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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 23 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 over 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 program is monitored by an Executive Committee consisting of one representative from each of the member countries. The leadership and management of the individual Tasks (projects) are the responsibility of Operating Agents.

The twenty members of the IEA Solar HEating and Cooling Programme are:

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

CURRENT TASKS

A total of twenty Tasks (projects) have been undertaken since the beginning of the Solar Heating and Cooling Programme.

Task 13	Advanced Solar Low Energy Buildings	Norway

Task 14	Advanced Active Solar Energy Systems	Canada
Task 16	Photovoltaics in Buildings	Germany
Task 18	Advanced Glazing and Associated Materials for Solar and Building Applications	United Kingdom
Task 19	Solar Air Systems	Switzerland
Task 20	Solar Energy in Building Renovation	Sweden
Task 21	Daylight in Buildings	Denmark

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IEA SHC Annual Report 1995

Chairman's Report

Prof. André De Herde
Université Catholique de Louvain
Belgium

INTRODUCTION

The IEA Solar Heating and Cooling (SHC) Program had another successful and productive year in 1995. It was a year of increased collaboration between the SHC Program, industry, and other IEA programs. With researchers from the 20 member countries involved in numerous projects under seven Tasks and two working groups, many notable results were achieved during the year. These included "Window Innovations '95, " an international conference organized by Task 18 and Canada Centre for Mineral and Energy Technology (CANMET) for researchers and industry representatives to share state-of-the-art information; the production of electrochromic windows by an English and a Japanese company for use in Task 18; and, the collaboration between Task 20 experts and Swedish manufacturers of absorbers and prefabricated houses to develop a roof-integrated solar collector, among many others. The accomplishments of other collaborative activities are covered in later sections of this report.

Every year our annual report includes a feature article on some aspect of solar technologies for buildings. This year's article, Solar Energy in Building Renovation, reviews the advances and challenges of using solar concepts in the renovation of buildings. Thanks to Prof. Arne Elmroth and Elisabeth Kjellsson of Lund University in Sweden for taking the lead in preparing this feature article.

Highlights of the Tasks and Working Groups

Notable achievements of the program's work during 1995 are mentioned below. The details of these and many other accomplishments are covered in the individual reports later in this report.

Task 13

Twelve experimental solar low-energy buildings have been built and the last three buildings of the Task are under construction in Germany, Sweden, and Switzerland. The monitoring results continue to be shared and discussed with experts in the field.

Task 14

The Innovative Concepts Subtask met in 1995 to develop recommendations for future work on active solar heating concepts that offer further improvements in costs, performance, and reliability.

Task 16

The final draft of a design handbook on photovoltaics in buildings was accepted for publication by James & James Science Publishers.

Task 18

Innovative glazing components (evacuated glazings and electrochromic devices) have successfully been prepared on a window scale (1 x 1m2), thus demonstrating the viability of scaling up the technologies and allowing for the key performance parameters to be measured on realistic dimensions.

Task 19

Twenty-two case studies were drafted of buildings with innovative solar air systems in nine countries with diverse climates. The buildings included were apartments, single family homes, gymnasiums, and industrial facilities.

Task 20

Seventeen solar renovation demonstration projects were reviewed by Task experts regarding the performance, occupant satisfaction, and effectiveness of the renovation to provide lessons for future solar renovation projects.

Task 21

The Project Definition Phase was completed. Approximately 40 experts from 14 countries participated in this process.

CSHPPS Working Group

Two workshops were held on the current technology of central solar heating plants: "1995 Workshop on CSHPSS Design" and "1995 Workshop on Large-scale Solar Heating."

New Projects

The Project Definition Phase of Task 22 on Solar Building Energy Analysis Tools was completed. Work under this new Task will include the evaluation of building energy analysis tools and an assessment of the value of such tools in analyzing low-energy solar buildings. The United States will act as Operating Agent.

A Project Definition Phase meeting will be held February 1996 in Oslo, Norway to plan a new Task on Optimizing Solar Energy Use in Large Buildings. The Task will focus on large scale, urban buildings and ways to optimize the combined use of different energy conservation and efficiency technologies.

Special Workshops

Australia organized a Low Temperature Storage workshop in February 1995 in San Diego, California. The workshop topic was "The Search for the Universal Storage Tank."

The second workshop on Solar Energy for Utility Demand-Side Management was held October 1995 in

Austria. Representatives from the IEA Energy Conservation in Buildings and Community Systems (BCS) Program, Photovoltaic Power System (PVPS) Program, and Demand Side-Management (DSM) Program participated.

The SHC Program will host a workshop on new developments in residential solar water heating technologies. The workshop, "Solar Innovations '96," will be held June 13-14, 1996 in Toronto, Canada.

Management Actions

Evaluations were performed by the Executive Committee on Tasks 12, 18, and 21 to test the new procedures. After reviewing these evaluations and the process used to perform them, it was agreed that Task Evaluation Teams, which include several Executive Committee members and an Operating Agent, will conduct evaluations midway through each Task and at the conclusion of the Task.

The Software Policy Committee continued to work on developing a software policy for the SHC Program that outlines intellectual property rights, distribution and licensing requirements and procedures, and other related issues.

The SHC Program launched its World Wide Web Home Page. The Home Page includes general program information, individual "pages" for each current Task, the Solar Update newsletter, information on SHC publications, and names of contacts in each participating country.

Two Executive Committee meetings were held in 1995--the first in May in Whistler, British Columbia, Canada and the second in October in Stockholm, Sweden.

International Solar Energy Society

The SHC Program organized a workshop for the International Solar Energy Society Congress held September in Harare, Zimbabwe. Four Executive Committee members and Operating Agents presented information on passive and active solar energy to an audience of architects, builders, and researchers.

Coordination with Other IEA Agreements

Coordination with the BCS Program continues. A joint meeting was held in conjunction with the October Executive Committee meeting in Stockholm, Sweden. In addition, the SHC Executive Committee agreed to have a representative serve on the Future Buildings Forum organizing committee.

A joint meeting between SHC Task 16, Photovoltaics in Buildings, and the PVPS Program Task 5, Grid Interconnection of Building Integrated and Other Dispersed Photovoltaic Power Systems, was held September 1995 in Freiburg, Germany. The transfer of Task results on building Integrated PV and building design between Task 16 and the PVPS Task will continue as the SHC Task draws to an end.

Publications

The following IEA Solar Heating and Cooling reports were published in 1995 and are not listed elsewhere in the annual report:

> *Building Energy Simulation Test (BEST) and Diagnostic Method.*
> R. Judkoff and J. Neymark. February 1995.
> Report #NREL/TP-472-6231 (Task 12).

Design Reference Year Users Manual.
Hans Lund, Technical University of Denmark. February 1995.
Report #IEA-SHCP-9E-1 (Task 9).

Improved Measurement of Solar Irradiance by Means of Detailed Pyranometer Characterization.
D.I. Wardle et al. March 1995 (Task 9).

Proceedings of the Workshop on Solar Water Heater Tank Design and Ratings.
February 1995.

Acknowledgements

In closing, I would like to thank the Operating Agents and Working Group Leaders, our Executive Secretary, Pamela Murphy, and our Advisor, Fred Morse, for their work on behalf of the Program. All their efforts are essential to the Program's continued success.

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Feature Article: Solar Energy in Building Renovation

Prof. Arne Elmroth and Elisabeth Kjellsson
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INTRODUCTION

Today, much of the energy used to provide heating, cooling, ventilation, hot water, lighting, and power for appliances in residential and commercial buildings is supplied by fossil fuels--oil, natural gas, coal--despite the fact that they pollute the air, ground, and water. Buildings need energy to condition space, meet electric loads, and provide hot water. Figure 1 shows how energy is used in a typical building located in a cold climate. In most countries, heating is needed during the winter to compensate for thermal losses through the building envelope. Unfortunately, solar radiation is at a minimum at this time of year. In order to cover the total energy needed for heating with solar energy, seasonal storage is needed. During the year electricity is needed for different purposes depending on the building type and location. Solar energy is being used to meet some of these electrical needs through building-integrated PV systems. Domestic hot water is typically heated by gas or electricity, however, solar energy also can be used to heat water throughout the year.

Significant progress has been made in reducing our reliance on fossils fuels for building energy; primarily through the introduction of energy efficiency technologies and measures, such as increasing levels of insulation, improved windows, increased air tightness, and energy efficient appliances. In addition, alternative energy sources, such as solar energy, have been introduced that offer the promise of even greater displacement of fossil fuels, and the ability to meet substantial portions of a building's energy needs--far greater than could be achieved by energy efficiency measures alone. However, solar concepts for buildings, particularly those that are integral elements of the building's architecture such as passive solar features, are frequently only considered when designing a new building. This is partly due to the greater difficulties in incorporating solar concepts in buildings which may not have optimal siting, orientation or physical elements, and partly due to the early phase of development of some of the most promising concepts. Nonetheless, the size and scope of the existing building market and the tremendous opportunities in building renovation cannot be overlooked if solar energy is to make a substantial energy impact.

A fundamental question is, how do we best realize this opportunity? While reduction in fossil energy use and its attendant pollution is the ultimate goal, the solar concepts that are developed must be attuned to the needs of the marketplace. In most cases, this means that a solar concept must add value to the solution of a particular renovation problem--a problem that in many cases may not be first and foremost an energy problem. There are many different reasons for renovating a building, perhaps, there is a need for more space; the use of the building is to change, for example, a factory is to be converted to an office building; the building's facade needs to be repaired; or the heating and ventilation system needs to be replaced to improve the thermal comfort level or reduce high energy costs. Independent of these reasons, there exists, besides the traditional methods of renovating a building (for example, adding more insulation or replacing windows), many possibilities to use solar concepts. These concepts not only can reduce energy operating costs, but many of them also increase thermal and visual comfort, enhance the living or working environment, add architectural interest, and provide greater energy independence/redundancy. These are considerations that, coupled with savings in energy operating costs, make additional investments in solar concepts worthwhile.

