IEA SOLAR HEATING & COOLING PROGRAMME

2004 ANNUAL REPORT

WITH AN OVERVIEW OF

Solar Assisted Air Conditioning of Buildings

IEA Solar Heating & Cooling Programme

2004 Annual Report

Edited by
Pamela Murphy
Executive Secretary
IEA Solar Heating and Cooling
Programme

Morse Associates, Inc.

Washington, DC 20009
USA

March 2005

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The Solar Heating & Cooling Implementing Agreement

BACKGROUND

The International Energy Agency, based in Paris, was established as an intergovernmental organization in November, 1974 under the Agreement on an International Energy Program (IEP) after the oil shock of 1973/1974. The 26 Member countries of the IEA are committed to taking joint measures to meet oil supply emergencies. They also have agreed to share energy information, to co-ordinate their energy policies and to co-operate in the development of rational energy programmes.

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 Programme is monitored by an Executive Committee consisting of one representative from each of the 19 member countries and the European Commission.

Current Tasks

A total of thirty-five Tasks (projects) have been undertaken since the beginning of the Solar Heating and Cooling Programme. The leadership and management of the individual Tasks are the responsibility of Operating Agents. The Tasks which were active in 2004 and their respective Operating Agents are:

Task 25
Solar Assisted Air Conditioning of Buildings
Germany

Task 27
Performance of Solar Facade Components
Germany

Task 28/ECBCS 38
Sustainable Solar Housing
Switzerland

Task 29
Solar Crop Drying
Canada

Task 31
Daylighting Buildings in the 21st Century
Australia

Task 32
Advanced Storage Concepts for Solar and Low Energy Buildings
Switzerland

Task 33
Solar Heat for Industrial Processes
Austria

Task 34/ECBCS Annex 43
Testing and Validation of Building Energy Simulation Tools
United States

Task 35
PV/Thermal Systems
Denmark

SHC Member Countries

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

Chairman's Report & Highlights of 2004

Mr. Michael Rantil
Executive Committee Chairman
Formas, Sweden

OVERVIEW

In 2004, the Solar Heating and Cooling (SHC) Programme made great strides in its work to promote solar thermal in the market. Activities included a workshop with solar thermal trade associations, another update of the report, *Solar Heating Worldwide*, presentation of the 2nd SHC Solar Award, and Task work focused on impacting the market.

SHC/Trade Association Workshop

In September, members of the SHC Programme and representatives from major solar thermal trade associations meet to discuss how they could better support each other's work. The meeting was a success with experts from six countries and the European Solar Thermal Industry Federation (ESTIF). Two important results came from this meeting:

- Agreed upon methodology to convert installed collector area into solar thermal capacity. Solar thermal data expressed for the first time in GWth, rather than in square meters of installed collector area – shows the global installed capacity to be 70 GWth (70.000 MWth). As stated by the President of ESTIF, Ole Pilgaard, "Now the solar thermal capacity should show up in all statistics alongside the capacities of other renewable energies. And seeing that the world wide capacity of solar thermal installations exceeds even that of wind power, people will realize that our technology can contribute tremendously to reducing greenhouse gas emissions and to making the global energy supply more sustainable."
- Prepared a Memorandum of Understanding formalizing collaboration between this Programme and signatory trade associations.

Solar Thermal Collector Market in IEA Member Countries

The updated edition of this report, *Solar Heating Worldwide* now includes 2001 data. Since the beginning of the 1990s, the solar thermal market has undergone a favorable development. At the end of 2001, a total of 100 million square meters of collector area were installed in the 26 recorded countries. These 26 countries repre-sent 3.3 billion people, which is about 50% of the world's population. The collector area installed in these countries represents approximately 85 - 90% of the solar thermal market worldwide. And, the contribution of solar collectors to the supply of energy by the end of 2001 in the 26 recorded countries is 42 TWh (more than 151PJ). This corresponds to an oil equivalent of 6.7 billion liter and an annual avoidance of 18.2 million tons of CO_2. This report can be downloaded from the SHC web site (www.iea-shc.org).

SHC Solar Award

The 2nd SHC Solar Award was presented to Prof. William Beckman at the World Renewable Energy Congress (WREC) Pioneer Awards ceremony in Denver, Colorado, USA this past September.

The award is given to an individual, company, or private/public institution that has shown outstanding leadership or achievements, with links to the IEA Solar Heating and Cooling Programme, in the field of solar energy at the international level within one or more of the following sectors: technical developments; successful market activities; and information.

Professor Beckman's accomplishments include the co-development of TRNSYS, a world renowned building energy analysis and research tool. TRNSYS has been used in IEA SHC work for over 25 years. His book, "Solar Engineering of Thermal Processes," continues to serve as a reference for experts participating in IEA SHC projects. In addition to developing tools and reference materials, Prof. Beckman has taught many SHC experts as director of the Solar Energy Laboratory at the University of Wisconsin. And, he has authored over 131 journal articles. In addition to his contributions to the IEA SHC Programme, Prof. Beckman served as President of the International Solar Energy Society and was selected as a Senior Fulbright Scholar at CSIRO in Australia. He also was a Visiting Staff member of CSTB in France.

The Programme will present the 3rd SHC Solar Award in 2005. The venue for this event is to be determined in early 2005.

New SHC Strategic Plan

The Executive Committee approved a new Strategic Plan for 2004-2008. The mission for the Programme for the period 2004-2008 is: To continue to be the preeminent international collaborative programme in solar heating and cooling technologies and designs.

Based on this mission, the SHC Programme will continue to take a whole buildings perspective, and success is to be measured by how well the Programme facilitates the greater use of solar design and technologies.

Programme Participation

Participation in the Programme remains strong with 19 Member countries and the European Union actively participating in its work. This year, Japan withdrew from the Programme due to a change in government priorities and funding. Japan made significant contributions to the Programme for over 25 years. It is the SHC Executive Committee's hope that Japan will renew its commitment perhaps through industry in the near future. The Executive Committee continued to correspond with those countries invited and interested in joining the Programme: Brazil, China, Czech Republic, Egypt, Greece, South Korea, South Africa and Turkey.

Tasks

As for Task work, The Executive Committee approved the start of Task 35: PV/Thermal Systems and the continuation of the Task Definition Phase of the Solar Resource Knowledge Management work. The newly approved SHC Task 35: PV/Thermal Systems will be a collaborative activity with the IEA Photovoltaic Power Systems Programme, and led by the SHC Programme.

The Executive Committee also approved the completion of one project—SHC Task 25: Solar Assisted Air Conditioning of Buildings. It is with sadness that the Committee says farewell to Dr. Hans-Martin Henning.

As the SHC Programme makes visible steps in promoting solar technologies in the market, I am confident that 2005 will be another year of growth for the industry and this Programme.

Michael Rantil

TASKS

Notable achievements of the Programme's work during 2004 are presented below. The details of these and many other accomplishments are covered in the individual Task summaries later in this report.

Task 25: Solar Assisted Air Conditioning of Buildings

The Committee approved the final management report of Task 25. This Task has played a major role in increasing the attention given to solar air conditioning techniques. Task participants initiated several new installations or were involved during their design. They also initiated or participated in several new national or international (mainly EU) projects on technology development, design issues or other accompanying measures, such as studies about energy-economic performance or dissemination work.

Task 27: Performance of Solar Facade Components

The project was completed in 2003, but the final report, "General Methodology of Accelerated Testing for Assessment of Service Life of Solar Thermal Components" was been submitted to the Secretariat of ISO/TC 59/SC 14 on service life planning. The submission was to be a contribution to the work in revising ISO 15686-1 and ISO 15686-2, and was formally made by the Swedish Standardization Committee SIS TK 209.

The SHC Task 27 input was discussed at the ISO TC59/SC14 meeting held in Toronto in early 2004. SHC Task 27 work is considered a valuable contribution to the SC14 work and will be considered in the revision of the standards, especially in a forthcoming revision of ISO 15686 - 2.

Task 28/ECBCS Annex 38: Sustainable Solar Housing

The book, Design of High Performance Housing - A Reference Book, will be published in 2005. An interesting example from this book is a cross comparison done to look for trends or commonalities in the design and construction of 20 Swiss houses that are achieving extremely low energy performance. It is interesting to note that the orientation of the house was not a significant design feature to achieve low energy levels. Houses not optimally oriented were able to offset this limitation by other energy saving features. On the other hand, compactness seems to be essential. Typically, the single family houses had an A/V ratio of 0.73 and apartment buildings the ratio was 0.49. Because space heating demand is reduced to such low levels, domestic hot water heating becomes relatively important. Not surprisingly, 3/4 of the houses in the sample had solar thermal systems for this end use.

This is a collaborative Task with the IEA Energy Conservation in Buildings and Community Systems Implementing Agreement.

Task 29: Solar Crop Drying

The Task's coffee drying project in Costa Rica had an official opening of the plant – the largest of its kind in Central America. At the Tilaran plant, 850 square meters of Conserval's Solarwall® panels are installed on the roof and intake fans draw in warmed air from the perforated panels to dry the coffee beans. This system is to replace the system that ran on wood. SHC Executive Committee members participated in the plants opening in November. Monitoring of the system has begun and the data collected will be analyzed in the beginning of 2005.

Task 31: Daylighting Buildings in the 21st Century

The collaboration between building owners, A/E teams and industry for the integration of daylighting responsive controls and shading devices has led to significant results in the New York Times Building Project. Dynamic façade and dimming controls have been commercially available for some years, but the barrier has been cost and reliable performance. By demonstrating and testing in a partially full-scale model of the New York Times Building on an outdoor site, it has been proven that with collaboration, smart integrated shading and electric lighting control systems can work and are cost effective.

Task 32: Advanced Storage Concepts for Solar and Low Energy Buildings

An improvement of the SHC Task 26 FSC method that compares designs of solar installations has been derived theoretically. Experts in this Task have adjusted the FSC method so that it now covers systems able to produce heat and cold from solar and eventually operating with long term storage. In 2005, the improved method will be validated against detailed simulation results.

Task 33: Solar Heat for Industrial Processes

State of the industry and the future potential of industrial-process solar heat were examined in 2004. The results of an Austrian study and the preliminary results of studies in Spain, Portugal and Italy show that the potential for solar low temperature heat ranges between 3% and 4 % of the total heat demand of the industry. Information also was collected on industrial-process solar heat plants operating world wide. From the 49 reported plants, the majority of the projects are in the food and beverage, textile, transport and chemistry sectors with a large majority in food processes.

Task 34/ECBCS Annex 43: Testing and Validation of Building Energy Simulation Tools

During 2004, ASHRAE Standard 90.1, which is used for regulating energy efficiency in commercial and non-low-rise residential buildings, had an addendum published that requires use of Standard 140 for testing software used in building energy efficiency assessments. The International Energy Conservation Code is also referencing Standard 140. These citations are important because they mandate software evaluation using test procedures developed under IEA research activities. For example because of the ASHRAE Standard 90.1 requirement to test software using ASHRAE Standard 140, two of the largest suppliers of building HVAC equipment in the world, Carrier and Trane Corporations are testing their respective software packages HAP and TRACE with Standard 140. Also, EnergyPlus, the USDOE's most advanced simulation program for building energy analysis, distributes their Standard 140 validation results with their CDs and from their website.

This is a collaborative Task with the IEA Energy Conservation in Buildings and Community Systems Implementing Agreement.

Task 35: PV/Thermal Systems

The kick-off meeting to this Task is scheduled for January 2005. The objectives of this Task is to catalyze the development and market introduction of high quality and commercial competitive PV/Thermal Solar Systems and to increase general understanding and contribute to internationally accepted standards on performance, testing, monitoring and commercial characteristics of PV/Thermal Solar Systems in the building sector.

This is a collaborative Task with the IEA Photovoltaic Power Systems Implementing Agreement.

NEW ACTIVITIES

Solar Resource Knowledge Management

The Executive Committee looks forward to the start of this Task in 2005. The objective of this Task is to exploit the emerging potential of satellite-derived solar resource information in response to the solar industry's expressed need for improved spatial and temporal coverage, worldwide benchmarking and validation, improved reliability and access to the information, and development of customized products such as solar forecasts. The first Task Definition Workshop was held in February 2004 in Spain, and a work plan and draft Annex have been developed. The Annex is currently under review by participating countries, and the level of support from each participating country is being established. The Annex will be submitted for formal approval at the next SHC Executive Committee meeting in June 2005.

It is to be is a collaborative effort with the IEA Photovoltaic Power Systems Agreement and the IEA SolarPACES Agreement.

Workshop

The Programme is considering holding another trade association workshop in 2005. And, will announce the final Memorandum of Understanding, signed by the SHC Programme and solar thermal trade industries worldwide, at select events in 2005.

EXECUTIVE COMMITTEE MEETINGS

2004 Meetings

The 2004 Executive Committee held meetings in May in Helsinki, Finland (included a joint meeting with the IEA Photovoltaic Power Systems Programme) and in November in Costa Rica (included the opening of a SHC Task 29 coffee solar drying project).

2005 Meetings

The 2005 Executive Committee meetings will be held 15-17 June in Porto, Portugal (includes a joint meeting with the IEA Energy Conservation in Buildings and Community Systems Programme) and 5-7 December in Australia.

INTERNET SITE

The Solar Heating and Cooling Programme's website continues to be updated and new pages added as needed. The site plays an important role in the dissemination of Programme and Task information. The Executive Committee continues to encourage the posting of as many Programme and Task reports as possible to the web site. In 2005, the Webmaster will finalize work on adding PDF files of the highly requested reports from completed Tasks to the web site. The address for the site is www.iea-shc.org.

COORDINATION WITH OTHER IEA IMPLEMENTING AGREEMENTS AND NON-IEA ORGANIZATIONS

The IEA Buildings Related Implementing Agreements (BRIA) is composed of the seven building-related IEA Implementing Agreements. The SHC Chairman continues to support the work of this group.

The IEA Energy Conservation in Buildings and Community Systems Programme is collaborating in four SHC Programme Tasks—SHC Task 27: Performance of Solar Facade Components, SHC Task 28/ECBCS Annex 38: Sustainable Solar Housing, Task 31: Daylighting Buildings in the 21st Century, and SHC Task 34/ECBCS Annex 43: Testing and Validation of Building Energy Simulation Tools. A joint meeting will be held during the June 2005 Executive Committee meeting in Portugal to facilitate the continued collaborative work between the Programmes.

The IEA Energy Storage Programme and SHC Programme continue to share information on relevant current Tasks, particularly on SHC Task 32: Advanced Storage Concepts for Solar Thermal Systems in Low Energy Buildings.

The IEA Photovoltaic Power Systems Programme worked with the SHC Programme in the development of Task 35: PV/Thermal Systems and the proposed Task on Solar Resource Management Based on Satellite Data. A joint meeting was held during the May 2004 executive Committee meeting in Finland to facilitate the continued collaborative work between the Programmes.

The IEA SolarPACES Programme is collaborating in Task 33: Solar Heat for Industrial Processes and the proposed Task on Solar Resource Management Based on Satellite Data.

FEATURE ARTICLE

Every year the SHC Annual Report includes a feature article on some aspect of solar technologies for buildings. This year's article is on what has been learned from the Programme's work on solar-assisted air conditioning of buildings.

ACKNOWLEDGMENTS

In closing, I would like to thank the Operating Agents, participating experts, Executive Committee Members and our Advisor, Fred Morse, for working hard this year to promote our Programme and its work. I would to also thank Pamela Murphy for her work as the Programme's Executive Secretary.

Solar Assisted Air Conditioning of Buildings – An Overview

Hans-Martin Henning

Fraunhofer Institute for Solar Energy Systems ISE
Freiburg, Germany

INTRODUCTION

Summer air conditioning represents a growing market in building services worldwide in both commercial and residential buildings. The main reasons for the increasing energy demand for summer air-conditioning are increased thermal loads, increased living standards and occupant comfort demands as well as building architectural characteristics and trends, such as an increasing ratio of transparent to opaque surfaces in the building envelope to even the popular glass buildings.

Air conditioning includes both temperature and humidity control of indoor air. Using solar energy for air-conditioning of buildings is a very promising concept. The great advantage of solar is that the seasonal cooling loads coincide with high solar radiation availability. However, systems are complex and the involved technologies, such as thermally driven chillers, are usually not designed to be operated with solar heat.

In 1999, the Solar Heating & Cooling Programme's initiated work to make solar air-conditioning more well-known among professionals, to provide tools for system design, and to improve conditions for the market introduction of solar assisted cooling systems.

This article, based on the work of SHC Task 25, Solar Assisted Air Conditioning of Buildings, provides an overview about the technologies, describes the new developments in the field of thermally driven cooling equipment, shows some key design guidelines and explains today's market situation of solar driven air-conditioning.

TECHNOLOGIES

Two major types of systems exist for using solar heat for air-conditioning applications:

- open cycles for the direct treatment (cooling, dehumidification) of air, and
- closed cycles for the production of chilled water.

Thermally Driven Water Chillers

The dominating technology of thermally driven chillers is based on absorption. The basic physical process consists of at least two chemical components, one serving as the refrigerant and the other as the sorbent. The operation of these systems is well documented (e.g., in ASHRAE, 1988) and therefore is not described here.

Absorption chillers are available on the market in a wide range of capacities and designs for different applications. However, for a long time only a few systems were available in a range below 100 kW of cooling capacity. Recently, a few machines have been developed that provide small cooling capacities in the range of 20 kW and lower (see below). For air conditioning applications, mainly absorption chillers using the sorption pair water-lithium bromide (LiBr) are applied, but also ammonia-water systems are used, primarily, in applications where temperatures below 0°C are needed. The basic construction of single effect machines, in which for each unit mass of refrigerant which evaporates in the evaporator one unit mass of refrigerant has to be desorbed from the refrigerant-sorbent solution in the generator. Under normal operation conditions these machines need temperatures of the driving heat of 80-100°C and achieve a COP-value (fraction of produced cooling per unit of driving heat) of about 0.7.

In addition to single effect machines, chillers using a double-effect cycle are available. Two generators working at different temperatures are operated in series, whereby the condenser heat of the refrigerant desorbed from the first generator is used to heat the second generator. The result is a higher COP in the range of 1.1-1.2. Driving temperatures in the range of 140-160°C are typically required to drive these chillers. This type of system is only available in capacities above 100 kW.

In addition to systems using a liquid sorbent there are machines using solid sorption materials. In these cycles, a quasi-continuous operation requires that at least two compartments, which contain the sorption material, are operated in parallel. The systems available on the market use water as the refrigerant and silica gel as the sorbent. They consist basically of the two sorbent compartments, the evaporator and the condenser. While the sorbent in the first compartment is regenerated using hot water from the external heat source (e.g. the solar collector) the sorbent in the second compartment (adsorber) adsorbs the water vapour coming from the evaporator. This compartment is cooled to achieve continuous adsorption. To date, only two Japanese manufacturers produce adsorption chillers. Under typical operating conditions, with a temperature of the driving heat of about 80°C, these systems achieve a COP of about 0.6.

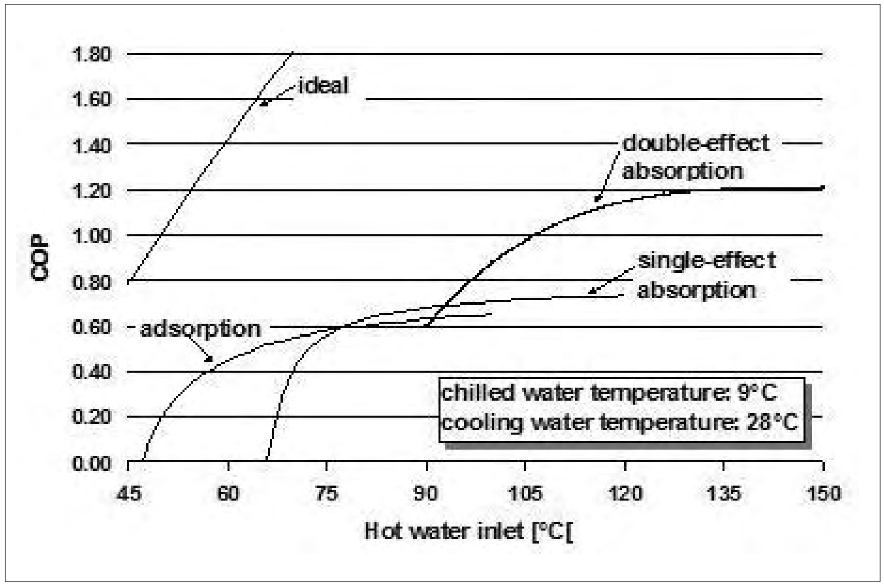


FIGURE 1. COP-curves of sorption chillers and the upper thermodynamic limit (ideal, reversible process).

Figure 1 shows the COP-characteristic of an ideal chiller (thermodynamic maximum) and characteristics of market available sorption chillers as a function of the driving temperature for typical operation conditions.

In recent years, many new developments have been achieved to commercialize water chillers with small cooling capacities. Examples of these are:

- **Water-LiBr absorption chillers**
  - EAW in Westenfeld, Germany (lowest available cooling capacity 15 kW)
  - Phönix Sonnenwärme in Berlin, Germany (10 kW)
  - University de Catalunya in Terrassa, Spain: air-cooled system (10 kW)
  - Rotartica in Spain: air cooled system with rotating absorber/generator (10 kW)
- **Ammonia water systems with mechanical solution pump**
  - Joanneum Research in Graz, Austria (10 kW, operation temperature -20°C ... 10°C)

A solar driven absorption cooling system is used at the German Traffic Ministry in Berlin, Germany. Pictured are the absorption machines(2 x 35 kWcool) and the flat plate solar collectors (229 m").

- AOSOL in Portugal: air-cooled machine (6 kW)
- University of Applied Research in Gelsenkirchen, Germany (25 kW)

◗ **Ammonia water-systems without mechanical solution pump**

- University of Applied Research in Stuttgart, Germany (approximately 2-5 kW)
- SolarFrost in Graz, Austria

◗ **Solid sorption**

- Sortech in Halle, Germany: adsorption heat pump (10 kW, working pair water/silica gel)
- ClimateWell AB in Hägersten, Sweden (10 kW, working pair Lithium chloride/water; includes thermo-chemical storage)
- SWEAT b.v., in the Netherlands (working pair Sodium sulfide/water; includes thermo-chemical storage)

These products are not yet well established in the market, but promise to open new market segments for solar air conditioning in small commercial buildings (e.g., offices, small hotels etc.) and even residential buildings. A very promising concept is to extend a solar combisystem (solar thermal system for hot water production and heating) to a system that also provides increased comfort during summer by using the solar collector field for air conditioning in summer.

Open Cycles – Desiccant Cooling Systems

While thermally driven chillers produce chilled water, which can be supplied to any type of air conditioning equipment, open cooling cycles directly produce conditioned air. Any type of thermally driven open cooling cycle is based on a combination of evaporative cooling with air dehumidification by a desiccant (i.e., a hygroscopic material). Again, either liquid or solid materials can be used. The standard cycle, which is used most often, uses rotating desiccant wheels, equipped with either silica gel or lithium-chloride as sorption material.

Systems using liquid sorption materials have several advantages, such as higher air dehumidification at the same driving temperature and the possibility of high energy storage by means of concentrated hygroscopic solutions, and therefore are close to market introduction.

In the field of open cooling cycles most new developments are focused on the application of liquid sorption due to its inherent advantages. First, it is more to cool using the sorption process. And second, the concentrated solution can be stored and provides high density, loss-free storage. Examples of new developments of open cooling cycles are:

◗ Menerga in Mülheim, Germany: new air handling unit using liquid sorption dehumidifier in combination with a standard indirect evaporative cooler
◗ Technion Haifa in Israel: small system for treatment of fresh air using liquid sorption
◗ ZAE Bayern in Munich, Germany: advanced open cooling system using liquid sorption; concentrated solution used as high energy density storage
◗ Fraunhofer ISE in Freiburg, Germany: high efficient indirectly evaporative cooled sorption dehumidifier using a air-to-air plate heat exchanger coated with zeolite

All developments employing liquid sorption use lithium chloride as sorption material.

