SOLAR UPDATE

NEWSLETTER OF THE INTERNATIONAL ENERGY AGENCY SOLAR HEATING AND COOLING PROGRAMME • NO. 34 FEBRUARY 2000

New Options Developed for Solar Energy in Buildings

The SHC Programme has completed work in two areas – Solar Air Systems and Solar Energy in Building Renovation – which focused on developing new ways to use solar energy in buildings. The following is a summary of the significant accomplishments and technical conclusions from these Tasks. Visit the SHC web site for more information on the Tasks' work and publications.

SOLAR AIR SYSTEMS

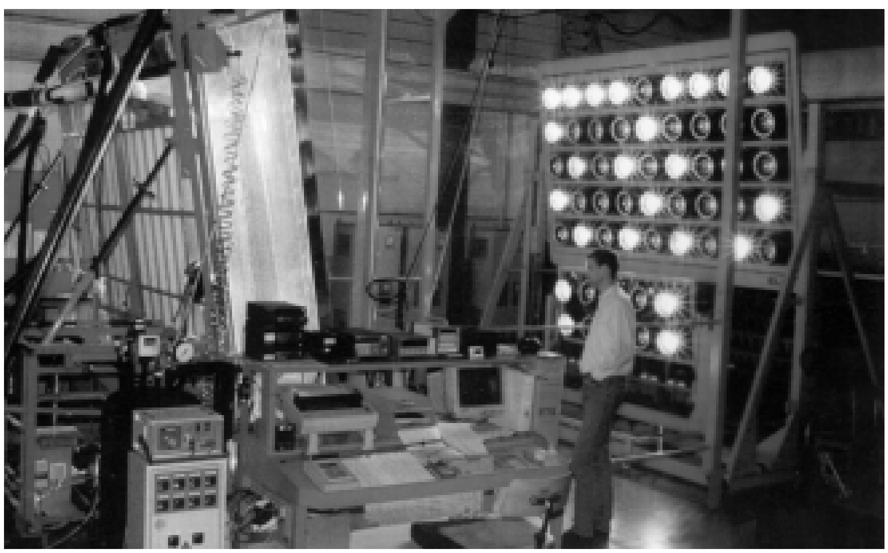
The goal of Task 19 was to facilitate the use of solar air systems in residential, institutional and industrial buildings. After holding two workshops on this topic in the 1980s, it became apparent that solar air systems showed great promise, but that the development of the technology needed a push. However, neither the architects designing individual systems nor the fledgling manufacturers developing solar air systems could finance the effort that was needed. And, therefore, the SHC Programme agreed to initiate a new Task. The work done by the Task experts has paid off by contributing greatly to the advancement of solar air technology.

As a way to capture the advances made over the course of this six-year Task, the experts documented the solar air systems on nine single family houses, ten multi-family buildings, four schools, three sports halls, six industry structures and one office building. Based on what was learned from these buildings, the experts were able to identify six basic system types. The differences between the systems were determined by how the heat was transported from the collector to the storage or heated space and then back.

Once specific systems were identified, the experts assessed the performance of collectors. To help with this process an accredited in-situ test procedure and a standardized test stand procedure were developed. Measuring the performance of solar air collectors proved to be more complex than solar water heaters due to the fact that it is difficult to measure air temperatures and air-mass flows. In addition, the experts had to address complex issues such as leakage, airflow pattern inside the collector and low heat transfer from the absorber. Seven manufacturers from seven countries accepted the offer to have their products tested at the Arsenal in Vienna, Austria. The products tested included well-established ones as well as promising prototypes. While some manufacturers used the test results to make technical adjustments in their products, the Task experts and others benefited from gaining first hand experience on how such testing should be carried out.

To share the results of this Task, the experts have produced several "tools." One is a design handbook to help engineers choose, size and detail a solar air system. It also provides information on how to assess energy performance and non-energy issues. The other tools produced were a computer tool to analyze key design variables and a catalogue of manufactured components to inform designers of the available "off the shelf" solar air systems.

