SOLAR HEATING & COOLING PROGRAMME
INTERNATIONAL ENERGY AGENCY

2005 ANNUAL REPORT

WITH AN OVERVIEW OF

Solar Heat for Industrial Applications

IEA Solar Heating & Cooling Programme

2005 Annual Report

Edited by
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Executive Secretary
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Solar Heating & Cooling Programme

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International Energy Agency

International Energy Agency (IEA), founded in November 1974, is an autonomous body within the framework of the Organization for Economic Co-operation and Development (OECD) based in Paris. At that time, the main objective of its member countries was to reduce dependence on imported oil through the development of alternative energy sources while improving energy efficiency. More recently, concerns such as greenhouse gas emissions and globalization have underlined the need for international collaboration.

Collaboration in research, development and demonstration of new technologies has been an important part of the Agency. The IEA R&D activities are headed by the Committee on Research and Technology (CERT). In addition, four Working Parties—End Use, Renewable Energy, Fossil Fuels and Fusion—are charged with monitoring the collaborative energy agreements. The Renewable Energy Working Party oversees the work of the SHC Agreement and eight agreements, and is supported by the Renewable Energy Unit at the IEA Secretariat in Paris.

Solar Heating & Cooling

The Solar Heating and Cooling (SHC) Implementing Agreement was one of the first collaborative R&D programs to be established within the IEA. 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 18 member countries and the European Commission.

SHC Mission

To continue to be the preeminent international collaborative programme in solar heating and cooling technologies and designs.

Based on this mission, the 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. The objectives and strategies of the SHC Programme are stated in the table on the following page.

SHC TASKS

A total of thirty-six Tasks (projects) have been undertaken since the beginning of the Solar Heating and Cooling Programme. The leadership and management of the individual Tasks are the responsibility of Operating Agents. The Tasks which were active in 2005 and their respective Operating Agents are:

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*

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Testing and Validation of Building Energy Simulation Tools | *United States*

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PV/Thermal Systems | *Denmark*

Task 36
Solar Resource Knowledge Management | *United States*

SHC ACTION PLAN 2004-2008

OBJECTIVE	STRATEGIES
Help achieve a significant increase in the performance of solar heating and cooling technologies and designs	Increase user acceptance of solar designs and technologies. Continue to develop cost-effective designs and technologies in collaboration with appropriate intermediary industries. Identify and prioritize R&D needs for solar heating and cooling that will lead to expanded markets
Help industry and government increase the market share of solar heating and cooling technologies and designs	Work with appropriate intermediary industries and end users to accelerate the market penetration of solar designs and technologies. Work with governments to promote and expand favorable policies to increase the market share. Work towards or support the greater use of solar designs and technologies in developing countries. Work to address issues regarding building design, aesthetics and its architectural value.
Be the primary source of technical information and analysis on solar heating and cooling technologies, designs and applications.	Assure that technical information and analysis developed in this programme is available and disseminated to the target audiences in useful formats. Working through relevant international standards organizations, support the development and harmonization of standards necessary for the widespread use of solar designs and technologies in the building, agricultural and industrial sectors.
Help educate decision makers and the public on the status and value of solar heating and cooling	Communicate the value of solar heating and cooling designs and technologies in publications, conferences, workshops and seminars to the public and relevant stakeholders. Provide analysis that links solar heating and cooling designs and technologies to energy security concerns, environmental and economic goals. Quantify and publicize the environmental, economic and climate change benefits of solar heating and cooling and supporting policy measures solar design and technologies in meeting environmental targets and addressing policies and energy, supply security. Review our products in relation to our objectives Annual Reports, Solar Update Newsletters, National Programme Review Reports, "*Solar Heating Worldwide: Markets and Contributions to the Energy Supply report*." Present the SHC Solar Award annually. Maintain the Progamme web site.

Chairman's Report & Highlights of 2005

Mr. Michael Rantil
Executive Committee Chairman
Formas, Sweden

In 2005, the global market for solar thermal continued to grow with a 30% increase, representing an additional 11,700 MWth, in the installed capacity of solar collectors from 2003. During the year, the IEA Solar Heating and Cooling Programme continued its work to expand the solar thermal market, to conduct R&D of hardware, materials and design tools, and to educate decision makers and users. To succeed in our efforts, the Solar Heating and Cooling (SHC) Programme has expanded its work and broadened its collaboration with other organizations.

SHC Tasks

Work on Task 35: PV/Thermal Systems and Task 36: Solar Resource Knowledge Management started in 2005. And, the Executive Committee approved a new renovation Task with a 2006 start date of Task 37: Advanced Housing Renovation with Solar & Conservation. Other work under consideration is Solar Assisted Cooling Systems, a follow-up to Task 25: Solar Assisted Air Conditioning of Buildings and Polymeric Materials for Solar Thermal Applications.

The Executive Committee approved the completion of one project—SHC Task 28: Solar Sustainable Housing. The Committee sincerely thanks Mr. Hastings for his dedication to the work of the SHC Programme by leading three Tasks and participating as the Swiss expert in two Tasks over the past 25 years.

Collaboration

To support our work, the SHC Programme is collaborating with other IEA Programmes and organizations in the field.

Within the IEA

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 of the Executive Committees was held June 2005 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 PhotovoItaic Power Systems Programme worked with the SHC Programme in the development of Task 35: PV/Thermal Systems and Task 36: Solar Resource Knowledge Management.

The IEA SolarPACES Programme is collaborating in Task 33: Solar Heat for Industrial Processes and Task 36: Solar Resource Knowledge Management.

Outside the IEA

Solar industry associations in Australia, Europe and North America are collaborating with the SHC Programme to increase the awareness of national and international government bodies and policy makers and to encourage industry to use solar thermal R&D results in new products and services.

It is the vision of this group that by the year 2025, solar thermal will provide 10-15% of the total energy demand in the OECD countries.

Joint Declaration for a European Directive to Promote Renewable Heating and Cooling, the IEA SHC Programme supported the European Renewable Energy Council's declaration for a European Directive that 25% of the EU heating and cooling supply be renewables in 2020.

ThERRA (Thermal Energy from Renewables – References and Assessment), the IEA SHC Programme will be represented on this Advisory Board by Mr. Werner Weiss. The objective of this group is to develop and disseminate a methodology for monitoring the total amount of renewable heat produced in the EU.

ESTTP (European Solar Thermal Technology Platform), to support the EU solar thermal platform initiated in 2005; the Chairman of the SHC Programme will serve on the ESTTP Steering Group. The objective of the platforms are to reach the objective, set at the March 2002 Barcelona European Council, to increase the average research investment level from 1.9% of GDP today to 3% of GDP by 2010, of which 2/3 should be funded by the private sector.

Solar Statistics

The SHC Programme produced a 2005 edition of the report, *Solar Heating Worldwide: Markets and Contribution to the Energy Supply*. At the end of 2003, the total installed capacity of the 35 reported counties equaled 92.7 GWth or 132 million square meters. The annual collector yield of all the solar thermal systems installed by the end of 2003 was 55,233 GWth—an oil equivalent of 8.8 billion liters and an annual avoidance of 24.1 million tons of CO2. This report may be downloaded from the SHC web site (www.iea-shc.org).

SHC Solar Award

The 3rd SHC Solar Award was presented to Dr. Jan-Olof Dalenbäck, Professor at the Chalmers University in Sweden, in June at the 2nd European Solar Thermal Energy Conference in Freiburg, Germany.

The award is given to an individual, company, or private/public institution that has shown outstanding leadership or achievements that supports the work of the SHC 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.

Dr. Dalenbäck was selected for his significant contributions to the realization of large-scale solar district heating networks, the development of a roof module with an integrated solar collector, and the renovation of buildings using solar applications. His work over the past 20 years has resulted in the successful transfer of solar thermal technologies in Sweden as well as in other countries. Dr. Dalenbäck has contributed his expertise to three SHC Programme Tasks: Task 7: Central Solar Heating Plants with Seasonal Storage, Task 20: Solar Energy in Building Renovation, and Task 24: Solar Procurement.

Programme Participation

Participation in the Programme remains strong with 18 Member countries and the European Commission actively participating in its work. This year, the United Kingdom withdrew from the Programme due to a change in government priorities and funding. The UK, one of the founding countries, made significant contributions to the Programme for 28 years; it is the SHC Executive Committee's hope that the UK will renew its membership in the near future.

In 2005, several new countries expressed interesting in joining the SHC Programme; they include Slovenia, Thailand and Malaysia. The Executive Committee also continued to correspond with countries previously

invited and interested in joining the Programme: Argentina, Brazil, China, Czech Republic, Greece, South Africa, South Korea, and Turkey.

Feature Article

This year's Annual Report includes a feature article on solar heat for industrial applications and was prepared by Mr. Werner Weiss, the Operating Agent for SHC Task 33.

In closing, I would like to thank the Operating Agents, participating experts, and the Executive Committee Members for another successful year of international collaborative work. I also would like to thank and our Advisor, Fred Morse, and our Executive Secretary, Pamela Murphy.

As the SHC Programme makes visible steps in developing solar technologies and working to expand the solar market, I am confident that 2006 will be another year of growth for the industry and this Programme.

Michael Rantil

TASKS

The Tasks of the SHC Programme achieved much in 2005. Highlights of the work are presented below. For more details on these highlights and other accomplishments, refer to the individual Task summaries later in this report.

Task 27: Performance of Solar Facade Components

As part of the case study on window/wall interface, a leakage-detection system based on a scanner with an optical detector for water and an infrared-camera at the window/wall interface was developed. This contribution is important because it allows

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

Task 28/ECBCS Annex 38: Sustainable Solar Housing

The Committee approved the final management report of SHC Task 28/ECBCS Annex 38. This Task has played a major role in

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, the largest plant of its kind in Central America, successfully completed its first drying season. The plant, which uses 850 square meters of Conserval's Solarwall® panels on the roof, is replacing wood as the fuel source. Analysis of the monitoring data has led to the recommendation of installing an automated control system, which is now under consideration by the plant owner.

Task 31: Daylighting Buildings in the 21st Century

LIGHTSWITCH, a user behaviour model, was completed and integrated into whole building simulations. It is the intention that LIGHTSWITCH will be integrated into other daylight analysis software packages in the future. The work of this Task will end in 2006.

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

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

A report on short-term heat storage, *Thermal Energy Storage for Solar and Low Energy Buildings: State-of-the-Art*, was published in 2005. The book draws on the expertise of 20 Task experts and three other well known storage experts. It will fill the gap in current literature on thermal storage.

This is a collaborative Task with the IEA Energy Conservation through Energy Storage Agreement.

Task 33: Solar Heat for Industrial Processes

In Spain, the first demonstration project with a nominal capacity of 357 kWth was installed in Barcelona. It is used for cleaning of transport containers of the company CONTANK. It is estimated that 22% of the 1990 MWh/a heat demand of the company will be satisfied by the solar system. The total investment was about 270.000.

This is a collaborative Task with the IEA SolarPACES Agreement.

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

Daylighting tests were performed at the Iowa Energy Resource Station in the United States to create an empirical validation data set for daylighting controls. Test conclusions were that overall predictions for daylighting performance were within acceptable ranges, and that uncertainty in a real building is

greater than in a controlled laboratory experiment. This was a good exercise to see how accurate predictions for a real building can be.

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

Task 35: PV/Thermal Solar Systems

The investigation of already available simulation models, TRNSYS components and theoretical models was carried out during the year. Based on this overview, the modelling activities of the Task have been started with the focus on modelling of the heat transfer between the solar cells and the media removing heat from the system.

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

Task 36: Solar Resource Knowledge Management

This Task got underway in July. The first Experts meeting was attended by 22 people representing all the Programme's member countries and the EC except Canada which is interested, but unable to send a representative. Observers to the meeting included representatives from Brazil and the European Space Agency.

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

NEW ACTIVITIES

Task 37: Advanced Housing Renovation with Solar & Conservation

This Task will get underway in 2006 led by Norway. The objectives of the work are to to create a solid knowledge base on how to renovate housing dramatically reducing primary energy demand while providing superior comfort and to develop sstrategies for supporting market penetration of such renovations. The Task will focus on single family housing, apartment buildings, neighborhoods and advanced renovation strategies (conservation, renewables, and efficient back-up as part of non-energy renovations).

Solar Assisted Cooling Systems

This Task will get underway in 2006. The objectives of the work are to improve conditions for the market introduction of solar assisted air-conditioning systems devoted to the residential and small commercial sectors, to develop concepts and create tools for the proper implementation of solar cooling (air-conditioning and refrigeration) in large scale applications (e.g., large office and residential buildings, hotels, industry, etc), and to facilitate the development of new systems and concepts through research activities.

Polymeric Materials for Solar Thermal Applications

This activity will begin the Task Definition Phase in 2006. The objective of the proposed work is to assess the potential of cost-reduction by using polymeric materials and polymer based new designs of solar thermal systems. The scope of the Task will be solar heating and cooling for buildings including (night cooling, desiccants, etc.) by use of liquid heat-transfer fluids or air and will focus on components and storage.

Solar Industry Trade Association Workshop

The SHC Programme will hold its 2nd workshop with solar industry trade associations in 2006. In 2005, this group promoted their new methodology for converting installed collector area to thermal capacity (square meters to MWth). To date, seven associations have signed the Memorandum of Understanding.

EXECUTIVE COMMITTEE MEETINGS

2005 Meetings

The 2005 Executive Committee held two meetings

- June in Esphino, Portugal (included a joint meeting with the IEA Energy Conservation in Buildings and Community Systems Implementing Executive Committee)
- December in Sydney, Australia.

2006 Meetings

In 2006, Executive Committee meetings will be held June 6-9 in Seville, Spain and November 6-8 in Rome, Italy.

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 2006, reports frequently requested from previous Tasks will be available as PDF files. The address for the site is www.iea-shc.org.

Solar Heat for Industrial Applications

Werner Weiss

AEE, Institute for Sustainable Technologies
Gleisdorf, Austria

The Potential of Solar Process Heat

The industrial sector represents the highest energy use in OECD countries at about 30%, closely followed by the transport sector. Due to the fact that energy from fossil fuels was for a long time cheap and seemingly infinitely available, manufacturing companies have only taken modest steps towards replacing energy from fossil fuels with energy from renewable sources.

The use of solar energy in manufacturing and industrial processes to heat production halls has been limited to just a few applications. The solar thermal collectors installed today have a total thermal capacity of around 105 GWth, but are used almost exclusively for domestic hot water, swimming pools and space heating in the residential and tourism sectors.[1]

To be able to make use of the huge potential for solar heat in the industry and to open a new market sector for the solar thermal industry, it is necessary to integrate solar thermal systems into the industrial processes in a suitable way. One of the first duties of SHC Task 33, Solar Heat for Industrial Processes, was therefore to investigate the potential of solar process heat, to document existing plants and uses, and to analyse the experiences of the plants.

Studies on the potential of solar heat for industrial processes at low temperatures conducted in Austria, Portugal and Spain show that solar heat could provide approximately 26 PJ. (This is the potential technically achievable at this time.). [2] If only 5% of this potential were to be achieved in the coming years this would require the installation of one million square meters of collectors with a capacity of 700 MWth and represent 0.6 % of the low-temperature heat requirement of these three countries.

Solar heat is used not only to provide process heat but also to heat production halls.

The current situation

About 85 solar thermal plants for process heat are reported worldwide, with a total installed capacity of about 27 MWth (38,500 m^2).

