IEA Solar Heating & Cooling Programme

1999 Annual Report

Edited by
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Programme

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The Solar Heating & Cooling Implementing Agreement

BACKGROUND

The International Energy Agency (IEA) was founded in November 1974 as an autonomous body within the framework of the Organization for Economic Cooperation and Development (OECD) to carry out a comprehensive program of energy cooperation among its 25 Member countries. The European Commission also participates in the work of the IEA.

The IEA's policy goals of energy security, diversity within the energy sector, and environmental sustainability are addressed in part through a program of international collaboration in the research, development and demonstration of new energy technologies, under the framework of 40 Implementing Agreements.

The Solar Heating and Cooling Implementing Agreement was one of the first collaborative R&D programs to be established within the IEA, and, since 1977, its participants have been conducting a variety of joint projects in active solar, passive solar and photovoltaic technologies, primarily for building applications. The overall Programme is monitored by an Executive Committee consisting of one representative from each of the 19 member countries and the European Commission.

SHC Member Countries

Australia	Japan
Austria	Mexico
Belgium	Netherlands
Canada	New Zealand
Denmark	Norway
European Commission	Spain
	Sweden
Germany	Switzerland
Finland	United Kingdom
France	United States
Italy	

CURRENT TASKS

A total of twenty-six Tasks (projects) have been undertaken since the beginning of the Solar Heating and Cooling Programme. The leadership and management of the individual Tasks are the responsibility of Operating Agents. The Tasks which were active in 1999 and their respective Operating Agents are:

Task 19
Solar Air Systems
Switzerland

Task 21
Daylight in Buildings
Denmark

Task 22
Building Energy Analysis Tools
United States

Task 23
Optimization of Solar Energy Use in Large Buildings
Norway

Task 24
Solar Procurement
Sweden

Task 25
Solar Assisted Air Conditioning of Buildings
Germany

Task 26
Solar Combisystems
Austria

Chairman's Report: Highlights of 1999

Mr. Lex Bosselaar
Executive Committee Chairman
NOVEM, b.v., The Netherlands

OVERVIEW

In 1999, the Executive Committee of the Solar Heating and Cooling (SHC) Programme continued to initiate a variety of new solar activities from workshops to Tasks. The new Tasks that the Executive Committee agreed to initiate, Solar Crop Drying and Solar Cities, will broaden the scope of the Programme to include work in developing countries as well as with other international and national solar organizations. In addition to the new Tasks, the Programme held a workshop in conjunction with the IEA Photovoltaic Power Systems Programme on Hybrid Thermal/PV Systems. The result of this workshop was the agreement between the two Programmes to initiate a Working Group on Thermal/PV Systems. The Executive Committee also agreed that a workshop on Advanced Solar Thermal Storage would be held in conjunction with TerraStock 2000 and that a workshop on Legionnaires' disease should be held in the beginning of 2000. The results of the ongoing Tasks are summarized below.

The participation in the Implementing Agreement continues to be strong with all 18 Member countries and the European Union active in the Tasks. Also, to the pleasure of the Executive Committee, Mexico joined the Implementing Agreement, and has already taken an active role in the Programme's work. Two other countries, Portugal and Greece, have shown interest in joining the Programme. With the active participation of Programme members, I look forward to the continued expansion of the Programme into the next century and the demonstration of the tremendous potential of solar heating and cooling technologies.

Every year our annual report includes a feature article on some aspect of solar technologies for buildings. This year's article deals with daylight in buildings, the focus of SHC Task 21. Thanks to Mr. Kjeld Johnson of the Danish Building Research Institute for preparing this summary.

HIGHLIGHTS OF THE TASKS AND WORKING GROUP

Notable achievements of the Programme's work during 1999 are presented below. The details of these and many other accomplishments are covered in the individual Task summaries later in this report.

Task 19: Solar Air Systems

This Task concluded in April 1999, however, Task experts continued throughout 1999 to compile the results into published reports and to conduct national presentations. As a result of this 5-year project, the experts have demonstrated that solar air systems are a credible, proven technology and have provided the tools needed to design such systems.

Task 21: Daylight in Buildings

It has been a very busy year for all the Task experts as they finalized the testing of systems, developed design tools and monitored and prepared detailed descriptions of 15 case study buildings. In addition, about 15 different daylight responsive lighting control systems have been tested and the results are to be documented in the report, "Application Guide for Daylight Responsive Lighting Control Systems."

Task 22: Building Energy Analysis Tools

All the planned activities on analytical tests have been completed. The results were distributed to leading building energy analysis tool authors throughout the world to inform them of the existing tests and to obtain their views and recommendations on the importance and value of analytical tests for tool evaluation/validation.

Task 23: Optimization of Solar Energy Use in Large Buildings

A computer tool for multi-criteria decision making, MCDM 23, was developed. This tool is intended to make some of the steps in this type of process easier to carry out. Due to its success, some Task 23 experts have expressed interest in integrating this tool in their own tool development.

Task 24: Solar Procurement

National meetings were held and buyer groups formed in Canada, Denmark, the Netherlands and Sweden. The buyer groups consist of representatives from municipalities, utilities, housing corporations, construction companies, real estate firms, NGOs and other organisations.

Task 25: Solar Assisted Air Conditioning of Buildings

Solar cooling is a promising new activity in the SHC Programme. To initiate this work, a survey was undertaken on the technical and economic aspects of installations built in the past. This survey indicated that in many climates the pay-back times for the best cooling technologies is similar to that of solar water heating. Based on this work, the other subtasks will focus on a design tools, marketing aspects and demonstration projects.

Task 26: Solar Combisystems

Task work has focused on the overview of combisystems, the definition of reference conditions for simulation runs and performance reports, and the criteria for ranking and making inter-comparisons of the systems. The first issue of an annual industry newsletter was distributed in December 1999, and in addition to the English version, several countries translated the general part of the newsletter into their national language.

Working Group on Materials in Solar Thermal Collectors

The Working Group concluded this year with some activities carrying over to March 2000. Many of the Group's results will serve as a basis for the work to be conducted in the new Task 27, Performance of Solar Facade Components. A report summarizing the experiences in performance and durability assessment will be printed in 2000.

NEW ACTIVITIES

Task 27: Performance of Solar Facade Components

This Task began in January 2000. The goal of this new work is to accurately determine the solar and thermal performance of materials and components, such as advanced glazing for use in more energy efficient sustainable buildings and systems, and to promote increased confidence in the use of these products by developing appropriate assessment methods for durability, reliability and environmental impact.

Task 28: Solar Sustainable Housing

This Task is scheduled to begin in April 2000. The objective of this work is to help achieve, in participating countries, a significant penetration of solar sustainable housing in the market by providing builders and institutional real estate investors with good examples of building projects, hard facts to use when making cost/benefit decisions on the mix of solar and conservation strategies, and guidance to improve energy, environmental and cost performance of their designs.

Task 29: Solar Crop Drying

This Task began in January 2000. The objectives are to identify and facilitate solar crop drying business opportunities. To accomplish this objective, system manufacturers and crop processors will be brought together to relate market needs to technology solutions. As a result, bona fide commercial projects will also serve as demonstrations. The role of the Task experts will be to provide the technical support for this work. Information from the demonstrations will be used in subsequent marketing programs and industry association awareness campaigns.

Task 30: Solar Cities

This Task is in the Task Definition Phase. It was started in cooperation with the International Solar Energy Society (ISES) and several other IEA Implementing Agreements. Currently, experts from these organizations are in the process of structuring the new work. The proposed objective of this Task is to increase the understanding of and application of solar technologies in cities. The overall goal of this effort is to reduce emissions in the targeted cities.

Working Group on Advanced Solar Low-Energy Dwellings

The objective of this Working Group is to collect and analyze the monitoring results of buildings from SHC Task 13, Advanced Solar Low Energy Buildings. Experts will compare predicted and measured performances, taking the climate and actual weather conditions into account, and analyze the reasons for deviation.

Working Group on PV-Thermal Systems

The objectives of this Working Group are to exchange information, to prepare a "road map" by identifying the necessary international steps needed to develop various markets for PV/T systems, and to advise the IEA on further work in this field. The Working Group will be a collaborative effort with the IEA Photovoltaic Power Systems Programme.

MANAGEMENT ACTIONS

Programme and Policy Actions

The Information and Marketing Group conducted a survey on the Programme's information dissemination activities. Responses were received from Executive Committee members and Operating Agents. Based on the results of the survey, the Committee will take action on proposed recommendations at their May 2000 Executive Committee Meeting. The Programme's web site also continues to play an increasingly an important role in the dissemination of information.

The Software Policy Committee continued to work on strengthening and ensuring that the policy is adhered to as new Tasks develop software.

The *Executive Committee* agreed to invite the Czech Republic to join the Implementing Agreement. Communication continued with the other countries that have already been invited to join – Brazil, China, Cyprus, Greece, India, Israel, Korea, Portugal, Slovenia and South Africa.

An updated version of the *Policy & Procedures* handbook was completed and distributed to the Executive Committee and Operating Agents.

Internet Site

The Solar Heating and Cooling Programme's World Wide Web site continues to be updated and new pages added as needed. In addition to the sections available to the public, a secure site for use by the Executive Committee and the Operating Agents was added. The address for the site is <http://www.iea-shc.org>.

Future Workshops

In 1999, the Executive Committee agreed to organize several workshops in 2000.

Advanced Solar Thermal Storage Workshop

This workshop will be held in August in conjunction with TerraStock 2000. The objectives of the workshop are a state-of-the-are review and identification of new R&D activities. The topics will include new materials and concepts (e.g., microcapsulated PCM in building materials, sorption storage), technologies and applications (e.g., passive solar, climitization), and pilot and demonstration plants.

Legionnaires' Workshop

This workshop is planned for April/May. The goal of this workshop is to exchange information on the perceived risks of this disease and solar water heaters.

COORDINATION WITH OTHER IEA IMPLEMENTING WORKING PARTIES/AGREEMENTS AND NON-IEA ORGANIZATIONS

The *IEA Energy Conservation in Buildings and Community Systems Programme* and this Programme held a joint meeting in May to facilitate the continued collaborative work between the Programmes.

The Operating Agent, Mr. Tony Schoen, from the *IEA Photovoltaic Power Systems Programme's* Task on PV in the Built Environment presented an overview of activities at the May Executive Committee meeting. Cooperation with the PVPS Programme is continuing with the organization of the collaboration Working Group on hybrid thermal/PV collectors.

The *International Solar Energy Society* will continue to collaborate with the

SHC Programme as our new Task on Solar Cities gets underway.

PUBLICATIONS

The following IEA Solar Heating and Cooling reports and related publications were printed in 1999 and are not listed elsewhere in this annual report.

Strategic Plan of the Solar Heating and Cooling Programme 1999-2004
P. Murphy Kunz, editor.

ACKNOWLEDGMENTS

In closing, I would like to thank the Operating Agents, Working Group Leader and our Advisor, Fred Morse for their work. I would especially like to thank our Executive Secretary, Pamela Murphy Kunz, for her help over the past year in preparation and reporting of the meetings and other Programme activities. Everyone's contribution to the Programme will continue to ensure its success as we enter this new millennium.

DAYLIGHT
A Basic Human Need

Kjeld Johnsen
Danish Building Research Institute
Denmark

INTRODUCTION

Daylight is a gift of nature and arguably one of the most important elements of human life, certainly for those fortunate to be blessed with the power of sight. And yet, light will not be seen. Light allows us not only to function effectively, but also allows us to enjoy and be stimulated by the world around us; and today it is commonly recognized to have an effect on our well-being and health.

Although the importance of daylight and the positive aspects of windows seem quite obvious to most people today, this has seldom been reflected in the architecture and space planning of many buildings in the last 30 years of the 20th century.

HISTORY OF THE WINDOW

The invention of glass changed the function and characteristics of buildings. The art of producing glass was known in Egypt around 3500 BC and probably, even before, in the old Asian cultures. Ancient Greeks used the sun to heat their homes, but the free openings reduced the heat gain in the winter. Such problems were solved, as many other significant technological achievements, by the Romans who used glass (50 AD) and explored the thermal benefits of glazing their buildings. Glass and windows enabled to some extent, isolation of the interior from the external climate, exhibiting great significance for cooler climates in northern Europe. The intention of the window derives from the word "wind eye" (both in Anglican and German language) to ventilate (smoke) but also illuminate the interior by natural light. Ventilation of the interior was also associated with air quality problems and health problems through the spread of diseases such as the plague.

