International Energy Agency

ECBCS

Energy Conservation in Buildings and Community Systems Programme

Commissioning of Building HVAC Systems for Improved Energy Performance

A First Vision of the Achievements of ECBCS Annex 40

Jean Christophe Visier,

Centre Scientifique et Technique du Bâtiment, France

Why use commissioning?

The demands of building users regarding the environment are growing. There are increasing requirements for comfortable and healthy indoor environments with no excessive use of natural resources and pollution of the outdoor environment. The heating, ventilation and air conditioning industry seeks solutions to fulfil these requirements. Many new products and systems are developed such as high efficiency generation systems using renewables, low energy cooling systems, natural ventilation systems, integrated control systems, etc. It is important to integrate energy efficient products with other building systems.

Moving from products to systems enables the development of more efficient and flexible solutions but leads to a higher level of complexity: complexity for the building owner who defines their demands in more detail; complexity for the designer who has to define a full system on the basis of a growing number of attractive components; complexity for the installer who has to install systems which are all different and often innovative; complexity for the users who have access to more and more choices for the operation of the building.

The management of this complexity demands new approaches, new skills, and new tools. Commissioning is one of these new approaches to manage the complexity of today's HVAC systems.

ECBCS Annex 40 have focused their efforts since 2001 on the development of tools for the commissioning of HVAC systems. A few months before the end of the Annex an overview is presented

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here of the main achievements of the project.

These achievements can be split in four categories:

- tools to manage the commissioning process,
- manual commissioning tools,
- approaches using building energy management systems for building commissioning,
- approaches for the use of component as well as whole building models to improve commissioning.

These results are supported by field application of the tools in several buildings throughout the world.

Tools for the commissioning process

The key challenge to commission a building is to manage the process well. A central document is the commissioning plan which defines the actions to be performed.

The commissioning plan is the key tool for the different players to understand:

- what is meant by commissioning on a specific project?
- what amount of effort and money it will require?
- how it will be managed?

Three types of tools were developed or used within the Annex to support the definition and application of the commissioning plan: standard model commissioning plans, checklists and matrices for quality control.

Examples of standard model commissioning plans, check lists and matrices for quality control will be available on the final Annex CD. They will be supported by descriptions of their application to different projects.

In addition to these tools, a detailed multi-lingual glossary has been developed and will be available in the Annex report and CD.

Manual commissioning tools

Functional performance tests are the core of commissioning. They are devoted to the detection of possible malfunctions and to their diagnosis. The malfunction may be due to: selection or sizing mistakes, manufacturing faults or initial deterioration, installation faults, wrong tuning, control failure, or abnormal conditions of use.

A standard format was defined to describe the Functional Testing Procedures and different procedures were developed and applied. The Annex report describes a general approach to developing FPT procedures, a set of documented procedures and also includes a description of the main sources of existing FPT.

The use of building energy management systems to assist in building commissioning

Building energy management systems (BEMS) are seen by some players as a future key tool to enable an efficient commissioning. Nevertheless this objective can be achieved only if the BEMS system itself is properly commissioned.

The Annex has reviewed the state of the art of BEMS commissioning in Japan, Canada, USA and France. The results presented in the report highlight gaps and opportunities.

The Annex has then clarified the different approaches for using BEMS to commission HVAC and energy systems. Four main techniques were studied to implement automatic commissioning tools:

- model based,
- rule based,
- performance index based, and
- control logic tracer based.

A model-based method involves comparing predictions of a model with the measured performance of a component or system.

A rule-based method transforms physical and logical prior (expert) knowledge of a system into a set of rules, e.g., IF/THEN statements. The rules should duplicate the same reasoning that an expert would use. Performance indices are calculated values or control values that quantify the performance of a control loop, component, or system.

The performance index-based method involves comparing indices of similar controllers or components under specific conditions (outside air temperature, humidity, etc) or under a specific period (instantaneous, one hour, one week). Limits can be set to define a range of values corresponding to acceptable behavior and values that lie outside the range can indicate that a problem exists.

The control logic tracer approach allows control algorithms to be visualized and understood by designers and operation managers. This understanding enables the diagnosis of failures by tracking down the causes when an operation or control in a HVAC system fails.

In addition to the description of these different techniques and the approaches followed to implement them in real BEMS systems, the final report describes 8 automated tools tested during the Annex.

Use of models in Commissioning

Models are more and more widely used for the design of HVAC components and for whole buildings and energy systems. The Annex has developed approaches for the application of models for commissioning purposes.

At the component level, two main uses of models were studied:

1) Using models to perform Functional Performance Tests. The goal here is to include the model in the Functional Performance Testing Procedure applied on site.

2) Using models to design tests. The aim is here to optimize the Functional Testing Procedure. In this case, the models are used by the test designer

but not by the people who apply the tests.

The steps to follow in these two cases are described in the Annex report. A library of models adapted to commissioning as well as a set of functional performance testing procedures using models have been documented by the Annex.

A clear understanding of the different possible uses of models at the whole building level for commissioning was achieved by the Annex. Six categories were defined:

1. Use early in the design process to assist in "commissioning" the design.
2. Use in the standard commissioning of new buildings.
3. Use of design simulation for on-going commissioning.
4. Use of calibrated simulation for retro-commissioning.
5. Use of calibrated simulation for on-going commissioning.
6. Use of simulation to evaluate new control code.

A series of papers illustrating each of the simulation applications will be available on the Annex CD.

Commissioning projects

Most of the tools developed within the Annex have been applied in real commissioning projects. The Annex report includes a synthesis of these projects, and presents a vision of the variety of applications of commissioning.