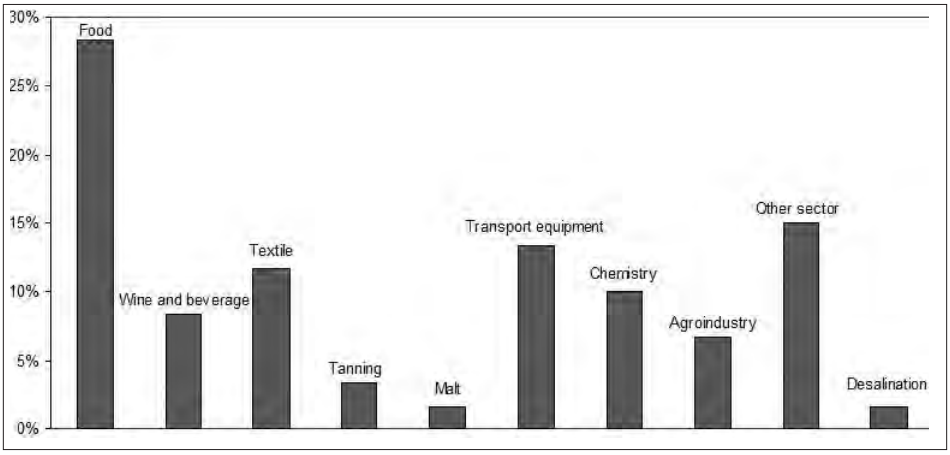

Figure 1. Distribution of documented solar thermal plants in different industrial sectors

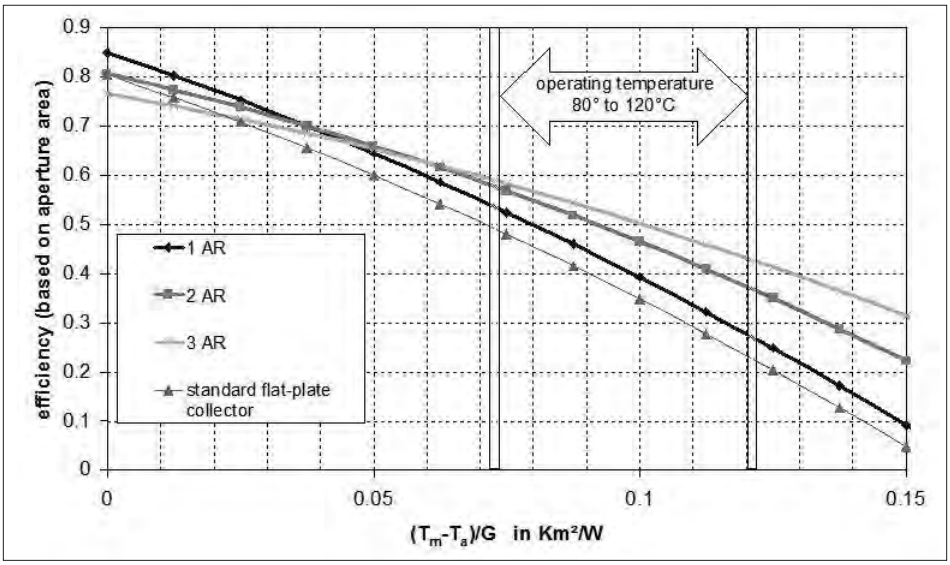

Figure 2. Comparison of the efficiency curves for a standard flat-plate collector (normal solar glass) and the curves for single, double and triple-anti-reflective (AR) glazed collectors (G=800 W/m_).

Source: M. Rommel, Fraunhofer ISE.

Table 1. Industrial sectors and processes with the greatest potential for solar thermal uses

Industrial sector	Process	Temperature level [°C]
Food and beverages	drying	30 – 90
	washing	40 – 80
	pasteurising	80 – 110
	boiling	95 – 105
	sterilising	140 – 150
	heat treatment	40 – 60
Textile industry	washing	40 – 80
	bleaching	60 – 100
	dyeing	100 – 160
Chemical industry	boiling	95 – 105
	distilling	110 – 300
	various chemical processes	120 – 180
All sectors	pre-heating of boiler feed water	30 – 100
	heating of production halls	30 – 80

Table 1 shows that the most significant areas for solar heat plants are in the food and beverage industries, the textile and chemical industries, and for simple cleaning processes, e.g. car washes. The reason for this is due to the low temperatures required for the processes in these sectors. Between the temperature range of 30°C–90°C, flat-plate collectors work very efficiently. Table 1 also shows a large potential for processes in the medium temperature range up to around 250°C.

To be able to provide heat for the entire medium-temperature range from 80°C to 250°C at a reasonable price, it is necessary to optimise and further develop medium temperature collectors.

Therefore, three categories of medium-temperature collectors are being developed and tested as part of SHC Task 33.

Development of Medium Temperature Collectors

Improved Flat-Plate Collectors

There are a number of different possibilities for developing flat-plate collectors that could be used in applications between 80°C and 120°C. In the first instance, it is necessary to reduce the thermal losses of the collectors without losing too much optical efficiency. This can be achieved, for example, by using multiply glazed flat-plate collectors with anti-reflective glass, or using a hermetically sealed flat-plate design where the collector is filled with a noble gas, or by the development of evacuated flat-plate collector designs. Figure 2 shows the efficiency curves for single, double and triple-glazed collectors covered with newly developed anti-reflective glass.

Concentrating Flat-Plate and Evacuated Tube Collectors

A further possibility for the development of medium temperature collectors is to reduce thermal losses in the collector by concentrating the solar rays and therefore reducing the glossy surface area. Concentrating flat-plate collectors, based on this principal, are being developed in Portugal by AoSol and INETI and in Austria by Solarfocus. Using a concentration factor around 2 there is no need for sun-tracking devices. Figure 3 shows the construction of a collector made by Solarfocus of Austria. The collector has absorber fins, which are absorbing on both surfaces, mounted in the reflector troughs perpendicular to the aperture opening.

Small Parabolic Trough Collectors

For collector circuit temperatures of 150°C to 250°C, it is interesting to consider more highly concentrating collectors. These, however, can no longer be mounted in a fixed position but require a one-axis tracking mechanism. At present, seven concentrating collectors are in development. Further information on these developments can be found in the SHC Task 33 brochure, Medium Temperature Collectors, available on the internet at www.iea-ship.org/3_1html.

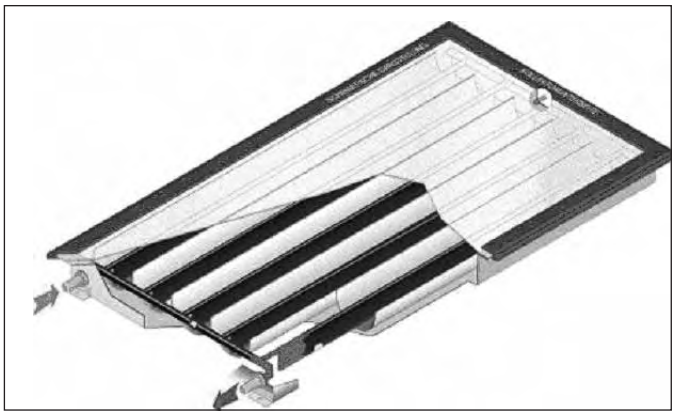

Figure 3. Concentrating flat-plate collector.
Source: Solarfocus

Figure 4. Testing of two PTC 1000 modular parabolic trough collectors at DLR in Germany. In these tests, the collectors are installed on a tilted testing platform to eliminate the effect of end-losses.

Integrating Solar Heat & Industrial Processes

There are several challenges to address before solar can be fully integrated in industrial processes. In using solar thermal energy, the temperature of the available heat and the vari-

ability of solar energy must be considered, as well as the heat profile required by the industrial process. Solar plants used to produce process heat can easily achieve a capacity of several hundred Kilowatt up to several Megawatt, but system technology is needed to be able to handle down time at a plant, for example weekends and holidays.

To address these challenges, more than 20 system concepts were developed within the framework of the Task according to the requirements of the different energy carriers (air, water-glycol, pressurised water or steam), the temperature levels and the process to be supplied with heat. These concepts are currently being realised and tested at demonstration plants.

Demonstration Plants

Production Halls

In contrast to other buildings, such as offices and apartments, production halls are very tall—5 to 10 meters—and usually require a relatively low room temperature between 15-18ºC. The combination of lower temperatures and simple heating systems are ideal conditions for the use of solar thermal energy, and open up a significant potential use in the industrial sector.

In recent years, many industrial spaces have been built, particularly in Austria, which are heated completely or partially using solar energy. All of the documented spaces use underfloor heating systems to introduce heat to the space, and thereby giving the advantage of a low flow temperature and that the mass of the foundation can be used as a heat reservoir. The solar collectors are often mounted on or integrated in the facade. In this design, the collectors fulfil multiple functions simultaneously as a weatherproof facade, energy converter and as insulation (due to the rear insulation of the collector). Since the solar collectors are generally used for heating purposes, as the hot water requirements are usually minimal, the facade collectors are well oriented towards the winter sun.

The capacity installed on the halls is between 60 kWth–150 kWth. The percentage of total energy supplied by solar in a hall ranges between 20%–100%.

Washing Processes

Cleaning processes are used primarily in the food and textile industries and in the transport sector. For cleaning purposes, hot water is needed at a temperature level between 40°C and

Figure 5. A solar heated production hall and office building in Doma, Austria

90°C and so flat-plate collectors are the recommended application. The system design is quite similar to large-scale hot water systems for residential buildings because they work in the same temperature range and the water is drained after usage. In these systems, the hot water loop is an open system, and usually heat recovery is not feasible.

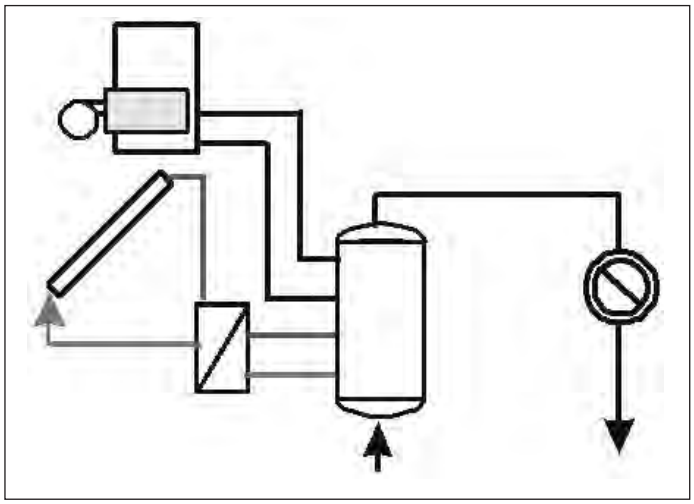

Figure 6. Generic system concept for a washing processes using an open hot water loop

One of the first demonstration systems of SHC Task 33 was at Contank (Parking Service Castellbisbal S.A.) in Barcelona, Spain. The company cleans containers used to transport liquid goods by rail. The major heat-consuming process in the company is the washing process, which uses hot water at temperatures 70 – 80 ºC (representing about 46% of the total heat requirement) and steam (representing 54%). The company requires 70 – 80 m3/day hot water, and the conventional system used is a gas-fired steam boiler.

The solar thermal system installed at Contank consists of two solar fields with selective flat-plate collectors and a total peak heat capacity of 360 kWth (with a net absorber surface of 510 m^2) and a 40 m3 unpressurized storage tank.

The yearly net heat production is 429 MWh (588 kWh/kWth) and solar energy makes up 21.55% of all energy used. If the gas price is assumed to be 25 /MWh based on the calorific values, this results in an annual cost saving of 14.300 . Taking into account maintenance costs, amortization is achieved in approximately 10 years.

Figure 7. The Parking Service Castellbisbal SA facility for container washing in Barcelona, Spain.
Source: Aiguasol Engineering, Spain

Dairies

An even greater potential is anticipated in dairies. The capacities of solar thermal plants in this sector are in the order of 1 to 10 MWth. The solar thermal plant at the Tyras dairy in Trikala, Greece has an installed capacity of 730 kWth (1040 m_). The average yearly production of the facility is 700 MWh and solar heat makes up 7% of the total heat requirements. The total investment for the plant was 172,500 , which is equivalent to 116 per kWth of installed capacity. Thanks to grant funding, which covered 50% of the costs, the short amortization time required by the industrial sector was achieved.

Distilling and Chemical Processes

For industrial processes where temperatures between 120–250 °C are needed, concentrating solar collectors, such as parabolic trough collectors have to be used. The heat carrier in these systems is either pressurized hot water or steam.

Figure 8. A view of the collector field at the Tyras dairy, Trikala, Greece
Source: A. Aidonis, CRES

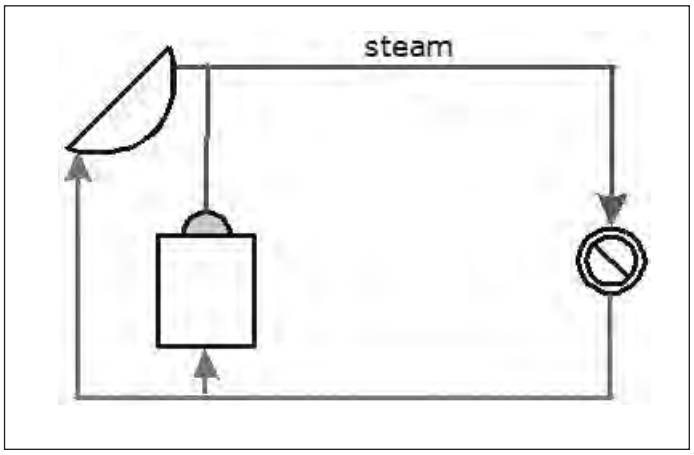

Figure 9. Steam production via a flashing process – a generic system concept

The Egyptian New & Renewable Energy Authority (NREA) issued an international tender to build parabolic trough collectors at a site just outside Cairo. The project, financed by the African Development Bank, has 144 parabolic concentrators arranged in four parallel loops that provide a net reflective area of 1.900 m_. The steam is produced by the reduction of the pressure of the water in the collector loop using a flashing valve and is delivered to an existing saturated steam network operating at 7.5 bar.

Figure 10. The El NASR Pharmaceutical Chemicals facility in Egypt has an installed capacity of 1,33 MWth
Source: Fichtner Solar GmbH. Germany

Conclusion

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 with solar thermal collectors already on the market. And, for the medium temperature processes, new collector designs are under development.

Recognizing the importance of this sector, the IEA SHC Programme and the IEA SolarPACES Programme are working collaboratively. The expertise from eight countries represented by 16 institutes and 11 companies have joined together to work in SHC Task 33. The participants will collaborate to provide a comprehensive description of the potential and the state-of-the-art applications of solar heat for industrial process; to disseminate the knowledge learned to solar manufacturers, process engineers, installers and potential buyers (industry); to identify applications and the corresponding temperature levels of the processes suitable for solar energy; to develop, improve and optimise collectors, components and systems with a temperature level up to 250°C; and to initiate pilot projects covering a broad range of technologies to become a "best practice."

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1 Weiss, W. et.al: Solar Heating Worldwide: Markets and Contribution to the Energy Supply, IEA Solar Heating and Cooling Programme, 2005, www.iea-shc.org/welcome/IEASHCSolarHeatingWorldwide2005.pdf.

2 Müller, T. et. al.: PROMISE – Produzieren mit Sonnenenergie, Projekt im Rahmen der Programmlinien „Fabrik der Zukunft" des Bundesministeriums für Verkehr, Innovation und Technologie, Endbericht, Gleisdorf, 2004, www.aee-intec.at.

3 Rommel, M.: Prozesswärmekollektoren – Aktuelle Entwicklungen im Mitteltemperaturbereich bis 250°C, in: erneuerbare energie 3-2005, Gleisdorf, 2005, www.aee-intec.at.

4 Jähnig, D., Weiss, W.: Solar beheizte Industriehallen in Österreich, in: erneuerbare energie 3-2005, Gleisdorf, 2005, www.aee-intec.at.

5 Schweiger, H. et. al.: 360 kW solarthermische Anlage für einen industriellen Waschprozess, in: erneuerbare energie 3-2005, Gleisdorf, 2005, www.aee-intec.at.

6 Aidonis, A.: Internal paper – status Trikala dairy, Task 33/IV, 2005.

Further information: www.iea-shc.org and www.iea-ship.org

TASK 27

Performance of Solar Facade Components

Michael Köhl

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

TASK DESCRIPTIONS

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 is focused 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.

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. The rest of Subtask A was completed in 2004 and the rest of Subtask B was completed the end of 2005.

ACTIVITIES DURING 2005

Subtask A: Performance

Experts prepared final reports on general energy performance methodology, switchable glazing and the performance of solar façade components.