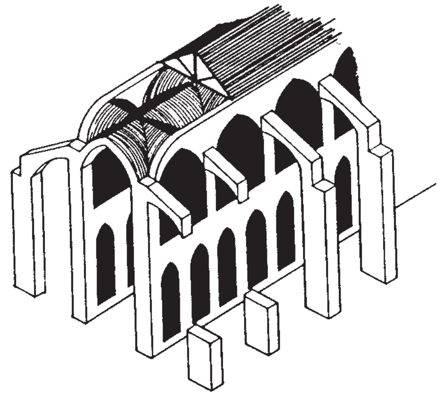


Figure 1. Groin vaulting and flying buttresses in Gothic cathedrals [from Lechner 1991].

Daylight has always been an important aspect of architecture because it reflects cultural traditions and basic human needs: *We were born of light. The seasons are felt through light. We only know the world as it is evoked by light...To me natural light is the only light, because it has mood - it provides a ground of common agreement for man - it puts us in touch with the eternal. Natural light is the only light that makes architecture* (Louis I. Kahn). Glass was used in medieval ecclesiastical architecture, and made its earliest influence in sacred buildings, although the load-bearing wall limited the width of the openings. Flying buttresses in Gothic cathedrals presented a skeleton construction, escalating larger windows in sacred architectural design (Figure 1).

During the Industrial Revolution (19th century) architectural design changed, because the rural population moved to the cities to work in mills and factories, and changing working conditions to indoors introduced the need for daylight inside buildings. There had been advances in the production of artificial light, such as the incandescent gas mantle invented by Welsbach in 1885, but the quality and luminous efficacy of the light source was low and expensive to use, compared to daylight. With the culmination of post and lintel construction (19th century), skeleton construction offered daylighted buildings with large and numerous windows. *Designers have achieved increasingly larger window openings, and eventually the all glass wall, in order to enhance the visual quality of the building interior by means of daylight* [Le Corbusier].

By enhancing the development of a skeletal framing, first of cast iron, then wrought iron, and later steel and reinforced concrete (20th century), a whole new architectural design for the use of natural light and ventilation was born. Glass buildings, such as the Crystal Palace in 1851, became a possibility because of the increased availability of glass, combined with the use of steel structures. Also new techniques in glass production and framing technology were invented, reducing cost and increasing the area of the glass panes. Together, glass and steel skeletons became a key element in the modern architectural movement. The ideals were now concerned with natural light, transparency, health and social well-being as building designers realized that glass would provide and symbolize these ideals.

Until the second half of the 20th century, when some say fluorescent lighting and cheap electricity became available, daylight and architecture were interpreted as being the same. At the beginning of the 20th century, daylight was still the main source of light during daytime, using artificial lighting at night. However, the development of fluorescent lighting in the 1930s changed the use of daylight as a design criterion. Significant improvement of artificial lighting efficacy and the development of mechanical ventilation resulted in a reduced need for windows, natural light and ventilation. Heat loss through the thermal envelope was reduced through the technological development in building materials and constructions, although single glazed windows were still common in the 1950s and 60s.

The energy crisis in the mid 1970s reexamined the potential for natural light in buildings, but the glazing unit also was addressed as the main source of heat loss and undesirable solar gain. In order to reduce solar gains and heat losses, the clear glass was sometimes replaced by tinted or reflective glass and the exterior environment excluded from the interior by decreasing the glazed area. Reduced natural light in the interior increased the daytime needs for artificial lighting, presenting new design problems.

DAYLIGHTING: THE INTEGRATION CHALLENGE

Today, thirty years later, in a world newly concerned about carbon emissions, global warming and sustainable design, daylit buildings are again proposed as part of the "solution." Daylighting, and the impact of daylighting on the heating and cooling of buildings, has come into the focus of the building design professionals, building owners and occupants, and society due to energy use and associated implications for carbon emissions. If the developed world is to meet the emission reduction targets outlined in Kyoto, energy savings from daylighting could play an important supporting role.

Daylighting design has, however, become a complex system integration challenge. Successful daylighting design requires trade-offs and optimisation between competing elements of facade, space, and lighting system, for example, finding the optima of light and heat trans-mittances for glazing that provide adequate daylight levels but control unwanted glare and excessive heat gains. Optimisation involves considerations of space layout, furnishing, functions as well as activities, but solutions can only be successful when they meet the basic needs of the occupants.

NEW DEMANDS AND NEW OPPORTUNITIES

It used to be simple logic that if the building designer wanted to exploit daylight at work places, then the layout of the spaces would need to be organised so that the individual work stations were placed near or under window openings. When looking at buildings of the last 30 years, it seems that the designers have often failed to use their sense of logic. The demand for efficient use of spaces has in general let to decreased height but increased depth of the working areas. Attempts to make spaces brighter by using all-glazing facades have not solved the problems of poor daylighting quality. On the contrary, this strategy has just added to the problems associated with the glazing: need for more ventilation, increased cooling loads, severe luminous contrasts and glare problems, extra need for artificial lighting, and often poor visibility due to use of tinted glazing.

So, before anything else, it is a question of sound and sensible architectural design with adequate attention to the aspects of integration between people and technology and between and among the hardware and software elements of the fenestration or daylighting system. However, this did not prevent building designers from taking advantage of the fast development in glazing technology through the 1990s. The improved thermal and optical properties (e.g. ratio between light and heat transmittances) offer new opportunities for opening the facades and letting in the natural light without sacrificing other indoor climate parameters. Now the challenge is more a question of control. Control of the direct sun and the diffuse sky light, as well as control of the distribution of the light entering the space. Controlling daylight also means to allow the occupant (e.g. the office worker) to work near the facade, to have a view, and still being able to protect himself from direct sun, glare, and reflections in his computer screen.

Through history many approaches have been made to improve daylight

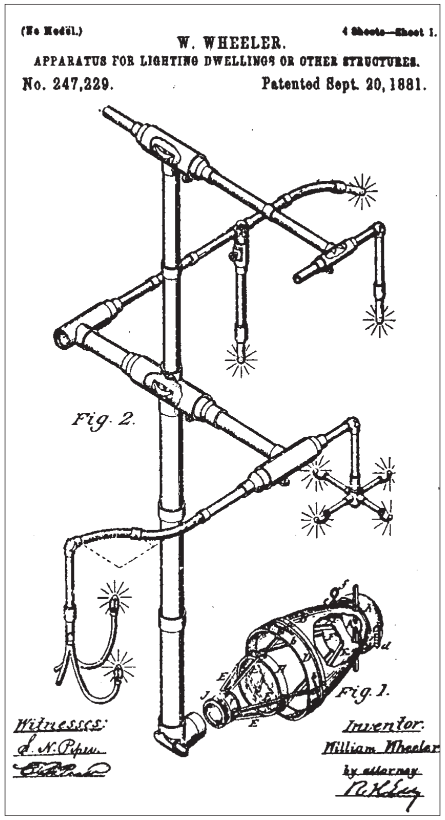


Figure 2. William Wheeler's 1881 patent for a system of lightpipes for domestic illumination. Significantly, the idea represents the first US patent to cover light guiding and is a beautiful example of Victorian patent art.

distribution in spaces and buildings, for instance by "transporting" light from the facade to the back of the room or the core of the building, see Figure 2.

Undoubtedly, redirecting or transportation of natural light will also be part of the strategies for improved daylight utilization in the future. But since the view and connection with the outdoors has always been considered to be the most important aspect of windows, the building designers may have to make a clearer distinction between the *view window* and the *daylighting window* when looking for a "daylighting solution." IEA Solar Heating and Cooling (SHC) Task 21, Daylight in Buildings, has tested many such combined "solutions" or systems and produced a com-pre-hensive description of most of the systems available on the market today.

TESTING INNOVATIVE DAYLIGHTING SYSTEMS

Until now, no standard monitoring procedures have been available to assess and compare performances of daylighting systems and daylight responsive lighting control systems. However, the collaborative efforts in SHC Task 21 have rectified this by establishing a comprehensive protocol for monitoring procedures for the assessment of daylighting strategies.

According to the SHC *Monitoring Protocol*, the performance of a given daylighting strategy or system is always compared to a reference situation in occupied or unoccupied rooms under real sky conditions. The procedures describe the necessary parameters to be considered, give guidance for measurements, and specify the acceptable accuracy of the measurements and procedures for user assessment. The Protocol also includes recommendations on documentation of the testing procedures and evaluation of the system's performance compared to the reference situation.

The monitoring of daylighting systems and/or control systems in test rooms have been carried out in Australia, Austria, Denmark, Finland, France, Germany, Netherlands,

Figure 3. Test facility at LESO, EPFL in Switzerland. Each room has windows on the upper part of the facade, the lower part of the wall being opaque (sill-height is 1.05 m above the interior floor). The system tested in this case is a so-called anidolic ceiling, an innovative system that brings light from the facade to the back of the room.

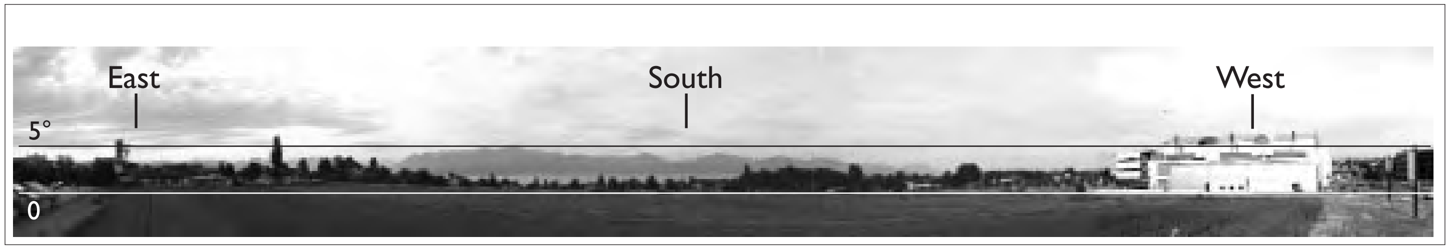


Figure 4. Panoramic view of the horizon as seen from the windows of the test rooms, when facing due South. For comparisons of the daylight conditions in the test room and the reference room, the exterior conditions must be almost identical, preferably with no obstructions. In this case, the angular altitude of external obstructions is lower than 5°.

Norway, Switzerland, the UK, and the USA. The Monitoring Protocol has been developed for use in studies of standard offices with only vertical window(s) and horizontal work planes. Figures 3-4 shows the test rooms used in Switzerland, at the site of EPFL, located near Lausanne, Switzerland (46.5°N, 6.6°E). These test rooms are moveable and can be orientated in all directions.

Performance Assessment

The performance of the daylighting systems is characterized by their ability to control the daylight levels, to improve the illuminance/luminance distribution in the room, to prevent glare, and to allow an unobstructed view out. The physical testing in the test rooms includes measurements for one day under overcast sky conditions and three days under clear sky conditions, taken around winter solstice, equinox and summer solstice.

The minimum subjective evaluation of the visual aspects consists of observations in the occupied or unoccupied rooms. It includes the detection of sun-patches and areas with high luminance and glare. For a more extensive evaluation of the visual conditions and statistical assessment of users' acceptance, a questionnaire has been developed.

System Descriptions

In the SHC Task 21 book, *Daylight in Building: A Source Book on Daylight Systems & Components*, the included daylighting systems are first categorized in a systems matrix that gives an overview and the monitored performance as well as the detailed technical and economical aspects for each system. However, this book does not prescribe any simple selection method. Each system or approach has distinct characteristics, and for each design case the relative importance of the performance parameters is different. Instead, the designer is urged to focus on answering the following questions: Is it useful to apply a daylighting system in my case? What kind of problems can I resolve with a system? What benefits can I potentially achieve? The designer also is urged to review the specific design context (site, latitude, etc.) and major objectives for applying daylighting systems: redirection of daylight to under-lit zones, improved daylighting as task illumination, improved visual comfort and glare control, and solar shading or thermal control.

