email: mark.zimmermann@empa.ch

TURKEY
to be arranged

UK
Mr Paul Davidson
BRE
Garston
Watford WD25 9XX
Tel: +44 (0)1923 664437
Fax: +44 (0)1923 664787
Email: davidsonp@bre.co.uk

USA
Mr Richard Karney,
Senior Technical Advisor, Office of Building Technologies, State and Community Programmes, US Department of Energy,
Mail Stop EE-421
1000 Independence Ave, SW,
Washington DC 20585
Tel: +1 202 586 9240
Fax: +1 202 586 1628
e-mail: richard.karney@ee.doe.gov

Current Projects and Operating Agents

5 Air Infiltration and Ventilation Centre (1979-)

Dr Peter Wouters
INIVE EEIG
Boulevard Poincaré 79
B-1060 Brussels
Belgium

Tel: +32 2 655 7711
Fax: +32 2 653 0729
e-mail: aivc@bbri.be
Web: www.aivc.org

36 Retrofitting in Educational Buildings – Energy Concept Adviser for Technical Retrofit Measures (1998-2002)

Hans Erhorn
Frauhofer Institute of Building Physics
Nobelstr.12
D-70569 Stuttgart
GERMANY

Tel: +49 711 970 3380
Fax: +49 711 970 3399
e-mail:erh@ibp.fhg.de
www.annex36.bizland.com

37 Low Exergy Systems for Heating and Cooling of Buildings (1999-2003)

Markku Virtanen
c/o Nella Jansson
VTT Building and Transport
PO Box 1804
FIN-02044 VTT
FINLAND

Tel:+358 50 596 7690
Fax:+358 9 6959 0666
e-mail: markku.virtanen@take-finland.fi
http://www.vtt.fi/rte/projects/annex37

38 Solar Sustainable Housing (with Solar Heating and Cooling Task 28) (2000-2005)

Robert Hastings (Operating Agent)
Architecture, Energy & Environment GmbH
Kirchstrasse 1
CH 8304 Wallisellen
Switzerland

Tel: +41 1 883 1717 or 16
Fax: +41 1 883 1713
Email: robert.hastings@aeu.ch
Hans Erhorn (ECBCS Representative)
Frauhofer Institute of Building Physics
Nobelstr.12
D-70569 Stuttgart
GERMANY

Tel: +49 711 970 3380
Fax: +49 711 970 3399
e-mail:erh@ibp.fhg.de

39 High Performance Thermal Insulation Systems (2001-)

Markus Erb and Hanspeter Eicher
Dr H Eicher and Pauli AG
Kasernenstrasse 21, CH-4410 Liestal
Switzerland
Tel: +41 61 921 99 91
Fax: +41 61 923 00 25
Markus.Erb@eicher-pauli.ch

40 Commissioning of Building HVAC Systems for Improving Energy Performance (2001-)

Jean Christophe Visier
CSTB, Head of Automation & Energy Management Group
84 Avenue Jean Jaurès, BP 02
F-77421 Marne la Vallée Cedex 02
France

Tel: +33 1 64 68 82 94
Fax: +33 1 64 68 83 50
email: visier@cstb.fr

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

Prof. Hugo Hens
K.U. Leuven
Department of Civil Engineering
Laboratory of Building Physics
Kasteelpark Arenberg, 51
B-3001 Leuven
Belgium

Tel: +32 16 32 44
Fax: +32 16 32 19 80
Email: hugo.hens@bwk.kuleuven.ac.be

42 COGEN-SIM : The Simulation of Building-Integrated Fuel Cell and Other Cogeneration Systems

Dr Ian Beausoleil-Morrison
CANMET Energy Technology Centre
Natural Resources Canada
580 Booth Street, 13th Floor
Ottawa K1A 0E4
Canada

Tel: +1 613 943 2262
Fax: +1 613 996 9909
Email: ibeausol@nrcan.gc.ca

43 Testing and Validation of Building Energy Simulation Tools

Ron Judkoff
Buildings & Thermal Systems Center
National Renewable Energy Lab (NREL)
1617 Cole Blvd.
Golden, CO 80401
USA

Tel: +1 303 384 7520
Fax: +1 303 384 7540
Email: ron_judkoff@nrel.gov

IEA Secretariat

Mr Alan Meier
Office of Energy Efficiency, Technology, R&D,
9 Rue de la Fédération
75739 Paris Cedex 15
FRANCE
Tel: +33 1 40 57 66 85
e-mail: alan.meier@iea.org
www.iea.org

Nancy Turck
IEA Legal Office
9 rue de la Fédération
75739 Paris Cedex 15
France
email: nancy.turck@iea.org

Published by
The ECBCS Secretariat (ESSU)
ECBCS Executive Committee Support Services Unit/ECBCS Bookshop
c/o Janet Blacknell, FaberMaunsell Ltd,
Beaufort House, 94/96 Newhall Street, Birmingham B3 1PB
Great Britain

Tel: +44(0)121 262 1900
Fax: +44(0)121 262 1994
email bookshop@ecbcs.org
Web www.ecbcs.org