Subtask B: Durability

Case Study: Reflectors

PCA analysis was used to compare indoor and outdoor test results 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 is 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 on the degradation mechanisms and on which accelerated screening tests best reflect changes in the IR spectrum observed for outdoor exposed samples, SP Swedish National Testing and Research Institute is trying to identify the most likely life limiting degradation mechanisms and the reaction kinetics.

A final report will be compiled after the termination of the evaluation of the experimental work.

Case Study: Solar Façade Absorbers

As most of the results and interpretations from the work of the case study now are available, the preparation of the final report for this case study is underway.

Case Study: Anti-Reflective and Polymeric Glazing Materials

The outdoor exposure of samples was terminated. The concluding work is focused on the investigation of the two most important degradation mechanisms for loss in the optical performance—soiling and out gassing of inappropriate insulation materials.

Service Life Prediction Tools for Complete Systems

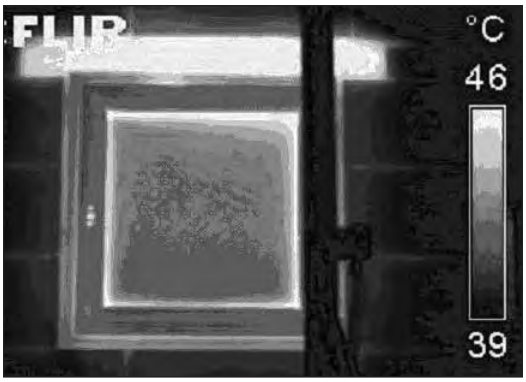
Failure Modes and Risk Analysis Related to Solar Collectors

The FMEA/FMECA analysis of flat-plate, evacuated tubular and CPC-type collectors was completed. An FMEA/FMECA analysis on the MARECO collector will be performed by Björn Karlsson of Sweden.

The final proposals for additional changes of the draft revised standard proposal for service-life-testing of absorber coatings is completed. Michael Köhl shall submit the revised standard proposal to DIN with a suggestion that the standard proposal be developed into an ISO/EN standard in accordance with the Vienna agreement.

Case Study: Window/Wall Interfaces

Developing suitable test methods for assessing the performance of window/wall interfaces was performed at Fraunhofer ISE in Germany by using a double climatic chamber, one with outdoor climatic conditions and the other with indoor climatic conditions. The wall between the two chambers contained a window and a window/wall interface. The infrared-technique was used to study the effects from thermal



Thermographic picture of the window/wall mounted in the double climatic cabinet (the dark bar at the right-hand sided edge of the window is the scanner for the humidity measurements)

Scanner with optical detector for water at the window/wall interface

bridges as well as the water penetration in the window/wall interface can be investigated by the use of a special water sensitive infrared-sensor. The work is ongoing.

WORK PLANNED FOR 2006

Finalizing all the outstanding Task reports.

REPORTS/EVENTS IN 2005

Reports
Durability of Polymeric Glazing Materials for Solar Applications, Solar Energy Journal, Volume 79, Issue 6, December 2005, Pages 618-623.

Events
A Workshop on Materials for Solar Thermal Systems with 68 participants was held November in Freiburg, Germany.

Task 27 work was presented at Glass Processing Days in Tampere, Finland in June. This is one of the major events for the glazing industry. Presentations included: Results of durability testing of antireflective glazing, Energy efficiency of switchable glazing in office buildings, Energy performance of facades and buildings–IEA as support for the European directive?, and Performance assessment for solar shading devices–state of the art.

Task 27 was presented at the 10th International Conference on Durability of Building Materials and Components in Lyon, France with the following papers: Study on durability and service lifetime prediction of some static solar energy materials; Energy performance of switchable glazing – IEA Solar Heating and Cooling Programme, Task 27; Real time simulations of the durability of insulating glass units; and Life-time estimation of polymeric glazing materials for solar applications.

The paper, Assessment of service life of some passive solar thermal materials, was prepared for the 2nd European Weathering Symposium in Gothenburg, Sweden in June.

MEETINGS IN 2005

Eleventh Experts Meeting
April 21-22
Lyon, France

Twelfth Experts Meeting
October, 24-25
Golden, Colorado, USA

MEETINGS IN 2006

No meetings are scheduled.

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SHC TASK 28/ECBCS Annex38

Sustainable Solar Housing

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TASK DESCRIPTION

The goal of this five-year Task was to help market penetration of sustainable solar housing by the year 2010 by providing home builders, institutional real estate investors and banks with:

- A guide to marketing sustainable solar housing,
- A Task web site illustrating built projects, exemplary in design, living quality, low energy demand and environmental impact,
- A Reference Books systematically compiling the experience of the experts, and
- A compilation of monitored data as a quantitative resource for writing articles, papers and brochures.

Work was contributed by experts from the Solar Heating and Cooling Programme and the Energy Conservation in Buildings and Community Systems Programme from the following countries:

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

Duration

The Task was initiated in April 2000 and was completed in April 2005.

Final Task Expert Meeting in Juan les Pins, France

ACTIVITIES DURING 2005

A final Task evaluation was carried out by the experts and approved by the SHC Executive Committee. The experts rated the Subtask and Task leadership highly, but were self-critical, noting that the contributions by experts/countries varied in a few cases considerably. Task outcomes were rated excellent as were also the Task goals, structure and methodologies.

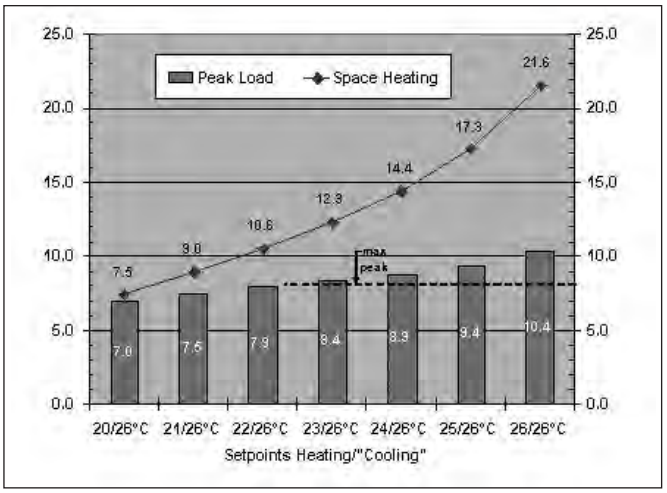
The final management report for the Task was written, presented to both the SHC and ECBCS Executive Committees at their joint meeting and approved. The SHC requested that the report be edited into two versions for the IEA SHC website: a public version and a password access version with candid recommendations by the Operating Agent. An important observation was that although the original scope in the Annex included housing renovation, time and work capacity did now allow this subject to be addressed. Rather than seeking a time extension, it was decided to propose a new Task, making use of the methodology and expertise developed in this Task.

Reports were completed and published (see Reports Published in 2005) and work is ongoing for the last reports to be published in 2006.

SOME INSIGHTS ON SUSTAINABLE HOUSING LEARNED FROM THE TASK

High performance houses often need more heating energy than planned, though the absolute energy demand is extremely small. Frequent causes include room temperature > 20°C and fewer occupants than assumed. Dynamic simulations with the program illustrate the effect of the room temperature setpoint on the heating demand by highly insulated houses. The following graph shows that in Gothenburg (S) for the Task 28 reference row house the heating demand nearly doubles if the desired room temperature is 24ºC instead of the normally assumed 20º C. The peak heating demand increases by over 25 percent. (in all cases it was assumed that the room temperature be allowed to rise to a maximum of 26 ºC from passive and internal gains).

Given the very low energy consumption, the embodied energy in the construction represents a bigger fraction of the total energy used over the lifetime of a structure than in conventional structures. Accordingly, it may make more sense to eliminate constructions with much embodied energy than to invest in a marginal energy saving feature.

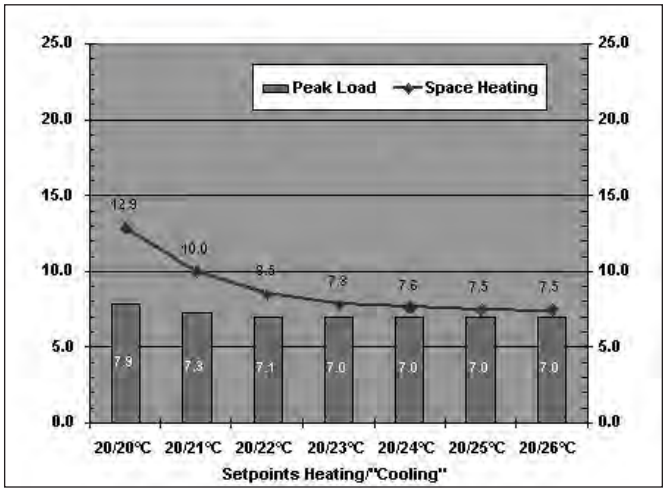


Sensitivity of heating energy demand and needed heating capacity to thermostat set point

Source: Maria Wall, Division of Energy and Building Design, Lund Univ.

Envelope

Generous window areas in sunlit facades (up to 50 percent) are possible. The delivered useful solar gains can compensate the increased heat losses from increasing the window area. This is true, even given the shortened heating season of highly insulated houses in middle Europe. High performance windows (U-values of glazing and frame < 0.7 W/m^{2}K) are a prerequisite, however. Here again, dynamic simulations illustrate the benefit of passive solar gains in reducing needed heating, if room temperatures are allowed to rise above 20ºC during the daytime. Thereby, passive solar and internal gains can be stored in the building interior and furnishings to then be slowly released nights. The following figure shows a 40



Benefit of passive solar and internal gains as a function of tolerated daytime room temperature rise

Source: Maria Wall, Division of Energy and Building Design, Lund Univ.

percent reduction in energy consumption if a daytime rise in room temperature to 24 ºC is tolerated.

Generous window areas are also important to assure well daylit rooms, and are a valuable marketing feature. Large windows can offset the self-shadowing caused by the deep wall cross section of highly insulated walls and the light losses of multiple pane window glazing with selective coatings.

Space Heating

A strong argument for so drastically reducing heating demand is that it is then possible to eliminate the conventional heat production and distribution systems, offsetting some of the costs to achieve such performance. By keeping the needed heating capacity to 10 W/m^2 or less heat can be delivered by the ventilation air, no other heat distribution system is needed and the heating plant can be extremely small. The project, "Sunny Woods" by architect Beat Kampfen in Zurich is an award-winning example.

Sunny Woods, Zürich. Architect Beat Kampfen (CH)

If the home-buyer insists on radiant heat, radiators need not be on exterior walls or under windows to offset radiant asymmetry or downdrafts. The highly insulating walls and windows have warm surface temperatures. Experience from latest generations of such high performance houses shows that home-buyers appreciate a radiator in the bathroom in any case.

Ventilation

Designing a ventilation system to also transport heat is challenging. First generation houses required too high air change rates on coldest days in order to deliver the needed heating. The needed air volume greatly exceeded that needed for room hygiene. The result was too dry air on coldest days. To solve this problem some projects today re-circulate some room air back into the supply air, reducing the intake of ambient air to that needed for air quality.

Acoustics

Occupants of highly insulated houses are especially sensitive to noise because they are so isolated from ambient noise when windows are shut. In a quiet house, one hears every noise!

Sound dampers in the air ducting are very effective in cutting sound transfer within the house or from the ambient. Their numbers and positioning have to be part of the architectural planning because they are bulky and unsightly. Ventilation system noise (air movement in ducts or fan motor) can be engineered out by isolating fan motors system and keeping air flows under 3m/s.

Summer comfort

High performance houses need not be hotter than conventional houses in summer. Both conventional and high performance house windows should ideally have exterior solar shading and reduced window areas facing west. Closing the house up during hottest, daytime hours and opening it at night is common sense. The thick insulation of high performance houses helps keep out the heat which builds up on the roof and sunlit facades. An earth to air heat exchanger for the supply air can supply weak but welcome cooling power.

FURTHER WORK NEEDED

Heat supply. How to optimize a combi-solar system to the unique load situation and shortened heating season of high performance housing.
Control systems. How to maximize the potential of home automation systems to optimize technical systems operation, improve comfort and reduce operating costs.
Architecture. How to integrate high performance strategies into people-oriented design (neither architecture-journal aesthetics nor engineering optimizations). High performance housing has not yet found its own "school" of design. Examples of a curious nostalgic relic are the "chimneys" of the Lindas Housing in Gothenburg which has neither fireplaces nor any form of combustion heating, but the design appeals very much to the market.

Housing renovation. How to apply strategies developed in the Task for new housing to achieve similar energy savings, improvement in comfort and economy in the renovation of existing housing. Time and work capacity did not allow the Task to explore this important topic.

"Chimneys" of the Lindas Passivhaus high-performance houses, Architect H. Eek (S)

REPORTS PUBLISHED IN 2005

Reports available under Outcomes on the Task 28 web page, http://www.iea-shc.org/task28/index.html:

Business Opportunities in Sustainable Housing–A Marketing Guide Based on Experiences from 10 Countries. A guide for developing a marketing strategy illustrated with success stories.

Exemplary Sustainable Solar Houses. Forty brochures describing demonstration sustainable solar housing projects.

I*nnovative Components and Systems.* Guidelines for selecting components and systems.

Design Insights from the Analysis of 50 Sustainable Solar Houses. Project descriptions and systematically compiled monitoring data.

Professional journal articles (a sampling):

"Solarunterstützte energieeffiziente Wohngebäude" (Solar, energy-efficient housing), Bauen Heute – Fachjournal für zeitgenössische Bauen, Sep. 2005, ISDN 071 860 00 55, Hastings, R. & Enz, D.

"Influence of Window Size on the Energy Balance of Low Energy Houses", Energy and Buildings, Elsevier Press, ISSN: 0378-7788, Persson, M-L.; Arne Roos, A.; & Wall, M.

"Energy-efficient terrace houses in Sweden. Simulations and Measurements", Energy and Buildings, Elsevier Press, ISSN: 0378-7788, Wall, M., http://dx.doi.org/10.1016/j.enbuild.2005.10.005

Television
A documentary film: Bauen mit Hausverstand
Passivhaus design including interviews with Task experts and the Operating Agent broadcast on three dates by ORF 3 / 3.SAT. The 45-minute documentary was watched by approximately 700,000 viewers and thereby achieved the highest viewer quotient of the day and ranked among the top three broadcasts of the month for this multi-national station (available as a DVD from www.Hausderzukunft.at).

MEETINGS IN 2005

Eleventh (final) Expert Meeting
April 10-11. April
Juan les Pins, France

Practitioner/Industry Workshop on Task results
June 30
Freiburg, Germany

REPORTS PLANNED FOR 2006

Design of High Performance Housing–A Reference Book. Insights from monitoring, simulation and the experts with sections on Strategies, Solutions, Exemplary Buildings and Technologies.
(James & James Science Publishers, London, www.earthscan.co.uk).

Sustainable Housing in Warm Climates–Learning from Innovative Projects, Exemplary Projects. Trends in approaches taken to build sustainable solar housing in cooling dominated climates are examined and illustrated with built housing projects.
(James & James Science Publishers, London, www.earthscan.co.uk).

The Environmental Brief. Advice to building clients and owners to help assure that early good intentions are finally achieved in ecologically sound buildings.
(EF&S Spon Press Ltd., London, ISBN: 0-419-24490-5).

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TASK 29

SOLAR CROP DRYING

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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.

Duration

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

The Lianghe Amorphophallus Product Company, Ltd. in China has installed 965 m^2 of perforated solar panels to dry the turnip-like tuber, moyu.

ACTIVITIES DURING 2004

Panama – Coffee Drying

The 2004/5 season was a good one in Panama and the Sona drying facility was operational during this time. Monitored data was collected and analyzed for this period. Results show that the airflow was less than predicted in both of the collectors. This was due to air leakage in other parts of the system. A Task expert visited the site in February and took measures to reduce the leakage from over 25% to under 5%. Because of the lower airflow, the collectors did not operate at the predicted efficiencies. The lower roof collector efficiency for the first few months ranged between 12% and 26%. After the leaks were treated, the efficiency for March was over 30%. The upper roof collector efficiency ranged between 18% and 27% before the remedial work and over 30% in March. There was some indication that the effect of heat loss from the collectors due to wind was higher than predicted on the high roof but this will be analyzed further.