Classification

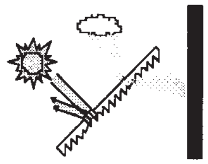
The systems described are categorized according to their main characteristics including the predominant sun and sky condition for which the systems have been designed. The systems matrix is a useful tool for the designer to quickly assess which technologies may be applicable for a specific building condition. The systems are grouped into two categories: (a) systems that provide control of direct sun and (b) systems that require additional measures to control direct sun. The following gives some system examples of the system categories.

Shading Systems

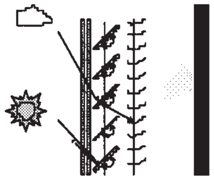
Shading systems are designed for solar shading and for daylighting, but they may address other daylighting issues as well, such as protection from glare and redirection of direct or diffuse daylight. The use of conventional solar shading systems, such as a pull-down shade, often significantly reduces the admission of daylight to a room. To increase daylight under these circumstances, advanced shading systems have been developed that both protect the area near the window from direct sunlight, and redirects direct and/or diffuse daylight via the ceiling deeper into the interior of the room.

Shading systems using primarily diffuse skylight

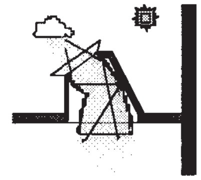
Shading systems, which reject direct sunlight, but allow transmission of diffuse skylight. These systems allow no view out and should only be installed in openings dedicated to daylighting.



Prismatic panel



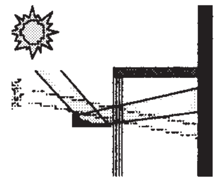
Prisms and Venetian blinds



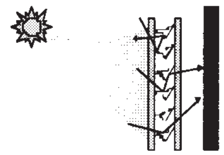
Anidolic Zenithal opening

Shading systems using primarily direct sunlight

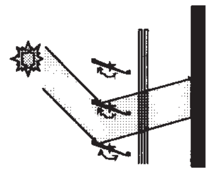
Shading systems, which redirect sunlight onto the ceiling. Such systems can normally not be installed below eye height (in the view window) but only in the upper part (the daylighting window).



Light shelf



Glazing with reflecting profiles (Okasolar)



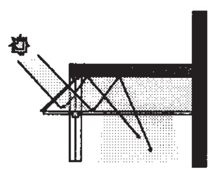
Movable lamellas

Daylighting systems without shading included

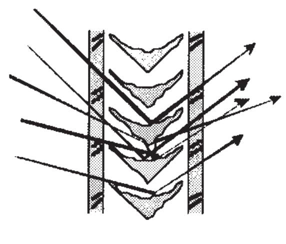
These systems are designed primarily to redirect daylight to areas further from the window or skylight opening. They may or may not block direct sunlight.

Diffuse light-guiding systems

Daylighting systems that redirect daylight from specific areas of the sky vault to the interior of the room. Under overcast sky conditions, the zenithal area of the sky is much brighter than the area near the horizon. For sites with tall external obstructions, typical of dense urban environments, the upper to zenithal portion of the sky may be the only source of daylight. For these situations light-guiding systems can improve daylight utilization.



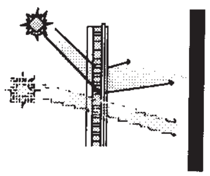
Anidolic ceiling



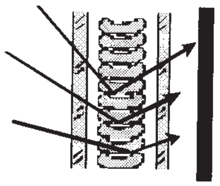
Reflecting profiles (Fish)

Direct light-guiding systems

Daylighting systems that redirect direct sunlight to the interior of the room. When installed correctly, the negative effects of glare and overheating can be significantly reduced.



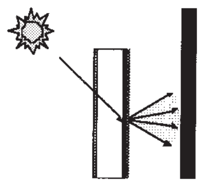
Laser cut panel



Glazing with sun directing profiles

Scattering systems

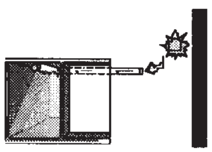
Light-scattering or diffusing systems that are used in skylight or toplit apertures to produce an even daylight distribution. If used in vertical window apertures, serious glare will often be the result.



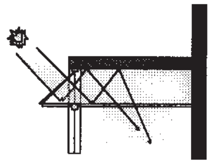
Scattering (diffusing) systems

Light transporting systems

Systems that collect and transport sunlight over long distances via fiber optics or light pipes to the core of the building. Theses type of systems were not monitored in SHC Task 21.



Light pipes



Light guiding ceiling

OUTLOOK

It is to be expected that the rapid development in glazing technology we have seen over the last 10 years will continue in the first decades of the new Millennium. New so-called "daylighting technologies" will show up, and the major challenge for the architect may therefore be (as it has always been) just to remember that daylight is an integral part of architecture, some say daylight is architecture. Designing with daylight starts from the space, from the function and the activities, but first of all from the occupants and the visual environment necessary for tasks to be conducted in the space.

However, since many building designers seem to think mainly of the exterior expression of buildings, the significant break-through for daylighting may not happen until the new chromatic glazings (electro-, thermo-, and photo-chromatic glazings) reach the marketplace at affordable prices. In any case, these technologies will present architects with new challenges, and gives them the chance to design buildings which truly integrate solar and daylighting control capabilities.

CONCLUSION

After 25 years of new research and applications, there are still numerous obstacles to the widespread use of daylight and its integration with other energy loads in buildings. And, there is still much to do, both in the

Figure 5. Interior view of the Oakland Federal Building testbed with electrochromic glazings installed.

research and development and the practical application of daylight systems.

The human dimension of the daylighting equation also is a critical element in any successful daylighting design. Surprisingly, after many years of R&D, users remains a weak point in our knowledge base even though they can have a fundamental impact on the design and selection of daylighting devices and systems. To address these challenges, it is necessary to continue the coordinated effort, as demonstrated by SHC Task 21, on a global basis. Attention to these critical areas will accelerate the beneficial impacts that daylighting can have in terms of energy efficiency, comfort, visual performance, and health and amenity in buildings of the 21st century.

References

Monitoring Protocol: Performance Assessment of Daylighting Systems and Daylight Responsive Lighting Control Systems. (available in mid 2000).

Daylight in Buildings: A Source Book on Daylight Systems and Components. IEA Solar Heating & Cooling Programme Task 21. (available in mid 2000).

TASK 19:

Solar Air Systems

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TASK DESCRIPTION

The objective of Task 19 was to facilitate the use of solar air systems for residential, institutional and industrial buildings by:

- Documenting **exemplary buildings** to inspire designers and building clients with the reliability, performance and aesthetics of building integrated systems.
  (Lead Country: Switzerland)
- Writing a **design handbook** to help engineers choose, dimension and detail a system; while assessing energy performance and non-energy issues.
  (Lead Country: Denmark)
- Developing a **computer tool** to analyze key design variables by means of TRNSYS modules of Task 19 systems and a user-friendly interface.
  (Lead Country: Germany)
- Compiling a **catalog of manufactured components** to inform designers what is available "off the shelf" for solar air systems and from where.
  (Lead Country: Norway)
- **Testing collectors** under laboratory conditions to help manufacturers optimize performance and to provide standardized data for consumers.
  (Lead Country: Austria)

Duration

The Task was initiated in October 1993 and completed in April1999.

Participation

Working in Task 19 were 25 experts from nine countries:

Austria	Germany
Sweden	Canada
Italy	Switzerland
Denmark	Norway
United Kingdom	

REVIEW OF 1999 ACTIVITIES AND COMPLETION OF THE TASK

In 1999, the manuscript for the Design Handbook was edited by the Operating Agent, page layouts completed by the publisher and sent to the respective authors for "good to print" approval/revisions. The front section and a sample technical chapter were approved by the Executive Committee.

In 2000, the Operating Agent and Task experts will work the publisher to complete the Design Handbook. The book will be published in early 2000 and distributed based on pre-orders.

Task Results

The most important results of the Task according to the Operating Agent are:

- Designer and building client awareness has been broadened beyond solar water systems to solar air systems. Further, confidence in air systems grew, given that many such systems were already built, performing well and looking attractive.
- The job for planners to engineer such systems was simplified by providing them with a kit of tools including a catalog of components, an engineering handbook and a PC tool.
- Manufacturers of components were assisted by the development

of a standardized laboratory testing procedure to allow performance assessment for marketing and product development.

- The economy of solar air systems has been improved by as much as a factor of four as a result of optimized manufactured collectors, more rational site-built collectors and simplification of the system configurations.

Industry participation was strong in Task 19 thanks to several manufacturers of solar air collectors having experts represent them at Task meetings. Examples include: ABB of Norway, Aidt of Denmark, Grammer of Germany, Secco Sistemi of Italy and Solarwall of Canada

Technical Conclusions

- Solar air systems have come of age. There exists a multitude of built systems serving diverse functions and for diverse building types. Task 19 documented solar air systems on nine single family houses, ten multi-family buildings, four schools, three sports halls, six industry structures and one office building.

- Collectors range from the simplest, unglazed units to high-performance manufactured units. Each type of collector has its place in the market. The simplest, unglazed collector demonstrated repeatedly the best economic performance. On the other hand, high-performance collectors make sense particularly if water is to be heated, or if the area available for collectors is limited. A sensible glazed collector configuration has only single glazing and an underflow metal absorber.

- The economics of solar air systems is a tough fight given the present costs of fossil fuels. To improve the economics three approaches proved effective:
  - Integrate the collectors in the skin of the building (saves material).
  - Use the massive building structure to store/distribute heat.
  - Specify details and components which are standard HVAC practice.
  - Incorporate an air to water heat exchanger to use the abundant solar energy in summer.

In summary, Task 19 has facilitated the introduction of solar air systems by informing the designers and building clients of the existence of numerous built examples, providing architects with convincing arguments for clients and then the tools needed to design such systems, and supporting industry with standardized testing procedures and a catalog demonstrating that this is a credible, proven technology.

REPORTS PUBLISHED IN 1999

Conference Proceedings: Solar-Luft-Systeme, Zurich, Switzerland, September 1999.

Solar Air Collectors for Buildings - domestic and non-domestic, Department of the Environment, BRE, General Information Report 58, 1999.

REPORTS PLANNED FOR PUBLICATION IN 2000

Solar Air Systems: A Design Handbook, James & James, (ISBN: 1 873936 86 9), expected printing date is: March 2000.

MEETINGS IN 1999

A national presentation on Task 19 was made to practitioners and industry representatives in September in Zurich, Switzerland.

A technical presentation on the work of Task 19 was presented to the SHC Executive at the November 1999 Executive Committee meeting in Switzerland. Presentations were made by: R. Hastings on a Task overview; H. Fechner on collector testing; Ch. Filleux on system type 4; K. Fort (CH): Hypocausts, A. Gutermann on example applications, and A. Knirsch on Trnsair

COMPLETE LIST OF TASK PUBLICATIONS

Solar Air Heated Buildings (Working Document) Solararchitektur, ETH-Hönggerberg, CH-8093 Zürich, September 1992.

IEA Task 19: Solar Air Systems: A Research and Demonstration Programme (Task Brochure), Solararchitektur, ETH-Hönggerberg, CH-8093 Zürich, January 1995. James & James Science Publishers, 35-37 William Rd. London NW1 3ER:

Solar Air Systems - Product Catalog James & James Science Publishers, 35-37 William Rd. London NW1 3ER, ISBN 1-873936-84-2.

Solar Air Systems - Case Studies
James & James Science Publishers,
35-37 William Rd. London NW1
3ER, ISBN 1-873936-85-0.

Solar Air Systems - A Design Handbook
James & James Science Publishers,
35-37 William Rd. London NW1
3ER, ISBN 1-873936-86-9.

TRANSAIR
(A PC tool for analyzing solar air systems)
Transolar (Contact: Alex Knirsch),
Nobelstr. 15, D 70569 Stuttgart.

"*Solar Air Heating*"
(feature article in the *1998 Annual Report of IEA Solar Heating & Cooling Programme*) Morse Associates, Inc.