The Annex CD and report will be available in spring 2005. The Annex results have been presented at the ICEBO conference in Paris on October 18th – 19th, 2004:

ddd.cstb.fr/icebo2004

www.ecbcs.org/annexes/annex40.htm

Increasing Energy Efficiency for Improved Life Cycle Performance of the Finnish Real Estate Sector

Summary of the IEA ECBCS Technical Day 9th June, 2004, Porvoo, Finland

Dakota Lavento, Finland

The 55th meeting of the IEA ECBCS Executive Committee was recently hosted in Porvoo, Finland, from the 10th to the 11th of June 2004. The preceding Technical day, held on 9th June, 2004, provided interesting and informative talks about increasing energy efficiency for improved life cycle costs, with speakers representing both the leading Finnish authorities on the subject and experts from around the world.

The aim of the seminar was to inform Finnish real estate and construction players about activities and achievements within the IEA Energy Conservation in Buildings and Community Systems Programme, but also to promote discussion between Finnish real estate and construction players and the wider international energy research community.

Dr. Ari Ahonen, the technology Director of Tekes, the National Technology Agency of Finland found it easy to explain why his countrymen lead progress in this field. " We are such a small nation. As everybody knows each other, developments goes smoothly. In bigger countries the real estate and the building sectors have not actually met yet", he says.

Dr. Ahonen gave his speech on major trends of technology development and the process of reforming the construction and real estate cluster in Finland.

Tekes is the main financing organization in applied research and development in Finland. By the late 1990´s, it had created a cluster-based strategy for the construction area which is widely believed to have succeeded. For the most part, it has been adopted by the whole construction industry in Finland.

The time has now come to set new targets for the whole industry. "The targets would set by the cluster and Tekes is going to play a supporting role in the cluster Mission, which is to move from cost reduction to maximizing added-value," Dr. Ahonen said.

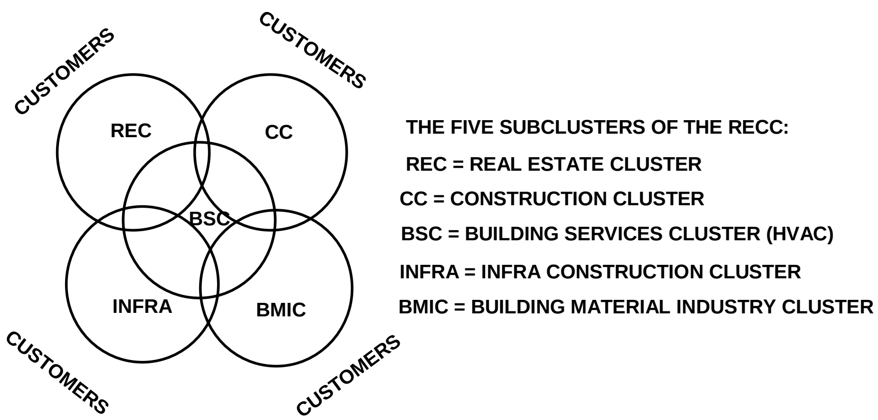

Figure 1: Tekes' Cluster Strategy 1997 - 2003 (Phase 1)

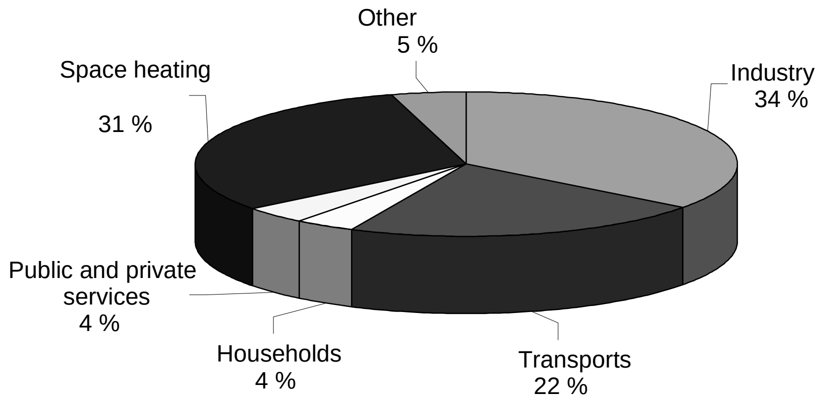

Figure 2: Carbon dioxide emissions from energy use in Finland (total approximately 60 million tonnes)

He sees research and development (R&D) as an essential part of business, but on the whole, awareness about research in this field should be raised within companies. Moreover, the time of solely national research, development and construction business operations is over. The end users, meaning both companies and consumers, are becoming more and more global, dragging the real estate business along behind them.

Dr. Ahonen presented a new vision for the Real Estate and Construction Cluster (RECC), a whole new way of thinking.

"The whole RECC has to harmonize standards, norms and regulations globally, as well as operate and network globally. In the future the real estate and construction business has to adopt a more transparent way of operating."

"As the ever increasing requirement of knowledge and reliable data multiplies, information and communications technology (ICT) becomes the core of the RECC business. Moreover, the future relies on innovation management, evolving to become the driving force of business networks in the RECC. "

"The future is based on a competent, strong, open minded and forward looking cluster, which is

– based on collaboration between private and public sectors,

– has a clear mission and vision,

– positions itself internationally and has a true international strategy.

In addition it has to have an open and successful collaboration between private companies, universities, and research institutes, forming a platform to the global visions."

This vision entails transformation and change management of business networks in every company and open communication throughout the whole industry.

"The RECC will see the development of more modern and versatile basic education and training in higher education, while fine tuning higher education and outsourcing research internationally. That will lead to active development all over," Dr. Ahonen concluded.

The Director of Customer Service and Business Development, Ilari Aho, from Motiva then described the targets for energy efficiency and environmental impacts of the real estate sector. Motiva is an impartial service organization promoting the market for renewable energy sources and efficient energy use. It produces, refines and disseminates information, develops methods and boosts the introduction of advanced technologies. It also implements the government's decisions on energy conservation and promotion of renewable energy sources.

"We need the R&D, but the impact of actual economic mechanisms are essential for change. Regulatory means, such as the building code and taxation are needed to force a change. Taxation has already proved influential", emphasized Director Aho. He listed energy tax and vehicle tax, which in themselves are penalizing, but also tax subsidies for renewable power production and other subsidies, which, of course, are rewarding.