A number of solar concepts that offer substantial opportunities for solving renovation problems have either been demonstrated or are currently under development. These include solar walls using transparent insulation materials (TIMs), glazed balconies and galleries, roof-integrated solar collectors, roof apertures, and solar ventilation pre-heat systems. While each of these can be considered as distinct concepts, the decision to apply which concepts and how best to integrate them with traditional renovation measures must be reached within a "whole building context." Even when the impetus to renovate a building is based on a specific problem or need, evaluating the situation from the total building perspective is important, rather than a component-by-component approach. Only in this manner can a solution be arrived at that yields maximum benefit to the building owner and occupants.

This article will review a few of the advances taking place in the application of solar renovation concepts in building renovation. Many examples used throughout the article are based on work currently being performed under the International Energy Agency (IEA) Solar Heating and Cooling Program's Task 20 on Solar Energy in Building Renovation. This Task is one of the first cooperative efforts dealing with the use of solar energy in existing buildings.

SOLAR RENOVATION CONCEPTS FOR EXTERIOR WALLS

The traditional way to improve a facade that has deteriorated or has poor insulation is to apply a new cladding and add opaque insulation. The reasoning is that the better the wall is insulated, the lower the heat loss will be. However, insulation also prevents solar gains from contributing to the building's heating needs during sunny periods. Solar concepts, which are under development, can accomplish results superior to these traditional methods. Solar alternatives include glazing the wall to aid in the capture and storage of heat. These glazed walls can be ventilated or not depending on how and when the heat is to be used. More recently, transparent insulation materials (TIMs) have been introduced which enhance the performance of such systems by further reducing heat losses through the walls, while still allowing significant capture of solar heat.

Like traditional external insulating facade systems (EIFS), such "solar walls" are used to improve the building envelope--to protect or replace an old facade, to reduce the need for space heating and/or to preheat ventilation air. The glazings or TIMs not only reduce the coefficient of thermal transmittance (U-value) of the facade, but also increase heat gain from solar radiation.

Transparent insulation is most effective on massive brick walls or poorly insulated concrete construction. When TIMs are used in solar walls, glass must protect them from the elements. Consequently, issues that must be addressed early in the design phase are condensation and glare. In addition, some sort of shading device (e.g., movable or fixed Venetian blinds), must be used to prevent unwanted solar heat gains during the spring and summer months.

In Germany, a new TIM application method has been developed, which enables the TIM to be installed directly to an existing wall. The TIM forms a matrix that is similar in appearance to traditional exterior insulating facade systems, and can be readily adapted to match existing stucco-like or masonry facades. This new TIM permits the renovation of historic buildings without compromising their unique characteristics. An added benefit is that by virtue of its construction and heat/light transmission properties, this TIM does not require shading. It also is less expensive than glazed TIM solar walls, and may open the way for new and interesting architectural designs.

SOLAR RENOVATION CONCEPTS FOR BALCONIES AND GALLERIES

Glazed balconies and galleries are also used to improve the building envelope. They can be used to protect the old facade, reduce the need for space heating, add living space, and in some cases, preheat ventilation air. In older buildings, balconies often have to be repaired due to corrosion. Instead of replacing the balcony, repairing it and enclosing it with a glazing can protect it from the weather and associated moisture-related corrosion problems. Buildings most suitable for glazed balconies are old apartment buildings. Balconies that are fully recessed (e.g., "aligned" or in the same plane as the building surface) or partially aligned offer the greatest opportunity for energy savings following enclosure. Apartment buildings with glazed balconies are often considered more attractive and as a result the value of the units increases.

If a glazed balcony is to be used to reduce the need for space heating while maintaining or enhancing daylighting opportunities, it must be designed with careful consideration of the amount of glazed area relative to the unglazed area, the type of glazing used (e.g., single-pane, double-pane, low-e, etc.), and the manner in which the space is to be used. If the balcony is to be used as additional living space year round, this may result in increased energy requirements.

Solar heat gain from a balcony also can be used to preheat ventilation air. By preheating ventilation air, energy use can be reduced during periods of sunshine. The effect depends on how much of the total ventilated air passes through the balcony. To control the balcony's ventilation rate, installing an exhaust air ventilation system in the building is necessary. The building envelope also must be airtight so that the air supply does not enter the house through air leaks from the outdoors. It should be noted that this strategy reduces energy requirements for heating ventilation air, but does not affect heating energy due to heat losses through the building envelope (assumes no change in the building U-value). This is another reason why it is advantageous to upgrade the building envelope when glazing a balcony.

Studies of glazed balconies show that their performance is closely linked to occupant behavior. If thermal energy performance is to improve, the building occupants must receive information on how to use their newly renovated balconies. If doors or windows between the balcony and the conditioned space are left open during cold and cloudy periods or evenings, this will require more conventional heating than originally needed. Also, to avoid overheating during sunny summer days, the balconies must have some type of ventilation system or shading device (for example, blinds or awnings). Designers also should address the possibility of condensation problems and how to clean the glass.

SOLAR RENOVATION CONCEPTS FOR ROOFS

Roof-integrated solar collectors can be applied to existing roof structures when roof renovation is required. They can be used for preheating domestic hot water and/or providing space heating. In IEA countries, it can be cost-effective to provide as much as 40 percent of the domestic hot water heating requirement with a solar water heating system. The collectors are typically placed on the roof or integrated in a south facing roof or wall. When integrated, they can also serve to improve the building envelope.

Roof-integrated solar collectors can easily be incorporated in a roof's architectural design. An ideal opportunity to add solar collectors is when rebuilding a flat roof to an inclined one. Many buildings with flat roofs have problems with water leakage and need frequent re-roofing (every 10-15 years). In Sweden, flat roofs are frequently being rebuilt with an incline to correct this problem. A new method that has been developed uses roof-integrated solar collectors that not only provide hot water, but actually act as a waterproofing element by serving as the roof membrane. The specially designed prefabricated roof modules are mounted directly on the roof trusses. The modules arrive on the building site completely pre-assembled and need only to be connected to the pipes. Once the solar collector is installed, it acts as a waterproofing layer on the roof. This means that the cost for repairing a leaky roof can be shared with the cost of the solar collector. The net cost of this roof-integrated collector (collector costs minus the cost of the traditional roofing membrane materials) makes this system much more competitive with conventionally fueled water or combined water and space heating systems. In volume production, it is anticipated that even the current costs could drop significantly.

CASE STUDIES

Under Subtask A of the Solar Heating and Cooling Program's Task 20, fifteen existing solar renovation projects from Denmark, France, Germany, the Netherlands, Sweden, and Switzerland, were evaluated. All but one of the projects, a Danish school, were multifamily building renovations. In each country, one or more solar concepts were applied to an entire building, except in the three Danish projects. These projects added glazed balconies and solar walls to only a few apartments in a building. The main reason for applying solar concepts was to reduce energy operating costs while improving the condition of the building. A common motive for renovating a building was to repair the facade, but in some cases, the solar concepts were applied purely for research purposes. Most of the projects also included traditional energy conservation measures. Typically, the occupants could live in the apartments during the renovation process since the activities involved construction primarily on the building envelope. And, only in a few instances did the construction work take longer than originally planned. The case studies have provided information on the reasons for the renovation, the design and decision-making processes that resulted in the solar design solution, the performance and cost impacts of the solar renovation, and the occupants' reactions following project implementation. Task 20 participants have used this information as a starting point for the development of improved and advanced concepts that are being examined and implemented under Subtask B and Subtask C.

Two general conclusions drawn from these earlier case studies are (1) the solar renovation concepts worked more or less as expected and (2) the occupants were generally satisfied with the renovation results. These projects prove that solar concepts can be used successfully in building renovations, but also underscore the need to better understand their performance and possible improvements.

LESSONS LEARNED

Many lessons were learned from these case studies. Perhaps the most obvious is that there are many possibilities and constraints to consider when renovating a building. Therefore, it is helpful to conduct a careful study before the renovation that examines the building's current condition and outlines the range of possible solutions in a whole building context.

CONCLUSION

The results from the solar renovation case studies show that these concepts can work alone or in combination with other renovation methods. The general approach for using solar applications is to strive to make the implementation easier (save time), improve construction (include or develop cheaper details), and improve the thermal performance (design, operation, etc.) and occupant comfort. Although still in the early stage of development, the advantages of using solar renovation concepts continue to be demonstrated. Solar concepts can offer a potentially cost effective renovation method that is useful, attractive, and nonpolluting. It is also worth taking into account other improvements, such as thermal comfort and better use of balconies, which can increase a building's value and attractiveness.

In the future, it can be foreseen that people will pay more attention to what kind of energy is used in buildings and how the production of different energy sources pollutes the environment. Solar energy is a clean and sustainable energy source and, therefore, has economical as well as environmental and societal value.

REFERENCE

Dalenback, Jan-Olof, 1995, Solar Energy in Building Renovation.
Manuscript accepted for publication in the Journal Energy and Buildings, Vol. 24, Issue no. 1.

Task 13: Advanced Solar Low-Energy Buildings

Prof. Anne Grete Hestnes
The Norwegian Institute of Technology
Operating Agent for The Royal Ministry of Petroleum and Energy, Norway.

TASK DESCRIPTION

Objective

The objective of the Task was to advance solar building technologies through the identification, development, and testing of new and innovative concepts which have the potential for eliminating or minimizing the use of purchased energy in residential buildings while maintaining acceptable comfort levels.

Scope

The focus of the Task was the application of passive and/or active solar technologies for space heating of single family and multi family residential buildings. The use of passive and active solar concepts for cooling, ventilation, and lighting was addressed, as well as advanced heating and cooling loads. Since the emphasis is on innovation and long-range (after the year 2000) cost-effectiveness, the materials, components, concepts, and systems considered need not be currently feasible, economical, or on the mass market today.

In order to accomplish the foregoing objective, the participants are undertaking work in three subtask areas, each coordinated by a lead country:

Subtask A: Development and Evaluation of Concepts (Germany)

Subtask B: Testing and Data Analysis (Denmark)

Subtask C: Synthesis and Documentation (Switzerland)

To facilitate the effective planning and implementation of the program of work, a feasibility phase was conducted prior to initiation of the research phase of Task 13. The primary result of the feasibility phase was a detailed work plan for the research phase. The research phase was started on September 1, 1989 and was scheduled to last until September 1, 1994. A two-year extension was later approved by the Executive Committee and therefore, the Task will last until September 1, 1996.

