IEA Solar Heating & Cooling Programme

1997 Annual Report

Edited by
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The Solar Heating & Cooling Implementing Agreement

Background

The International Energy Agency (IEA) was founded in November 1974 as an autonomous body within the framework of the Organization for Economic Cooperation and Development (OECD) to carry out a comprehensive program of energy cooperation among its 24 member countries. The European Commission also participates in the work of the IEA.

The IEA's policy goals of energy security, diversity within the energy sector, and environmental sustainability are addressed in part through a program of international collaboration in the research, development and demonstration of new energy technologies, under the framework of over 40 Implementing Agreements.

The Solar Heating and Cooling Implementing Agreement was one of the first collaborative R&D programs to be established within the IEA, and, since 1977, its participants have been conducting a variety of joint projects in active solar, passive solar and photovoltaic technologies, primarily for building applications. The overall Programme is monitored by an Executive Committee consisting of one representative from each of the 19 member countries and the European Commission.

The members are:

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

Current Tasks

A total of twenty-three 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 1997 and their respective Operating Agents are:

Task 18
Advanced Glazing and Associated Materials for Solar and Building Applications
United Kingdom

Task 19
Solar Air Systems
Switzerland

Task 20
Solar Energy in Building Renovation
Sweden

Task 21
Daylight in Buildings
Denmark

Task 22
Building Energy Analysis Tools
United States

Task 23
Optimization of Solar Energy Use in Large Buildings
Norway

Chairman's Report: Highlights of 1997

Prof. André De Herde
Executive Committee Chairman
Université Catholique de Louvain, Belgium

OVERVIEW

1997 was an active year for the Executive Committee members and Operating Agents of the Solar Heating and Cooling (SHC) Programme as Task 18 drew to a close, Task 23 and a Working Group on Advanced Low Energy Dwellings were started, and three new Tasks were initiated. Executive Committee members also began to plan for the future as the current SHC Strategic Plan will end in 1998. Special sessions were held during the May and November 1997 Executive Committee meeting to determine the future direction of the Programme and prioritize areas of work. The SHC Programme also received exposure at the United Nations when we were invited to participate in the IEA exhibit at the United Nation's *Sustainable Development in Action Exhibition* in the United States.

With IEA SHC researchers from the 19 member countries and the European Commission involved in five Tasks and two Working Groups, 1998 will no doubt be another year full of notable achievements.

Every year our annual report includes a feature article on some aspect of solar technologies for buildings. This year's article, based on the SHC National Program Review workshop held in conjunction with the May 1997 Executive Committee meeting, summarizes the recent national activities and trends in solar building technology policies and programs of the SHC member countries.

HIGHLIGHTS OF THE TASKS AND WORKING GROUP

Highlights of the Programme's work during 1997 are presented below. The details of these and many other accomplishments are covered in the individual Task summaries later in this report.

Task 18: Advanced Glazing

The Task concluded in March 1997 and achieved all its scientific and technical goals. A few of the many technical accomplishments include facilitating the development of vacuum glazing prototypes to a commercialized product, development of a monolithic aerogel window with a U-value of <0.5 W m^{-2} K^{-1}, and identification of appropriate applications for advanced glazing materials and the quantifying of energy benefits from their use.

Task 19: Solar Air Systems

A direct result of Task 19 work is the introduction of a new and innovative solar collector by ABB of Norway on the market in early 1998.

Laboratory testing of solar air collectors continued at the ARSENAL in Vienna, Austria. Five solar collectors were tested, and results included collector efficiency, pressure drop, leakage rate and surface air speed dependency under precisely controlled ambient conditions such as wind speed and direction. In addition, a method to determine in-situ efficiency of solar air collectors was developed and tested.

Task 20: Solar Energy in Building Renovation
A report on improved solar renovation concepts and a brochure series on solar renovation concepts were published. Eighteen demonstration projects were selected for evaluation of their construction and commissioning phases as well as operational results.

Task 21: Daylight in Buildings
Seven countries began to test daylighting systems and monitor case study buildings. The types of systems being tested included louvres/blinds, light shelves, laser cut panels, prismatic panels/films and anidolic solar blinds.

Task 22: Building Energy Analysis Tools
A series of "blind" empirical validation exercises were conducted using measured data from several test rooms and houses operated by Electricity of France. The Energy Resource Station of the Iowa Energy Center was selected for a second set of exercises based on a full-scale commercial building test facility to be conducted in 1998.

Task 23: Optimization of Solar Energy Use in Large Buildings
Work just recently began under this Task. The primary focus of work to date has been on selecting and analyzing buildings for Case Stories. Twenty low energy and solar buildings have been selected to study and 12 Case Stories have been drafted.

Working Group on Materials in Solar Thermal Collectors
Work on durability aspects on the use of polymeric materials in solar collecting devices was completed. The results of this interlaboratory work will be compared to the results of outdoor tests conducted by the Working Group.

NEW PROJECTS
The Project Definition Phase for three new Tasks began in 1997:

Task 24: Active Solar Procurement. The Task objective is to achieve a performance and cost breakthrough for active solar water heating systems and to increase their market share through collaborative buying initiatives.

Task 25: Solar Assisted Cooling Systems for Building Climitization. The Task objective is to create conditions that allow solar cooling of buildings to enter the market through the identification of promising technologies and technical problems and the promotion of international R&D and marketing of solar assisted building climitization.

Task 26: Solar Combisystems. The Task objective is to review, analyze, test, compare, optimize and improve the design of solar combisystems (active solar space and water heating systems).

MANAGEMENT ACTIONS
20th Anniversary
Activities revolving around the Programme's 20th Anniversary continued in 1997. One highlight was the special session held at the May 1997 Executive Committee meeting in Norway. To recapture how the Programme began and progressed over the years, the former chairmen and Executive Secretary were invited to participated in a panel discussion. An overall conclusion by all the speakers was that the research work of over 250 experts from 19 countries has created an invaluable knowledge base on all aspects of solar energy. The Programme's exhibit also traveled the world to a variety of events, the ANZSES conference in Australia, the NorthSun '97 conference in Finland, and the Solar '97 conference in the United States.

National Program Review Workshop
A workshop on the national solar programs of the SHC member countries was held at the May 1997 Executive Committee meeting in Oslo, Norway. Each participating country presented a report on their country's work in this field during 1995-1997. These country reports will be compiled and published in early 1998.

Programme and Policy Actions
A Programme update was presented to the IEA Renewable Energy Working Party (REWP) in June 1997. The REWP was pleased with the high activity level and professionalism in operation and management of the Implementing Agreement. The REWP looks forward to the Programme's continued work and integration with other IEA Implementing Agreements. Also in June, the Chairman participated in a joint IEA/EC workshop in Belgium.

A committee to improve the Programme's information dissemination activities was established. The three-person committee will begin its work in 1998 and make recommendations to the Executive Committee.

The Software Policy Committee continued to work on strengthening the Programme's software policy. The Executive Committee agreed that software should be treated like all other assets developed under the Programme and also clarified wording for a standard disclaimer.

The Executive Committee also revised its policy on Programme activity evaluations. The new evaluation policy is intended to simplify the process for conducting mid-term evaluations. The revised process and an evaluation questionnaire were adopted by the Executive Committee.

Internet Site

The Solar Heating and Cooling Programme's World Wide Web site, which includes detailed information on current Programme Tasks, a bibliography of publications, recent Programme newsletters, past annual reports, contact information and Internet links to other organizations, continues to bring increased visibility to the Programme. Recent updates to the graphics and information should make visiting the site even more rewarding. The address for the site is http://www.iea-shc.org.

Strategic Plan 1999-2004

The Programme's present Strategic Plan ends in 1998. In an effort to revise this plan, the Executive Committee held special sessions at the May and November 1997 Executive Committee meetings. These sessions provided an opportunity for the Executive Committee members and Operating Agents to examine and discuss the Programme's strengths, weaknesses, opportunities and barriers. The November session concluded with a long list of possible priority areas for new work over the next five years. A new Strategic Plan will be approved by the Executive Committee in 1998.

COORDINATION WITH OTHER IEA IMPLEMENTING AGREEMENTS

The third joint meeting with the Energy Conservation in Buildings and Community Systems (BCS) Programme was held in conjunction with the November 1997 Executive Committee meeting in Australia. Also, the collaborative work in SHC Task 21/BCS Annex 29 continued to achieve useful results and information on daylighting systems for buildings.

In May 1997, a workshop, initiated by the Solar Heating and Cooling Programme, concluded that the IEA should undertake, within its current building-related Programmes, collaborative work in the area of sustainable (resource-efficient) buildings. A follow-up workshop is planned for September 1998. Representatives from the seven building-related Programmes as well as the End Use and Renewable Energy Working Parties are overseeing the planning of this follow-up workshop.The workshop will identify high priority collaborative work required to facilitate the transition of the building sectors of the IEA Member countries towards more sustainable buildings.

PUBLICATIONS

The following IEA Solar Heating and Cooling reports and related publications were printed in 1997 and are not listed elsewhere in this annual report.

Project Development Guide for Central Solar Heating Plants with Seasonal Storage.
C. Leenaerts, editor, October 1997.

Dynamic Testing of Active Solar Heating Systems, Volumes A&B.
H. Visser, editor, October 1996.

James & James Titles from IEA Programmes.
A promotional brochure of IEA Programme publications including those of the Solar Heating and Cooling Programme.

ACKNOWLEDGMENTS

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

Solar Energy Activities in IEA Countries

1995-1997

INTRODUCTION

In May 1997, the Executive Committee held its 6th National Programme Review workshop on activities in solar energy for buildings in IEA countries. The workshop, held approximately once every two to three years, provided an opportunity for Programme members to share information on their national solar energy programs, market and technology developments and related issues in the member countries. The focus of these reports was on solar heating, cooling, daylighting and building-integrated photovoltaic technologies.

In an effort to disseminate the information provided by member countries to the wider solar energy community, the Executive Committee is publishing *Solar Energy Activities in IEA Countries*. This document reports on the status of solar building technology policies, funding levels, research, technology advances and commercial developments in the member countries of the IEA Solar Heating and Cooling (SHC) Programme. Data are also provided on government funding for solar energy programs, government incentive programs for solar technologies, and solar commercial activities in the reporting countries.