This system may be monitored for the 2005/6 drying season. A decision is expect before the end of 2005.

Costa Rica – Coffee Drying

The solar preheat system at the Coopeldos drying facility operated throughout the 2004/5 drying season and system data was collected and measured. In spite of much effort to seal leaks in the ducting and furnace, the air flow through the collectors was significantly less than predicted. Also, for the months of December, January and February, the incident solar radiation was less than estimated (in February less than 70%), all of which meant that the collectors did not operate at peak efficiency and the solar energy delivered to the system did not meet expectations.

Further investigation revealed that manual control of some dampers located between the furnace and dryers may have been a cause for the reduced air flow. An automated control system is being considered to address this problem. No remedies for the lack of sunshine in the area last year have been proposed.

India – Coir Pith Drying

It is believed that the coir pith system continues to operate satisfactorily. It has been difficult to get accurate updated information from the site to confirm this, but in this case we consider no news to be good news. Due to a number of issues including lack of project feedback, timing and the delay in the second project in India, the Task has decided not to monitor this project.

The Coopeldos coffee drying system in Costa Rica has now operated successfully through a drying season. Shown above is the duct from the solar panel entering the furnace.

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

India – Tea Drying

The plant belongs to the Marionbarie Tea Co. Ltd. and is located in Dooars in the province of West Bengal. The proposed solar system for this project includes over 1,000 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.

The solar panels for the project have been manufactured and prepared for shipment, but financing for the project is now in question. It is understood that the client's financing agency is now insisting that the furnaces be converted to coal fired before further funding for the solar component will be advanced. At this point, it is not clear what action the client company will take, and from the Task point of view, the project has been put on hold. We are optimistic that the project will eventually proceed but it is not likely to be in time to have full monitored data included in the Task report.

China – Jujube Drying

No further contact has been made with this project. We do plan to include information on the pilot project which was

completed and has been operating for several years but there will be no monitored data for this or the now cancelled full-scale facility.

China – Moyu Drying
This project includes the installation of a solar air preheat system on the new workshops of the Lianghe MoYu Taro Products Limited Company. The company is building a 2,000 square metre addition to its existing plant in Yunan Province in southern China.

Moyu is a vegetable grown in China which is very similar to a turnip. Other names for the tuber are Konjac, Devil's Tongue, Voodoo Lily and Magic Taro. It is used in China and Japan for making noodles and gelatine for thickening stews, sauces and soups.

The last report from the site indicated that the solar panels have been installed, but that the duct work for half of the system was not complete. The company exhibited a great enthusiasm for solar energy by installing approximately twice the collector area that was recommended by the Task experts. More discussion is required to determine how best to use this extra capacity in a cost effective manner. Until the Task is satisfied that the system can operate efficiently, the project will not be monitored. Given the remaining time in the Task, it is likely that monitored results will not be available for the final report.

Zimbabwe – Tobacco Drying
A summary report on this project was prepared by the Dutch expert. Although the project was not completed due to the political situation in the country, the report does draw some important conclusions. It recognizes that tobacco might be one of the most difficult agricultural products to cure but there is likely a place for solar energy in the process. Both air and water based systems can be adapted to the process. Properly designed air systems could use minimal or no grid electricity and may be less expensive. Water based systems are simpler to design and control but would require a large air heater. The economics improve if one system can serve multiple drying barns.

Similar to the experience in other Task projects, much greater efficiencies in the process can be gained through better design and construction of other parts of the system including furnaces, ducting and drying chambers.

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

Activities Planned for 2006

Activity for 2006 will be limited to completing the monitoring and possible improvements for the projects in Central America. A final report will be prepared and is planned for completion by June 2006.

LINKS WITH INDUSTRY

No new industry initiatives were undertaken in 2005. Work in the Task concentrated on realizing the projects on hand.

REPORTS PUBLISHED IN 2005

No official reports were published in 2005.

REPORTS PLANNED FOR 2006

The final Task report will be prepared in 2006.

MEETINGS IN 2005

There were no Task expert meetings held in 2005. Canada is effectively the remaining active participant in the Task with ongoing projects. The Canadian team held regular phone meetings throughout the year.

MEETINGS PLANNED FOR 2006

No full Task meetings are planned for 2006. The Canadian team will continue meeting as required.

TASK 29
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TASK 31

Daylighting Buildings in the 21st Century

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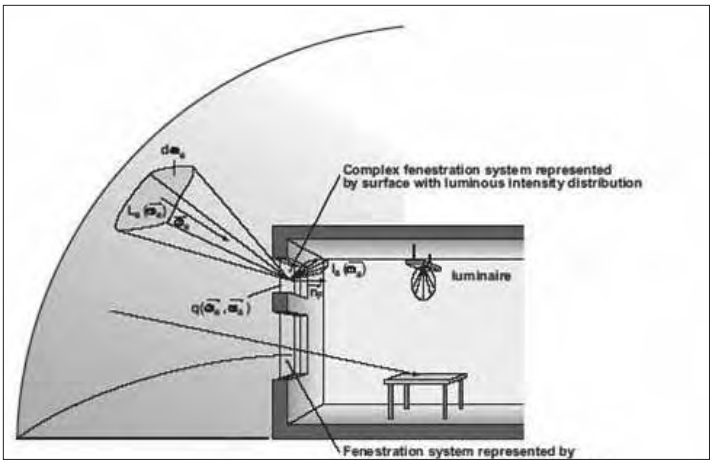
TASK DESCRIPTION

SHC Task 31, Daylighting Buildings in the 21st Century, has sought to make the use of daylighting with controls the typical and preferred design solution for lighting buildings. The Task has focused on commercial buildings, both new and existing, with the aim to address issues that have arisen in the past decade, particularly the need to integrate human response with the application of daylighting systems and associated shading and electric light control strategies. The SHC Task 31 web site with its links to reports and a special daylighting issue of Energy in Buildings will represent the state of the art for 2005/2006 when the work ends in 2006.

International Energy Agency experts from 14 countries in Europe, North America, Asia, Australia and New Zealand have collaborated in the SHC Task 31 four-year work programme. It should be noted that during these four years, changes have been made to the original work plan due to reduced available funding and changes in energy policy by several participating countries.

The research work of this international team is organized into four research areas:

- Subtask A: User Perspectives and Requirements (Lead Country: Canada) Concerned with human response, occupant preferences and switching behaviour
- Subtask B: Integration and Optimisation of Daylighting Systems (Lead Country: USA) Concerned with the creation of the infrastructure of a road map, an advanced controls design guide and a commissioning and calibration guide
- Subtask C: Daylighting Design Tools (Lead Country: Germany) Concerned with the improvement of lighting tools to predict the energy performance and visual comfort conditions of complex fenestration systems.
- Subtask D: Daylight Performance Tracking Network and Design Support (Lead Country: France). Concerned with the construction of an international web site and an educational package for use by design professionals and building developers



Calculation method for room illumination using luminous intensity distributions

Significant achievements of Task 31 are:

- Subtask A: User perspectives and requirements
  - New glare probability index
  - Response model LIGHTSWITCH integrated into whole building simulations
  - Extended monitoring protocol to include human response

- Subtask B: Integration and optimisation of daylighting systems
  - Controls design guide including adaptive controls
  - Controls commissioning and calibration guide
  - Daylighting design framework for a roadmap

- Subtask C: Daylighting design tools
  - Numerical goniophotometer created
  - Models of indoor lighting from complex fenestration systems
  - Test cases for validation of simulation programs

- Subtask D: Daylight performance tracking network and design support
  - International web site and education package

Duration

SHC Task 31 was initiated in September 2001 and will be completed in June 2006.

The Task was extended to June 2006 to enable an education package including the framework of the road map, and the completion of projects in ECCO-Build (glare probability index and advanced lighting controls).

ACTIVITIES DURING 2005

Subtask A: User Perspectives and Requirements

Literature Survey

An annotated bibliography of important literature was completed and placed on the web site. The database documents important aspects of daylighting research relevant to the activities of SHC Task 31, such as:

- Measurement and modeling of sky luminance and daylight availability
- Radiance based annual daylight simulations
- Advanced daylight system control algorithms and user acceptance
- Discomfort glare from daylighting
- Visual comfort assessment methods
- Daylighting in school buildings
- Daylighting in atrium buildings
- Light pipes for daylighting applications.

Visual Assessment Methods

Monitoring Protocol for the assessment of occupant usage of lighting and shading controls

An extension of the SHC Task 21 measurement protocol is being continued for monitoring studies of user behaviour in SHC 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.

New daylight glare probability index

Work on the new daylight glare probability index (DGP), part of the project ECCO-Build, has provided an insight into the impact of luminance distributions on glare and user acceptance of daylighting systems. This index is based on vertical eye illuminance, the source luminance, its solid angle and a position index. Most existing glare indices estimate possible glare sensations of a "standard observer." The evaluations of the results from the experiments showed a very strong correlation between the DGP and the user's response. It has been concluded that the probability model should be extended with other solar shading systems besides Venetian blinds as well as with additional parameters such as quality of view to the outside. The results will be published at the end of the project (February 2006) in a special issue of Energy and Buildings in 2006.

User Behaviour Modelling

A report on a user behaviour model LIGHTSWITCH was completed and reviewed for publication. The LIGHTSWITCH model was integrated into the dynamic thermal simulation

program ESP-R (Refer 2.). It is intended that the model be integrated into other daylight analysis software packages in the future.

Survey on Role of Daylighting in Sustainable Design

The National Research Council of Canada conducted an on-line survey on "the role of daylighting in sustainable design." The questionnaire was developed together with various peer researchers at Natural Resources Canada and in SHC Task 31. The survey has provided guidance for the daylighting design framework that focuses on design practitioners with an interest in daylighting and sustainable design but no expert knowledge.

The main objectives for the survey were to:

- Understand which daylight performance indicators, rules-of-thumb, and design tools practitioners are currently using to integrate daylighting.
- Understand which aspects and barriers towards better daylighting are not covered by the current generation of design guides.
- Propose content and format for a daylighting design guide that addresses these needs.

There were nearly 200 respondents to the survey predominantly from Australia, Canada and the USA, and mostly from architectural and engineering design professions. The results will be used in the framework of the daylighting design roadmap. The final report will be available March 2006.

Subtask B: Integration and Optimisation of Daylighting Systems

Daylighting Design Roadmap

The daylighting design roadmap will provide a framework for design decisions that can provide access to information developed in the Task and can provide better access to the use of existing and new tools. In addition, the framework is to be shared by all countries, even though its specific implementation will vary between countries, and with their specific tools, code requirements, and available data. The framework will lay out, for several different users and design use scenarios, the sequence of key decisions that must be made at critical points in the design process, the types of information and tools that might be used to address them, and how the information and tool output might be used by designers to address the specific design challenges. Professionals being targeted are those that have at least a high level of motivation or knowledge on daylighting. The framework will include "rules of thumb" and will be an electronic document with hyperlinks to referenced documents and tools.

The roadmap will be part of an educational package that will be available in the latter part of 2006.

Control Guides

Controls Design Guide

The controls design guide will be completed for review by the end of December 2005. It will include the taking into account of user response and the target audiences are 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).

Commissioning and Calibration Guide

The key concerns have been to avoid a 'reference-only' type document. It was decided that the completed first draft would not serve as a useful site document as it is currently too onerous for practical application on site, and that control systems using network based architecture and wireless technologies should be more fully addressed. It has also decided that it should be implemented in a software format and that comment should be sought from contacts in the control industry.

Field and Laboratory Studies

Table 1 shows the field and laboratory studies that will be included in the report.

Project name Project location Advancement of electrochromic windows LBNL, Berkeley, USA Cost effective daylighting New York New York USA ENTPE Field study Vaulx en Velin, France Fraunhofer ISE Office Building Freiburg, Germany ECCO-Build Project Freiburg, Germany ECCO-Build project Lausanne, Switzerland AdControl Lausanne, Switzerland ECCO-Build project Horsholm, Denmark Auto-adaptive system Berlin, Germany Field evaluation of energy savings control system Vancouver, Canada

This work is a summary of the field work that was contributed to work in Subtasks A and B. There have been convincing results to date on the daylighting of buildings not only on satisfying the visual requirements of occupants, but that buildings themselves can be designed so that electric lighting can be turned off for 40% of the time. This has been proven in the New York Times Building. The web site of the New York Times Building is: http://windows.lbl.gov/comm_perf/newyork-times.htm

Subtask C: Daylighting Design Tools

User Interactions

A working document was completed on a tools survey and additional funding has been received for a revision of the ADELINE GUI. This work will be performed beyond the scope of SHC Task 31.

Algorithms and Plug-Ins

Reports on goniophotometry, modeling, indoor illumination from complex fenestration systems, all sky validation and implementation are being prepared for review and publication.

Work on the "all sky model" including validation work with more Japanese climatic data and the development of calculation models for RADIANCE inclusion was carried out. There are still mismatches between the model and measurements so a final calibrated model has not been finalized.

A report entitled, *"Status and Further Development of Skies"* is to be compiled. It was recommended that an indication on how to link measured irradiance data (TMY, TRY) to the 16 or more standard CIE luminance distributions be included with comments on the impact of the different sky luminance distributions on indoor illumination levels.

The capabilities to model and calculate complex fenestration systems have been extended. The software DELight was integrated into the EnergyPlus simulation program. EnergyPlus, a new building simulation program, is 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.

The Institute of Building Physics (IBP) in Germany will provide a program allowing the filtering of the BTDF (Bidirectional transmittance distribution function) exporting data in IES format.

Validation

Reports are under review on the experimental validation of simulation methods at the daylighting performance level and on the application of CIE test cases to assess the accuracy of lighting computer programs. The results of the validation work are partially available on the SHC Task 31 webpage. This online site is to be used as a future validation and benchmark site. New validation datasets will be included according to a defined procedure and compared to other already performed validation runs.

The database on systems will be made publicly available via a website hosted by IBP of Germany. For ongoing inclusion of datasets beyond the scope of SHC Task 31, IBP will seek collaboration with LBNL of the USA and LESO of Switzerland.

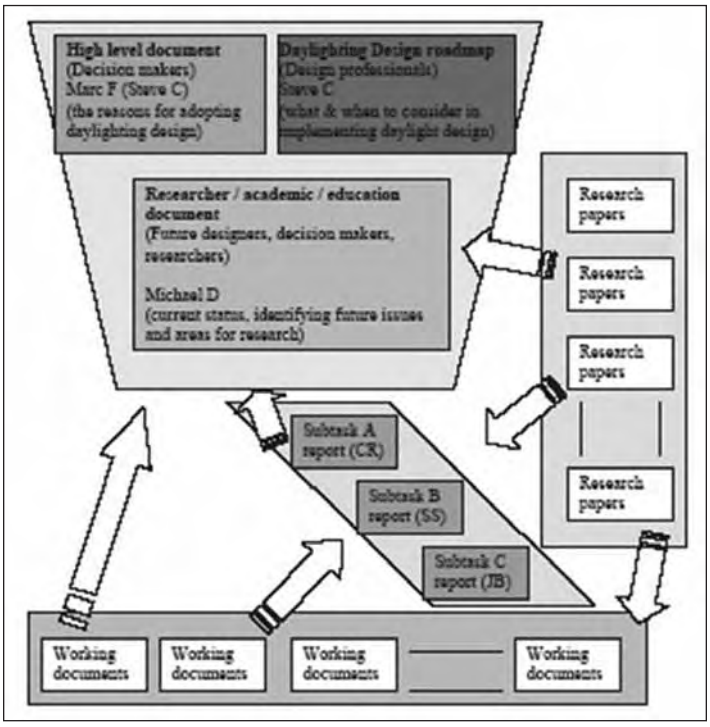
Subtask D: Performance Tracking Network and Design Support

Subtask D has been working on how to pass SHC Task 31 information on to professionals. This will include an educational package. The concept is to supply an information digest for the web site and make this information accessible to all with copyright free images.

Education Package

The educational package will be comprised of three documents:

1. An introductory document "teaser" for decision makers giving the reasons for adopting daylight design
2. A document for researchers, academics, and educators defining the current status of daylight in buildings, and identifying future issues and areas of research
3. The framework of a daylighting design roadmap for design



The infrastructure of the education package

professionals-describing what, when and where to implement daylight design. This document will be linked to research papers, working documents, reports and tools.