ACTIVITIES DURING 1995

Experimental Buildings

Most activities have been related to the construction, instrumentation, and monitoring of experimental buildings. By now, ten of the participants have completed construction of one or more buildings. In most countries, a single family house, a duplex, or a row house unit was constructed. However, Germany and the United States have constructed two houses, in two different locations, Denmark has constructed a row house with a total of 55 units, and the Netherlands has constructed a large apartment building with 42 units.

The calculated energy consumption values for the various buildings show that the total annual consumption, for all end uses, averages only 45 kWh/m2. Of this, auxiliary space heating comprises only 16 kWh/m2 and electricity only 18 kWh/m2. Most of the buildings use a number of energy conservation and solar thermal strategies to reach these very low levels. In addition, some of the buildings use grid connected photovoltaic systems.

The buildings are now being extensively monitored, and monitoring results are being analyzed. For instance, preliminary results for the apartment building in the Netherlands, the Urban Villa, indicate good correspondence with calculated values. The same is the case for the German duplex in Rottweil, where the measured energy consumption for heating is 18.7 kWh/m2, while the calculated value was 18 kWh/m2. Results for the Finnish single family house, on the other hand, are so far considerably higher than expected. They have measured 50 kWh/m2, while they calculated 34 kWh/m2. Some of the reasons for this have been found and adjustment are being made. They therefore expect lower numbers later.

The participants from the Netherlands are discussing the possibility of extending the monitoring period with the local utility company. The utilities are using the project to test a system where they collect the data over the cable net and send it back to the researchers for analysis. They are also considering providing the occupants with the data, in real time, on their personal televisions.

Information Dissemination

The experimental buildings are all presented in a 50-page booklet published by James & James Science Publishers in London.

Work on the final report of the Task is now nearing completion. This report is titled, Solar Energy Houses: Strategies, Technologies, Examples. A complete draft has been produced and discussed, and changes and additions have been made. This book also will be published by James & James Science Publishers. It will be available by the end of the Task in September 1996.

Work has started on planning the second, and final, Task symposium. It will be conducted in conjunction with the European Union's Solar Energy in Architecture and Urban Planning conference in Berlin, Germany on March 26-29, 1996.

Summary of Accomplishments

Subtask A: Development and Evaluation of Concepts

- A first draft of the catalogue of Task 13 construction details was presented and discussed. The catalogue is to be titled, High Performance Building Construction Systems and Details: The IEA Task 13 Experience.
- Results from simulations of the Italian Task 13 apartment building, placed in three different Italian locations, were presented and discussed.
- Task experts visited the Belgian and Finnish Task 13 buildings, in Louvain-la-Neuve and in Pietarsaari.
- New versions of the computer programs ENERGY 10, FRAME, and SERI-RES were demonstrated.
- The IEA SHC Tasks 14, 16, and 19 were presented to the Task 13 experts.

Subtask B: Testing and Data Analysis

- The report Component and System Testing was published.
- Testing of dynamic insulation concepts was carried out and presented by Germany.
- Testing of the light distribution in the Swedish three dimensional window unit was carried out and presented by Sweden.
- Construction of four more Task 13 buildings in Denmark, the Netherlands, and the United States were completed and construction of the last three in Germany, Sweden, and Switzerland started.
- Monitoring results from the other buildings were presented and discussed. The monitoring of the last ones completed has started.

Subtask C: Synthesis and Documentation

- Three thousand copies of the booklet Solar Low Energy Houses of Task 13 were printed and distributed.
- A complete draft of the final report of the Task was produced, presented, and discussed.

WORK PLANNED FOR 1996

Part of the work will still be related to the experimental buildings. At this point, all the buildings will be completed. The major activity will therefore be related to the monitoring of the buildings and extensive discussions on the monitoring results will take place at the Experts Meetings.

The other important part of the work at this stage is related to information dissemination. The production of the final report, which includes 250 pages of descriptions of the experimental buildings, technologies and strategies used in them, and comparisons between them will still require considerable effort. In addition, a Task symposium involve most of the Task participants. The symposium will include an overview presentation of the Task, a presentation of the strategies used in the various experimental buildings, and presentations on a number of the buildings. The buildings selected will show the diversity of technologies used and contexts encountered. The results of the Task also will be presented at other relevant conferences during the year. The most important of these are the PLEA'96 conference in Louvain-la-Neuve, Belgium in July and the EUROSUN'96 conference in Freiburg, Germany in September.

Summary of Work Planned

- Work on the catalogue of construction details will be completed and a report will be distributed.
- The last experimental buildings will be completed and instrumented and then monitoring of them will start.
- Monitoring results for the other buildings will be analyzed, presented, and discussed.
- The final report will be completed and published.
- The final Task symposium will be conducted in Berlin, Germany in March.

REPORTS PUBLISHED IN 1995

Component and System Testing (IEA Report)
This report can be ordered from Bjarne Saxhof (see Task Participant list at end of chapter for address).

Solar Low Energy Houses of Task 13 (Booklet)
James & James Science Publishers, ISBN 1 873936 37 0

REPORTS TO BE PUBLISHED IN 1996

High Performance Building Construction Systems and Details (Working Document)

Solar Energy Houses: Strategies, Technologies, Examples (IEA Report)

1995 MEETINGS

Eleventh Experts Meeting
January 16-18, 1995
Waterloo, Belgium

Twelfth Experts Meeting
July 3-5, 1995
Rovaniemi, Finland

1996 MEETINGS

Thirteenth Experts Meeting January 23-25, 1996
Arizona, U.S.A.

Another meeting may be arranged at the end of the Task, but the decision has not yet been made.

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Task 14: Advanced Active Solar Energy Systems

Doug Lorriman
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Operating Agent for Natural Resources Canada

TASK DESCRIPTION

Task 14 was initiated to advance the state-of-the-art in active solar energy systems. Over the past six years, Task experts have worked on the leading edge of system development within their own countries and bringing their expertise together within the Task to accelerate advancements in this field. Task activities include development of computer simulation models for advanced system features, development and testing of new components and systems and design, construction and monitoring of actual operating systems.

System applications included in the Task are:

- Domestic Hot Water
- Ventilation Air and Space Heating for Commercial Buildings
- Large Scale Heating under 200C

Activities of the Task began in January 1990. The final reports of the Working Groups on Domestic Hot Water, Air Systems, and Large Systems as well as the final report of the Dynamic Testing Subtask will be completed in early 1996.

Working Groups

The goal of the Working Groups is to facilitate interaction between participants with similar projects. Participants in these Working Groups identify and address issues of common concern, exchange knowledge and experience, and identify prospective collaborative activities. Working Groups have been established in the following areas, each coordinated by a lead country:

- Domestic Hot Water Systems (United States)
- Air Systems (Canada)
- Large Systems (Lead position rotates between Sweden, Germany, the Netherlands, and Spain. The current lead is the Netherlands.)

Innovative Concepts Subtask (United States)

This Subtask was established to provide a mechanism for the ongoing sharing of new ideas on active solar heating among the Task participants. The work of the Subtask helps to identify promising concepts which offer improvements in cost, performance and/or reliability. Meetings of the Subtask typically involve informal presentation and discussion of new concepts which have been identified by the participants and could be of interest to other Task participants in their projects. There was only one meeting of this Subtask during the year, and it focused on making specific recommendations for future work. The recommendations included:

- Combination DHW/Space Heating systems for cost reduction
- Construction and testing of dream systems developed in Task 14, perhaps incorporating a competition
- Expanded applications for transpired air collectors
- In-situ performance verification of active systems
- Annual DHW workshops for the exchange of ideas and experiences

These recommendations were passed on to the Executive Committee.

Dynamic Testing Subtask (Switzerland)

This Subtask became part of Task 14 during 1992. It was established to further develop the work done by the IEA Dynamic Systems Testing Group which submitted its final report in early 1992. The general goals of the Subtask are:

- Develop short-term component test procedures.
- Develop test procedures for SDHW systems that are not covered by the existing Dynamic System Testing model.
- Perform tests to validate the procedures.
- Develop methods for rating and performance prediction of large systems.
- Evaluate the need for a user-friendly modeling tool for system simulation, layout, and optimization.

The Task was scheduled to end on December 31, 1995 but will continue into 1996 to allow for the completion of Task reports.

ACTIVITIES DURING 1995

Work of the Task during 1995 revolved primarily around the preparation of final reports. All reports that were scheduled to be completed by the end of 1995 are now scheduled for completion in the first quarter of 1996.

LINKS WITH INDUSTRY

It was a stated objective at the beginning of the Task to involve industry, and the record shows that this objective was successfully achieved.

During the feasibility phase, industry representatives from the United States, the Netherlands, and Sweden were involved in forming the goals and developing the Work Plan. This participation helped ensure that the work would be both realistic and relevant to industry needs. As the Task progressed, more industry representatives participated at the meetings and became involved in the work at a national level. By the end of the Task, meetings were regularly attended by industry representatives from Canada, the United States, Denmark, Germany, and the Netherlands. In fact, the Lead Participant from the Netherlands was the industry representative. For a short time, Italy was an observer to the Task and their representative was also an industry person.

As in the beginning, throughout the Task the industry representatives brought a sense of reality and practicality to the discussion and the work. Their input is further reflected in the final reports which were designed and written to be equally valuable to both industry and research readers.

Direct benefits from industry participation were seen even before the Task was completed. Switzerland now markets a domestic hot water system that was developed in conjunction with the Task 14 program. In other countries, some systems were modified as a result of lessons learned and information provided during the Task. These changes were seen not only in the systems directly manufactured by the industry participants, but by others who benefited from national reporting of the Task work.