Some of the technical aspects of solar air systems that were learned from this work include:



The indoor test stand for solar air systems used by SHC Task 19 experts at the Arsenal in Vienna, Austria.

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The Yellow House in Aalborg, Denmark was a Task 20 demonstration project. The solar renovations made were the renovation of the building facade using glass with PV-cells, and the installation of solar air collectors for preheating ventilation air, glazed balconies, and solar water collectors on the roof for domestic hot water.

Tasks 19 and 20

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◗ Electricity consumption proved not to be the problem it is sometimes thought to be--that is, "a solar air heating system is electrical heating." Many of the monitored projects demonstrated that as much as 20 to 30 kWh of heat could be delivered per kWh of electricity.

◗ Over-dimensioning of the collector area and/or the storage area is common. And although not critical to the performance of the system, it could impact the cost. For example, a whole roof slope could be used as the collector for aesthetic reasons or the entire length of a floor could be used for a hypocaust even though only the first few meters are effective in storing and discharging heat.

◗ The underestimation of hydraulic losses in the system due to the fan being unable to move the needed volume of air through the collector could be avoided with a simple design correction — remove sharp bends in the air channels and do not use ribbed plastic tubing.

◗ The use of rockbeds in open loop systems (the air circuit includes the room) was a concern for many. Possible problems that had been cited in the past were mold, bacteria growth and odors. However, the Task experts failed to produce a single literature citation documenting an actual incidence of such problems. To the contrary, it has been suggest that the high temperatures in a rockbed create a very hostile environment for the growth of mold.

In summary, due to the significant contributions of this Task's work, solar air systems have a bright future. The wide variety of collector types and their ability to serve multiple functions and to be applied in conventional building construction will no doubt lead to their continued growth in the 21st century. The experts in this Task have indeed succeeded in proving that solar air collectors are a credible, proven technology.

TASK 19 HIGHLIGHTS

To help manufacturers optimize performance and to provide standardized data for customers, a laboratory test rig with 55 special 1000 W lamps approximating the solar spectrum was constructed at the Arsenal in Vienna, Austria. Seven European and Canadian firms tested their collectors at this facility.

Task experts collaborated with representatives from eight collector manufacturers to produce a set of standardized product sheets and a selection guide.

An in-situ performance test procedure was developed and validated by the Solar Energy Laboratory in Denmark.

The computer tool, TRANSAIR, was developed to analyze key design variables for planning a solar air system.

Task experts contributed to a four-fold reduction in the cost of installed solar air systems by working to optimize manufactured collectors, encourage the use of more rational site-built collectors and simplify system configurations.

Solar Energy in Building Renovation

Task 20 took on the challenge of how to increase the use of solar energy in existing buildings. Solar concepts for buildings, particularly those that are integral elements of the building's architecture, such as passive solar features, are often only considered when designing a new building. However, the size and scope of the existing building market, and the tremendous opportunities in building renovation should not be overlooked if solar energy is to impact national energy consumption.

To address this issue, the Task 20 experts asked the fundamental question, how do we best realize this opportunity? What they found was that if solar concepts were to be used in building renovation then they must meet the needs of the market. In other words, a solar concept must add value to the solution of a particular renovation problem. For example, a roof-integrated solar collector solar, a glazed balcony or gallery, or a solar wall using transparent insulation materials, to name just a few, are concepts that can meet a renovation requirement as well as create savings in energy operating costs.

The use of one or more solar concepts in a building renovation project can add value to a building by:

◗ Improving the quality of indoor space.

◗ Adding living space or more efficient use of space during a greater part of the year.

◗ Reducing facade degradation, stopping degradation of balconies, repairing leaking roofs.

◗ Improving thermal and visual comfort.

◗ Improving a building's appearance.