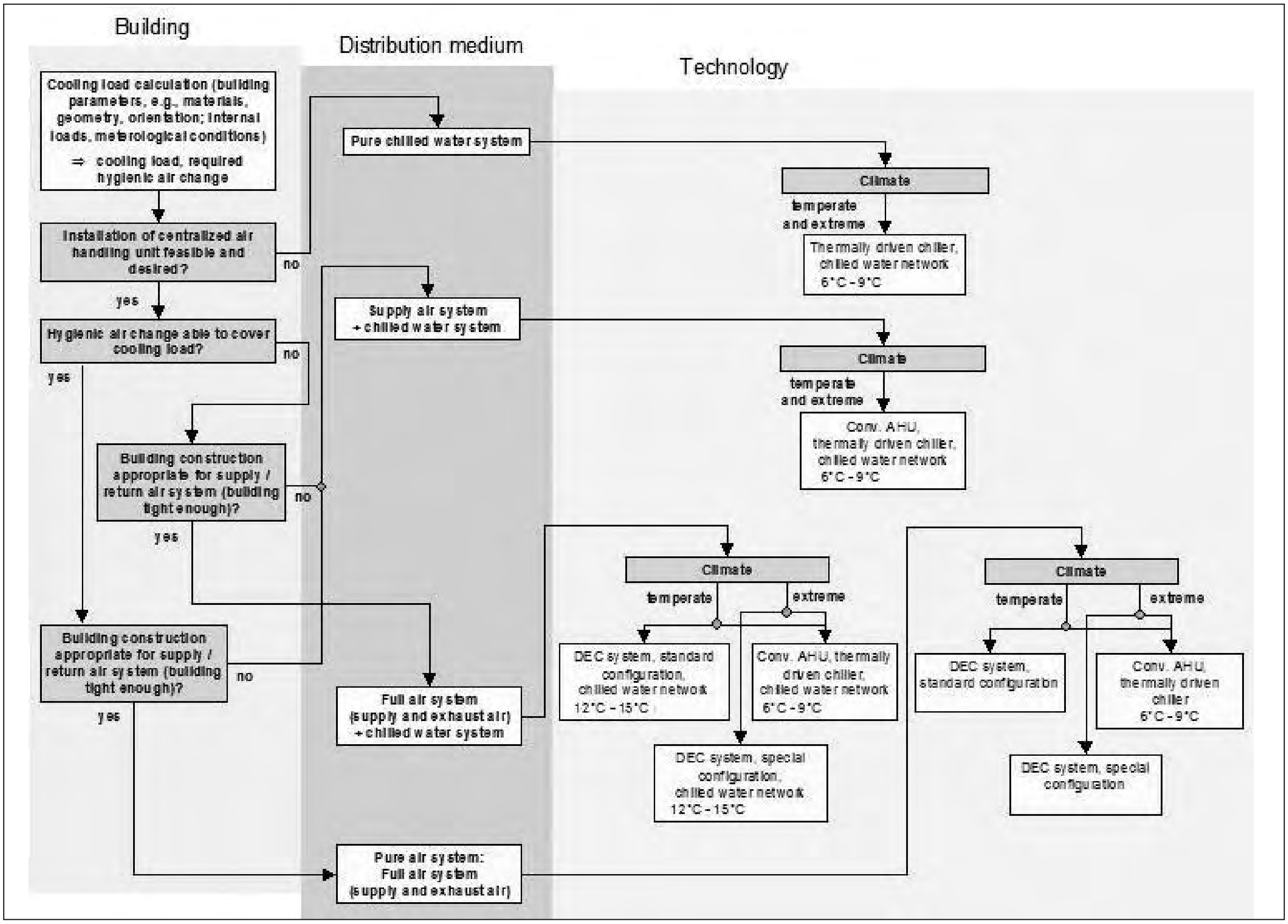


FIGURE 2. Scheme for decision guidance.

SYSTEM DESIGN AND DESIGN GUIDELINES

Which System for Which Application?

Choosing the appropriate technology depends on many factors, such as the climate of the site, the building and its construction, and the user. A basic scheme to guide the decision is shown in Figure 2 . A basic assumption is that both the indoor temperature and the humidity are to be controlled.

The starting point always is a calculation of cooling loads based on the design case. Depending on the cooling loads and the desire of the users/owner either a pure air system, a pure water system or hybrid air/water system are possible for extracting heat and humidity out of the building. The basic technical decision is whether or not the hygienic air change is sufficient to also cover cooling loads. This will typically be the case in rooms/buildings with a requirement of high ventilation rates, such as lecture rooms. However, a supply/return air system only makes sense in a rather airtight building otherwise the leakage through the building shell will be too high.

In cases of supply/return air systems, both thermally driven technologies (i.e., desiccant systems) and thermally driven chillers are possible. In all other cases, only thermally driven chillers can be used in order to employ solar thermal energy as the driving energy source. The lowest required temperature level of chilled water is determined by the question whether air dehumidification is realized by conventional technique (i.e., cooling the air below the dew point) or whether air dehumidification is realized by a desiccant process. In the latter case, the temperature of chilled water - if needed at all - can be higher since it has to cover only sensible loads. Using desiccant techniques in extreme climates, for example, climatic conditions with high ambient air humidity values, requires special configurations of the desiccant cycle.

TABLE 1. SHC Task 25 demonstration projects.

Country	Application/ Building	Site	System type	Cooling capacity	Collector gross	Collector area type
-	-	-	-	kW	m2	-
Netherlands	Offices	Waalwijk	Desiccant, solid	22	33	FPC
Germany	Laboratory	Freiburg	Adsorption	70	170	ETC
	Cooling network	Berlin	Absorption	70 (2 x 35)	229	FPC
	Offices	Berlin	Absorption	70 (2 x 35)	348	ETC
	Seminar room	Freiburg	Desiccant, solid	50	100	SAC
Austria	Offices, lecture room	Hartberg	Desiccant, solid	30	12	ETC
Spain	Library	Mataro	Desiccant, solid	55	105	SAC
Israel	Offices	Haifa	Desiccant, liquid	4.5	20	FPC
France	Offices	Guadeloupe	Absorption	35	123	ETC
	Offices	Sophia-Antipolis	Absorption	35	58	ETC
Portugal	Offices	Lisbon	Desiccant, solid	36	51	CPC

Abbreviations: FPC = flat plate collector; ETC = evacuated tube collector; SAC = solar air collector; CPC = stationary concentrating collector

Basic Design Guidelines

For most thermally driven cooling equipment suitable for use in solar assisted air conditioning systems, the Coefficient of Performance (COP), that is the ratio between the produced cooling effect and the invested heat for this purpose, is noticeably below 1. This means that replacing a conventional air conditioning system, which typically uses an electrically driven vapour-compression chiller, with a solar assisted system does not necessarily imply primary energy savings. Several design restrictions affecting solar assisted air conditioning systems result from this fact:

- If a thermally driven cooling or air conditioning system with a comparatively low COP is used with a fossil-fueled heat source as the back-up, a high solar fraction is necessary in order to achieve significant primary energy savings. An appropriate design of the solar system (i.e., suitable dimensioning of the solar collector and system-integrated energy storage) is necessary for this purpose.
- Systems using thermally driven cooling equipment with a high COP lead to energy savings even at comparatively low solar contributions to the required heat for driving the system.
- In cases where a back-up system is needed either a second heat source, such as a back-up burner, to drive the thermally driven cooling equipment or a conventional chiller may be employed. The latter option may be appropriate if a large overall amount of cooling power is needed. In this case, the solar system mainly serves to reduce electric energy consumption as well as peak electricity loads.
- Solar-thermally autonomous systems that do not use any conventional heat source or back-up on the cold side may also be used. In these cases, energy savings are always achieved, but there is no guarantee of meeting the cooling loads and maintaining the indoor climate within the comfort conditions.
- In any case, the use of the solar collector field should be maximised through the exploitation of the solar heat source to match other loads such as space heating or domestic hot water production. Particularly in climates with high cooling loads during summer, the solar system also can contribute significantly to meet the heating loads during winter.

REALIZED PLANTS

Today, there are about 70 systems installed in Europe, with a total solar collector area of about 17,000 m2 and a total capacity of about 6 MW chilling power. The majority of these systems use absorption chillers (about 60%), about 28% are desiccant cooling systems (mainly employing rotating desiccant wheels), and about 12% use adsorption chillers. The average specific collector area, defined as the collector area per kilowatt of installed cooling power, differs over a wide range, though the average range is close to 3 kW/m2.

Eleven demonstration systems have been monitored and evaluated as part of SHC Task 25. An overview of the demonstration systems is given in Table 1. In general, experience gained from the installations working under real operating conditions has shown that there are frequent shortcomings in systems' hydraulic design and controls. Furthermore, the expected energy savings that could be achieved in practice were only after detailed monitoring and subsequent optimization of the controls, and in some cases, the improvement of the hydraulic scheme. Some general monitoring results were:

- Real values about the parasitic consumptions (fans, pumps, cooling tower, water, etc.) were achieved during measurements. In almost all cases, there is an opportunity for improvements. In particular, energy consumption of the cooling tower (pump, fan) is higher that expected. But in all cases, the parasitic consumption of the solar collector system (pumps) was not dominating.
- Most systems worked reliable, however, in each case monitoring was essential in order to identify any shortcomings and problems.
- During daytime in the summer, the chillers were mainly solar driven (sometimes with a delay due to heating up of the collector circuit) in the case of high radiation availability. COP values of 0.6 or above were achieved with sufficient high driving temperatures.
- The hydraulic design of the solar collector system is crucial in order to achieve even flow through the collector field and protect the system against damage during stagnation.

SUMMARY AND OUTLOOK

Several thermally driven air conditioning technologies are available in markets, which enables the use of solar thermal energy for this application. Based on current technologies (i.e., market available thermally driven cooling devices and market available solar collectors) solar assisted air conditioning can lead to remarkable primary energy savings if the systems are properly designed. Pre-conditions necessary to achieve primary energy savings are a sufficient collector size and a suitable size of energy storage in the system. As part of SHC Task 25 two tools were produced—a handbook for planners and a computer design tool—to help design systems properly.

Compared to the situation 5 years ago, solar cooling has made remarkable progress. Far more systems are in operation today and there are increased experiences regarding their operation. New developments in the area thermally driven cooling technology also is opening far more potential for solar assisted applications. Due to the work in SHC Task 25, a better understanding of a proper system design is now available and the technology is more well-known among professionals, such as manufacturers and planners.

Nevertheless, solar assisted air conditioning technology is just at the beginning of its way to become a standard solution. Far more experiences at the system level are necessary and a broad dissemination of the lessons learned to the target audiences is needed. Best practice solutions also need to be documented in order to serve as references for new projects. And, cost reductions have to be achieved in order to make this technology economically competitive. Here further R&D work is necessary in order to reduce costs on all levels: components, systems and the design process. With increasing energy prices, increasing shortages of existing electricity supply due to air conditioning during summer, and increasing environmental concerns regarding conventional refrigerants solar air conditioning will be a very attractive solution in the future.

TASK 25

Solar Assisted Air Conditioning of Buildings

Hans-Martin Henning

Fraunhofer Institute for Solar Energy Systems ISE
Operating Agent for the German Federal Ministry of Economics and Labour (BMWA)

TASK DESCRIPTION

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

- Definition of the performance criteria for solar assisted cooling systems considering energy, economy and environmental aspects,
- Identification and further development of promising solar assisted cooling technologies,
- Optimization of the integration of solar assisted cooling systems into the building and the HVAC system focusing on an optimized primary energy saving - cost performance, and
- Creation of design tools and design guidelines for planners and HVAC engineers.

The work in Task 25 was carried out in four Subtasks.

Subtask A: Survey of Solar Assisted Cooling (Lead country: Mexico)

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

Subtask B: Design Tools and Simulation Programs (Lead country: Germany)

The objective of Subtask B was to develop design tools and detailed simulation models for system layout, system optimization and development of advanced control strategies of solar assisted air conditioning systems. The main result was an easy-to-handle design tool for solar assisted cooling systems dedicated to planners, manufacturers of HVAC systems and building engineers.

Subtask C: Technology, Market Aspects and Environmental Benefits
(Lead country: Netherlands until 2002, Austria until Task end)

The objectives of Subtask C were to provide an overview on the market availability of equipment suitable for solar assisted air conditioning and to support the development and market introduction of new and advanced systems. Design-guidelines for solar assisted air conditioning systems were developed and target groups dealing with solar assisted air conditioning were addressed by workshops and brochures in national languages.

Subtask D: Solar Assisted Cooling Demonstration Projects (Lead country: France)

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

Duration

The Task was initiated in June 1999 and completed in November 2004.

Participation

The following eleven countries participated in the Task:

Austria	France	Germany	Greece
Israel	Italy	Japan	Mexico
Netherlands	Portugal	Spain	

TASK ACCOMPLISHMENTS

The main objective of Task 25 was to improve conditions for the market introduction of solar assisted cooling systems in order to promote a reduction of primary energy consumption and electricity peak loads due to cooling. If one compares the situation of implementation of solar air conditioning at the beginning and the end of the Task it is obvious that the technology still has a very low impact in terms of installations using solar energy among all installations of centralized air conditioning systems. On the other hand, the interest among key players— from solar collector companies and associations to innovative air conditioning companies, engineers, planners, architects, and building owners—is quite significant and definitely far higher than 5-6 years ago. It is obvious that Task 25 played a major role in increasing the attention now given to solar air conditioning techniques.

Participants of Task 25 initiated several new installations or were involved during their design. Participants also initiated or participated in several new national or international (mainly EU) projects on technology development, design issues or other accompanying measures, such as studies about energy-economic performance or dissemination work.

Results and Products

An overview of Task 25 products is shown in Table 1. These products are described in more detail in the following sections.

TABLE 1. Task 25 products.

Subtask	Products/Results
A	Webpage on solar cooling programmes and projects
B	Component models
	Computer design tool SOLAC and accompanying written documentation
C	Technical report, "Ongoing research relevant for solar assisted air conditioning systems"
	Handbook, "Solar Assisted Air Conditioning in Buildings - A Handbook for Planners" (see Figure 1)
	Brochure, "Using the sun to create comfortable indoor conditions"
	Poster series, (10 bilingual English/German, 3 bilingual English/Italian, 3 bilingual English/Portuguese, 3 bilingual English/Spanish)
	Guideline document, "Decision scheme for the selection of the appropriate technology using solar thermal air conditioning"
	Presence at 3 trade fairs and accompanying conferences
	Dissemination workshops, 6 workshops in 4 countries (some workshop still to held)
	Market related workshops, 5 workshops in 5 countries
D	11 demonstration projects: monitoring data
	Technical report on Subtask D projects
	Webpage on Subtask D project
Overall	Task 25 webpage with all documents

Subtask A Survey of Solar Assisted Cooling

Subtask A was finalized in 2001 with the production of webpage of short summary reports on solar cooling activities in the Task's participating countries and a database of projects/systems installed in the past. The address of the webpage is http://ocuilih.cie.unam.mx/cgi-bin/main_menu.cgi and the password for entering the database is "task25." The webpage has two partitions:

- Part 1: Review of finished solar cooling programmes. Short national reports on activities in the field of solar

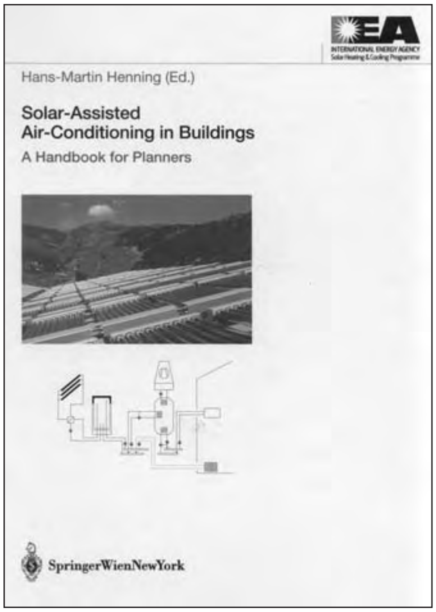


FIGURE 1. Task 25 handbook.

assisted cooling and air conditioning (This is not available to all countries).

- Part 2: Review of existing solar assisted cooling systems. Overview on about 25 solar cooling projects that were installed prior to the start of Task 25.

This webpage is linked to the Task 25 Subtask A page, "Database on finished and ongoing solar assisted cooling projects," on the IEA SHC website (www.iea-shc.org).

Subtask B: Design tools and simulation programs

The main results and products of Subtask B were component models for important solar cooling system components and a computer design tool for complete systems (SOLAC = SOLar Air Conditioning design tool). An overview of the newly developed models of components is given in Table 2. All these models were implemented in the design tool, and some are also available in FORTRAN code for using in TRNSYS. All models are described in the report on the SOLAC design tool.

The main result of Subtask B is the computer design tool. With this tool many different configurations of solar assisted air conditioning systems can be designed based on an annual simulation. The tool calculates the annual energy balance and computes a complete cost break-down including annual cost. The main goal of this tool is to enable architects and planners to carry out feasibility studies in a very straight forward and user-friendly way. The user-interface of the tool is shown in Figure 2. A total of more than 500 different system combinations can be modelled by activating or switching off single components.

TABLE 2. Overview about component models produced in Task 25.

Component	Short Description	Source Code Open?	FORTRAN Code for TRNSYS?
Adsorption cooling machine	semi-physical steady-state models of the only two commercially available adsorption chillers (Japan)	yes	yes
Absorption cooling machine	physical steady state models for absorption chillers with mechanic solution pump and bubble pump (based on the Yazaki WFC 10)	yes	yes
Cooling tower	semi-empirical steady state model of an open cycle wet cooling tower	no	no
Solar system	physical steady state collector model and detailed model of stratified hot water tanks; the solar system model also includes the radiation processor	yes	no
Desiccant wheel	semi-empirical steady state model of desiccant wheels using manufacturer date from three manufacturers	yes	no
Air handling unit	physical steady-state model of the air states in an air handling unit depending on operation mode and component performance	yes	no
Room components	physical steady-state models of major room components such as fan-coils and radiative ceilings	yes	no
Control strategy	control to decide about the activation of system components depending on actual comfort demands (temperature and humidity control)	no	no

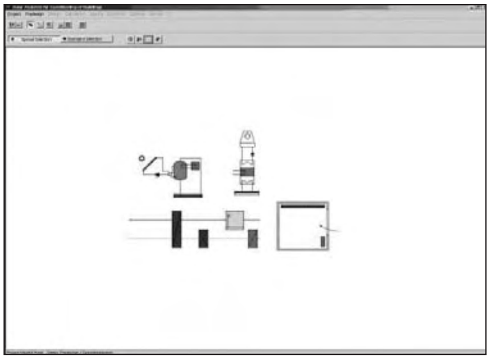


FIGURE 2. User interface of the Subtask B design tool (example system).

The main chapters of the program documentation are:

- Introductory Remarks
- Programme Organization
- Programme Functions and Handling of Programme
- Literature
- Appendix 1: Figures, Tables
- Appendix 2: Files (Data)
- Appendix 3: Calculation Models

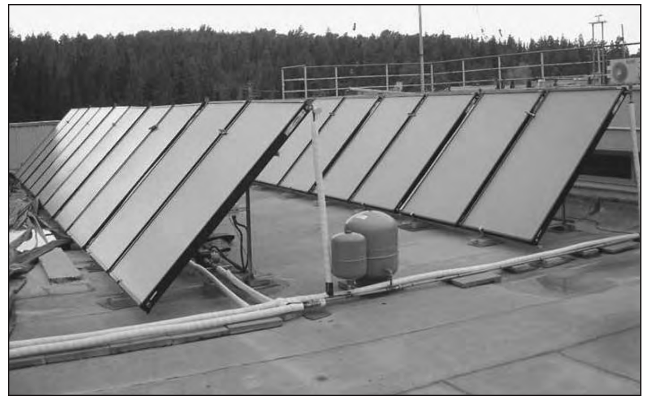
Subtask C: Technology, Market Aspects and Environmental Benefits

Subtask C was divided into five working packages. Work packages C1 to C3 lasted for the first three years of the Task and C4 to C5 for the last two years of the Task.

C1: Description of Hardware

In this working package, an overview was produced of the hardware components useful for solar assisted air-conditioning. The main components considered were solar collectors, thermally driven chillers, and thermally driven systems for the treatment of air (desiccant systems, open cycles). Results from this work were included in the Handbook.

A second activity was the selection of typical loads and the production of typical load files. In addition, three model buildings (office building, hotel, lecture room) and seven model climates were selected (Tropic: Merida, Mexico; Mediterranean/coastal: Palermo, Italy Athens, Greece; Mediterranean/moderate: Madrid, Spain, Perpignan, France; Central European/moderate: Freiburg, Germany; and Central European/north: Copenhagen, Denmark). Twenty-one load files were produced and then implemented in the design tool of Subtask B and used as example design descriptions in the Handbook.



The pilot system using liquid desiccant technology at Technion in Haifa, Israel. Pictured are the liquid dessicant system (4,5 kWcool) and the solar flat plate collectors (20 m").

C2: Development of New Cooling Technologies

In this working package, an overview of relevant R&D activities for solar assisted air conditioning were collected in the participating countries. The technical report, "Ongoing research relevant for solar assisted air conditioning systems" was then produced on the national and international R&D work on new components and systems.

C3: Comparative Description of Solar Assisted Cooling Systems

A work sheet for comparative evaluation of solar assisted air conditioning systems and their relation to energy, economy and environmental benefits was produced and included in the Handbook. Major energy related, economic and energy/economic performance figures were defined and developed to compare different systems, such as the overall annual primary energy saving or the cost of saved primary energy. An example of this approach is presented in the Handbook.

C4: Market Oriented Work

A total of 5 national workshops on both technical and market issues related to solar assisted air conditioning technology have been carried out. An overview is given in Table 3.

TABLE 3. Overview of national workshops on understanding market opportunities and further R&D needs.

Place	Date
Austria	December 16, 2003
Germany	September 26, 2003
Italy	March 2, 2003
France	October 21, 2003
Spain	October 27, 2003

A guideline document, "Decision scheme for the selection of the appropriate technology using solar thermal air conditioning" was produced. This scheme is designed to guide the decision for a certain technical solution which involves the use of solar thermal energy for air conditioning for a given situation, defined by climatic, building and occupation related factors.

C5: Dissemination and promotion
The following are the results of work package C5:

- A multi-colour brochure which informs interested non-professionals or semi-professionals about solar assisted air conditioning technology and status. The brochure is available as a PDF document that can be downloaded from the Task webpage on the SHC website.
- National workshops for information dissemination that were held in several countries, often in combination with other associations and/or project consortiums (e.g., projectswith support from the European Commission).
- Task 25 participated in three trade fairs with posters, information materials and presentations. An overview of these activities is given in Table 4.
- Posters to inform about solar assisted air-conditioning technology and shown on different occasions. The series of posters consists of 10 bilingual posters in English/German, 3 bilingual posters in English/Italian, 3 bilingual posters in English/Portuguese, and 3 bilingual posters in English/Spanish.

Subtask D: Solar Assisted Cooling Demonstration Projects
The goal of Subtask D was to gather experiences about solar air conditioning through practical application in demonstration systems or pilot plants. Eleven demonstration projects in 6 countries were selected and detailed monitoring data collected. Although in many systems it was quite difficult to obtain long periods of reliable measurement data many valuable results were achieved. A list of the Subtask D demonstration projects is given in Table 5.

The main products of Subtask D are:

- A final technical report on Subtask D projects. Each project is described in a standardized way using form sheets. For each project at least a typical operation day is presented and for many systems also performance results for long periods (<1 year or more) are presented. For each project a detailed description of major problems and possible solutions also is outlined. The book summarises with general conclusions and a comparative assessment.
- Subtask D projects are presented on a special webpage, which will become part of the Task 25 webpage on the SHC website soon after completion of the Task.

ACTIVITIES DURING 2004

Important activities of the whole Task in the year 2004 were:

- In early 2004, the Handbook for Planners entitled " Solar Assisted Air-Conditioning in Buildings - A Handbook for Planners" was published. Several hundred copies were ordered.

TABLE 4. Trade Fairs that Task experts participated.

Trade fair	Participation activities
AirConTec Trade Fair at Light & Building Trade Fair in Frankfurt, Germany; April 14-17, 2002	10 posters (German/English) on the stand of the Fachinstitut Gebäude-Klima (FGK), a German HVAC association. Desiccant cooling demonstration system with interactive poster; ne-day workshop; 2 presentations at accompanying "Building Performance" conference.
Mostra Convegno Expocomfort, HVAC Trade Fair & Conference in Milano, Italy; March 2-6, 2004	3 posters (Italian/English) at the Italian HVAC association AICCAR stand; market oriented workshop; 2 presentations at an accompanying conference.
Climamed conference and ExpoClima Trade Fair, Lisbon/Portugal; April 16-17, 2004	3 posters (Portuguese/English) at the Portuguese HVAC association APIRAC stand; 3 presentations at an accompanying conference.

- In many countries participating in the Task, national workshops with professionals were carried out.
- Task 25 was presented at two international air conditioning trade fairs and conferences (Milano, Italy and Lisbon, Portugal) with lectures and posters.
- A small decision guideline on system selection was developed.
- The monitoring of the Subtask D demonstration systems was completed.

A summary of Subtask research activities carried out during 2004 is presented below.

Subtask A: Survey of Solar Assisted Cooling
Subtask A work was completed in 2001.