Just as important (if not more so) as the direct participation by industry in the Task was the highly successful series of Industry Workshops that were held coincident with the Task meetings. These workshops, usually coordinated by a local group, provided a direct vehicle for Task participants to present their work, to share product and marketing experiences from different countries, and to help all understand the problems and opportunities in various markets. In most cases, these workshops provided a unique opportunity for local business people to interface with our group of international experts. By the end of the Task, industry workshops had been held in most of the participating countries.

Although not officially part of the Task, at least two of the European participating countries organized "low flow" tours. In these tours, a group of industry representatives from one country visited industries in other countries to discuss technical and marketing aspects related to the "low flow" concept for domestic solar hot water systems. The ideas and contacts that made these tours successful originated at the Task 14 meetings.

Major industry participants in Task 14 include: Conserval Engineering Ltd. and Thermo Dynamics Ltd (Canada), Batec (Denmark), Solvis (Germany), Technotherm (Sweden), Solair Systems b.v. (Netherlands), Solar Energy Industry Association (U.S.A.), and Metec Engineering (Italy as an observer).

1995 MEETING

Experts Meeting
February, 1995
San Diego, California, U.S.A.

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IEA SHC Annual Report 1995

Task 16: Photovoltaics In Buildings

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TASK DESCRIPTION

Photovoltaic power supply for buildings utilizes a decentralized approach for electricity generation. It offers the possibility to match supply and demand and thus to reduce transmission losses, peak power, and storage. For system optimization, all energy aspects such as lighting, heating, cooling, and hot water production have to be taken into account.

Task 16 is assessing techniques for maximizing the solar share in total energy concepts and optimizing the economics. Results of these findings will be incorporated into Task 16 demonstration projects which will be undertaken in most of the Task 16 member countries. Both residential and commercial buildings as well as grid-connected and stand-alone buildings are to be included.

Task 16 is divided into four Subtasks, each coordinated by a lead country:

Subtask A: System Design and Engineering (Finland)

In this Subtask, participants are producing working documents on existing PV-systems, components, energy-efficient electric appliances and lighting equipment, safety issues and national regulations, codes and pricing practices for electricity generation, based on responses to questionnaires. Based on this information, recommendations and guidelines for energy concepts, utility interface issues, and monitoring procedures will be made.

Subtask B: Building Integration (Switzerland)

Various methods of integrating PV-modules into building structures will be investigated and tested. The development of special modules designed for building integration will be undertaken, taking into account restrictions caused by building standards or safety requirements. The best integration methods will be demonstrated on the Task 16 Demonstration Site "Photo-voltaic Building Elements" at EPFL in Lausanne, Switzerland.

Subtask C: PV Demonstration Buildings (Netherlands)

Based on the results of the preparatory work in Subtasks A and B, photovoltaic buildings will be designed, constructed, and monitored. It is expected that most of the Task 16 participating countries will build one or more demonstration building. The data from these buildings will be made available to the public.

Subtask D: Technology Communication (Germany)

Based on the information gained through Subtasks A and B and the PV demonstration buildings, the handbook, Photovoltaics in Buildings: A Design Handbook for Architects and Engineers, will be compiled. To further disseminate the results of Task 16, national workshops and an international symposium with published proceedings will be organized.

The Task was initiated on November 1, 1990 and will conclude on April 30, 1996.

ACTIVITIES DURING 1995

Subtask A: System Design and Engineering

On the basis of the evaluation of national activities, information has been collected and discussed on existing PV-systems, energy efficient electric appliances, safety issues, and national regulations. This information provided direct input to several chapters of the design handbook. Other Subtask activities included discussions on the development of national electric safety standards and its influences on international regulations and the preparation of a special "Guidelines for Commercially Available Batteries in Photovoltaic Systems." There also is work underway on the documentation and characterization of different inverter types and discussion among experts on the question, "How do solar insolation and a utilitys load profile coincide?"

Subtask B: Building Integration

The PV Demonstration Site for Photovoltaic Building Elements at EPFL in Lausanne, Switzerland, comprises twelve pavilions showing recent techniques that have been developed for the integration of photovoltaics in buildings. Examples of these integration techniques include a PV shading system and a semi-transparent roofing application. The Demosite remains a highlight of Task 16 as a world-wide selection of government delegates, architects, building constructors, and engineers continue to visit the Demosite (more than five visitors a day on average). Slides and other materials are available and an invitation brochure has been prepared and distributed. In addition, a Demosite Newsletter is published by the EPFL Lausanne.

One major item of Subtask B is the modelling of the irradiance distribution on building surfaces. The program RADIANCE was used to compute the irradiation distribution. An indoor illumination calculation procedure that was extended for the purposes of Task 16 was use to calculate further characteristic examples for the irradiation on different building structures.

Subtask C: PV Demonstration Buildings

The objective of this subtask is to demonstrate and evaluate the integration of PV into buildings. For this purpose, 17 demonstration buildings were constructed by the participating countries during 1990-1994. All the designs were reviewed and critiqued by the Task experts at special meetings. And after construction, each project was monitored for a period of at least one year. Many of the designs are based on the results of the preparatory work of Task 16 dealing with systems design and the development of building integration techniques.

Subtask D: Technology Communication

The final draft of the Photovoltaics in Buildings: A Design Handbook for Architects and Engineers has been finalized and will be published in 1996. The design handbook considers the integration of photovoltaics in buildings and reviews all topics related to the current state-of-the-art building-integrated PV systems. It is one of the most important outcomes of Task 16 because it includes a majority of the significant results in the different working modules. The handbook will be approximately 300 pages and include more than 200 pictures and drawings.

ACTIVITIES DURING 1995

- Ongoing success of the PV Demonstration Site for Photovoltaic Building Elements at EPFL in Lausanne, Switzerland.
- The book Photovoltaics in Buildings: A Design Handbook for Architects and Engineers was finalized and is ready for publication.
- Collaboration continued between the organizers of the IEA Photovoltaic Power System (PVPS) Program's Task 5 on PV Power Systems. A joint meeting between the two Tasks took place in Freiburg, Germany on September 25, 1995.
- The report Guidelines for Commercially Available Batteries in Photovoltaic Systems is ready for publication.
- A new update of the Inventory of Inverters for Grid-Connected PV Systems was prepared.
- Two presentations by invited specialists on PV potential were given at the September Experts Meeting in Freiburg, Germany.
- The internal working document PV Systems Simulation Programs was finalized.
- Monitoring of the demonstration buildings continued and a brochure introducing this activity was printed and distributed.
- Organizational matters for the 1st International Solar Electric Buildings Conference in Boston, Massachusetts, U.S.A. were completed.
- Industry involvement continued to take place.

WORK PLANNED FOR 1996

Task 16 has been extended for six months to complete monitoring, evaluate results, and allow for experts to present their results at the final meeting.

The activities planned for 1996 are:

- The final conference will take place in Boston, Massachusetts on March 4-6, 1996 to conclude the work of Task 16. The purpose of this conference is to present the results of the Task's work on solar electric buildings and to consider ongoing efforts in this area. In addition, institutional and policy issues that are critical to widespread implementation of building integrated photovoltaics will be discussed.
- The Task results will be presented at the European Union's Solar Energy in Architecture and Urban Planning conference in Berlin, Germany in March 1996.
- The Photovoltaics in Buildings: A Design Handbook for Architects and Engineers will be printed by James & James Science Publishers and distributed.
- Monitoring of the data from the demonstration houses will be completed and evaluated. Datasheets characterizing technical and monitoring details for the demonstration houses will be finalized and distributed with a brochure.
- There will be an extensive information transfer between this Task and the PVPS Program's Task 5.

LINKS WITH INDUSTRY

Industry representatives are actively contributing to several Task 16 Subtasks. Most of the industry participants are involved in constructing and evaluating IEA Task 16 demonstration buildings. Other activities industries are taking part in include production and contribution to several official and internal working documents, such as Storage Module Survey and the Photovotaics in Buildings: A Design

Handbook. Also, industry representatives from the Austrian utility OKA Linz and the Canadian company SOLENER, Inc. will be speakers at the 1st International Solar Electric Buildings Conference in Boston, Massachusetts.

Industries involved in Task 16 include: OKA Linz (Austria), SOLENER Inc. (Canada), Neste Oy (Finland), Flachglas Solartechnik GmbH (Germany), and KANDENKO Company Ltd. (Japan).

REPORTS PUBLISHED IN 1995

Demonstration Buildings (Brochure)

REPORTS TO BE PUBLISHED IN 1996

Market Survey and Test Results for Inverters (Technical Report)

Simulation of Irradiation Distribution (Internal Working Document)

Trade-Off Summary (Internal Working Document)

Brochure on all Task demonstration buildings (Technical Report)

1995 MEETINGS

Eighth Experts Meeting
April 18-20
Austria

Nineth Experts Meeting
September 20-22
Freiburg, Germany

Joint PVPS Task 5 and SHC Task 16 Meeting
September 25
Freiburg, Germany

1996 MEETINGS

Final Task 16 presentation at the 1st International Solar Electric Buildings Conference
March 4-6
Boston, Massachusetts, U.S.A.

Tenth Experts Meeting
March 7
Boston, Massachusetts, U.S.A.

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Task 18: Advanced Glazing & Associated Materials for Solar & Building Applications

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TASK DESCRIPTION

Objective

The objective of this Task is to develop the scientific, engineering and architectural basis which will support the appropriate use of advanced glazings and associated materials in buildings and other solar applications with the aim of realizing significant energy and environmental benefits.

Scope

This Task builds upon work begun in Task 10, Materials Research and Testing. Comprehensive measurements of key glazing performance parameters are being made for advanced glazing materials, components and window systems. Building energy analysis tools are employed to identify appropriate applications and predict energy and environmental impacts which will derive from the use of advanced glazing products. Task 18 has a specific focus on the application and technology transfer of new materials and components with an emphasis on near-market technologies.

The Task aims to provide guidance for design engineers, building engineers and industry on the properties, use, performance and selection of advanced glazing materials. Necessary measurable parameters for specification of the thermal performance of advanced glazing materials are identified and defined and appropriate measurement test procedures are being developed.