In order for solar concepts to meet the needs of the market, Task 20 experts facilitated the integration of solar concepts in the renovations occurring in 16 buildings in 7 countries. For example, an integrated thermal solar collector roof module was introduced to save building material, reduce construction time, and simplify the building process. Today, depending on the application, roof integrated solar collectors are competitive with traditional hot water heating systems. Task experts also tested other types of solar collectors, and although the design of the systems varied from location to location, they concluded that a solar collector could easily cover 40-50% of a house's domestic hot water (DHW) demand. The primary problems that arose were from uncertain DHW demand.

Another solar concept the Task experts tested and evaluated is a relatively new concept, Transparent Insulation (TI). One of the major benefits of TI is that it improves the thermal and visual comfort for the building occupants. Examples of some possible applications of TI include windows in industrial buildings, building walls and entrances, apartment building staircases, glazed walls at swimming pools, windows and roofs in libraries, galleries and studios. An example of a relatively inexpensive TI system that was tested is the German STO compound system. Some of the benefits of this system are that it can be applied directly to an existing wall and no shading is required.

Valuable experiences were gained from working to improve the solar concepts noted above, as well as to improve the use of glazed balconies, daylighting and photovoltaics in existing buildings. Over the last five years, Task experts have demonstrated that solar concepts can offer a cost-effective renovation method that is useful, attractive and non-polluting. Whether being used alone or in combination with other renovation methods, solar energy can add value to existing buildings. ✷

TASK 20 HIGHLIGHTS

As a result of the Task, a close cooperation between researchers at Chalmers University of Technology in Sweden and the Swedish company, Derome, resulted in the development and production of a prefabricated roof-integrated solar collector.

Task experts, in cooperation with the German company STO, improved and demonstrated the use of a compound transparent insulation system that is cheaper than other similar applications and rarely requires shading devices.

Based on the successful results of this Task, other solar renovation projects have been realized, for example, as part of the EU THERMIE SHINE project in the Netherlands, Germany and Sweden.

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.

Building Energy Software

As a result of work in Task 22, Building Energy Analysis Tools, a whole-building, full year, thermal simulation tool is available. This building simulation program, IDA Indoor Climate and Energy (ICE), is primarily intended for non-experts in the field of HVAC. However, simulation experts may find it useful to study key processes that can normally only be handled with research tools (e.g., fully coupled air flow network and thermal problems, 3-D shading from enclosing buildings, computed vertical temperature gradients, Fanger's comfort indices at arbitrary room locations, and CO_2 modulated ventilation).

The real power of the program, however, lies in the way that it has been built. Every component model in ICE is defined in a special modelling language, which means that component models are easy to extend and adapt to a special problem – something which is close to impossible in traditional, monolithic tools. Testing a new concept, for example a solar heated wall or floor layer, can be done in a matter of hours.

The Swedish version of ICE was introduced in mid 1998. Today, 180 licenses have been sold and ICE is the leading tool among Swedish HVAC consultants. The international version was released in 1999.

For more information, contact Per Sahlin at Bris Data, Sweden (per.sahlin@brisdata.se) or visit www.brisdata.se/ice/.✷

Mexico Benefits From Being in the Solar Belt

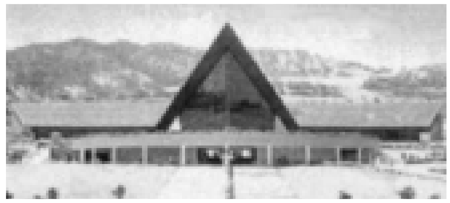
Introduction

Since the 1940s renewable energy has been a part of Mexico's energy mix. In the beginning, the main uses for renewables were for solar hot water heating, biodigestors for agricultural uses and windmills for the extraction of water for irrigation purposes. Since then, many international and national projects have been undertaken focused on the application and demonstration of renewable energies, in particular, on solar energy.

Despite the experiences gained through countless solar application projects, Mexico still lacks a national solar energy program. This is due in part to the fact that Mexico has an energy structure based on the use of hydrocarbons (about 80% of the total). In addition, the technical and economic potential of renewable energy sources (RES) is still unknown. In 1996 the Energy Ministry estimated that renewables, including hydro and geothermal energy, contributed no more than 6% to the national energy balance.