Voluntary actions, such as energy conservation agreements, adopting clean development mechanisms, improving energy efficiency by

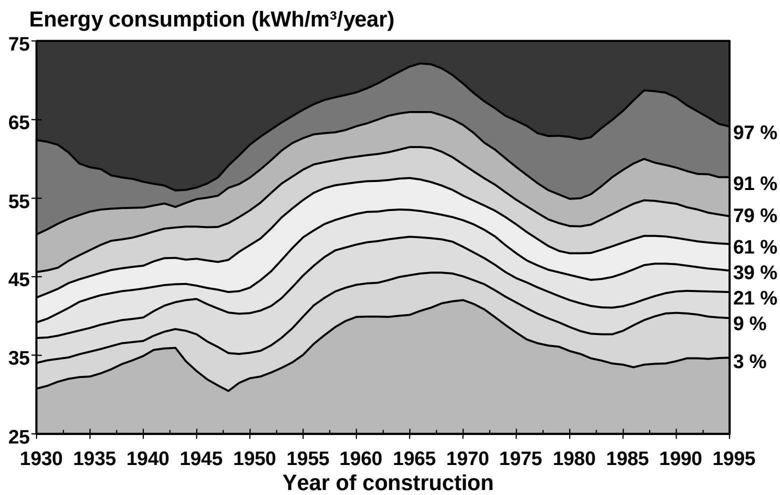

Figure 3: Energy consumption for space heating - Finnish apartment buildings

renovation and development of urban structure, still require official support.

The objective of the national programme is to achieve a total of approximately a quarter of Finland's targeted greenhouse gas reduction by means of energy conservation measures by 2010. Measures to increase the use of renewable energy are expected to account for another quarter of the reduction. On the whole, targets of voluntary agreements in the Energy Efficiency Programme are challenging: 80 percent of the existing building stock should be audited by the year 2005 and in the rental housing sector, by five years later. Space heating should have been reduced by 10% by 2005 and by a further 5% by 2010. Moreover, we should see the end of growth in specific electricity consumption by 2005.

"The current Finnish building code regulates technical characteristics of individual building elements, such as U-values or heat recovery. The last revision in 2003 meant a 20% - 30% improvement in required minimum levels. The next ongoing revision driven by the Directive on the Energy Performance of Buildings, will see only minor changes in minimum requirement levels, but a major change of approach from individual building elements to overall energy performance requirements. Even major refurbishments will be included within the explicit scope of building regulations. "

"Targets will be defined and initiatives driven by the national climate strategy.

There will be strong political emphasis on the existing building stock, voluntary measures, public-private partnership and the deployment of market-based mechanisms in developing the energy efficiency of the real estate sector," Director Aho concluded.

Sector	Efficiency indicator	Indicator value 1999	Change 1999 - 2010		ECP/BAU by 2010
			BAU[1]	ECP[2]	
Industrial fuel use	Mtoe/value added	0,06	-22 %	-25 %	96 %
Industrial electricity use	kWh/value added	0,25	-20 %	-21 %	99 %
Space heating (residential and tertiary)	kWh/m^3	47	-8 %	-17 %	91 %
Electricity use in households	MWh/ household	4,7	0 %	-2 %	98 %
Electricity use in the tertiary sector	kWh/value added	0,03	-13 %	-16 %	97 %
Private car transports	l/vehicle/year	1211	-19 %	-24 %	94 %
Total primary energy consumption	Mtoe/GNP	0,05	-14 %	-18 %	96 %

[1] Business as usual [2] Energy Conservation Program

Table 1: Energy efficiency targets for Finland

Energy-Efficient Future Electric Lighting for Buildings

New ECBCS Research Project (Annex 45)

Liisa Halonen and Eino Tetri, Helsinki University of Technology, Finland

Background

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

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

Objectives

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

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

Scope

The potential for energy savings are very large and can be further increased by integrating electric lighting, daylighting and HVAC systems. The implementation of new light sources, integrated and ‘smart’ controls and innovative luminaires provides the opportunity for much greater variation in the spatial distribution, spectral content and temporal control of various light sources. As lighting moves into this more dynamic regime, it is critical that the impact on performance of the system components, the end user, and associated integrated building systems are well understood, documented and predicted. This knowledge will help to optimize the energy efficiency of new and existing building-integrated systems, improve the implementation of the new technologies, and accelerate the introduction of more energy efficient and ergonomic products and procedures, thus providing better working environment and cost-effectively contributing to the global reduction of greenhouse gas emissions.

The components that affect the total lighting energy use are:

- the lighting equipment used (lamps, ballasts, luminaires, sensors, etc),
- the lighting performance targets and design of lighting, and
- the control and integration of lighting.

The project structure is shown in Figure 1. It will be run using four subtasks to achieve its goals.

Subtasks

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

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

Subtask B Innovative technical solutions

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

Subtask C Energy-efficient controls and integration

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

Subtask D Information dissemination

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

Management of the Annex

The Annex is managed by the Operating Agent with the assistance of four Subtask Leaders.