Means

The work of Task 18 is managed under two Subtasks, each coordinated by a lead country:

Subtask A: Applications Assessment and Technology Transfer (Australia)

Subtask B: Case Study Projects (Norway)

The 19 projects identified for inclusion within Subtasks A and B are listed below together with the lead country responsible for the management of each project :

Subtask A:

A1 Applications, potentials and characteristics (Australia)
A2/A3 Modeling and Control strategies (U.S.A.)
A4 Environmental and energy impacts (Australia)
A5* Applications guidance (U.K.)

Subtask B:

B1 Monolithic and granular aerogels (Denmark)
B2 Geometric media (honeycombs and capillary structures) (Germany)
B3 Chromogenic glazings (U.S.A.)
B4 Low-emittance coatings (Sweden)
B5 Evacuated glazings (Australia)
B6 Advanced solar collector covers (Switzerland) - no longer running in Task 18
B7 Angular selective transmittance coatings (Australia)
B8 Daylighting materials (Australia) - ongoing work transferred to Task 21
B9 Frame and edge seal technology (Norway)
B10* Advanced glazing materials properties database and technology summaries (U.K.)
B11 Optical properties and scattering behavior of advanced glazing Materials (Sweden)
B12 Measurement of the total energy transmittance of advanced glazing systems (Germany)
B13 Directional optical properties measurements of advanced glazing materials (France)
B14 Measurement of the U-value of advanced glazing systems (Netherlands)

*A5 & B10 now merged into single project.

The Task was initiated on April 1, 1992 and will continue until March 31, 1997.

ACTIVITIES DURING 1995 AND WORK IN PROGRESS

Task 18 is engaged in activities which address all key issues relevant to the use of advanced glazing technology in buildings. The work encompasses basic materials research, window design and construction, performance definition, measurement and testing, simulation of energy benefits, environmental impacts, applications assessment, and information dissemination.

In 1995, the Task continued to make good progress in all key areas of activity and is on schedule to achieve its goals by the completion date of March 1997. Two Experts Meetings were held in France and Canada, the latter being held with the "Window Innovations '95" (WIC 95) Conference. A review of achievements of the past year is presented below.

Subtask A: Applications Assessment and Technology Transfer

Advanced glazing materials promise new architectural and insulation opportunities. Windows can become net sources of useful heat, enable dynamic control of transmittance, and enhance thermal and visual comfort. Little practical experience presently exists in monitoring the use of advanced glazing, and their integration into the building envelope will require reassessment of building services needs and implementation of effective control strategies. The goals of Subtask A are to identify appropriate applications, determine the energy and environmental impacts and provide applications guidance in order to promote awareness of potential benefits and stimulate market opportunities.

Applications assessment

The technical work of Project A1 "Applications, potentials and characteristics" is now complete and the final report will be approved early in 1996. The work of the project was described in detail in last year's Annual

Report.

Modeling and control strategies

Work on simulating the energy and comfort performance of advanced glazing systems and dynamic control strategies in realistic residential and commercial building environments was undertaken by 11 countries representing different climatic regions. The work is also evaluating the ability of current window and building simulation tools to properly characterize the dynamic and annual performance of these systems and improve tools as necessary to create common technical approaches for simulation. The project is structured to enable participating countries to evaluate glazing performance within the context of their own particular environment. Locations vary from Darwin, Australia, characterized as tropical, hot and humid, to Sodankylaa, Finland which has very cold winters and mild summers. Commercial and residential buildings are being simulated by most countries. The commercial buildings vary from prototypical single-floor office buildings to multi-floor buildings with ground floors, intermediate floors and rooftop floors. Residential buildings are either single-story or two-story with floor plans and construction typical of the participating country. A paper describing the first simulation results was presented at the WIC 95 conference. The next review of results will be made in February 1996.

Environmental impacts

Although the most common focus of attention in the evaluation of new windows is the energy saving and resultant reduction in CO_2 and other emissions which may be achieved through their use, it is apparent that these are not the only environmental consequences of new window technologies. An energy efficient technology is not by default environmentally sound. Within Task 18 work is in progress to evaluate life-cycle analysis methodologies which consider the procurement of raw materials, materials processing, manufacture and assembly, installation, use and maintenance, removal, reprocessing, reuse/recycling, and disposal. Much of this work will be completed in the second half of the Task. The work will help to establish and validate tools and techniques for environmental quality measurement.

Applications guidance

The U.K. leads the Task's work on information dissemination. Important links have been established with other relevant organizations and programs concerned with applications guidance and the promotion of best practice. The success of the Task's work in this area is essential if the results are to be presented to the widest possible audience in forms appropriate to their needs in order to promote awareness of the potential of advanced glazing systems. Draft forms of guidance material are now in preparation and will be circulated widely for critical review in the coming year. Funding has been awarded for the preparation of education and training material for architects and engineers. Opportunities for dissemination of information in different forms appropriate to the target audience are being explored. In addition to written and electronic information, workshops and seminars have been held in several countries to promote knowledge of the outcomes of the Task. Evaluation of the guidance materials is being undertaken in association with representatives of the glass and glazing industry who are strongly involved with the work of the Task.

Subtask B: Case Study Projects

In Subtask B each Case Study Project integrates a series of materials development and measurement activities to enable an extensive, in-depth determination and examination of materials properties and performance levels for potential use in advanced glazing systems. Each Project is undertaking measurement and characterization work concerned with basic materials properties (e.g., optical, thermal, mechanical, etc.). Where possible, measurements are being performed on large area samples of advanced glazing materials and there is particular emphasis on investigating the properties of whole windows comprising advanced glazing materials and their associated frames and sealant materials.

High performance glazings for thermal insulation

Low emittance glazing is now widely available for use in double or triple glazed units, which may be filled with a low conductivity gas such as argon. Such low U-value products successfully achieve the aim of reducing heat loss through windows albeit with some reduction in incident solar gain. For the present and immediate future this technology represents an excellent solution for improving the thermal performance of the building envelope. However, there are a number of alternative materials and glazings (i.e., aerogels, transparent insulation, evacuated glazing) which have the potential to reduce heat losses still further and these opportunities are being analyzed and evaluated in the Task.

Aerogels

Silica aerogel is an open-pored transparent material with optical and thermal properties that make the material very interesting as an insulation material in windows. The open-pored structure in combination with the small pore size makes it possible to achieve vacuum-like properties of the aerogel at a very moderate vacuum ($p < 100$ mbar). The Task aims to produce a large area partially evacuated monolithic aerogel window with a solar heat gain coefficient (total energy transmittance) of 0.75 and U-value less than 0.5 W m-2 K-1. The presence of short wavelength scattering of light impairs the visual appearance of aerogels and the Task has investigated the sources of this scattering. The influence of the manufacturing process on the scattering properties of aerogels has been studied and aerogels with reduced short scattering and improved transparency have been prepared. A full characterization of the physical and optical properties of monolithic aerogels has been conducted. Work is now in progress to prepare a large area monolithic glazing to allow measurement of the key glazing performance parameters and to demonstrate the technical feasibility of manufacturing a full-size window.

Transparent insulation materials (geometric media)

The concept of transparent insulation, using materials such as plastic or glass honeycombs, in combination with low-e coated surfaces, are being investigated and developed within the Task. To date some 15000 m2 of facades within Europe have been installed. The main application of transparent insulation is within windows and as facade elements for passive solar collector walls, utilizing the building structure for the system. The influence of climate, building type and material selection on the energy performance are being investigated. Optimization studies on TI-structures in large area solar collectors for district heating applications and on TI-systems employing natural convection loops are in progress. The optical and thermal properties of a wide range of different materials have been completed.

Evacuated glazing

Four large area (1 m x 1 m) evacuated glazings, constructed by the University of Sydney, Australia, have been delivered to Canada, the Netherlands, Norway, and the United Kingdom. Measurements of U-value and total energy transmittance are being made. The glazings will also be put into high performance frames and whole window properties measured.

Accurate measurements have been made of the radiative heat transfer between parallel surfaces of uncoated and doped tin oxide coated glass. The infrared properties of the tin oxide coated glass are calculated by a novel approach by fitting a three parameter Drude model to reflectance measurements at a specified angle, and over a restricted range of wavelengths. Estimates of the radiative heat transfer between uncoated and coated glass surfaces are calculated from a consideration of the directional spectral emittances and the blackbody spectrum. The procedure gives results that are in more consistent agreement with experimental measurements than results obtained by conventional techniques of considering the hemispherical total, or directional total emittances.

Since the probability of failure for vacuum glazing is a function of the stresses in the structure, it is important to consider the sources and magnitudes of these stresses. Due to a temperature difference across the glazing, there is a differential thermal expansion and contraction between the two glass sheets. This can cause the sheets to bend, resulting in the presence of bending stresses within the glass. A finite element model has been developed to calculate the thermal stresses in vacuum glazing for different situations at the edge. The model is validated by measurements of both surface deflections and strains under well defined conditions. It is appropriate to use this model to determine the stresses in vacuum glazing under realistic conditions, such as the ASTM standard fenestration test conditions, for a probability of failure analysis.

Solar gain control

Advanced glazings can be employed to filter incident radiation allowing only the visible portion of the solar spectrum to be transmitted, to reduce glare and avoid visual discomfort and to regulate solar gain dynamically using switchable, or "smart," windows. Applications include the reduction of heating and cooling demands and the effective use of daylight. Many of the candidate solar gain control glazings are sophisticated thin film coatings and the Task's research program is establishing a basis of knowledge on the properties and potential of these glazings.

Chromogenic glazings

In the previous year a state-of-the-art review on chromogenic technologies was completed. This year the Task completed a report on the electrochromic properties of tungsten oxide films prepared by OCLI for both proton and lithium intercalation and successfully interpreted the influence of surface microstructure and deposition process on the results.

All solid state and polymer-laminated variable transmission electrochromic devices were constructed by Asahi Glass, Japan, and Pilkington, U.K. for performance assessment within the Task. Plans were agreed upon for environmental performance testing of large area samples of the Pilkington device at the USA MOWITT thermal testing facility run by the Lawrence Berkeley Laboratory. The energy performance of electrochromic devices in cooling dominated climates in both residential and commercial buildings was studied using detailed building energy analysis tools and various control strategies for switching the glazing were investigated.

