SOLAR UPDATE

NEWSLETTER OF THE INTERNATIONAL ENERGY AGENCY SOLAR HEATING AND COOLING PROGRAMME • NO. 35 DECEMBER 2000

Solar Combisystems for a Sustainable Energy Future

Since December 1998, 25 experts and 11 solar industries from 9 countries have been collaborating to further develop and optimize solar combisystems for detached single-family houses, groups of single-family houses and multi-family houses. This project, which is part of the Solar Heating and Cooling Programme, is working to standardize the classification and evaluation of solar combisystems with the overall objective of developing recommendations for the international standardization of combisystem test procedures.

Why Solar Space Heating?

Throughout the world, hundreds of thousands of domestic solar hot water systems are demonstrating the possibilities of this renewable energy source. Due to the success of these hot water systems, more builders are turning to solar energy for space heating. The heating requirements of a single- or multi-family dwelling can be met at acceptable costs by combining solar heating systems with short-term heat storage and well-insulated buildings. And in several European countries, such as Austria, Denmark, Germany and Switzerland, the demand for solar combisystems is increasing rapidly (see figure 1).

What is a Combisystem?

Solar combisystems are solar heating systems for combined domestic hot water preparation and space heating. They are similar to solar water heaters in that they use solar energy and transport the produced heat to a storage device. The major difference is that the installed collector area is generally larger for combisystems, as there are two heat loads to meet. Also, a combisystem uses at least two energy sources to supply hot water and heating—a solar collector and an auxiliary energy source. The auxiliary energy source could be biomass, gas, oil or electricity.

The key design challenge is how to integrate the different requirements of the heating source and the heating loads into a single, cost-effective, durable and reliable heating systems while achieving the most benefit from each installed square meter of collector.

The complexity of solar combisystems has led to the development of a large number of different system designs. These designs do not necessarily reflect local climate or practice. For example, several systems on the market can be used in a variety of geographical locations. It is for this reason that collaborative work to analyze and optimize combisystems is important if these systems are to reach a more wide spread market.

How Combisystems Can Contribute to a Cleaner Environment

The increasing concentration of greenhouse gases in the atmosphere and the potential global warming and climatic change associated with it, represent one of the greatest environmental dangers of our time. The reason for this impending change in the climate can, for the most part, be attributed

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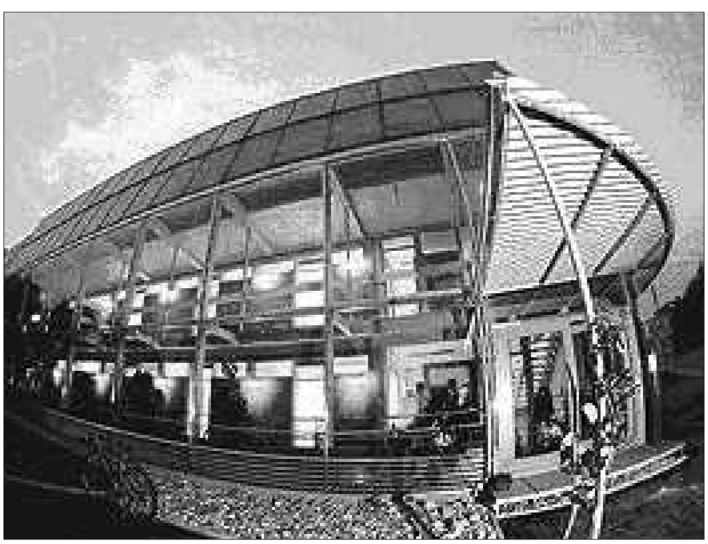

Solar combisystem provides 60% of the space heating demand to six terraced houses in Austria. (Source: AEE)

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Solar Combisystems

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to the combustion of fossil fuels and the associated emission of CO_2. The effective protection of the climate, according to many experts, will require at least a 50% reduction in the anthropogenic emission of greenhouse gases over the next 50 years.

As a result of the climate conferences over the last decade and the discussions on sustainable development, the European Commission has set goals for the future development of renewable energy sources in the White Paper “Energy for the Future: Renewable Sources of Energy.” In the Commission’s White Paper the following is mentioned as a strategic goal: “... to increase the market share of renewable sources of energy to 12% by the year 2010.” The White Paper estimates that a 20% annual increase in the installed collection area in EU countries is needed. Thus, solar heating systems in operation in the year 2010 would correspond to an overall installed collector area of 100 million m² (see figure 2).