WORK PLANNED FOR 2006

Most of the technical work for Task 31 has been completed. The following work is planned for 2006:

- Completion of the educational package
- Completion of the reports on commissioning and calibration and field and laboratory studies
- Release of a database on systems
- Completion of the validation web site

LINKS WITH INDUSTRY

In Australia, a Lighting Innovation Centre, a collaborative network of associations, universities and state government, has been created 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 involved a best practices in lighting program delivered via a seminar series in Australian cities in 2004. Another seminar is being organised for 2006.

REPORTS PUBLISHED IN 2005

No reports were published in 2005.

The Proceedings of Lux Europa 2005 included 10 papers on Task 31 research.

REPORTS TO BE PUBLISHED IN 2006

- LIGHTSWITCH Model to Determine the Impact of User Behaviour on Energy Use
- Daylight Glare Probability Index
- Overview of Subtask A
  - Framework for a Design Guide
  - Control Design Guide
  - Commissioning Guide Including Procedures to Calibrate and Commission Key Daylighting Control Systems
  - Case Studies Re Energy Savings and Occupant Response
- Overview of Subtask B
  - Goniophotometry and Assessment of Bidirectional Photometric Properties of Complex Fenestration Systems
  - Experimental Validation of Simulation Methods for Bidirectional Transmission Properties at the Daylighting Performance Level
  - Modeling Indoor Illumination by Complex Fenestration Systems Based on Bidirectional Photometric Data
  - Application of the CIE Test Cases to Assess the Accuracy of Lighting Computer Programs
  - A Reliable Database to Assess the Accuracy of Lighting Computer Programs
  - All Sky Model Validation and Implementation into Radiance
- Overview of Subtask C
  - Education Package
  - Energy and Buildings Special Issue

MEETINGS IN 2005

Eighth experts meeting
April 18-21
Berkeley, California

Ninth Experts Meeting – Final Meeting
September 19-21
Berlin, Germany (in conjunction with Lux Europa 2005)

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TASK 32

Advanced Storage Concepts for Solar and Low Energy Buildings

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BASE Consultants SA
Operating Agent on behalf of the
Swiss Federal Office of Energy

TASK DESCRIPTION

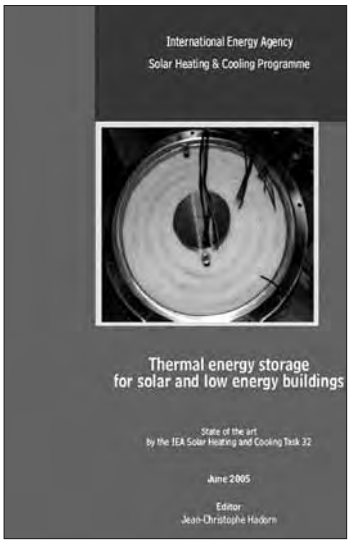
The main goal of this Task is to investigate new or advanced solutions for storing heat in systems providing heating or cooling for low energy buildings.

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 heat pumps or fossil boilers in order to reduce cycling and thus to reduce pollutant emissions due to partial combustion.

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 (solar, heat pump or boiler) for low energy housing. This provides both a framework and a goal to develop new technologies.

The Subtasks are:

- Subtask A: Evaluation and Dissemination (Lead Country in 2005: Switzerland)
- Subtask B: Chemical and Sorption (Lead Country: Sweden)
- Subtask C: Phase Change Materials (Lead Country: Austria)
- Subtask D: Water (Lead Country: Germany)



Duration

The Task was initiated in July 2003 and was initially planned to be completed in December 2006. Due to unexpected difficulties in setting up laboratory experiments with new materials and developing new models for heat storage modules, the Task was extended to December 2007.

ACTIVITIES DURING 2005

General

In 2005, two meetings gathered more than 20 experts from 8 countries, with a strong participation from 6 countries. Unexpected difficulties have been encountered in laboratory testing and in modelling of new storage materials.

Subtask A: evaluation method and dissemination of results

The main activity of Subtask A during 2005 was the publication of a "State-of-the-Art" handbook on short-term heat storage. The book is based on contributions from Task experts and three well known storage experts outside the Task. The content, both scientific and technical, fills a gap in the current literature on thermal storage.

The reference conditions for simulating different options with the same framework has been issued by the Austrian team. It is a useful piece of information for comparing systems, including 4 different climates, 3 different types of houses and various heating and cooling options. A reference "solar combisystem" has also been defined so that all teams can simulate their storage solutions within a similar system.

Subtask B: Chemical and Sorption Storage

Five projects are being investigated and two others could be brought into our Task depending on national financial support. Sorption storage solutions appear to be complex and more suited to heat pump systems where both heating and cooling could be achieved, rather than pure solar systems. Zeolite is still an option but the driving force needed during unloading is still a limiting factor. A new idea from Germany for a seasonal storage based on Zeolite (8m3 for a one-family house) has been proposed theoretically in 2005 and will be studied during 2006. A 1000 kg storage tank filled with silica gel will be installed during 2006 in a combisystem for a solar house in Austria and will be monitored during 2007.

Subtask C : Phase Change Materials

Six projects are being developed. Most of them use sodium acetate as the phase change material. Characterisation of the material in different combinations of heat transfer enhancers has been the main work of 2005. The heat transfer coefficient is indeed the limiting factor for a useful PCM storage, and it was shown that the preparation of the samples may induce very different results for the material properties. It is anticipated that this work is preliminary work for an international standard on PCM characterisation for heat storage.

Modelling the subcooling effect is also a difficult topic that was adressed by two teams. Models are not completely developed, but first results showed that the number of nodes in the discretization process influence strongly the quality of the results. The Danish team showed, in a theoretical study with a simplified model, that seasonal storage could benefit from this effect by a 30% reduction of the storage volume if the effect is mastered.

Computational Fluid Dynamics (CFD) tools also have been used to better understand the convection effects in a PCM within a bottle placed at the top of a water tank. Comparisons with a Trnsys model have been undertaken, and show that convection has to be taken into account even in simple models. This is still a challenge.

Subtask D: Water tanks

In 2005, Subtaks D issued a report on the possible improvements of water tank storage for combisystems. The trends are to increase solar energy savings, to better integrate, to improve the thermal performances, to try to use a mixture of water and PCM, to use CFD tools to better understand the thermal behaviour inside the tank, to look for cost reduction (standardised and simpler systems, polymeric materials), and to use non-pressurized tanks.

In a Danish study, three different ways to produce domestic hot water have been studied and lead to useful recommendations. In Switzerland, 11 different combisystems were compared and the comparison produce very results for better designs.

WORKED PLANNED FOR 2006

Task 32 experts plan to have models of several storage options that could be used within Trnsys with a common framework. With the extension of the Task, it is anticipated that the goal can be reached, however it is not known if the chosen solutions can be completely mastered during laboratory tests and that the models can be fully validated.

LINKS WITH INDUSTRY

An industry day was held at the research center of EDF in France in November.

REPORTS PUBLISHED IN 2005

State of the Art Handbook
Task Electronic Newsletter, June 2005

Working Documents:
Method of Comparison and Criteria
Identification and Selection of Projects
Thermal Properties and Laboratory Analysis
Identifications and Selection of Projects
Thermal Properties and Laboratory Analysis for PCMs
Review of Advanced Concepts and Dream Systems for Tank Storage

REPORTS PLANNED FOR 2006

Task Electronic Newsletter

Working Documents:
Boundary Conditions and Reference Conditions
Laboratory Prototypes of Storage Units

MEETINGS IN 2005

5th Experts Meeting
May 18-20
Lleida, Sapin

6th Experts Meeting
November 23-25
Fontainebleau, France

MEETINGS PLANNED FOR 2006

7th Experts Meeting
May 29-30
Stockton, New Jersey, USA, in conjunction with Ecostock '06 Conference

8th Experts Meeting
November
Stuttgart, Germany

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TASK 33

Solar Heat for Industrial Processes

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TASK DESCRIPTION

Around 150 million square meters of solar thermal collectors, corresponding to an installed capacity of 105 GWth, were installed by the year 2004 worldwide. 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 additions, the development of design tools (based on TRNSYS simulations) and a software tool for fast feasibility assessment, economic analyses as well as the design and the erection of pilot plants in co-operation with industry are planned.

Scope of the Task

The scope of the Task is on solar thermal technologies for converting solar radiation into heat, (i.e., starting with solar radiation reaching the collector and ending with hot air, water or steam transferred to the application.) The distribution system, the production process, and 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 where heat up to a temperature level of approx. 250°C is needed.
- 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), parabolic trough collectors.

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

- Subtask A: Solar Process Heat Survey and Dissemination of Task Results (Lead Country: Italy)
- 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 of 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 Programme on a "moderate level" according to the SHC "Guidelines for Co-ordination with other Programmes."

Duration

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

ACTIVITIES DURING 2005

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

Potential studies

Several potential studies carried out in different European countries have highlighted the huge potential for the application of solar process heat in the industrial sector. The potential studies for the three countries—Spain, Portugal and Austria—have shown that the need for industrial heat at low temperatures, which could be met using solar heat, is around 26 PJ (technically achievable potential). Even if only 5% of this potential were to be achieved in the coming years, equal to only 0.6 % of the low-temperature heat requirement of these three countries, this would require the installation of one million square meters of collectors with a capacity of 700 MWth .

A first potential study was also carried out for Italy, showing that about 1/3 of the industrial heat demand is in the temperature range below 250°C. According to the study carried out by the University of Rome "La Sapienza," the potential for solar process heat is about 17.5 TWh/y, which corresponds to 19% of the Italian industrial heat demand below 250 °C, or 5.4% of the total industrial heat demand in Italy. Most of the application potential lies in the food sector (44%) and in the textile industry (25%).

In the framework of the Subtask A activities, a draft report summarizing the main results and outcomes of all potential studies has been prepared. The final summary document will be available in 2006.

Currently about 85 solar thermal plants for process heat are reported worldwide, with a total installed capacity of about 27 MWth (38,500 m^2).

Classification of systems

The integration of solar heat into the industrial process is a key challenge. For using solar thermal energy, the temperature of the available heat and the variability of solar energy must be considered, as well as the heat profile required by the process. To rise to these challenges, 23 generic system concepts were developed according to the requirements of the different energy carriers (air, water-glycol, pressurised water or steam), the temperature levels and the process to be supplied with heat. These concepts are currently being realised and tested in demonstration plants.

Diffusion Activities

Industry workshops

In 2005, two industry workshops were organized. The first industry workshop was held in Madrid on February 25th, under the framework of the GENERA 2005, an international energy and environment trade fair. The workshop was attended by 70 persons.

The second industry workshop was organized at the University of Kassel (Germany) in parallel with the 5th Task 33 experts meeting. The workshop was attended by about 50 participants.

Industry Newsletter

The first annual Industry Newsletter of Task 33 was translated into 5 languages and distributed in electronic and paper versions in the participating countries.

Subtask B: Ivvestigation of Industrial Energy Systems

Matrix of indicators

By analysing unit operations of industrial energy applications, it could be concluded that low temperature processes exist in nearly all industrial sectors that are suitable for using solar thermal energy. Some industry sectors such as food, chemistry, plastic processing, textile industry, building materials industry and business establishments can be distinguished as very promising sectors. The investigation of these industrial energy systems has to focus on an integrated analysis of cooling and heating demands taking into account competitive technologies, when assessing the (economic) feasibility of solar thermal energy. Among those competing technologies are heat integration, co-generation, new technologies and heat pumps.
A matrix of indicators was developed in Subtask B as a decision support tool for solar experts. With this matrix the work with industry and the identification of suitable solar applications will be facilitated. With the matrix it should be possible to investigate and calculate the installation of solar heat in production processes without detailed knowledge of the relevant unit operations. The research concludes promising technical and economical feasibility of solar thermal energy for industrial processes and identifies a seminal step to a sustainable zero emission production.

Improved flat plate collectors in a process heat application: double glazed anti-reflective flat plate collectors from ESE (Belgium) are used in this compact solar driven desalination system developed by Fraunhofer ISE, Germany.

Within the scope of Subtask B also the possibilities for heat recovery and use of solar thermal energy in an Austrian dairy were examined within a feasibility study.

Subtask C: Collectors and Components

In Subtask C, a report was elaborated on that provides an overview of the different medium-temperature collector developments under investigation in connection with Task 33. The different collector developments are described briefly in concise papers. The report, Medium Temperature Collectors, is now available for download at http://www.iea-ship.org/3_1.html.

Work on the different medium-temperature collectors continued with two activities, in particular:

- A new medium temperature collector was introduced to the market: The company SCHÜCO presented a double glazed flat-plate collector at the ISH-fair in Frankfurt, Germany in March 2005. The anti-reflective double glazing of this collector is hermetically sealed and the gap between the glass

panes is filled with an inert gas to reduce the heat losses of the collector cover.

- In Spain, the development of a concentrating collector is planned with a fixed reflector and a tracking receiver. This means, that within Subtask C now four different concepts for concentrating collectors are investigated:
  - tracked parabolic trough collectors
  - reflector and receiver are tracked together,
  - tracked parabolic trough collectors
  – with fixed receiver and tracking reflector
  - Fresnel collectors with tracking reflectors and fixed receiver,
  - and the new concept with a fixed reflector and a tracking receiver.

The collector developments will be continued in 2006.

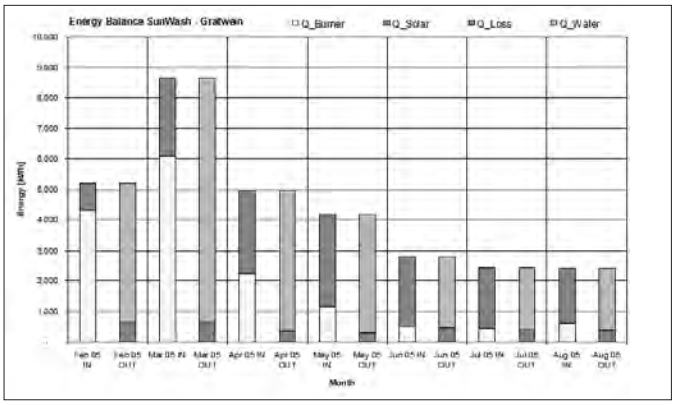
Collector Testing

The general approach in the work on this topic 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 into the existing EN12975 standard: improved flat-plate collectors, stationary concentrating collectors, tracked parabolic trough collectors and other concentrating collectors. Most of the necessary points of discussions refer to concentrating and tracked collectors. A first test on a parabolic trough collector was carried out by DLR/ITW during summer 2005. In these tests a testing facility was used in which the tilt angle of the testing platform could be adjusted. Therefore the influence of end-loss effects could be eliminated in these tests. The work on collector testing will be intensified in 2006.

Subtask D: System Integration and Demonstration

In Spain the first demonstration project with a nominal capacity of 357 kWth was installed in Barcelona. It is used for cleaning of transport containers of the company CONTANK. It is

The Sunwash plant in Gratkorn, Austria



Monitoring results from the Sunwash plant in Gratkorn, Austria

expected that some 22% of the 1990 MWh/a heat demand of the company will be satisfied by the solar system. The total investment was about 270.000.

In Austria, a solar production hall heating system has been completed, and a warehouse with a solar supported heating system is under construction.

First monitoring results were obtained by AEE INTEC at the car wash plant "Sunwash" in Gratkorn, Austria. During the period May 2005 to August 2005, solar fractions between 72% and 82% were reached. The highest energy consumption occurred in March, and in absolute values, the solar field contributed almost as much energy as during a summer month. The monitoring of this installation will be continued.

WORK PLANNED FOR 2006

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

The summary report of the potential studies and a report on existing plants will be finalized. And, the plant survey and inventory table summarizing the existing plants for solar process heat will be updated. A Power Point archive ("roadshow") of the existing plants will be finalized. The next industry workshop will be organized in conjunction with the March Experts meeting in Italy. The second edition of the Industry Newsletter will be available the end of January 2006 in English and in the languages of all participating countries.