OVERVIEW OF SOLAR ENERGY ACTIVITIES

Addressing Climate Change and Other Environmental Issues

Environmental issues continue to be the driving force for the development of alternative energy technologies in IEA countries. The recognition that fossil fuels are contributing emissions of carbon dioxide (CO_2) and other greenhouse gases to the atmosphere — and formal commitments by many world nations to stabilize those emissions — has spurred public and private sector interest in energy alternatives. Solar energy is widely seen as an excellent option for achieving CO_2 emission reduction objectives and protecting the environment. Many IEA countries — Australia, Canada, Denmark, Finland, Germany, Japan and Switzerland, for example — have cited the challenge of climate change as a primary motivation for conducting solar energy research, development and demonstration (RD&D) and market development activities.

Renewable Energy Budgets

Despite the generally strong interest in solar technologies as a means of tapping into an environmentally "clean" and renewable energy source, funding levels for solar energy activities continue to vary across IEA Member countries.

Some countries, including Austria, Belgium, Japan, New Zealand and Turkey, have noted recent increases in government funding for solar and other renewable energy activities. Most notably, funding for Japan's solar energy program increased by about 43% between 1996 and 1997. Others, however, report that solar activities have been negatively impacted by government spending restraint and cost-cutting measures. Countries in this category include Germany, France, Canada, Norway, and the United States. In the United States, funding for solar building-related activities has decreased from US$15.6 million in 1995 to US$8.7 million in 1997, largely as a result of completion of the PV-BONUS program and reductions in the active solar and electrochromics budgets. Other IEA countries, including Denmark and Finland, have maintained a relatively steady level of funding for solar energy activities.

One trend noted by many countries is a move toward increased funding for PV technology development and commercialization. This appears to reflect a widely held view that the return on investment in PV will be greater in the long term than for either active or passive solar. For example, Japan's budget for building-integrated PV more than doubled between 1996 and 1997. Belgium and Australia have also noted increased funding for PV technologies.

As well, most member countries are reporting a growing emphasis on cost-shared RD&D with the solar energy industry, universities and other partners. In many cases, government funding is directed toward areas where the domestic industry has particular interest or expertise. By focusing on areas of strength, governments are able to leverage funding from the private sector with the ultimate objective of creating jobs and economic growth.

In many countries, state/regional/provincial/local governments also fund solar energy RD&D activities. Although specific amounts were generally not indicated in the national reports, this funding is nevertheless considered to be an important source of financial support for the solar energy industry.

Table 1 provides figures on government funding for active and passive solar and building- integrated PV technologies for the past three years. The total funding for these activities was US$174 million in 1995, US$187 million in 1996 and US$237 million in 1997.

Major Technical Advances

Through the RD&D partnerships mentioned above, technical advances are being made in many facets of solar research. In their national papers, several countries indicate that new products will soon be commercialized in such areas as high-performance windows, passive solar design tools, solar domestic hot water (SDHW) systems, solar absorbers and storage systems, transparent insulation, daylighting, and building-integrated PV systems.

Passive Solar

Passive solar technologies continue to be viewed as offering great potential in many IEA countries. National programs and several IEA Solar Heating and Cooling Tasks continue to provide the knowledge and guidance needed by designers and builders to ensure that passive solar buildings perform properly.

For example, several countries are focusing on developing energy-efficient windows with advanced glazing systems (SHC Task 18). With funding support from the federal government, Canadian scientists and engineers are working with triple and quadruple glazing, krypton gas fill, low-profile frames, organic aerogels and electrochromic technologies. Electrochromic glazings are also being studied in France, where research has shown that this technology can reduce annual energy needs by up to 45% in southern regions of the country, and in the U.S. and Italy. Canada, Australia and the U.S. have also developed testing and labeling programs that will help consumers, designers and builders make informed decisions on energy-efficient window purchases.

A major effort is under way in the U.S. to support the development and evaluation of advanced solar strategies. The Exemplary Buildings Program is funding the design, construction, commissioning and monitoring of buildings capable of achieving 75% or more of their energy needs from passive solar used in combination with energy efficiency technologies. Four residential buildings and four non-residential buildings have been constructed to date, and their performance is being measured. Two of the residential buildings were developed in conjunction with SHC Task 13, Advanced Solar Low Energy Buildings.

In France, the solar design of buildings is steadily being replaced by the concept of "green building design," in which energy performance, the use of safe materials, daylighting, occupant comfort and health, and other factors enter into the design process. This new approach, which aims at emphasizing environmental concerns, will be used in the design of a new office building for the French

Table 1

Government Funding for Active and Passive Solar and Building-Integrated PV Technologies 1995-1997 (in USD thousands)

COUNTRY	ACTIVE SOLAR						PASSIVE SOLAR									BUILDING-INTEGRATED PV			TOTAL '95	TOTAL '96	TOTAL '97
	Heating	Heating	Heating	Cooling	Cooling	Cooling	Heating	Heating	Heating	Cooling	Cooling	Cooling	Daylighting	Daylighting	Daylighting						
	1995	1996	1997	1995	1996	1997	1995	1996	1997	1995	1996	1997	1995	1996	1997	1995	1996	1997			
Auatralia[1]	-	6	-	8	-	-	246	67	476	205	35	440	130	2	199	7,343	5,327	6,365	7,932	5,437	7,480
Austria[2]	680	470	620	-	-	-	710	530	580	-	-	-	70	70	50	1,160	800	790	2,620	1,870	2,040
Belgium[3]	-	-	70	-	-	-	830	610	810	-	-	-	80	60	180	610	560	690	1,520	1,230	1,750
Canada	576	581	494	-	-	-	660	590	486	-	-	-	35	69	69	-	-	-	1,271	1,240	1,049
Denmark[4]	2,000	1,500	2,000	-	-	-	2,000	1,800	2,100	-	-	-	-	-	-	800	600	500	4,800	3,900	4,600
Finland[5]	100	200	200	-	-	-	1,200	1,000	1,000	-	-	-	-	-	-	800	1,000	1,000	2,100	2,200	2,200
France[6]	1,800	1,700	1,200	-	-	-	700	600	500	-	-	-	-	-	-	100	100	100	2,600	2,400	1,800
Germany[7]	-	4,100	3,500	-	-	-	-	18,200	15,200	-	-	-	-	900	700	-	900	600	-	24,100	20,000
Italy																					

1. Figures for Australia are estimated to represent about 75% of RD&D funding for solar energy (some data are missing). Figures provided are for 1994-95, 1995-96 and 1997-98 fiscal years, respectively.
2. 1997 figures for Austria are estimated.
3. The budgets for passive solar heating in Belgium include spending on cooling.
4. The budgets for passive solar heating in Denmark include spending on daylighting.
5. The budgets for active solar heating and passive solar heating in Finland include spending on cooling.
6. The figures for France are rough estimates and do not include tax credits or other incentives. Figures presented under active and passive heating include funding for cooling and, in the case of passive energy, daylighting. These figures should not be compared with the 1993 report, which covered a much broader scope of activities.
7. The 1995 budget for Germany is comparable to the 1996 budget. Funding for passive solar heating includes spending on cooling and energy conservation in buildings.
8. Figures for Japan presented under active and passive heating include funding for cooling and, in the case of passive energy, daylighting. Funding for building-integrated PV includes subsidies for market introduction.
9. Industry in Norway provides approximately the equivalent level of R&D funding.
10. Figures for Switzerland presented under active and passive heating include funding for cooling and, in the case of passive energy, daylighting. PV funding does not distinguish between building-integrated and other PV. Dollar amounts indicated are for the Swiss Federal Office of Energy. Total public funding for solar energy RD&D is estimated to be double the figures shown here.
11. Figures for the United Kingdom are based on a financial year starting 1 April. Active solar funding includes all heating applications, and passive solar funding includes heating, ventilation and daylighting. Building integrated PV figures are estimates and the 1997 figure includes £500,000 from the £million 'Solar' Programme.
12. In the United States, passive solar R&D , excluding electrochromics research, emphasized "whole buildings research" and building energy technology integration. Work on solar cooling was essentially eliminated during 1995-1997.

Agency for Environment and Energy Management in Angers.

Daylighting is also an area of growing interest and importance. In Italy, several RD&D projects are being carried out to optimize daylight use in buildings and to improve the control systems that regulate the use of natural and artificial light, the characteristics of windows and shading systems, and the efficiency and color rendering of artificial light sources.

Active Solar Systems

Many countries have reported growing consumer interest in SDHW systems, as well as significant improvements in technology and cost reductions. A Canadian firm, for example, is on the verge of commercializing a 3,000 kilowatt hour, high-efficiency solar water heating appliance that is based on the low-flow concept pioneered in Canada. The new appliance will sell for less than US$1,500, and will offer a five-year payback when replacing an electric system.

Several countries are developing test procedures for rating SDHW systems, including Germany, Japan and the U.S. SDHW systems have generally been proven to be efficient and technically mature. Further reductions in their cost, combined with government programs to encourage and support market penetration in the U.S. and elsewhere, are expected to increase the adoption of this technology.

Work continues in Germany on the 10-year Solarthermie-2000 program, which was launched in 1993 to promote the use of centralized solar-assisted heating systems in large buildings. Under this program, up to 100 large centralized solar-assisted heating plants will be installed in public buildings. As well, large-scale, solar-assisted district heating plants with seasonal storage are being demonstrated.

Building-Integrated PV

As previously noted, many countries have reported a shift in emphasis toward supporting building-integrated PV technologies as viable, long-term solutions to energy-related environmental problems and issues of energy infrastructure and costs in remote areas.

In Japan, where the government has established a target of solar contribution to the total energy supply of 2% by the year 2000 and 3% by 2010, PV demonstration plants are being subsidized in public buildings. A subsidy program has also been initiated to accelerate grid-connected PV installations in private houses. Japan has set a target of improving array efficiency of building-integrated PV systems by 8.5% by 2000, as well as significantly lowering the cost of such systems.

Germany is also demonstrating strong interest in building-integrated PV. The German program includes a national architectural competition to promote innovative new concepts for the integration of PV elements into the building facade. As well, a monitoring program of 2,200 PV systems installed on residential rooftops is coming to an end, and has already contributed to improvements in system technology.