However, if new applications were considered for use not only in the country's rural areas, but also for use in urban buildings, services and industries, then the RES percentage presented by the federal government would be higher. As a means to promote the development of RES, the National Commission for the Saving of Energy (CONAE) has worked since 1995 to promote the use, application and development of renewable energy sources in Mexico. Renewable energy sources also have been included in the Development and Restructuration Programme of the Energy Sector 1995-2000.

Another effort to promote the development of renewables began in 1997 through the Consultative Council for the Development of Renewable Energies (COFER). COFER is a joint effort between CONAE, in co-ordination with the National Solar Energy Association (ANES), a non-governmental organization, and the Mexican section of the International Solar Energy Society (ISES), which has been promoting the use of renewable energy for the last 25 years. The mission of COFER is to promote and strengthen renewable energy use in Mexico thereby setting the basis for an adequate governmental policy. Two other government programs also have been created to promote the use of RES in Mexico. They are the Promotion Programme of Renewable Energies in Mexico (PPER) and the Research Network on Solar Energy (RSI).



Club Campestre Ecológico Asturiano is one of the largest thermal solar water heating installations in Latin America.

Solar Energy

Mexico is blessed with being in the "maximum global radiation belt." That is, the country has an exceptional high index of solar radiation – a monthly average between 18 to 21 MJ/m^{2}day and, on average, more than 250 days per year of good isolation.

Many solar application and demonstration projects have been realized over the years. Examples include the cooling and heating of buildings, water heating of swimming pools, preservation and refrigeration of perishables products, ice manufacturing, water pumping, ocean water desalination, food drying as well as some work on the generation of electric power using steam cycles. In addition, an important number of photovoltaic systems have been installed to provide electricity in rural dwellings, pumping and irrigation, marine and terrestrial indicators, telecommunications and water treatment, etc.

In view of the country's positive climatological conditions, solar technologies are applied to buildings, primarily, to solve the problems of warm and warm-wet conditions. The use of solar to heat buildings is less frequent and only applied in cool weather areas in the northern part of the country. Nevertheless, the heating of water for special services, such as swimming pools and household use, are important applications. For example, the "Club Campestre Ecológico Asturiano," a sport center located in the State of Morelos, uses 2,335 m^2 of glazed flat plate collectors and 2,200 m^2 of unglazed flat plate collectors to heat a swimming pool and showers. This application is considered to be one of the largest thermal solar water installations in Mexico.

This is a government employee hospital that uses 300 sq m^2 of solar collectors to heat the hospital's water.

Solar Thermal

Capitalizing on Mexico's high solar radiation index, nearly 70 solar companies are in business -- 25 are manufacturers, most of whom are distributors of national and international equipment. The industrial and commercial solar sector activity is based on an installed capacity of 40,000 m^2/year with a production from 15 to 20,000 m^2/year. In 1998, the accumulated area was around 260,000 m^2, serving nearly 90 million people and providing a penetration factor of solar energy of 0.003 m^2/person. Today's domestic solar heating water system costs between US $400 - $700 for a family of five.

The industrial and commercial activities over the years have advanced with varied rhythms. A constant factor has been the flat plate solar collector market, where growth has been low, but constant. A potential area for growth is in the urban areas to supply hot water for industrial sanitary uses and heat processes. For example, solar could be used to heat the water needed for bottle washing in the soft drink industry or heat employee showers at companies. Because of the country's high population growth rate and the inevitable concentration of people in the large cities, solar technologies have the potential to play an important role in the national energy saving program and to decrease CO_2 emissions.

