International Energy Agency

Energy Conservation in Buildings and Community Systems Programme

Sustainable Buildings: A Summary of Policy in 16 OECD Member Countries and the European Commission

presented by Shoichi Ando, Ministry of Construction, Japan, at the Future Buildings Forum Think Tank 2001, held 9th - 11th May 2001 in Oslo, Norway

The construction, use and demolition of buildings all have very considerable positive effects upon OECD member country economies. The construction sector accounts for 10 to 15% of GDP and buildings represent one half of fixed capital assets in the OECD area. However, the effects of construction activities and building operations on the environment are of increasing concern, since they impact both on the natural and on the social environment. On average, the construction sector is responsible for one sixth of total freshwater withdrawals and, with the demolition sector, is responsible for 20 to 30% of waste generation in the OECD countries. Furthermore, the sector is directly or indirectly responsible for approximately 30 to 40% of the total energy consumption and CO2 emissions, if the operation phase and production process of construction materials are included.

The environmental and economic performance of the construction sector can be enhanced through the efficient use of materials and energy resources, and by considering its influences on the ecological and social surroundings. The aim of the OECD sustainable building project is to review and analyse policies and strategies of achieving sustainability of residential, commercial and public buildings. This entails the evaluation of policies developed by governments, and of initiatives promoted by influential stakeholders as diverse as, for instance, architects, buildings, suppliers and investors. These policies and initiatives affect both new construction and the refurbishment of existing buildings.

In this issue:

Table 1: Sustainable Buildings: Legal Systems and Policy Programmes by Country

Country	Regulation	Other Policy	Country	Regulation	Other Policy
Australia	2	14	Korea	3	0
Belgium	4	2	Netherlands	2	7
Canada	10	11	New Zealand	3	2
Czech Republic	4	0	Sweden	2	10
Finland	8	2	Switzerland	5	14
France	5	5	United Kingdom	1	3
Germany	17	0	United States	0	4
Greece	4	4	European Commission	5	4
Japan	6	6			
			Total	**81**	**88**

In November 1998 the OECD initiated a four year project on sustainable buildings as part of its activity to advance resource efficiency within OECD member countries. The objective of this project is to support member countries in their efforts to develop effective policies to address environmental impacts of buildings and the construction sector. By the end of July 1999, 16 member countries and the European Commission had submitted reports providing overviews of policy frameworks in the area of "sustainable building". Each country report consists of an outline of the national legal framework, a list of relevant organisations, some model or pilot projects, a list of publications and/or other available information on building and the environment. The present report summarises the replied received from member countries, and provides the first comprehensive report on policies to improve the sustainability of buildings.

Sustainable buildings can be defined as those buildings that have minimum adverse impacts on the built and natural environment, in terms of the buildings themselves, their immediate surroundings and the broader regional and global setting. Sustainable building may be defined as building practices which strive for integral quality (including environmental quality) in a very broad way. Thus, the rational use of natural resources and appropriate management of the building stock will contribute to saving scarce resources, reducing energy consumption, and improving environmental quality.

Sustainable building involves considering the entire life cycle of buildings, taking environmental quality, functional quality and future values into account. In the past, attention has been primarily focused on the size of the building stock in many countries. Quality issues have hardly played a significant role. However, in strict quantity terms, the building and housing market is now saturated in most OECD countries, and the demand for quality is growing in importance. Accordingly, policies that contribute to the sustainability of building practices should be implemented, with a recognition of the importance of existing market conditions. Both the environmental initiative of the construction sector and the demands of users are key factors in the market. Governments will be able to give a considerable impulse to sustainable buildings by encouraging these developments.

The amount of information collected with the assistance of WPPPC delegates is impressive.

Table 1 and Figures 1 and 2 give an overview of the results.

Figure 1: Policy Objectives

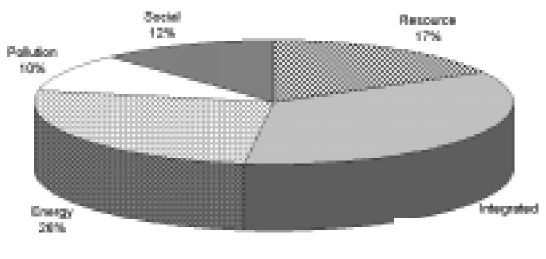
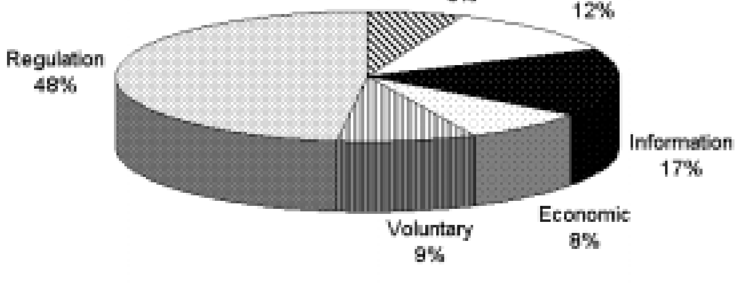


Figure 2: Policy Tools



A new Annex - Annex 40

Building Commissioning to Improve Energy Performance

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

It is anticipated that some of the procedures developed in the Annex will be transferred to standardisation bodies and could eventually become the basis for new commissioning regulations. The work performed in the Annex will focus on HVAC systems and their associated control systems, but will take into account, when appropriate, interactions with other systems and with the building shell.

Subtasks:

A: Commissioning Process;

B: Manual Commissioning Procedures;

C: BEMS Assisted Commissioning Tools;

D: Design Models and Commissioning;

E: Commissioning Projects.

The Annex will include a preparation phase and a working phase. The programme plan was initiated by a workshop involving 41 participants from 13 countries.