Samples of polymer dispersed liquid crystals (PDLC) were obtained from the 3M company and distributed for testing.

Angle selective transmittance coatings

The growth of oriented columnar thin films by oblique incidence thin film processes is capable of producing coatings which exhibit anisotropic transmittance properties. The growth angle of the columns can be controlled to enable reflection of light incident at large angles whilst preserving normal viewing conditions at near-normal angles. Such coatings have potential in the reduction of glare in buildings and can be adjusted for use in a range of climates.

New samples of angle selective transmittance coatings on low-e substrates have been prepared by the University of Technology, Sydney, and circulated for testing. Optical performance data have been used as input to building energy analysis simulations to enable the energy performance to be assessed and compared to more conventional glazings.

Daylighting

Some work on the characterization of daylighting materials and the assessment of different daylighting systems has been completed. With the decision to commence the planning phase of a new IEA SHC Task on Daylighting, much of the Task 18 effort has been focused into ensuring effective interaction between the two Tasks. Recently a decision was taken to cease work on daylighting within Task 18 and transfer the available resources to the new Task 21.

Frame and edge seal technology

Following on from the successful state-of-the-art survey work in this project has focused on developing design guidelines and combined testing and simulation of frame and edge seals for advanced glazings. New advanced glazings will require new types of frame and edge seal products. As the insulation properties of the glazing itself reach a performance close to that of well-insulated opaque walls, the thermal bridging caused by the spacer bars and the frames will be unacceptable, even for wooden windows. The new glazings will also integrate other functions (e.g., electrical control, which will also influence frame design). New materials and products for the edge seal and frame are being developed, such as pultruded fibre glass, and computer models for frame design and performance calculation can substitute for laboratory testing of new products. Measured U-values of Scandinavian and Canadian windows have been compared with simulated results obtained using the Canadian FRAME program and show excellent agreement.

Measurement of glazing performance

Directional optical properties and scattering

The accurate determination of angular dependent solar and thermal optical properties is essential to enable the total energy gains and losses to be understood. Directional measurements have long proved difficult to perform with high accuracy and much of the Task's efforts in this area will contribute to improved measurement techniques for future application, possibly in international standards. Work has focused on improving the accuracy of measurements made with integrating spheres and on developing and validating correction methods for measured signals.

Seven countries have completed a round-robin to measure the spectral reflectance and transmittance of low-e coated glass samples as a function of incidence angle. The samples were supplied by Pilkington and Interpane and were also measured in a USA NFRC round-robin. Much has been learned regarding sources of error in spectrophotometric measurements and appropriate correction factors have been developed for single and double-beam instruments. The agreement between measured values and calculations based on a Fresnel formulism are very good. The data on the test samples can be used as inputs to the calculation the performance parameters being measured on edge-sealed units in the total energy transmittance and U-value projects of the Task.

Total energy transmittance

A software tool to enable the calculation of the total energy transmittance through aerogel and honeycomb materials was developed by Germany and circulated to participants for evaluation. The participants now have the means to calculate theoretically the influence of variations of the experimental boundary conditions on measured results. Thus they may estimate and judge problems present in their experiments. This is necessary to improve and develop the testing methodologies. A description of the component model calculation methodology and a state-of-the-art report on calorimetric devices for TSET measurements using indoor and outdoor instrumentation were completed together with an analysis of principal sources of error in such measurements.

U-value measurements

Accurate determination of U-value in highly insulating glazings is a demanding and difficult task. To prepare for future measurements on highly insulating glazings, U-values have been determined for the Pilkington and Interpane windows described above. Measurements were made with guarded hot box and guarded hot plate test facilities. Results for the opaque reference panel agree to within about 3 percent. Error analyses have been performed to estimate the uncertainty in the data. International standardization is still in progress both within ISO and CEN. Although the international standards on hot plate/heat flow meter measurements still show some discrepancies, the main uncertainties which require careful attention concern the hot box test procedures.

1995 was once again a successful year for Task 18. As the Task moves into the final full year of its Research Phase, it is well placed to continue to progress in all major areas.

LINKS WITH INDUSTRY

Task 18 has strong working links with industry, international standards organizations, the European Community JOULE Program, and the US National Fenestration Ratings Council.

In 1995, the Task jointly organized a major international conference with the Canadian Ministry for Minerals and Energy Technology (CANMET) called "Window Innovations '95." The conference was held in Toronto, June 5-6, and a large number of representatives from the North American glass and glazings industry were present amongst the 320 delegates. Task 18 presented many of the results of its work through some 12 technical papers which were published in the conference proceedings. The conference objective was to provide an international forum for sharing state-of-the-art information between researchers and industry. Seventy papers were presented and a conference proceedings of 680 pages resulted. WIC was organized by CANMET in cooperation with IEA Task 18 and was sponsored by NRC Canada, Edgetech IG, Libby Owens-Ford Co., Morton, Tremco, AFG, Cardinal IG, IGMAC, and the Canadian Window and Door Manufacturers' Association. In addition to the technical program, WIC contained an exhibition and a tour of demonstration projects and Canadian laboratories. The Task 18 presentations created the backbone of a world-class technical event on leading edge, energy efficient fenestration technologies and applications.

During 1995, the Task also published a six-page color brochure describing the technical activities of the Task and more than 3,500 copies have been distributed.

In the coming year the Task will make a major presentation of its results to date to the ISES EUROSUN Conference which will be held in Freiburg, Germany from September 16-19, 1996.

REPORTS PUBLISHED IN 1995

A full list of Working Documents published is contained in the Task 18 Information Plan which may be obtained from the Office of the Operating Agent on request.

Many technical reports of the Task's work appear in the "Window Innovations '95" Conference Proceedings which may be purchased from the Office of the Operating Agent.

1995 MEETINGS

Sixth Experts Meeting
January 10-12
Grenoble, France

Seventh Experts Meeting
June 7-9
Toronto, Canada

1996 MEETINGS

Eighth Experts Meeting
February 26-March 1
Thun, Switzerland

Ninth Experts Meeting
September 23-27
Rome, Italy

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Task 19: Solar Air Systems

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TASK DESCRIPTION

Solar air systems can deliver space heating and temper ventilation air while offering unique advantages. Air, unlike water, needs no freeze protection, nor are leaks damaging to the building structure or its contents. In contrast to passive systems, active air systems provide better heat distribution and hence improved comfort and fuller use of solar gains. Solar air systems are a natural fit to mechanically ventilated buildings and mechanical ventilation is increasingly common, not only in commercial and institutional buildings, but also in very low energy residences.

The economics of air systems are enhanced when they serve additional uses, such as to admit daylight, induce cooling, provide sunshading, generate electricity, or preheat domestic hot water. They may also have non-energy functions, such as to provide a usable zone, a load bearing element, weather protection or a barrier to street noise.

Unfortunately, designers lack experience in planning, analyzing, and constructing such systems. Furthermore, documentation of built prototypes to convince building clients is scarce. The two Subtasks of Task 19 address these needs:

Subtask A: Generic Systems

- Components will be tested and documented in collaboration with industry.
- Computer algorithms will be developed to model recommended systems.
- A design handbook will be written to help engineer solar air systems.

Subtask B: Building Applications

- Exemplary buildings with solar air systems will be monitored.
- Design reviews of new building projects will be carried out.
- A book documenting exemplary buildings with solar air systems will be produced.

Task 19 was initiated October 1, 1993 and will conclude September 30, 1997.

ACTIVITIES DURING 1995

The following work was completed:

- Twenty-two case studies of buildings with innovative solar air systems in the diverse climates of nine countries have been drafted. Applications include apartment buildings, single family houses, schools, gymnasiums and industrial facilities.
- An alpha version of an easy to use personal computer (PC) analysis tool was developed and tested at a workshop. It will help a designer decide if a solar system makes sense and identify which system type shows the most promise. Beneath a graphic interface, TRNSYS modules provide rigorous analyses.
- Partial drafts of each chapter of the engineering handbook were written. The layout and basis for creating nomograms to allow a designer to dimension a system by hand were established and a prototype nomogram was reviewed in detail.
- The catalog of manufactured components was drafted and remaining work defined and delegated. This document will help designers locate "off the shelf" components (also from abroad), lowering one threshold to wider application of solar air systems.

Several of the system types are proving to be of special interest. The System Type 2, in which warm air from the collector is used to heat water, combines the advantages of an air system (no risk of collector freeze damage) and a water system (compact distribution system). The heat can be used for space heating or domestic water heating. The latter improves the economics drastically since the collectors have a summer use as well as winter use. A second system which is proving economical in Sweden and Denmark is the System Type 3. Here an inexpensive roof collector delivers low-temperature air to channels in building envelope, thereby drastically reducing or eliminating room heat loss through these surfaces (see figure 1). The Danish apartment block illustrated in figure 2 employs such a hybrid system.

The experts and the programmers decided to phase the PC design tool in four levels of development of increasing complexity:

- Level 0: System selection: system energy performance computed for fixed building geometries, 3 occupancy types, in 3 climates. Results will feed handbook chapters on system selection.
- Level 1: System configuration can be varied to see how performance is affected for the above building, constructions.
- Level 2: Components are analyzed, varying component parameters.
- Level 3: Building, system and components can be individually specified.

Several important decision were made regarding the handbook. J. Hollick (Canada) agreed to draft a new chapter on System Type 1 including work from G. Löf (U.S.A.) and simulations offered by O. Morck (Denmark). Several new component chapters were defined and authors identified:

- Double Facades: M. Schuler (Germany)
- Spatial collectors: K. Lomas (U.K.)
- Rockbeds: J. Hollick and R. Bishop (Canada/New Zealand)
- Fire Safety: Chr. Nordström (Netherlands)
- National Solar Industries: A. Gassler (Switzerland)

WORK PLANNED FOR 1996

- Six new case studies will be written and include the world's tallest air collector on a Canadian apartment tower, a solar air retrofit for a Swiss single family house, and an urban apartment block in Germany with side-by-side systems cross comparisons.
- Current ongoing monitoring of all case study buildings will be completed.
- A mock-up of the whole case studies book will be compiled.
- The Task 19 PC tool will be completed through Level 2.
- Parametric studies using the PC tool will be done to produce the first nomograms for each of the

system chapters of the handbook.