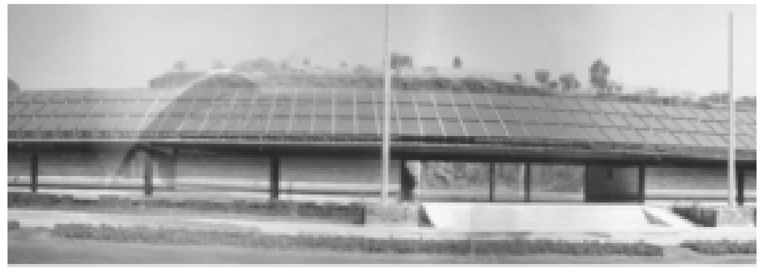
In the service sector, the potential for solar applications exists in the tourist industry (for example, hotels) and public hospitals. There also exists the possibility to accelerate regional development based on the integration of renewables in the agricultural sector.

Photovoltaics

As part of the Rural Electrification Program, 48,000 photovoltaic systems have been installed on houses and nearly 200,000 people are benefiting from the electricity generated. Of these systems installed, 65% supply 50W, 30% supply between 75 -100W, and 5% supply150W.

Mexico's most important photovoltaic system demonstration project is in the rural area of Mexico City. Approximately 5kW have been installed, with an accumulated power of 5 MW (3 MW in rural houses, 1MW in communications and 1MW in rural applications). The estimated cost is US $18 - $20/W installed. In addition to this project, the Mexican government has proposed to install 5 MW of photovoltaic systems for rural development through the four-year program " Alianza para el Campo (Alliance for the Field).

The National University in Mexico City uses solar collectors to heat its swimming pools and showers.



R&D

Concerning research and development activities, approximately 400 researchers, engineers and technicians, representing more than 40 research institutions, are involved in R&D topics related to solar energy. The primary research areas are: solar architecture, heating and cooling of buildings, solar materials, solar chemistry, flat plate collectors, concentrating collectors, refrigeration and air conditioning, water purification, drying, thermal systems, evaluation of the solar resource, basic research in solar cell materials, electrochemical cells, and photovoltaic applications and instrumentation. Although a reduced number of national industries have the economic or human resources to focus on applied research and technological development activities, some companies that are subsidiaries of foreign companies are taking on this work.

Conclusion

The potential for solar energy in Mexico is great, and people are already benefiting from its applications. However, if the use of solar energy is to grow then several institutional barriers need to be addressed. Some of the barriers hampering the expanded use of solar energy include, a lack of incentives and subsidies, no regulatory rules for the application of solar technologies in buildings, an urban development program that does not include solar energy as a priority, and a lack of financing mechanisms.

The sun is ready to work, and hopefully, the country will continue its solar efforts too. As a new member of the IEA Solar Heating and Cooling Programme, Mexico has already begun work in the area of solar assisted air conditioning of buildings.

This article was contributed by SHC Executive Committee member Isaac Pilatowsky and his colleague, Robert Best, at the Centro de Investigacion en Energia, UNAM, Mexico. ✷

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:

http://www.iea-shc.org

IN BRIEF

NEW WORK BEGINNING IN 2000

Task 27: Performance of Solar Facade Components

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

Task 28: Solar Sustainable Housing

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

Task 29: Solar Crop Drying

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

Task 30: Solar Cities

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

Working Group on PV-Thermal Systems

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

UPCOMING EVENTS

Advanced Solar Thermal Storage Workshop

Finding an efficient storage medium or improving the performance of an energy storage technology for solar building applications has often been considered a component development challenge. However, another approach is to look at energy storage in a broader system context of how to overcome the intermittence of the solar energy input. What this requires is to consider the solar building system as a whole.

Recognizing that energy storage continues to be one of the main challenges for the future of solar building applications, the SHC Programme plans to hold a follow-up workshop to the February 1997 workshop held in Finland. This workshop will focus on identifying new R&D activities in this field. The topics to be discussed by workshop participants will include materials and concepts (e.g., microcapsulated PCM in building materials, sorption storage), integrated systems and applications (e.g., passive solar, climitization), and pilot and demonstration plants.

The workshop will be held in conjunction with the TERRESTOCK 2000 August 28 – September 1, 2000 in Stuttgart, Germany.