Subtask B: Design Tools and Simulation Programs
Work on mathematical models for all key components of solar assisted air conditioning systems was completed. A complete version of the WINDOWS design tool SOLAC with user-friendly interface is available and was tested by Task participants. The tool will be available to the public via Task 25 webpage by early 2005.

TABLE 5. List of Subtask D demonstration systems.

System	Site, Country	System Description
Verhuelst	Waalwijk, Netherlands	desiccant cooling with flat plate collectors; primary air for an office floor
Uni-Klinik	Freiburg, Germany	adsorption chiller with evacuated tube collectors; air conditioning of a laboratory
BMBW	Berlin, Germany	absorption chillers with flat plate collectors; chilled water network
BPA	Berlin, Germany	absorption chillers with evacuated tube collectors; office cooling
IHK	Freiburg, Germany	desiccant cooling with solar air collectors; lecture room
Technion	Haifa, Israel	liquid desiccant system with flat plate collectors; offices
Öko-Zentrum	Hartberg, Austria	desiccant cooling with evacuated tube collectors; offices and lecture room
Library	Mataro, Spain	desiccant cooling with air-cooled PV-facade and solar air collectors; library cooling
DIREN	Guadeloupe, France	absorption cooling with evacuated tube collectors; offices
CSTB	Sophia Antipolis, France	absorption cooling with evacuated tube collectors; offices
INETI	Lisbon, Portugal	desiccant cooling with stationary CPC-collectors; office air-conditioning

Subtask C: Technology, Market Aspects and Environmental Benefits
The completion and dissemination of the handbook for planners was a major result of Subtask C. The creation of a tool for decision-making ("decision-tree") in an early phase of a project was finished. This tool guides selection of the most appropriate solar thermal driven cooling technology for a given building. Also a multi-coloured brochure about solar assisted air conditioning was produced.

Subtask D: Solar assisted cooling demonstration projects
The demonstration and monitoring of 11 plants was finalized. A technical report which summarizes all the results and documents the projects' history and learning was produced and will be published in early 2005. Demonstration project results will be available on the Task webpage.

MEETINGS IN 2004

Trade Fair Participation
Mostra Convegno Expocomfort, HVAC Conference & Trade Fair, Milano, Italy, March 2004

CLIMAMED Conference & Trade Fair in Lisbon, Portugal, April 2004

Tenth Expert Meeting
April 19-20
Lisbon, Portugal

Eleventh Expert Meeting
October 7-8
Sophia Antipolis, France

KEY REPORTS AND PUBLICATIONS

Conference Papers & Presentations
Solar Cooling of Buildings - possible techniques, potential and international development. Hans-Martin Henning, Thomas Erpenbeck, Carsten Hindenburg, Sören Paulußen; EuroSun '98, Portoroz, Slovenia.

Solar Air Conditioning of Buildings. Proceedings China-
European Union Energy Efficiency in Buildings Technology, Peking, China. Hindenburg, C., Henning, H-M.; 12/1998.

The potential of solar energy use in desiccant cooling cycles. H-M. Henning, T. Erpenbeck, C. Hindenburg, I.S. Santamaria:; International Sorption Heat Pump Conference ISHPC '99, Munich, March 1999

Desiccant Cooling in Combination with Solar Energy - Technology and Pilot Plant with Solar Energy as Heat Source. Henning, H-M.; Hindenburg, C.; EuroSun 2000, 3rd ISES Europe Solar Congress, Copenhagen, Denmark, 19.-22.6.2000

Solar Thermal Energy for Air Conditioning of Buildings, Hindenburg, C.; Henning, H-M.; Chemie Ingenieur Technik (CIT), 3rd European Congress of Chemical Engineering, Nürnberg/Germany, 26.-28.6.2001

Recent Activities on Solar Air-Conditioning. C.A. Balaras, A.A. Argiriou, E. Michel, H.M. Henning; ASHRAE Annual Winter Meeting, January 26-29, Chicago, USA (2003)

Solar Assisted Air Condtioning Of Buildings - An Overview (Invited Keynote). Henning, H.; Wiemken, E.; Proceedings. ISES Solar World Congress 2003 "Solar Energy for a Sustainable Future", June 14-19, 2003, Göteborg, Sweden

Solar Assisted Air Conditioning – A New Market For Solar Thermal Energy In Europe. Henning, H.; Balaras, C.A.; Infante-Ferreira, C.A.; Podesser, E.; Wang, L.; Wiemken, E.; Proceedings ESTEC 2003 - European Solar Thermal Energy Conference, Freiburg, 2003.

Solar Assisted Air Conditioning of Buildings - Overview on Technologies And State-Of-The-Art. Henning, H-M., Wiemken, Edo; Climamed Conference, Lisbon, April 2004.

A Breath of Fresh Air - Use of Solar-Assisted Air Conditioning in Buildings. Hans-Martin Henning; Renewable Energy World, Volume 1, 2004, pp. 94-100.

Solar assisted air-conditioning of buildings – an overview (invited keynote). Henning, H-M., Wiemken, Edo; 44th AICARR International Conference - Mostra Convegno Expocomfort, Fiera di Milano; Milano, March 2004.

Design and Planning Support for Solar Assisted Air-Conditioning: Guidelines and Tools. Edo Wiemken, Mario Motta, Carsten Hindenburg, Hans-Martin Henning; EuroSun 2004, 5th ISES Europe Solar Congress, Freiburg, Germany, June 2004.

Solar assisted Air-conditioning of Buildings (invited plenary lecture). Henning, H-M.: EuroSun 2004, 5th ISES Europe Solar Congress, Freiburg, Germany, June 2004.

Overview of Solar Assisted Air-Conditioning Systems & Applications. C.A. Balaras, G. Grossman, H-M. Henning, C.A.I. Ferreira, S. Kontoyiannidis, E. Podesser, L. Wang, E. Wiemken; 3rd International Conference on Heat Powered Cycles - HPC 2004 - Cooling, Heating and Power Generation Systems, Larnaca - Cyprus, October 2004.

Solar Assisted Air-Conditioning Of Buildings - An Overview. Hans-Martin Henning; submitted to: Proceedings Heat SET 2005 - Heat Transfer in Components and Systems for Sustainable Energy Technologies; Grenoble, France, April 2005.

Commercially Published Report

Solar-Assisted Air-Conditioning in Buildings – A Handbook for Planners. Hans-Martin Henning (Editor); Springer-Verlag Wien/NewYork; ISBN 3-211-00647-8.

Reports Available on the Internet

(www.iea-shc-task25.org)

Ongoing Research Relevant for Solar Assisted Air Conditioning of Buildings. Technical Report.

Solar Assisted Air-Conditioning Demonstration Projects. Technical report on the demonstration projects of Subtask D. To be published in early 2005.

Decision Scheme for the Selection of the Appropriate Technology Using Solar Thermal Air-Conditioning. Technical document for system selection ("decision tree"). To be published in early 2005.

Multi-colour information brochure to be published in early 2005.

TASK 25
National Contact Persons

Operating Agent
Hans-Martin Henning
Fraunhofer Institute for Solar Energy Systems ISE
Heidenhofstr. 5
D-79100 Freiburg
Germany

Austria
Michael Neuhäuser (leader Subtask C)
Arsenal Research
Faradaygasse 3, Objekt 210
1030 Vienna

France
Jean-Yves Quinette (Leader Subtask D)
Tecsol
105, rue Alfred Kastler - Tecnosud - B.P. 434, F-66004 Perpignan

Germany
Uwe Franzke (Leader Subtask B)
Institut für Luft- und Kältetechnik
Bertolt-Brecht-Allee 20
D-01309 Dresden

Greece
Constantinos A. Balaras
Group Energy Conservation
IERSD, National Observatory of Athens
Metaxa & Vas. Pavlou
R 15236 Palea Penteli

Israel
Gershon Grossman
Technion Haifa
Haifa 32000

Italy
Marco Beccali
DREAM - Dipartimento di Ricerche Energetiche e AMbientali
Università degli Studi di Palermo
Viale delle Scienze ed. 9
90100 – Palermo

Mexico
Wilfrido Rivera
Universidad Nacional Autonoma de Mexico
Apdo. Postal #34 Temixco 62580
Morelos

Netherlands
Daniel Naron
TNO Building & Construction Research
Schoemakerstraat 97, P.O. Box 49
2600 AA Delft

Portugal
João Farinha Mendes
DER / INETI, Edificio G
Estrada do Paco do Lumiar, 22
1649-038 Lisboa

Spain
Jordi Cadafalch
Universitat Politècnica de Catalunya
C/ Colom, 11
E-08222 Terrassa (Barcelona)

TASK 27

Performance of Solar Facade Components

Michael Köhl

Fraunhofer Institute for Solar Energy Systems Operating Agent for the Forschungszentrum Jülich

TASK DESCRIPTION

The objectives of this Task are to determine the solar visual and thermal performance of materials and components, such as advanced glazing, for use in more energy efficient, comfortable, sustainable buildings, on the basis of an application oriented energy performance assessment methodology; and to promote increased confidence in the use of these products by developing and applying appropriate methods for assessment of durability, reliability and environmental impact.

Scope

The work will focus on solar facade materials and components selected from the following:

- Coated glass products
- Edge sealed glazings, windows and solar façade elements
- Dynamic glazing (i.e., electrochromic, gasochromic and thermochromic devices, thermotropic and other dispersed media)
- Antireflective glazing
- Light diffusing glazing
- Vacuum glazing
- Transparent insulation materials
- Daylighting products
- Solar protection devices (e.g., blinds)
- PV windows
- Solar collector materials, including polymeric glazing, facade absorbers and reflectors.

Means

The work in Task 27 is carried out in the framework of three subtasks.

- **Subtask A: Performance** (Lead Country: Netherlands)
- **Subtask B: Durability** (Lead Country: Sweden)
- **Subtask C: Sustainability** (Lead Country: France)

Main Deliverables

Subtask A:

- A further developed coherent energy performance assessment methodology to enable comparison and selection of different products and to provide guidance for their assembly and integration into building envelope elements.
- A structured data base of components and façade elements to present data in a consistent and harmonised form, suitable for product comparison and selection and for simulation of performance in specific applications.
- Recommended calculation and test methods for solar and thermal performance parameters in support of international standards development.

Subtask B:
- A validated methodology for durability assessment of advanced solar building materials.
- An estimation of the service lifetime based on degradation of performance for selected materials tested.
- Recommended standard test procedures for service life testing of selected materials and components.

Subtask C:
- A review of international knowledge base, tools, actions and requirements related to glazing, windows and solar components.
- An overview of the FMEA tool capabilities, adaptation to the field of glazing, windows and solar components, and guidelines for using it in the assessment of possible shortening/ reduction of the service life.

Duration

The Task was initiated in January 2000. Subtask C and parts of Subtask A and B were completed in December 2003. Parts of Subtask A were extended until the end of 2004. Parts of Subtask B will be continued until the end of 2005.

ACTIVITIES DURING 2004
Subtask A: Performance

PROJECT A1: General Energy Performance Methodology

In project A1 general methodologies for performance determination of solar façade components are being investigated. The integral impact of facade components on the energy related performance of buildings can be assessed with hourly simulation in principle, but simulation tools have to be adapted to comply with specific component properties. Apart from simulation on an hourly basis a simplified basis suitable for building energy performance assessment would be favourable, especially when looking to the requirements of national and international performance requirements such as the directive of the European Union on the energy performance of buildings. The four working items for the project in 2004 were:

1) Simplified methods
2) Demonstration case studies
3) Test conditions and performance indicators
4) Documentation and recommendations

Demonstration Case Studies

It was decided to use individual building and component models (e.g., single zone: PARASOL, HELIOS-WINSIM, using the reference office: TRNSYS. Results for PARASOL were sent to the participants, but more explanation and documentation is needed. The HELIOS and TRNSYS simulations are not yet complete.

Results

- Development of cooling methodology. A document in German is available (giving basic equations and definitions). The method is based on EN 832 / prEN13790. A general set of equations is shown, and nomenclature defined in order to allow for:
  - positive and negative transmission heat losses (summer/winter); and
  - inclusion of equipment in equations (losses and gain of heat in building zones)
- Simulation and simplified calculation method for reference office - sensitivity studies. A document in German is available (giving first results and summarising a presentation with comments and headers in English).
- Very simple model for DEF (only for building performance). A very simple model has been developed based on energy balance of an unheated glass space by Werner Platzer.
- Testing conditions for slat devices (MS5). The measurements of the various systems (internal, integrated and external blinds) have been completed in laboratory and outdoors. Suitable models have been defined which allow to investigate some parameters on the testing results such as divergence of the solar simulator. Using the comparison between model and experiment conclusion on favourable testing conditions can be drawn (EMPA: outdoor, ISE: indoor).
- Performance evaluation of solar shading devices. A discussion paper in German exists on a simplified way to characterise facades with shading devices in a summer and winter situation.
- Measurements of solar shadings (integrated+interior) have been completed (EMPA, LTH partly: outdoor, ISE: indoor).

PROJECT A2: Switchable Glazing

Simulation results have been reported. The results show some discrepancies in heating and cooling demand for the north and south offices in the reference office block.

Some systematic trends could be noted:

- Some differences in input data were identified.
- Possible differences in how the software handles ventilation, lighting, and occupancy must be sorted out.
- Possible differences in how the software handles angle dependent optical properties must be sorted out.

In the final report, a comment on the energy consumption and embodied energy of switchable glazing will be made.

PROJECT A3: Solar Control Devices (Hans Simmler, EMPA, CH)

General

Procedures and conditions for performance assessment of solar shading devices and their integration into building envelope assemblies or façade systems (windows, single and double envelope facades) are investigated. Models are further developed that allow for component performance calculations on a detailed and on a simplified level useful for building energy performance assessment. Based on these results, recommendations are developed for shading performance testing and calculation procedures as well as for the integration of suitable shading performance data in an enhanced performance assessment methodology for different building types.

Component measurement, modelling, validation

Various indoor/outdoor measurement data are available from Task 27 "reference" devices and former projects (exterior, integrated, and interior shading in combination with insulating glazing). Lab data, ray-tracing and view-factor calculation methods are basically in good agreement. As seen in outdoor testing non-diffuse albedo components may affect the solar gain substantially in the natural radiation environment. Data on this issue is available also from a real building investigation. Validated CFD modeling of double envelope configurations with integrated shading shows clear limitations of simplified calculation schemes of air flow and heat exchange in mechanically ventilated cavities in particular cases.

Impact on energy performance of buildings

Some simulation results are available (e.g., impact of shading and control strategy on thermal comfort in an office building, and hourly based heating-cooling energy simulation for a single zone with a physical louver type shading model in comparison with a simplified monthly based calculation). Comprehensive sensitivity analysis linking static/dynamic shading properties, control strategies, different building types etc. with major building performance indicators (e.g., TSET, direct / visual transmittance, thermal comfort, cooling-heating-lighting power) could not be undertaken because of a lack of suitable simulation tools and missing personal resources.

Standardisation recommendations

Recommendations regarding calculation of device performance can be made on the basis of existing data (e.g., comparison of ray-tracing and extended view factor methods with a standardised "flat slat" calculation). In the testing field, German work on standardisation of a calorimetric TSET test procedure and standard conditions is available.

Shading in building energy performance assessment methodology

Towards an improved consideration of shading devices in building energy performance assessment, various aspects were discussed and will be included in the final report:

- Proposal(s) for simplified but realistic performance indicators for the glazing-shading system shall be made, both for product characterisation and for use in cooling-heating energy calculation schemes.
- Minimum criteria on thermal and visual comfort shall be given and recommendations on the effectiveness of shading system vs. building type with regard to those criteria shall be made.
- Options on how shading performance data may be used quantitatively in simplified or more detailed energy performance assessment methodologies shall be shown.

Obviously these issues cannot be treated in a comprehensive way, but illustrated by qualitative considerations and demonstrated by examples.

Subtask B: Durability

PROJECT B1: Durability Assessment Methodology Development

The project was completed in 2003, but the final report, “General Methodology of Accelerated Testing for Assessment of Service Life of Solar Thermal Components” was been submitted to the Secretariat of ISO/TC 59/SC 14 on service life planning. The submission was to be a contribution to the work in revising ISO 15686-1 and ISO 15686-2, and was formally made by the Swedish Standardization Committee SIS TK 209.

The SHC Task 27 input was discussed at the ISO TC59/SC14 meeting held in Toronto in early 2004. SHC Task 27 work is considered a valuable contribution to the SC14 work and will be considered in the revision of the standards, especially in a forthcoming revision of ISO 15686 - 2.

PROJECT B3: Durability Assessment of Static Solar Materials

The general objective of project B3 is the assessment of the durability, reliability and service life of static solar materials. Materials that are studied include anti-reflective (AR) and polymeric glazing materials, reflectors, and solar façade absorbers. Work on these is performed in form of case studies. A large variety of materials representing the different categories of materials of the case studies were selected for investigations and samples of those have been distributed to the participants for testing. Presently both outdoor and indoor tests are performed with the aim of developing durability test procedures following the general methodology of project B1.

Case Study Reflectors

Reflectors that are studied include pure Al, Miro4, Miro27KK from Alanod, SO 790 from Alusuisse, aluminum foil protected by clear coat from Skultuna Flexible in Sweden, a thin glass mirror reflector from Naugatuck Glass and a laminated reflector provided by NREL. Anodised aluminum is used as a reference material. In outdoor exposure tests samples are exposed at different test sites with monitoring of the macro- and microclimate data and with optical characterization of exposed samples. Results from the 2-1/2 years of outdoor exposure are available.

Accelerated screening tests have been performed and reported and include high temperature/high humidity/UV tests, condensation-test with additional UV, temperature-tests with additional UV and pollutants-tests. The results of tests are presently analyzed with respect to observed damage and degradation mechanisms.

ISE had performed a preliminary principle component analysis, PCA, of reflectance spectra from ISE using also climatic data measured by ISE. During the preparation of the data-sets it turned out that before a general PCA with data from all labs could be started, all the available data has to be compiled in a way that load profiles could be generated from the outdoor climatic data as well as from the indoor test conditions. The PCA analysis will be used in the comparison of indoor and outdoor test results and would also be used for the purpose of estimating long-term degradation in performance during outdoor use from the results of the most relevant indoor tests. In parallel the conventional way of developing a procedure for service life assessment will be followed, including analysis of degradation mechanisms from spectral data and estimation of service life from the results of the most appropriate tests identified during screening testing.

Case Study Solar Façade Absorbers

Solar Façade Absorbers that are studied include coloured sputtered selective solar absorber coatings (INTERPANE), and thickness insensitive spectrally selective paints (NIC). As references also some electrochemically produced black chrome coated stainless steel absorber surfaces are tested. Outdoor exposure tests of solar facade absorber samples continue as an extension of the EU-Joule Sunface project and accelerated screening tests have been performed according to test procedures defined also in the EU Sunface project. Tests that have been performed are corrosion, condensation and high temperature tests. The last two mentioned tests were performed with and without artificial solar irradiation exposure of test samples. Results from outdoor exposure, monitoring of outdoor climatic data and accelerated testing are available in reports on the WIRE. Presently those data are analysed as a base for service life prediction. Additional accelerated tests also have been performed to understand better the degradation of samples observed. Today, most of the interpretation work has been completed and a final report describing the work of the case study will be prepared.

Case Study Anti-Reflective and Polymeric Glazing Materials

Anti-reflective materials being studied include sol-gel coated AR glass from Flabeg and from CIEMAT, etched AR glass from Sunarc. Polymeric glazing materials that are studied are a PVC glazing material (Duroglass) and a PC glazing material from Bayer (tests on this material are only performed at SP Swedish National Testing and Research Institute).

Optiwhite is used as reference. In outdoor exposure tests those glazing materials are exposed at different test sites with monitoring of the macro- and microclimate and with optical characterisation. Results from more than two years of exposure are available and reported. Initial risk analysis of potential failure modes has been performed following the general procedure of project B1. A programme for screening testing, involving high temperature/high humidity tests, condensation-tests, high temperature tests, pollutant tests and outgassing tests, has been completed and the results of the tests are now analysed.

Regarding durability analysis of the antireflective glazing materials for use in a solar collector it seems that the two most important degradation mechanisms for loss in the optical performance are soiling and in certain cases also outgassing if an inappropriate insulation materials is chosen.

PROJECT BC: Service Life Prediction Tools for Complete Systems

This project is a continuation of activities in projects B1, C2 and C3, and is aimed at adopting and comparing existing tools for service life prediction of complete solar façade components with the purpose of improving existing durability test methods for qualification. The first objective of the proposed project is to integrate a material oriented approach to service life prediction with a system-oriented approach. The second objective is to critically review the existing qualification test standards for selected solar façade components with respect to durability assessment and also in this analysis make use of existing data on service life on materials and complete solar façade components. The third objective is to improve the existing standards for qualification of durability of selected solar façade components. Presently work has been initiated related to durability of solar collectors and to durability of window/wall interfaces.

Failure modes and risk analysis related to solar collectors

INETI has prepared a draft report presenting the first steps of work in a FMEA/FMECA analysis on a low concentrating CPC solar collector. The product under study has well-known characteristics and results are available from qualification testing of the product as well as from field inspections of solar systems in which the collector has been installed.

The FMEA/FMECA analysis as described in the report, treats function of a component in a very general and qualitative way e.g. energy collection, resistance to environmental stress, etc. whereas in the IFMA, function requirements are quantitatively defined, which means also that failure is quantitatively defined. To consider resistance to environmental stress as a function as often seen in the FMEA/FMECA analysis may be misleading as this is durability and if quantitatively express this is the service life of the considered component/material.

In the FMEA/FMECA analysis you identify different failure modes, failure causes and failure effects. In an IFMA analysis you try to identify damage modes and associated degradation mechanisms that may give rise to a certain failure. The IFMA therefore is aimed mainly at identifying those degradation mechanisms, which may be the limiting for the service life of a certain material/component. The cause of failure in this case is thus the environmental stress factors or degradation factors determining the rate of degradation. The FMEA/FMECA analysis uses failure detection methods as e.g. visual inspection whereas in the material oriented approach degradation indicators are utilised that can be assessed quantitatively. It should however, be emphasised that the main purpose of the FMEA/FMECA analysis is to assess, based on a risk assessment, the importance of different correction actions for avoiding failure. The risk assessment made in the IFMA analysis is aimed to be the stating point for the set up of a program for qualification testing.

Revision of ISO standard proposal for qualification testing of solar absorber surfaces

Mr. Bo Carlsson had prepared a first draft of revised ISO proposal for qualification testing of solar absorber surfaces. The main changes made concern replacing the old method for testing the thermal stability of an absorber surface with a new method partly developed within the framework of SHC Task 27.

WORK PLANNED FOR 2005

Subtask A: Performance

This Subtask ended in 2004 and work in 2005 will focus on the completion of final reports.

Subtask B: Durability

PROJECT B3: Durability Assessment of Static Solar Materials (Bo Carlsson, SP, S)

Case Study Reflectors

The PCA analysis will be used in the comparison of indoor and outdoor test results and would also be used for the purpose of estimating long-term degradation in performance during outdoor use from the results of the most relevant indoor tests. In parallel the conventional way of developing a procedure for service life assessment will be followed, including analysis of degradation mechanisms from spectral data and estimation of service life from the results of the most appropriate tests identified during screening testing.

To obtain additional information about the degradation mechanisms and which accelerated screening tests that best reflect changes in the IR spectrum observed for outdoor exposed samples, SP Swedish National Testing and Research Institute will try to identify the most likely life limiting degradation mechanisms as well as the reaction kinetics.

Case Study Solar Façade Absorbers

Preparation of the final report for this case study will be started.

Case Study Anti-Reflective and Polymeric Glazing Materials

Work will focus on the investigation of the two most important degradation mechanisms for loss in the optical performance: soiling and outgassing of inappropriate insulation materials.

Project BC: Service Life Prediction Tools for Complete Systems

Failure modes and risk analysis related to solar collectors
Work will continue on the FMEA/FMECA analysis of collectors. An FMEA/FMECA analysis on the MARECO collector also will be performed.

A revised standard proposal to DIN for service-life-testing of absorber coatings will submitted along with a suggestion that the standard proposal shall be developed into an ISO/EN standard in accordance with the Vienna agreement.

Critical review of existing standards and test methods for materials in solar collectors
As a start of the activity on critical review of existing standards, the content of Annex B and Annex E of the standard EN 12975-1 (Thermal solar systems and components - Part 1: General requirements) were discussed. Annex B specifies in general terms requirements on the design of the collector and requirements on also the materials/components of the collector. The standard proposal for qualification testing of absorber surfaces is here of great importance. Regarding requirements and qualification test methods for cover plate materials, reflectors and insulation materials information given in the annex can be considerably improved. References to suitable qualification test methods are missing and it was the opinion of the meeting to make use of the outcome of SHC Task 27 to improve the content of the EN standard annex. Suitable test methods for determining the out-gassing properties of insulation materials and the different methods will be evaluated.