Subtask B: Investigation of Industrial Energy Systems

The focus of the work in Subtask B will be the extension of the matrix, primarily for three industry sectors (food, textile, electroplating) and to fill in the matrix with data and information in a defined depth.

Work will continue on the methodology for the energy audit scheme and the roadmap. The road map shall be an instrument to visualize the differences, advantages and disadvantages of viable investment or operating options and the expected results in terms of either costs and energy use for the different approaches. The intended purpose of the road map is to provide companies with a decision tool to find a tailor-made procedure for investments and/or operating options for consecutive projects protracting over a longer period with several investment phases or changes in operation.

Subtask C: Collectors and Components

Work on the development of medium temperature collectors will continue in the different projects involved in the Task.

Testing of medium temperature collectors will start a round robin test in mid-2006. Different testing institutions are prepared to participate in the activity. Also, the investigation on material tests will start in 2006. Performance parameters for material tests will be defined at the March Experts meeting. Accelerated exposure tests are planned to start late 2006.

Regarding system aspects, first field test results will be discussed at the March Experts meeting. Also, work on the stagnation behavior of large solar thermal systems for process heat will be carried out.

Subtask D: System Integration and Demonstration

In 2006, the first draft version of the design guidelines on how to integrate solar thermal heat into industrial processes will be prepared. The related documents and tools will be collected and maintained in a specific section on the Task Website. This site will contain a general description and procedure for the design of solar process heat systems and the use of the tools provided, the template/questionnaire for the collection of information for a specific site, the "pinch tool" under development at JOINTS, the GREENIUS fast assessment tool under development at DLR, as well as nomograms developed for specific applications.

Due to the size of the matrix developed by JOINTS, this tool will be made available to the participants on CD. All documents and tools are regarded as "working documents" to be updated and improved based on the experiences of the users. A first version shall be ready for discussion at the March Experts meeting.

In addition to the design guidelines on the integration of solar heat into industrial processes, design guidelines for space heating of production halls are going to be finalized and published in 2006.

A main focus of the work in Subtask D will be on a number of case studies in order to initiate further pilot projects. Breweries, space heating of production halls and metal cleaning/surface treatment appear most promising, since several case studies or even ongoing projects already exist and contacts to further potential users in these sectors have been reported. To enhance the chances for identification and realization of pilot installations, dedicated workshops for these sectors will be held at the next Expert meetings to intensify the exchange of experience and fully exploit potential synergies.

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 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 are participating in the Task.

REPORTS PUBLISHED IN 2005

- State-of-the-art report on medium temperature collectors
- Subtask B report

REPORTS PLANNED FOR 2006

- Report on the potential of solar heat for industrial processes and the most promising industrial sectors
- Report and design guidelines for space heating of production halls
- Report on existing plants for solar process heat (draft)

MEETINGS IN 2005

Fourth Experts Meeting
February 23 – 25
Madrid, Spain

Fifth Experts Meeting
October 3 – 8
Kassel, Germany

PLANNED MEETINGS FOR 2006

Sixth Experts Meeting
March 29 – 31
Rome, Italy

Seventh Experts Meeting
October 11 – 13
Lisbon, Portugal

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SHC TASK 34/ECBCS Annex 43

Testing and Validation of Building Energy Simulation Tools

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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 or other regulatory agencies to certify software used for showing compliance with building energy standards, tax credits, or other building energy incentive programs. 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 is investigating 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 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.

Duration

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

Participation

During 2005 a total of 42 participants from 26 organizations in 12 countries participated in this Task. The participating countries are:

Australia	France	Sweden
Belgium	Germany	Switzerland
Canada	Japan	United Kingdom
Denmark	Netherlands	United States

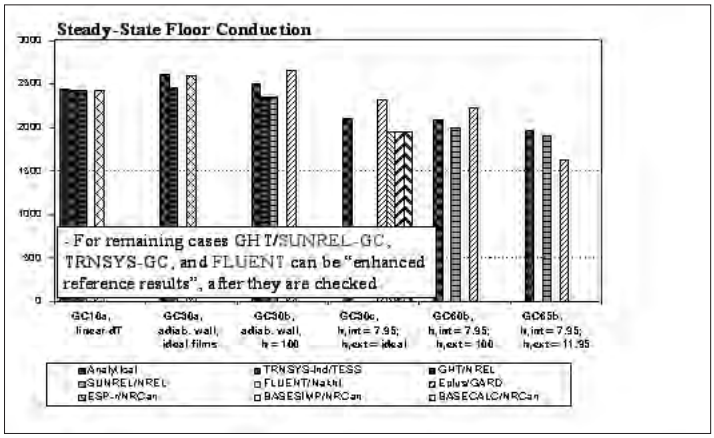
ACTIVITIES DURING 2005

Activities during 2005 consisted of finalizing project plans, development of test specifications, acquiring empirical test data, doing preliminary simulations of test cases, improving test cases based on participants' comments, and further simulations of improved test cases.

Ground Coupled Floor Slab and Basement Comparative Tests

NREL of the United States revised and distributed the in-depth test specification in 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 cases have now been divided into "a"-series, "b"-series and "c"-series cases. The "a"-series test cases are for checking proper implementation of the 3-d numerical-methods models run independently of whole-building simulations (independent models). They include a steady-state 3-d analytical verification test case, and two other steady-state and periodically varying comparative test cases that have boundary conditions more applicable to the models integrated with whole-building simulations (integrated models). The "b"-series and "c"-series cases compare integrated ground models to the independent detailed models, applying assumptions common to the more constrained integrated models. Parametric variations in these cases 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). Simulation results were received for:

- EnergyPlus (USA)
- FLUENT (UK)
- HOT3000/Basesimp/Basecalc (Canada)
- SUNREL-GC/GHT (USA)
- TRNSYS (USA)
- VA114 using ISO 13370 calculation (Netherlands)



Ground-Coupled Floor Slab Sample Results, Floor Conduction: Establishing Numerical Methods Results as "Enhanced Reference Results" using SteadyState Analytical Verification (GC10a) "Touchstone"

Multi-Zone and Airflow Comparative Tests

This project is divided into two sub-projects: Multi-Zone Non-Airflow Tests led by US/NREL and Airflow Tests including Multi-Zone Airflow led by Japan.

Non-Airflow Tests

NREL distributed updates to five in-depth test cases in February with further revisions in August. The objectives of the current test cases are: test models' ability to correctly keep account of interzonal heat transfer and to help define a starting point for multi-zone airflow cases, to test the ability of programs to account for shading by neighboring zones, and to test the ability to model internal windows. Shading and internal window test cases employ idealized calorimetry (building zones designed as calorimeters) for testing shading and solar gains effects. Simulation results were submitted by 9 participants. The multi-zone conduction case is done. The shading models cause increased range of results disagreements versus

unshaded solar results, about doubling the percent range of disagreement for shaded transmitted solar radiation versus unshaded transmitted solar radiation. Refinement of the test case to improve shading diagnostics is near completion. For the internal window cases trend agreement between results for ESP, TRNSYS-TUD, and VA114 is encouraging.

Airflow Tests including Multi-Zone Airflow

The current cases under development are based on the geometry of the multi-zone non-airflow cases, are simpler (potentially more diagnostic) than the ECBCS Annex 23 (Comis airflow) cases, and allow use of nodal, zonal, and CFD models. For analytical verification case development, Japan did a comparison of VENT-SIM and COMIS to an analytical solution for wind driven airflow; results indicated good agreement for both programs versus the analytical solution.

Shading/Daylighting/Load Interaction Empirical Tests

This project is divided into two sub-projects: EMPA Shading/Daylighting/Load Interaction led by EMPA and ERS Shading/Daylighting/Load Interaction led by ERS.

EMPA Shading/Daylighting/Load Interaction

The goals of the project are to collect empirical data in EMPA test cells for the validation of thermal performance models of windows with/without shading devices in building energy simulation codes and to compare simulation results with empirical data.

The experiments are:
1. Overall test cell conductance
2. Overall test cell internal capacitance
3. Glazing only
4. Glazing with external textile shading screen
5. Glazing with internal textile shading screen
6. Glazing with external Venetian blinds
7. Glazing with internal mini-blinds
8. Window, i.e. glazing with frame.

Experiments #1 and #2 are for characterization of simulation inputs. EMPA has completed running 6 of these 8 experiments. Simulations of Experiment #3 have been run using EnergyPlus, DOE-2.1E,TRNSYS-TUD, KoZiBu and HELIOS.

The simulations are to predict the cooling power required to maintain the constant zone temperature. Based on uncertainty ranges presented in results plots at the October Experts' meeting, overall uncertainty in various input parameters causes roughly ±3% uncertainty in simulated cooling load results. Experimentally determined cooling loads have similar uncertainty.

EMPA Test Cells in Duebendorf, Switzerland

ERS Shading/Daylighting/Load Interaction

The purpose of the work being done at THE Iowa Energy Resource Station in the United States is to create an empirical validation data set for daylighting controls. 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. Daylighting tests were performed at ERS during July 1 to July 7, 2005. Test room configurations varied:

- Glazing system (clear glass versus 2 types of low-e glass)
- Interior window shading (motorized mini-blinds, fixed angle mini blinds, roller shades, or no shading device)
- Exterior window shading (exterior fins or no shading device)

Simulation results were received from ISU/EMPA, US/Switzerland (EnergyPlus, DOE-2.1E) and TUD, Germany (TRNSYS-TUD). 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.

Systems, Components, and Controls Empirical Tests

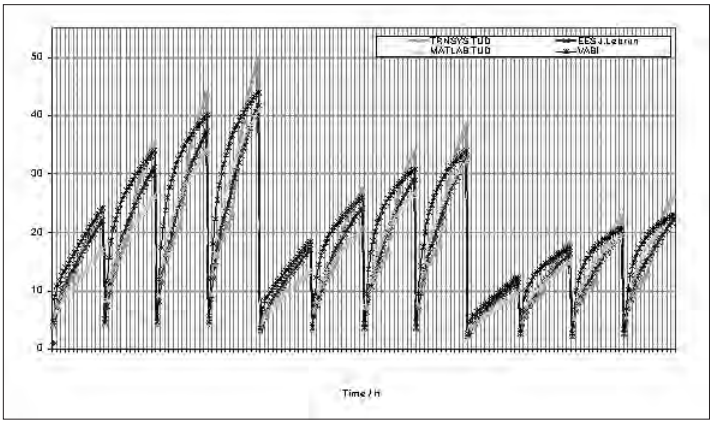
This work is focusing on chilled- and hot-water systems, and is separated into several sub-exercises to focus on single components tabulated below. Experimental and measurement facilities at the Iowa Energy Resource Station will be used for empirical studies.

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

The work has begun 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. Empirical data for a hot-water air heating system and a chilled-water air-cooling system were recently obtained.

Cooling coil comparative tests are designed to predict leaving air and water temperatures when measured entering air and water temperatures are given. Simulation results for these tests have been obtained for TRNSYS-TUD, MATLAB/Simulink, EES and VA114.

Empirical cooling coil and hydronic network tests are utilizing data collected from the Iowa Energy Resource Station (ERS) facility on 2 October 2004. The empirical cooling coil tests have the same simulation participants as for the comparative tests. The hydronic network empirical tests have simulations



HVAC Equipment/Controls First Comparative Test: Cooling Coil, Total Cooling Loads

from EES and MATLAB, so far. Conclusions of the work are that simple models are giving acceptable results and there are bigger heat transfer prediction errors when combining coil/hydronic models.

Double-Facade Empirical Tests

The objective for this project is to 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 the collection of available literature on typologies, modeling approaches, measurements, tools, etc., the description of test facility and test cases used for validation, and documentation of the measured standard data sets, and the development of a user guide for tools, including sensitivity analysis on the main influences.

Empirical tests are being led by Aalborg University (AAU) in Denmark using a new facility under construction at 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'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.

Double-Skin Buildings Empirical Validation Tests

Aalborg University has experienced a 9-month construction delay on their test facility. As of October, the facility is about _ completed, with completion planned for December 2005. Draft test cases are: DSF100-All façade openings closed, DSF200-Openings are open to the outside, DSF300-Openings are open to the inside, DSF400-Bottom opening open to outside; top opening open to inside, and DSF500-Top opening open to outside; bottom opening open to inside.

Double-Skin Buildings Empirical Validation Tests

This project was dropped due to a lack of resources.

Building Simulation Centre Proposal

This project was dropped due to a lack of resources.

Web Site for Consolidation of Tool Evaluation Tests

The objective of this project is to consolidate the tool evaluation tests from IEA: SHC Task 12 / ECBCS Annex 21, SHC Task 22, and SHC Task 34 / ECBCS Annex 43 (IEA 34/43) to a single web site. A web page for IEA 34/43 was activated during 2005.

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.

During 2005, ASHRAE Standard 90.1-2004, which is used for regulating energy efficiency in commercial and non-low-rise residential buildings, had an addendum published that requires use of Standard 140-2004 for testing software used in building energy efficiency assessments; publication of the addendum is expected in mid-2006. 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.

ANSI/ASHRAE Standard 140-2004

Also, EnergyPlus, the USDOE's most advanced simulation program for building energy analysis, maintains their Standard 140 validation results on their website.

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). Portugal is also using BESTEST as their basis for software quality control under the EPD.

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. The UK is setting up software accreditation for detailed thermal models, and is planning to use some building thermal fabric test cases from IEA BESTEST 1995.

Communication continues with a number of CEN Technical Committees, including 89, 156, 229, which are also addressing building energy calculation methods and the development of building energy analysis tool test cases.

WORK PLANNED FOR 2006

Ground Coupled Floor Slab and Basement Comparative Tests
Continue to develop the 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. Finish the revision of the "c"-series cases to accommodate geometric assumptions found in simplified programs.

Multi-Zone Heat Transfer Comparative Tests

Non-Airflow Test Cases

Finish the refinement of the test case to improve shading diagnostics. Include an option in the 3-zone (2 internal window) internal-window case so that simulation tools that cannot model 2 internal windows in series can run the test case.

Airflow Test Cases

Develop a useable test specification for the IEA 34/43 participants. 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. Japan plans to develop the cases in 1-zone, 2-zone and 3-zone contexts. 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 2006; additional iterations may occur during 2007.

Shading/Daylighting/Load Interaction Empirical Tests

EMPA Experiment 7 (Glazing with internal mini-blinds) will be run in October 2005, and EMPA Experiment 8 (Window, i.e. glazing with frame) will be run in April 2006. Simulations of EMPA experiments 5-8 are also planned for completion. All of the data will be on their website (www.empa.ch/ieatask34).

For the ERS experiments, the next steps are to provide a test specification to the participants, including experimentally determined inputs (weather data, etc.), and to run simulations of the test cases. Iterations to revise the test specification and simulations are expected.

Systems, Components, and Controls Empirical Tests

Work planned for 2006 includes to develop:

- Additional chilled-water system comparative tests diagnostic cases: steady state, dry coil, wet coil
- Additional chilled-water system empirical tests: obtain empirical data, distribute test specification, compare empirical data with simulation results
- Hot-water system comparative tests: preliminary test specification, compare simulation results
- Hot-water system empirical tests: obtain empirical data, distribute test specification, compare empirical data with simulations.

Complete TRNSYS-TUD and VA114 simulations of empirical hydronic network tests (to be included with the EES and Matlab/Simulink results already completed).

Double-Facade Empirical Tests

(Leader: Denmark/Aalborg University)

AAU will write a chapter (to be include in Lund University's literature review) on modeling approaches and methods for modeling double-skin façade buildings.

AAU is planning to complete construction of their test facility in late 2005 or early 2006. After completion of construction and installation of instrumentation they will begin acquiring data for the empirical test cases.

AAU will also distribute revised test specifications for comparative and empirical tests. Participants will simulate the test cases, and AAU will analyze the simulation results including comparisons with empirical data.

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 being adapted for inclusion with ANSI/ASHRAE Standard 140:

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

ASHRAE formal public review of the HVAC BESTEST Furnace Cases (Addendum a to Standard 140-2004) is scheduled for Spring 2006. HVAC BESTEST Volume 2 was adapted for Standard 140 by NREL as Addendum b to Standard 140-2004; pending SSPC 140 approval, public review could occur in 2006.