If solar heating is to make a relevant contribution to the energy supply then solar technologies that do more than domestic hot water preparation must be developed and widely distributed. A realistic approach would be to assume that in the next ten years about 20% of the collector area installed annually in the European Union would be used for solar combisystems. This means that EU countries would need to install approximately 120,000 solar combisystems with 1.9 million m² of collector area per year.

Combisystem Designs

The solar contribution of combisystems varies from 10% up to 100% depending on the size of the solar collector surface, storage volume, hot water consumption, heat load of the building, and climate. As mentioned before, there are a variety of systems

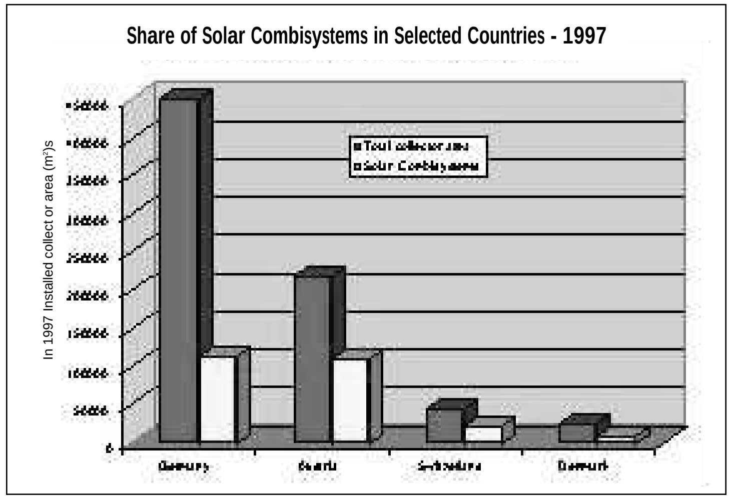


Figure 1. Installed combisystems and collector area for 1997 in selected countries.

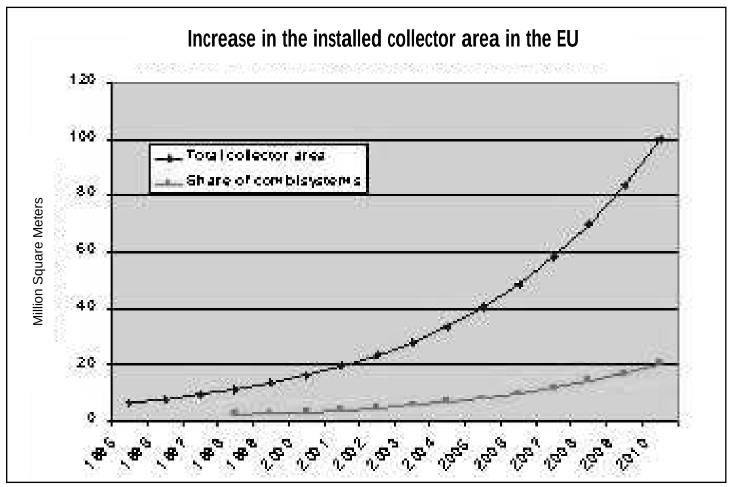


Figure 2. Installed collector area goals until 2010 in European Union member countries.

Solar combisystem for a single-family house in Sweden. (Source: SERC)

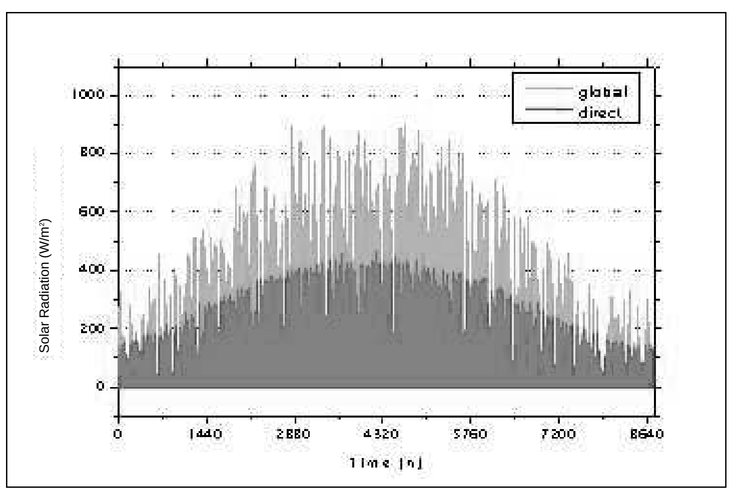


Figure 3. Solar radiation on a horizontal plane in Zurich, Switzerland.

on the European market. The difference in the systems is partly due to the conditions prevailing in the individual countries. For example, the “smallest systems” in terms of collector area and storage volume are located in those countries where gas or electricity is primarily used as the auxiliary energy source. In the Netherlands, for instance, a typical solar combisystem consists of 4-6 m^2 of solar collector and a 300 litre storage tank, and therefore, solar energy meets a relatively small share of the heating demand.