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TASK 21:

Daylight in Buildings

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TASK DESCRIPTION

Artificial lighting represents a major part of the overall energy consumption in non-residential buildings. However, more daylight conscious architectural solutions and the introduction of innovative daylighting systems and efficient lighting controls could displace a considerable part of this electricity consumption by utilizing the natural resources offered by daylight. Further-more, it is generally recognized today that the design of the fenestration system and the proper use of daylight in building interiors are important factors, both for the conservation of non-renewable fuels and for the well being of occupants.

However, a number of barriers hinder appropriate integration of daylighting aspects in the building design. One is the lack of documented, empirical evidence that daylighting can substantially improve energy efficiency and visual quality in buildings. Furthermore there is insufficient knowledge and lack of information on new fenestration technologies and lighting control systems and the ability of such systems to enhance utilization of daylight, and a lack of user friendly daylighting design tools and models for innovative daylighting systems.

Task 21 will contribute to the overcoming of the identified barriers. The Task was initiated in 1995 with the main objectives to advance daylighting technologies and to promote daylight conscious building design. Through selected Case Studies the Task will demonstrate the viability of daylighting designs under various climatic conditions emphasizing system performance regarding energy savings and user acceptability.

The main deliverables from the Task will be:

- A system specific Design Guide on daylighting systems and control systems providing recommendations on systems integration and performance data on energy saving potentials.
- A set of Daylighting Design Tools that will markedly improve the designers' ability to predict the performance of daylighting systems and control strategies and to evaluate the impact of daylight integration in the overall design concept.
- A Case Studies Report, documenting measured data on daylighting performance, energy consumption and user appraisal of the environmental conditions.

The work of the Task is structured in the following four Subtasks, each coordinated by a lead country.

Subtask A: Performance Evaluation of Daylighting Systems

(Lead Country: Australia)

This Subtask will provide design guidance on the performance of both innovative and conventional daylighting systems. Systems will be assessed according to energy saving potential, visual aspects and the control of solar radiation. The evaluation of systems is to be based not only on technical feasibility but also on architectural and environmental impacts.

Subtask B: Daylight Responsive Lighting Control Systems
(Lead Country: Netherlands)
Energy savings from daylighting cannot be significant without an appropriate integration of window design and electrical lighting systems. The objectives of Subtask B are to evaluate the performance of existing selected daylight responsive lighting control systems (in conjunction with selected daylighting systems) in terms of their capability to control the artificial lighting in response to available daylight and in terms of user acceptance of the systems. This will assist building owners, developers, architects, and engineers to select and commission daylighting responsive systems, and to estimate the potential energy savings at an early stage of design.

Subtask C: Daylighting Design Tools
(Lead Country: Germany)
The objective of Subtask C is to improve the capability, accuracy and ease-of-use of daylighting design and analysis tools for building design practitioners, covering all phases of the design process. The practitioners will be able to predict the performance of different daylighting systems and control strategies and to evaluate the impact of the integration of daylighting in the overall building energy concept by using these design tools.

Subtask D: Case Studies
(Lead Country: Denmark)
Despite claims that daylighting can substantially improve visual quality and energy efficiency of buildings there is little documented empirical evidence. The main objective of Subtask D is to demonstrate the viability of daylighting buildings in various world climate zones as an energy saving potential in buildings while maintaining a satisfactory visual and thermal environment for occupants, and to provide real validation data to computer models.

Duration
The Task was initiated in September 1995 and completed in December 1999.

ACTIVITIES DURING 1999
It has been a very busy year for all the experts, finalizing the testing of systems, developing design tools and monitoring and preparing detailed descriptions of the case study buildings. Many reports are in the final stage now, ready for approval by the Executive Committee, before the release in year 2000.

Two experts meetings were held in 1999, one in Innsbruck, Austria, and the last one in Copenhagen, Denmark. A short overview of the achievements in each of the four Subtasks is given below.

Subtask A: Performance Evaluation of Daylighting Systems
The main result of this Subtask is the report "Daylighting Systems: - A source book on building integration of systems and components for improving daylight performance." This report includes the detailed system descriptions, general experience, test results, and performance evaluations for all systems examined in the test facilities. Table 1 shows an extract of the matrix giving the daylighting systems overview in the report.

Subtask B: Daylight Responsive Lighting Control Systems
The testing of about 15 different daylight responsive lighting control systems has now been completed. The results will be documented in the "Application Guide for Daylight Responsive Lighting Control Systems", which consists of two parts, 1) a general handbook and 2) examples and performance results from practice.

The Application Guide will be in the form of a CD-ROM, which will include the whole Application Guide (parts 1 and 2), and possibly a database of the systems, the pilot studies, and the monitoring protocol.

Samples of Subtask B daylighting system components: ballasts, sensors and controllers used in Subtask B.

Subtask C: Daylighting Design Tools
Twelve institutions representing 10 IEA countries are involved in production and evalu-ation of daylighting design tools. Many of the reports of this Subtask are in the approval process and will be available early in 2000. The simple daylighting design tool DIAL developed by EPFL and already approved by the Executive

Table 1. Extract of matrix overview of daylighting systems

2. Daylighting systems without shading included

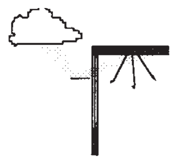
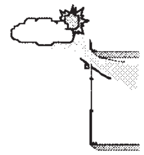
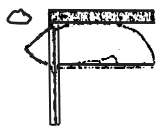
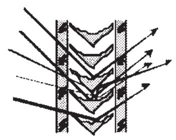
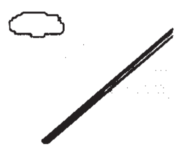
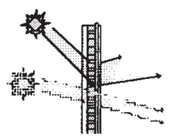
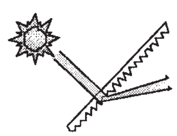
Division	System		Climate	Attachment	Criteria for the choice of elements						
	Name	Sketch			Glare protection	SView outside	Lightguiding into the depth of the room	Homogeneous illumination	Saving of energy for artificial lighting	Need for tracking	Availability
2A Diffuse light guiding	Lightshelf (› 4.3)		Temperate climates, cloudy skies	Vertical windows	D	Y	D	D	D	N	A
	Anidolic Integrated System (› 4.12)		Temperate climates	Vertical windows	N	Y	Y	Y	Y	N	A
	Anidolic ceiling (› 4.12)		Temperate climates, cloudy skies	Vertical facade above viewing window		Y	Y	Y	Y	N	T
	Fish System		Temperate climates	Vertical windows	Y	Y	Y	Y	Y	N	A
	Zenith light guiding elements w/ Holographic Optical Elements (› 4.10)		Temperate climates, cloudy skies	Vertical windows (especially in court-yards), sky-lights		Y	Y	Y	Y	N	A
2B Direct light guiding Systems	Laser Cut Panel (LCP) (› 4.6)		All climates	Vertical windows, skylights	N	Y	Y	Y	Y	N	A
	Prismatic panels (› 4.5)		All climates	Vertical windows, skylights	D	D	D	D	D	Y/N	A

Figure 2. Example of a Radiance rendering of an office with a light shelf.
© G. Ward 1994.

Committee, is an easy-to-use tool for educational purposes and for buildings design analysis. The new version 3.0 of the ADELINE package, also available soon, has improved in user friendliness. Two new dialogs have been developed allowing the graphically supported selections of items from the object library and the selection of luminaries based on either IES or EULUMDAT format descriptions. These new dialogs will be integrated in the RADIANCE Scene Editor. More than 300 objects are currently part of the object library. Figure 2 shows an example of simulation capabilities of the Radiance software, the main program of ADELINE.

Subtask D: Case Studies

Fifteen Case Study buildings have been monitored and described in detail, especially regarding their day-lighting performance. The Case Studies Report is to be published in colors by a professional publisher in Autumn 2000. Figures 3-6 are from the ADO office building in Cologne, Germany. The daylighting strategy on the North facade is to catch high luminance zenithal skylight on elements with a holographic surface, which redirects the light to the depth of the room. The very deep (12 m) spaces at the South facade are equipped with sunlight guiding elements that redirect the daylight to the high reflective ceiling and deep into the rear part of the rooms.

LINKS WITH INDUSTRY

All Subtasks have significant links to industry, and in many participat-ing countries, industry offers significant financial support for work being undertaken. Most of the day-lighting systems and lighting control systems are provided by manufacturers, who naturally have an inte-rest in the Task's testing procedures results. In Subtask B on Control Sys-tems, major manufacturers are directly involved in the research activities and are providing excellent facilities for the testing of several systems and strategies. In Subtask C on Design Tools, the development of a common platform for integration of building design tools is partly based on the standards set by the Industry Alliance for Interoperability (IAI). Subtask D on Case Studies is led by a private engineering consul-tant and has strong links to a similar project under the European Community's JOULE program-me. In this Subtask, building owners have made their buildings available for Task monitoring and user evaluations. In

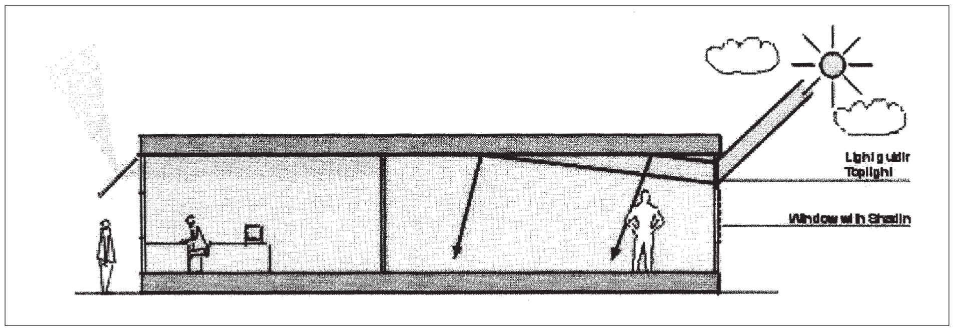


Figure 3. Principles of the daylighting strategies in the ADO office building, Cologne, Germany.

Figures 4 and 5. Outside and inside view of the zenithal light guiding elements on the north facade.

some cases, the owners have provided unoccupied spaces for direct full scale testing.

REPORTS PLANNED FOR 2000

Table 2 gives a list of all official reports planned for Task 21. When approved, many of the reports will be downloadable from the Internet.

1999 EXPERTS MEETINGS

Eighth Experts Meeting
April 12-16
Innsbruck, Austria

Ninth Experts Meeting
September 27-30
Copenhagen, Denmark

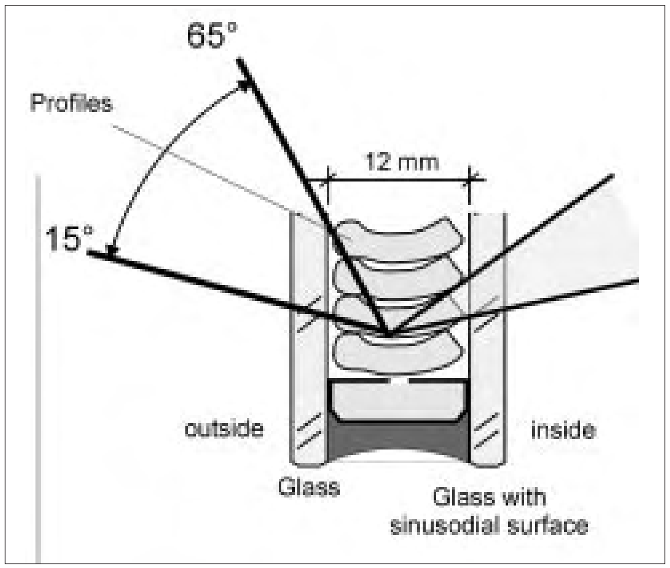


Figure 6. The sunlight guiding elements on the south facade. The elements consist of acrylic profiles that redirect the sunlight from a wide angle of altitudes to the ceiling.