In a JOULE-supported project, French, Spanish and German researchers are collaborating on a prototype building with integrated photovoltaic-thermal modules for the new Library of Mataro near Barcelona. The U.S. has launched a new activity aimed at increasing the adoption of building-integrated PV in the short term, and the Netherlands, Austria, Denmark and Italy have also demonstrated strong interest in building-integrated PV.

Information Activities

IEA Member countries have undertaken a wide range of information, education, training and technology transfer activities. Target audiences include the general public, building owners and developers, researchers, manufacturers and the building design community.

In Norway, for example, national media campaigns are considered to be an important means of reaching private households and other small-volume energy users with messages about renewable energy and energy efficiency technologies. Regional energy efficiency centers are responsible for local information and training activities, and conferences, seminars and technical magazines/newsletters disseminate information on solar energy to professionals and the general public.

The World Wide Web is fast becoming an important means of distributing information on solar technologies and developments. Many IEA countries sponsor energy efficiency/renewable energy home pages that contain a wide range of information on solar technologies and other matters of interest to energy consumers. In the U.S., for example, the Energy Efficiency and Renewable Energy Network serves as a central point of information about energy efficiency and renewable energy programs. The Energy Efficiency and Renewable Energy Clearinghouse, which provides an answer and referral service for questions about energy efficiency and renewable energy technologies, can also be accessed via the Internet.

Canada has developed a Passive Solar for Canadian Houses design guide for consumers. The guide includes software to support the integration of passive solar technologies into conventional housing (as opposed to a passive solar home), and is made widely available to the building community and the general public.

Government Incentives

In many IEA countries, the move toward "small government" has meant an end to incentive programs for solar energy technologies. Nevertheless, several countries continue to use incentives to promote the market penetration and demonstration of solar technologies. In Austria, for example, the federal, provincial and some local communities provide direct financial support and financial incentives for solar systems. In Finland, organizations may be eligible for government subsidies amounting to 35% of the total cost of new energy system, and private households can apply for a 20% subsidy.

The Danish government supports the installation of solar water heating systems with a subsidy that is based on the calculated energy savings achieved under standard conditions. The amount of support is currently set at US$0.70 per kilowatt hour of energy saved per year, which represents a subsidy of 20% to 30% of the total installation costs. Solar water heating systems are becoming so popular in Denmark, it is anticipated there will be no need for a subsidy by the year 2000.

In Japan, significant funding has been allocated to subsidize the market introduction of PV technologies in public buildings (US$11.7 million in 1997) and private homes (US$96.5 million in 1997). The incentive for private homes has resulted in an estimated 9,400 installations. At the same time, Japan has ended its 17-year practice of subsidizing bank loan interest to install SDHW systems due to already low interest rates.

Other types of incentives offered by IEA Member countries include subsidies for energy retrofits of public buildings (Belgium); tax incentives and accelerated depreciation allowances (Germany, Canada and others); interest-free loans for technological applications and R&D by industry (Turkey); and special mortgage programs for energy-efficient homes (U.S.).

A country-by-country breakdown of government incentive programs is provided in Table 2.

Solar Market Activity

Despite being hampered by low prices for conventional energy sources, the market for active solar systems continues to grow in many parts of the world. Austria, Denmark, Finland, Germany and Turkey, in particular, have noted growth in solar markets.

In many IEA Member countries, rationalization of the active solar industry continues. Although the number of companies has declined in many countries, those that remain tend to be stronger and are better able to withstand market fluctuations. The privatization of electric utilities in several countries could increase utility interest and involvement in bringing solar energy systems to the marketplace. As well, do-it-yourself collector building groups are gaining momentum and expanding the use of active solar systems in Austria and elsewhere.

Passive solar techniques continue to be widely applied in the design of both residential and commercial buildings. Countries like France, Italy and New Zealand offer significant potential for the increased use of double-glazed windows, while Canada's cold climate offers many opportunities to increase the market share of high-performance windows.

Interest in building-integrated PV is growing rapidly in many IEA countries, including Japan, Spain, Finland, Norway and the U.S. The future outlook for this sector of the solar industry is particularly bright.

Table 3 provides more information on market activity in member countries. A development of particular

Table 2
Government Incentive Programs

Country	Incentives
Australia	No incentive schemes to encourage the market penetration of renewable energy products. However, a 125% tax deduction is available for R&D projects.
Austria	Federal government, provincial governments and local communities offer different levels of support, either through direct funding or tax incentives.
Belgium	Subsidies covering one-third of the cost of energy retrofits of public buildings, schools and hospitals.
Canada	Federal government offers an accelerated depreciation allowance for certain energy-producing equipment, including some solar energy products.
Denmark	Subsidy provided for installation of SDHW systems, based on estimated energy savings achieved under standard conditions. Subsidy currently set at US$0.70 per saved kilowatt hour per year.
Finland	Organizations may be eligible for subsidies amounting to 35% of the total cost of new energy systems. Private households may apply for a 20% subsidy.
France	Tax credits or accelerated capital cost allowance procedures may be available for solar systems.
Germany	Incentives include subsidies for certain renewable energy systems, incentives for the installation of SDHW systems, and tax credits for low-energy buildings.
Italy	Funding may be provided for specific projects.
Japan	Subsidies are offered to support the installation of grid-connected PV demonstration plants in public buildings and grid-connected PV installations in private houses. Subsidies for 50% of solar system costs are available for solar heating/cooling and SDHW systems in local government buildings.
Netherlands	A subsidy scheme exists for active solar thermal systems, but subsidy levels are decreasing in keeping with market-based policies. Tax incentives are available to corporations for renewable energy. Low interest rate loans are available for "green investments."
New Zealand	Grants available for practical measures that will improve energy efficiency. However, renewable energy technologies have not been able to compete on a cost-effective basis for grants.
Norway	None
Spain	Subsidies available to industries that want to improve their products and to support energy conservation in buildings. In the case of the latter, subsidies are available for both passive and active solar initiatives, as well as grid-connected PV installations.
Switzerland	Subsidies are available for large installations. For solar collectors, subsidies range up to 10% of the total investment, while for PV (more than 1 kWp), subsidies may be up to 25% of costs. Regional subsidies may also be available.
Turkey	Interest-free loans of up to US$1 million for technological applications and R&D by industry. Turkey also provides funding for R&D of up to 50% of the project budget.
United States	Tax credits are available from certain states and rebates are provided by a number of utilities for the purchase and installation of solar energy systems in buildings. Energy-efficient mortgage programs are available to help finance the cost of more energy-efficient residences.

Table 3
Market Activity

Country	Status
Australia	Largest industry sectors are PV (two major players) and solar water heating (with the leading company exporting most of its production overseas). One manufacturer is developing electrochromic windows for regional export markets. Small innovative companies are finding valuable export markets for daylighting products. Currently, SDHW systems are installed on 350,000 to 400,000 homes, and production of systems is increasing steadily.
Austria	The total area of installed collectors is in the order of about 1,457,000 m^2 , 32% of which are for swimming pool heating and 38% for hot water heating. In 1996, annual heat output of solar technology was in the order of about 490 GWh.
Belgium	Commercial activity in area of active solar energy is extremely limited. Some expansion noted in the area of natural lighting combined with artificial lighting.
Canada	Canada's active solar industry comprises about 15-20 small- and medium-sized companies that manufacture products ranging from residential pool heating collectors and domestic hot water systems to solar preheating ventilation air systems. Sales in 1996 were estimated at US$3.5 million. For the passive solar industry, high-performance windows accounted for about 35% of 1996 sales by the window industry, which is made up of dozens of manufacturers.
Denmark	Two major manufacturers of active solar heating systems, as well as 10 or more smaller companies. Continued strong growth in domestic installations, and some exports to neighbouring countries. Energy-efficient windows now a standard requirement. Currently, one Danish firm manufactures PV modules, using imported cells. Several companies produce control systems and pumps for stand-alone PV systems in Third World markets.
Finland	Solar collector manufacturing has recently begun in Finland. During the past two years, two major collector manufacturers have entered the market. Low-energy building technology is being commercialized. PV now installed in 30,000 summer residences (total of 1,500 kW). Total installed collector area in Finland is 113,000 m^2.
France	About five small firms manufacture solar collectors and/or solar water heaters. Currently estimated that 400,000 m^2 of solar collectors have been installed in France, mostly for individual or collective hot water heating, following by swimming pool heating and space and water heating. Four major companies produce energy-efficient glazing products.
Germany	Annual installed solar collector area has increased from 50,000 m^2 in 1990 to 300,000 m^2 in 1995. Total installed collector are estimated to be approximately 1.3 million m^2. A few large manufacturers and many small companies.
Italy	Low national production of solar collectors. Currently, about 15,000 m^2 of solar collectors installed per year.
Japan	Solar thermal energy industry is in decline due to such factors as low oil prices and an economic recession. Collector manufacturing in 1995 was 825,908 m^2. Total accumulated installations of active solar heating/cooling and SDHW systems at the end of 1996 was 493,587 (excluding natural circulation type solar water heaters). PV industry is growing, with annual production of 100 MW in 1997, compared to 20 MW in 1994.
Netherlands	Approximately 14,000 SDHW systems installed in 1995. Objective is to increase installations to 80,000 systems by 2000 and to 1,000,000 systems by 2020. Total installed collector area is 77,528 m^2 of glazed and 91,840 m^2 of unglazed. Total building-integrated PV installed at the end of 1995 was 200 kWp.

Table 3
Market Activity (cont)

Country	Status
New Zealand	Eight firms involved in solar manufacturing sell a total of 500 to 700 units per year of SDHW equipment. Nevertheless, the installed base remains small. Significant growth noted in sales of double-glazed windows. No building-integrated PV systems installed.
Norway	Largest commercial market to date has been for PV. More than 70,000 systems have been installed, with annual sales of approximately 5,000 systems. Market for solar water heating has been limited, with only about 500 systems installed.
Spain	Spain has three manufacturers of PV modules and numerous installation and marketing firms. A large amount of production is exported. The installed surface area of low-temperature collectors amounted to 320,000 m^2 at the end of 1995. The industry is made up of 10 collector manufacturers, as well as installers.
Switzerland	The solar industry is made up of less than 10 small companies. Employment is slowly increasing. Some firms are endeavouring to tackle foreign markets with high-quality products or systems. The installation of collectors is showing steady annual growth.
Turkey	Only the solar collector manufacturing industry is well established. In 1995, installed solar collector capacity reached 1.9 million m^2, and every year increases by more than 200,000 m^2. Industry is expanding through exports to European Community countries, the former Soviet Republics and the Middle East.
United States	Pool heating and SDHW applications continue to be the predominant end-uses for active solar systems. In 1995, approximately 628,000 m^2 of collectors were shipped for pool heating (an increase), and 70,000 m^2 for SDHW (a small decrease). The number of solar collector manufacturers has decreased, with the market dominated by a few companies. Interest appears to be increasing in passive solar technologies. The market for PV is also increasing, particularly in the residential sector. It is estimated that approximately 6272 kWp of PV modules were shipped for the residential market in 1995.

interest is the requirement that all of the buildings and energy systems for the 2000 Olympic Games in Australia be designed to minimize the production of greenhouse gases. As a result, the Olympic Games are expected to play a major role in the development of a viable solar energy industry in Australia.