For more information contact: Volkmar Lottner, Forschungszentrum Jhlich - BEO, Germany, Fax: +49 2461 61 31 31, E-mail: v.lottner@FZ-Juelich.de. ✷

Welcome To...

Earle Perera, of the Building Research Establishment, will serve as the new U.K. Executive Committee representative and Roger Gebbels, of DETR, will serve as the alternate member.

Michael Kohl, of the Fraunhofer Institute for Solar Energy Systems, will lead the new Task on the Performance of Solar Facade Components. He is well known by the Executive Committee as he just finished leading the Working Group on Materials in Solar Thermal Collectors.

Robert Hastings, of Solarrarchitektur, is also a former Operating Agent. After just completing his work as the Operating Agent of Task 19, Solar Air Systems, he will now lead the new Task on Solar Sustainable Housing.

Doug Lorriman, of Namirrol Ltd, will lead the new Task on Solar Crop Drying. The Executive Committee is happy to welcome him back after a five-year hiatus from the Programme after serving as the Operating Agent for Task 14 on Advanced Active Solar Energy Systems.

Peter Droege, of the University of Sydney, will serve as the Task Organizer for work beginning on Solar Cities. ✷

The SHC Programme has published several new reports. These reports document results from work on solar building renovation, daylighting, spectral radiation and low energy buildings. To order copies or for more information contact the SHC Executive Secretary, Pamela Murphy or visit the SHC web site.

Solar Renovation Concepts and Systems

This report documents 13 projects in five different fields of solar renovation: 1) glazed balconies, 2) solar wall heating with transparent insulation, 3) preheating of air for mechanical ventilation systems, 4) solar thermal collectors, and 5) improved use of daylight. The intended audience is R&D managers and product managers of solar systems. Part I documents the work, draws conclusions and provides recommendations. Part II consists of a "catalogue of concepts and systems" which includes detailed descriptions of the 13 projects.

Applicability of Daylighting Computer Modeling in Real Case Studies:

Comparison between Measured and Simulated Daylight Availability and Lighting Consumption

This report investigates the accuracy and limitations of the ADELINE 1.0 lighting software in simulating the luminance distribution from daylighting and the electrical lighting energy savings of an existing atrium building. The purpose of the study was to compare the computed outputs from Superlite, Superlink and Radiance against data collected in a real building.

Leso-DIAL software

The aim of this computer software is to give architects relevant information regarding the use of daylight at the very first stage of the design process. In this version (1.1), you can describe up to 30 openings (6 for each facade and 6 in the roof). It also allows you to calculate daylight factor values on the work plane and to estimate daylighting autonomy (according to the lighting requirements, Leso-DIAL estimates the time during which no artificial lighting is required). Best of all the software is user-friendly.

Survey Simple Design Tools

Participants in Task 21, Daylight in Buildings, completed this survey. In addition to a number of basic and already well-known tools, several new design tools recently developed by institutes participating in the Task are included. To allow for problem-sensitive selection, the survey includes a table characterizing the reviewed the tools.

Laboratory Characterizations and Calibrations of Long-wave Radiometers

This technical report covers the calibration technique for pyrgeometers and some characterization measurements on these instruments. In particular, the influence of the temperature of the filtering silicon dome is examined in theory and through experiments. Also, results from some different methods to calibrate the responsivity of pyrgeometers are compared as well as a method to measure the pyrgeometer cosine response with the angle of incidence. The report is based on results primarily from the French institution, MÉTÉO-FRANCE.

Description of Case Stories: Task 23, Optimization of Solar Energy Use in Large Buildings

This report documents 21 buildings designed using the "whole building approach." Both the processes used in the design of the buildings and the resulting building performance were evaluated. The solar buildings documented include offices, schools, and conference and research centers. The buildings use a number of low energy and solar techniques, including daylighting, passive and active solar systems, and photovoltaics. ✷

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 20 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

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SOLAR UPDATE

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