Case study on window/wall interfaces
Developing suitable test methods for assessing performance of window/wall interfaces will be performed at Fraunhofer ISE by using a double climatic chamber, one with outdoor climatic conditions and the other with indoor climatic conditions. The wall between the two chambers contains a window and thus also a window/wall interface. IR-technique is going to be used to study the effects from thermal bridges but also water penetration in the window/wall interface by the use of a special water sensitive IR-sensor.

LINKS WITH INDUSTRY

See the list of Task 27 national contact persons for further details.

REPORTS PUBLISHED IN 2004

- Advanced Procedure For The Assessment Of The Lifetime Of Solar Absorber Coatings, Solar Energy Materials and Solar Cells, Volume 84, Issues 1-4, October 2004, Pages 275-289.
- The Applicability of Accelerated Life Testing For Assessment of Service Life of Solar Thermal Components, Solar Energy Materials and Solar Cells Volume 84/1-4, pp 255-274.
- Assessment Of Durability And Service Lifetime Of Some Static Solar Energy Materials, Proceedings Eurosun 2004.
- Optimisation of the Micro-Climate in Solar Collectors, Proceedings Eurosun 2004.
- Gebrauchsdauerabschätzung Von Solarabsorbern, Tagungsband 14. Symposium Thermische Solarenergie, Bad Staffelstein 2004.
- Prüfung Und Optimierung Des Mikroklimas In Solarkollektoren, Tagungsband 14. Symposium Thermische Solarenergie, Bad Staffelstein, 2004.
- Workshop on “Windows in Buildings” with 75 participants was held in May in Lund, Sweden.

REPORTS PLANNED FOR 2005

Presentations at “Glass Processing Days” in Tampere, Finland in June. Topics will be: energy efficiency of switchable glazing in office buildings; energy performance of facades and buildings - IEA as support for the European directive?; performance assessment for solar shading devices - state of the art; and results of durability testing of antireflective glazing.

Presentations at the 10th International Conference, “Durability of Building Materials and Components.” Papers will be on: energy performance of switchable glazing – SHC Task 27; lifetime estimation of polymeric glazing materials for solar applications; and study on Durability and Service Lifetime Prediction of some Static Solar Energy Materials

MEETINGS 2004

Ninth Experts Meeting
May 16-19
Lund, Sweden

Tenth Experts Meeting
October 6-7
Zurich, Switzerland

MEETINGS PLANNED FOR 2005

Eleventh Experts Meeting
April 21-22
Lyon, France
In conjunction with 10th Conference on Durability of Building Materials and Components

Twelfth Experts Meeting
October
Date and location TBA

TASK 27
National Contact Persons

Operating Agent
Michael Köhl
Fraunhofer ISE
Heidenhofstr. 2
79110 Freiburg
Germany

Denmark
Karsten Duer
VELUX A/S
Maskinvej 4
2860 Soborg

Germany
Werner Platzer
Fraunhofer ISE
Heidenhofstr. 2
79110 Freiburg

Helen Rose Wilson
Interpane E & BmbH c/o Fraunhofer ISE
Heidenhofstr. 2
79110 Freiburg

Italy
Maurizio Cellura
DEAF - Università di Palermo
Viale delle Scienze
Palermo
90128

Michele Zinzi
ENEA
Via Anguillarese 301
00060 S.Maria Di Galeria, Roma

Norway
Ida Bryn
Erichsen & Horgen A/S
P.O. Box 4464 Torshov
0403 Oslo

Portugal
Maria João Carvalho
Instituto de Technologias Energeticas
(INETI)
Estrada do Paço do Lumiar 22
1649-038 Lisboa

Sweden
Bo Carlsson
SP Swedish National Testing and
Research Institute
Materials Technology Section for
Polymers
Box 857
50115 Boras

Björn Karlsson
Vattenfall Utveckling AB
Solar Energy
814 26 Älvkarleby

Arne Roos
University Uppsala
Box 534
75121 Uppsala

Switzerland
Stefan Brunold
Institut für Solartechnik SPF Hochschule
Rapperswil HSR
Oberseestrasse 10
8640 Rapperswil

Hans Simmler
EMPA Eidgenössische Materialprüfungs-
und Forschungsanstalt
Überlandstr. 129
8600 Dübendorf

USA
James Fairman
Aspen Research Corp.
1700 Buerkle Road
White Bear Lake, MN 55110

SHC TASK 28/ECBCS Annex38:

Sustainable Solar Housing

S. Robert Hastings
Architecture, Energy and Environment GmbH
Operating Agent for the Swiss Federal Office of Energy

TASK DESCRIPTION

The goal of this Task is to help participating countries achieve significant market penetration of sustainable solar housing by the year 2010 by providing home builders, institutional real estate investors and banks with:

- A Task web site illustrating built projects, exemplary in design, living quality, low energy demand and environmental impact.
- Brochures on Exemplary Sustainable Solar Housing as a basis for local language publications to communicate the experience from built projects and motivate planers to develop marketable designs.
- A guide: Marketable Sustainable Solar Housing: with guidelines, graphs and tables derived from building monitoring, lab testing and computer modeling.
- A Reference Book systematically compiling the experience of the experts.
- Workshops after the Task conclusion presenting the results of the Task.

Sharing the work of the Task this period are experts from 16 countries:

Austria	Canada	Italy	Norway
Australia	Czech Republic	Japan	Sweden
Belgium	Finland	Netherlands	Switzerland
Brazil	Germany	New Zealand	UK/Scotland

Duration

The Task was initiated in April 2000 and is planned for completion the end of April 2005.

ACTIVITIES DURING 2004

The emphasis this year was on completing full drafts of publications on marketing, exemplary houses, a reference book for sustainable solar housing in heating dominated climates and a separate reference book for cooling dominated climates.

During the year, the experts actively communicated findings from the Task at both national and international events. Particularly effective were symposia held just following Task meetings. At these symposia, the host city profited from the convergence of so many international experts, and attendance was high with participants coming from the whole country.

Poster from the symposia in Lillehammer, Norway and Aberdeen, UK – the host cities of the Task Expert Meetings in 2004.

Subtask A: Market Strategies

A final report on strategies to market sustainable solar housing was completed by T. Haavik of Segel Consultants, Norway with funding from the Norwegian State Housing Bank. The report, Business Opportunities in Sustainable Housing - A Marketing Guide Based on Experiences from 10 Countries, will be published on the SHC Task 28 web site in 2005. Readers are welcome to publish part or all of the report nationally. The Norwegian State Housing Bank plans to produce bound, color copies for distribution in Norway in 2005. An abbreviated version of the report was written by E. Prendergast of the Netherlands and will comprise an important section of the Task Reference Book.

Subtask B: Design Reference Book

Simulations to establish optimized solutions and show the sensitivity of key parameters have been completed. Results were graphed, interpreted and written into chapters for the cold climate (all building types), temperate climate (single family and row houses). Results for mild climates (e.g., Milan) are still outstanding and expected early in 2005. Work continued on the book, Design of High Performance Housing - A Reference Book.

Learning from the trends of built, very low energy housing

An interesting example of results is from Switzerland where 20 houses achieving extremely low energy performance were cross-compared to look for trends or commonalties in design or construction. It is interesting to note that the orientation of the house was not a significant design feature to achieve low energy levels. Houses not optimally oriented were able to offset this limitation by other energy saving features. On the other hand, compactness seems to be essential. Typically, the single family houses had an A/V ratio of 0.73 and apartment buildings the ratio was 0.49. Because space heating demand is reduced to such low levels, domestic hot water heating becomes relatively important. Not surprisingly, 3/4 of the houses in the sample had solar thermal systems for this end use.

Subtask C: Demonstration Projects

In 2004, 22 brochures were posted on the SHC web site bringing the total to 36. To conclude this work, the brochures will be completed and be sorted into two categories: 1) houses with very low energy consumption documented with performance data and 2) good examples with less exceptional energy performance, but with important sustainable features or projects in planning/construction.

One of six solar houses built on the principals of "Passivhaus" against a river dike in Sliedrecht, the Netherlands by Archidome Holland BV.

Experts and the ExCo are encouraged to use the brochures as a source for local language articles. The two sites to view the projects are:

- IEA SHC:
  http://www.iea-shc.org/task28/index.html
  (pulldown menu outcomes)
- ENOVA:
  http://www.enova.no/?itemid=2035

In a separate project, led by Harald Rostvik of Norway, an internet site on innovative components or systems for sustainable solar housing was developed which draws upon the demonstration houses of this Subtask. The site is structured after the chapter structure of the technology section of the reference book. An English version of the now operative Norwegian web site is underway (www.enova.no/?itemid=1414)

Subtask D: Demonstration Projects

The report, *Design Insights from the Analysis of 50 Sustainable Solar Houses*, will be published on the SHC web site in 2005. A German language publication drawing on the contents of this book was completed in a bi-national project and published in December 2004. the co-authors are C. Hoffmann, R. Hastings and K. Voss.

An example of publishing Task results in a local language: Wohnbauten mit geringem Energieverbrauch - 12 Gebäude: Planung, Umsetzung und Realität (Housing with very low energy consumption 12 buildings: planning, implementation and reality).

Sustainable Housing in Warm Climates
The book, Sustainable Housing in Warm Climates Learning from Innovative Projects, will be published in 2005.

Kawanda Muna House in Adelaide, Australia. An ecological, sustainable and affordable house which is self-sufficient for water and waste while using minimal electricity. Constructed from recycled materials to minimize embodied energy.

Environmental Design Briefs
Working together, the Task's Subtask C, Subtask D and the Cooling Group, have produced the book, *The Environmental Design Brief* has been completed and a publisher selected. Its objective is to help designers maximize environmental benefits at an affordable house prices. It is structured in three parts:

A Review of Theory, Methods of Briefing, and Case Studies from Task 28/38
(Australia, Italy, Japan, Sweden and the UK). The book will be published in 2005.

WORK PLANNED FOR 2005

Work through the end of the Task focuses on the final editing and approval of the promised publications (see Table 1, below).

LINKS WITH INDUSTRY

Since the Task addresses the topic of housing the major "industries" include home builders, designers, consultants to designers, mortgage-banks, housing institutions and component manufacturers.

Directly participating in the Task, attending expert meetings and contributing parts of the publications are persons who, themselves are house designers, consultants and bankers. In a few cases the experts' participation in this Task was co-funded by component manufacturers, providing this link as well.

A direct link with component manufacturers is also assured by the work on the internet directory created by Norway. It describes important features a component should have for application in high performance housing and also provides links to manufacturers or manufacturer association of a sample of components used in the Subtask C demonstration projects.

REPORTS PUBLISHED IN 2004

Task results were presented at the following international and national conferences:

- "EuroSun 2004" Congress in Freiburg, Germany
- "Passivhaus Conference" Krems on the Donau, Austria
- Status Seminar, ETH-Z in Switzerland

Articles appeared in the following technical journals:

- Energy and Building
- Erneuerbare Energien
- Architektur und Technik
- Spektrum Gebäude Technik
- Schweizer Baujournal
- Haus Tech
- Bauen für die Zukunft, Baublatt.

MEETINGS IN 2004

Subtask: B Workshop
LCA Workshop
January 29-30
Wallisellen, Switzerland

9th Expert Meeting
April 26-28
Lillehammer, Norway

10th Expert Meeting
October 18-19
Aberdeen, Scotland

Summer Solar Academy
Hosted by ISES with experts, lecture material and tools from Task 28 held in Freiburg, Germany from August 29 - September 4.

The ISES Solar Academy 2005 in Freiburg, Germany

REPORTS PLANNED FOR 2005

Business Opportunities in Sustainable Housing - A Marketing Guide Based on Experiences from 10 Countries. Will be available on the SHC web site.

Design of High Performance Housing - A Reference Book. Will be published by James & James (Science) Publishers.

Sustainable Housing in Warm Climates - Learning from Innovative Projects. Will be published by James & James (Science) Publishers.

Exemplary Sustainable Solar Houses. A series of brochures that will be available on the SHC web site.

Innovative Components and Systems. Will be available on the SHC web site.

Design Insights from the Analysis of 50 Sustainable Solar Houses. Will be available on the SHC web site.

The Environmental Brief. Will be published by Spon Press Ltd.

PUBLIC SYMPOSIA PLANNED FOR 2005

Material from the Task will be presented by the experts in numerous international conferences in 2005, following are a few examples:

- A technical workshop in conjunction with the Joint meetings of the Executive Committees SHC und BCS (Portugal, 15. June 2005).
- The 9th International Passivhaus Conference (Rhein-Neckar-Dreieck (Germany, 29. April - 1.May 2005). Plenary lecture and technical session lectures.
- The 15th Symposium Thermische Solarenergie (Kloster Banz (Germany, 27.-29 May 2005): Plenary lecture: "A Time-Trip of Solar Architecture through Sustainable Solar Housing of Today"
- The 3rd Building Documentation Symposium "Sustainable Solar Housing" (ETH Hönggerberg, September 2005).

MEETINGS PLANNED FOR 2005

Subtask B Workshop
February 14-18
Wallisellen, Switzerland

Final Experts Meeting
April 11-12
Juan les Pins, France

SHC TASK 28/ECBCS ANNEX 38
Contact Persons

Operating Agent
Robert Hastings
(Subtask B Co-Leader)
Architektur, Energie & Umwelt GmbH
Kirchstrasse 1
CH-8304 Wallisellen, Switzerland

Austria
Gerhard Faninger
IFF
University of Klagenfurt
Sterneckstrasse 15
A-9020 Klagenfurt

Australia
Richard Hyde
(Hot Climates Working Group Leader)
Department of Architecture
The University of Queensland
St. Lucia
AUS-4072 Brisbane

Belgium
Andre DeHerde
Architecture et Climat
Univ. Catholique de Louvain
Place du Levant 1
B-1348 Louvain-la-Neuve

Brazil
Marcia Ribeiro
Fed. Univ. of Minas Gerais
Rua Inconfidentes 355/J001
BR-Belo Horizonte, MG CEP-30140-120

Canada
Pat Cusack
Arise Technologies Corp.
321 Shoemaker St.
CDN-Kitchener, Ontario, N2E 3B3

Czech Republic
Miroslav Safarik
ZECM Envir. Institute
Kodanska 10
CR-10010 Praha 10

Germany
Christel Russ (Subtask D Leader)
Fraunhofer ISE
Inst. for Solar Energy System
Heidenhofstr. 2
D-79110 Freiburg

Finland
Jyri Nieminen
VTT Building & Transport
Building Physics
P.O. Box 1803
FIN-02044 VTT

Italy
Francesca Sartogo
PRAU
Via Costabella, 34/36
I-00197 Roma

Japan
Motoya Hayashi
Miyagigakuin Womens' College
9-1-1 Sakuragacka Aobaku
J-981-8557 Sendai

Norway
Anne Gunnarshaug Lien
(Subtask C Leader)
Enova SF
Innherredsv. 7A
N-7014 Trondheim

Netherlands
Peter Erdtsieck (Subtask A Leader)
MoBius consult bv.
Diederichslaan 2
NL-3971 PC Driebergen - Rijsenburg

New Zealand
Albrecht Stoecklein
Building Research Assoc.
Private Bag 50908
NZ-Porirua

Sweden
Maria Wall
(Subtask B Co-Leader)
Dept.of Constr.& Arch.
Lund University
P.O. Box 118
SE-221 00 Lund

Scotland
Gökay Deveci
Faculty of Design & Technology
Robert Gordon University
Garthdee Rd.
UK-Aberdeen, Scotland

USA
Guy Holt
Coldwell Banker
6317 NE Antioch Rd.
USA-64119 Kansas City MO

Task 29

Solar Crop Drying

Doug Lorriman

Namirrol Ltd.
Operating Agent for Natural Resources Canada

TASK DESCRIPTION

One of the most promising applications for active solar heating worldwide is the drying of agricultural products. In a recent study, the potential amount of energy that could be displaced using solar in this market was estimated to be between 300 PJ and 900 PJ annually, primarily in displacing fuel-fired dryers for crops that are dried at temperatures less than 50C. The use of solar energy for these markets is largely undeveloped. Wood and conventional fossil fuels are used extensively at present. In many countries, more expensive diesel and propane fuels are replacing wood. Three key barriers to increased use of solar crop drying are the lack of awareness of the cost-effectiveness of solar drying systems, the lack of good technical information and the lack of good local practical experience.

The objective of the Task is to address the three barriers above by providing technical and commercial information and experience gained from the design, construction and operation of full-scale, commercially viable solar drying systems for a variety of crops and a number of geographical regions where solar is expected to have the greatest potential. Crop grower and processor industry associations are key partners in dissemination of the results.

After two years of bad harvests, hopes are high for a good harvest this year and the full start-up of the solar heating system installed at this new coffee drying facility near Sona in Panama.

The Core Pith drying system in India has been operating successfully for over one year. The owner is very happy with the performance. This system operates all year which enhances the economic benefits of the system.

Duration

The Task was initiated in January 2000 and is planned for completion in May 2006. This includes an extension to allow for monitoring a number of delayed projects.

ACTIVITIES DURING 2004

Panama – Coffee Drying

The solar system was ready for the late 2002 harvest, however, the harvest was much smaller than anticipated and some operational problems were encountered. The project was further hampered by the sad passing of one of the key members of the client team.

We were eagerly anticipating full operation of the system for the 2003/4 harvest season but once again, there was a poor harvest in the region which the drying facility serves and the owners of the plant decided not to operate the facility at all last year.

It should be noted that this drying facility was constructed in connection with an initiative of Café Duran to introduce coffee growing to an economically depressed lowland region of Panama. This is not an area which is ideal for coffee growing and the company is taking great financial risk to support this initiative. There are many variables associated with the success of the project and the solar system is only one innovation which is being tested.

During the year, the company made great strides in improving key problems in the fields, the most significant of which were the installation of an extensive irrigation system and improvements in enhancing pollination of the coffee plants. The results of these efforts seemed to have paid off as the 2004/5 harvest season looks very promising.

A Task participant visited the site in November to inspect all aspects of the solar system and help the owners take full advantage of its capabilities during this drying season.

We are expecting to have good monitoring data available after the season ends in March 2005.

Costa Rica – Coffee Drying

The solar air preheating system installed at the Coopeldos R.L. drying facility near Tilaran in the northern mountains of Costa Rica was finished this year. We had hoped that it would be completed in time to get some operational data during the last harvest season but some unavoidable delays prevented this.

The system was ready to begin operation with the start of the 2004/05 harvest season in late October. By mid November, the plant was operating at full capacity and one of the Task experts visited the facility to check on its performance. A number of recommendations were made to the owners to improve the performance of both the solar preheat system and the furnaces in general. The monitored data collection has begun and this will be analysed in the next few months.

An official opening of the solar system was held in conjunction with the November 2004 meeting of the Executive Committee in San Jose.

India – Coir Pith Drying

The solar system continues to operate well and the operators appear to be satisfied. The monitoring system at the Task site has not yet been installed. We continue to wait for the second Task project in India to be completed so that both monitoring systems can be installed in one trip.

Coir Pith is a powder found on the shells of coconuts, which after processing, is widely used as a fertilizer.

India – Cardamon Drying

Unfortunately, in spite of good efforts on the part of Task experts and others, it was agreed in November that we would not proceed with this project. It appears that the client

Activities Planned for 2005

The following activities are expected to be completed in 2005:

Project		Status
Panama –	Coffee Drying	System monitoring for one season competed and results analyzed
Costa Rica –	Coffee Drying	System monitoring for one season competed and results analyzed
India –	Coir Pith Drying	Monitoring system installed System monitored and results analyzed
India –	Tea Drying	Solar system installed System commissioned Monitoring system installed System monitored and results analyzed
China –	Moyu Drying	Facility completed Solar system installed Monitoring system installed System monitored
Zimbabwe –	Tobacco Drying	System report completed

company was not able to secure sufficient financing to complete the system.

India – Tea Drying

This is a new project that has recently been identified and is a promising replacement for the Cardamom project. The plant belongs to the Marionbarie Tea Co. Ltd. and is located in Dooars in the province of West Bengal. The project potentially involves supplying and installing over 1000 square metres of solar collector to preheat the supply air for two existing high temperature furnaces. Specific attractions of this project to the Task are the long drying season, the displacement of oil as the primary fuel source and the indication from the client that they have other sites for possible future solar installations following the anticipated successful results from this project.

China – Biomass Drying

This project has been discontinued by the government agency which was supporting it. The reasons cited are difficulties in the corporate structure of the company which is operating the plant, difficulties which are not likely to be resolved in the near future.

China – Jujube Drying

At the time of writing this report, the project is effectively dead. A Task expert will be in China before the end of the year and will meet with representatives there to make one last effort to revive it. There has been no progress on the part of the clients for over a year. As far as we know, the pilot plant is still in operation and we may decide to monitor it but this will depend on the upcoming discussions.

China – Moyu Drying

This project was proposed by the Chinese government authority as a substitute for the biomass project. The proposal is to install a solar air preheat system on the new workshops of the Lianghe MoYu Taro Products Limited Company. The company is building a 2000 square metre addition to its existing plant in Yunan Province in southern China.

At the time of writing this report, Task experts are working out the technical details for the installation. Moyu is a vegetable grown in China which is very similar to a turnip.

Zimbabwe – Tobacco Drying

This project is effectively stalled due to the political situation in Zimbabwe. Two test systems were installed on tobacco drying silos at the facilities of the Tobacco Research Board. The systems were operated for a short period of time before the 2002 election. A principle observation during that time was that there was significant air leakage in the silos which hampered the performance of the solar systems.

The Dutch participant has agreed to prepare a report on the information gained during the time in which the systems were operating.

United States – Various Projects

The USA projects are not officially part of the Task, but we do intend to include reference to them in our final report. These projects include:

- Walnut drying in California
- Prune drying in California

- Grain drying in New York
- Wool drying in New York
- Chicken manure drying in New York

LINKS WITH INDUSTRY

The Task continues to maintain excellent links with industry as summarized below:

A seminar was held in conjunction with the Executive Committee meeting in San Jose, Costa Rica. Some Task projects were highlighted at the seminar and a number of inquiries were subsequently made regarding other prospective projects in the area. The president of Conserval Engineering and the manufacturer of Solarwall® attended the seminar and have followed up on some of these leads with Costa Rican representatives.

The completion of the system in Costa Rica should further demonstrate the feasibility for using solar crop drying systems in the region. An official opening was held that attracted press and representatives from the coffee industry in Costa Rica. An official of the government organization which is responsible for the coffee industry was an official speaker at the opening.

A major international coffee industry conference is held each year in Costa Rica. A Solarwall® representative attended the trade show as part of the conference and highlighted the Coopeldos project. Many prospective leads were generated. The owners of the Panamanian coffee processing plant have indicated an interest in building a second facility which will use only dry chaff and solar as the energy sources. This has been temporarily put on hold pending the success of their current plant. The owners also have requested help in staging an official opening of their solar plant much the same as was held in Costa Rica.

The tea project in India involves a major tea producer in the country and could lead to additional projects in that industry.

REPORTS PUBLISHED IN 2004

No official reports were published in 2004.

REPORTS PLANNED FOR 2005

Work will start on the final Task report.

MEETINGS IN 2004

There were no Task expert meetings held in 2004. It is a policy of the Task to hold meetings in countries where there are active projects. The two remaining countries are India and China, but it was decided that it would be more productive to hold these meetings when the projects are completed and operating.

The Canadian team, which is responsible for most of the projects, did meet regularly throughout the year.

MEETINGS PLANNED FOR 2005

At this point, it is not clear if there will be additional meetings at the site locations.

The Canadian expert team will continue to meet as necessary to complete the active projects.

TASK 29
National Contact Persons

Operating Agent
Doug Lorriman
Namirrol Ltd.
20 Tiny Beaches Rd. N.
Site 8, Comp. 8
Perkinsfield, ON
Canada L0L 2J0

Canada
Doug McClenahan
Alternative Energy Division
CANMET
Natural Resources Canada
580 Booth St.
Ottawa, ON K1A 0E4

John Hollick
Conserval Engineering Ltd.
200 Wildcat Road
Downsview, ON M3J 2N5

Netherlands
Egbert Gramsbergen
Gramsbergen Solar
Tus 7
5507 MG Veldhoven

United States
Peter Lowenthal
Solar Energy Industries Association
1616 H Street N.W., 8th Floor
Washington, DC 20006-4999

TASK 31:

Daylighting Buildings in the 21st Century

Nancy Ruck

University of Sydney
Operating Agent for Standards Australia International

TASK DESCRIPTION

SHC Task 31 seeks to make daylighting with controls the typical and preferred design solution for lighting buildings in the 21st century. The intent is to integrate the application of daylighting systems, shading and electric light control strategies with human acceptance and to ensure the transfer the outcomes to building design professionals, building owners, and manufacturers.