The Future Buildings Forum Think Tank 2001

the meeting was held between 9th - 11th May 2001 in Oslo, Norway

The ECBCS Programme organises the FBF on behalf of the IEA Buildings Co-ordination Group (BCG). The FBF was established for the purpose of identifying future challenges facing the building sector, and recommending research activities to meet these challenges for the IEA's End-Use and Renewable Energy working party agreements.

The FBF's activities are built around the concept of "Think Tanks" designed to explore long-term (25 years plus) scenarios for the built environment, and to engage participants in developing nearer term R&D strategies that address the challenges posited by the scenarios. Think Tank sessions are held every five years and involve participation by a number of futuristic speakers as well as representatives from each of the seven buildings-related IEA Implementing Agreements in two and a half days of discussions and brainstorming sessions.

The papers presented included the following:

- Global Challenges, by Oystein Dahle, Head of the World Watch Institute, Scandinavia

- The Energy situation in 2025 and Beyond, by Claes Otto Wene, IEA Secretariat, Paris

- Trends in Lifestyles, by Margrethe Aune, SINTEF, Norway

- Factor 4-10 in Buildings,by Sverre Tiltnes, GRIP Center for Sustainable Production and Consumption, Norway

- Long Term Trends in the Swiss Building Sector, by Mark Zimmermann, EMPA ZEN, Switzerland

- Challenges in Building Energy Efficiency in Warmer Climates, by Poul Kristensen, Denmark

- Buildings End-Use Working Party Perspective, by Bertil Petterson, Swedish Ministry of Environment, IEA End-Use Working Party

- Urban Planning for a Green and Sustainable Future, by Tony Rigg, UIA Architecture & Energy Work Programme, Israel

- Existing Buildings, by Leigh Breslau, Design Partner, USA

- High Performance Commercial Buildings: A Technology Roadmap, by Richard Karney, US Department of Energy, USA

- Energy Systems in Buildings, by Asger S Kjeldsen, Encon Electrical Utility, Denmark

- Information About Tomorrow, by Fred Morse, Morse Associates, USA

A total of twenty papers were presented and the meeting was attended by around forty delegates from the building research community worldwide.

Parallel workshop sessions were held to discuss:

- New Buildings

- Existing Buildings

- Energy Systems in Buildings

It is anticipated that the outcome from the Future Buildings Forum will be used strategically by the various IEA buildings-related Implementing Agreements (such as the ECBCS) to develop their programmes of work over the next five years.

For more information see the contact details on the back page of this newsletter, or the ECBCS web pages.

News on Ongoing Projects

Annex 39 – High Performance Thermal Insulation

A workshop followed by the kick-off meeting for the annex took place in January 2001.

Annex 38– (Solar) Sustainable Housing

This is a joint activity with IEA Solar Heating and Cooling. The programme has been modified significantly to concentrate on building energy conservation issues.

Annex 37 – Low Exergy Systems for Heating and Cooling

The general objective of Annex 37 is to promote rational use of energy by means of facilitating and accelerating the use of low valued and environmentally sustainable energy sources for heating and cooling of buildings. Specific objectives are:

- To investigate the technical and market potentials for replacing high valued energy (e.g. fossil fuels and electricity) by low valued energy sources and to assess its impact on global resources and environment;

- To assess existing technologies and components for low exergy heating and cooling in buildings, to enhance the development of new technologies and to provide the necessary tools for analysis and evaluation of low exergy systems;

- To develop strategic means for the introduction of low exergy solutions in buildings by case studies, design tools and guidelines.

Four sub-tasks will be carried out in order to reach the objectives:

A: Exergy Analysis Tools for the Built Environment;

B: Low Exergy Concepts and Technologies;

C: Case Studies and Market Potentials;

D: Documentation and Dissemination.

The guidebook produced via this annex will incorporate practical tools. A newsletter is available from the Operating Agent.

Annex 36– Retrofitting of Educational Buildings – REDUCE

The objectives of Annex 36 are:

- To provide tools and guidelines for decision makers and designers to improve the learning and teaching environment of educational facilities through energy-efficient retrofitting;

- To support the decision makers in evaluating the efficiency and acceptance of available concepts;

- To give recommendations on how to operate the retrofitted buildings;

- To promote energy- and cost-efficient retrofit measures.

To accomplish the objectives of the Annex, the participants will carry out research and development in the framework of the following four Subtasks and one joint working group:

A: Selection and Analysis of Existing Information;

B: Case Studies;

C: Software Development and Analysis Methods;

D: Documentation and Dissemination;

- Joint Working Group: “Energy Concept Adviser”.

Denmark, Finland, France, Germany, Italy, Poland, UK and USA are members of this annex, with Norway, Canada, Greece and Portugal as observers. Dissemination activities currently include a website, newsletter and articles. An open forum is planned for next year. Currently, eleven case studies representing a wide range of schools and building types have been analysed. It is planned to cover universities, colleges and associated laboratories, halls etc. as well as schools. In total the Annex is planning 30-40 case studies.

Annex 35 – Hybrid Ventilation (HybVent)

The objectives of Annex 35 are:

- To develop control strategies for hybrid ventilation systems in new build and retrofit of office and educational buildings;

- To develop methods to predict hybrid ventilation performance in hybrid ventilated buildings;

- To promote energy and cost-effective hybrid ventilation systems in office and educational buildings;

- To select suitable measurement techniques for diagnostic purposes to be used in buildings ventilated by hybrid ventilation systems.

To reach these objectives, the Annex is structured into three sub-tasks:

A: Development of control strategies for hybrid ventilation;

B: Theoretical and experimental studies of performance of hybrid ventilation. Development of analysis methods for hybrid ventilation;

C: Pilot studies of hybrid ventilation (includes 14 pilot study buildings).

Fifteen countries and the AIVC are participating in this Annex.