In countries such as Switzerland, Austria and Sweden where solar combisystems are typically coupled with a biomass boiler, larger systems with high fractional energy savings are installed. Common systems for a single-family house consist of 15 m^2 up to 30 m^2 of collector area and a 1-3 m^3 storage tank. The share of the heating demand met by solar energy in these systems is between 20-60%. In contrast to the Dutch system described above, which uses DHW to store heat for subsequent delivery to the space heating loop, these systems store heat for space heating in the water of the space heating loop itself.

In addition to systems for one- or two-family houses, there are systems for multi-family houses and terraced houses. These larger systems also have shown promising results over the years. In Gleisdorf, Austria, a system was installed in 1998 for an office building and six terraced houses. The collectors have been integrated into the roofs of the winter gardens and cover 80% of the hot water and 60% of the space heating demand. The remaining energy needs are provided by a biomass boiler, and a local heating network that connects the houses to the central 14 m^3 storage tank.

The solar contribution of combisystems varies from 10% up to 100% depending on the size of the solar collector surface, storage volume, hot water consumption, heat load of the building, and climate.

Solar Energy Availability

This French house uses a solar floor heating system to meet hourly and overnight variations in the solar energy supply. (Source: Clipsol)

Installed systems clearly show that solar space heating is possible even under mid- and northern European climatic conditions. The solar energy available in summer is more than twice that available in winter, which is practically the opposite of the demand for space heating. Unlike hot water preparation, the heating load is dependent upon the outside temperature. Measurements of solar radiation and temperature in the transitional periods (September-October and March-May) clearly show that solar radiation availability is relatively high at the beginning and the end of the space heating season. Even on winter days, energy demand and solar radiation are partially related.

Figure 3 shows the solar radiation on a horizontal plane in Zurich, Switzerland. It can be seen that, under this latitude, there are not only strong seasonal variations in radiation throughout the year, but that solar radiation varies widely on a daily and even hourly basis.

In order to make efficient use of the available solar energy supply, it is necessary to even out the fluctuations using storage systems so that hot water can be supplied continuously and a constant room temperature can be guaranteed. To balance out the variations in energy supply and demand, the following options are available:

- Hourly or overnight variations can be compensated for by the inertia of the heat emission system (e.g., floor heating) or the storage mass of the building.
- If little or no solar radiation is available for several days, a small buffer storage volume can be used to make up the difference in solar radiation. In this case, heat storage may be combined with domestic hot water storage or an additional storage tank used for hot water.
- Seasonal variations in the solar energy supply can only be compensated for by using seasonal storage. Several systems show that it is possible to store summer heat in large water reservoirs (60 -130 m^3) for use later on in winter. Systems in Sweden, Denmark and Germany provide interesting examples.

For more information on this Task contact Werner Weiss, SHC Task 26 Operating Agent, e-mail: w.weiss@aee.at and fax: +43-3112-588618, or visit the SHC web site.

A colored brochure, "Solar Combisystems in Austria, Denmark, Finland, France, Germany, Sweden, Switzerland, the Netherlands and the USA – Overview 2000," can be ordered from: Büro n+1, Postfach 130, CH-3000 Bern 16, e-mail: n+1@email.ch and fax: +41-31-3527756.

Advancing Daylighting Technologies and Daylight Conscious Building Design

An international collaborative effort to advance daylighting technologies and to promote daylight conscious building design was jointly undertaken by the experts of the Solar Heating and Cooling (SHC) Programme and the Energy Conservation in Buildings and Community Systems (ECBCS) Programme.

The experts of the SHC and ECBCS Programs set out to promote daylight conscious building design in IEA countries. Recognizing the importance of this work, industry was actively involved as well as design practitioners and consultants. This diverse and knowledgeable group of experts worked for four years to achieve their objectives.