The Task focuses on commercial buildings, both new and existing, including office, retail and institutional buildings, such as schools. International Energy Agency experts from 14 countries in Europe, North America, Asia, Australia and New Zealand are now collaborating in the Task 31 work programme that emphases communication with building owners, professional designers and industry.

Through discussions with industry and subsequent changes in building design in the application of daylight, it is evident that visual comfort, health and productivity are now building priorities rather than energy savings alone. Consequently Task 31 has made a strong effort to involve industry in their research and development programme.

Symposiums have been held in Tokyo, Japan and in Torino, Italy in conjunction with experts meetings. These have been well attended with much discussion on work programme topics.

To carry out the Task 31 work programme there are four main Subtasks.

- **Subtask A: User Perspectives and Requirements** (Lead Country: Canada)
- **Subtask B: Integration and Optimisation of Daylighting Systems** (Lead Country: USA)
- **Subtask C: Daylighting Design Tools** (Lead Country: Germany)
- **Subtask D: Daylight Performance Tracking Network and Design Support** (Lead Country: France)

These Subtasks were modified in 2004 to comprise only 3-4 project areas per

Subtask due to funding difficulties of some countries. Progress in Subtasks has been made in modelling user response to lighting controls and shading devices (refer Subtask A); in collaborating with building owners, architects and engineers in the integration of daylighting responsive controls and shading devices (refer Subtask B) and in the use of algorithms and plug-ins in software (refer Subtask C).

Duration

SHC Task 31 was initiated in September 2001 and will be completed in September 2005.

ACTIVITIES DURING 2004

A detailed summary of Subtask research activities is presented below:

Subtask A: User Perspectives and Requirements

Web Site:
http://irc.nrc-cnrc.gc.ca/ie/light/daysim/extra/ieatask/

Literature Survey
The content of references in the literature survey data base has been summarized as one pagers into a short, concise document. This document together with the reference database will be a final deliverable.

Visual Assessment Methods
◗ Visual Assessment Publication
The draft of an overview of research on visual comfort has been completed. The draft is being compiled into an IEA SHC report and a submission for the Energy &Buildings special issue on daylighting in 2005.

◗ User Acceptance Surveys
User acceptance surveys are now underway in Belgium office buildings (Magalia Bodart, Université Catholique de Louvain) and in several buildings with different daylighting systems in Germany (Alexander Rosemann, Technical University of Berlin). A common survey questionnaire is being currently being discussed and may be set up next year.

◗ Glare Investigations
Within the European Ecco-build project Germany (Jan Wienold Fraunhofer-Institute for Solar Energy Systems, Freiburg) and Denmark (Jens Christoffersen, Danish Building and Urban Research Institute) are carrying out glare investigations for an improved glare rating system using a CCD camera. Measurements of illuminance and luminance are being carried at one minute intervals.

Data Processing Used in the Test Room Studies:
1. Conversion raw (pf) pictures to RADIANCE format
2. Consistency check: synchronisation of time and measured data
3. Picture evaluation into indices
4. Compilation of indices-in right format and order
5. Input into SPSS program
6. Correlate data with answers from occupants

Results:
In the comparison of picture calculated illuminance values versus direct measurements there was a correlation of 0.981; and existing glare formulae showed low correlation. The methodology and results will be published in the Special issue of Energy and Buildings.

Glare investigations for an improved glare rating.

The New York Times Headquarters Building New York and its full-scale mock up.

User Behaviour Modelling

◗ Lightswitch

A report on a user behaviour model called Lightswitch has been drafted as an IEA Report. The model is being integrated into the dynamic thermal simulation program ESP-R (Refer 2.). It is intended that the model be integrated into daylight analysis software packages.

◗ Lightswitch Integrated

A new 4-year NRC project is being carried out with Natural Resources Canada, and Public Works and Government Services Canada. The project will also involve students from Laval University (Architecture), McGill (Architecture), and Waterloo (Mechanical Engineering). The objective of this project is the integration of user behavioral models (such as NRC's Lightswitch model) into ESP-R; together with the development of new optical and thermal models for blinds and skylights, and collecting new field study data to validate and expand existing models.

◗ Energy and Buildings Special Publication, 2005

Initiated by Subtask A Leader Christoph Reinhart, Elsevier Science Publishers will be publishing a special Task 31 publication in 2005 on daylighting buildings. Nineteen draft papers are being submitted for review.

Subtask B: Integration and Optimisation of Daylighting Systems

Design Guide

It has been determined that no single guide will serve all countries and all purposes. The purpose of the Design Guide is to develop a shared framework that can be customized by each country and the USA and Canada are working together to produce a "North American" version within SHC Task 31. This "NA" version is to be modified and adapted by other participant countries for motivated non expert users for architectural and engineering firms, lighting designers, consultants and informed owners. The project is to be divided into two segments:

◗ Version 1: Guidance to establish performance goals

Guidance to establish performance goals will be based on the adaptation of a basic approach from the existing documents "Tips for Daylighting" Daylighting Guide for Canadian Commercial Buildings and SHC Task 21 Daylighting in Buildings publication.

The basic approach in these documents will be expanded by adding:

–Benchmarked performance data (Subtask B)

–Lighting controls (Subtask B)
–User interactions (Subtask A)
–Links to new tools (Subtask C)
–Links to controls case studies

The draft is to be completed by April 2005.

◗ Version 2: Hyperlinked, web–based version of generic guide
The Guide to implement daylighting will include decision points and links to design support tools including case studies. It will be based on Version 1 but will add in-depth reference materials in specific areas of interest to Task 31 participant countries (in their own language) and add links to the country's specific tools, the country's specific case studies, codes and standards. The Guide will be tested with real building projects.

The working document for this Guide will be completed by September 2005.

◗ Version 3: Electronic version
Version III will have built in decision support tools and is to be completed after the Task has ended. It will be put on the Task 31 web site which will continue after the Task ends.

Optimized Lighting Controls

◗ Control Design Guide (Nicolas Morel, Switzerland)
The second draft of the Control Design Guide has been prepared. A first discussion concerning the target audience of the document resulted in the document, being focused on rather technical issues of control systems, and aimed at essentially designers and planners of control systems (i.e. the control systems manufacturers, the manufacturers of technical equipment, or the specialized engineers concerned with building services); not building designers (architects).

◗ Calibration and Commissioning Guide (Martin Butcher, Australia)
The first draft of the calibration and commissioning guide has been prepared and is out for comments from participant countries. The pre-commissioning planning and commissioning steps have been drafted. To be completed are the sensor design and placement and the commissioning of automated shades, blinds and other window treatments, and networked systems and systems with complex algorithms. There will be a final manual update.

◗ Auto-adaptive Systems (Alex Rosemann, Germany)
The initial development of an auto adaptive system has been installed by the TU Berlin. A description of this work is to be published in the Special issue of Energy and Buildings.

Field and Laboratory Studies

◗ Collaboration between Building Owners, A/E Teams, and Industry (LBNL)
The collaboration between building owners, A/E teams and industry for the integration of daylighting responsive controls and shading devices has been accomplished in the USA. The New York Times Building Project (LBNL) has been initiated and developed to accelerate product market transformation by the interests of motivated manufacturers and innovative owners being converged. Dynamic façade and dimming controls have been commercially available for some years but the barrier has been cost and reliable performance. By demonstrating and testing in a partially full-scale model of the New York Times Building on an outdoor site, it has been proven that with collaboration, smart integrated shading and electric lighting control systems can work and are cost effective.

◗ Project POLITO (Anna Pellegrino and Valentina Serra, Italy)
The project POLITO which is concerned with monitoring schools has been delayed; therefore it will not be ready on time for the Task 31 report.

◗ Project Light Cube: Laboratory experiments on user response under different illumination levels (Finland)

◗ Descriptions of additional projects are as follows:

- New York Times mockup building-monitoring for different shading and electric lighting control systems
- Research facility in Berkeley (electrochromic glazing)-monitoring user response.

◗ New York Times mockup building (Eleanor Lee, Steve Selkowitz)
The project proved the performance claims of integrated systems, that the technological solution is reliable and robust and to transform the market from a niche to a commodity product by disproving myths across the entire life- cycle. Through this project, it is now understood how these technologies are specified, installed, commissioned, operated, and maintained before procurement and achieved the following:

◗ Direct experience with commercially-available systems
◗ Understanding of performance and user acceptability issues
◗ Confirmation of the added-value benefits for their employees and building operations

- Fine-tuning of the product specs for their unique owner requirements
- The logistics of how to implement the installation in the final building
- Knowledge of what in-house expertise that would be needed to modify & maintain the systems

The conclusion is that smart controls, Dynamic Glazings and Integrated Lighting controls are key to achieving the desired performance. Correlation studies and a final synthesis will be added to the Field and Laboratory Report.

- LBNL Research Facility (Eleanor Lee, Steve Selkowitz)

A user survey is being carried out in the LBNL testing facility to determine user acceptance of electrochromic glazings. Results are to be published in the Special issue of Energy and Buildings. The objective is to determine the physical characteristics and user response to an electrochromic window system. The method consists of the user varying the electric lighting and blinds but not the transmission, and for the user varying the window transmission and the electric lighting regarding the overall desired light level. The results to date show that the reduced luminance levels when the electrochromic windows were dimmed were correlated with lower perceptions of glare and higher levels of satisfaction and that the energy savings depended on the use of appropriate control strategies.

- Project Light Cube (Jorma Lethovaara, Liisa Halonen)

Experiments have been carried out in the "Light Cube" to measure the observation ability of the eye. Before every experiment, luminances from the background and from the computer displays were measured with each illuminance level. In the second test series the objective was to study the effect of lighting situations on the measured performance and subjective assessments in different lighting situations. Daylight was used in addition to electric lighting. In the third test series measurements with daylight were carried out to investigate the effects of quantitative and qualitative factors on the lighting on office and screen based tasks. It was found that significant glare (from window luminance) began to be perceived at 2500-4000cd/m2 and visual comfort decreased with increasing window luminance being poor with 1000 cd/m^2. Work is continuing and conclusions will be available in 2005.

- Monitoring Protocol for the Assessment of Occupant Usage of Lighting and Shading Controls

An extension of the IEA SHC Task 21 measurement protocol is being carried out for monitoring studies of user behaviour in Task 31 and beyond. The working document will suggest what physical properties should be measured in long term field studies on occupant use of lighting and shading controls and analysis methods. The following is a draft of the contents showing progress:

- Section 1: Introduction-at an advanced stage
- Section 2: Underlying assumptions-at an advanced stage
- Section 3: Experimental techniques-needs further work
- Section 4: Data analysis techniques-needs further work

Subtask C: Daylighting Design Tools

User Interactions

- Tool survey

The questionnaire on user expectations of design tools has been brought into the final format of a working document.

Algorithms and Plug-Ins

- Report on Goniophotometry

A report on goniophotometry is to be available in 2005. A paper on goniophotometry will be submitted for a special issue of Energy and Buildings in 2005.

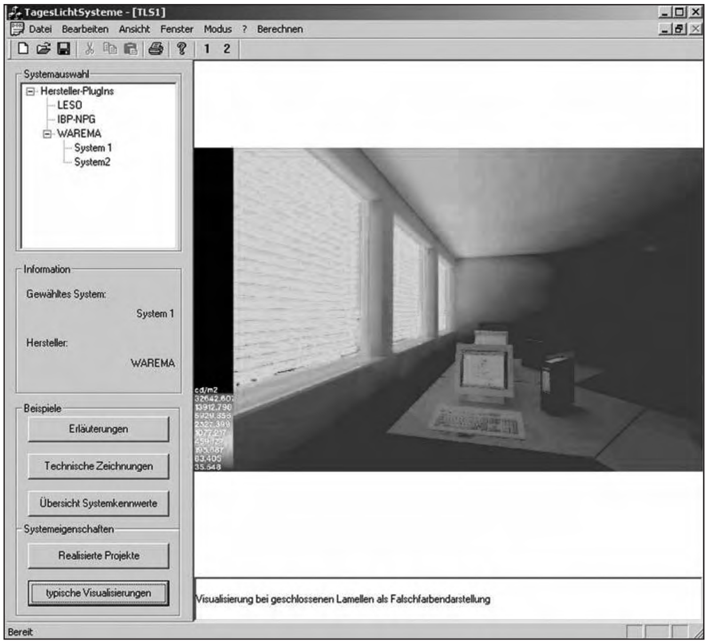
- Application of Numerical Photometer

A working document on the application of the IBP numerical goniophotometeris to be completed by the end of 2004. There is a graphical user-interface of the numerical goniophotometer, which allows it to automatically generate macros for the virtual test stand set up and diverse samples of daylighting systems. In addition it allows the transformation of the evaluated flux distributions into standard btdf data formats.

The serraglaze system is being investigated in order to have a common and standard dataset for validation of complex fenestration systems (CFS). A sample has been previously measured in the EPFL goniophotometer. The additional calculations with the EPFL and IBP numerical goniophotometers have been performed and the simulated datasets compare well. Some deviations with measured data have been identified. The exact type of serraglaze sample – whether it is embedded into layers of glazing – is to be checked again. The comparison of daylight software simulation results with scale model data have been performed..

- Plug-ins

The final working document on plug-ins for inter-program communication of different peaces of software developed in the scope of this subtask has been compiled.



A page from the Complex Fenestration System (CFS) Data Base.

◗ Database
IBP presented the current status of the system database. The graphical representation is based on the OpenGL based Open-Inventor library. The system is being implemented using MS-Visual C++ based on COM technology allowing to plug it into other applications as well as to plug-in in other applications into the database itself. It provides a simple overview with rather qualitative information on systems and an expert mode, which allows getting a variety of detailed photometric information on the selected daylight system. Due to manufacturer license issues, some datasets have to be included in an anonymous format. The beta version of the database has been completed. The GUI will be translated into English. A report on a standard data set for validation of complex fenestration systems is being drafted

◗ "All sky Model"
Work on the "all sky model" Has been completed including validation work with more Japanese climatic data and the development of calculation models for radiance inclusion. A draft of a final report will be edited for April 2005.

Development of Tools Catalogue
◗ Tools catalogue
All activity on the web tool catalogue had to be stopped due to funding problems

◗ DELight
The software DELight has been integrated into Energy Plus and the capabilities to model calculate complex fenestration systems have been extended. IBP is to provide a program to filter the btdf. Energy plus is a new building simulation program replacing DOE2. The US Government is promoting a free download-end use license. It has a weather conversion utility converting hourly data into an EnergyPlus format with 800 weather files around the world including European and Australian cities. The DELight engine includes the daylighting factor and electric lighting control calculations. Quality calculations are not included.

Validation
◗ Report: Test case to assess the accuracy of lighting computer programs is now being drafted (with CIE)
The completed CIE Technical Report of TC 3.33 "Test Cases to Assess the Accuracy of Lighting Computer Programs", has now become an official IEA Task 31 report and the results of the validation work are partially available on the Task 31 webpage. This online site shall be used as a future validation and benchmark site. This project has been completed.

Performance Tracking Network and Design Support Groups
Development of web server structure
A summary document has been drafted for the references in the database.

Database #2
Various fenestration systems have been compared in terms of cost: - the roof light with frame on roof, LED lighting, the sky dome, the vertical window and borrowed light. The cost of these various lighting systems has been compared over 20 year's amortisement.

Database #3
Noteworthy buildings are being presented in terms of daylighting features that are of interest e.g. sun protection, the filtering of light, the issue of orientation, simplicity of solutions, colour of light, and cost effectiveness or low cost. The examples that have been included are: the Stechlinsee Center, Berlin, Fraunhofer, ISE, Freiburg, EDB Net Office Building, Hamm, Westfalen, ECOTEC, Solar optimized office building, Bremen, Huebner, Production Hall, Kassel-Waldau, University of Applied Science, Bonn-Rheim-Sieg, and International solar center ISZ, Berlin.

LINKS WITH INDUSTRY
Industry Involvement in Experts Meetings

◗ Dr. Karsten Ehling of LichtVision recommended auto-controlled blinds and electronic controls to give better results in day lit buildings and suggested inputs to Task 31 on work on user interactions and productivity to convince clients to use daylight in buildings.

◗ There was a round table conference with owners/investors and design professionals at the Victoria University of Wellington... Invited participants from New Zealand industry were: Steve Young and Barry Andrews from Connell Wagner, David Ragg and Claire Benge from the Building Industry Authority, Armour Mitchell, Energy & Technical Services Ltd< Don Smith, DTZ New Zealand, James Fenton and Christopher Kelly, Architecture Workshop, Marc Van de Loo, Velux NZ Ltd, and David Cogan, Energy Efficiency and Conservation Authority. The general impression was that practitioners currently lacked guidance of how to implement daylighting in their designs. It is expected, that the Subtask B roadmap will be an important element to train designers. It was also evident from the discussion that only a very small fraction of building stock in NZ was daylighted and that there was the need to demonstrate the value from daylighting buildings, to create versatile tools, and to further develop cost effective technologies. The issue that architects often do not trust their simulation results were raised which makes guidance on the use of prediction tools also necessary.

◗ Matthais Akerman of Amstein and Waltert, Engineering Company in Geneva noted that there were problems in investing in daylighting and shading controls as 30% savings in electricity consumption were required. He summarized in saying that energy savings in Switzerland are not the real incentive for new buildings in Switzerland. User comfort including related costs is the most important.

Industry involvement in the following projects is as listed:

CompanyCommentsProvidesFunding ToKalwall Corporation US manufacturer of translucent glazings NRC(Canada) Structures Unlimited Inc.engineering companyNRC(Canada)BC HydroUtility Company in British Columbia, Canada NRC (Canada)LedaliteCanadian Lighting Control Companyin-kind support to NRC (Canada)Smart BlindCanadian Lighting Control Companyin-kind support to NRC (Canada)OSRAMGerman manufacturer of lamps, electronic ballasts and building management componentsTU Berlin (Germany)Sage Electrochromics, Inc.US manufacturer of electrochromic windowsNo direct funding – provides in-kind support to USViraconUS manufacturer of conventional windowsNo direct funding – provides in-kind support to USWausau Window and Wall SystemsUS manufacturer of curtain wall systemsNo direct funding – provides in-kind support to USMechoShade Shading SystemsUS manufacturer of automated roller shadesNo direct funding – provides in-kind support to USLutron Electronics, Inc. with Vimco (subsidiary of Lutron)US manufacturer of daylighting controls and automated roller shadesNo direct funding – provides in-kind support to USSiemens Manufacturer of daylighting control systemsNo direct funding – provides in-kind support to USThe New York Times CompanyBuilding ownerNo direct funding – provides in-kind support to USAdvance Electronics US manufacturer of electronic ballastsNo direct funding – provides in-kind support to USLiteControlUS manufacturer of lighting fixturesNo direct funding – provides in-kind support to USGensler InteriorsUS architectural firmNo direct funding – provides in-kind support to USSusan Brady Lighting DesignUS lighting designerNo direct funding – provides in-kind support to USFlack + KurtzUS building engineering firm: electrical engineeringNo direct funding – provides in-kind support to USSouthern California EdisonCalifornia UtilityNo direct funding – provides in-kind support to USGriesserCH manufacturer of shading devicesNo direct funding – provides products for research in ItalyZumtobelGerman manufacturer of luminaries and control systemsNo direct funding – agreed in providing products for research in Italy3F FilippiItalian manufacturer of luminariesNo direct funding – agreed in providing products for research in ItalyVelux Foundationroof windows, etc (Velux)funding an (already finished) EPFL (Switzerland) project on electrochromic windowsDelta Lux ABDaylight equipment and light FittingsNo direct funding-provides products for research in Sweden

Seminars on Best Practice in Lighting in Australia

The proposed Lighting Innovation Centre -a collaborative network consisting of the Australian Electrical and Electronic Manufacturers' Association, Property Council of Australia, Institution of Engineers Australia, Royal Australian Institute of Architects, Illuminating Engineering Society of Australia and New Zealand, Lighting Council Australia, International Association of Lighting Designers, Queensland University of Technology, University of Sydney, Deakin University, Griffith University, Queensland Government is to provide services for the research, development, commercialisation, education and provision of information and expertise in best practice lighting solutions (satisfying human, environmental and economic outcomes). The Centre aims to lift the knowledge of lighting amongst the greater community in order to facilitate a demand for more sustainable quality lighting solutions and technologies. Its initial activity has involved world class best practices in lighting program delivered via a seminar series in Australian cities, namely, Sydney, Brisbane, Cairns, Darwin, Perth, Adelaide, Hobart and Melbourne.

In summary, the Best Practices in Lighting Seminar program aims to:

- Have the industry, as a whole, producing lighting solutions well above the energy performance levels currently set and other standards.
- Prepare industry for higher performance building energy codes and MEPS in the future and most likely increase their support.
- Produce indoor spaces more suited to the well being of the occupants
- Deliver added asset value to buildings
- Reduce in greenhouse gas emissions through energy efficient lighting installations
- Establish a network of lighting related professions and professionals able to further utilise the services of the Lighting Innovation Centre for ongoing best practice lighting initiatives.

The total seminar attendance was approximately 320. The dominant professions amongst attendees were electrical engineers, facility managers, architects, and lighting designers.

Feedback was gained through attendees completing a short questionnaire. Ratings were obtained for each topic/presenter. (1 = poor to 5 = excellent) The Daylighting series was the highest rated topic. Attendees written comments on a number of positive aspects of the seminar were:

- Having daylighting and electric lighting combined in a seminar
- Physical explanation of glazing/skylighting performance
- Introduction of daylighting into design
- Aspects from pre-design to facility management
- Implications of poor daylighting considerations
- Examples of existing buildings
- Understanding of the importance of facilities management
- Lack of compartmentalisation of topics
- Emphasis on communication with FM
- Sustainability and how it affects design

An issue raised was a lack knowledge of "rules of thumb" that can be used when arguing the case for daylighting in the early planning (pre-design) meetings. Without basic performance figures for various "families of daylighting strategies" (eg light shelves, skylights, automated blinds, spectrally selective glazings) arguments for daylighting cannot be critically debated with any chance of success. What software is available and when should it be used in the design process. A current observation was that, in general professionals are not aware of the tools that are available and where in the design process to use them. They will be assisted by Task 31's roadmap to be published in September 2005.

REPORTS PUBLISHED IN 2004

Papers in "Lighting" Art and science for international designers
Official publication of the IES lighting society published by RALA information services www.lighting.rala.com.au
and now the International Daylighting publication outlet.