Table 2. Official reports of IEA SHC Task 21: Daylight in Buildings

SUBTASK A: Performance evaluation of daylighting systems	Format	Available Month/Year
Survey of Architectural Solution (IBUS)	Print, CD	04.2000
Monitoring Protocol (SBI/TUD)	Print, CD	04.2000
Physical characteristics measured in Lab (TUB)	Print, CD	02.2000
Source Book (printed/CD-ROM/on the Web)	Print, CD	07.2000
Document on test room facilities (SBI)	Print, CD	07.2000
Scale model measurements on daylighting systems (EPFL)	Print, CD	07.2000
Daylighting Systems Data Base (TUB)	CD	07.2000
SUBTASK B: Daylight responsive lighting control systems		
Monitoring Protocol (TUD/SBI)	Print, CD	04.2000
Application Guide (TNO et al.)	CD	06.2000
Database of daylight responsive lighting control system (TUB)	CD	06.2000
Introduction Brochure to Application Guide	Print	06.2000
SUBTASK C: Daylighting design tools		
Validation of daylighting design tools (ENTPE)	Print	02.2000
Applicability of daylighting computer modeling in real case studies (NRC)	Print	01.2000
LESO DIAL (EPFL)	CD	09.1999
Daylight simulation: Methods, algorithms, and resources (LBNL)	Print, CD, Web	01.2000
Survey of simple design tools (FhG-IBP)	Print, CD	02.2000
Methodology of Atria tool (EMPA)	Print	03.2000
Adeline 3.0 and brochure (FhG-IBP)	CD, (print)	02.2000
Summary report from Subtask C (FhG-IBP)	Print, (CD)	04.2000
SUBTASK D: Daylight in Buildings, Case Studies		
Monitoring Protocol	Print, CD	09.1998
POE Procedures and results	Print, CD	04.2000
Daylight in buildings – 15 monitored case study	Print, CD	10.2000

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TASK 22:

Building Energy Analysis Tools

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TASK DESCRIPTION

The overall goal of Task 22 is to establish a sound technical basis for analyzing solar, low-energy buildings with available and emerging building energy analysis tools. This goal will be pursued by accomplishing the following objectives:

- Assess the accuracy of available building energy analysis tools in predicting the performance of widely used solar and low-energy concepts.
- Collect and document engineering models of widely used solar and low-energy concepts for use in the next generation building energy analysis tools.
- Assess and document the impact (value) of improved building energy analysis tools in analyzing solar, low-energy buildings, and widely disseminate research results to tool users, industry associations and government agencies.

Task 22 will investigate the availability and accuracy of building energy analysis tools and engineering models to evaluate the performance of solar and low-energy buildings. The scope of the Task is limited to whole building energy analysis tools, including emerging modular type tools, and to widely used solar and low-energy design concepts. To accomplish the stated goal and objectives, the Participants will carry out research in the framework of two Subtasks:

- Subtask A: Tool Evaluation
- Subtask B: Model Documentation

Tool evaluation activities will include analytical, comparative and empirical methods, with emphasis given to "blind" comparative evaluation using carefully designed test cases and "blind" empirical validation using measured data from test rooms or full scale buildings. Documentation of engineering models will use existing standard reporting formats and procedures. The impact of improved building energy analysis tools will be assessed from a building owner perspective.

The audience for the results of the Task is building energy analysis tool developers. However, tool users, such as architects, engineers, energy consultants, product manufacturers, and building owners and managers, are the ultimate beneficiaries of the research, and will be informed through targeted reports and articles.

Duration

The Task was initiated in January 1996 and is planned for completion in June 2000.

ACTIVITIES DURING 1999

A summary of Subtask research activities completed during 1999 is presented below.

Subtask A: Tool Evaluation

This Subtask is concerned with assessing the accuracy of available building energy analysis tools in predicting the performance of widely-used solar and low-energy concepts. Three tool evaluation methodologies are being employed:

1) Analytical Tests
2) Comparative Tests
3) Empirical Validation Tests

Work accomplished during 1999 on each of these tool evaluation efforts is summarized below.

- **Analytical Tests:** All planned activities have been completed. The Working Document, along with a questionnaire, a recommended implementation process, and a series of one page summaries of use experience, was distributed to leading building energy analysis tool authors throughout the world. The purpose is to inform code authors of the existing analytical tests, and to obtain their views and recommendations on the importance and value of analytical tests for tool evaluation/validation.

- **Comparative Tests:** The HVAC BESTEST specification has been revised to incorporate a larger number of test cases and resolve a few remaining ambiguities. The new test cases complement the existing test cases and improve the diagnostic capability of HVAC BESTEST. A third round of comparative analyses is currently underway involving five (5) tools from four countries. As a result of the first and second rounds of comparative analyses, two simulation tools have been modified to address problems or deficiencies uncovered.

- **Empirical Validation Tests:** The final report on the ETNA and GENEC test room empirical validation exercises, prepared by France (EDF), was approved by the Executive Committee and distributed to the Task Experts, Executive Members, and tool authors and researchers throughout the world. The report contains the final results of all Task Participants for the "blind" and "non-blind" empirical validation exercise, involving several test conditions in the ETNA and GENEC passive solar test facilities. In general, the tool predictions of energy and temperature are in close agreement with the measured test room data. Innovative parameter identification and validation techniques uncovered an experimental deficiency which helped to understand the tool results.

The second round of analyses has been completed for the commercial empirical validation exercise using monitored data from the Iowa Energy Center's Energy Resource Station (ERS) test facility. Five tools from three countries are participating in the exercise. Three validation data sets were collected from experiments conducted in EDS's match pair of test rooms:

1) Constant Air Volume with Terminal Reheat
2) Variable Air Volume with Terminal Reheat
3) Very Variable Air Volume with Terminal Reheat

A "blind" empirical validation exercise was conducted by the Task participants. Refinements to the models are currently being made as ambiguities and modeling uncertainties are being resolved. A final set of runs will be made and the final report of the empirical validation exercise prepared.

Subtask B: Model Documentation

This Subtask is concerned with the collection and documentation of existing engineering models and the creation of a models library accessible by object-oriented (modular) simulation tool developers. Task Participants have selected the Neutral Model Format (NMF) as the standard format for "hard" (computer-machine readable) model documentation.

KTH of Sweden operates and maintains the Simulation Model Network (SIMONE) on its Internet web site (http://www/brisdata.se/NMF). This web site allows users to review available engineering models documented in the neutral model format. These models can be downloaded for translation for use by object-oriented (modular) simulation tools.

KTH has prepared a final Subtask B report which documents the forty engineering models contained in the SIMONE web site. A translator, which converts the NMF code to tool-specific (usable) code, has been developed and tested for IDA, TRNSYS, and SPARK.

WORK PLANNED FOR 2000

A summary of planned activities for Subtask A projects is presented below:

- **Analytical Tests.** Revise Working Document, as appropriate, based on comments received from tool authors, and the addition of new analytic tests.
- **Comparative Tests.** A final round of analyses will be conducted for all HVAC BESTEST cases. A pre-

liminary final report will be prepared which presents the test specifications, results, participant (modeler) reports, and conclusions and recommendations.

- A final round of analyses will be conducted on the three ERS experiments. The "blind" status of the tests will be removed and participants (modelers) will look for justifiable modeling errors or problems with their tools, where substantial disagreement with the measured results exist.

LINKS WITH INDUSTRY

Because of the nature of the Task – tool evaluation and emerging tool research – links with industry take a somewhat different form than other IEA SHC Programme Tasks. The primary audience for Task 22 research is building energy analysis tool authors. A secondary audience is building energy codes and standards writing organizations. For tool authors, a number of links have been established. The Analytical Solutions Working Document has been distributed for their use and comment, and a number of tool authors are participating in the HVAC BESTEST and ERS tool evaluation exercises. These activities keep Task 22 research effectively linked to the needs and recommendations of the world's leading building energy analysis tool developers.

The results of Task 22 research are used as prenormative information in the establishment of national building energy codes and standards. For example, the BESTEST cases are being developed by ASHRAE into a standard for energy standard compliance tool certification. Also, the U.S. National Association of State Energy Officials has referenced IEA BESTEST for certification of home energy rating software. A number of other countries are considering BESTEST as a standard method of testing building energy analysis tools for their national energy codes.

Through these kinds of industry links, the participants of Task 22 ensure the valuable use of its research results.

REPORTS PUBLISHED IN 1999

The following reports or results were published in 1999:

Comparison Between EDF ETNA and GENEC Test Cell Data and Building Energy Analysis Simulation Models, Electricity of France, December 1999.

Models for Building Indoor Climate and Energy Simulation, KTH, Sweden, December 1999.

Simulation Model Network (SIMONE) web site of NMF engineering models, BrisData, Sweden, 1999.

REPORTS PLANNED FOR 2000

The following reports or results are planned for 2000:

HVAC BESTEST Specifications and Comparative Results, NREL, USA.

Empirical Validation of Energy Analysis Models Using Energy Resource Station Data, CIEMAT, Spain.

Parameter Estimation/Identification Technique for Modeling Error Diagnostics, GISE/ENPC, France.

1999 EXPERTS MEETINGS

Seventh Experts Meeting
March 17-20
Dresden and Berlin, Germany

Eighth Experts Meeting
September 29-October 1
Stockholm, Sweden

2000 EXPERTS MEETINGS

Ninth Experts Meeting
March 20-23
Madrid, Spain

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TASK 23:

Optimization of Solar Energy Use in Large Buildings

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TASK DESCRIPTION

The main objectives of Task 23 are to ensure the most appropriate use of solar energy in each specific building- project for the purpose of optimizing the use of solar energy and also of promoting more use of solar energy in the building sector.

This is achieved by enabling the building designers to carry out trade-off analyses between the need for and potential use of energy conservation, daylighting, passive solar, active solar, and photo-voltaic technologies in systematic design processes.

In addition, the objective of the Task is to ensure that the buildings promote sustainable development. This is done by including considerations of other resource use and of local and global environmental impact in the trade-off analyses to be carried out.

Scope

The work primarily focuses on commercial and institution-al buildings, as these types of buildings clearly need several types of systems. In particular, office buildings and educational buildings are addressed. The same issues are relevant for many ---other commercial and institutional buildings. However, some of these, such as for -instance hospitals, require rather specialized design teams and would broaden the scope of the Task tremendously. They are therefore excluded from the Task in order to ensure concentration and focus in the work carried out.

Means

The work in the Task is divided in four Subtasks:

- Subtask A: Case stories
  (*Lead Country: Denmark)*
- Subtask B: Design process guidelines
  (*Lead Country: Switzerland)*
- Subtask C: Methods and tools for trade-off analysis
  (*Lead country: USA)*
- Subtask D: Dissemination and demonstration
  (*Lead country: Netherlands)*

Subtask A provides the knowledge base to be used in the development of guidelines, methods, and tools in Subtasks B and C, while Subtask D ensures that the results of the work are disseminated to the appropriate audiences.

Duration

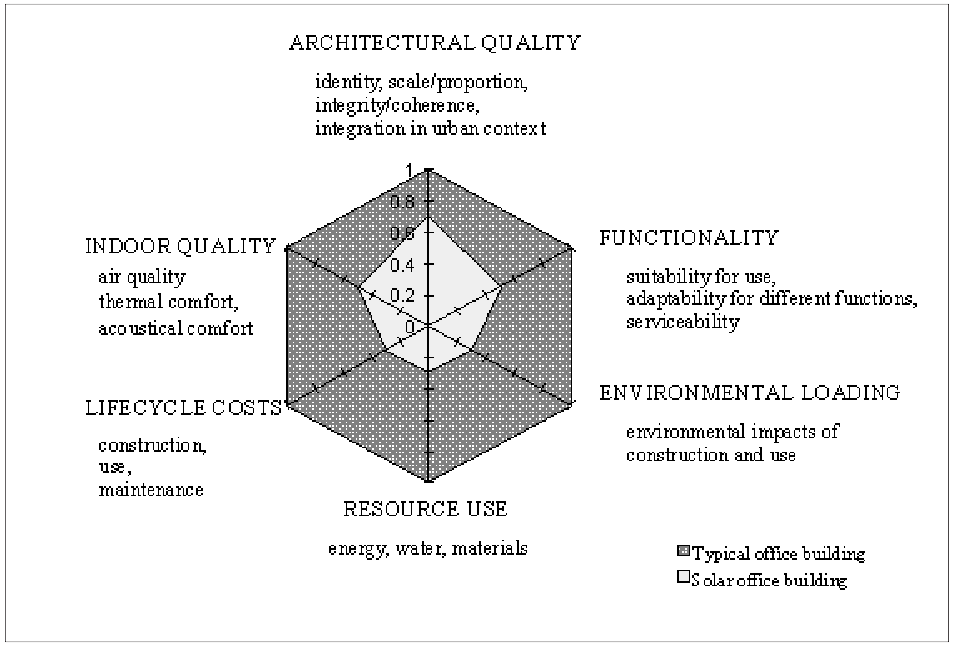
The Task was initiated on June 1, 1997 and will be completed on June 1, 2002.