Operating Agent: Finland, Helsinki University of Technology, Professor Liisa Halonen

Subtask A Leader: France, École Nationale des Travaux Publics de l’État (ENTPE), Professor Marc Fontoynont

Subtask B Leader: Austria, Zumtobel Staff GmbH, Dipl.Ing. Peter Dehoff

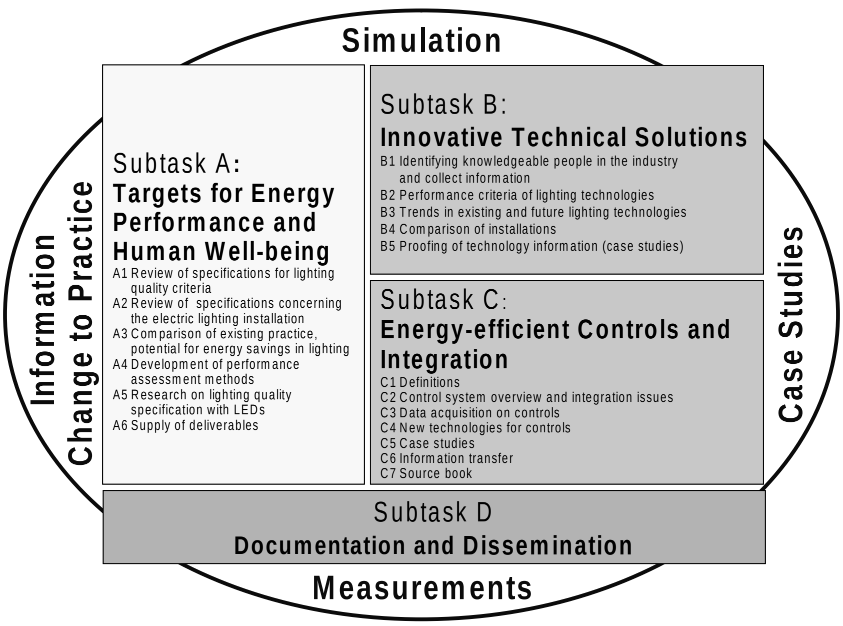

Figure 4: Structure of the new ECBCS research project on energy efficient future electric lighting for buildings.

Subtask C Leader: Germany, Technische Universität Berlin, Professor Dr. rer. nat. Heinrich Kaase

Subtask D Leader: Finland, Helsinki University of Technology, D.Sc. Eino Tetri.

Schedule

The research project was formally accepted as ECBCS Annex 45 in June 2004. The Annex will run for four and a half year, with the first six months for preparation and the following four years for carrying out the work.

For more information about the project, please contact Liisa Halonen (liisa.halonen@hut.fi) or Eino Tetri (eino.tetri@hut.fi) from Helsinki University of Technology. Alternatively information can be found on the Web:

www.ecbcs.org/annexes/annex45.htm

Air Infiltration and Ventilation Centre

The IEA ECBCS Information Centre on Ventilation-Related Aspects of Buildings

Peter Wouters, INIVE eeig, Belgium

The Air Infiltration and Ventilation Centre (AIVC – www.aivc.org) is operated under Annex 5 of the Energy Conservation in Buildings and Community Systems Implementing Agreement of the International Energy Agency. Created in 1979 and this year celebrating its 25th Silver Jubilee Conference, the primary objective of the AIVC is to provide a high quality international technical and information forum covering the areas of ventilation and air infiltration in the built environment with respect to efficient energy use, good indoor air quality and thermal comfort. The main drivers for this work are the national and international concerns in the areas of sustainable development, responses to climate change impact and healthy buildings.

The AIVC provides different services which can be grouped as follows:

- a technical forum for all relevant international and national ventilation and related activities;
- synthesised leading edge research information to meet industry needs;
- synthesised information for the research community, policy-makers, industry with emphasis on the end-use and practice;
- advice on cost-effective measures for energy efficient buildings and good indoor climate conditions.

The Annex is a partly task shared and partly jointly funded activity. The participating countries are represented on the Steering Group, which serves as the AIVC's Board of Directors. At present, the AIVC countries are Belgium, Czech Republic, France, Greece, Netherlands, Norway and United States of America.

Since its creation in 1979, a whole range of publications have been produced, including:

- 58 Technical Notes
- 6 Guides
- 12 Annotated Bibliographies
- 32 Literature Lists
- 7 Ventilation Information Papers
- a bibliographical database with more than 15000 references
- 25 AIVC Annual Conference Proceedings
- 100 issues of the Air Information Review

The AIVC deliverables for the period 2004 - 2007 include:

- AIVC Website as a reference portal for ventilation related issues;
- Updates to ventilation database AIRBASE. At present, there are some 15600 references in AIRBASE; AIRBASE is available on the AIVC-CD and can be consulted by using Microsoft Access;
- Recent Additions to Airbase' four times/year;

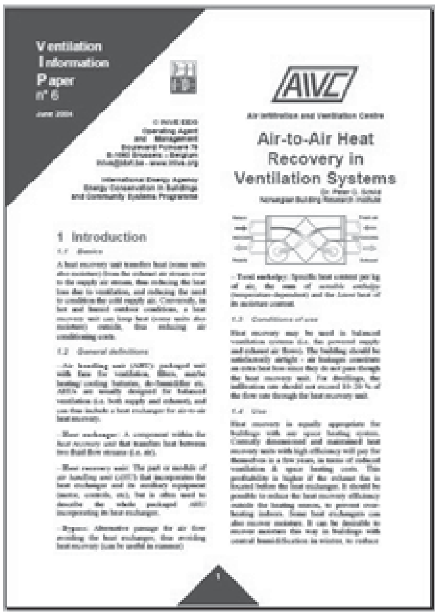

Figure 5: VIP 6 - Air-to-Air Heat Recovery in Ventilation Systems

- Newsletter AIR (Air Information Review) four times/year with information on the most relevant developments regarding ventilation, indoor climate and energy in buildings;
- Publication of technical notes, focused on activities within and outside the AIVC;
- Update of Guide to Energy Efficient Ventilation;
- AIVC Annual Conference (2004 Prague, 2005 Brussels, 2006 Lyon);
- Finally, but not at least, the publication of '**Ventilation Information Papers**' (**VIP's**).

The 'Ventilation Information Papers' are a new series of AIVC publications. With a typical size of 6 to 10 pages, they treat a series of topics in a not too technical way, whereby a major objective is to correctly inform non-specialists of specific ventilation issues.