REPORTS PLANNED FOR 2005

Subtask A: User Perspectives and Requirements

- Report on the Lightswitch model
- Report on an overview of visual assessment methods
- Working document on glare investigations
- Special Edition of Energy and Buildings

Subtask B: Integration and Optimisation of Daylighting Systems

- Report on Lighting Controls Design Guide
- Report on Calibration and Commissioning Guide
- Report(s) on Field and Laboratory Studies
- Working Document on Extended Monitoring Protocol
- Working Document on Design Guide

Subtask C: Daylighting Design Tools

- Report on Goniophotometry
- Report on the "All Sky Model"
- Report on Test Cases to Assess the Accuracy of Lighting Computer Programs
- Working document on User Expectation of Design Tools
- Working Document on the Application of the IBP Numerical Goniophotometer
- Working Document on Plug-ins for inter-program Communication

Subtask D: Daylight Performance Tracking Network and Design Support

- Working Document on Summary of References
- Working Document on Benefits and Costs of Daylighting
- Working Document on Noteworthy Buildings

MEETINGS FOR 2004

Sixth Experts Meeting
March 22-26
Tokyo, Japan

Seventh Experts Meeting
September 20-24
Torino, Italy

MEETINGS PLANNED FOR 2005

Eighth Experts Meeting
April 18-21
Berkeley, California

Ninth Experts Meeting
September 19-21
Berlin, Germany (with Lux Europa)

IEA SHC TASK 31
National Contact Persons

Operating Agent
Nancy Ruck
School of Architecture, Design Science and Planning
University of Sydney
Sydney NSW 2006
ncr1@austarnet.com.au

Australia
Stephen Coyne
Centre for Medical, Health Environment Physics
School of Physics & Chemical Sciences
Queensland University of Technology

GPO Box 2434
Brisbane,
Queensland 4001
s.coyne@qut.edu.au

Phillip Greenup
Ove Arup and Partners
Sydney
Phillip.Greenup@arup.com

Mark Luther
Built Environment Research Group

Deakin University
Geelong, Victoria
luther@deakin.edu.au

Belgium
Magali Bodart
Université Catholique de Louvain
Architecture et Climat
Place de Levant 1
1348 Louvain-la-Neuve
bodart@arch.ucl.ac.be

Arnaud Deneyer
Belgian Building Research Institute
arnaud.deneyer@bbri.be

Canada
Christoph Reinhart
National Research Council,
Canada Institute for Research in Construction
1500 Chemin Montreal Road
Ottawa, Ontario KIA 0R6
christoph.reinhart@nrc.ca

Denmark
Kjeld Johnsen and Jens Christoffersen
Danish Building and Urban Research
Energy and Indoor Climate Division
Postboks 119
DK-2970 Hørsholm
kjj@by-og-byg.dk or kjj@sbi.dk
jsc@by-og-byg.dk or jsc@sbi.dk

Finland
Liisa Halonen
Helsinki University of Technology
Otakaari 5 A
02150 Espoo
liisa.halonen@hut.fi

Jorma Lethovaara
Helsinki University of Technology
Lighting Laboratory
PO Box 3000
FIN-02015 HUT
jjorma.lethovaara@hut.fi

France
Marc Fontoynont, Fawaz Maamari,
ENTPE/DGCB
Rue Maurice Audin
69518 Vaulx-en-Velin, Cedex
Marc.fontoynont@entpe.fr

Germany
Jan de Boer and Hans Erhorn
Fraunhofer-Institut für Bauphysik
Nobelstrasse 12
70569 Stuttgart
hans.erhorn@ibp.fhg.de
jdb@ibp.fhg.de

Alexander Rosemann
Technical University of Berlin
rosemann@ee.tu-berlin.de

Italy
Valentina Serra
Politecnico di Torino
Viale Mattioli 39
10125 Torino
valentina.serra@polito.it

Anna Pellegrino
Dipartimento di Energetica-
Facolta di Architettura-
Politecnico di Torino
Viale Mattioli 39
10125 Torino
anna.pellegrino@polito.it

Japan
Koga, Yasuko
Dept. of Architecture and Urban Design
Kyushu University
Japan
koga@arch.kyushu-u.as.jp

New Zealand
Michael Donn and Werner Osterhaus
Victoria University of Wellington
Centre for Building Performance
P.O. Box 600
Wellington 1
michael.donn@vuw.ac.nz
werner.osterhaus@vuw.ac.nz

Norway
Barbara Matusiak
Norwegian University of Science and Technology
Faculty of Architecture, Planning and Fine Arts
7034 Trondheim

Sweden
Helena Bülow-Hübe
Lund University
Division of Energy and Building Design
Department of Construction and Architecture
P.O. Box 118
S-221 00 Lund
helena.bulow-hube@ebd.lth.se

Nils Svendenius
Lund University
Department of Atomic Spectroscopy
Sölvegatan 14
S-223 62 Lund
nils.svendenius@astro.lu.se

Lars R Bylund
PELK Design Group
Drottningsgatan 71 C
SE-11136 Stockholm
lars.r.bylund@telia.com

Switzerland
Nicolas Morel, Jean-Louis Scartezzini, Antoine Guillemin, Marilyne Andersen
Solar Energy & Building Physics Lab.
École Polytechnique Fédérale de Lausanne
1015 Lausanne
Nicolas.morel@epfl.ch
Jean-louis.scartezzini@epfl.ch

United Kingdom
John Mardaljevic
Institute of Energy & Sustainable Development
Leicester
UK LE7 9SU
jm@dmu.ac.uk

United States
William Carroll
Lawrence Berkeley National Laboratory
Mail stop 90 - 3111
Berkeley, California 94720
wlcarroll@lbl.gov

Steve Selkowitz
Lawrence Berkeley National Laboratory
Building 90-Room 3111
Berkeley, CA 94720
seselkowitz@lbl.gov

Eleanor Lee
Lawrence Berkeley National Laboratory
Building 90-Room 3111
Berkeley CA 94720
eslee@lbl.gov

TASK 32:

Advanced Storage Concepts for Solar and Low Energy Buildings

Jean-Christophe Hadorn

BASE Consultants SA
Operating Agent for the Swiss Federal Office of Energy

TASK DESCRIPTION

The main goal of this Task is to investigate new or advanced solutions for storing heat in systems providing heating or cooling for low energy buildings.

The first objective is to contribute to the development of advanced storage solutions in thermal solar systems for buildings that lead to high solar fraction up to 100% in a typical 45N latitude climate. The second objective is to propose advanced storage solutions for other heating or cooling technologies than solar, for example systems based on current compression and absorption heat pumps or new heat pumps based on the storage material itself.

The ambition of the Task is not to develop new storage systems independent of a system application. The focus is on the integration of advanced storage concepts in a thermal system for low energy housing. This provides both a framework and a goal to develop new technologies.

To carry out the Task 32 work programme there are four main Subtasks:

- **Subtask A: Evaluation and Dissemination** (Subtask Leader in 2004: Switzerland)
- **Subtask B: Chemical and Sorption** (Subtask Leader: Chris Bales, Sweden)
- **Subtask C: Phase Change Materials** (Subtask Leader: Wolfgang Streicher, Austria)
- **Subtask D: Water** (Subtask Leader; Germany to be confirmed)

Duration

The Task was initiated in July 2003 and will be completed in December 2006.

ACTIVITIES DURING 2004

Meetings

In 2004, two meetings gathered 20 experts from 8 countries plus invited persons. The main outcomes were:

- There are new Phase Change Materials that are suited to solar applications and are being tested in combisystems.
- The recent process of microencapsulation of PCM can bring new ideas for storage of solar heat or collecting heat with slurries.
- The improvement in density of storage compared to water will be however hardly higher than a factor 1.5.
- Storage based on sorption principles could bring interesting new solutions, but more for reversible heat and cold heat pumps than for long term storage. Mainly because a low grade heat source is still needed in wintertime, a new option from expert H. Kerkes might however bring a long term storage solution.
- Chemical storage is not deeply investigated in participating countries due to the lack of funding.
- Improvement in classical market standard water stores is still possible in a few directions that are being investigated both theoretically and experimentally.
- A PCM storage can improve the environmental emissions of a classical boiler by limiting the on/off cycling.
- Apart from models for advanced storage techniques, a model for a boiler in transient mode is missing in the TRNSYS library and will have to be developed.

Task Web Site (www.baseconsultants.com/iea32)

A presentation of the scope of the Task, of the participants and some official reports can be found on the site. Links to manufacturers of special storage material for solar and low energy buildings can be found. All internal reports and articles of the Task 32 (about 100 documents) are in a section of the site with restricted access to Task participants.

IEA SHC Task 26 FSC Method

An improvement of the IEA SHC Task 26 FSC method that compares designs of solar installations has been derived theoretically. FSC now covers systems able to produce heat and cold from solar and eventually operating with a long term storage. It will now be validated against detailed simulation results.

State-of-the-Art Report on the Heat/Cold Storage Solutions for Solar Houses

This report was originally planned for 2004. Due to external contributions and a more ambitious table of contents than anticipated in 2003, the final publishing date will be April 2005.

New Task Participants

Two new participants joined in 2004, an expert in PCM from Spain and an expert from EDF Research in France.

Newsletter

An electronic newsletter was issued in December 2004.

WORKED PLANNED FOR 2005

Task work will include the simulation of a common reference case (a low energy house placed in four climates), but with different kind of storage alternatives and experimental validation of devices, units or systems depending on each project's status and financial resources. In addition, each team in the Task will proceed with laboratory measurements on their project and development of new storage component model for TRNSYS.

A brochure describing the Task will be produced and distributed.

REPORTS PUBLISHED IN 2004

- Task 32 description of projects in a common reporting format
- Extended FSC method for cooling and or larger storage capacities. Access to this report is restricted to Task members at this time.

REPORTS PLANNED FOR 2005

- State-of-the-Art Report on the Heat/Cold Storage Solutions for Low Energy Houses
- Report on Reference Conditions for the Common System

MEETINGS IN 2004

Third Experts Meeting
Combined with ECES Annex 17 meeting
June 8-10
Arvika, Sweden

Fourth Experts Meeting
December 1-3
Graz, Austria

MEETINGS PLANNED FOR 2005

Fifth Experts Meeting
May 18-20
Lleida, Spain

Sixth Experts Meeting
November 23-25
Paris, France

TASK 32
National Contact Persons

Operating Agent
Jean-Christophe Hadorn
BASE Consultants SA
51 Chemin du Devin
CH-1012 Lausanne
jchadorn@baseconsultants.com

Austria
Prof. Wolfgang Streicher, Andreas Heinz
And Peter Puschnig
Institute of Thermal Engineering
Graz University of Technology
Inffeldgasse 25, 8010 Graz, Austria
streicher@iwt.tu-graz.ac.at
heinz@iwt.tugraz.at
puschnig@iwt.tugraz.at

Waldemar Wagner and Dagmar Jaehnig
AEE INTEC
Arbeitsgemeinschaft ERNEUERBARE ENERGIE
Feldgasse 19
A-8200 Gleisdorf
w.wagner@aee.at
d.jaehnig@aee.at

Denmark
Simon Furbo, Elsa Andersen,
Jorgen Schultz, and Niels Kristian Vejen
Solar Energy Center Denmark
Technical University of Denmark
Department of Buildings and Energy
Building 118
DK-2800 Lyngby
sf@byg.dtu.dk
ean@byg.dtu.dk
js@byg.dtu.dk
nkv@byg.dtu.dk

France
Thomas Letz
Maison des energies - ASDER
562 Avenue du Grand Arietaz BP 99499
F-73094 CHAMBERY Cedex
thomas.letz@asder.asso.fr
Laurent Barthel
EDF Paris
laurent.barthel@edf.fr

Germany
Harald Drueck and Henner Kerskes
Institut fuer Thermodynamik und Waermetechnik (ITW)
Pfaffenwaldring 6
D-70550 Stuttgart
drueck@itw.uni-stuttgart.de
kerkes@itw.uni-stuttgart.de

Hans-Martin Henning
Thomas Nunez
Thermal Systems and Components
Fraunhofer Institute for Solar Energy Systems ISE
Heidenhofstr. 2
D - 79110 Freiburg
hansm@ise.fhg.de
nunez@ise.fraunhofer.de

Frank Thole
Schüco International KG
fthole@schueco.de

Spain
Luisa F. Cabeza
Escola Universitària Politècnica
Universitat de Lleida
Jaume II, 69
SP - 25001 Lleida
lcabeza@diei.udl.es

Sweden
Chris Bales
Lecturer and Researcher in Environmental Engineering (Energy)
Högskolan Dalarna
Solar Energy Research Center SERC
Dept. of Mathematics, Natural Sciences and Technology
S-78188 Borlänge
cba@du.se

Switzerland
Stéphane Citherlet and Jacques Bony
EIVD - School of Engineering
Solar Laboratory and Physics of Building
Route de Cheseaux 1
CH - 1401 Yverdon-les-Bains
stephane.citherlet@eivd.ch
Jacques.Bony@eivd.ch

Andreas Luzzi, Peter Vogelsanger, Paul Gantenbein
And Michel Haller
SPF Hochschule für Technik Rapperswil
Oberseestr. 10
CH-8640 Rapperswil
Andreas.Luzzi@solarenergy.ch
peter.vogelsanger@solarenergy.ch
paul.gantenbein@solarenergy.ch
michel.haller@solarenergy.ch

The Netherlands
Jacob van Berkel (2003-2004)
Entry technology
Spoorbaanweg 15
3911 CA Rhenen
NL - KvK Utrecht 30142996
jvb@entry.demon.nl

Klaas Visscher, Wim van Helden and Marco Bakker
Energy research Centre of the Netherlands (ECN)
P.O. Box 1
NL - 1755 ZG Petten
visscher@ecn.nl
vanhelden@ecn.nl
m.bakker@ecn.nl

TASK 33:

Solar Heat for Industrial Processes

Werner Weiss

Arbeitsgemeinschaft ERNEUERBARE ENERGIE Institute for Sustainable Technologies Operating Agent for the Austrian Ministry of Transport, Innovation and Technology

TASK DESCRIPTION

Around 100 million square meters of solar thermal collectors, corresponding to an installed capacity of 70 GWth, were installed by the year 2001 in the OECD countries. Until now, the widespread use of solar thermal plants has focused almost exclusively on swimming pools, domestic hot water preparation and space heating in the residential sector.

The use of solar energy in commercial and industrial companies is currently insignificant compared to the use in swimming pools and the household sector. Most solar applications for industrial processes have been used on a relatively small scale and are mostly experimental in nature. Only a few large systems are in use worldwide. However, if one compares the energy consumption of the industrial, transportation, household and service sectors in OECD countries, the industrial sector has the highest energy consumption at approximately 30%, followed closely by the transportation and household sectors.

The major share of the energy, which is needed in commercial and industrial companies for production processes and for heating production halls, is below 250°C. The low temperature level (< 80°C) complies with the temperature level that can easily be reached using solar thermal collectors already on the market. The principles of operation of the components and systems apply directly to industrial process heat applications. The unique features of these applications lie on the scale on which they are used, system configurations, controls needed to meet industrial requirements, and the integration of the solar energy supply system with the auxiliary energy source and the industrial process. For applications where temperatures up to 250°C are needed, the experiences are rather limited and suitable components and systems are missing. Therefore, for these applications the development of high performance solar collectors and system components is needed.

To be able to make use of the huge potential for solar heat in industry and to open a new market sector for the solar thermal industry, SHC Task 33 is going to carry out potential studies, it will investigate the most promising applications and industrial sectors for solar heat, and it will optimize, develop and test solar collectors for medium temperature applications (up to approximately 250°C). The development of integral solutions for solar thermal energy applications for given industrial processes (based on the "PINCH-concept") is also one of the main topics of this Task. In addition to the development of design tools (based on TRNSYS simulations); other planned activities include a software tool for fast feasibility assessment, economic analyses and the design and construction of pilot plants in co-operation with industry.

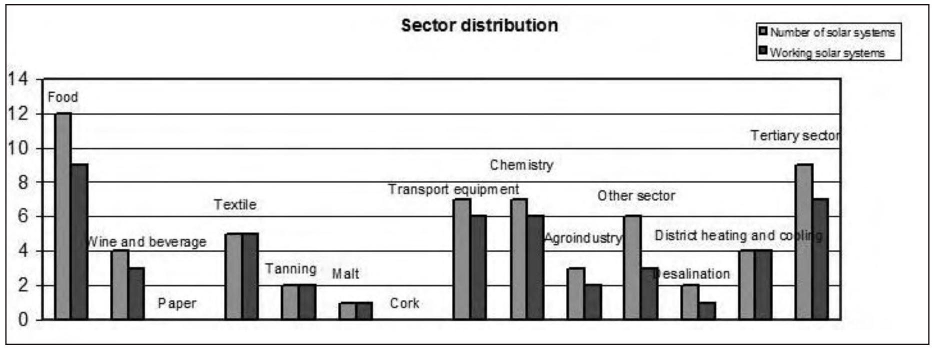


FIGURE 1. Distribution of solar plants reported to Task 33/IV. Number of projects: (a) total and (b) plants still in operation. State: April 2004.

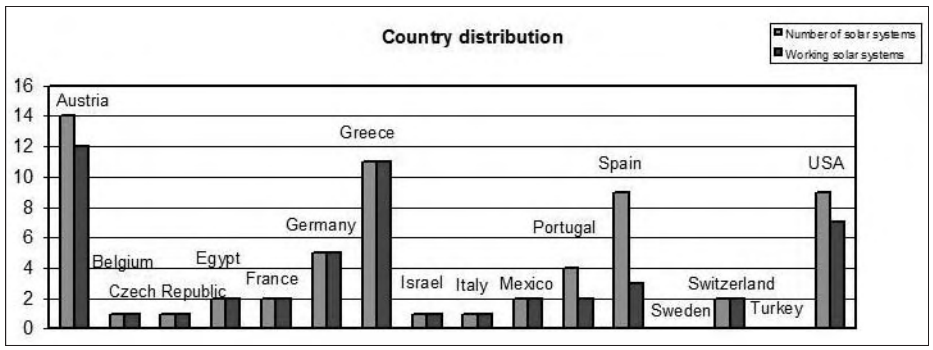


FIGURE 2: Solar plants documented by Task 33/IV: Distribution by countries. State: April 2004.

Scope of the Task

The scope of the Task is on solar thermal technologies for converting solar radiation into heat, (i.e., starting with the solar radiation reaching the collector and ending with the hot air, water or steam transferred to the application.) The distribution system, the production process and/or the optimization of the production process are not the main topics of the Task. However, influences on the production process and the distribution system arising from the solar character of the heat source will be studied in the framework of the Task.

Applications, systems and technologies, which are included in the scope of this Task, are:

- All industrial processes requiring heat to a temperature level of approximately 250°C.
- Space heating of production or other industry halls is addressed, but not space heating of dwellings.
- Solar thermal systems using air, water, low pressure steam or oil as a heat carrier (i.e., not limited to a certain heat transfer medium in the solar loop).
- All types of solar thermal collectors for an operating temperature level up to 250°C are addressed: uncovered collectors, flat-plate collectors, improved flat-plate collectors, for example, hermetically sealed collectors with inert gas fillings, evacuated tube collectors with and without reflectors, CPC collectors, MaReCos (Maximum Reflector Collectors), and parabolic trough collectors.

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

- **Subtask A: Solar Process Heat Survey and Dissemination of Task Results** (Lead Country: Spain)
- **Subtask B: Investigation of Industrial Energy Systems** (Lead Country: Austria)
- **Subtask C: Collectors and Components** (Lead Country: Germany)
- **Subtask D: System Integration and Demonstration** (Lead Country: Germany)

Collaboration with other IEA Programmes

Due to the complementary background and know-how among the participants of the SHC and the SolarPACES Programmes, significant synergies were expected from collaboration. Therefore, it was agreed to co-operate with the SolarPACES Program on a "moderate level" according to the SHC "Guidelines for Co-ordination with other Programs."

Duration

The Task was initiated on November 1, 2003 and will be completed on October 31, 2007.

ACTIVITIES DURING 2004
Subtask A: Solar Process Heat Survey and Dissemination of Task Results

During 2004, a potential study for Austria was completed and the final report is available. The results of the Austrian study and the preliminary results of studies for Spain, Portugal and Italy show that the potential for solar low temperature heat ranges between 3% and 4 % of the total heat demand of the industry.

Information also was collected on industrial-process solar heat plants operating world wide. From the 49 reported plants, the majority of the projects are in the food and beverage, textile, transport and chemistry sectors with a large majority in food processes. There are 12 plants in the food industry in fish, meat and olive processing. In the transport sector, most plants are washing installations. And, in the textile industry, most are laundry companies.

The majority of the operating plants are in countries with the most important solar industrial development. Indeed, in Austria, Greece, Spain and the USA, where there have been several plants built during the 1990s, there are more than 67% of the reported plants.

Most of the reported plants supply heat at temperature levels between 60°C and 100°C. Some plants are working at temperatures above 160°C, and there is only one project operating in the intermediate range from 100° to 160°C. Out of the five plants working at more than 160°C there are two prototype plants and three plants for space heating and cooling with double effect absorption machines (steam production).

Following are several plants for solar process heat in industry are described:

A pharmaceutical chemical company's solar application in Egypt.

EL NASR, pharmaceutical chemicals facility in Egypt

Application: production of process steam for a pharmaceutical company

Location:	Cairo, Egypt
Installed capacity:	1330 kW
Collector area:	1900 m^2
Collector type:	parabolic trough collectors
Heat transfer medium:	steam (8 bar)
Operating temperature:	173 °C
Start of operation:	2004 (January)

An Austrian hall and office building that uses solar for heating.

100% renewable energy for production hall and office building in Austria

Application: heating of a productionhall

Location:	Bludesch, Austria
Installed capacity:	56 kW
Collector area:	80 mÇ
Collector type:	flat-plate collector
Heat transfer medium:	water-glycol
Operating temperature:	20 – 80°C
Storage:	950 litres
Start of operation:	1994

Solar-powered air conditioning system for a road traffic control centre in Portugal

Application: space heating and cooling with a single effect lithium-bromide 79 kW absorption cooling machine.

Location:	Carcavelos (BRISA), Portugal
Installed capacity:	464 kW
Collector area:	663.3 m2
Collector type:	CPC solar collectors
Heat transfer medium:	water-glycol
Operating temperature:	80 - 90 °C
Storage:	20 m3
Start of operation:	2004 (January)

Industry Workshops

In conjunction with the Task 33 Experts meeting in Brussels, Belgium an industry workshop was organized. Eleven representatives from the solar industry, the European Solar Thermal Industry Federation (ESTIF), the European Commission and the EUREC Agency participated. Another industry workshop was organized in November in conjunction with the ISES Latin America Regional Conference in Guanajuato, Mexico.

Subtask B: Investigation of Industrial Energy Systems

The integration of solar heat into industrial production processes is a challenge to both the process engineer and the solar expert. In applying solar heat, attention must be paid to the temperature levels used in the heat supply system. Another challenge is the time-dependency of the solar energy supply and the heat demand of the processes.

Favorable conditions for solar thermal energy are mean temperatures which are as low as possible, processes that need a constant amount of energy during sunlight hours and high energy prices in the existing system. Besides these parameters, the characteristics of load curves of industrial production processes with the potential to use solar heat have been documented and analyzed with regard to peak hours and stop times and compared with the supply loads of solar thermal systems.

Based on the analyses described above, the most promising processes, applications and industrial sectors for solar heat were identified.

The expansion of existing heat integration models (PINCH technology) to solar energy and the expansion of design tools for solar heating systems to industrial processes were other main topics in 2004. The minimum energy demand of a production system and the maximum potential for heat recovery was analyzed for several industrial processes based on the PINCH theory.

In general, heat integration means the linking of hot and cold streams in a process in a thermodynamically optimal way. The pinch analysis is the most important concept in the field of process integration methodologies. Linnhoff et al developed this concept into an industrial technology and the technology was later expanded into new areas such as water pinch and hydrogen pinch.

The fundamental principal behind the pinch concept is the ability to match the individual demand for a commodity with a suitable supply. The suitability of the match depends on the quality required and the quality offered. In the case of energy the commodity is heat/energy and its quality is measured as temperature.

The pinch analysis is a structured approach to identify energy inefficiencies in industrial processes. The minimum theoretical utility requirement in the processes is calculated for overall energy use as well for specific utilities.

Operations and processes in some important industrial sectors
(• : important, X: very important)

process	food	textiles	building materials	galvanising, electroplating	fine chemicals	pharmaceutical and biochemical	service industry	paper industry	automotive supply	tanning	painting	wood and wood products
cleaning	X	X	•	X	•	X	X		•	•	X	
drying	X	X	•		•	X	X	•	•	X	X	X
evaporation and distillation	X				•	X						
pasteurisation	X					X						
sterilization	X					X						
cooking	X											
general process heating	•	•	•	X	•	•	X		•			•
boiler feedwater preheating	X	X	•		•	•		•		•		
heating of production halls	X	X		•	•	•	•		X	X	X	X
solar absorption cooling	X			•		X	X					

TABLE 1. The most promising processes, applications and industrial sectors for solar heat

Subtask C: Collectors and Components

An overview of the different medium-temperature collector developments that are being investigated in connection with the Task was prepared. Concise papers which describe the collectors were written. A report based on these papers, which summarizes the information on the current state-of-the-art, will be published.

The new term 'medium-temperature collectors' is used to denote collectors with operating temperatures between 80°C and 250°C. The aim is to develop collectors that are suitable for applications in this temperature range within which there has been very limited experience to date. In order to give a short overview, three categories may be introduced (the involved partners are given in brackets):

- Improved flat-plate collectors: double-glazed flat-plate collectors with anti-reflection glazing (ISE, Germany).
- stationary, low-concentration collectors: stationary CPC type collectors (INETI, Portugal and Solarfocus, Austria),
- tracked concentrating collectors: small parabolic trough collectors (AEE INTEC and Button Energy, Austria; SOLEL, Israel; DLR and SOLITEM, Germany; CIEMAT, Spain)

All collector developments are on-going and will be continued in 2005.

Parabolic trough collector under development at AEE INTEC in Austria.

Double glazed collector with AR-glasses on an outdoor test site at Fraunhofer ISE in Germany.

Two examples of installations using medium-temperature collectors put into operation in 2004 were:

◗ In mid 2004, a system with a SOLITEM parabolic trough collector was put into operation. The system is installed in Dalaman, Turkey. The medium-temperature collectors supply heat for an absorption cooling machine for a dryer and for the air-conditioning system of a hotel with 700 beds.
◗ In December 2004, a compact sea-water desalination system was installed by Fraunhofer ISE in Spain (Gran Canaria) in which double-glazed anti-reflective flat plate collectors are used.

Collector Testing

Until the planned round-robin test starts, it makes sense to describe the medium-temperature collector testing and the activities associated with the test and qualification standards for medium-temperature collectors up to 250°C together. In the course of the work on this topic, the general approach is to base the considerations on the existing European collector testing standard EN12975. The aim is to investigate which changes or additional requirements are necessary in order to include the broad spectrum of medium-temperature collectors (improved flat-plate collectors, stationary concentrating collectors, tracked parabolic trough collectors) into the existing EN12975 standard. Most of the necessary points of discussions refer to tracked parabolic trough collectors. Based on further discussion it was decided that the following topics need further clarification:

◗ definition of the reference area;
◗ conditions for valid measurement points;
◗ wind requirements;
◗ IAM definition as in EN12975; and
◗ how to deal with end losses.