The State of the Art Review report has been published, and is available via the Operating Agent, or the ESSU Bookshop. A recent meeting in Belgium attracted 25 attendees from the building industry. The Annex final report, "Principles of Hybrid Ventilation" will be a 30-page booklet with a CD containing supporting material aimed at designers and newcomers to the topic.

Annex 34 – Computer-Aided Evaluation of HVAC Performance

The objective of this Annex is to work with control manufacturers, industrial partners and/or building owners and operators to demonstrate the benefit of computer aided fault detection and diagnostic systems. Methods are based on either stand-alone "PC" based systems or incorporated within a future generation of "smart" building control systems.

Subtasks include:

- Constructing a prototype performance validation system for assisting with the final stages of the commissioning or re-commissioning of HVAC systems;

- Constructing prototype performance monitoring systems to detect unsatisfactory performance by comparing current performance with that predicted by a reference model;

- Interfacing prototype systems to building control systems;

- Testing and demonstrating performance validation and monitoring systems in real buildings.

It is concluded that the design of commercial fault detection and diagnosis (FDD) tools should be user driven. The main beneficiaries of FDD are most likely to be building operators and owners, as well as service providers. In fact, it is very difficult to diagnose some faults from normal operating data. Artificial faults must be introduced when testing tools. Annex 34 has taken basic research to the point where it is ready to be commercially exploited. The final report for this annex is under review.

Annex 33 – Advanced Low Energy Planning – LEP

The purpose of the Annex is to apply modern statistical and analytical tools that have been developed for scientific system analysis to the area of local or urban energy and environmental planning. The approach has been one of direct application to specific towns and cities within participating countries.

The Annex is divided into three subtasks covering:

- Transfer and Sharing of Knowledge;

- Case Studies;

- Guidebook Production and Dissemination.

The final report for this annex is available via the ESSU bookshop.

Annex 32 – Building Envelope Performance Assessment

The final report for this annex has been produced and distributed. The Annex is now formally closed.

Annex 31 – Environmental Impacts of Energy in Buildings

The aim of this study is to understand the total energy and environmental impact of buildings. This is based on such factors as the life cycle of the building itself combined with energy and material throughput during building use. The results are being compiled into a comprehensive handbook covering:

- Theory;

- Analytical Evaluation Tools;

- Applications;

- Benchmarks;

- Databases;

- Case Studies.

A summary report is available for this annex as well as a website, which provides a scientifically based summary of the work.

Annex 28 – Low Energy Cooling

This annex is now formally closed. Check the ECBCS website for publications. Several Annex 28 papers were presented at the Winter 2001 ASHRAE meeting in Atlanta.

Annex 27 – Domestic Ventilation Systems

A new software design tool has been developed during the extension period of this annex and is under review. A handbook/final report is soon to be published. See pages 11-12 for details.

Annex 5 – Air Infiltration and Ventilation Centre (AIVC)

Annex 5 is set to continue for another three year operating period from June 2001. The new Operating Agent is Peter Wouters of INIVe (International Network for Information on Ventilation), based at the Belgian Building Research Institute. A newsletter and CD of publications and information are due to be published in September 2001 to coincide with the annual AIVC conference.

Liaison with Other Implementing Agreements

The IEA ECBCS implementing agreement has close ties with both the IEA Solar Heating and Cooling (SHC) and IEA Energy Conservation through Energy Storage (ECES) implementing agreements.

In November 2000 a successful joint technical workshop was held between ECBCS and ECES in Tokyo, Japan.

Presentations from ECES representatives included:

- a briefing by Professor Halime Paksoy;

- an overview of ECES Annex 8 "Implementing Underground Thermal Energy Storage Systems (UTES), by Dr Bo Nordell;

- ECES Annex 14, "Cooling with Thermal Energy Storage in all Climates", by Professor Halime Paksoy;

- ECES Annex 10, "Thermal Energy Storage with Phase Change Materials and Chemical Reactions", by Professor Fredrik Setterwall;

- ECES Annex 12, "High Temperature Underground Thermal Energy Storage", by Dr Burkhard Sanner; and

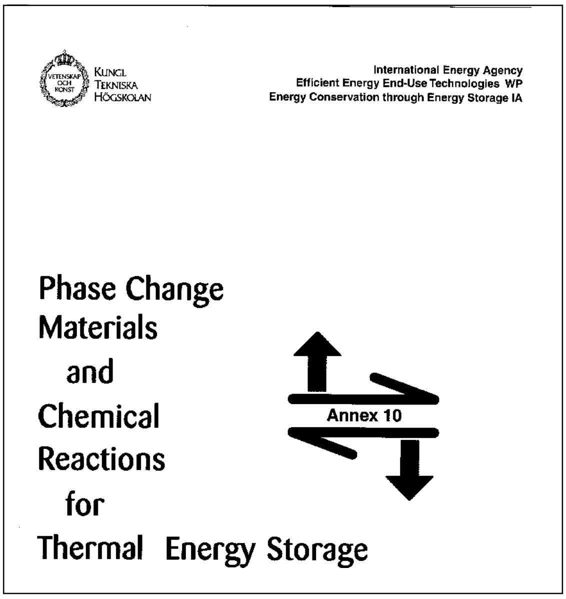
- ECES Annex 15, "Electrical Energy Storage and the Integration of Renewables", presented by Dr Alan Collinson.

Further topics of joint interest discussed included

- hybrid heating and cooling;

- low thermal inertia construction;

- space cooling/heating methods optimized for UTES applications, and others.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International Energy Agency
Efficient Energy End-Use Technologies WP
Energy Conservation through Energy Storage IA

Phase Change Materials and Chemical Reactions for Thermal Energy Storage

Annex 10

Annex 37: Low Exergy Systems for Heating and Cooling of Buildings

Mia Leskinen, Carey Simonson and Markku Virtanen, VTT Building Technology, FINLAND, firstname.lastname@vtt.fi Annex 37 Website: www.vtt.fi/rte/projects/annex37

Summary

This report describes the initiation of the work within Annex 37 and reviews the contents of the first publications to be written in Subtasks A, B and C.