To narrow the scope of their work, the experts focused on daylighting systems and strategies that could be applied in new and existing buildings with a high aggregate electricity saving potential, such as offices, schools, and commercial and institutional buildings. The experts tested systems and strategies and conducted performance assessments in laboratories and case study buildings as well as with computer simulations. These assessments covered visual, architectural and environmental aspects, including user acceptance of the systems.

A conclusion of this work is that although the future will bring new technological daylighting concepts to the market, many of the current limitations will remain. Therefore, manufacturers and building designers will need to accept this fact so that daylighting systems can be successfully applied.

The following are examples of the 15 buildings monitored in Australia, Canada, Denmark, Germany, New Zealand, Switzerland, United Kingdom and the United States, including the electricity savings they achieved using different daylighting technologies.

Denmark

▲ The Bayer Nordic headquarters in Copenhagen, Denmark achieves 23% energy savings in the winter and 92% savings in the summer. This L-shaped building has an atrium that extends throughout the entire length of the building. In each office daylight enters two daylight windows and two vision windows which use integrated tilting blinds. Daylighting and occupancy sensors are used to control the artificial lighting.

Germany

▲ A secondary school in Zehdenick, Germany achieves 66% energy savings in the winter and 98% savings in the summer. This four-storey building has an atrium with fixed angled louvers that lights the stairwells and halls. The classrooms are daylit from windows on the south-west facade and clerestorey windows facing the atrium. External shades protect the windows from high incidence sunlight while internal semi-translucent blinds are used to decrease glare.

United States

▲ The National Renewable Energy Laboratory's Solar Energy Research Facility in Colorado, United States has achieved a 75% increase in energy savings. This building combines two-storey research laboratories with single-storey offices. The primary daylighting elements are a stepped roof form with lightshelves over a large open floor space. Occupancy sensors, solar-control films on the windows, and motorized window shades all contribute to the building's energy efficiency.

Germany

▲ The Götz office building in Würzburg, Germany achieves 77% energy savings in the winter and 91% savings in the summer. This two-storey building has a completely glazed double facade and a center atrium with a sliding roof. Integrated reflective and absorptive shading louvers are used to control the solar loads and the daylight. Daylighting and occupancy sensors are used to control the artificial lighting and the louvers.

TASK 21 HIGHLIGHTS

- Established international procedures for evaluating the performance of conventional design solutions and innovative daylighting systems and the performance of daylight responsive lighting control systems.
- Established international procedures and protocols for monitoring the daylighting performance of real buildings including the assessment of users' opinion of their working environment.
- Wrote a comprehensive source book on daylighting systems and components providing an overview of the main technologies for enhancing penetration or improving distribution of daylight in workspaces.
- Conducted a survey of actual design solutions in buildings throughout IEA Member countries.
- Developed a series of user-friendly daylighting design tools, from simple tools to be used in the early design stage to advanced tools to be used when detailed design decisions are made at the end of the process.
- Conducted a comprehensive monitoring program to evaluate the energy and daylighting performance of 15 case study buildings.

For more information on SHC Task 21/ECBCS Annex 29, Daylight in Buildings, visit the SHC web site.

IN BRIEF

New Work Underway

Task 22: Building Energy Analysis Tools

This Task has been extended for two years so a comprehensive and integrated suite of building energy analysis tool tests can be created. This suite of analytical, comparative and empirical methods will be used to provide quality assurance during tool development and certification of tools for energy standard or code compliance. The results from this work will include 1) a revised, expanded and tested working document of analytical solutions, 2) a comprehensive and integrated suite of Envelope and HVAC BESTEST cases for tool evaluation, and 3) a comprehensive and integrated set of experimental data for the empirical validation of tools.

> The SHC Programme continues to initiate new work to demonstrate the power of solar.

Task 31: Daylighting Buildings in the 21st Century

This work is in the Task Definition Phase. The proposed objective to make daylighting the typical and preferred design solution for lighting commercial buildings. This will be accomplished by 1) determining the impact of occupant response, 2) integrating advanced daylighting systems, electrical lighting and shading controls while taking into account occupant response, and 3) transferring the knowledge gained to building design professionals, building owners and manufacturers. This new Task also will include continued work on design tools developed in SHC Task 21/ECBCS Annex 28, such as ADELINE, LesoDIAL and DELight.