The present status of the Task work was published in a working document by M. Rommel, which summarizes the topic from the point of view of the low-temperature collector testing experience. The approach from the high-temperature technology point of view is described in a paper by Lüpfert, Hermann, Price, Zarza and Kistner, "Towards standard performance analysis for parabolic trough collector fields", and was presented at the SolarPACES conference in Oaxaca, Mexico in October 2004.

Realistic Medium-Temperature Component Parameters for Simulation Models

In the course of the work carried out so far, the decision was made to restrict the work to components of the solar loop and to concentrate especially on piping losses. First results of investigations on measured piping losses in testing systems installed at the testing facilities at Fraunhofer ISE and at PSA

(Plataforma Solar Almeria) revealed that the measured losses are distinctively higher than those estimated from plain well-insulated pipes. This work will be continued in 2005.

Subtask D: System Integration and Demonstration

TRNSYS was agreed upon as the standard simulation tool within Task 33/IV, since most partners are already using it and many solar thermal components are already available. A list of available TRNSYS models applicable for solar process heat systems and their components will be compiled, to form a basis for the identification of further development needs.

A numeric tool to assist inexperienced users in the assessment of potential applications for solar process heat can help to identify promising applications at an early stage without undue engineering analysis effort which presently creates a significant barrier for the market entry of solar process heat technologies. In 2004, a number of programs were screened, but no suitable existing program could be identified. GREENIUS, developed by DLR for the assessment of different renewable electricity generation technologies, was found to provide a good basis to be adapted for the purposes of Task 33/IV.

Besides the work on simulation and design tools, seven case studies have been carried out in different industry sectors and countries:

- A textile company and a dairy in Austria. Carried out by AEE INTEC and JOINTS
- Food industry (jam pasteurising), paper industry (cardboard drying), hotel (laundry and hot water preparation), food industry (slaughterhouse), all in Nicaragua. Carried out by AEE INTEC
- Parking service (hot water preheating) in Spain. Carried out by Aiguasol.

These studies indicated interesting potential in the lower temperature range, and provided good experience for the use of interim results and further development of the design guidelines.

WORK PLANNED FOR 2005

Subtask A: Solar Process Heat Survey and Dissemination of Task Results

Two reports are planned for 2005. A report on the potential of solar heat for industrial processes and the most promising industrial sectors in the participating countries will be prepared in 2005. And, a second report will focus on state-of-the-art solar collector technology, system concepts and system costs in the participating countries and will review existing and projected solar process heat systems.
Another main topic of Subtask A will be the organization of two workshops targeted at industries not directly involved in the Task and potential users of the Task results. These "Industry Workshops" will be organized in conjunction with the Task meetings. One will be organized in Madrid in February 2005 in conjunction with the biennial Spanish industrial trade fair for cogeneration and for HVAC technologies (GENERA 2005). The second industry workshop will take place in October 2005 in Kassel, Germany.

The publication of the second Industry Newsletter is planned for autumn 2005.

Subtask B: Investigation of Industrial Energy Systems

Since the work of Subtask B must be finalized in 2005, the focus of Subtask B will be on the integration of existing heat integration models (PINCH technology) into the design procedure of solar thermal systems. The other two main topics for 2005 will be the evaluation of solar energy in comparison with other ways to save fossil fuels such as energy efficiency, heat pumps and heat integration, and the development of a short-cut "Total Cost Analysis" for solar plants for industrial applications.

Subtask C: Collectors and Components

The work on the development of the different medium-temperature collectors will be continued in 2005 and a first cost analysis will be carried out for the different collector technologies involved. It is also planned to include LCA (life cycle analysis) considerations, mainly to compare different medium-temperature collector technologies with each other (flat-plate, vacuum tube, parabolic trough).

A first draft of the recommendations for the performance tests of medium-temperature collectors is planned for 2005. The work on testing methods suitable for medium-temperature collectors will be continued and a round robin test for a medium-temperature collector will be started at the end of 2005.

Concerning the reliability of collectors for industrial processes, a first definition of the performance parameters for new materials in medium-temperature collectors is planned for the end of 2005. This mainly concerns the performance parameters of reflectors, absorbers and insulation materials. Accelerated exposure tests on existing and new materials for medium-temperature collectors will be started.

Other work topics will focus on simulation models and on the investigation of the stagnation behavior of large medium-temperature systems. An interim report on the stagnation behavior of large systems for industrial applications will be prepared.

Subtask D: System Integration and Demonstration

According to the work plan, work on the "Design Guidelines" and the adaptation of the GREENIUS program is scheduled to start at a workshop in October 2005.

A main focus in Subtask D will be on a number of case studies in order to initiate first pilot projects. Further activities will be the definition of common monitoring guidelines and the acquisition of funds for the implementation of appropriate equipment in selected installations.

LINKS WITH INDUSTRY

The Task defines two levels of participation for the solar industry:

- Level 1. An industrial participant at this level should expect to participate in an annual workshop organized by SHC Task 33 and to receive at least once during the Task duration a visit from a Task participant, and to answer technical and marketing questions on solar heat for industrial applications (this activity is part of the system survey and the dissemination activity of Subtask A).
- Level 2. An industrial participant at this level should expect Level 1 commitment and to participate in all Task meetings and to bring information and feedback from the market. Level 2 participation should be seen in close connection with the main participant of the country of origin of the industry.

A total of 15 companies from Austria, Italy, Spain, Portugal, Germany, Belgium, France and Brazil participate in the Task.

REPORTS PUBLISHED IN 2004

- Austrian potential study for solar heat for industrial applications
- First Industry Newsletter
- Six papers on solar heat for industrial applications and the development of medium temperature collectors were presented at international conferences in 2004.

REPORTS PLANNED FOR 2005

- Report on the potential of solar heat for industrial processes and the most promising industrial sectors
- Report on the state-of-the-art of the solar collector technology, system concepts and system costs in the participating countries
- Report and design guidelines for space heating of production halls
- State of the art report on medium temperature collectors
- Second Industry Newsletter
- Subtask B report

MEETINGS IN 2004

Second Experts Meeting
March 29-30
Brussels, Belgium

Third Experts Meeting
October 3-5
Oaxaca, Mexico

MEETINGS PLANNED IN 2005

Fourth Experts Meeting
February 23-25
Madrid, Spain

Fifth Experts Meeting
October 3-8
Kassel, Germany

TASK 33
National Contacts

Operating Agent
Werner Weiss
AEE INTEC
AEE - Institute for Sustainable Technologies
Feldgasse 19
A-8200 Gleisdorf
Austria

Australia
Wes Stein
Lucas Heights Science & Technology Centre
New IllawarraRd, Lucas Heights NSW, PMB 7
Bangor NSW 2234

Austria
Dagmar Jähnig and Thomas Müller
AEE INTEC
AEE - Institute for Sustainable Technologies
Feldgasse 19
A-8200 Gleisdorf

Hans Schnitzer and Christoph Brunner
Joanneaum Research
Elisabethstrasse 16/1
A-8010 Graz

Gernot Gwehenberger
Technical University of Graz
RNS
Inffeldgasse 25c
A-8010 Graz

Czech Republic
Bohumil Horák
VSB- Technical Universtity of Ostrava
17. listopadu 15
CZ 70833 Ostrava-Poruba

Eva Kudrnova
Technology Centre AS CR
Rozvojova 135
165 02 Prague 6

Germany
Klaus Vajen and Elimar Frank
Kassel University
Department of Mechanical Engineering
Solar and System Technology
D-34109 Kassel

Andreas Häberle
PSE GmbH
Christaweg 40
D-79114 Freiburg

Klaus Hennecke
DLR
Institut für Technische Thermodynamik
D-51170 Köln

Matthias Rommel
Fraunhofer ISE
Heidenhofstrasse 2
D-79110 Freiburg

Stephan Fischer
ITW, Stuttgart University
Pfaffenwaldring 6
D-70550 Stuttgart

Markus Peter
dp2 - Energienutzung mit Verstand
Michelsweg 29
D- 59494 Soest

Italy
Riccardo Battisti, Annalisa Corrado
Claudia Vannoni, Serena Drigo
University of Rome "La Sapienza"
Department of Mechanical and Aeronautical Engineering
Via Eudossiana
18 00184 Rome

Mexico
Claudio Estrada
CIE-UNAM
Privada Xochicalco, S/N, Col. Centro
Cuernavaca, Mor., Mexico

Portugal
Maria Joao Carvalho
INETI
Edificio H, Estrada do Paço do Lumiar, 22
1649-038 Lisboa

Spain
Esther Rojas Bravo
CIEMAT-PSA
Avda. Complutense, 22, Edificio 42
28040 Madrid

Eduardo Zarza
CIEMAT-PSA
P.Box 22, Tabernas
04200-Almería

Hans Schweiger
AIGUASOL Engineering
Palau 4, 20 2°
08 002 Barcelona

SHC TASK 34/ECBCS Annex 43:

Testing and Validation of Building Energy Simulation Tools

Ron Judkoff

National Renewable Energy Laboratory Operating Agent for the U.S. Department of Energy

This work is the combined effort of SHC Task 34 and Energy Conservation in Buildings and Community Systems (ECBCS) Annex 43.

TASK DESCRIPTION

The goal of this Task is to undertake pre-normative research to develop a comprehensive and integrated suite of building energy analysis tool tests involving analytical, comparative, and empirical methods. These methods will provide for quality assurance of software, and some of the methods will be enacted by codes and standards bodies to certify software used for showing compliance with building energy standards. This goal will be pursued by accomplishing the following objectives:

- Create and make widely available a comprehensive and integrated suite of IEA Building Energy Simulation Test (BESTEST) cases for evaluating, diagnosing, and correcting building energy simulation software. Tests will address modeling of the building thermal fabric and building mechanical equipment systems in the context of innovative low-energy buildings.
- Maintain and expand as appropriate analytical solutions for building energy analysis tool evaluation.
- Create and make widely available high quality empirical validation data sets, including detailed and unambiguous documentation of the input data required for validating software, for a selected number of representative design conditions.

Scope

This Task will investigate the availability and accuracy of building energy analysis tools and engineering models to evaluate the performance of innovative low-energy buildings. Innovative low-energy buildings attempt to be highly energy efficient through use of innovative energy-efficiency technologies or a combination of innovative energy efficiency and solar energy technologies. To be useful in a practical sense such tools must also be capable of modeling conventional buildings. The scope of the Task is limited to building energy simulation tools, including emerging modular type tools, and to widely used innovative low-energy design concepts

Activities will include development of analytical, comparative and empirical methods for evaluating, diagnosing, and correcting errors in building energy simulation software. The audience for the results of the Task/Annex is building energy simulation tool developers, and codes and standards (normes) organizations that need methods for certifying software. However, tool users, such as architects, engineers, energy consultants, product manufacturers, and building owners and managers, are the ultimate beneficiaries of the research, and will be informed through targeted reports and articles.

Means

At this time a number of projects have been defined. For the purpose of describing the work, it is useful to define the terms "comparative tests" and "empirical validation." In comparative testing, a BESTEST-type comparative/diagnostic evaluation test procedure is written and software programs are compared to each other. Advantages of comparative tests include ease of testing many parameters, and that simple building descriptions may be used; the major disadvantage is lack of any truth standard in comparisons for cases where analytical solutions are not possible. In empirical validation, software is compared with carefully obtained experimental data. The advantage of empirical tests is that true validation of the models may be accomplished within the uncertainty of the experimental data; disadvantages are that gathering high quality experimental data is expensive and time consuming, making it difficult to test the individual effects of many parameters.

Comparative tests include:
- BESTEST ground-coupled heat transfer with respect to floor slab and basement constructions
- BESTEST multi-zone heat transfer and shading
- BESTEST airflow, including multi-zone airflow

Within the comparative test cases, analytical verification tests for evaluating basic heat transfer and mathematic processes in building energy analysis tools will be included where possible. Analytical verification tests are comparisons with closed-form analytical solutions or with numerical methods solutions performed outside of the environment of whole-building energy simulation software. Such solutions represent a "mathematical truth standard" based on the underlying physical assumptions given in the test specifications.

Empirical validation tests include:
- Shading/daylighting/load interaction
- Chilled-water and hot-water mechanical systems and components
- Buildings with double-skin facades.

When a number of building energy simulation programs are tested against the same empirical data set, comparative tests are also possible. Such comparative tests can help identify deficiencies in the empirical experiment if they exist, or broad-based deficiencies in the current modeling state of the art.

Regarding buildings with double-skin facades, both Fraunhofer Institute and Aalborg University have internal funding and impressive test facilities to conduct their Double-Skin Buildings research. However, Fraunhofer Institute needs supplemental funding from the ECBCS Executive Committee to take on the extra work of co-leading an IEA project. Extra responsibilities of the project leader include preparing a detailed test specification, supporting modelers in interpreting the specification, collating and reporting on results of experiments and modeling, and preparing an IEA Technical Report.

Administrative support projects are proposed to facilitate availability and distribution of IEA tool evaluation test procedures. These support projects include:
- Develop a single web site that consolidates IEA tool evaluation tests from SHC Task 12 / ECBCS Annex 21, SHC Task 22, and SHC Task 34 / ECBCS Annex 43
- Building Simulation Centre Proposal.

The Building Simulation Centre would be a proposal to create an entity dedicated to the coordination of building simulation software development activities including validation and testing. There is a need for ECBCS to support a leadership role by an appropriate Expert related to further development of the Building Simulation Centre concept within IEA 34/43.

Duration

The Task was initiated in September 2003, and will be completed in December 2007.

Participation

During 2004 a total of 35 participants from 25 organizations in 15 countries participated in this Task. The participating countries are:

Australia	Netherlands*	Denmark
Czech Republic	United Kingdom	Italy
Japan	Canada	Sweden
Switzerland	Germany	
Belgium	Spain	*Observer
France	United States	

ACTIVITIES DURING 2004

A summary of Subtask research and codes & standards activities completed is presented below.

Projects

This year was dedicated to completing planning and Subtask formation, and commencing project work. Activities during 2004 consisted of finalizing project plans, development of test specifications, acquiring empirical test data, and doing preliminary simulations of test cases.

Ground Coupled Floor Slab and Basement Comparative Tests (Leader: US/NREL)
NREL (US) revised and distributed the in-depth test specification in early June. The objective of the in-depth test cases is to determine the causes for disagreements among detailed-model results found in preliminary test cases developed during SHC Task 22. The new test cases compare ground models integrated with whole-building simulations to independent detailed models. There is also an analytical verification test case for checking the independent detailed models, and for checking that such models are applied properly by users. Parametric variations include: periodic ground surface temperature variation (versus steady-state), floor slab aspect ratio, slab size, deep ground temperature depth, and interior and exterior convective coefficients (realistic versus high values to test the effect of surface temperature uniformity).

Multi-Zone and Airflow Comparative Tests
(Leaders: US/NREL, Japan)
This project is divided into two sub-projects:
Multi-Zone Non-Airflow Tests led by USNREL; Airflow Tests including Multi-Zone Airflow led by Japan.

Non-Airflow Tests, US/NREL

- During May 2004 NREL distributed updates to four in-depth test cases. The objectives of these test cases are to test models' ability to correctly keep account of interzonal heat transfer and to help define a starting point for multi-zone airflow cases. The tests include steady-state 2-zone and 3-zone configurations for comparison of whole-building simulations with simple analytical solutions. Parametric variations enable (versus previously disabled) infrared radiation exchange in both cases. Simulation results were submitted by 9 participants (submitting participant in parenthesis): CODYRUN (U. Reunion Island, France), COMFIE (Ecole des Mines de Paris, France), DOE-2.1E (ACHSL, Spain), ESP-r (U. Strathclyde, UK), HTB2 (Cardiff U., UK), SIMBAD (CSTB, France), TRNSYS-TUD (Dresden U. of Technology, Germany), TRNSYS 15 (Brno. Univeristy Czech Republic, University Liege, Belgium). Results indicated generally good agreement–see Figure 1–with disagreements noted in the results handout that was distributed by NREL to the participants on October 1, 2004.

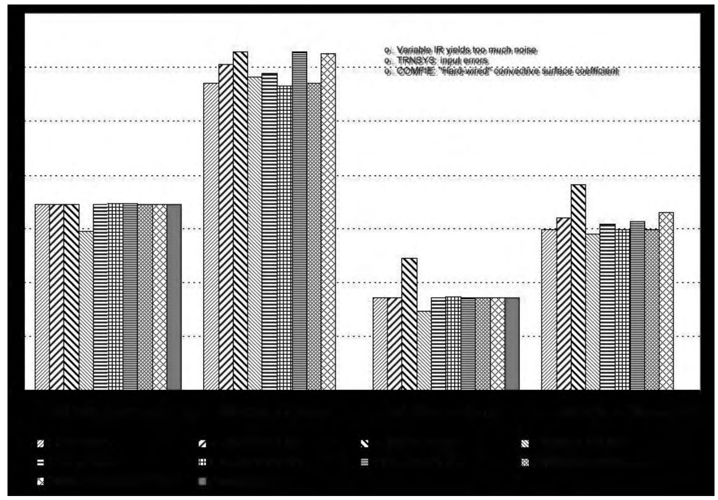


FIGURE 1. Multi-Zone Non-Airflow Sample Results, Cooling Loads.

Airflow Tests including Multi-Zone Airflow, Japan
At the November 2004 Experts' Meeting, INCT (Japan) presented a review of ECBCS Annex 23 work with testing COMIS. Some conclusions of Annex 23 were that large results differences come from modeling errors or typing errors, and including: misunderstandings of the test specification, and unclear definitions of reference heights for: buildings, zones, meteorological stations, and building orientation. One limitation of the Annex 23 work is that input specifications are only applicable to COMIS.

Shading/Daylighting/Load Interaction Empirical Tests
(Leaders: Switzerland, US/Iowa)
This project is divided into two sub-projects: EMPA Shading/Daylighting/Load Interaction led by EMPA; ERS Shading/Daylighting/Load Interaction led by ERS.

EMPA Shading/Daylighting/Load Interaction, Switzerland
During 2004 EMPA (Switzerland) improved their test cell–shown in Figure 2–by mounting an external guard zone over the wall with window for thermal characterization experiments, as suggested by NREL (US). Both overall conductance and internal capacitance experiments have been completed. Effects of thermal bridges (edges, corners, etc) were numerically modeled with TRISCO, with the TRISCO results made

available for input by simulations. 7 sets of simulation results were submitted: HELIOS (EMPA, Switzerland.), EnergyPlus (ISU/EMPA, US/Switzerland), DOE-2.1E (ISU/EMPA, US/Switzerland), TRNSYS (TUD, Germany), COMFIE/PLEIADES (EDMP, France), ESP-r (CVUT, Cz. Rep.), SIMBAD (CSTB, France). Conclusions so far: work to date provides enough information to describe the steady-state and transient thermal characteristics of the test cell; all simulations' zone air temperature predictions are within 3K; additional simulation iterations (e.g., for correction of input errors) may result in better agreement.

FIGURE 2. EMPA Test Cells in Duebendorf, Switzerland.

ERS Shading/Daylighting/Load Interaction, US/Iowa
The purpose of the work being done at Iowa Energy Resource Station in the United States is to create an empirical validation data set for daylighting controls. Tests were conducted to study the ability to model internal shading by roller shades and drapes for windows at south, east, and west orientations and to study the ability to model external shading by overhangs and fins applied to south windows. Equipment used includes: dimmable ballasts, fabric shades, exterior shading fins, and equipment for scheduled internal gains. Electric lights are controlled to maintain a minimum illuminance level; when enough natural daylight is available electric lighting is reduced. Simulation results were received from ISU/EMPA, US/Switzerland (EnergyPlus, DOE-2.1E) and TUD, Germany (TRNSYS-TUD). Other interested participants include Australia (eQUEST [DOE-2.2]) and Spain (DOE-2.1E). Example experimental and simulation results for zone electric lighting power are included in Figure 3. Conclusions are that overall predictions for daylighting performance were within acceptable ranges, and that uncertainty in the ERS – a real building – is greater than in a controlled laboratory experiment. This is a good exercise to see how accurate predictions for a real building can be.

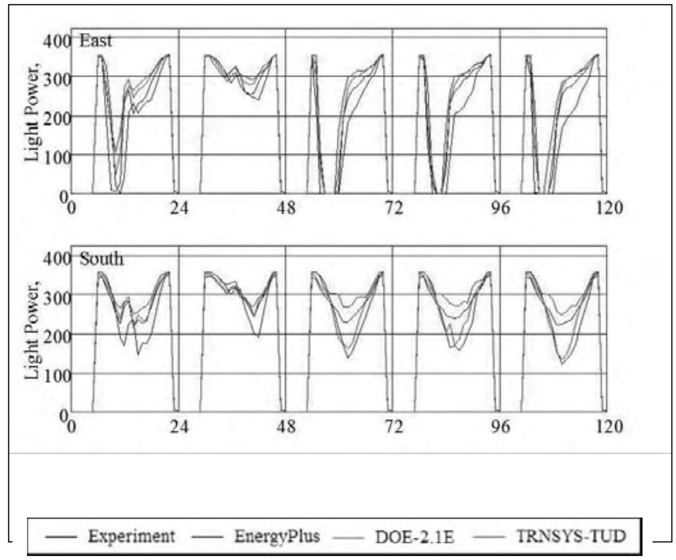


FIGURE 3. ERS Shading/Daylighting Results, Zone Lighting Power.

Systems, Components, and Controls Empirical Tests
(Leader: Germany/TUD)
During 2004 the project plan was more clearly defined, and preliminary work began. This work is focusing on chilled- and hot-water systems, and is separated into several sub-exercises to focus on single components tabulated below. Experimental and measurement facilities at the Iowa Energy Resource Station will be used for empirical studies.

TEST CASE	SIMULATION EXERCISES
Chilled water system	**Chiller** (two scroll compressors)
	Cooling coil (dry / wet regime with condensing water flow rate measurement)
	Hydronic network (pipes, pump, valve)
	Complete system
Hot water system	**Boiler** (condensing atmospheric natural gas boiler with variable firing rate)
	Heat exchanger (terminal re-heat)
	Hydronic network (pipes, pump, valve)
	Complete system

Work accomplished during 2004 began with comparative test cases of chiller hydronic systems including tests for models of: chiller, hydronic network (piping, valves, etc.), the air/water heat exchanger (coil), and the entire system. A preliminary comparative test specification was distributed, and simulation results have been obtained for TRNSYS-TUD (TUD, Germany) and EES (U. Liege, Belgium). Air-cooled chiller model results indicate agreement for predictions of supply water temperature, but have disagreements for electric load and COP. Coil model results indicate disagreement if there are latent loads present. Disagreements were found to be caused by an input error in the EES model.

Double-Facade Empirical Tests (Leaders: Denmark/Aalborg University, Germany/Fraunhofer Institute)
During 2004 the following objective was defined for this project: assess suitability and awareness of building energy analysis tools for predicting heat transfer, ventilation flow rates, cavity air and surface temperatures and solar protection effect and interaction with building services systems in buildings with double facade. Project activities were defined to include:

- Collection of available literature on typologies, modeling approaches, measurements, tools, etc.
- Description of test facilities and test cases used for validation. Documentation of the measured standard data sets
- Development of a user guide for tools, including sensitivity analysis on the main influences

This project is divided into two sub-projects: VERU facility tests led by Fraunhofer Institute for Building Physics (FIBP), Germany; Aalborg University (AAU), Denmark facility tests led by AAU. Additionally, Lund University, Sweden has been sharing their work on a literature survey being done in conjunction with a Swedish project on double-skin buildings.

Double-Skin Buildings Literature Survey, Lund University, Sweden
Lund University's literature review covers: building energy consumption, thermal and visual comfort, acoustics, environmental impacts during construction and operation, and application of new technologies. They have studied several categories of double-skin building construction types; advantages and disadvantages of double-skin facades; and modeling issues including airflow, thermal and daylighting simulations. The literature review found roughly 50 case studies. Their future field of interest is to study airflow within the double-skin cavity including proper width and positioning of openings, shading devices (type and position), and other design issues related to integration of double-skin facades.