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, a recent study comparing 20 whole building energy simulation tools indicates that 19 of the 20 tools reviewed had been tested with at least one of the IEA BESTEST procedures; 10 of the tools had been tested with more than one of the BESTEST procedures. The study also indicates that test procedures developed by the IEA dominate the set of available tests. Further examples of industry links are evident from recent citations in conference papers. Five 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 (IBPSA), September 2003 in Eindhoven, Netherlands. Three papers by software developers related to using simulation software test procedures devel-

oped during SHC Task 22 and SHC/ECBCS Task 12/Annex 21 were presented at the Canadian ESim conference (June 2004 in Vancouver, Canada). At the IBPSA 2005 conference in Montreal, Canada, seven papers cited use of BESTEST procedures in the contexts of: use with codes and standards by a national organization (1 paper), documentation of simulation engine testing (2 papers), development of empirical validation procedures (1 paper), use as standard geometry for simulation studies (2 papers), and other citations (1 paper). 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 pre-normative information in the establishment of national and international building energy codes and standards, as discussed above under codes and standards activities. The Operating Agent has been acting as liaison with, and is the Chair of, ASHRAE SSPC 140 (the ASHRAE project committee responsible for ANSI/ASHRAE Standard 140). The IEA BESTEST cases were used by ASHRAE to develop a standard method of test for evaluating building energy analysis programs (Standard 140). 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, Portugal, 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. As part of their building energy performance assessments under the European Community's Energy Performance Directive, Austria, Denmark, Greece and The Netherlands are using a new software tool that includes algorithms that have been checked with BESTEST. Also, CEN has utilized BESTEST to check their reference cooling load calculation general criteria of prEN ISO 13791 (CEN 2004a) and simplified methods of prEN ISO 13792 (CEN2004b).

REPORTS PUBLISHED IN 2005

Only internal documents.

REPORTS PLANNED FOR 2006

No final reports are planned.

MEETINGS IN 2005

Fourth Experts Meeting
April 6-8, 2005
Liège, Belgium

Fifth Experts Meeting
October 3-5, 2005
Aalborg, Denmark

MEETINGS PLANNED FOR 2006

Sixth Experts Meeting
April 10-12
Ankeny, Iowa, US

Seventh Experts Meeting
September – November 2006
Dates and location to be determined.

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TASK 35

PV/Thermal Solar Systems

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TASK DESCRIPTION

PV/Thermal Solar Systems combine photovoltaic technologies and solar thermal technologies into one system with both electricity and thermal energy output. The typical systems are solar collectors with photovoltaic systems integrated in the collector-surface or photovoltaic panels used as collector directly as solar air collector. Through combined production of electricity and heat, the overall efficiency can potentially be higher for a specific collector-area, than the efficiency of traditional "side-by-side" photovoltaic and solar thermal systems. The systems are typically integrated in the built environment.

The EU has set targets for 2010 of 100 million m^2 for solar thermal corresponding to 70 GWp thermal and 3 GWp for PV. The markets for both solar thermal and PV are growing rapidly globally, and PV/T has the potential to experience a similar growth since the technical potential of the technology is large, especially if the market for domestic applications can be reached. However, very few commercial PV/T manufacturers exist.

The objectives of the Task are to catalyse 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.

The Task is organised in five Subtasks:
- Subtask A: Market and Commercialisation of PV/T
- Subtask B: Energy Analysis and Modelling
- Subtask C: Product and System Development, Tests and Evaluation
- Subtask D: Demonstration Projects
- Subtask E: Dissemination

Collaboration with other IEA Programmes

It has been agreed to collaborate with the Photovoltaic Power Systems Programme

at a "minimal level" according to the SHC guidelines for coordination with other programmes.

At this level, experts selected by ExCo PVPS participate in expert meetings of the Task managed by ExCo SHC. The Task is fully defined and managed by ExCo SHC with appropriate input from ExCo PVPS.

Duration

The Task was initiated on January 1, 2005 and will be completed December 31, 2007.

ACTIVITIES DURING 2005

A kick-off meeting for the Task was held January in Copenhagen, Denmark with participation of 22 experts from Australia, Canada, Denmark, Germany, Greece, Hong Kong, Israel, The Netherlands, Spain, Sweden and Switzerland.

The 2nd Task meeting was held in the Netherlands in October, hosted by ECN. The meeting was organised as a 2_ day meeting to allow sufficient time to co-ordinate the details of the planned laboratory experiments and have updated presentations of on-going work relevant to the development of PV/Thermal Solar Systems.

A key focus point of the co-ordination of the Task in the reporting period has been to identify and ensure that the necessary resources are available to experts to be able to carry out the planned work.

Subtask A: Market and Commercialisation of PV/T

Important input to the Task work has been provided from the PVT Forum project, which is part of the EU-supported project PV Catapult. Here a main deliverable is an overall road-map for commercialisation of PV/T. The focus of the EU-funded work is naturally with the focus on the European situation, but the methodology of the project and reporting structure is very helpful as starting point for the work in Subtask A, where also countries and design aspects outside Europe will be covered.

Specific activities have been started regarding the investigation of the market. Principles for segmentation of the market has been developed for both the PV and the solar thermal market and these analyses will be used as starting point for the further investigation of the market for PV/Thermal Solar Systems. Collection of existing market surveys and compilation of these has been initiated.

Subtask B: Energy Analysis and Modelling

The investigation of already available simulation models, TRNSYS components and theoretical models has been carried out during this year. The overview will be reported in a separate document relevant to all experts interested in starting modelling PV/Thermal Solar Systems.

Based on this overview the modelling activities of the Task have been started with the focus on modelling of the heat transfer between the solar cells and the media removing heat from the system. Interesting for this development is current research on parameters determining the radiation balance and combination of absorbing and transmitting layers of typical solar cells and the possibilities to vary these properties.

In popular terms, this work could lead to solar cells optimised for PV/Thermal Solar Systems, where all radiation, which can be utilised for electricity production, is absorbed by the solar cell and the same solar cell can be transparent to all other wavelengths so that the part of radiation not generating electricity will pass the solar cell be absorbed by a thermal absorber under the solar cell. This strategy would provide both an increase in the overall electrical efficiency, since the heating up of the solar cell will be reduced and a large part of the radiation would still be absorbed by the solar thermal absorber, so that the overall energy yield pr. area covered will be optimized.

Subtask C: Product and System Development, Test and Evaluation

An MS Excel spreadsheet with an overview of PV/T components, initiated by IEA PVPS Task 7 and continued by the IEA SHC PVPS Joint Working Group on PV/Thermal Solar Systems, was expanded and updated.

Considerations about how to categorise PV/T products and systems were made, but the final categorisation has not been defined yet. It is most likely that the categorisation will be according to the PV/T roadmap described earlier:

- PV/T Liquid collector
- PV/T Air collector
- PV/T Concentrator
- Ventilated PV with heat recovery

Many manufacturers have participated in the development, production and marketing of various PV/T systems and products in all the above mentioned categories. However, the number of commercially available systems is very small and

long-term experiences with operation of the systems are scarce.

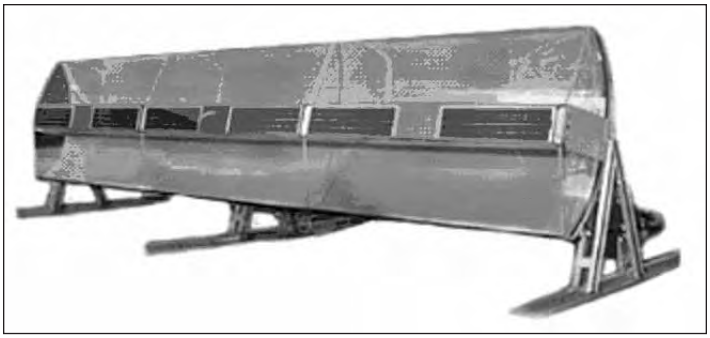
The PV/T liquid collectors can be subdivided into glazed and unglazed collectors. Although several manufacturers have tried to commercialize glazed PV/T liquid collectors, a commercial product has only very recently become available in the Netherlands (PVTWINS). This means that at present only two manufacturers of commercial PV/T liquid collectors exist (Millennium Electric T.O.U. Ltd. with the product Multi Solar System and PVTWINS with both a glazed and unglazed product). Three commercial PV/T air collector manufacturers exist (Grammer Solar, Aidt Miljø A/S Solar heating and Conserval Engineering, Inc. with their respective products TWINSOLAR, SolarVenti and SolarRoof, but, apart from the summer cottage market, the number of PV-air collectors installed is very small. For PV/T concentrators one commercial manufacturer has been identified (Menova Engineering Inc. with the product Power-Spar).

Various projects with PV/T systems in the category ventilated PV with heat recovery have been identified. The systems typically have emerged from specific solutions for specific buildings, where the primary focus has been building integration of PV and where the need for ventilation of the PV-systems in order to maximise the electrical yield has been combined with utilisation of this heat for preheating of ventilation air, space heating or similar. Attempts have been made to standardise the design of such systems.

Commercial PV/T liquid modules.
(a) Multi Solar System from Millennium Electric T.O.U. Ltd., (b) Glazed collector from PWTWINS

In order to achieve a much better understanding of the performance of already existing systems, a number of products and systems relevant for testing has been identified, and will be made available for testing at various laboratories during the first half of 2006. The first round of testing methodology has been discussed and decided at the 2nd task meeting in the Netherlands. An issue on round-robin tests versus testing according to current norms and standards was discussed at the meeting. It was decided to have the round-robin test when sufficient knowledge regarding characterisation of the performance of the different types of systems has been established, however until then different test methodologies based on the experiences from the participating laboratories and most recent international standardisation of testing procedures of solar systems will be used to achieve the first level of understanding of the performance of the systems. Furthermore PV Catapult deliverables regarding discussion and recommendations of PV/T performance measurement guidelines including reliability tests for one type of PV/T collectors will be reviewed, extended and used in this Task.

Commercial PV/T air collectors.
(a) TWINSOLAR from Grammer Solar, (b) SolarVenti from Aidt Miljø A/S Solar heating, (c) SolarRoof from Conserval Engineering, Inc.



Commercial PV/T concentrator Power-Spar from Menova Engineering Inc.

Subtask D: Demonstration Projects

In order to be able to gain knowledge from demonstration projects within the time schedule of the Task, the planning of work in subtask D is focusing on the identification of potential projects to be realised during 2006, allowing for monitoring of the realised projects and comparison with simulated performance of the systems.

Currently several PV/Thermal Solar Systems are being planned in the Netherlands, South Korea, Canada and Israel. Details on these projects are being collected and analysed and decision on which projects to assist regarding design, monitoring and dissemination will be decided at the next Task Experts meeting in first half of 2006.

Main activities of this Subtask in the reporting period focus on establishing contact to potential hosts of demonstration projects and provide understanding of the needs and possibilities of the host and the specific objective of the demonstration project in each case.

Subtask E: Dissemination

A good brainstorm session on dissemination activities at the 2nd Task Experts meeting resulted in several ideas on how to disseminate Task results and how to learn from the dialogue with the key stake holders regarding key design criteria, key performance indicators relevant to focus on in order to target the market, and input regarding specific need for building integration of the technology into various types of building and architectural styles.

Among the planned activities is the use of the IEA information stand at upcoming conferences, exhibiting a standard PV, a standard Solar Thermal and a PV/Thermal Solar system, questioning interested visitors on the stand about their immediate impression and what they would expect of the combined system if they should consider it as an alternative to traditional systems.

Other activities of this Subtask focus on the development of presentation templates (MS PowerPoint) to be available for Task experts to ease the presentation of the Task in general, the participating experts, ongoing and completed activities and scientific material in general regarding PV/T.

WORK PLANNED FOR 2006

Subtask A: Market and Commercialisation of PV/T

Planning and performance of market survey activities in order to investigate potential markets for PV/T will be carried out in 2006. The primary commercial parameters (order qualifiers and order winners) on the market for PV/T will be identified during the first half of 2006. After that possible marketing mixings (product, price, place and promotion) in parallel with the technical improvements of the PV/Thermal Solar Systems elaborated in Subtask C will be identified.
The PV Catapult roadmap for commercialisation of PV/T will be reviewed in the beginning of 2006 and there will be a running revision of the roadmap.

Subtask B: Energy Analysis and Modelling

Optical, thermal and electrical modelling of PV/T modules and modelling of PV/T systems will be carried out in the first half of 2006. Programming of PV/T models into simulation programmes will be carried out and validation exercises on both module and system level will be initiated.

Development of a standardized method for characterisation and monitoring of PV/T-modules will also be initiated. In the end of 2006 monitoring of PV/Thermal Solar Systems to be simulated in whole building context will be started.

Subtask C: Product and System Development, Tests and Evaluation

In the investigation of the need for development for PV/T components industry, manufacturers, designers will be asked and the results will be used to identify where there is a need for new materials.

Different already existing PV/T systems will be tested at various laboratories during the first half of 2006 to achieve the first level of understanding of the performance of the systems. Round-robin tests will be carried out when sufficient knowledge regarding characterisation of the performance of the different types of systems has been established based on the PV Catapult deliverables regarding discussion and recommendations of PV/T performance measurement guidelines including reliability tests for one type of PV/T collectors.

Identification of when PV/T systems need a "new´" type of control strategy compared to PV and solar thermal certification in order to later on develop optimum control strategies and components for PV/T will be initiated in 2006.

Subtask D: Demonstration Projects

Interviews of stakeholders (e.g. clients, architects, engineers, contractors, users and financiers) for PV/T systems to learn from their experience and recommendations for next generation of demonstration projects will be planned and carried out on a national basis.

A number of existing projects already exists and the recommendations and guidelines from Subtask B will used to achieve monitoring results from these projects to the extent where it is practically possible and of value to the task.

If demonstration projects can be identified sufficiently early, the outcome of Subtask B can be demonstrated and project monitoring results will be possible to use in the task work. Activities for identification and initiation of demonstration projects will be initiated. A collection of requirements for demonstration projects will be listed and a leaf letter/brochure explaining the interest of the task and benefit of hosts by having demonstration projects within the PV/T-sector will be made.

Subtask E: Dissemination
The Task web page http://www.iea-shc.org/task35 will continuously be updated to give access to all approved Task results, dialogue with the task experts and provide a hub for information exchange on PV/Thermal Solar Systems.

Regarding common presentation material templates an introduction of PV/T: technology, yield, costs etc. will be made. This presentation will be expanded and revised on a semi-annual basis to include the status and findings of the task.

A logo competition is to be arranged. It will be investigated whether it would be feasible to organise a student competition at a graphical design school in the Netherlands.

LINKS WITH INDUSTRY

Several manufacturers of PV/T components have joined the first two Expert meetings. Their comments and inputs to discussions are very valuable for the Task. It is the aim that the presence and involvement of industry is intensive throughout the whole Task period as their input is needed in several of the Subtasks. Specific R&D-activities will be carried out in close collaboration with manufacturers of PV/Thermal Solar Systems in order to improve overall performance and solve generic problems with existing concepts and components.

REPORTS PUBLISHED IN 2005

No reports were scheduled to be published in 2005.

REPORTS PLANNED FOR 2006

- Report on market survey on potential markets for PV/Thermal Solar Systems
- Report on primary commercial parameters defining the market for PV/Thermal Solar Systems
- Report on heat transfer and electric performance models in PV/Thermal Solar systems
- Report and article on the experience gained by all stakeholders involved in selected PV/Thermal Solar System projects.

MEETINGS IN 2005

Kick-off Meeting
January 27-28
Copenhagen, Denmark

Second Experts Meeting
October 13-15
Petten, The Netherlands

MEETINGS PLANNED FOR 2006

Third Experts Meeting
June 8-9
Location to be determined

Fourth Experts Meeting
Date and location to be determined

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TASK 36

Solar Resource Knowledge Management

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TASK DESCRIPTION

The goal of SHC Task 36, Solar Resource Knowledge Management, is to provide the solar energy industry, the electricity sector, governments, and renewable energy organizations and institutions with the most suitable and accurate information of the solar radiation resources at the Earth's surface in easily-accessible formats and understandable quality metrics. The scope of solar resource assessment information includes historic data sets and currently derived data products using satellite imagery and other means.