OUTLOOK

Each country has provided an assessment of the national outlook for solar energy building technologies. A brief synopsis of these assessments is provided below.

Australia

The solar water heating industry is showing small signs of growth and the PV industry has a strong future. Energy prices are expected to rise as utilities are privatized, which will help level the playing field for renewable energy sources. The 2000 Olympic Games are seen as a potentially valuable opportunity for the renewable energy industry to become viable.

Austria

The use of solar energy in the building sector is seen as an important element for a sustainable future. To date, attention has focused on small residential buildings. There are opportunities to extend the use of solar energy into larger buildings, which will have a greater impact on overall energy consumption.

Belgium

Commercial activity in the area of active solar energy is extremely limited. The coming years will see the pursuit and expansion of RD&D in such areas as passive solar for heating, cooling, natural lighting and ambient air quality; limiting CO_2 emissions; and PV energy systems.

Canada

Canada is continuing to make advances in solar energy technologies. By working in partnership with industry, the Canadian government is supporting the development and use of renewable energy technologies and is ensuring these technologies make it to the marketplace.

Denmark

By the year 2000, SDHW systems are expected to be commercially feasible without subsidies. However, promotional efforts will continue to be needed to increase the use of solar energy. Market development instruments will include promoting the use of solar energy in combination with natural gas, oil and electricity. A shift in emphasis is expected from active solar energy toward passive and building-integrated solar energy.

Finland

The long-term potential for solar energy in buildings is significant due to Finland's harsh northern climate. Solar energy could contribute 5% to 10% of the national energy demand without causing large disturbances in the energy infrastructure. The medium-term outlook remains strong for passive solar and small-scale PV, which are already common. Active solar and PV in buildings may grow in importance in the future.

France

Concern for the environment is expected to become more prevalent in political strategies and decisions. However, prices for natural gas and domestic electricity are expected to continue to decline, which could limit the penetration of solar technology to small niche markets. A SDHW tax-exemption program started in three overseas territories in 1996 will be renewed and possibly extended to mainland France. Incentives for such systems as "solar heating floors" are expected to gradually decline.

Germany

The market penetration of solar technologies in Germany is expected to continue at a strong rate over the next few years, particularly given the government's commitment to a 25% to 30% reduction in CO_2 emissions by 2005. The government has proposed that until 2005, all RD&D efforts should focus on improving new energy-saving and solar technologies and to gathering reliable data for the technical and economic assessment of different energy technologies.

Italy

RD&D programs over the next few years will focus on developing transparent materials and daylighting systems; developing plane solar collectors for domestic hot water heating; integrating solar technologies into building renovations; and developing, producing and testing building-integrated PV systems.

Japan

Ongoing solar thermal and PV programs are expected to help Japan meet its targets for solar energy contribution to energy supply by the year 2010 (for PV, the targets are 40 MGW by 2000 and 460 MGW by 2010).

Netherlands

The Netherlands aims to increase the contribution of renewable energy from less than 1% of energy supply today to 3% by 2000 and 10% by 2020. The priority is to increase installations of SDHW systems, with expected market growth of 30% per year until 2000. Funding for RD&D of passive solar energy will be increased, and interest is growing in building-integrated PV.

New Zealand

New Zealand has agreed to return net CO_2 emissions to their 1990 level by 2000. The increased use of renewable energy sources, including solar energy, will be part of the solution. However, New Zealand's energy policy remains reliant on market mechanisms.

Norway

No substantial Norwegian market for new renewable technologies is expected in the near future, although a niche market may emerge for PV units in remote areas. RD&D efforts will mainly focus on product development for export markets. An expected shortage of electricity, as well as more intensive political actions to decrease CO_2 emissions, could signal increased interest in solar energy.

Spain

The Spanish government will continue to support the development and use of renewable energy technologies according to the objectives defined by the European Union — namely, economic growth, the creation of employment, maximum self-sufficiency and enhancing the quality of life through improved environmental conditions.

Switzerland

A new energy law anticipated for 1999 is expected to include a "Solarinitiative" program that will increase subsidies for solar and other forms of renewable energy. Otherwise, no developments are anticipated that will substantially change the market for solar technologies.

Turkey

New environmental taxes are scheduled to be imposed on fossil fuels. These taxes, along with new incentives for solar energy, will make solar energy applications (other than SDHW) more economical and affordable by consumers.

United States

Growing awareness of the role solar building technologies can play in helping to achieve domestic and international environmental objectives could result in increased funding and activity in the future. In the current environment of deregulation and restructuring, electric utilities and state regulatory bodies have expressed interest in ensuring that renewable energy remains an important component of their energy supply mix. Within the buildings sector, the trend toward single building codes and the increased use of performance-based compliance should increase the opportunities for solar energy in new construction.

TASK 18:

Advanced Glazing and Associated Materials for Solar and Building Applications

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Operating Agent on behalf of the United Kingdom Department of Environment

TASK DESCRIPTION

Objective

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

Scope

Glazings were defined as clear and translucent media for building windows and facades and solar collector applications. Associated materials included the necessary support systems required to realise usable components, e.g., frames, sealants, spacers.

The advanced glazing materials included in the Task were broadly categorised as:

- High Performance Insulating Glazings: low emittance coatings, monolithic and granular aerogels, geometric media (i.e. honeycomb and capillary structures), high transmittance polymers and anti-reflecting glass, evacuated glazings.
- Dynamic Optical Switching Devices: electrochromic, thermotropic and liquid crystal devices.
- Solar Gain Control Coatings: high visible transmittance, low solar transmittance low-emittance coatings, angle selective transmittance coatings.

Task 18 built upon the work of Task 10, Solar Materials R&D, but with a more specific focus on the application and technology transfer of new materials and components. The emphasis was on near market technology, but possible future glazing materials such as angle selective transmittance coatings were included. Complex glazings such as view windows with integral moveable blinds were also included.

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

Means

The work of Task 18 is managed under 2 Subtasks:

Subtask A
Applications Assessment and Technology Transfer
Lead Country : Australia

Subtask B
Case Study Projects
Lead Country : Norway

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

Subtask A
Applications Assessment and Technology Transfer

A1 Applications, potentials and characteristics (Australia)

A2/A3 Modelling and Control strategies (U.S.A.)
A4 Environmental and energy impacts (Australia)
A5* Applications guidance (U.K.)

Subtask B
Case Study Projects

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

*A5 & B10 merged into single project

The Task was initiated on 1 April 1992 and continued for five years until its completion on 31 March 1997.

Fifteen countries participated in the Task. These were:

Australia
Canada
Denmark
Finland
France
Germany
Italy
Japan
Netherlands
Norway
Spain
Sweden
Switzerland
United Kingdom
United States of America

During the course of the Task some 80 different experts from the 15 countries participated in the work.

Subtask A, Applications Assessment and Technology Transfer, focussed on the application of advanced glazing systems in buildings and other solar energy systems. The Subtask sought to demonstrate the effectiveness and potential advantages which will result from advanced glazing use and to enable educated choices in the selection of candidate glazing systems for solar and building applications to be made. The primary objective of the Subtask was to determine the energy and environmental impacts of the application of advanced glazing and the associated climatic dependence. Technical and economic potential was to be investigated by simulating the energy performance of buildings in different climates and glazing physical properties and control strategies critical to performance were to be established. The Subtask also sought to collate important information into applications guidance formats suitable for dissemination to relevant end users.

Subtask B, Case Study Projects, was composed of a series of individual projects which integrated a series of materials development and measurement activities to enable an extensive, in-depth examination of materials properties, design considerations for window development, component performance determination and establishment of a comprehensive knowledge base. Much of the data generated within the Subtask represents state-of-the-art knowledge in the field. Data generated from Subtask B were used as primary inputs to the work of Subtask A. The measurements undertaken in Subtask B established improved test procedures and levels of accuracy and represent a body of pre-normative work relevant to national and international standards development.

REVIEW OF 1997 AND COMPLETION OF THE TASK

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

In 1997 Task 18 reached its conclusion and satisfactorily achieved its scientific and technical goals. The 10th and final Experts Meeting was held in Nagoya, Japan, where, in parallel, a successful Industry Workshop was also held involving major Japanese industries. A review of achievements of the Task is presented below.

It was learned that the annual energy performance of buildings employing advanced glazing is highly climate-dependent and is a complex function of trade-offs between solar heat gain and thermal insulation. In very dull winters, a low U-value is more important than a high total solar energy transmittance (TSET) because of the limited benefits deriving from passive solar design. Double glazing with a pyrolytic hard low-emittance coating and argon gas fill appears the most cost-effective choice at current energy prices. Clear hard-coat low-e vacuum windows actually yield lowest heating energy needs because of an increase in solar heat gain in comparison to triple or quadruple glazed windows. For equator-facing facades in all countries, low-e argon filled windows can out perform insulated walls with no windows. Cooling energy needs are a strong function of the window TSET. In warm to hot climates, high performance single glazings with a high level of solar rejection offer good cost-effectiveness and can outweigh the need for a low U-value.

The high quality of low-e cool glazings, i.e., multi-layer silver based coatings with high visible transmittance and low solar transmittance, reduce cooling loads and offer good cost effectiveness. The Task energy performance results are extensive and it is dangerous to introduce numbers which may very soon become authoritative and used out of context! Nevertheless, Task 18 results indicate that in residential houses a saving of 25-35% on the annual heating or cooling demand can result due to a cut of 60-70% in heat loss through actual windows. Savings in offices of 30% on the annual energy demand for heating, cooling and lighting would result and a reduction in services plant capacity would also help to offset the cost of better glazing.