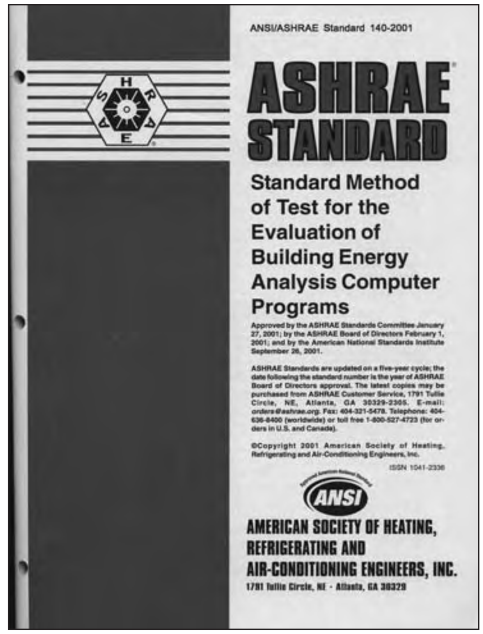
Double-Skin Buildings Empirical Validation Tests, Aalborg University, Denmark
Aalborg University has experienced a 6-month construction delay on their test facility because of delays in obtaining construction permits. They have a PhD student who began work on the project in October 2004.

Double-Skin Buildings Empirical Validation Tests, FIBP, Germany
At the April 2004 Experts Meeting, the IEA 34/43 participants visited FIBP's impressive VERU double-skin building test facility. FIBP has developed the facility to validate simplified methods for design of facades, including double facades. The work is in conjunction with the performance-based European Building Performance Directive (EPBD) and DIN V 18599 (calculation of primary energy consumption of non-residential buildings). The project is 60% funded by the German government, and has 24 industry partners providing the remainder of funding. There has been a 1/4-year delay in the project start because the industry collaborators are waiting to give signature approval until after the government gives signature approval. FIBP needs additional funding to collate/analyze IEA 34/43 participants' simulation results and prepare an IEA report.

Building Simulation Centre Proposal (Leader: Switzerland)
The IEA Building Simulation Centre would have the following objectives:

- To provide a network for knowledge exchange and expertise for the simulation community
- To be a partner for program developers and users to improve building design in terms of energy and comfort
- To enhance the quality of both program software, and program use and application
- To promote and support the application of building simulation programs.

During 2004, the Swiss ECBCS Executive Committee member distributed a survey regarding the Simulation Centre to the IEA 34/43 Experts. Over the summer the results of the survey were compiled by Switzerland. The following survey conclusions were: financial feasibility is considered difficult; strong commitment by program developers is wanted; and the simulation community is a closed group, primarily interested in their own issues. Areas of interest include: user guidelines and checklists; documented test cases, validation procedures and data sets; national user groups, workshops and tutorial


ANSI/ASHRAE Standard 140-2001

ASHRAE STANDARD

Standard Method of Test for the Evaluation of Building Energy Analysis Computer Programs

Approved by the ASHRAE Standards Committee January 27, 2001; by the ASHRAE Board of Directors February 1, 2001; and by the American National Standards Institute September 26, 2001.

ASHRAE Standards are updated on a five-year cycle; the date following the standard number is the year of ASHRAE Board of Directors approval. The latest copies may be purchased from ASHRAE Customer Service, 1791 Tullie Circle, NE, Atlanta, GA 30329-2305. E-mail: orders@ashrae.org. Fax: 404-321-5478. Telephone: 404-636-8400 (worldwide) or toll free 1-800-527-4723 (for orders in U.S. and Canada).

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ISSN 1041-2336

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courses. Switzerland sent the survey to the IBPSA Board and IBPSA's response will be forwarded to the ECBCS and SHC Executive Committees.

Codes and Standards Activities

A key audience for the research undertaken within this Task is national and international building energy standard making organizations. These organizations can use the test cases developed in SHC Task 12/ECBCS Annex 21 and SHC Task 22, and test cases that are being developed in this Task to create standard methods of tests for building energy analysis tools used for national building energy code compliance.

ANSI/ASHRAE Standard 140-2001 incorporates the IEA BESTEST suite of test cases developed under IEA SHC Task 12 and ECBCS Annex 21, which are primarily related to building thermal fabric heat transfer. During 2004, ASHRAE Standard 90.1, which is used for regulating energy efficiency in commercial and non-low-rise residential buildings, had an addendum published that requires use of Standard 140 for testing software used in building energy efficiency assessments. The International Energy Conservation Code is also referencing Standard 140. These citations are important because they mandate software evaluation using test procedures developed under IEA research activities. For example because of the ASHRAE Standard 90.1 requirement to test software using ASHRAE Standard 140, two of the largest suppliers of building HVAC equipment in the world, Carrier and Trane Corporations are testing their respective software packages HAP and TRACE with Standard 140. Also, EnergyPlus, the USDOE's most advanced simulation program for building energy analysis, distributes their Standard 140 validation results with their CDs and from their website.

SSPC 140 is the cognizant committee for ANSI/ASHRAE Standard 140. During 2004 ASHRAE published Addendum A to Standard 140-2001 that includes the test cases of HVAC BESTEST Volume 1, which were developed under IEA SHC Task 22 and are related to unitary space cooling mechanical equipment. Currently, ASHRAE is developing a revised version of Standard 140 (ANSI/ASHRAE Standard 140-2004) that fully integrates 140-2001 Addendum a along with the original 140-2001 material into Standard 140. Re-publication of Standard 140-2004 is imminent.

The Netherlands (TNO) has developed their Energy Diagnosis Reference (EDR) based on BESTEST. TNO has developed the EDR to satisfy the European Performance Directive (EPD) of the European Union. The EPD emphasizes performance-based standards and requires certification of software used to show compliance with energy performance standards (normes).

Elsewhere, IEA BESTEST has been referenced in codes and standards in Australia and New Zealand. France (CSTB) has used BESTEST to test simulation tools used in conjunction with development of CEN Standards.

Communication continues with a number of CEN Technical Committees, including 89, 156, 229, which are also addressing building energy calculation methods and the development building energy analysis tool test cases. Discussions were continued on how CEN and SHC Task 34/ECBCS Annex 43 can cooperate in the development and promulgation of test cases for evaluating building energy analysis tools.

WORK PLANNED FOR 2005

Ground Coupled Floor Slab and Basement Comparative Tests (Leader: US/NREL)

Continue development of BESTEST-GC User's Manual for ground-coupled heat transfer test cases. Conduct field trials of user's manual using hourly (or sub-hourly) building energy simulation software programs. Perform iterations of field trials for both user's manual and simulation software improvements. Test sequence will include:

- Steady state 3D analytical solution for rectangular slab.
- Harmonic 3D analytical solution for rectangular slab and basement, if a useable closed-form analytical solution is readily available.
- Basic heat ground heat transfer tests that cannot be solved analytically

- Solar interaction with building mass and the ground using internal gains as solar surrogate.

Multi-Zone Heat Transfer Comparative Tests

Non-Airflow Test Cases (Leader: US/NREL)
Additional non-airflow test cases were discussed at the October 2004 Experts Meeting. Based on the conclusions of that discussion, NREL plans to make the following revisions to the test specification during 2005:

- For all cases require use of constant combined surface heat transfer coefficients as if IR exchange were on, using typical values of ASHRAE, CIBSE, or CEN, etc. This will make it easier to focus on calculation issues specific to multi-zone modeling (e.g. accounting, convergence, etc.).
- Move forward with development of additional test cases beginning with a 3-zone configuration. Incrementally include (from initial steady state with conditions around the building clearly defined): varying internal gains and weather, transmitted solar radiation, internal window, shading of neighboring zone by external fin and by the building itself.

Airflow Test Cases (Leader: Japan)
For the near-future Japan will continue work on development of airflow test cases. Initial airflow cases will emphasize natural ventilation, buoyancy, wind driven, and temperature-difference driven flows; further cases will include interaction of airflow and thermal models. These cases will be based on the geometry of the multi-zone non-airflow cases, be simpler (potentially more diagnostic) than the previous ECBCS Annex 23 cases, and allow use of zonal, nodal, and CFD models. Later work would address the coupling of CFD airflow simulation tools.

Both Non-Airflow and Airflow Test Cases
- Conduct field trials using the test specifications with several hourly (or sub-hourly) building energy simulation software programs, some of which may be linked to zonal, network, coarse CFD, or full CFD models.
- Use the results from the simulations to improve the test specifications and the simulation programs. Conduct two iterations of this process during 2005; additional iterations are expected over the course of the project.

Shading/Daylighting/Load Interaction Empirical Tests

(Leaders: Switzerland, US/Iowa)

Conduct series of EMPA test cell experiments
- Glazing only
- Glazing with external shading screen (textile)
- Glazing with internal shading screen (textile)
- Glazing with external Venetian blinds (painted aluminum slats)
- Glazing with internal mini-blinds
- Window (Glazing with frame)
- ERS experiments: Window with/without mini-blinds/external shading device

Year 1
- June, September, and December Tests
- Internal shading with screens (A) and muslin fabric (B)
- Dimmable lighting controls in both sets of test rooms
- South room's external shading with fins and overhang

Begin Preparation for Year 2 Tests
- Dimmable lighting controls in both sets of test rooms and automatic control of variable position mini-blinds.

Systems, Components, and Controls Empirical Tests

(Leader: Germany/TUD)

Empirical data is planned to be collected for the chilled-water system test cases at ERS during summer 2005. Future work will include developing the tests for a hot-water system; it may be possible to perform hot-water system experiments at ERS during Winter 2004/2005. Other modelers interested in this work are Spain (EnergyPlus, DOE-2.1E), U. Brno (TRNSYS), and CVUT (ESP-r).

Double-Facade Empirical Tests (Leaders: Denmark/Aalborg University, Germany/Fraunhofer Institute)

During 2005 Aalborg University (Denmark) is planning to prepare a preliminary report containing: specification of the test building, proposal for a test suite, preliminary calculations of building performance, and analysis of simulation results based on their preliminary test specification. They also plan to complete construction of their double-skin building test facility, and begin acquiring data for the empirical test cases.

Fraunhofer Institute will continue to seek supplemental funding from the ECBCS Executive Committee to take on the extra work of co-leading an IEA project. Extra responsibilities of the project leader include preparing a detailed test specification, supporting modelers in interpreting the specification, collating and reporting on results of experiments and modeling, and preparing an IEA Technical Report. Sweden may be able to lead the VERU work if they can get funding. If a project leader for the FIBP work is found, prospective simulation modelers include: Arup, Australia; Lund U., Sweden; Brno U., Cz. Rep.; CVUT, Cz. Rep.; and maybe TUD, Germany.

Virtual Centre Proposal (Leader: Switzerland)

Switzerland will make a recommendation to ECBCS regarding further proposal development, and ECBCS and SHC will decide next steps. There will be no activity on this within IEA 34/43 unless it is funded and led by Switzerland (EMPA).

Other

Continue work outside the scope of this task related to bringing evaluation test procedures developed under IEA research into codes and standards (normes). Currently, two test procedures developed within SHC Task 22 are planned to be adapted for inclusion with ANSI/ASHRAE Standard 140:

- HVAC BESTEST Fuel-Fired Furnace Tests, by Natural Resources Canada (NRCan), Canada
- HVAC BESTEST Volume 2: Cases E300-E545, by National Renewable Energy Laboratory (NREL), United States.

During summer 2004 NRCan began the process of adapting the Fuel-Fired Furnace test cases for inclusion into Standard 140; they are currently addressing comments by members of the cognizant ASHRAE standards project committee (SSPC 140). NREL is planning to begin Standard-140 adaptation of HVAC BESTEST Volume 2 during summer 2005.

LINKS WITH INDUSTRY

The primary audiences for the IEA tool evaluation research are building energy analysis tool authors and national and international building energy standard (norme) making organizations. For tool authors, a number of links have been established. Activities of previous related SHC Task 22 and SHC/ECBCS Task 12/Annex 21 research effectively are linked to the needs and recommendations of the world's leading building energy analysis tool developers. This link continues in SHC/ECBCS Task 34/Annex 43. For example, 5 papers by software developers related to use of tool evaluation test procedures created under SHC Task 22 were presented at the conference of the International Building Performance Simulation Association, September 2003 in Eindhoven, Netherlands. Three papers by software developers related to using simulation software test procedures developed during SHC Task 22 and SHC/ECBCS Task 12/Annex 21 were presented at the Canadian ESim conference (June 2004 in Vancouver, Canada). Additional papers by software developers related to use of SHC Task 22 and SHC/ECBCS Task 12/Annex 21 test procedures have appeared regularly at ASHRAE meetings in the US.

The results of IEA tool evaluation research are used as prenormative information in the establishment of national and international building energy codes and standards, as discussed above under codes and standards activities. The IEA BESTEST cases were used by ASHRAE to develop a standard method of test for evaluating building energy analysis programs. Also, the U.S. National Association of State Energy Officials has referenced HERS BESTEST for certification of home energy rating software. HERS BESTEST, which is conceptually based on IEA BESTEST, was developed for use specifically in detached-residential applications. A number of other countries, such as the Netherlands, Australia and New Zealand are using BESTEST as a standard method of testing building energy analysis tools for their national energy codes or home energy rating software.

REPORTS PUBLISHED IN 2004

Only internal documents.

REPORTS PLANNED FOR 2005

As this is the second full year for project work, no final reports are planned. Draft reports covering the following topics are expected:

- Revised ground coupled heat transfer test specification and results
- Revised multi-zone non-airflow comparative test speci fication and results
- Airflow comparative test specification and results
- Revised Shading/Daylighting/Load Interaction: test procedures, test cell specifications, empirical data sets, and simulation results
- Double-Skin Buildings: test procedures, test cell specifications, empirical data sets, and simulation results

MEETINGS IN 2004

Second Experts Meeting/Final Planning Meeting
April 5-7
Grosse-Hartpenning (Munich), Germany

Third Experts Meeting
October 6-8
Prague, Czech Republic

MEETINGS PLANNED FOR 2005

Fourth Experts Meeting
April 6-8
Aalborg, Denmark

Fifth Experts Meeting
September – November
Dates and location to be determined

TASK/ANNEX 34/43
National Contact Persons

Operating Agent
Ron Judkoff
National Renewable Energy Laboratory
1617 Cole Boulevard
Golden, Colorado 80401
United States

Australia
P.C. Thomas
Arup
Level 10
201 Kent Street
Sydney NSW 2000

Angelo Delsante
CSIRO Manufacturing & Infrastructure Technology
PO Box 56, Highett. Vic. 3190,
(Street address: Graham Rd, Highett, Vic. 3190)

Belgium
Jean Lebrun
University of Liege
Thermodynamics Laboratory
Building B49
B4000 Liege

Christophe Adam
University of Liege
Department of Environmental Management and Science
Avenue de Longwy, 185
B-6800 Arlon

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

Czech Republic
Miroslav Jicha, Pavel Charvat
BRNO University of Technology
Dept. of Thermodynamics and Environmental Engineering
Technicka 2
61669 Brno

Milos Lain, Frantisek Drkal
CTU Prague
Dept. of Environmental Engineering
Technicka 4
16607 Prague 6

Irena Plockova
Czech Energy Agency
Ministry of Industry and Trade
NA Frantisku 32
Prague 1
11000 CZECH REPUBLIC

Denmark
Per Heiselberg
Aalborg University
Hybrid Ventilation Centre
Sohngaardshdmsvej 57
9000 Aalborg

France
Zaki El Khoury, Peter Riederer
Centre Scientifique et Technique du Bâtiment
CSTB - DDD/AGE
84 Avenue Jean Jaurès, B.P. 2
77447 Marne la Vallée cedex 02

Frederic Maranville
Civil Engineering and Building Physics research Team
University of Technology
40, avenue de Soweto
97410 Saint-Pierre

Bruno Peuportier
Centre d'Energetique,
Ecole des Mines de Paris
60, Bd St Michel 75272 Paris cedex 06

Joseph Ojalvo
Electricite de France, Department SEVE
Les Renardieres
Route de Sens, Ecuelles
77818 Moret-sur-Loing Cedex

Jean-Robert Millet
CSTB
BP02
F77421 Marne la Vallee, Cedex2
FRANCE

Germany
Clemens Felsmann
Technische Universität Dresden
Institut für Thermodynamik und Techn. Gebäudequsrüstung
Helmholtzstr. 14
01062 Dresden

Hans Erhorn
Fraunhofer-Institut für Bauphysik
Nobelstr. 12
D-70569 Stuttgart

Erwin Lindauer, Herbert Sinnesbichler
Fraunhofer-Institut für Bauphysik
Postfach 1152
D-83601 Holzkirchen
Fraunhoferstrasse 10

Italy
Maurizio Cellura, Valerio lo Brano
Univerita di Palermo

Japan
Yasuo Utsumi
Department of Architecture
Institutes of National Colleges of Technology
Natori, Miyagi, 981-1239

Teruaki Mitamura
Yokohama National University
79-5 Tokiwadai Hodogaya-ku, Yokohama

Yukiko Yoshida
National Institute of Environment Studies
16-2 Onogawa
Tsakuba, Ibaraki

Netherlands (Observer)
Wim Maassen, Wim Plokker, Aad Wijsman
TNO Building and Construction Research
Van Mourik Broekmanweg 6
Postbus 49
2600 AA Delft

Spain
Juan Travesi
ACHSL Consultoria
Benito Castro 10
28028 Madrid

Sweden
Hasse Kvist, Harris Poirazis, Maria Wall, Ake Blomsterberg
EBD, LTH
Lund University
P.O. Box 118
SE-221 00 Lund

Switzerland
Heinrich Manz, Thomas Frank, Peter Loutzenhiser
EMPA
Laboratory for Applied Physics in Buildings
Uberlandstr. 129
CH-8600 Duebendorf

Viktor Dorer, Markus Koschenz, Andreas Weber
EMPA
Energy Systems/Building Equipment Lab
Uberlandstr. 129
CH-8600 Duebendorf

Mark Zimmermann
EMPA
Centre for Energy and Sustainability in Buildings
Uberlandstr. 129
CH-8600 Duebendorf

Gerhard Zweifel
Hochschule Technik + Architektur Luzern
Abt. HLK
CH-6048 Horw

Pierre Hollmuller
Universite de Geneve
Centre universitaire d'etude des problemses de l'energie
Route de Drize 7
Ch – 1227 Carouge – Geneve

United Kingdom
Donald Alexander
Welsh School of Architecture
Cardiff University
Cardiff, Wales

Paul Strachan
ESRU, Dept. of Mechanical Eng
University of Strathclyde
Glasgow G1 1XJ, Scotland

United States
Joel Neymark
J. Neymark & Associates
2140 Ellis Street
Golden, Colorado 80401

Gregory Maxwell
Mechanical Engineering Department
Iowa State University
2025 Black Engineering Building
Ames, Iowa 50011

Peter Loutzenhiser
Mechanical Engineering Department
Iowa State University
0095E Black Engineering Building
Ames, Iowa 50014

Curtis J. Klaassen
IEC Energy Resource Station
DMACC, Building 23
2006 S. Ankeny Boulevard
Ankeny, Iowa 50021

International Energy Agency
Solar Heating and Cooling Programme

Executive Committee Members

AUSTRALIA
Colin Blair
Standards Australia
International
GPO Box 5420
Sydney
NSW 2001

Alternate
Mr. Ken Guthrie
Sustainable Energy Authority
Victoria 215 Spring Street
Melbourne
Victoria 3000

AUSTRIA
Prof. Gerhard Faninger
c/o Universität Klagenfurt, IFF
Sterneckstraße 15
A-9020 Klagenfurt

BELGIUM
Prof. André De Herde
Architecture et Climat
Université Catholique de Louvain
Place du Levant, 1
B-1348 Louvain-la-Neuve

CANADA
Mr. Doug McClenahan
CANMET - Natural Resources
Canada
580 Booth Street
Ottawa, Ontario K1A 0E4

DENMARK
Mr. Jens Windeleff
Danish Energy Authority
Amaliegade 44
DK-1256 Copenhagen K

Alternate
Mr. Poul E. Kristensen
IEN Consultants
Hasselvej 30
2830 Virum

EUROPEAN COMMISSION
Mr. Pietro Menna
Commission of the European
Union (DG TREN)
Rue de la Loi 200
B1049 Brussels, BELGIUM

FINLAND
Mr. Jarkko Piirto
Tekes, National Technology
Agency
Energy and Environment
Employment & Economic
Development Centre for
Ostrobotnia
FIN-00101 Helsinki

FRANCE
Mr. Yves Boileau
French Agency for the
Environment and
Energy Management (ADEME)
500 Route des Lucioles - Sophia
Antipolis
F-06565 Valbonne Cedex

GERMANY
Dr. Volkmar Lottner
Forschungszentrum Jülich - PTJ
D52425 Jülich

ITALY
Dr. Paolo Zampetti
Division of Systems for Energy
Conservation ENEA
Via Anguillarese 301
I-00060 S. Maria di Galeria
(Rome)

MEXICO
Dr. Isaac Pilatowsky
Centro de Investigacion en
Energia Universidad Nacional
Autonoma de Mexico
Apartado Postal #34
62580 Temixco, Morelos

Alternate
Dr. Wilfrido Rivera Gomez-Franco
same address as below

NETHERLANDS
Mr. Lex Bosselaar
Senter Novem
P.O. Box 8242
3503 RE Utrecht
(Street address:
Catharijnesingel 59)

NEW ZEALAND
Mr. Michael Donn
School of Architecture
Victoria University of Wellington
P.O. Box 600
Wellington 1

NORWAY
Mr. Fritjof Salvesen
KanEnergi AS
Hoffsveien 13
0275 Oslo

PORTUGAL
Mr. Joao A. Farinha Mendes
INETI – Edificio G
Departamento de Energias
Renovaveis
Estrada do Paco do Lumiar, 22
1649-038 Lisboa

SPAIN
Dr. Manuel Romero
Director Renewable Energy
Division
CIEMAT
Avenida Complutense 22
E-28040 Madrid

SWEDEN
Mr. Michael Rantil
(Chairman)
Formas - The Swedish Research
Council for Environment,
Agricultural Sciences and
Spatial Planning
Box 1206, SE-111 82 Stockholm
Visiting address: BirgerJarlstorg5

SWITZERLAND
Mr. Urs Wolfer
Federal Office of Energy
CH3003 Bern
Visiting address: Worblentalstr.
32, 3063 Ittigen

UNITED KINGDOM
Prof. David Strong
Managing Director –
Energy Division
Bucknalls Lane
Garston, Watford
Herts WD2 7JR

Alternate
Mr. Nick Hayes
Director Energy Technology
BRE
Bucknalls Lane
Garston, Watford
Herts WD2 7JR

UNITED STATES
Mr. Drury Crawley
(Vice Chair)
U.S. Department of Energy
Energy Efficiency and
Renewable Energy
EE-2J, Office of Building
Technologies
1000 Independence Ave. S.W.
Washington, D.C. 20585-0121

International Energy Agency
Solar Heating and Cooling Programme

Task Operating Agents

TASK 25
Dr. Hans-Martin Henning
Fraunhofer Institute for Solar Energy Systems ISE
Thermal Systems and Components
Heidenhofstr. 2
D-79110 Freiburg, GERMANY

TASK 27
Mr. Michael Köhl
Fraunhofer Institute for Solar Energy Sytems
Heidenhofstr. 2
D-79 110 Freiburg, GERMANY

SHC TASK 28/ECBCS Annex 38
Mr. Robert Hastings
Architecture, Energy & Environment GmbH
Kirchstrasse 1
CH 8304 Wallisellen,
SWITZERLAND

TASK 29
Mr. Doug Lorriman
20 Tiny Beaches Rd. N.
Site 8, Comp. 8
Perkinsfield, ON
L0L 2J0, CANADA

TASK 31
Dr. Nancy Ruck
79 Amaroo Drive
Smiths Lake, NSW 2428 AUSTRALIA

TASK 32
Mr. Jean-Christophe Hadorn
BASE CONSULTANTS SA
51 Chemin du Devin
CH-1012 Lausanne
SWITZERLAND

TASK 33
Mr. Werner Weiss
AEE INTEC
Feldgasse 19
A-8200 Gleisdorf, AUSTRIA

SHC TASK 34/ECBCS ANNEX 43
Mr. Ron Judkoff
Director, Buildings & Thermal Systems Center
National Renewable Energy Laboratory
1617 Cole Boulevard
Golden, CO 80401, USA

TASK 35
Mr. Henrik Sørensen
Head of Branch Office and
Energy and Indoor Climate Section
Esbensen Consulting Engineers
Ltd.Carl Jacobsens Vej 25D
Sukkertoppen - Copenhagen
DK-2500 Valby, DENMARK

PROPOSED SOLAR RESOURCE MANAGEMENT TASK
Dr. David S. Renné
National Renewable Energy Laboratory
1617 Cole BoulevardGolden,
Colorado 80401-3393, USA

Executive Secretary

Ms. Pamela Murphy
Morse Associates, Inc.
9131 S. Lake Shore Dr.
Cedar, MI 49621, USA

IEA Secretariat Liaison

Mr. Peter Tulej
International Energy Agency
9 rue de la Fédération
75739 Paris Cedex 15, FRANCE

Advisor

Dr. Frederick H. Morse
Morse Associates, Inc.
2012 O Street, NW
Suite 24
Washington, DC 20036, USA

SHC Internet Site

http://www.iea-shc.org