ACTIVITIES DURING 1999

Subtask A: Case Stories

The main objective of Subtask A is to provide the knowledge needed in the development of the guidelines, methods, and tools which are being developed in Subtasks B and C. This is done by evaluating and documenting a set of buildings designed using the "whole building approach". Both the particular processes used in the design of the buildings and the resulting building performances are evaluated.

The Technical Report on Case Stories, the main result of this, is now



Example of how the result of a multi-criteria evaluation of a specific solar design ("solar office building") versus a traditional design ("typical office building") can be illustrated in a so-called "star diagram" using the MCDM 23 tool.

printed and distributed. An article based on the contents of the report is also produced, and plans for wide international distribution of this have been made. Plans for a second volume of the report, with a few new buildings, have also been made. This will be a Working Document, for internal use.

Subtask B: Design Process Guidelines

The main objective of Subtask B is to develop design process guidelines suitable for the early stages of design, as the integrated design approach is particularly important in these stages. The guidelines deal both with the make up of and the interaction between members of the design team, with the information required by the team, and with the ways of designing the building as a system, where the different low energy and solar technologies to be used are integral parts of the whole.

The Subtask B working group has developed what may be called an electronic multidimensional information space which includes all the information they collect/develop on design processes and which helps sort this information in relevant files. This information space they use as a tool in identifying the elements that are key to a successful design process specifically aimed at the design of solar low energy buildings. Using these results, they will proceed to produce a set of relatively simple design process guidelines. The information space itself may in the end become a supplement to this.

At the last experts meeting the group organized a workshop providing input to this work.

One of the key outcomes of the workshop was the realization that at least some of the work in Subtask B should focus on design competitions. Competitions are typically used in the design of larger buildings, they are becoming more and more common, and they are often a serious obstacle to good solar design. It is therefore especially important to develop guidelines for how to organize competitions in a way that promotes solar low energy design. For that purpose it seems that the Task 23 guidelines and methods/tools can be useful both in the development of competition programs and in the evaluation of entries.

Subtask C: Methods and Tools for Trade-off Analysis

The main objective of Subtask C is to develop methods and tools to be used by the designers when doing trade-off analyses between different low energy and solar technologies. As designers, builders, and owners optimize against a large number of criteria, such as energy use, comfort, cost, aesthetics, environmental impact, etc., it is assumed that there is a need for both a computer-based tool that can optimize against a relatively limited set of criteria and a more complex, multi-criteria decision making method that will enable the designers to do more general and, therefore, less detailed optimizations.

The first version of such a multi-criteria decision making (MCDM) method has now been tested in

The leader of Subtask B attempting to explain their multi-dimensional information space to the other experts.

local/national workshops on real design problems. The participants experienced that the clients often were unaware of their own priorities with respect to the buildings they wanted to have built. The team workshops therefore helped both the clients and the others find out what they really wanted. The conclusion from testing the process was also that it proved to be a very valuable process in bringing the team together and in extending the range of issues being considered. The workshops, and the reports from them, also taught the Task 23 experts a lot about "real life" design processes. All the participants will now either start, continue, or repeat the testing. The results of the tests will be used to refine the method.

A computer tool, MCDM 23, which includes the worksheet used in the MCDM method and which presents the results as star diagrams, has also been produced. The tool is intended to make some of the steps in the MCDM process easier to carry out. This tool has in general been very well received by the participants, and some of the Task 23 experts have expressed interest in integrating it in their own tool development. This will be possible as long as due credit is given to Task 23.

Subtask D: Dissemination and Demonstration

The main objective of Subtask D is to disseminate the results of the Task's work to the building community. For architects and engineers designing low energy and solar buildings it is assumed that dissemination through workshops, seminars, and design competitions will be particularly effective. For builders, owners, and occupants it is assumed that demonstration buildings will be most effective.

The first workshop with external participation has now been conducted, and plans for the next one have been made. Plans for demonstration buildings are also coming along, with quite a few of the participants now having fairly concrete ideas for which buildings to use:

- Canada wants to use a new building planned for the Concordia University School of Building Science, in Montreal.
- Denmark will use the "Scanport" building, a new office building for Skanska, to be built next to the Copenhagen Airport. The Danish Task 23 experts are already involved in the design.
- Norway will use Oppegård Skole, a new school to be built close to Oslo. One of the Norwegian Task 23 experts has the contract for the design.
- Spain will use an apartment building to be built in Madrid. It is the winning entry in a design competition, won by the Spanish Task 23 experts together with one of the German Task 23 experts.
- Austria's Task 23 experts have entered a design competition with a very promising concept and hope to win. If so, they will use this as a demonstration building.

Several of the other participants are also actively looking for possible demonstration projects.

SUMMARY OF WORK TO DATE

Subtask A:

- The Technical Report on Case Stories has been produced and distributed.
- A journal article presenting the results of the case stories has been produced.
- Plans for a second volume of the Case Stories report have been made.

Subtask B:

- An electronic, multidimensional workspace with all the information collected in Subtask B has been produced and presented.
- The contours of a design process guideline have been identified.

Subtask C:

- The proposed Task 23 multi criteria decision making (MCDM) process has been tested and the results discussed.
- A computer tool, MCDM 23, has been produced.
- Task 23 libraries and default values for Energy-10 have been produced and distributed.

- The work on making Energy-10 more usable as a Task 23 tool is continuing.
- An advanced Energy-10 workshop has been conducted.

Subtask D:
- Two Task 23 workshops have been conducted.
- National information dissemination plans have been presented.
- Plans for demonstration buildings have been finalised.

General:
- Two Experts Meetings have been conducted.
- A number of group meetings have been conducted.
- Fruitful partnerships have been established.

WORK PLANNED FOR 2000

In 2000, the main emphasis will be on Subtasks B and C. Within these Subtasks, revised versions of the guidelines, methods, and tools will be produced. These will be tested in two workshops to be arranged in conjunction with the two Experts Meetings. Both workshops will be open to invited participants from the design community in the host countries for the meetings and are expected to give good feedback on the capabilities of the guidelines, methods, and tools.

The work in Subtask D also will gain momentum, both with the workshop activities, with the publication of the booklet on good examples, and especially with the development of demonstration buildings.

Summary of Work Planned
Subtask A:
- The case story article will be published in several journals.
- A working document on the criteria used in the design of the case story buildings will be produced.
- Work on a second volume of the Case Stories report will start.

Subtask B:
- A Task 23 design process guideline will be produced.
- Final reports on the various Subtask B surveys will be produced.
- Work on the multidimensional Subtask B "information space" will continue.

Subtask C:
- The Task 23 multi criteria decision making method will be further tested and refined.
- The MCDM 23 computer tool will be completed.
- Decisions on how to integrate MCDM 23 in other tools will be made.
- Version 1.3 of Energy-10 will be distributed.

Subtask D:
- A Task 23 poster will be produced.
- Two more Task 23 workshops will be conducted.
- The Task 23 Booklet on "Good examples of integrated solar design" will be produced.
- A Task publication plan will be developed.
- Work on demonstration buildings will commence.

REPORTS PUBLISHED IN 1999

Description of Case Stories: A Technical Report of IEA SHC Task 23 Subtask A, Report available from Esbensen Consulting Engineers AS, Copenhagen, 1999.

"*Integrated Design of Solar Buildings: The Work in IEA Task 23,*" *Proceedings of Intelligent Building Design Conference*, Stuttgart, Germany, 1999.

"*Building Integration of Solar Energy Systems", Proceedings of ISES Solar World Congress*, Jerusalem, Israel, 1999.

1999 EXPERTS MEETINGS

Fourth Experts Meeting
March 1-3
Toledo, Spain

Fifth Experts Meeting
October 6-9
Vienna, Austria

2000 EXPERTS MEETINGS

Sixth Experts Meeting
March 8-10
Saariselkä, Finland

Seventh Experts Meeting
September 14-16
USA

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TASK 24:

Solar Procurement

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TASK DESCRIPTION

The main objective of Task 24 is to create a sustainable, enlarged market for active solar water heating systems (mainly domestic systems).

This objective will be achieved through major cost and price reductions for all cost elements, including marketing and installation, as well as performance improvements and joint national and international purchasing.

Subtasks

The work in Task 24 is divided into two Subtasks, each co-ordinated by a lead country:

- Subtask A: Procurement and Marketing (*Lead Country: Netherlands)*
- Subtask B: Creation of Tools (*Lead Country: Denmark)*

The objectives of Subtask A are:

- To raise interest in active solar thermal solutions
- To form buyer groups to purchase state-of-the-art and innovative systems

The procurement activities will consist of two rounds: the first with smaller projects and a low degree of joint international collaboration, and the second with larger projects and a higher degree of collaboration.

The objectives of Subtask B are:

- To collect, analyse and summarise experience
- To create tools to facilitate the creation of buyer groups and the realisation of projects and procurements. These tools will be included in a manual: "Book of Tools"
- To define a process for prototype testing and evaluation, using existing methods

Duration

The Task was initiated on April 1, 1998 and will be completed on March 31, 2003.

ACTIVITIES DURING 1999

- During the year, much of the work has focused on the identification of buyers and on forming national buyer groups. A number of national meetings have been held and buyer groups have been formed in Canada, Denmark, the Netherlands and Sweden. These groups consist of representatives of municipalities, utilities, housing corporations, construction companies, real estate developers, NGOs and other organisations. An international buyer group workshop took place in the Netherlands in May, with participation of representatives from several potential buyer groups from the above-mentioned four countries. In connection with this workshop, there were study tours to solar thermal sites of interest.

- Switzerland officially joined Task 24 in September 1999 and work has started on identifying suitable projects and planning the work together with buyer groups.

- Preparations for the First Round of procurements have been going on in the countries. Draft specifications and competition documents have been drawn up.

- The importance of a dialogue with suppliers (including manufacturers, installers, retailers and distributors) has been stressed by the Task 24 participants. There have been supplier meetings in all the participating countries. Several contacts have been made with the supplier organisations ASTIG and ESIF, and an international meeting with suppliers was held in the Netherlands in May.

- The work on the manual, Book of Tools, has proceeded with Denmark as co-ordinator of the work. Participating countries have provided case studies, and 10 cases will be included in the book. A draft will be published on the Task 24 website, for review by Task members, in December 1999.

- To raise further interest in Task 24, information activities are considered to be essential. Brochures, articles and other information material have been produced and published in all the participating countries. The Task 24 official website (www.IEAtask24.org) has been updated by Canada. A newsletter, published on the website, has been produced and updated by Denmark. Additional sources for financing the information activities have been investigated and an application to the European Commission ALTENER Programme was sent at the end of November.

- Several contacts and meetings with representatives from different organisations in Germany and Austria have taken place in order to get them involved in Task 24. These contacts will continue.

WORK PLANNED FOR 2000

The First Round of procurements with smaller national projects will proceed and tenders will be announced. All the National Co-ordinators will work further with different buyer groups and projects. Some examples are mentioned below.

- In Canada, an NGO tendered and installed solar domestic hot water systems in the autumn of 1999. Parties involved include also a utility, a city and Natural Resources Canada. The experience obtained from the tender specifications will be used for future tenders. A parallel project has begun with another NGO being the project manager; the first round of systems is expected to be installed in early 2000. It is expected that both buyers will form a buyer group next year for Phase 1 tendering under Task 24.

- Work in Denmark will continue with four specific buyer groups: a utility, employees at an industrial company, two housing developers (where the contacts go through an NGO working with renewable energy) and a regional effort.