- First drafts of all the handbook chapters will be completed.

LINKS WITH INDUSTRY **Manufacturers**

- Three European manufacturers are now considering production of solar air collectors and closely follow the work of the Task.
- The German collector manufacturer Grammar funds an expert to contribute to Task 19 work (S. Schröpf).
  A national testing laboratory in Vienna has received federal funding to test collectors from participating countries free of charge.
- The Catalogue of Components is evolving out of direct collaboration among the experts and manufacturers.

Architects

- Several architects of the case studies buildings are participating in Task 19 including: S. Larson (Austria), H. Rostvik (Netherlands) and Chr. Nordström (Sweden).
- The case studies will be an important source of concepts for architects and a useful document to convince building clients through examples.

Consulting Engineers

- DGS (German Solar Energy Society) founded a Working Group: Solar Air Systems with 15 industry and practitioner members.
- Engineers directly responsible for the planning of the solar air systems of the case study buildings include: J. C. Hollick (Canada), M. Schuler (Germany), J. Morhenne (Germany), O. Morck (Denmark).
- The handbook and the PC-based analyses tool are directed at serving engineers.

REPORTS PUBLISHED IN 1995

A four-page picture brochure describing Task 19 was prepared for the Task experts to distribute to interested persons in their respective countries. It explains what solar air systems are, what the goals of the Task are, and who is involved in the work.

REPORTS TO BE PUBLISHED IN 1996

The Catalogue of Components, will inform the reader what functions a component must perform, criteria how to select it, and example product sheets from Task 19 industry contacts. The scope covers collectors, storage elements, air/water heat exchangers, fans, and dampers. Hardware for fire protection and controls also will be reported on briefly. The catalog should be submitted to the Executive Committee for approval for publication at the end of 1996.

MEETINGS IN 1995

Fourth Experts Meeting
March 21-23 Zürich,
Switzerland

Emphasis was on the engineering handbook. Progress on the case studies and the PC design tool development was checked, ongoing work on the handbook coordinated, and work on the catalog assigned.

PC Tool Workshop
October 2-3
Nürtingen, Germany

Ten Task 19 experts involved in writing the handbook test used the alpha version of the Task 19 TRNSYS-based tool. Transsolar, the host, provided ten new computers to allow the participants to test run the program for their individual system types.

Fifth Experts Meeting
October 4-6
Nürtingen, Germany

Twenty-eight participants from Austria, Canada, Denmark, Germany, Italy, Norway, Sweden, Switzerland, and the U.K. were in attendance. Subjects of the meeting were the first draft of the catalog of manufactured components, 22 building case studies in 1st to 3rd drafts and three systems chapters as 1st draft.

MEETINGS PLANNED FOR 1996

Sixth Experts Meeting
April 15-17
Stratford upon Avon, U.K.

Seventh Experts Meeting September 23-27 (approximate dates)
Canada proposed location

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PREVIOUS CONTENTS NEXT

Task 20: Solar Energy in Building Renovation

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TASK DESCRIPTION

Task 20, Solar Energy in Building Renovation, is the first IEA SHC task to focus specifically on the use of solar energy in existing buildings. The objective of the Task is to increase the utilization of solar energy in existing buildings by developing strategies for effectively and economically integrating widely-applicable solar designs and concepts in the renovation process. This includes compiling guidelines needed by designers and remodelers, and developing strategies to reach key players in the renovation process to obtain their support and to provide them with needed information on solar opportunities.

Renovation or remodeling can be motivated by a variety of needs, including a desire to repair or replace a leaking roof, a deteriorated concrete balcony, or poor windows; increase living or work space area; upgrade a building's appearance; improve indoor comfort levels; improve daylight usage; reduce utility expenses; or accommodate changes in building use. Regardless of the reason, renovation presents special challenges and opportunities to apply different solar energy strategies.

Task 20 is divided into four Subtasks, each coordinated by a lead country:

Subtask A: Evaluation of Existing Building Applications (Sweden)

This Subtask has focused on obtaining as much relevant information as possible from existing solar renovation projects-both positive and negative. Information was collected on the reasons for renovation, various features employed, the renovation process, and occupants' reactions.

Subtask B: Development of Improved/Advanced Renovation Concepts (Belgium)

The main focus of the Subtask is the development of improved and advanced renovation concepts. A wide variety of possible systems, components, and strategies have been identified and analyzed in specific renovation situations to assess their feasibility and performance.

Subtask C: Design of Solar Renovation Projects (Denmark)

Subtask activities are divided into two areas: the design of solar renovation projects and the evaluation of solar renovation projects. Subtask participants created designs for demonstration solar renovation projects and developed monitoring procedures and reporting formats.

Subtask D: Documentation and Dissemination (Netherlands)

Under this Subtask, the results of the Task will be summarized and documented. Various information dissemination methods will be used. The Subtask consists of the following elements:

- D1 - Document Solar Renovation Strategies and Lessons Learned
- D2 - Arrange and Participate in International Symposia
- D3 - Compile Illustrative Source Materials
- D4 - National Dissemination

Task 20 was initiated August 1, 1993 and will run until July 31, 1996.

ACTIVITIES DURING 1995

Two Experts Meetings were held in 1995. The participating countries are involved in all four Subtasks with the same Experts, except Belgium and the United States, who did not contribute to Subtask A.

Subtask A: Evaluation of Existing Building Applications

Subtask A has been completed and no new activities were undertaken in 1995. A summary of the results of Subtask A will be published in the journal Energy & Buildings.

Subtask B: Development of Improved/Advanced Renovation Concepts

Four documents will be the basis for an international guide to be produced under Subtask B. The first document is "*Work Area*," a diagram that illustrates how architectural, technological, and economical aspects work together in the renovation process. A double entry table is used with the strategies (heating, cooling, and daylighting), the concepts and elements on one side and the possible renovation activities on the other side.

The second document defines the following issues: the objectives and the elements of resolution together with the corresponding systems.

The third document is "*Tables of Design Solutions*." In this document renovation activities are divided into three groups: (1) the envelope, (2) second order of activities, and (3) consequences of the two first groups.

In document number four, which is not yet complete, the results from the simulation work will be presented. This simulation work includes single family houses with roof windows and light core; multifamily buildings with facade windows, glazed balconies, glazed facades, transparent insulation materials, light core, domestic hot water (solar collectors), and photovoltaics; offices with transparent insulation materials; and, schools and department stores with roof windows, glazed facades, solar walls, and preheat. The international guide will include a large section on the simulation results.

Subtask C: Design of Solar Renovation Projects

In Subtask C, the framework for a common presentation of proposals for solar renovation demonstration projects was completed. Seventeen proposals for demonstration projects were discussed and reviewed during the Experts Meetings. Six of the project buildings include different types of solar walls and at least two of the projects will be monitored during the year. One demonstration project is testing a new roof-integrated solar collector mounted directly on the roof trusses. The project will be monitored for one year starting in the spring of 1996. Another project is a Danish building that is demonstrating glazed balconies together with PV-panels. Although some projects that include daylighting elements are theoretical, they are based on common types of houses. The design reports, which include the design process and comments on different designs, will be published in a technical report in 1996.

Subtask D: Documentation and Dissemination

In Subtask D, preparation for documentation and dissemination of Task results continues. At least four brochures are planned for publication in Subtask D. Three of the brochures will cover specific solar renovation concepts: glazed balconies, roof-integrated solar collectors, and solar walls. The fourth brochure will be an overall Task 20 brochure that highlights project results. Presentations at international symposia and congresses continue to be made.

WORK PLANNED FOR 1996

As 1996 is the last year for Task 20, the plans are to finalize all the work and publish the reports listed below.

LINKS WITH INDUSTRY

Cooperation between Chalmers University of Technology (Task 20 Swedish Expert), Teknoterm (Swedish manufacturer of absorbers) and Derome Träteknik AB (manufacturer of prefabricated houses) has resulted in the development of a roof-integrated solar collector. The prefabricated modules are mounted directly on the roof trusses and the solar collector is completely integrated in the roof construction. The first demonstration project of this technology is underway in Sweden.

REPORTS PUBLISHED IN 1995

Evaluation of Existing Building Applications in Residential Building Blocks (Working Document, Subtask A).

REPORTS to be published in 1996

Subtask B Technical Report to be published in June 1996.

Subtask C Technical Report to be published in July 1996.

Brochures to be published July 1996:

Task 20 Overview

Roof-Integrated Solar Collectors

Glazed Balconies

Solar Walls

1995 MEETINGS

Fourth Experts Meeting March 6-9
Freiburg, Germany

Extra Meeting May 22
Frankfurt, Germany

Fifth Experts Meeting September 4-7
Göteborg, Sweden

1996 MEETINGS

Sixth Experts Meeting February 12-14
Brussels, Belgium

Seventh Experts Meeting Tentatively to begin June 10
Colorado, U.S.A.

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IEA SHC Annual Report 1995

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, but by using the natural resources offered by sunlight through the use of more daylight-conscious architectural designs and the introduction of innovative daylighting systems and lighting controls a considerable part of this electricity consumption could be displaced. Furthermore, it is generally recognized that the design of the fenestration system and the proper use of daylight in building interiors are important factors, both for the conser vation of non-renewable fuels and for the well-being of occupants.

However, a number of barriers hinder the appropriate integration of daylighting aspects in building designs. One barrier is the lack of documented, empirical evidence that daylighting can substantially improve energy efficiency and visual quality in buildings. Other barriers include a lack of information on new fenestration technologies and lighting control systems and their ability to enhance use of daylight as well as a lack of user-friendly daylighting design tools and models for innovative daylighting systems.

Task 21 will help to overcome these 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 different climatic conditions emphasizing the energy savings and user acceptence of system performance.

The main deliverables of 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 consumptions and user appraisal of the environmental conditions.