At present, 7 VIP's have been published:

- VIP 1 - Airtightness of ventilation ducts
- VIP 2 - Indoor Air Pollutants – Part 1: General description of pollutants, levels and standards
- VIP 3 - Natural ventilation in urban areas
- VIP 4 - Night ventilation strategies
- VIP 5 - Displacement Ventilation
- VIP 6 - Air-to-Air Heat Recovery in Ventilation Systems
- VIP 7 - Indoor Air Pollutants – Part 2: Description of sources and control/mitigation measures

It is expected to have before the end of 2005 a total of 15 to 20 VIP's.

Key figures for the AIVC

- AIVC has an annual financial contribution of €9000 per country; the dissemination part is handled on behalf of the IEA by INIVE EEIG (www.inive.org) which is a grouping comprising BBRI, CETIAT, CSTB, EMPA, Fraunhofer IBP, ENTPE, NBI, NKUA and TNO.
- The AIVC Web site is receiving more than 7000 visitors per month.
- Since September 2001, a 3-monthly newsletter AIR together with the AIVC-CD is produced in 3000 to 5000 copies.
- The AIVC as a dissemination centre on ventilation has a high visibility. As an example, during most of the time AIVC is the first reference in Google when searching for 'ventilation', although there are some 3.5 million references.
- AIVC is becoming THE Reference Portal for ventilation related issues. Dissemination will be primarily Web based.

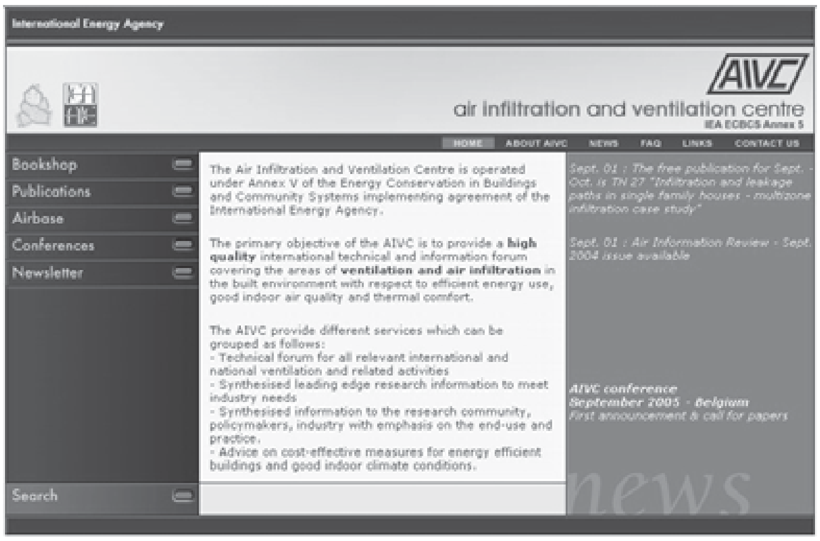

Figure 6: Home page of the AIVC Web site

The AIVC Annual Conference

The 26th AIVC conference will be held in Brussels (Belgium) from September 21st – 23rd, 2005. The main theme of this conference is '**Ventilation in relation to the energy performance of buildings**'. Topics include:

- Treatment of ventilation aspects in standards and regulations
- Handling of ventilation in energy performance regulations outside Europe
- Airtightness of buildings and ducts
- Energy for transport of air
- Innovative ventilation systems and energy performance regulations
- Impact of regulations on ventilation market
- Good indoor climate and energy performance
- Ventilation in the context of energy certification of buildings
- Commissioning and inspection of ventilation systems
- Ventilation related challenges for the existing building stock
- Ventilation in very low energy buildings
- Ventilation aspects in warm and cold climates
- Economics of indoor climate

The sub-theme of the conference is ''Whole Building Heat, Air and Moisture', whereby specific attention will be given to '*The coupling, in terms of air flow processes, between building and building envelope*' and '*The combined effect of ventilation and* *hygric inertia on the indoor climate and the energy consumption.*' Presentations related to such work in IEA Annex 41 'Whole Building Heat, Air and Moisture' in particular are appreciated.

In order to maximize the interest for practitioners and researchers, during most of the conference it is foreseen to have 2 parallel sessions, whereby one session will be more practice oriented (and mainly linked to the topic of the energy performance of buildings) and whereby the other session will be more scientific/academic oriented.

For more information, see www.aivc.org.

ECBCS Building Retrofit Initiative

Mark Zimmermann, EMPA, Switzerland

Introduction

A major conclusion of the last Future Buildings Think Tank (held in May 2001 near Oslo) was that an initiative of all buildings-related IEA programmes should be started to promote the development and demonstration of advanced retrofit concepts.

The energy demand of the existing building stock is tremendously important for sustaina-ble development of our society. Roughly 50% of energy consumption in developed countries is rela-ted to the construction and operation of buildings. This energy demand is primarily dependent on the state of the existing building stock. Assuming there are about 30% new constructions up to 2050, the energy consumption will increase less than 10% (Figure 7).

It is obvious that for sustainable development the energy consumption of the existing building stock has to be reduced also – not only by 10% or 20% but as much as 80% to 90%.

Various demonstration projects have proven that advanced retrofit concepts can reduce the energy consumption of exis-ting buildings for heating and hot water by a factor of 10 (factor of 5 to 15, depending on situation and needs). Hence, existing buildings can theoretically rival the best new buildings in terms of energy performance (Figures 8 and 9).

Exploitation of this energy-saving potential is vital. The development of new buildings inevitably forces up demand. Global warming and the depletion of fossil energy resources can only be effectively combated by reducing the existing energy consumption. Moreover, renovated buildings generally enhance comfort and the quality of life.

Figure 7: Energy consumption of domestic buildings for heating and hot water in relation to the year of construction (Canton of Zurich). Each square represents (from 1940) the amount of energy consumed (floor area x specific energy consumption). The buildings constructed between 1940 – 1980 clearly figure most prominently. Future buildings constructed from 2005 until 2050 will consume less than 10%.