Description of Annex 37

Annex 37 will run for four years, 2000-2003. The participating countries are: Canada, Denmark, Finland, France, Germany, Japan, the Netherlands, Norway and Sweden.

Objectives

The main objective of Annex 37 is to promote the rational use of energy by means of facilitating and accelerating the use of low valued and environmentally sustainable energy sources for the heating and cooling of buildings. The specific objectives are:

- to investigate the technical and market potentials for replacing high valued energy (e.g. fossil fuels and electricity) by low valued energy sources and to assess its impact on global resources and the environment;

- to assess existing technologies and components for low exergy heating and cooling in buildings, to enhance the development of new technologies and to provide the necessary tools for analysis and evaluation of low exergy systems; and

- to develop strategic means for the introduction of low exergy solutions in buildings by case studies, design tools and guidelines.

Subtasks

Four subtasks will be carried out in order to reach the objectives.

Subtask A: Exergy Analysis Tools for the Built Environment

The main objective of this Subtask is to assess and develop a comprehensive set of tools to enable an assessment of low exergy technologies, components and systems.

Subtask B: Low Exergy Concepts and Technologies

The main objective of this subtask is to create a comprehensive database of low exergy concepts, and to assess their advantages, requirements and limitations.

Subtask C: Case Studies and Market Potentials

The main objective of this subtask is to collect practical experiences gained from installed low exergy systems and to analyse the market potential of low exergy systems in different countries.

Subtask D: Documentation and Dissemination

The objective of this subtask is to compile and widely disseminate the Annex research results and to identify the means of influencing the energy policies and regulations in order to promote the use of low exergy systems.

Start of the work under Annex 37

At the Annex's First Expert Meeting in Maastricht (April 5 to 7, 2000), the progress of work was reviewed and the actions for the next six months were decided.

An 'Introduction to the concept of exergy' document has been prepared in Subtask A and is due for publication. [1]

The work on the database of low exergy technologies, concepts, system solutions and their impacts is well underway. Each participant will contribute to the work by filling in one or two pages about one or more low exergy concepts or technologies. The database will contain information about traditional heating or cooling systems for comparison. 'Traditional' in this context would mean the systems widely used in the participating countries. [2]

A report on the side effects of the low temperature heating systems is in preparation. The idea is to demonstrate that, in addition to the desired heating or cooling effect, low exergy systems can provide occupants with a comfortable, clean and healthy environment. [3]

Conclusions

Exergy defines the quality of energy and is an important tool for designing and assessing different heating and cooling systems. In Annex 37, 'low exergy systems' are heating or cooling systems that allow the use of low valued energy as the energy source. In practice this means systems that provide heating or cooling energy at a temperature close to room temperature. There are currently many low exergy technologies available and these technologies will be formed into a database and appropriate design guidelines will be developed during Annex 37. The application of low exergy systems provides many additional benefits besides energy supply benefits such as: improved thermal comfort, improved indoor air quality and reduced energy consumption. These aspects will be promoted to increase the application of low exergy systems for the heating and cooling of buildings.

[1] Subtask A working group, edited by Alain Legault. 2000. Exergy Analysis – Concepts and Facts. Unpublished report.

[2] H H E W Eijdems, A C Boerstra, P J M Op 't Veld. 2000. Low Temperature Heating Systems: Impact on IAQ, Thermal Comfort and Energy Consumption. Unpublished article for the first Annex 37 Newsletter.

[3] Zöllner, G, et al. 1985. Wärmeabgabe; wärmetechnische prüfung und auslegung von warmwasserfussbodenheizungen, *Proceedings Clima 2000, Summaries and author index*, Vol. 7, pp. 341.

The following brief articles give an introduction to ongoing work for Annex 37

Low Exergy Concepts and Technologies

In the database of low exergy heating and cooling systems for buildings, the systems were divided into the following groups:

- Surface heating and cooling systems (floor, wall and ceiling heating and cooling or phase change material surfaces)

- Air heating and cooling systems (air-to-air heat exchangers, water-to-air heat exchangers, steam or vapour-to-air heat exchangers and passive systems like atria or evaporative cooling)

- Metabolic systems (biological systems like bacteria, animals or plants)

- Heat generation (boilers, heat pumps, solar collectors, CHP, waste heat)

- Thermal storage (seasonal or short term)

- Heat distribution systems (liquid or air as transfer medium)

- Conventional systems (for comparison purposes)

During the first three meetings of Annex 37, many examples of low exergy systems in the participating countries were presented.

In Finland, the use of district heating is very common and air-to-air heat recovery is widely applied. Now there is even a specific system concept called Thermonet[a] that provides district cooling. Thermonet[a] offers different concepts for various needs of energy management e.g. in swimming halls, super markets, office buildings etc. The idea is to use an integrated system solution to promote the use of low valued energy like waste heat or solar heat. Another Finnish system concept is Sensus, which is designed to provide occupants with a desired indoor climate (including temperature, draft and lighting).

The Germans have worked a lot with large-scale solar systems with long-term energy storage. This represents a low exergy system, where the low temperature level of the distribution network will significantly improve the efficiency of the whole system.

At the second preparation phase meeting in Montreal, the Japanese presented an exergy analysis for a composting tank. In this case it was not used for heating, but the analysis showed, that biowaste produces low temperature heat, and perhaps could be used for heating under some circumstances.