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

Subtask A: Performance Evaluation of Daylighting Systems (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 (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 (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 (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.

The Task was initiated on September 1, 1995 and will conclude on August 31, 1999.

ACTIVITIES DURING 1995

The main work in the beginning of 1995 was devoted to the finalization of Annex 21 to the Implementing Agreement of the Solar Heating and Cooling Program and production of the final draft of the Task Work Plan. Approximately 40 experts from 14 countries participated in the Project Definition Phase, through which the Task objectives were more narrowly focused, the scopes of the four Subtasks were more specifically described, and the duration of the Task reduced to four years.

At the first Experts Meeting, a rough outline of testing procedures was established and pilot studies for testing the procedures were planned.

WORK PLANNED FOR 1996

In Subtasks A and B most of the work in 1996 will be dedicated to the establishment of the final procedures for testing and performance assessment of daylighting systems and control systems, and the evaluation of these procedures through pilot studies.

Subtask C will establish a forum for exchange of daylighting algorithms, select simplified daylighting tools, and carry out a study on the feasibility of using and existing integrated design system as platform for the daylighting design tools.

Subtask D will set up a "database" giving an overview and context of the selected cases studies and establishing the procedures for monitoring and evaluating the case studies.

LINKS WITH INDUSTRY

Industry representatives are involved in many of the Subtasks, and in many participating countries, industry provides significant financial support for work being undertaken. Most of the daylighting systems and lighting control systems are provided by manufacturers who naturally have an interest in the Task's testing procedures and results. In Subtask B on Control of Systems, major manufacturers are directly involved in current research activities and are providing excellent facilities to test several systems and strategies. Subtask D on Case Studies is led by a private engineering consultant and has strong links to a similar project underway in the European Community's JOULE Program. In this Subtask, building owners have made available their buildings for Task monitoring and user evaluations. In some cases, the owners have provided unoccupied rooms for direct full-scale testing.

REPORTS to be published in 1996

Subtask A

Architectural Solutions and Daylighting Systems (Draft Document)

Testing Procedures and Work Plan for Evaluation (Document)

Subtask B

Monitoring and Analysis Protocol

Database on Control Systems (Final, Working Draft)

Subtask C

Electronic Information System on Daylighting Algorithms on WWW

ADELINE 2.0 software package

Common, Integrated Data Model (Draft Working Document)

Design Tools to be Included in the Task (Draft Document)

Subtask D

Preliminary "Database" on Selected Case Studies

Monitoring Procedures (Document)

MEETINGS IN 1995

Final Project Definition Phase Meeting
March 6-10
Morges, Switzerland

First Experts Meeting
November 27-December 1
Stratford-Upon-Avon, U.K.

MEETINGS PLANNED FOR 1996

Second Experts Meeting
April 10-14
Berkeley, California, U.S.A.

Third Experts Meeting
September
Possibly in France

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Belgium, Japan, New Zealand, Spain

* Participation not confirmed as of December 1, 1995.

PREVIOUS CONTENTS NEXT

Working Group: Central Solar Heating Plants with Seasonal Storage

DESCRIPTION

The main aim of the Central Solar Heating Plants with Seasonal Storage (CSHPSS) Working Group is to maintain the collaboration on large-scale solar heating technologies which began in IEA SHC Task 7. The Netherlands led the Working Group from its formation in 1992 and in 1993 the leadership passed to Sweden. The Working Group ended this year, however, CSHPSS activities will continue under other SHC Program Tasks and activities.

The Working Group's objective is to provide a forum for continued knowledge transfer (international and national) on CSHPSS (residential heating, district heating, process heating at moderate temperatures) and to concentrate resources--funding as well as experts.

The collaboration of the Group Working has led to a series of workshops covering large-scale solar heating applications and the preparation of a number of documents. The workshops are held annually, at the minimum, in connection with a CSHPSS demonstration project. The workshops are open to all IEA countries as a means to create a common forum for expert groups working with central solar heating plants and to form the basis for continued international cooperation.

ACTIVITIES DURING 1995

Two workshop were held during 1995. " The 1995 Workshop on CSHPSS Design" was held in Stuttgart, Germany, March 9-11. Thirty-eight participants from Austria, Denmark, Germany, Finland, Italy, Sweden, Switzerland, and the Netherlands attended the three-day meeting. The workshop included a one-day review of the Friedrichshafen-Wiggenhausen and Hamburg-Bramfeld projects plus a second day of presentations and discussions related to existing and future water storage designs and new CSHP projects. On the third day, a study tour was given to the Rottweil pilot storage site, the building site for the Friedrichshafen-Wiggenhausen project, and the Ravensburg projects (two CSHPDS systems with roof-integrated collectors).

The second workshop, "1995 Workshop on Large-scale Solar Heating," was held in Vienna, Austria, October 5-7. Forty-two participants from Austria, Denmark, Finland, Germany, Greece, Italy, Slovenia, Sweden, and the Netherlands attended the workshop. The three-day program consisted of presentations and discussions on national activities, the EU/APAS project on Large-Scale Solar Heating Systems, lessons learned from projects in operation and under construction, and collector, storage and system design. The last day of the workshop was a study tour to Deutsch Tschanschendorf.

LINKS TO INDUSTRY

Several major European solar collector manufacturers and several consulting companies have participated in the workshops mentioned above.

REPORTS PUBLISHED IN 1995

Notes from the 1995 Workshop on CSHPSS Design.

Notes from 1995 Workshop on Large-scale Solar Heating.

WORKING GROUP PARTICIPANTS

The following experts and Solar Heating and Cooling Executive Committee members participated in the planning of the activities over the last two years.

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Working Group: 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 generalize test procedures for standardization.
- To develop guidelines for solar collector design to achieve the most favorable microclimate conditions for materials.

The following areas have been identified for joint research work. In each of these areas a number of well defined projects are being conducted:

- Durability and Life-Time Assessment of Solar Absorber Coatings
- Antireflecting Devices for Solar Thermal Applications
- Methods for Characterization of Microclimate for Materials in Collectors
- Durability Aspects on the Use of Polymeric Materials in Solar Collecting Devices.

The activities of the Working Group were initiated in October 1994 and will conclude in October 1997. This year the leadership of the working group was handed from Bo Carlsson (Sweden) to Michael Köhl (Germany) as agreed upon at the start of this work.

ACTIVITIES DURING 1996

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

- Project A1: To make use of the experience gained in absorber durability from existing solar installations. Absorber samples have been taken from collectors in about 15 existing solar systems and are being analyzed with respect to degradation in optical performance. The results to date confirm the outcome of the life-testing performed under IEA Task 10. The project was completed and reports published during 1996.
- Project A2: Presently, a second series of interlaboratory comparisons on durability testing of absorber coatings are being executed. Their aim is to refine the test procedures developed within the

framework of IEA Task 10 so that the reproducibility of tests can be further improved. Results from this round robin test will be a survey on the most important absorber coatings on the market and more confidence in the test procedures.

- Project A3: The experiences gained in project A2, were used to generalize recommended test procedures for an international standard proposal drafted in 1996.
- Project A4: Because the real loads on absorber coatings are not constant project A4 is focusing on the influence of cycling loads on the degradation of absorber coatings and the development of suitable indoor-test-procedures.
- Project A5: The interest in evacuated collectors is growing, therefore, a new project was initiated to modify the durability test methods according to the other degradations factors and load profiles.

Project B: Antireflecting Devices for Solar Thermal Applications

- Project B1: A research program was initiated comprising as a first step the preparation of a state-of-the-art report. This report was used as a point of departure for selecting materials for further studies. The review covers both cover plate materials such as soda lime, low iron, borosilicate glasses, and transparent polymeric materials like acrylic, fluorocarbon, polycarbonate and polyester thin sheets and foils. The next phase of this work will be on cost benefit analysis of materials selected.
- Project B2: In the second phase of work, optical and mechanical properties of selected materials will be measured in round robin tests. And in the last phase, the participants will develop accelerated tests for durability assessment of materials and compare the results with those of outdoor-tests.

Project C: Methods for Characterization of Microclimate for Materials in Collectors

- Project C1: A round robin test on test procedures for the assessment of rain tightness and air tightness of collectors was initiated in the autumn of 1995. The test procedures used are presently being discussed in the work of CEN and ISO on solar collector testing.
- Project C3: To make comparative measurements on microclimate parameters in collectors possible detailed measurements procedures for a large number of parameters, identified as important in the work of Task 10, have been formulated and reference collectors equipped with sensors and installed Working Group participants.
- Project C4: Measurements of microclimate parameters in collectors started this June in outdoor test facilities will continue for one year. The work is focused on data evaluation.
- Project C2: The results of these measurements will be utilized for refining existing mathematical models (multivariate regression, computational fluid dynamics and deterministic physical models) for calculating microclimate data for different kind of collectors in different macroclimates.

Project D: Durability Aspects on the Use of Polymeric Materials in Solar Collecting Devices

- Project D1: In order to identify new types of transparent polymeric materials, with high glass transition temperatures, for possible use as cover plate materials in collectors, a questionnaire was prepared and distributed to manufacturers of plastic materials by the participants of group. Based on the results of this inquiry a state-of-the-art report was published 1996.
- Project D2-D4: Further work on polymeric materials will be on interlaboratory comparisons of the measurements of the properties of optical and mechanical materials identified as particularly interesting. The research on artificial aging tests are to be used in the assessment of durability of materials. The comparison with outdoor test results will be carried out within the framework of project B2. In this work, reference materials tested outdoors in so called mini-collectors in Switzerland for as long as ten years will be used to design the most relevant aging test for transparent cover plate materials.

LINKS WITH INDUSTRY

All Working Group participants 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 are being 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.

1996 MEETINGS

Third Experts Meeting
April 25-26
Boras, Sweden

Fourth Experts Meeting
November 13-15
Freiburg, Germany

1997 MEETINGS

Fifth Experts Meeting
June 6-7
Helsinki, Finland

To be held in conjunction with the North Sun '97 conference.

Sixth Experts Meeting
December 1-3
Golden, Colorado, USA

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