Advanced concepts for Sustainable Building Retrofit SUBURET

The IEA Future Buildings Forum decided to organize a Sustainable Retrofit Workshop and thus set out to discuss and establish a framework of international collabo-ration to promote an advanced retrofit programme for existing buildings and community systems. The workshop was held in January 2003 in St. Moritz, Switzerland and was organized by EMPA, the Swiss Federal Laboratories for Materials Testing and Research. The aim of the workshop was to bring national programme managers together to discuss the options for a joint sustainable building retrofit programme. Representatives from the seven building-related IEA programmes were directly invited,

Figure 8: Retrofit Demonstration Building Therwil in Switzerland, After renovation (right) only 1/4 of the original energy consumption (left) for heating and hot water (~ 50 kWh/(m2·a) is consumed.

along with project managers from the 26 countries participating in the IEA programmes.

The results of the workshop should facilitate the creation of a framework of international cooperation for the seven building-related programmes. One key achievement was the development of the Integrated Project "Advanced Concepts for Sustainable Building Retrofit", based on workshop discussions, which was successfully submitted to the EU 6th Framework Programme. Further pro-ject proposals focus on specific topics for building renovation and propose collaborative research and demonstration work under the auspices of the IEA. A novel feature of this initiative was the common kick-off workshop to activate and coordinate the collaborative work of seven independent building-related IEA programmes.

General findings of the SUBURET Workshop

- The importance of sustainable building retrofit is unquestioned.
- Retrofit – especially energetic retrofit – is basically a socio-economic, rather than a technical issue.
- The costs for sustainable retrofit is of similar magnitude as the costs for a new building.
- The option of reconstruction versus renovation has a growing importance.
- Retrofit related technologies have often a strong link to retrofit specific products. Innovation is needed on the product level, but product development and optimisation is not a priority for international research.

A key strength of IEA research is developing and demonstrating advanced design methods

Opportunities for IEA building related R&D-programmes

Advanced insulation technologies for envelope and openings

The maximum heating demand of renovated houses should be reduced to 10 - 15 W/m^2 (today's average is about 50 W/m^2). Limited space for thermal insulation is a main problem of building renovation. New systems could apply vacuum-insulation or nanogel technology in combination with traditional insulation materials where appropriate. Special retrofit components have to be developed, tested and demonstrated. The focus of these proposed technologies will be on cost efficiency and robustness. Achievement of a service life of more than 50 years is the main target of ongoing IEA ECBCS Annex 39 "High Performance Thermal Insulation". The development of special vacuum-insulated components as vacuum insulated doors and window frames and unfinished products that are easy and safe to apply represent a further goal. Due to the substantially lower space requirement, the newly developed solutions will not only be cost-competitive but also create added value.

New roof systems with integrated solar systems

Special attention should also be given to existing roofs as those of old houses tend to leak and be poorly insulated. The re-roofing of existing buildings could efficiently reduce thermal losses, improve airtightness and maximize use of the attic space without changing the architectural character. Optimized prefabricated solutions for roof replacement and attic use need to be developed in collaboration with forward-looking timber contractors.

In addition, research and development projects should aim to fully exploit the insolation on roof surfaces. Using the most promising technologies available, the entire roof area will be exploited for PV installations, solar collectors and absorption collectors for heat pumps. The challenge will be to provide roof-integrated and custom-sized solutions that satisfy architectural requirements and the need to conserve the urban environment.

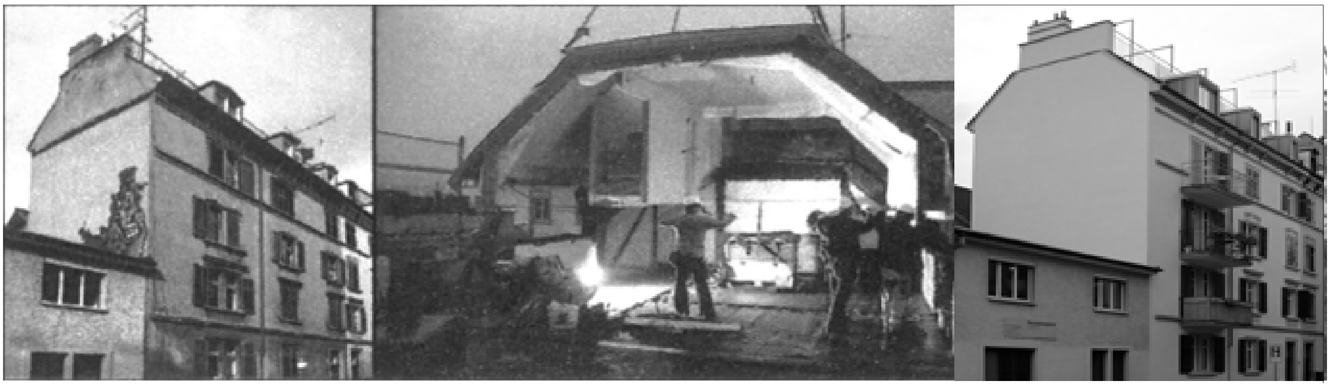

Figure 9: Retrofit Passive-House Magnusstrasse in Zurich

	Old Building	Standard New Building	Renovation Magnusstrasse
Heating	*165 kWh/(m^2· a)*	*64 kWh/(m^2· a)*	*19 kWh/(m^2· a)*
Hot Water	*35 kWh/(m^2· a)*	*35 kWh/(m^2· a)*	*3 kWh/(m^2· a)*
Electricity	*33 kWh/(m^2· a)*	*28 kWh/(m^2· a)*	*15 kWh/(m^2· a)*
Total (Final Energy)	*233 kWh/(m^2· a)*	*127 kWh/(m^2· a)*	*37 kWh/(m^2· a)*

Integrated energy systems

The switch from a fossil-fuel-dominated energy supply to renewable-energy-based systems represents a new technological approach. Gas- and oil-fired boilers will no longer play a central role in future heating systems. Heat pump technology will become more important. Apart from ensuring a lower primary energy consumption and reduced CO_2 emissions, they are also ideal for waste heat recovery and as a combined heating and cooling source. Heat pumps will therefore feature prominently in future energy systems.