The Dutch have initiated an implementation program for low temperature distribution systems (like floor and wall heating systems), which includes feasibility and theoretical studies, field experiments and demonstration projects. In their studies they have found that floor and wall heating systems offer great benefits for indoor air quality, thermal comfort and energy savings.

Side Effects

Major savings in energy consumption can be realised by fully utilising the potential of *Low Valued Energy. Low Valued Energy* is available from residual heat, ambient heat and renewable sources. It can be used for Low Temperature Heating (LTH) in residential and commercial buildings, but the buildings and installations should be designed for low temperature distribution systems. Appropriate distribution systems, like floor and wall heating, have a life cycle of 40 to 50 years. Therefore to implement *Low Valued Energy* sources within the next half century, heat distribution systems should be designed for lower temperatures as soon as possible. Aware of this need for quick action, the Netherlands Agency for Energy and the Environment (NOVEM) initiated an implementation program in 1996. This program has demonstrated that, besides the argument of savings in energy supply, there are additional benefits in the fields of:

- Indoor Air Quality (particles, mites, lower air temperature, annoyance and dust);

- Thermal Comfort (radiant heat, temperature gradient, radiant heat asymmetry, floor temperature, temperature fluctuations, heating up period, cooling, air velocities and draught);

- Energy Consumption (transmission/ venting losses, transport energy, utilisation of gains).

Other possible benefits include: reduction of burning risk, extra space due to the absence of radiators and other equipment, reduction in mould growth, etc. By highlighting these additional benefits a quicker and broader introduction of LTH-systems may occur. In addition, application on a broader scale will also lower the prices of these systems. Many disadvantages can be avoided by proper designs and compensating measures. Arguments against LTH-systems often appear to be based on negative experiences in the past (poor design or installation) or a lack of knowledge.

Due to a better insulation of new and retrofitted buildings and new techniques for reducing ventilation losses, the heating demand of modern buildings is decreasing. This ongoing trend enables a broader application of LTH-designs for the smaller heating capacities needed. Wall and floor heating systems fit very well into an LTH-design, but also air heating, enlarged radiators and enlarged convectors can be applied. LTH-designs can be defined according to the design temperature ranges given in Table 1.

Thermal Comfort

The radiant heat transmission component of LT-systems is much higher than for other systems. Therefore the convection heat transfer is reduced and the air temperatures can be 1–2 °C lower and provide the same comfort level. It is presumed that radiant heat transfer (i.e., relatively cool air and warm surrounding surfaces) better satisfies the comfort needs of human beings because it is more ‘natural’ (like solar radiation on the skin).

In computer simulations and laboratory and field experiments, a clear difference was found in vertical temperature gradients between floor and HT-radiator heating. With floor heating, practically no temperature distribution is found in well-insulated buildings, but the temperature distribution resulting from radiator, wall and other heating systems are very dependent on the design. Normally, gradients range from 2–3 °C between floor and ceiling, while poorly designed systems show gradients up to 7 °C. In particular, the gradient between ankle and head levels influences the perceived thermal comfort.

Cold window surfaces can cause discomfort by radiant heat losses, which are not in balance with radiant heat flows in other directions. Complaints occur when differences exceed 23 W/m^2 or 10 °C. Conventionally, compensation was provided by placing hot radiators close to the cold surfaces, but due to better insulating windows, this aspect is becoming less important. At higher U-values, the height of the window can be restricted or compensation, for instance by extra heating in the outer circle of floor heating system, is recommended. Discomfort from heated floor or wall surfaces does not occur.

A heated floor increases the comfort in many applications. Floor covering, like carpets, is not needed for walking bare-foot or sitting on the floor (e.g., at home, nurseries and swimming pools). Optimal floor temperatures range from 20-28 °C with shoes and 23-30 °C with bare feet depending on the flooring material.

Temperature fluctuations around a constant mean value are annoying for occupants and LTH-systems provide fewer fluctuations because LTH-systems have a greater inertia and the driving forces are smaller due to large surfaces and low temperature differences. Inertia is often considered to cause discomfort during solar gains or sudden changes in internal gains, but in fact, LTH-systems have ‘self-regulating’ abilities. Since LTH-systems operate at small temperature differences, any change in the indoor temperature has a relatively large effect on the heat supply and therefore the heat supply reacts almost instantly to temperature changes in the interior.

Conventional heating systems have a shorter heating-up period (after cooling down e.g. for 8 hours) due to the inertia of direct connected thermal mass for floor and wall heating systems. The temperature raise for LTH-systems, however, is much lower than for HT-systems. Moreover heating up is often associated with air temperatures, but considering operative temperature (mean value of air and radiant temperature) reduces the differences between LT and HT- heating systems.

Increasing the insulation grade of buildings together with reducing ventilation losses and utilising solar gains, increases the risk of overheating during the summer. LTH systems can often be adapted for cooling easily and inexpensively, especially when com-

Table 1. Definition of temperature ranges for heating designs

System	Supply Flow	Return Flow
High temperatures (HT)	90°C	70°C
Medium temperatures (MT)	55°C	35-40°C
Low temperatures (LT)	45°C	25-35°C
Very low temperatures (VLT)	35°C	25°C

bined with a ground collector (and heat pumps).

Draught can be caused by cold (window) surfaces, at which the air in the boundary layer cools down and flows downwards. This can be avoided for instance by placing hot radiators under the window. Laboratory studies show that mean air velocities for HT radiators and floor heating are in the same order within the living zones. The fluctuations around the mean value however (turbulence-intensity) are about 20 % higher with HT radiators. Applying well-insulated glazing and limited window heights (max. 1.7 m for clear double-glazing) reduces sufficiently the risk of draught with floor (and likely for other LT) heating systems. Special attention is needed for natural supply grills in the facade for ventilation.