The environmental impacts project which calculated the embodied energy of windows concluded that energy efficient windows do save more energy than they cost to produce. Although facade coating materials and their application technologies are generally very energy intensive, so little of such materials are used that they add little (<1%) to the embodied energy of building facades. The Task concluded that the total embodied energy of windows is very small (<1%) when compared to the potential operational energy saving over a building lifetime of say 40 years.

LINKS WITH INDUSTRY

Task 18 sought out and sustained contact with industry throughout its lifetime. Avenues for consultation with major glass and glazing manu-

Task 18 Technical Accomplishments

The technical accomplishments of Task 18 are many. Task 18 remained throughout a rigorous quantitative scientific programme, advancing and establishing an improved reliable knowledge base of materials and component properties. It is not possible in a report of this nature to mention all the progress made; with this in mind the following accomplishments are listed:

- *The identification and definition of all important parameters used to characterise the energy performance of windows and the contribution to harmonisation of terminology.*

- *The identification of appropriate applications for advanced glazing materials and the quantifying of energy benefits obtained from their use.*

- *The pivotal role that Task 18 played in facilitating the development of Australia's new Window Energy Rating Scheme (WERS) for residential windows.*

- *The quantification of the significant improvements in heating, cooling and lighting energy performance of buildings employing advanced glazing which emerged from the results of the building energy analysis simulations in 10 countries.*

- *The positive results which emerged from the embodied energy life cycle analysis studies.*

- *The development, construction and testing of large area prototypes for all high performance insulating glazing materials identified within the Task.*

- *The development of a monolithic aerogel window with TSET > 0.75 and U-value < 0.5 W m^{-2} K^{-1}.*

- *The advancement of the development of vacuum glazing from laboratory prototypes to commercialisation facilitated by the Task.*

- *The development of innovative methods to determine the rate of heat transfer through vacuum glazing and the comprehensive understanding obtained of the mechanical stresses due to atmospheric pressure, and temperature differentials.*

- *The design and construction of the world's first framed vacuum window exhibited at Glastec 96 with centre of glass U-value of 0.8 W m^{-2} K^{-1} and whole window U-value of 1.2 W m^{-2} K^{-1}.*

- *The complete angular characterisation of the optical properties of angle selective transmittance coatings and the use of these data to model the annual energy and daylighting performance of such windows in buildings.*

- *The bringing together of the major bulk of internationally available information and its conversion into state-of-the-art design guidance on frame and edge seals for advanced glazings.*

- *The validation of computer models that can predict the thermal performance of complex advanced frames and edge seals to a very high degree of accuracy through a programme of parallel hot-box testing and computer simulations.*

- *The measurement of the thermal conductivity of a wide range of new products used as spacers in warm edge technology glazing.*

- *Participation in the development of reliable prototype electrochromic and thermotropic devices and their characterisation and testing coincident with the emergence from industry of prototypes close to commercialisation.*

- *The measurement of the optical properties of most important clear and scattering glazing materials and where possible the angle dependence of these properties.*

- *The identification of potential sources of error in the ISO 9050 standard for determining optical properties of windows by calculation if the properties of individual panes are known and the demonstration of the method to overcome these errors through the use of polarised input data.*

- *The development of a reliable simplified procedure for prediction of the angle dependent optical properties which classified glazing coatings into materials categories.*

- *The surveying and reporting of all major facilities in the participating countries for the measurement of the key glazing performance parameters.*

- *The construction of new devices in three countries for the measurement of total solar energy transmittance facilitated by the cooperation of the nine participating TSET project countries.*

- *The completion of the TSET round-robins on insulated glazing units, the identification of sources of error and the subsequent improvement to the measurement procedure and accuracy in the calorimetric determination of total solar energy transmittance.*

- *The measurement of TSET for complex glazings, such as transparent insulation and glazings with integrated blinds and shading devices and the development of associated calculation procedures beyond the level of current standards.*

- *The generation of two new European Union projects within the Standards, Measurements and Testing programme of DG XII which enable the work of Task 18 to be extended in the areas of TSET determination (ALTSET) and angle dependent optical properties measurements (ADOPT).*

- *The completion of an inter-laboratory comparison which provided the first world-wide common experience with new (ISO/CEN draft) test procedures for determination of glazing U-value using hot box test methods.*

- *The development of detailed error analysis to establish accuracy and improve confidence in the measurement of U-value.*

- *The completion of numerical analysis to study edge effects (lateral heat fluxes).*

- *The identification and critical review of relevant solar and thermal test procedures and standards and the close co-operation with ISO/CEN working groups and contribution to improvement of and confidence in standards.*

facturers were opened during the Programme Definition Phase and industry representatives directly influenced the content and priorities of the Work Plan. In particular, the need to develop frame and edge seal technology to permit the development of windows rather than simply to understand properties of materials strongly influenced the Task's thinking.

The glass industry participated at the experts level. Representatives from Interpane, Germany, and Asahi Glass Ltd, Japan, regularly attended the Experts Meetings. Information was transferred from industry to the Task particularly in the areas of manufacturing, cost and embodied energy assessment.

As is common in many Tasks, industry provided a large number of samples for evaluation within the Task projects. These included coated glass products for near-normal and angle dependent optical properties measurements and customised low emittance argon filled double glazed edge sealed units which were used for calibration and round-robin testing in the B11, B12, B13 and B14 projects were manufactured and distributed by Pilkington and Interpane. OCLI, USA, 3M, USA, Gentex, USA, Interpane, Germany, and Asahi Glass Ltd, Japan, all provided samples of smart materials including electrochromic, thermotropic and liquid crystal prototype devices for testing in the B3 Chromogenics project.

AS Spilka Industri, Norway, manufactured the low-loss wooden frame designed within B9 to house the 1.0 x 1.0 evacuated glazing edge sealed unit built by the University of Sydney, Australia. This cooperation enabled the Task to display the world's first prototype full-scale vacuum window at the Glastec exhibition in 1996. This window had earlier been tested within the Task and the results enabled validation of calculation methods employed for determining window U-value. Task 18 and the Solar Heating and Cooling Programme also played a vital role in facilitating the human contacts between Prof. Collins, University of Sydney and representatives of Nippon Sheet Glass, Japan, which resulted in licensing agreements, the commercialisation of the vacuum window and the launch in 1997 of the Spacia vacuum window.

Early in the Task, working contacts were established with the National Fenestration Rating Council, NFRC, U.S. NFRC plays a key role in the development of procedures for performance rating and energy labelling of windows and related products throughout the USA. Task 18 provided the Chair of the NFRC International Advisory Committee, Dr. Peter Lyons, Australia. The contact facilitated the development of the Australian Window Energy Rating Scheme (WERS) which was developed and established during the life of Task 18.

Task 18 regularly sought ways to reach members of industry through organisation of industry clubs, workshops and conferences. Most notable were the Australian Industry Workshop (1993), from which it is said a major Australian window manufacturer changed completely their approach to window design and construction, the Window Innovations '95 Conference, Toronto, Canada (1995), the Glastec exhibition, Dusseldorf, Germany (1996) and the Japanese Industry Workshop (1997). Such activity on four continents has provided industry with encouragement and confidence to market value-added products according to performance and purpose

INFORMATION DISSEMINATION

The links to industry described above formed an important element of the information dissemination strategy pursued by the Task. The targeted workshops in Australia and Japan, the major international Window Innovations '95 Conference in Canada, the Glastec 96 Exhibition in Germany and presentations at the annual NFRC meetings all contributed significantly in raising awareness of the Task's work and providing channels for communication and information transfer. In individual countries the work of national industry clubs, national conferences, training workshops and newsletters all added further support. Experts from the Task organised training courses in the use of desktop tools such as the: FRAME, VISION, and WINDOW programmes and workshops were held in Australia, UK, USA, and Canada.

Major international conference presentations describing results from Task 18 were made by the Operating Agent at the World Renewable Energy Congress, UK-ISES in 1994, EuroSun '96 in

Germany, and the EC 4th Solar Energy in Architecture and Urban Planning Conference in Berlin in 1996. These plenary presentations have been supported by many papers resulting from the work performed in individual projects across the Task presented by the experts. A presentation of the final results of Task 18 will be submitted to ISES EuroSun '98.

Review articles describing advanced glazings and benefits to be derived from their use were written by the Operating Agent for publication in UK-ISES conference proceedings and the Japanese ISES Journal. A theme article on smart windows was written for the IEA SHC 1995 Annual Report. During the past year, the Operating Agent has been working as Guest Editor for the Solar Energy Journal on the production of a "Special Issue on Advanced Glazing Materials." The issue is now close to completion and the expected publication date is February 1998.

The Task maintained a comprehensive ftp site in Australia, mirrored in Italy, which allowed experts to transfer information freely. In 1997 Task 18 produced a video to alert people to the Task's work.

The three final Technical Reports of Task 18 are ready for Executive Committee approval in 1998. The Subtask A technical report is targeted at architects and designers. The two Subtask B reports on advanced glazing materials and measurement procedures for determination of key glazing performance parameters are highly technical and very extensive. They will be of great value to the scientific and technical research community, the glass and glazings research community and to the standards organisations. Following completion of the technical reports a textbook entitled "Advanced Glazing Materials," describing the work undertaken in Task 18 and edited by the Operating Agent, will be published.

In addition to the above, some 300 Working Documents were prepared by the Task but have not been officially distributed. The index to these Working Documents is archived in the final issue of the Information Plan, T18/OA/IP11/97, available from the Operating Agent.

CONCLUSIONS

Task 18 has played an important role in advancing knowledge and awareness in the field of advanced glazing. A comprehensive knowledge of materials properties, glazing performance and building energy performance has been developed which will be of value for many years to come. Excellent international working relationships were developed between the participating countries providing many new opportunities for further future collaboration within and without IEA. The links and relevance of the measurement work to CEN and ISO have been strengthened.

Given proper selection and design, the use of advanced glazings appears beneficial in residential and commercial buildings in all climates. During the life of Task 18 new advanced glazing products have come to the market (e.g., vacuum windows; electrochromic windows). Task 18 has assisted the commercialisation of these products and has contributed effectively to the establishment of the necessary foundations to enable the future development and application of advanced glazing products.