- In the Netherlands, a project is planned for 300 medium-sized systems through an umbrella organisation of housing associations. There are specific plans to work with a utility and a province aiming at housing associations in the province. Together with this utility, there also are plans for a project of installing at least 1,000 solar water heaters in new housing developments in their supply area. A national solar installation company will be set up, in which 50 installers participate. The company aims at national-wide projects, the first one in collaboration with the World Wildlife Fund with the aim of realising 2,500 solar water heaters in 2000. A Dutch bank also is planning a solar water heating campaign directed towards all existing and new clients.

- Sweden will focus on both small systems and large plants, with two separate buyer groups. Interested participants include two of Sweden's largest contractors, some counties, utilities and housing companies. Purchasing of small systems and order forms will be launched through regional and national campaigns. The buyer group for large plants will consist of housing companies, contractors, utilities and others. The competition documentation will be completed in early 2000, after which the tender will be announced towards national and international manufacturers.

- Work in Switzerland will focus on three utilities in three regions. There also are plans for contacts with the Union of Swiss City Works. Very well prepared background documentation has been developed which will be used in order to raise Swiss interest in the procurement activities.

- Since many solar water heater campaigns have been prepared and will be carried out in all the countries, efforts will be made to create as much synergy as possible between the various campaigns. Synergy can be achieved in many phases, such as tendering, preparation of publicity and evaluation.

- Information activities will continue. The Task 24 newsletter will be updated and published on the website. The Subtask Leaders are planning presentations and papers for the EuroSun 2000 conference in Denmark in June, and a presentation also is planned by the Operating Agent at an Austrian solar conference in September.

- Contacts with interested organisations will continue in Germany and Austria and be started in Belgium, United Kingdom and United States. Further contacts will be taken with the supplier organisations ASTIG and ESIF in order to give them the possibility of influencing the framework of the coming tender documents and inform-ing them of the ongoing preparation of national tenders.

REPORTS PUBLISHED IN 1999

Opportunities for Large-Scale Purchase of Active Solar Systems, the first official report of Task 24, produced in collaboration with CADDET in the United Kingdom. It was printed in December 1998 and distribution started in January 1999.

Full information about Task 24 can be found on the Task 24 website (www.ieatask24.org) which is produced and updated by Canada.

Models for specifications of collector systems for large solar heating applications and of small domestic hot water systems for detached houses have been drawn up by Sweden in drafts in English and German. These models may inspire the preparations for concrete procurements in the different countries.

REPORTS PLANNED FOR 2000

A second draft of the *Book of Tools* is planned for December 2000.

Tender documentation will be drawn up for the different national tenders and will be exchanged between the participating countries.

1999 EXPERTS MEETINGS

Third Experts Meeting
May 4-5
The Netherlands

Fourth Experts Meeting
September 30 - October 1
Denmark

2000 EXPERTS MEETINGS

Fifth Experts Meeting
February 28 - March 1
Canada

Sixth Experts Meeting
September 11-12
Switzerland

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TASK 25:

Solar Assisted Air Conditioning of Buildings

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TASK DESCRIPTION

The main objective of Task 25 is to improve conditions for the market introduction of solar assisted air conditioning systems in order to promote a reduction of primary energy consumption and electricity peak loads due to air conditioning of buildings. Therefore the project will aim to :

- Define the performance criteria of solar assisted cooling systems considering both energety related as well as economic performance,
- Identify and further develop of promising solar assisted cooling technologies,
- Optimize the integration of solar assisted cooling systems into the building and the HVAC system focusing on an optimized primary energy saving - cost performance and
- Create design tools and design concepts for architects, planers and civil engineers.

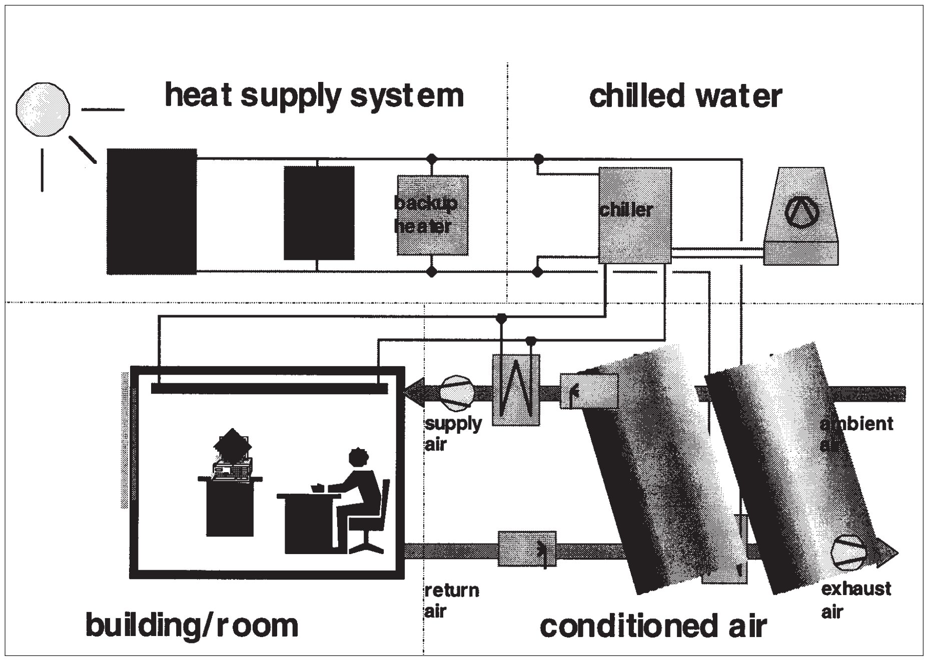
The work in Task 25 is carried out in the framework of four Subtasks.

Subtask A: Survey of Solar Assisted Cooling

The objective of Subtask A is to provide a picture of the state-of-the-art of solar assisted cooling. This includes the evaluation of projects realized in the past.

Subtask B: Design Tools and Simulation Programs

The objective of Subtask B is to develop design tools and detailed simulation tools for system layout, system optimization and development of advanced control strategies of solar assisted cooling systems. Main result will be an easy-to-handle design tool for solar assisted cooling systems dedicated to architects,



A type of system covered in Task 25. The chiller may be either a thermally driven chiller (absorption, adsorption) or an electrically driven vapour compression machine.

building engineers and planners.

Subtask C: Technology, Market Aspects and Environmental Benefits

The objectives of Subtask C are to provide an overview on the market availability of equipment suitable for solar assisted air conditioning and to support the development and market introduction of new and advanced systems. Design-guidelines for solar assisted air conditioning systems will be developed.

Subtask D: Solar Assisted Cooling Demonstration Projects

Several demonstration projects will be carried out and evaluated in the framework of Task 25. The objectives are to achieve practical experience with solar assisted cooling in real projects and to make data for the validation of the simulation tools available. The suitability of the design and control concepts will be studied and reliable results about the overall performance of solar assisted air conditioning will be available.

Duration

The Task was initiated in June 1999 and will be completed in May 2004. Subtask A will be completed in May 2000 and Subtasks B and C will be completed in May 2002.

ACTIVITIES DURING 1999

A summary of Subtask research activities started during 1999 is presented below.

Subtask A: Survey of Solar Assisted Cooling

A survey of realized solar assisted cooling projects has been started. For this purpose a detailed questionnaire was developed which covers all technical and economic aspects of installations built in the past. An evaulation of the information gathered with the questionnaire will lead to results on technologies involved, design experiences, operations experiences and problems found. Most promising concepts considering both energy related and economic criteria will be identified.

Subtask B: Design Tools and Simulation Programs

Main decisions concerning the design tool development have been made. The purpose of the design tool will be to help architects and planners to design solar assisted air conditioning systems and to carry out feasibility studies quickly and accurately. The design tool will be an easy-to-handle WINDOWS-application and consist of several fixed system configurations. A form was developed to define a series of interesting system configurations, as for instance single-effect absorption chiller driven by a vacuum tube collector and a backup gas heater which produces chilled water for a chilled ceiling. It is estimated that about 10-15 system types will be defined. Gathering interests of participating countries in these system configurations has been started recently.

Subtask C: Technology, Market Aspects and Environmental Benefits

Work has started to yield an overview on market available equipment for solar assisted air conditioning. Therefore a form for gathering information on solar collectors has been established and distributed.

Subtask D: Solar Assisted Cooling Demonstration Projects

Work in Subtask D starts in June 2000.

WORK PLANNED FOR 2000

A summary of Subtask research activities planned for 2000 is presented below.

Subtask A: Survey of Solar Assisted Cooling

A review of past activities in solar assisted cooling will be realized. This consists of two parts: review of past research activities (mainly in the US and Japan) and review of solar assisted cooling/air conditioning projects in the past, i.e., survey on existing plants in participating countries. Information on existing plants will be gathered and evaluated until April 2000.

Subtask B: Design Tools and Simulation Programs

A decision on most important system configurations modelled in the design tool will be taken, the program surface will be developed and a decision on reference buildings (cooling load files) to be included taken. Work on algorithms for the components (chillers, desiccant cooling systems, solar collectors, AC equipment) will start.

Subtask C: Technology, Market Aspects and Environmental Benefits

The description of market available hardware components for solar assisted air conditioning will be carried out. For each of the main components (solar equipment, AC and cooling equipment, tpyical loads) a form for gathering data will be finished. These forms will be used by participants to put together data and information. Concerning new developments of cooling technologies in participating countries a list of those developments will be completed and a draft of an overview produced. A form for the performance assessment related to energy and economy of solar assisted AC systems is to be developed. This form shall help to allow a comparative analysis of different system configurations for a given application.

Subtask D: Solar Assisted Cooling Demonstration Projects

First decisions on demonstration installations will be made and the design of these systems start. Participants will achieve an agreement on specifications of the monitoring system for the demonstration projects of Task 25.

REPORTS PUBLISHED IN 1999

No official technical reports were published in 1999.

REPORTS PLANNED FOR 2000

Survey of solar assisted cooling and air conditioning projects, a product of Subtask A.

1999 EXPERTS MEETINGS

First Experts Meeting
June 17-18,
Perpignan, France

2000 EXPERTS MEETINGS

Second Experts Meeting
January 27-28
Delft, Netherlands

Third Experts Meeting
September 21-22
Mexico

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TASK 26:

Solar Combisystems

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TASK DESCRIPTION

Solar heating systems for combined domestic hot water preparation and space heating, so called solar combisystems are increasing their market share in several countries.

Much is already known about solar domestic hot water systems, but solar combisystems are more complex and have interaction with extra subsystems. These interactions profoundly affect the overall performance of the solar part of the system. The general complexity of solar combisystems has led to a large number of widely differing system designs, many only very recently introduced onto the market. After the first period of combisystems (1975-1985) where design of not standard and complex systems by engineers was the rule, a new period has been opened since 1990. Now the design is done essentially by solar companies trying to sell simpler and cheaper systems. But current designs result mainly from field experiences and they have not yet been carefully optimized. Substantial potential for cost reduction, performance improvement and increase in reliability exists and that needs to be scientifically addressed.

Scope and main activities to be undertaken

Task 26 is reviewing, analyzing, testing, comparing, optimizing and improving designs and solutions of solar combisystems for:

- detached one family houses
- groups of one family houses, and
- multifamily houses or equivalent in load with their own heating installations.

This Task does not refer to solar district heating systems or systems with seasonal storage or central solar heating plants with seasonal storage.

A solar combisystem for a detached house in Austria.

To accomplish the objectives of the Task, the Participants are carrying out research and development in the framework of the following three Subtasks:

- Subtask A: Solar Combisystems Survey and Dissemination of Task Results
  (Lead Country : Switzerland)
- Subtask B: Development of Performance Test Methods and Numerical Models for Combisystems and their Components
  (Lead Country: The Netherlands)
- Subtask C: Optimization of Combisystems for the Market
  (Lead Country: Austria)

A solar combisystem for a detached house in Finland.

Besides 24 experts from 9 countries 14 companies from almost all participating countries are taking part in the work. Their contributions will make the results of the Task more relevant to the solar heating industry in general.

Duration

The Task was initiated on December 1, 1998 and will be completed on December 31, 2001.