Indoor Air Quality

In a field study in Finland, visible dust on floors was found to correlate to neurotic complaints like headache, fatigue, and concentrating problems, etc. LT-heating was found to give less eye-irritation and throat and other mucous diseases. Also a correlation was found between the temperature of the heating surface and particle deposition. It is assumed that the lower air fluctuations from LTH-systems results in a lower quantity of suspended particles in buildings.

Many studies show a positive effect from floor heating on reduction of the mite population in dwellings. This is mainly caused by a lower relative humidity (RH) in the boundary layers above the floor (within the floor covering). The mite survival threshold is 45 % RH during long term. Floor heating systems have been calculated to reduce the RH in the boundary layer by about 10% RH, which just suffices to bring the RH under the threshold value.

As a result of the high contribution of radiant heat transfer, the room air temperature can be 1-2 °C lower for LTH systems. Several studies show a better performance for stuffiness and perceived air quality at lower air temperatures. Mucous irritation complaints increase significantly at air temperatures over 22-24 °C. The annoyance from all kinds of emissions (TVOC etc) is correlated to the air temperature and a correlation has been found for Sick Building Syndrome and the air temperature.

Inhaling dust can cause allergic reactions and the sensitivity of humans to inhaled particles is more dependent on the quality of the particles than on the quantity. At temperatures exceeding 55 °C, the process of dust singe starts. The particles get more reactive and irritating from the higher temperatures that occur at HT heating elements. So LTH systems not only give less suspending particles in the air but moreover the particle spread is less aggressive due to absence of dust singe.

Energy Consumption

Due to floor and wall heating, the mean temperatures in the heated constructions are higher during the heating season. Heated walls in the outer envelope have up to 50 % large heat losses, but applying a thicker insulation layer (2.5-5.0 cm thicker) in heated constructions can easily compensate for these extra losses. Transmission losses from hot air flowing along window surfaces are reduced with LTH.

In buildings with LTH, the ventilation losses are lower due to the lower air temperatures. In particular infiltration and natural ventilation cause less energy consumption. For ventilation systems with balanced air exchange and heat recovery the savings are smaller.

Larger flows of the heating medium might need to be transported because of lower temperature intervals (especially with floor heating). In combination with a heat pump a continuous heat flow is preferred at the lowest possible supply temperatures. Therefore the duty cycle of the transport pump will often be higher for LTH systems. Extra transport energy can be restricted to about 400 MJ electricity per year (on an average domestic electricity consumption of 10 GJ/year) by a good hydraulic design.

In buildings with average insulation levels, solar and internal gains are utilised 100 % for reduction of auxiliary heat demand. In light mass buildings with improved insulation, the utilisation of gains decreases. The energy saving from better utilisation is also dependent on the layout of the heating system and thermal zoning in the building (e.g. through transport of solar gains by a floor system from south to north zones).

New Publication

IEA Energy Conservation in Buildings and Community Systems Programme: Annex 27

Evaluation and Demonstration of Domestic Ventilation Systems: Final Report

Contents

The main motivation for initiating this Annex was the need to develop tools to better evaluate domestic ventilation systems in various situations. Different systems in various climates must handle situations with a large range of residential behaviour. With the use of the most complex models and development of new ones, a large number of combined situations enable us to develop simplified tools, that can be used by practitioners in specific cases.

This report presents the various simplified tools and an application of the use of the tools on a specific case. The detailed results on which the simplified tools are based can be found in more detailed background reports.

Participation

The countries which have participated in this task are: Canada, France, Italy, Japan, The Netherlands, Sweden, UK, and the USA.

Introduction

This report is a concluding work and a summary of all the background reports for the project.

Background

Ventilation is of major importance for the wellbeing of people in their homes. The rate of outdoor air supply, as well as comfort aspects associated with air distribution and the ability of a system to remove pollutants, are important factors to be considered at the design stage, during the commissioning procedure and when using the building during its lifetime.

The two main purposes of ventilation are to obtain an acceptable indoor air quality and to avoid degradation of the building fabric, e.g. rot in wood, rust on steel. “Acceptable indoor air quality” is not easy to define, especially in dwellings. However, everyone should have the right to acceptable indoor air quality at home. As distinct from a workplace, residents’ sensitivity can vary widely from an allergic infant to a well trained sportsman, from an active person spending most of their time outdoors to an elderly person confined to a life indoors.

Over the lifetime of a building, its occupancy patterns will vary. This results in a varying need for outdoor air to obtain acceptable indoor air quality (IAQ) and avoid degradation of the fabric. Emissions from building materials are also time dependant. When the building is new or recently refurbished it may be necessary to dilute the emissions by increased flow rate. In standards and codes the supply air needed in a dwelling is generally based on the maximum number of persons living in the dwelling defined by the possible number of beds contained therein. Statistics from various IEA countries indicate that, in general, about 50 % (range 46 – 71 %) of dwellings have only one or two residents.

Dwellings represent about 25 – 30 % of all energy used in the OECD countries, and domestic ventilation will in the future represent up to 10 % of the total energy use. Thus even a relatively small reduction in overall ventilation levels could give significant savings in total energy use. Of course, the greatest potential for savings lies in existing buildings.

Today there is a vast range of different ventilation strategies in the different OECD countries. In some countries the only ventilation present is adventitious ventilation and window airing, while in others natural stack ventilation systems are more or less in common use. In countries with colder climates, mechanical systems have been installed in new buildings over the last 15 – 20 years. The systems are either exhaust only or balanced, with or without heat recovery units. However, the majority of dwellings still have natural ventilation, even in countries with colder climates.

Improvement of residential ventilation is of concern in both existing and future buildings. The functioning of the ventilation systems can deteriorate at all stages of the building process and during the life-time of the building.