1997 MEETINGS

The Tenth and final Experts Meeting
March 10-14
Nagoya, Japan

The final Technical Presentation of the work of Task 18 was presented to the Executive Committee at the November 1997 Executive Committee meeting in Australia

1998 MEETINGS

A Planning Workshop to identify areas for future IEA activities in the area of advanced glazings is being organised by the United States Executive Committee member and will be held in the spring of 1998.

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TASK 19:

Solar Air Systems

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TASK DESCRIPTION

Objectives

The goal of Task 19 is to facilitate the use of solar air systems for residential, institutional and commercial buildings by:

- Documenting exemplary buildings: The effectiveness of building-integrated solar air systems is being demonstrated by evaluating and documenting successful, projects in a case studies book.
- Writing a Systems Design Handbook: This will help designers to choose an appropriate system, estimate its energy performance, assess non-energy issues, dimension the system and detail the construction.
- Developing a computer tool: Key design parameters will be quantified for the handbook. A new user-interface and models of solar air system types in TRNSYS will provide a viable design tool.
- Compiling a catalog of manufactured components: This document will inform designers what is available "off the shelf" for solar air systems.

Duration

October 1993 to April 1999.

ACTIVITIES DURING 1997

The following work was completed:

- Thirty-three case studies were edited by the Operating Agent, distributed to Task experts and a publisher for review, and final revisions and comments were received for revisions by the Operating Agent. The publisher provided valuable insights on how to better target the book to the expected readership.
- Product sheets were delivered by industry, mostly from collector manufacturers. Accordingly, the emphasis of the catalog will be on collectors including: Solarwall (Canada), Grammer (Germany), Aidt Miljo (Denmark), ABB (Norway) and Secco Sistemi (Italy).
- The Arsenal in Vienna, Austria completed the testing of five solar air collectors: Grammer (Germany), Aidt Miljo (Denmark) and Solarhart (Austria), Tekno-Term (Sweden) and Solarwall (Canada). Results included collector efficiency, pressure drop, leakage rate and surface air speed dependency under precisely controlled ambient conditions such as wind speed and direction. A procedure was developed for modifying test results for different incident sun angles.
- A method to determine in-situ the efficiency of solar air collectors was developed and tested at the Solar Energy Laboratory, DTI Energy in Denmark. Determining the efficiency of air collectors is more difficult than for water collectors because results are strongly influenced by the actual mass flow rate inside the collector. It is therefore difficult and often impossible to extrapolate data from tests of single collectors on test stands to larger solar air collector arrays. The DTI developed a testing methodology whereby: accurate measurements do not disturb the air flow pattern in the collector loop. The efficiency can

be determined under dynamic conditions.
- The 2nd draft of 15 of the foreseen 23 Handbook chapters were reviewed at a recent Experts Meeting.
- Three Climate Similarity Indices (CSI) were defined by the University of Siegen in Germany to cover a good spread of climates. These simplify estimating saved energy by a solar air system. Sample calculations using this ratio of solar radiation during the heating season to heating degree days yielded good results compared to using local climate data.
- Transair models for all six system types have been distributed and are in use by the respective experts. The newest version is more user friendly and the run speed has increased by 50%. Logic tests have were completed and the tool found to be in order. Parameter studies to generate nomograms for the handbook have begun.

WORK PLANNED FOR 1998

- Case Studies the Operating Agent will enhance CAD plans and sections to better show the solar system, create CAD country maps to pinpoint each building, append all the figures, graphics, photos to the end of each chapter, rewrite all building types introductions, edit two new case studies (which will improve the distribution by system type) and expand the introduction for a more general readership.
- The IEA-expert written parts of the Components Catalog will be sent to the ExCo for approval. Experts will contact additional manufacturers of non-collector components to obtain product sheets.
- Two additional collectors are scheduled to be tested at the Arsenal: the Bara Costantini collector from Italy and the newly developed collector from ABB.
- The 2nd/ 3rd draft of the Handbook will be written, and nomograms and test used will be presented at next expert meeting. A new section of the Handbook will address “Alternative Uses of Systems” including three new chapters: Domestic Water Heating, Cooling (with hypocausts or rockbeds coupled to an earth register or night flushing), and Electricity Production (combined pv/thermal systems using PV panels as the absorber and the air system to extract the heat).
- Level 4 of Transair will be sent to the system authors. This version allows more flexibility and ease of use. The system authors will complete parametric studies for generating nomograms. Task 19 architects will test use the tool on selected case studies to evaluate the usability of the tool by non-computer specialists, and provide further insight into the case studies.

Metzler Garage: A mechanic’s workshop with an open-loop solar air system in Vorarlberg, Austria.

LINKS WITH INDUSTRY

A new type of solar air collector, developed by ABB in Norway in collaboration with Pilkington Glass in the United Kingdom, makes use of insulating glass technology. The rear glass in an insulating glass unit is replaced by a metal absorber in the production process. This standard-dimension unit can then be installed in conventional facade construction, which also provides for an underlying channel for air to circulate and be warmed by the absorber. ABB sees a good market potential, thanks to the standard construction both in the fabrication process as well as at the building site. The product came into being, thanks in no small part, to the support of Task 19, the Norwegian expert reported.

REPORTS PLANNED FOR 1998

Solar Air Systems: Exemplary Buildings
James & James Science Publishers, London, spring 1998.

Solar Air Systems: A Catalog of Products and Components (supplement to the book, *Exemplary Buildings*).

1997 MEETINGS

Eighth Experts Meeting
April 6-9
Bregenz, Austria
The meeting included a technical tour of Austrian solar air heated buildings.

Ninth Experts Meeting
October 5-7
Roskilde, Denmark
The meeting included a technical tour of Danish solar air heated buildings.

1998 MEETINGS

Tenth Experts Meetings
April 19-22
Sirmione, Italy

Eleventh Experts Meeting
October
Norway

TASK 19
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TASK 20:

Solar Energy in Building Renovation

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Operating Agent for the Swedish Council for Building Research

TASK DESCRIPTION

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

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

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

Subtask A: Evaluation of Existing Building Applications (Sweden)

This Subtask focused on obtaining as much relevant information as possible from existing solar renovation projects—both positive and negative. Information was collected on the reasons for renovation, various features employed, the renovation process, and occupants' reactions. Subtask A was completed in 1995. A summary of the results were published in the journal *Energy and Buildings* (Volume 24, 1996, pp 39-50, Elsevier, Switzerland).

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

The main focus of the Subtask was to develop improved and advanced renovation concepts. A wide variety of possible systems, components, and strategies were identified and analyzed in specific renovation situations to assess their feasibility and performance. This Subtask has also concluded.

Subtask C: Design of Solar Renovation Projects (Denmark)

The objective of Subtask C is to demonstrate the application of promising solar renovation system concepts in different buildings in different climates. The Subtask activities are divided into two areas: the design of solar renovation projects and the evaluation of solar renovation projects. Subtask participants have created designs for solar renovation demonstration projects and developed monitoring procedures and reporting formats. Sixteen different solar renovation projects are described in a report, most of them residential buildings, but also an office, factory and school. Several solar techniques were used: building integrated collectors, glazed balconies, solar mass walls, transparent insulation, second skin facades, daylight elements, photovoltaic systems.

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

The document, *Solar Renovation Strategies and Lessons Learned*
- Arrangement and participation in international symposia
- Compilation of illustrative source materials
- National dissemination of Task results

The Brandaris building in Zaandarn, the Netherlands before renovation. This project consists of one building, built in 1968, with 364 similar apartments, about 80 m^2. The building requires renovation of the heating system and the individual domestic hot water (DHW) systems. The renovation will reduce heating from 145 kWh/m^2 to about 47 kWh/m^2 and increase DHW from 15 kWh/m^2 to 32 kWh/m^2. The solar features that will be used in the renovation are 750 m^2 of solar collectors on the roof and a 40 m^3 storage tank. Some of the apartments also will have glazed balconies.

Subtask E: Evaluation of Demonstration Projects (Germany)
Subtask E comprises an evaluation of the realized solar renovation projects that were documented in Subtask C. Other projects have also been added to complete the experience. Construction and commissioning phases as well as operational results will be evaluated and reported on. Experiences like energy performance, comfort, maintenance and user influence will be documented and an economic evaluation will also be included. Non-energy aspects will get attention as well as the energy performance results. The added values of the renovated building (improved architecture, ending of facade degradation, improved thermal and visual comfort, etc.) will be an important part of the evaluation.

Subtask F: Improvements of Solar Renovation Concepts and Systems (Switzerland)
The objective of this Subtask is to improve the adaptability of solar concepts and the required systems for renovation conditions. Critical aspects of solar components will be documented, with emphasis on industrial production for improved market implementation. The results will be documented in a technical report and a catalogue of systems specifications.

Subtask G: Dissemination of Results (Netherlands)
The objective of this Subtask is to use existing documents to disseminate Task 20 results nationally and internationally. This Subtask will also synthesize and document information obtained from Subtasks E and F. A brochure will be produced documenting the results from Subtask E. This brochure will be linked to the other brochures that have been produced in Task 20.

Duration
Task 20 was initiated on August 1, 1993 and was scheduled to run until December 31, 1996. The work of Subtasks A, B, C and D were covered in this phase. A two-year extension was later approved by the Executive Committee and the Task is to continue until December 31, 1998. Subtasks E, F and G are covered in this phase.

ACTIVITIES DURING 1997
Two Experts Meetings were held in 1997. Six countries are active in the Task, as Belgium is not participating in the extension.