The focus will be on integrated energy systems using renewable energies to provide heating, ventilation and hot water as well as cooling and base electricity supply, where applicable. The challenge will be to select and improve suitable systems that are already on the market, to develop intelligent interfaces and to provide guidance on how to combine and use such systems. Close co-operation with industry partners to develop equipment that is tailored to the needs of building retrofit and a comprehensive testing and demonstration programme are needed.

New concepts for district heating and cooling

The future role of district heating and cooling systems in conjunction with low-energy housing with a heating demand as low as 10-15 kWh/m^2 and year needs to be analysed. Cooling will become more important in future, but a switch from district heating in winter to district cooling in summer is unrealistic. The role and services of future district systems serving low-energy housing has to be discussed and redefined. Otherwise district systems may even compete against energy efficiency.

Risk management for advanced technologies

Risk management techniques could help to limit the risks posed by new technologies for design teams, contractors and house owners. Advanced concepts and new technologies inevitably entail greater

Figure 10: Figure 10: Vacuum insulation is a new technology and due to its very low space demand especially suited for building renovation.

Figure 11: Pre-fabricated roof constructions offer a great potential for optimised insulation and solar system integration (Photo: Nina Mann)

risk in the event of flawed design, failures or unexpected costs. Methods need to be developed to quantify, minimize and manage such risks.

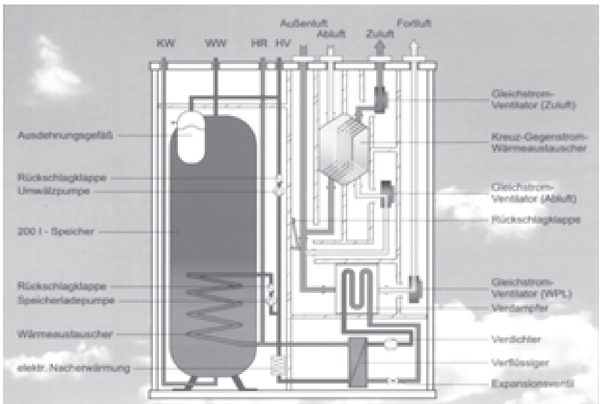

Figure 12: Integrated energy systems for heating, ventilation, heat recovery and hot water will replace the traditional gas- and oil-fired boiler. They are especially interesting for retrofitting old houses without an adequate heating system.

Building Simulation '05

Conference Announcement

August 15-18, 2005, Montreal, Quebec, Canada

The International Building Performance Simulation Association (IBPSA) is a non-profit international society of building performance simulation researchers, developers and practitioners, dedicated to improving the built environment.

The bi-annual IBPSA Building Simulation Conference and Exhibition is the premier international event in the field of building performance simulation. The next conference will be held between 15 - 18 August, 2005, in Montreal, Quebec, Canada.

Previous Conferences have been held in Vancouver, Canada (1989), Nice, France (1991), Adelaide, Australia (1993), Madison, USA (1995), Prague, Czech Republic (1997), Kyoto, Japan (1999), Rio de Janeiro, Brazil (2001) and Eindhoven, Netherlands (2003).

Program

Building Simulation 2005 will consist of keynote speeches, presentations of high quality papers, software demonstrations, and plenary sessions. The conference will include several social events, including a banquet, an accompanying persons program, and post- conference tours.

Exhibition

A trade exhibition will be organized as a part of Building Simulation 2005. This is an excellent opportunity for any institution or company to present building performance simulation products or services. Companies and organizations are also invited to take up a conference sponsorship.

Who should attend?

Architects, designers, researchers, environmental engineers, city planners, simulation software producers, and all academics, professionals and practitioners involved in the wide range of disciplines associated with building performance simulation.

There is a discount for registrations received before 15 June, 2005.

Further information and registration

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Optimal Integration of Heat Pumps in Buildings

Jean Lebrun, University of Liège, Belgium

In buildings, substituting a heat pump in place of a boiler may save more than 50% of primary energy, if electricity is produced by a modern gas-steam power plant (even more if a part of the electricity is produced by other means). This fact is illustrated in Figure 13, where the potential energy saving is plotted as function of the heat pump COP (coefficient of performance), for a range of power plant efficiencies. Heat pump use is today probably one of the quickest and safest solutions to save energy and to reduce CO_2 emissions.

As the first step in a proposed project intended to demonstrate how to optimally integrate heat pumps into buildings, a two-day working meeting was organized by the ATIC in Brussels, between April 26th and 27th 2004, and was held in cooperation with two Implementing Agreements of the International Energy Agency :

- Energy Conservation in Buildings and Community Systems (ECBCS), and
- the Heat Pump Programme (HPP).

The meeting consisted of a preparatory workshop together with a business meeting: The workshop was attended by 70 participants, coming from 7 different countries, during which 15 papers were presented. The business meeting was hosted by the Belgian Ministry of Economic Affairs. It was attended by 15 participants who worked together on a proposal for a new IEA co-operative project. The resulting proposal, now being considered by both ECBCS and HPP, is based on the facts given below.

A promising solution...

Heat pump technology is now very robust and the characteristics of most of its components are already well known. A lot of work has previously been done in order to assess the performance of different heat pump systems and to open the way to optimal designs.

Numerous pilot studies were performed during the last decades, including those in the framework of the IEA Heat Pump Programme, with real systems, and were associated with different building types, exposed to different climates and used different heat sources. The most successful experiences were found using the ground as a heat source. Different 'connections' were considered: direct, or indirect expansion, with horizontal or vertical heat exchangers. Exhaust and outside air were also used as heat sources in a few of these studies. Space heating (through floor and/or wall panels) was considered as a priority, but tap water heating was also tested. Most of the available results confirm the full reliability and the high performance provided by these techniques.