ACTIVITIES DURING 1999

A summary of Subtask research activities during 1999 is presented below.

Subtask A: Solar Combisystems Survey and Dissemination of Task Results

So far, the emphasis has been put on the overview of combisystems, on the definition of reference conditions for simulation runs and performance reports, and on criteria for ranking and making inter-comparisons of the systems.

Overview of Combisystems

During the summer of 1999, a color brochure was drafted presenting relevant existing solar combisystems. The targeted audience is industry (architects, engineers, HVAC companies). It will be an attractive catalogue of 19 existing generic systems in the participating countries. The brochure is planned to be published in February 2000.

Criteria for the ranking and inter-comparison of combisystems

- So far agreement has been reached on two types of diagram: (1) an efficiency diagram representing the fractional energy savings as a function of the main dimensioning parameter (the ratio of the yearly solar radiation incident on the collector array to the yearly heat consumption for space heating and domestic hot water), and (2) a cost performance diagram with the annual energy savings represented as a function of the system considered and of the additional investment cost related to solar. These two diagrams shall allow the identification of trends related to the system type, design and dimensioning.
- Also a number of qualitative ranking and inter-comparison criteria have also been discussed by Subtask A. An internal document on the ranking and inter-comparison criteria developed by Subtask A will be worked out in the first two months of 2000.

Industry newsletter

The first issue of the annual industry newsletter was prepared and will be published in English in December 1999. Several countries have announced their intention to translate the general part of the newsletter into their national language, with regional co-operation between countries speaking the same language.

Subtask B: Development of Performance Test Methods and Numerical Models for Combisystems and their Components

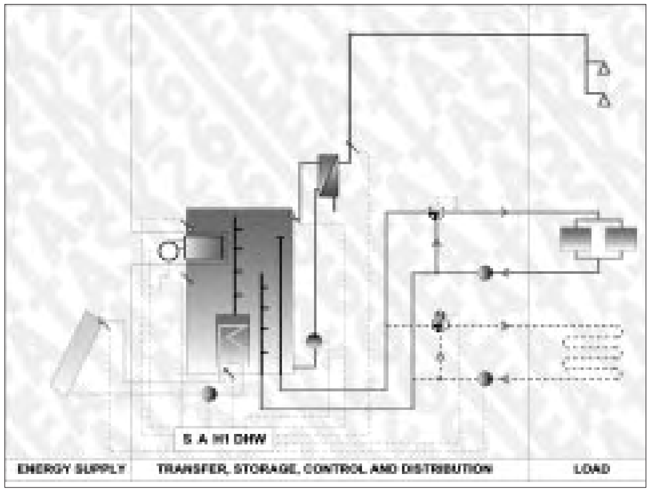
The test method development for solar combisystems includes both the thermal performance and hot water comfort. Model development supports both test the definition of procedures, the evaluation of tests in Subtask B and the optimization of solar combisystems in Subtask C.

Test method development for thermal performance characterization

- The thermal performance test should (1) indicate the well-functioning of the system and aspects for improvement and (2) reveal an annual performance prediction with sufficient accuracy.
- The exchange of ideas with respect to the test conditions as well as on specific items of the test procedure has led to a proposal for the test conditions. As simple characterization works by means of analyzing the input-output relations and extrapolating short term test data, test conditions should include realistic near average values on weather and operating conditions. Presently, the test procedure is considered to consist of three test periods simulating winter, spring/autumn and summer operation. The test should directly lead to an indication of the annual system performance.
- Space heating demand is directed through solar irradiation and differences in demand temperature (auxiliary control) permit variations; a choice has been made to couple the heat demand to the 100 kWh/(m2year) reference house. For winter conditions, this means a high space heating load for 'no' solar irradiation and a medium load for low solar irradiation. For spring/autumn conditions, test conditions reach from a medium space heating load for low solar irradiation up to a medium-low load for medium solar irradiation. In summer, there is no space heating.
- Reference heat demand for tap water is 140 liter per day, heated from 10 to 45*C. For winter and spring/autumn conditions, the distribution of tap water draw-off is identical on all days, i.e. 40% in the morning, 20% at noon and 40% in the early evening. For summer conditions, there is a variation between 60% and 170% of the nominal draw-off.
- The proposed test sequences for the AC/DC method will now be investigated using simulated measuring data and the first results from real testing will become available.
- Another achievement is the testing of several solar combisystem heat stores in Germany and Sweden using the CTSS method available.

Model development

In 1999 work has been carried out on the detailed collector model. A burner model has also been developed further and missing aspects such as the electricity use and heat losses by incomplete combustion during start-up have been indicated. For the distribution side, radiator and floor heating models have been developed. The development of the building model has almost been completed. Space heating loads for the mid-European (Zurich) climate have been translated into model parameters for the building model.



Hydraulic scheme of an advanced solar combisystem

Subtask C: Optimization of Combisystems for the Market

The objective of this Subtask is to enhance existing solar combisystem designs by optimization based on simulation of the systems and to help industry to propose new system designs being able to match demand with better thermal and economical performance than before. The reference conditions for simulation runs are defined and approved by the participants. 19 system designs chosen by Subtask A now are going to be optimized.

Optimization procedure

The following suggestion for the optimization procedure made by the Subtask Leader was accepted:

- Model the system in TRNSYS
- Define non relevant and fixed parameters as well as limits for variations with manufacturers Perform a sensitivity analysis with all parameters (Zurich climate, 4 buildings)
- Define critical parameters
- Optimize systems with critical parameters (optimization routine has yet to be defined)
- Do step three with an optimized system in order to check non-sensitive parameters and find overall optimum

Additionally it was agreed to discuss and define DREAM SYSTEMS for combisystems in the final phase of the Subtask.

WORK PLANNED FOR 2000

A summary of planned activities for each of the Subtasks is presented below.

Subtask A:

- Listing and discussion of criteria for comparison and ranking of solar combisystems.
- Definition of parameters for system optimization
- Prepare an internal synthesis document on reference conditions suited to comparison and simulation activities in conjunction with subtask B and C
- Organization of two industry workshops. The industry workshops will be organized in conjunction with the Task 26 meeting in Sweden and Finland.
- Production of a yearly Newsletter
- First outline of the design handbook and preparation of data.

Subtask B:

- Development of still missing numerical models
- Definition of performance test methods and parameters to be identified
- Development of test methods or extension of existing test methods for solar DHW systems or components:
  - further development of test methods for water stores,
  - development of dynamic test method for stores with integrated gas burners or auxiliary heaters (wood assisted combisystems),
  - further development of test methods for subsystem and complete system testing,
  - development of a guideline to describe the test results and the necessary reference conditions of a combisystem.
- Performance tests according to the new procedures will be performed for combisystems delivered by industry.

Subtask C:

- Modeling of chosen combisystems based on the survey produced by subtask A and simulation within their respective boundary conditions and validation against measured data if available;
- Sensitivity analysis for various parameters including control strategies, and optimization with respect to all parameters chosen by subtask A that can be modeled with the available tools;
- Quantitative comparison of the optimized systems with respect to criteria defined in Subtask A
- Qualitative evaluation of the systems with respect to overall quality, simplicity for installers, reliability, cost, known problems, in close contact with industry participants.

LINKS WITH INDUSTRY

Fourteen companies from almost all of the participating countries are taking part in Task 26. The industry workshops jointly organized by Subtask A and the Operating Agent have received a positive response from industry, especially from industry in the country which just hosted an Experts Meeting. Between 11 and 24 industry representatives attended the workshops.

Also, the printing cost of the color brochure presenting relevant existing solar combisystems will be financed by the industry participants.

LINKS WITH CEN TC 312

Liaison status has been granted to IEA SHC Task 26 with CEN/TC 312 "Thermal solar systems and components," by Resolution 7/99. The duration of this liaison is three years and will be reviewed accordingly on October 2002. CMC (CEN Management Center) has recorded as permanent interface between the CEN/TC 312 and IEA SHC Task 26 : Dr Jean-Marc Suter of Switzerland and Mr. Huib Visser of the Netherlands.

REPORTS PUBLISHED IN 1999

No official technical reports were published in 1999. However, a Working Document on 19 generic combisystems, the summary of the reference conditions for simulation and the proceedings of two Industry Workshops were distributed to the Task Participants.

REPORTS PLANNED FOR 2000

Subtask A: Solar Combisystems Survey and Dissemination of Task Results

Color brochure presenting relevant existing solar combisystems

Second Industry Newsletter

Proceedings of Industry Workshops

Subtask B: Development of Performance Test Methods and Numerical Models for Combisystems and their Components

Description of the test methods for solar combisystems

Report on existing and new numerical models for solar combisystems and their components
Subtask C: Optimization of Combisystems for the Market.

Report on simulation models of the most attractive system configurations

First description of optimized solar combisystem designs

1999 EXPERTS MEETINGS

Second Experts Meeting
April 11-14
Taastrup, Denmark

Third Experts Meeting
October 3-6
Stuttgart, Germany

2000 EXPERTS MEETINGS

Fourt Experts Meeting
April 2-5
Borlange, Sweden

Fifth Experts Meeting
October 8 - 11
Helsinki, Finland

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Level 1: Participation in 1 workshop per year and will answer technical and marketing questions.

Level 2: Participation in all Task meetings and will provide feedback from the market.

Working Group on Materials in Solar Thermal Collectors

Michael Köhl
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WORKING GROUP DESCRIPTION

The Working Group was established in the autumn of 1994 as an extension of work which had been conducted on solar collector absorbers in Subtask B of Task 10, Solar Materials R&D.

The objectives of the Working Group are:

- To develop or validate durability test procedures for solar collector materials.
- To generalise test procedures for standardisation.
- To develop guidelines for solar collector design to achieve the most favourable microclimate conditions for materials.

The following areas have been identified for joint research work:

- Durability and Life-time Assessment of Solar Absorber Coatings.
- Anti-reflecting Devices for Solar Thermal Applications.
- Methods for Characterisation of Microclimate for Materials in Collectors.
- Durability Aspects on the Use of Polymeric Materials in Solar Collecting Devices.

Duration

The activities of the Working Group were initiated in October 1994 and concluded in October 1999. The leadership of the working group was handed from Bo Carlsson (Sweden) to Michael Köhl (Germany) according to a respective agreement at the start of the work.

ACTIVITIES DURING 1999

A: Durability and Life-time Assessment of Solar Absorber Coatings

The drafted ISO test procedure for absorber coatings was modified because of the higher loads of the novel, high efficient selective absorber coatings.

B: Anti-reflecting Devices for Solar Thermal Applications

Accelerated screening tests for durability assessment of material samples of iron-free glass and PMMA with anti-reflected surfaces as well as PVC and polycarbonate (APEC) samples were compared with outdoor-test results. The results are the basis for service with life studies within the new SHC Task 27, Performance of Solar Facade Components.

C: Methods for Characterisation of Microclimate for Materials in Collectors

A test procedure for the assessment of the air tightness and ventilation rate of collectors was initiated in the autumn of 1995. These procedures were worked out in detail. A second Round Robin test was conducted for a selected collector in order to compare and validate the test procedure.

The measurement of microclimate parameters in collectors started in June 1996 at outdoor test facilities and was finished in June 1997. Work continued on the evaluation and interpretation of the data.

- A book summarising the experiences in performance and durability assessment was drafted. The methodology for service life prediction is described and illustrated by examples (absorber coatings, reflectors, glasings) in this book. It is to be printed in 2000.

LINKS WITH INDUSTRY

All participants of the Working Group work closely with solar material and solar collector manufacturers, therefore, many industry representatives participate indirectly in the work being undertaken. There are also informal links to industry via the ongoing standardization work on solar collector and solar collector materials in CEN TC 312 and in ISO TC 180. Efforts also have been made to establish a liaison with CEN 312 in the area of solar collector materials.

REPORTS PUBLISHED

A list of working documents can be obtained from the Working Group Leader on request.

1999 EXPERTS MEETINGS

Ninth Experts Meeting
March 21-22
Freiburg, Germany

Tenth Experts Meeting
September 19
Lausanne, Switzerland

These meetings were held in conjunction with Task Definition workshops for SHC Task 27, Performance of Solar Facade Components.

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