There are three main objectives of this Task to achieve this goal:

- To provide further standardization and benchmarking of international solar resource data sets,
- To provide improved data reliability, availability and accessibility in formats that address specific user needs, and
- To develop methods that improve the quality and the spatial and temporal coverage, with customized solar resource products, including reliable solar radiation forecasts.

Achieving these objectives would reduce the cost of planning and deploying solar energy systems, improve efficiency of solar energy systems through more accurate and complete solar resource information, and increase the value of the solar energy produced by solar systems.

Scope

This task focuses on the development, validation, and access to solar resource information derived from surface-based and satellite-based platforms. The Task will investigate benchmarking and data quality assessment procedures for data products and validation data sets, examine means by which the data can be made easily available to users through various web-based hosting schemes, and conduct studies on improving the input data sets and algorithms from which satellite-derived products

are produced, including the investigation of short term forecasting and past and future climatic variability of the solar resource.

Means

The Participants shall address the objectives through sharing a co-coordinated work plan encompassing three subtasks:

Subtask A: Standardize and Benchmark Solar Resource Products to Ensure Worldwide Intercomparability and Acceptance
The objectives of this Subtask are to provide:

- Coherence and benchmarking of models producing solar irradiance values from satellite data;
- Accessibility and coherence of ancillary model input data such as atmospheric conditions and land surface parameters;
- Sensitivity analyses;
- Ground truth validations with high quality data;
- Definition of validation protocols and measures of end-product confidence; and
- Cross-satellite platform and cross-model comparisons.

Subtask B: Develop Common Structure for Archiving and Accessing Data Products
The objectives of this Subtask are to develop and produce deliverables designed to provide:

- Development of worldwide networking between distributed data centers resulting in a global coverage for high-quality solar resource data;
- Development of information and data exchange protocols;
- Reliable and fast end-user access; and
- Preparation of data documentation for specific end-user applications.

Subtask C: Improve Techniques for Solar Resource Characterization and Forecasts
The objectives of this Subtask are to develop and produce deliverables designed to provide:

- Short-term (hours) to medium-term (days) solar resource forecasting;
- Analysis of long-term variability of solar resources;
- Improved exploitation of existing satellite resources (e.g. very high spatial resolution for plant micro-siting);
- Adaptation of resource assessment techniques to the capabilities of new generations of satellites; and
- Development of new methods to provide improved products like spectrally- or angular- resolved information.

Collaboration with other IEA Programmes
Knowledge on solar resources is highly important for all forms of solar energy applications. Therefore Task 36 is conducted as a collaborative Task together with the IEA Implementing Agreements SolarPACES and Photovoltaic Power Systems. Co-operation is based on "minimum level" according to the SHC *"Guidelines for Co-ordination with other Programmes."*

Task Duration

The Task was initiated July 1, 2005 and will be completed June 30, 2010.

ACTIVITIES DURING 2005

First Experts Meeting

The Work Plan and Annex for Task 36 was approved at the 57th meeting of the SHC ExCo in June 2005. Dave Renné of the National Renewable Energy Laboratory (USA) was approved as the Operating Agent.

Several informal meetings between the OA and key persons of the Task took place in 2005. In addition, a side meeting with the OA, the leaders of Subtasks A and C, and several task participants took place during the Solar World Congress in Orlando in August 2005. Out of these meetings, a decision was made to hold the first Task Experts Meeting at DLR-Oberpfaffenhofen in Germany on 16-18 November. The main progress to be reported for 2005 is a summary of the key outcomes of this meeting.

Twenty-two participants attended the Task Experts Meeting, including representatives from all participating countries (and the EU) except Canada. However, the Canadian representative sent his regrets and provided extensive background materials to be used during the deliberations at the Experts Meeting. In addition, there was guest representation from Brazil, PVPS Task 2, and the European Space Agency.

A summary of the activities associated with each subtask is as follows:

Subtask A: Standardization and Benchmarking of Solar Resource Products

- Identification of high quality surfaced broadband and spectral solar measurement data sets:

- Establishing in greater detail the measures of model quality
- Establishing model benchmarking measures
- Application of benchmarking procedures to be applied to the products in Subtask C
- Production of a handbook offering user guidance

Subtask B: Common Structure for Archiving and Accessing Data Products

In this Subtask, a somewhat different approach was adopted from the earlier versions of the work plan, where data from the data providers are now made available to customers through "brokers," rather than data portals as envisioned earlier. The broker offers a unique access by customers to an ensemble of information supplied by providers. Thus, the broker is taking care of the relationship with its customers on the one hand, and with its providers on the other hand.

Subtask B will deliver, among other deliverables, instruments to realize such an information system. These instruments include software, metadata, guidelines, documentation to providers and brokers, technology transfer means. These instruments will be demonstrated by realizing a prototype of an information system, which will be used to raise awareness and show to brokers, providers, and customers what can be achieved, at what expenses and which benefits can be drawn for each community.

Given that the domain of web services is evolving quite fast, it is believed that in five years, there will be enough interest, commercial or not, for the installment of several brokers. If this is the case, the prototype set up by Subtask B will disappear as it has successfully fulfilled its role.

As a result of this approach, the following activities will be undertaken:

- Evaluation of the legal aspects (data rights, etc.) of the prototype system
- Identification of users requirements
- Determination of data exchange protocols and metadata
- Development of the data dissemination prototype
- Networking of resource providers
- Use of prototype by users
- Automatic access by commercial applications
- Example application of the prototype system using solar micro-siting in GIS

Subtask C: Improved Techniques for Solar Resource Characterization and Forecasting

During the first Task meeting the work plan for Subtask C was substantially revised and simplified, based on the feedback from the Task participants The eight activities proposed in the original work plan have been synthesized into four activities, based on priorities and availability of resources for the Task.

These activities, in order or priority, are:

- Improving satellite data retrieval method
- Climatological Long-Term Analysis
- Forecasting of Solar Energy Resources
- Solar Micro-Siting

The first activity, "improving satellite data retrieval methods," will focus on improving the input data describing the state of the atmosphere, which in turn will improve the calculations of the radiative transfer by solar radiation models. Further, better data on ground reflectivity will help to improve the solar radiation retrievals. The approach will also include acquisition or derivation of better aerosol and water vapor data from satellites. For example, Figure 1 shows that aerosol optical depth data can be highly variable. Using improved aerosol data such as shown in the figure can significantly improve model results.

In the course of the Task new retrievals utilizing the new Meteosat Second Generation (MSG) satellite series will be further developed and tested. Improvements also are expected for snow-detection, which often lead to misinterpretation as clouds and thus cause errors in the solar irradiance results. Further, this activity now includes improvements towards spectral and angular solar radiation products.

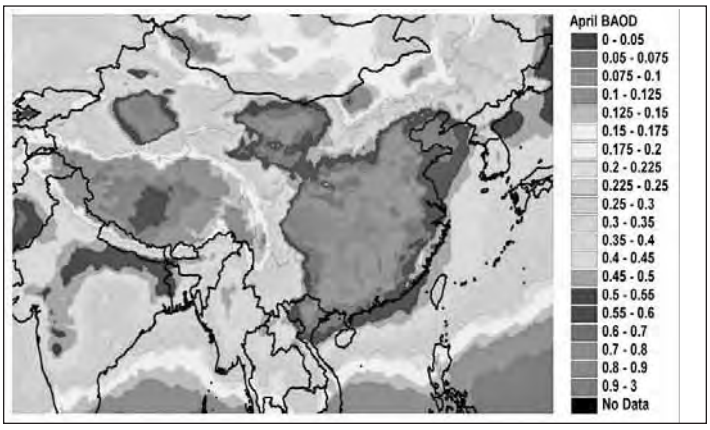

Figure 1: Example of high spatial resolution aerosol optical depth data, derived by Dr. Chris Gueymard.

The "Forecasting of Solar Resources" activity includes "Now casting" (up to 3 hour predictions) and near-term (up to 72-hour) solar forecasts. The activity may also include "mid-term" (several days to several weeks) forecasting as an option.

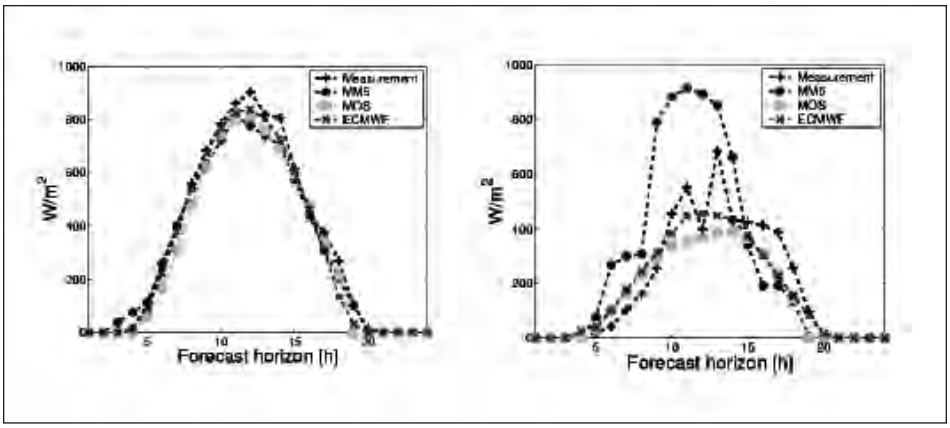

Figure 2: Comparison of different forecast approaches to ground measured irradiance for examples days (16.6. and 19.6.2003, Germany).
Source: Marco Girodo, Oldenburg University, 2005

For forecast horizons up to 3 days several approaches to derive solar irradiance forecasts from global numerical weather predictions will be investigated. For an enhanced modeling of local effects mesoscale models will be applied. Some numerical weather prediction models, e.g. the global ECMWF model or the mesoscale model MM5, directly provide forecast of the solar irradiance. These forecasts will be analyzed and further enhanced. Figure 2 presents example evaluations for different irradiance forecasts, derived from MM5, the ECMWF model and a model output statistic (MOS) forecast system (Girodo, PhD thesis Oldenburg University 2006, in progress).

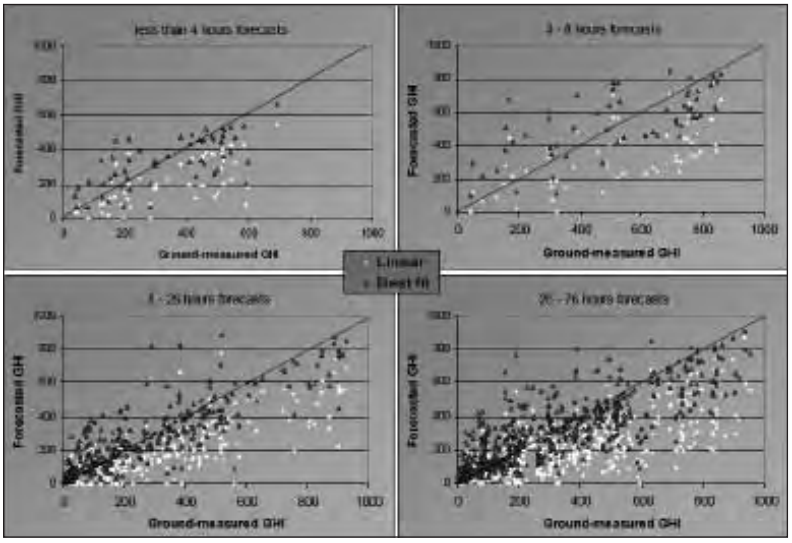

Figure 3: Examples of forecast vs. ground-based irradiance measurements, developed by Dr. Richard Perez.

Furthermore methods to forecast solar irradiance based on predicted cloud properties by numerical weather prediction models will be developed or further improved and tested. Here statistical methods will be considered as well as methods based on radiative transfer modeling and a combination of both approaches. An example of recent results in parameterized short term forecasting is shown in Figure 3 (Perez, Solar World Congress 2005).

Additional aerosol forecasting will enhance the quality of solar resource predictions. Now casting of solar irradiance will be based on motion vectors derived from satellite images.

Outreach to the Global Earth Observation System of Systems

In December 2005, the OA sent a letter of introduction to the Secretariat of the Global Earth Observation System of Systems (GEOSS) headquarters office at the World Meteorological Organization in Geneva. The letter suggests possible ways that the Task supports GEOSS goals and explores mechanisms for participation in an upcoming joint IEA/GEOSS meeting.

WORK PLANNED FOR 2006

Subtask A: Standardize and Benchmark Solar Resource Products to Ensure Worldwide Intercomparability and Acceptance

- Data will be subject to a common formatting and QC procedure. Prototypes of formats (DLR) and QC (CIEMAT, DLR) shall be presented by March 2006 and be finally discussed at the next Experts meeting.
- A proposal for 1st (MBE, RMSE) and 2nd order quality (match of distributions, temporal correlations) should be given by CIEMAT and H2M at the next task meeting.
- A proposal for the preparation of data set used for benchmarking, being subject to appropriate thresholds, should be presented by DLR at the next Experts meeting.
- Existing solar radiation products shall be analyzed. Products analyzed include Meteonorm (Analyzer: UNIGE), Satel-light (ENTP), Helioclim (JRC, Armines), Solemi (DLR) and SSE (NASA). This activity will start after the next Experts meeting.

- Preparation of a User's Handbook will begin.

Subtask B: Develop Common Structure for Archiving and Accessing Data Products

- A report will be prepared that will serve as a guide for the stakeholders of an information system (customers, broker, providers).
- A User Requirements Survey will be developed that be circulated to a wide range of stakeholders, seeking their input on a variety of aspects of the data requirements including such aspects as economic assessment, education, resource assessment, monitoring systems/maintenance, prediction of performance, forecasts and research activities.
- Based on the outcomes of the user survey, a limited series of data types available in several databases having different properties but with some redundancy will be suggested. Metadata will be used to describe these databases.

Subtask C: Improved Techniques for Solar Resource Characterization and Forecasting

- Several activities in Germany and the US will be undertaken to develop solar radiation forecasts. These will focus on the time range from now casting (several hours ahead) to short-term forecasting up to two days.
- Significant effort will be undertaken to further improve solar radiation retrievals using the Meteosat Second Generation satellite. Snow-detection shall be improved in Europe.
- Analysis of long-term variability of solar resources will proceed through inter-comparisons of various long-term data sets to determine if changes of the available solar resources in the last decades observed for several regions in the world are significant. This work will benefit from improvements made to derive solar irradiance from satellite data with higher accuracy and further completion of satellite archives.

A feasibility study for solar micro-siting shall be conducted. This shall answer, what kind of algorithms could handle the 3D problem, what kind of remote sensing data sets are required as input for proper results and how such new methods could be validated through dense ground-based measurement networks.

LINKS WITH INDUSTRY

Two small companies are participating in the Task. The audience for the results of Task 36 includes the technical laboratories, research institutions, and universities involved in developing solar resource data products. More importantly, data users, such as energy planners, solar project developers, architects, engineers, energy consultants, product manufacturers, and building and system owners and managers, and utility organizations, are the ultimate beneficiaries of the research, and will be informed through targeted reports, presentations, web sites, handbooks and journal articles.

REPORTS PUBLISHED IN 2005

Since the Task activities did not begin until July 2005 so no reports have been published. A poster display describing the Task was presented at the Solar Program Review in Denver, Colorado, US in October.

REPORTS PLANNED FOR 2006

- Informational report and a position paper based on results of the User Survey under Subtask B
- Two peer-reviewed papers on long-term variability of solar irradiance
- Inter-comparisons of various long-term data sets from satellite and measurements to be presented and discussed at the Solar 2006 conference in Denver, Colorado, US.
- Three papers describing various aspects of short-term forecasting for solar energy applications
- A concept paper on very high-resolution solar mapping (1-km resolution)

MEETINGS IN 2005

Task Leaders Meeting
August 11
Orlando, Florida, United States

First Experts Meeting
November 16-18
Wessling, Germany

MEETINGS PLANNED FOR 2006

Second Experts Meeting
July 6-7
Denver, Colorado, United States

Third Experts Meeting
Date and location to be determined

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