Objectives

The overall objective has been to develop tools for better selection of domestic ventilation systems, that can better predict the expected indoor climate and make a choice for the most likely situations in dwellings. The work within IEA Annex 27 has been to:

- Develop tools for evaluating domestic ventilation systems

- Validate that the methods work

- Demonstrate the tools

The main aim in this report is to give guidance on how to use the tools for evaluating domestic ventilation systems in different situations.

The Subtasks

The Annex has been divided into subtasks dealing with specific topics. The main goal, to produce tools usable for practitioners, has resulted in splitting up the work in the following way:

First the background data was collected in a State of the Art report (Månsson 1995) which included statistical data on housing, frequently used systems, standards and codes, reviews of recent research reports on material emissions, residents' behaviour, and evaluation methods. The report was a collection of background material for the assumptions needed in the ensuing work.

Simplified tools were developed for evaluation of ventilation systems. Tools have been developed for energy, thermal comfort, noise, inside to outside pressure difference, life cycle cost, reliability, user and building aspects, indoor air quality for constant emission sources, CO_2, tobacco smoke, cooking products, water vapour in habitable rooms and the bathroom.

There was a need to validate the developed simplified tools. Hence measurements have been performed in a range of dwellings both to validate the tools and give background material.

Target Audience

Decisions on ventilation are made in all countries by standards bodies, policy makers, companies involved in the housing industry, and others. But these decisions have often been made without a comprehensive evaluation method. Research in recent years described in the IEA Annexes, for instance, has now made it possible to formulate such methods to evaluate domestic ventilation systems. The tools developed can be used both for new and for existing dwellings undergoing renovation, and for detecting, analysing and solving problems.

Handbook Use

In general the handbook can be used for new dwellings, the renovation of existing buildings and to find explanations for certain situations for existing systems. A flow chart provides a very easy way to handle the tools, and for each of the tools, there are tables which provide results mostly in a qualitative way. The selection of one parameter may give an excellent quality for one tool whilst giving an adverse effect on another one. This might result in an iterative procedure, necessitating going through the flow chart more than once, to come to a final satisfactory result.

The easiest way is to look at the 'Application' chapter first, and then go back to each of the tool chapters to find the result of your own chosen example.

For those who are interested in detailed analysis, where the number of residents varies over the life time of the dwelling, and different sizes of dwellings, we recommend you read the more detailed background reports. This is also the case if you want to use your own experienced values for e.g. reliability of system performance and life cycle cost calculations.

The handbook will be published soon.

To order a copy, contact Janet Blacknell, ESSU Bookshop, at the address on page 16 of this newsletter.

Focus on Completed Projects - Technical Synthesis Reports

The technical synthesis reports are a series of overview publications which contain a summary of the relevant ECBCS annex. They are primarily aimed at building services practitioners, designers and policy makers who require background knowledge of the subject. They are designed to be accessible to the non-expert and to give an introduction, making reference to the full Annex reports whenever necessary.

Seven reports are currently available via the ESSU Bookshop, price £20.00 plus postage. Three more reports are in preparation, for the following annexes:

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

Annex 27: Evaluation and Demonstration of Domestic Ventilation Systems

Annex 30: Bringing Simulation Models to Engineers

The seven published reports are as follows:

Annex 16 & 17: Building Energy Management Systems (TSR 01)

Annex 18: Demand Controlled Ventilating Systems (TSR 02)

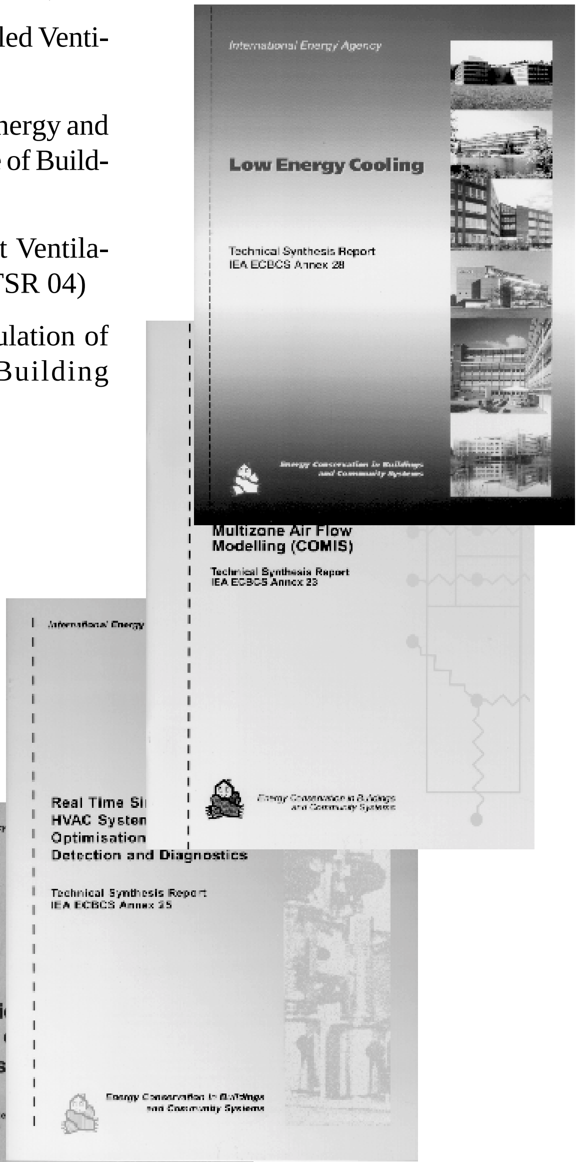
Annex 21: Calculation of Energy and Environmental Performance of Buildings (TSR 03)