Table 1
Proposed Demonstration Projects

Project		ID	Build. Type	Solar Renovation Feature
The Yellow House	DK	STC	Multifamily	Roof-integrated collectors (DHW), Glazed balconies, ventilated solar walls (preheating ventilation air), solar wall with PV-cladding
Villa Tannheim	DE	STC	Small Office	TI compound system, advanced glazing, roof-integrated collectors for DHW and space heating
Salzgitter	DE	STC	Industry hall	TI glass wall (thermal insulation and daylighting)
Wurzen	DE	New	School	TI wall
Erfurt	DE	New	School	Advanced daylighting elements
Oederan	DE	New	Multifamily	Roof-integrated collectors (DHW)
NREL Visitor Center	US	New	Multi-functional	Daylighting
Austin	US	New	Office	Tracking skylight[1]
Brandaris	NL	STC	Multifamily	Glazed balconies, roof-mounted collectors (DHW)
(N.N.)[2]				
Älvkarleby[3]	SE	New	Multifamily	Roof module (1) + roof-integrated (2) collectors (DHW)
Ekerö[3]	SE	New	Multifamily	Roof-integrated (3) collectors (DHW)
Ringtorp[3]	SE	New	Multifamily	Roof-integrated (4) collectors (DHW)
Henån[3]	SE	New	School	Roof-integrated (5) collectors (DHW)
Onsala	SE	STC	Multifamily	Roof module coll. (pilot plant on new building)
Ekoporten	SE	New	Multifamily	Glazed balconies, roof-integrated collectors (DHW)
Affolternstrasse	CH	STC	Multifamily	TI walls, roof-integrated collectors (DHW)
Brugghof	CH	STC	Multifamily	TI walls, roof tile PV-system
Synergie	CH	New	Multifamily	Glazed balconies with controlled ventilation

[1] not proven, [2] project not defined yet, [3] combined evaluation

Subtask B: Development of Improved/Advanced Renovation Concepts

The technical report with the results from this Subtask, was completed during 1997. This international guide includes three parts starting with a section of tables to illustrate the applicability of different solar renovation strategies and concepts of four basic building types: houses, apartments, schools, and offices. The next section presents the simulation results of the most relevant concepts carried out by the participating countries. The report ends with conclusions and basic market conditions for each concept, including the main characteristics of the existing products, their situation in the building market, and the financial, practical and constructive aspects.

Subtask C: Design of Solar Renovation Projects

The experiences of designing 16 demonstration projects are reported in, *Solar Renovation Demonstration Projects.* This report is near completion and will be published in 1998.

Subtask D: Documentation and Dissemination

To be able to reach a wider audience, the results from Subtasks A, B and C have been compiled into four brochures. An overview brochure, *Solar Energy in Building Renovation,* provides an introduction to solar energy in building renovation. The three other brochures describe more in-depth different solar concepts. Their titles are *Solar Collectors in Building Renovation, Glazed Balconies in Building Renovation,* and *Transparent Insulation in Building Renovation.* Each brochure is 16 pages and the four brochures are put together in one binder. They were published by James & James Science Publishers Ltd, London in September 1997.

Subtask E: Evaluation of Demonstration Projects

In Subtask E, 18 demonstration projects have been selected to be evaluated. Seven of these projects have been evaluated in Subtask C regarding the design phase. Several concepts will be used in these projects, such as different types of roof-integrated collectors, transparent insulation for heating and daylighting purposes, and different types of glazing and glazed balconies. An evaluation format has been developed and the first draft of the working document has been prepared.

Subtask F: Improvements of Solar Renovation Concepts and Systems

In Subtask F, a System Specification Format was developed. The participating experts are now completing this format with different system concepts representing interesting concepts, such as glazed balconies with mechanical ventilation, fix shading for wall heating with transparent insulation, facade integrated collector system. More concepts will be added and they will be reported on in a catalogue with systems specifications.

Subtask G: Dissemination of Results

The activities in this Subtask have so far been mainly to co-ordinate the presentations of the Task and to prepare for the publication of the next brochure.

WORK PLANNED FOR 1998

During 1998 the work in Task 20 will be concluded. In Subtask E, the demonstration projects will be evaluated and reported on. In Subtask F, there will be an industry workshop and the system specifications will be outlined in a technical report and a catalogue of systems specifications.

During the EuroSun ´98 in Slovenia in September 1998, a special renovation session is planned and the work of Task 20 will be presented.

LINKS WITH INDUSTRY

One representative from the manufacturing industry, TI wall and glazing elements manufacturer: Ernst Schweizer AG in Switzerland, is participating as a Task expert. Two representatives from engineering consultants companies are participating in the Task.

A workshop is being planned for industry representatives dealing with glazed balconies. The tentative location is in Germany. Task participants also are planning a workshop for collector manufacturers.

REPORTS PUBLISHED IN 1997

Improved Solar Renovation Concepts

This report can be ordered from Architecture et Climat, Université Catholique de Louvain, Place du Levant,1, 1348 Louvain-la-Neuve, Belgium, Fax:+32-10 47 45 44, e-mail: deherde@arch.ucl.ac.be.

Brochure Series:

- *Solar Energy In Building Renovation*
- *Solar Collectors in Building Renovation*
- *Glazed Balconies in Building Renovation*

- *Transparent Insulation in Building Renovation*

These four sixteen-page brochures are distributed together in a wallet and may be ordered from James & James (Science Publishers) Ltd, 35 - 37 William Road, London NW1 3ER, UK, fax: +44-171 387 8998, e-mail: orders@jxj.com. Customers from North America contact: Books International Inc., P.O.Box 605, Herndon, Virginia 20172, U.S.A., fax: +1-703-661-1501

REPORTS PLANNED FOR 1998

Solar Renovation Demonstration Projects
This report will be available from: Esbensen Consulting Engineers, FIDIC, Teknikerbyen 38, DK-2830 Virum, Denmark, Fax:+45-45 83 68 34, e-mail: esb.cph@esbensen.dk

Subtask E Working Document, *Evaluation of Demonstration Projects*

Subtask F, Industry Workshop Proceedings

1997 MEETINGS

Eighth Experts Meeting
March 3-5
Zürich, Switzerland

Ninth Experts Meeting
September 8-10
Leiden, Netherlands

1998 MEETINGS

Tenth Experts Meeting
March 20 - April 1
Denmark

Eleventh Experts Meeting
September 28 - 30
Sweden

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TASK 21:

Daylight in Buildings

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TASK DESCRIPTION

Artificial lighting represents a major part of the overall energy consumption in non-residential buildings. However, more daylight conscious architectural solutions and the introduction of innovative daylighting systems and efficient lighting controls could displace a considerable part of this electricity consumption by utilising the natural resources offered by daylight. Furthermore, it is generally recognized today that the design of the fenestration system and the proper use of daylight in building interiors are important factors, both for the conservation of non-renewable fuels and for the well-being of occupants.

However, a number of barriers hinder appropriate integration of daylighting aspects in the building design. One is the lack of documented, empirical evidence that daylighting can substantially improve energy efficiency and visual quality in buildings. Furthermore there is insufficient knowledge and lack of information on new fenestration technologies and lighting control systems and the ability of such systems to enhance utilization of daylight, and a lack of user friendly daylighting design tools and models for innovative daylighting systems.

Task 21 will contribute to the overcoming of the identified barriers. The Task was initiated in 1995 with the main objectives to advance daylighting technologies and to promote daylight conscious building design. Through selected Case Studies the Task will demonstrate the viability of daylighting designs under various climatic conditions emphasizing system performance regarding energy savings and user acceptability.

The main deliverables from the Task will be:

- A system specific Design Guide on daylighting systems and control systems providing recommendations on systems integration and performance data on energy saving potentials.
- A set of Daylighting Design Tools that will markedly improve the designers' ability to predict the performance of daylighting systems and control strategies and to evaluate the impact of daylight integration in the overall design concept.
- A Case Studies Report, documenting measured data on daylighting performance, energy consumptions and user appraisal of the environmental conditions.

The work of the Task is structured in the following four Subtasks and their lead countries:

Subtask A: Performance Evaluation of Daylighting Systems (Australia)

This Subtask will provide design guidance on the performance of both innovative and conventional daylighting systems. Systems will be assessed according to energy saving potential, visual aspects and the control of solar radiation. The evaluation of systems is to be based not only on technical feasibility but also on architectural and environmental impacts.

Subtask B: Daylight Responsive Lighting Control Systems (The Netherlands)
Energy savings from daylighting cannot be significant without an appropriate integration of window design and electrical lighting systems. The objectives of Subtask B are to evaluate the performance of existing selected daylight responsive lighting control systems (in conjunction with selected daylighting systems) in terms of their capability to control the artificial lighting in response to available daylight and in terms of user acceptance of the systems. This will assist building owners, developers, architects, and engineers to select and commission daylighting responsive systems, and to estimate the potential energy savings at an early stage of design.

Subtask C: Daylighting Design Tools (Germany)
The objective of Subtask C is to improve the capability, accuracy and ease of use of daylighting design and analysis tools for building design practitioners, covering all phases of the design process. The practitioners will be able to predict the performance of different daylighting systems and control strategies and to evaluate the impact of the integration of daylighting in the overall building energy concept by using these design tools.

Subtask D: Case Studies (Denmark)
Despite claims that daylighting can substantially improve visual quality and energy efficiency of buildings, there is little documented empirical evidence. The main objective of Subtask D is to demonstrate the viability of daylighting buildings in various world climate zones as an energy saving potential in buildings while maintaining a satisfactory visual and thermal environment for occupants, and to provide real validation data to computer models.

Example of innovative daylighting system from the Learning Resources Centre, Anglia Polytechnic University, U.K.

ACTIVITIES DURING 1997
While in 1996 much time was dedicated to thorough planning of the testing procedures and monitoring procedures, 1997 was the year when the real testing of systems and the monitoring of case study buildings began. Two experts meetings were held, one in Veldhoven, the Netherlands, and one in Brisbane, Australia. An overview of the work in progress and the achievements in each of the four Subtasks of the past year is given below.

Subtask A: Performance evaluation of daylighting systems
In the past year, nine institutions from seven countries were actively involved in the development of procedures and the first testing of the daylighting systems. Table 1 gives an overview of the systems to be tested at the different institutions. The table shows that the testing of about half the systems began in 1997 while the remaining will be tested in 1998.

Subtask A produced a comprehensive set of working documents of which some eventually will be official Task 21 documents available to design practitioners and industry. The most significant are:

- Daylighting system descriptions (USYD)
- Survey questionnaire (IBUS)
- Monitoring Protocol for Test Room Assessment of Daylighting Performance of Buildings (SBI)

Table 1
Testing of daylighting systems (full scale and/or scale models) in Subtask A.