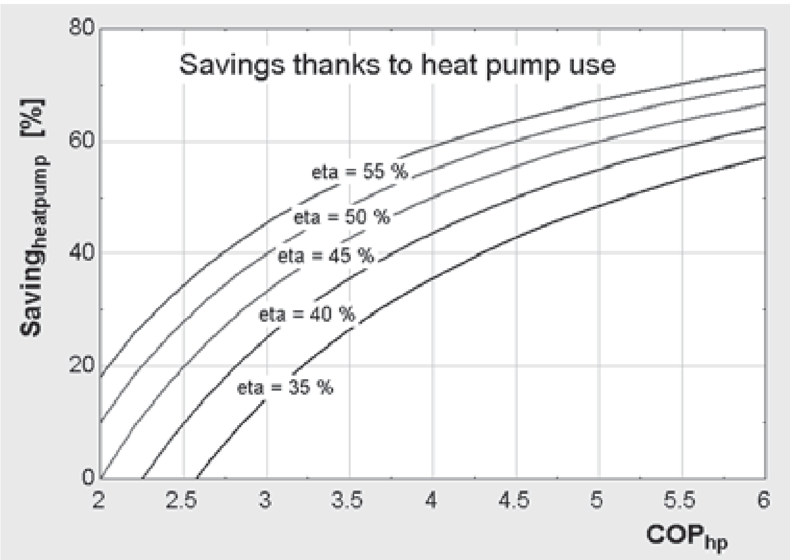

Figure 13: Potential energy savings from heat pumps for a range of power plant efficiencies

That should be better promoted...

Aside from regions where cooling is essential (and where the heat pump is usually nothing other than a reversed cooling system), and for a very few other ones (Switzerland and a part of Austria), the heat pump market remains surprisingly marginal. This only moderate success might be due to the following obstacles:

- Wrong (or non-updated) information: misleading publicity resulted in the 1970's, with poor efficiency heat pump systems, poor efficiency electrical power plants and insufficiently trained installers. Heat pumps gained a bad reputation at that time.
- Some 'conservatism': building designers and engineers tend to promote the techniques they know the best and refrigeration is, for many of them, a bit 'mysterious'.
- Prohibitive capital costs: a (low tech) residential heat pump is sold today for 10 times the price of a (high tech) car air conditioning unit!
- Prohibitive running costs: electrical energy, peak of electrical power and maintenance are still too expensive.

These obstacles may be overcome through the following actions:

- Defining better the heating demands, in relationship with: the characteristics of the building, the climate, and occupant behaviour;

- Updating the information about heat pump performance, in relationship with the heat source available and with the heating system selected;
- Developing design tools adapted to the different phase of a project, in such a way as to guarantee the best integration of the heat pump into the building heating system;
- Developing reliable methods to evaluate global performance and commissioning procedures to apply throughout the building life cycle, with ('manual' and 'BEMS-assisted') tests of functional performance;
- Conducting and documenting successful case studies.

For all building types...

Until now, most of the studies were concentrated on applications to new ('low' and 'very low' energy) residential buildings. But, other types of building are also relevant:

- Existing residential buildings, with or without renovation of the heating system;
- New commercial buildings, with 'combined' heating and cooling systems;
- Existing commercial buildings, with possible adaptation of the existing cooling system (if any).

The proceedings of the workshop are available from the Thermodynamics Laboratory of the University of Liège. For more information and also for remarks and suggestions, please contact: J.Lebrun@ulg.ac.be

Recent ECBCS Annex Publications

Annex 5: Air Infiltration and Ventilation Centre (AIVC)

- AIR Newsletter and AIVC CD published every 3 months. See www.aivc.org for details of Annex 5 publications.

Database

- AIRBASE - bibliographical database, containing over 15,000 records on air infiltration, ventilation and related areas.

Technical Notes

- Reducing Indoor Residential Exposures to Outdoor Pollutants, 2003, Sherman M and Matson N, TN 58

Annotated Bibliographies

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

AIVC Conference Proceedings

- Ventilation, Humidity Control and Energy, 2003, Washington, USA, CP24
- Ventilation and Retrofitting, 2004, Prague, Czech Republic, CP25

Ventilation Information Papers

- Airtightness of ventilation ducts, 2003, Delmotte Ch, VIP 01
- Indoor Air Pollutants – Part 1: General description of pollutants, levels and standards, 2003, Levin H, VIP 02

Annex 27

Evaluation and Demonstration of Domestic Ventilation Systems

- Technical Synthesis Report: Annex 27 Evaluation and Demonstration of Domestic Ventilation Systems, Concannon, P, 2002.
- Simplified Tools and Handbook CD with VENSET, 2002

Annex 30

Bringing Simulation to Application

- Technical Synthesis Report: Annex 30 Bringing Simulation to Application, Warren P, 2002

Annex 31

Energy-Related Environmental Impact of Buildings

- Energy-Related Environmental Impact of Buildings (Highlights), 2002
- Environmental Framework, 2001
- Decision-Making Framework, 2001
- Directory of Tools, A Survey of LCA Tools, Assessment Frameworks, Rating Systems, Technical Guidelines, Catalogues, Checklists and Certificates, 2001
- LCA Methods for Buildings, 2001

See www.annex31.com to download Annex 31 publications.

Annex 35

Control Strategies for Hybrid Ventilation in New and Retrofitted Office Buildings (HYBVENT)

- Principles of Hybrid Ventilation, edited by Per Heiselberg, report and CD, 2002

Annex 36

Retrofitting of Educational Buildings

- Retrofitting of Educational Buildings - Case Study Reports, edited by Morck O, 2003

Annex 38

Solar Sustainable Housing

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

See www.iea-shc.org/task28 to download Annex 38 publications.

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36 Retrofitting in Educational Buildings – Energy Concept Adviser for Technical Retrofit Measures (1998-2004)

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38 Solar Sustainable Housing (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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42 COGEN-SIM : The Simulation of Building-Integrated Fuel Cell and Other Cogeneration Systems

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