Whole Building Sustainability and Tools

A meeting was held October 2000 in the Netherlands to begin the process of defining the work in this proposed new Task. Thirty-two experts (buildings owners, tool developers and users, and government officials) from 12 countries attended the meeting. The proposed objective of this new work is to accelerate the transition to a more sustainable built environment, both new and existing, through improved information, methods and tools. The Task would be divided into three subtasks which would focus on 1) defining the context and market needs, 2) defining and developing indicators (e.g., regulations, performance, targets, benchmarks, weights, labels) to describe sustainability, and 3) defining key problems faced by tool developers.

The SHC Programme has published several new reports and software. These reports document results from work on solar air systems, solar energy use in large buildings, daylighting and solar building renovation.

Solar Air Systems—Built Examples

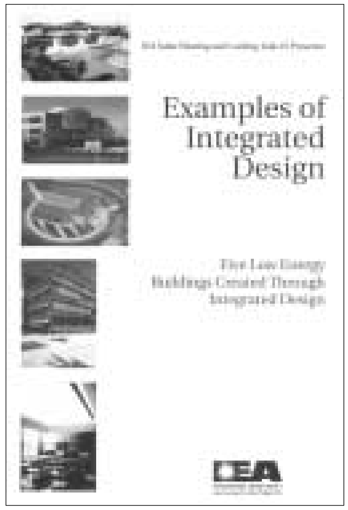
The purpose of this book is to share the experiences from 35 building in wide ranging climates. Applications include single-family houses, apartment buildings and commercial buildings. Six different types of solar air systems are covered.

To order contact: James & James (Science Publishers) Ltd, e-mail: james@jxj.com and fax: +20-7387-8998. Cost: US$ 75.

Solar Air Systems—A Design Handbook

This book guides architects and engineers through the process of designing and selecting one of the six active solar systems presented and optimizing that system. Tips also are given on construction and how to avoid problems.

To order contact: James & James (Science Publishers) Ltd, e-mail: james@jxj.com and fax: +20-7387-8998. Cost: US$ 75.



Examples of Integrated Design: Five Low Energy Buildings Created Through Integrated Design

This booklet showcases five buildings selected from 21 buildings which demonstrate how integrated design can create attractive, sustainable buildings. The story of each building describes how the design team managed the design process, traces the work flows and relations between the participants in the team, and shows how the work resulted in sustainable construction.

To order contact: Gerelle van Cruchten, Damen Consultants, e-mail: gc@damenconsultants.nl and fax: +31 26-351-1713.

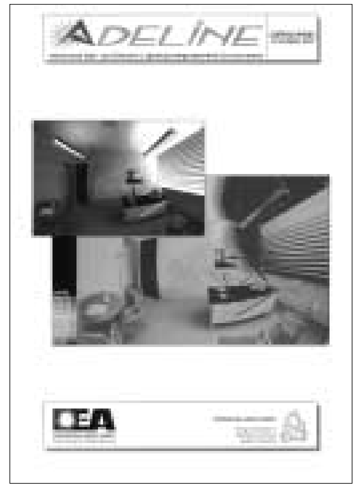
Solar Renovation Demonstration Projects: Results and Experiences

This booklet summarizes the major findings of 14 demonstration projects that integrated solar concepts into their builing renovation. It includes a list of recommendations for future work in this area.

To order contact: James & James (Science Publishers) Ltd, e-mail: james@jxj.com and fax: +20-7387-8998

A CD-ROM with Task demonstration buildings and building details also is available.

To order contact: SHC Executive Secretary, see back page for address.



ADELINE 3.0 Software Package and Brochure

This software is an integrated lighting design computer tool that provides architects and engineers with accurate information about the behavior and the performance of indoor lighting systems. Both natural and artificial lighting problems can be solved in simple rooms or complex spaces. Innovative and reliable results are produced by processing data to perform light simulations and to produce comprehensive numeric and graphic information.

To order contact: Hans Erhorn of Fraunhofer Institute of Building Physics, e-mail: Adeline@ibp.fhg.de and fax: +49-711-970-339. Software cost: EUR 500.

Solar Heating and Cooling 2000 Annual Report

The annual report provides detailed information on program activities and task accomplishments during 2000. The feature article is on Solar Cities.

To order contact: SHC Executive Secretary, see back page for address. Cost: US $20.

MARKETPLACE $ $ $ $ $ $ $ $ $ $ $

The Solar Heating and Cooling Programme is not only making strides in R&D, but also impacting the building sector. This section of the newsletter highlights solar technologies which have been developed or conceptualized in a SHC Task and are now being commercially manufactured, marketed or used.