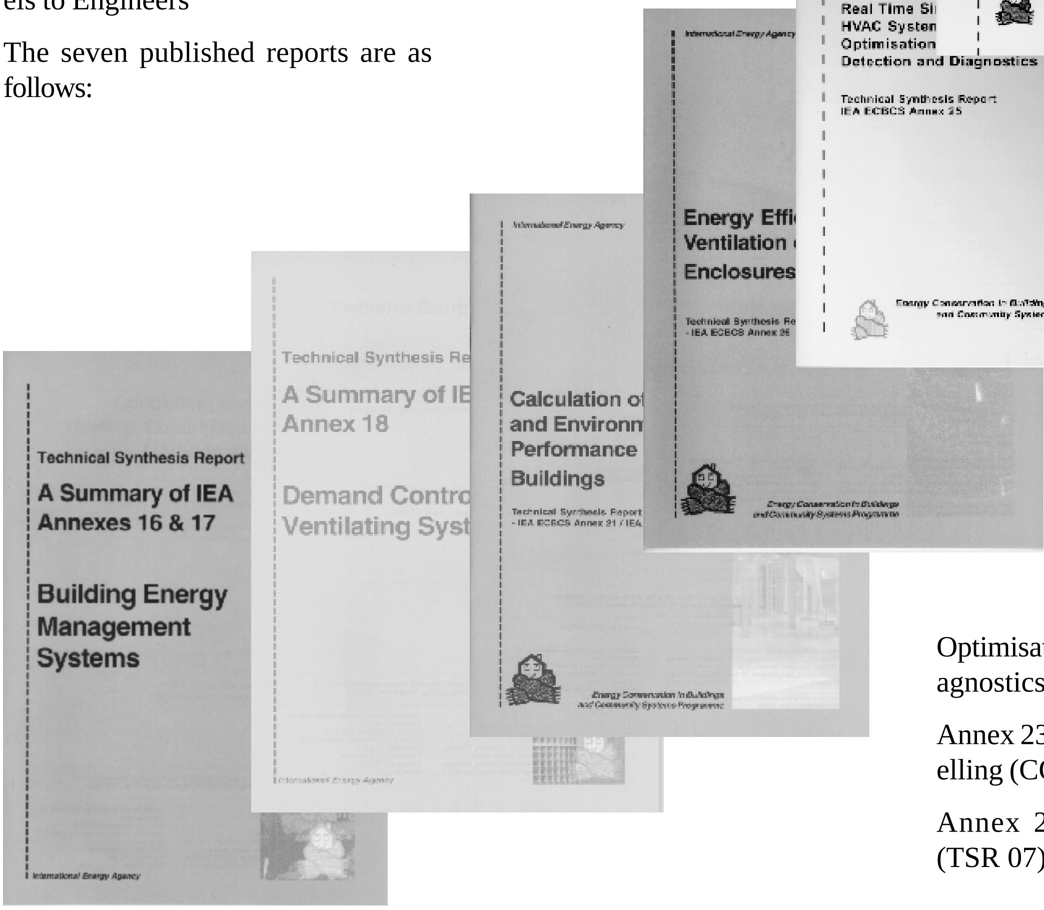
Annex 26: Energy Efficient Ventilation of Large Enclosures (TSR 04)

Annex 25: Real Time Simulation of HVAC Systems for Building Optimisation, Fault Detection and Diagnostics (TSR 05)

Annex 23: Multizone Air Flow Modelling (COMIS) (TSR 06)

Annex 28: Low Energy Cooling (TSR 07)





Publications and Final Reports for the ECBCS Programme

Published reports are available from the following completed projects:-

1. Load Energy Determination of Buildings (1977-80)
3. Energy Conservation in Residential Buildings (1979-82)
6. Energy Systems and Design of Communities (1979-81)
7. Local Government Energy Planning (1981-1983)
8. Inhabitant Behaviour with Regard to Ventilation (1984-87)
9. Minimum Ventilation Rates (1982-86)
10. Building HEVAC Systems Simulation (1982-87)
11. Development of Tools for Energy Auditing of Buildings (1982-87)
12. Windows and Fenestration (1982-86)
13. Energy Management in Hospitals (1985-89)
14. Condensation and Energy (1987-90)
15. Energy Efficiency in Schools (1988-90)
16. Building Energy Management Systems 1: User Interfaces and System Integration (1987-91)
17. Building Energy Management Systems 2: Evaluation & Emulation Techniques (1988-92)
18. Demand Controlled Ventilation Systems (1987-92)
19. Low Slope Roof Systems (1987-93)
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21. Calculation of Energy & Environmental Performance of Buildings (1988-93)
22. Energy Efficient Communities (1991-93)
23. Multizone Air Flow Modelling (1990-94)
24. Heat, Air and Moisture Transport (1991-95)
25. Real Time Simulation of HVAC-Systems for Building Optimisation, Fault Detection and Diagnosis (1991-95)
26. Energy Efficient Ventilation of Large Enclosures (1993-96)
27. Evaluation and Demonstration of Domestic Ventilation Systems (1993-1998)
28. Low Energy Cooling (1993-97)
29. Daylighting in Buildings (participating via IA-SHC) (1995-99)
30. Bringing Simulation to Application (1995-98)
31. Energy Related Environmental Impacts of Buildings (1996-99)
32. Integral Building Envelope Performance (1996-99)
33. Advanced Local Energy Planning (1996-98)

Energy Efficiency in Educational Buildings (Working Group)

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

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Current Projects and Operating Agents

5 Air Infiltration and Ventilation Centre (1979-)

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27 Evaluation and Demonstration of Domestic Ventilation Systems (1993-)

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34 Computer Aided Fault Detection and Diagnosis (1997-2001)

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35 Control Strategies for Hybrid Ventilation in New and Retrofitted Office Buildings - HybVent (1998-2002)

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http://hybvent.civil.auc.dk

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

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www.annex36.bizland.com

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

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

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39 High Performance Thermal Insulation Systems (2001-)

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

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