Daylight Responsive Lighting Control Systems

Daylight responsive controls for lighting have been on the market for quite some time, but with limited use. To increase their use, lighting industries, researchers and consultants worked together in SHC Task 21/ECBCS Annex 29, *Daylight in Buildings*, to analyze the functional and practical aspects of lighting controls. This collaborative work has led to the improvement of products and produced detailed information on energy savings and user acceptance.

Task results show that properly installed systems can save 30-50% in electricity costs in offices spaces approximately 5 meters wide during a 9-hour work day compared to the same lighting system without daylight responsive controls. Daylight responsive controls are used in new office buildings in many European countries. It is estimated that such controls are now installed in 30% of all the new office buildings in Europe.

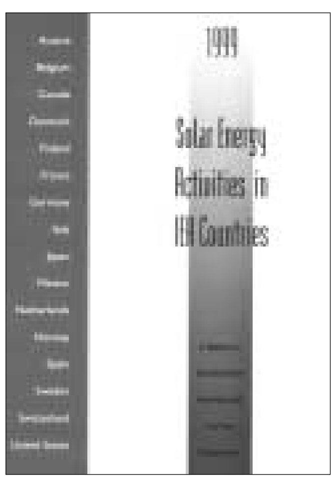
Task experts also found that the differences in energy savings between the different types of daylight responsive controls were minimal. Instead, control systems were selected based on how much the user (occupants or building owner) could adjust the controls and whether the system could be integrated with other building management functions.

The results of this work are detailed in the report, *Application Guide for Daylight Responsive Control Systems*. The first section of this guide describes the different types of systems, gives guidance on the selection, installation, economics, maintenance and user aspects. The second section shows a number of practical cases, with results from energy measurements and user surveys. This report will be available on CD-ROM in early 2001. ✷

Solar Energy Activities in IEA Countries – 1999

This publication reports on the status of solar energy activities in countries participating in the SHC Programme. An overview chapter provides a summary of the national activities and key trends in solar building technology policies and programs. Data also is provided on government funding for solar energy programs, government incentive programs for solar technologies and solar commercial activities.

To order contact: SHC Executive Secretary, see back page for address. Cost: US$ 30. ✷



Thanks To...

Conny Rolén who served as the Swedish Executive Committee member and as Vice-Chair. The Committee appreciates his contributions to the work of the SHC Programme and efforts to facilitate collaboration between the SHC Programme and the ECBCS Programme. **Michael Rantil**, also from the Swedish Council for Building Research, is once again serving as the Swedish representative. The Executive Committee was happy to welcome Michael back to the Programme and elected him Vice-Chair at his first Executive Committee meeting.

Katsuhiko Masuda who served as the Japanese Executive Committee member. Minoru Yonekura, director of MITI's Renewable Energy Technologies/ Systems, will replace him.

Kjeld Johnsen who served as the Operating Agent for Task 21, *Daylight in Buildings*. Kjeld has the distinction of successfully running one of the Programme's largest Tasks. The Executive Committee congratulates him on his dedication and valuable work.

Welcome To...

Portugal the newest country to join the SHC Programme. **João Farinha Mendes** of INETI will serve as the first Portuguese Executive Committee representative.

Simon Hayman of the University of Sydney who will serve as the Task Organizer for new daylighting work, Task 31, *Daylighting Buildings in the 21st Century*. This Task will continue the daylighting work of Task 21, *Daylight in Buildings*.

IEA Solar Heating and Cooling Programme

The International Energy Agency was formed in 1974 within the framework of the Organization for Economic Cooperation and Development (OECD) to implement a program of international energy cooperation among its member countries, including collaborative research, development and demonstration projects in new energy technologies. The 21 members of the IEA Solar Heating and Cooling Agreement have initiated a total of 29 R&D projects (known as Tasks) to advance solar technologies for buildings. The overall program is managed by an Executive Committee while the individual Tasks are led by Operating Agents.

Current Tasks and Operating Agents

Task 22: Building Energy Analysis Tools
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Task 27: Performance of Solar Facade Components
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The SHC Web Site

Visit the SHC web site next time you're on the Internet. You will find Programme information, details on Task activities, publications, names of Programme contacts, calendar of upcoming SHC meetings and workshops as well as other useful information.

Our Internet address is:

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