System	Test Room	Scale Models	Institute	Start time	Status
Louvres/blinds	Yes		BRE (3)	Sep. 96	
			TUB	Jan. 97	
			NTNU	Jun. 98	
			LBNL	Apr. 96	Pilot study
			EPFL	Jun. 96	Pilot study
			BAL	Dec. 97	
Light shelf	Yes		NTNU (2)	Jun. 97	
		Yes	EPFL	Done	Pilot study
			BRE	Done	Pilot study
			LBNL	Done	Pilot study, Scale model
			SBI	Jan. 98	
Laser cut panel	Yes		NTNU	Jun. 97	
Angular selective skylights	Yes		QUT	Jan. 98	
Sun directing glass	Yes		ILB	Mar. 98	
			EPFL	Done	Pilot study
Prismatic panels/films	Yes		BRE	Done	Pilot study
			NTNU	Jun. 97	
HOE - Zenithal light guiding glass	Yes		ILB	Mar. 98	
HOE - Transparent shading system	Yes		ILB	Mar. 98	
HOE- Directional selective shading	Yes		ILB	?	
Light guiding shade		Yes	QUT	Apr. 98	
Anidolic ceiling	Yes		EPFL	Nov. 96	Pilot study
Anidolic solar blind	Yes		EPFL	Nov. 97	
Anidolic zenithal openings		Yes	EPFL	Done	Pilot study
Light Guiding shade		Yes	EPFL	Apr. 98	
HOE Light Guiding Glass		Yes	EPFL	Apr. 98	
Optically treated light pipes		Yes	LBNL	?	Pilot study

- Pilot Study Report on Monitoring of Test Rooms (Draft) (BRE)
- Report on physical characteristics measured in laboratory facilities (TUB)
- Assessment of users' evaluation of lighting conditions in test rooms (SBI, KTH)
- Combined Subtask A and B testing (TUB)
- Outline - Daylight in Buildings - A Source Book on Daylight and Control Systems Part 1 (NTNU)
- Anidolic Ceiling - Technical File (EPFL)

Subtask B: Daylight Responsive Lighting Control Systems
Eight institutions from 6 IEA countries participate in Subtask B. In 1997 the work focused on the completion of the data base of lighting control systems. The detailed monitoring protocol for the testing and evaluation of the systems' ability to control the artificial light as function of daylight availability was adjusted based on experience from the pilot studies, and the real testing began at most institutions.

The number of systems that are planned to be tested is summarized in table 2.

The most significant reports of Subtask B in 1997 were:

- The Daylight Database for Subtask A and B
- Monitoring Procedures for the assessment of Daylighting Performance of Buildings (TUD, SBI) (revised)
- Report on pilot studies (ENTPE)

Measurement of angle-dependent transmittance at Fraunhofer ISE, Freiburg

The angle-dependent solar and light transmittance $\tau_{dh}^{S}(\Theta)$ and $\tau_{dh}^{L}(\Theta)$ have been determined with an integrating sphere using a pyroelectric radiometer and a photometer consisting of a photodiode with a $V(\lambda)$-correction filter glass. The polar angle Θ (incidence angle) had been varied from 0° to 75° in steps of 5°. The hemispherical reflectance ρ_{hh} of the back side of the samples for incident diffuse radiation (originating from the integrating sphere) has been determined for the samples with the Diffuse Radiation Source DRS using a sample port aperture of 10 cm diametre; this value is needed for the second order correction stemming from the change of sphere throughout due to the sample at the measurement port.

Subtask C: Daylighting Design Tools
Twelve institutions representing 10 IEA countries are involved in production and evaluation of daylighting design tools. The collection of daylight algorithms and the established WWW page has become an interesting source of information. The work on simplified design tools has been progressing well on an atria study and graphical method development. The work on the program package ADELINE has focused on the (Task-internal) α-release of a new radiance version with MS Windows NT interface and the development of a common data output module, of which a first draft was discussed at the Experts meeting in Australia.

The most significant products of Subtask C in 1997 were:

- Draft document on pilot study simulations and documentation
- Updated Web-page of daylighting algorithms: http://eande.lbl.gov/task21/subtaskc.html (accessible to Task participants only)
- Draft report on survey of existing Integrated Building Design Systems and STEP toolkits

- Second version of graphical method for assessment of lighting, heating and cooling demands in buildings adjacent to atria
- Survey of Simple Design Tools, Working Document, draft
- α-release of ADELINE of MS Windows NT version

Subtask D: Case Studies
Eleven institutions representing 8 IEA countries are actively involved in the work on monitoring the performance of the Case Study buildings. In 1997 the monitoring on all of the 16 Case Studies started and the whole monitoring programme will be finished in mid 1998. In four of the Case Studies, post occupancy evaluations are being conducted at least over two periods, of which the first was in 1997. The most significant products of Subtask D in 1997 were:

- Draft WD on Case studies Documentation Plan
- Daylighting Monitoring Protocols & Procedures for Buildings, approved by ExCo
- Procedures for POE studies in Case Studies

Mid-Term Task 21 Evaluation
A mid-term evaluation of Task 21 was conducted by sending a questionnaire to all the Task participants. A total of 25 completed questionnaires were received by the OA and documented in a separate report. In short, the Task evaluation revealed that: 1) the planning process was very good and useful, giving fairly clear descriptions of motives, approach, objectives, and milestones;

Table 2
Plan for testing of lighting control systems in test rooms.

Institute	Number of systems to be tested	Type of systems
Helsinki University of Technology, HUT	5	ETAP ELS (P) Servodan system Glamox system (S) Altemberg Lichtkonstanter (C) Helvar Mimo 3 (C)
Ecole Nationale des Travaux Publics de l'Etat, ENTPE (list subject to changes)	3-4	Philips Trios (C) French switching system (S) Thorn local system (P?) Manual control system (i.e. observation of users behaviour) Somfy daylighting control system
Norwegian Electrical Power Research Institute, EFI	4	Helvar Mimo 1 (C) Glamox system (S) Zumtobel Luxmate (P or C?) Siemens system (C)
ENEA, Systems and Components for Energy Savings	1	?
ETAP B.V. - TNO *Artificial lighting control systems:*	5	Philips LuxSense (with ceiling mounted luminaries and with pendant luminaries) (P) ETAP ELS (P) Glamox system (S) Philips Trios (C) Servodan system ? (P?)
Daylighting control systems:	2	Huppe system Warema system (P)
Technische Universität Berlin, TUB	7	Philips Helio (LonWorks) (c) Siemens ETAP ELS Zumtobel - Luxmate (p) - Professional (p) Philips LuxSense (P) Philips Trios (C)
Philips Lighting B.V.	2	Philips LuxSense Philips Trios

Switching systems (S), Stepped systems proportional dimming systems (P), Constant holder systems (C), Closed loop/ Open loop, Central system / Local system.

2) the expertise in Task 21 is very adequate; but 3) the general level of effort must be raised if all the planned objectives are to be achieved on schedule.

WORK PLANNED FOR 1998

The experts of Task 21 will be very busy in 1998. Most of the testing of daylighting systems in full scale and in scale models will be carried out, as well as the monitoring in all case study buildings. The development of the new ADELINE version 3.0 will continue with a planned α-release at the end of the year.

LINKS WITH INDUSTRY

All Subtasks have significant links to industry, and in many participating countries, industry offers significant financial support for work being undertaken. Most of the daylighting systems and lighting control systems are provided by manufacturers, who naturally have an interest in the Task's testing procedures results. In Subtask B on Control Systems, major manufacturers are directly involved in the research activities and are providing excellent facilities for the testing of several systems and strategies. In Subtask C on Design Tools, the development of a common platform for integration of building design tools is partly based on the standards set by the Industry Alliance for Interoperability (IAI). Subtask D on Case Studies is led by a private engineering consultant and has strong links to a similar project under the European Community's JOULE programme. In this Subtask building owners make their buildings available for the Task monitoring and user evaluations. In some cases, the owners have provided unoccupied spaces for direct full scale testing.

Screen image of the common database describing daylighting systems and lighting control systems.

REPORTS PRODUCED IN 1997

Reports

The first official report of Task 21 approved by the Executive Committee was *Daylighting Monitoring Protocols & Procedures for Buildings.* Other reports that were finalized in 1997, but have not yet been approved are:

Report on physical characteristics measured in laboratory facilities

Monitoring protocol for performance evaluation of daylighting systems and lighting control systems in test rooms

Newsletters

Australian Newsletter: International Daylighting

The 4th Newsletter was sent out in September 1997.

Paper Presentations

Several presentations and articles of Task 21 work were presented at various conferences. About 12 papers were presented at the following events:

- Lux Europa in Amsterdam, The Netherlands, April 1997
- Building Simulation '97 in Prague, Czech
- CISBAT '97 in Lausanne, Switzerland
- Right Light in Copenhagen, Denmark, November 1997.

REPORTS PLANNED FOR 1998

The final version of the report on monitoring of physical characteristics as well as the procedures for performance evaluations will be available in 1998. Also in 1998, the first drafts of the final documents for the design guides/source books on daylighting systems and lighting control systems as well as the first draft of the Case Studies book will be produced.

1997 EXPERTS MEETINGS

Fourth Experts Meeting:
April 21 - 24
Veldhoven, The Netherlands

Fifth Experts Meeting
October 28 - 31
Brisbane, Australia

1998 EXPERT MEETINGS

Sixth Experts Meeting
May 1998
Ottawa, Canada

Seventh Experts Meeting
October 1998
Berlin, German

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TASK 22:

Building Energy Analysis Tools

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TASK DESCRIPTION

The overall goal of Task 22 is to establish a sound technical basis for analyzing solar, low-energy buildings with available and emerging building energy analysis tools. This goal will be pursued by accomplishing the following objectives:

- Assess the accuracy of available building energy analysis tools in predicting the performance of widely used solar and low-energy concepts;
- Collect and document engineering models of widely used solar and low-energy concepts for use in the next generation building energy analysis tools; and
- Assess and document the impact (value) of improved building energy analysis tools in analyzing solar, low-energy buildings, and widely disseminate research results to tool users, industry associations and government agencies.

Task 22 will investigate the availability and accuracy of building energy analysis tools and engineering models to evaluate the performance of solar and low-energy buildings. The scope of the Task is limited to whole building energy analysis tools, including emerging modular type tools, and to widely used solar and low-energy design concepts. To accomplish the stated goal and objectives, the Participants will carry out research in the framework of two Subtasks:

Subtask A:
Tool Evaluation

Subtask B:
Model Documentation

Tool evaluation activities will include analytical, comparative and empirical methods, with emphasis given to blind empirical validation using measured data from test rooms or full scale buildings. Documentation of engineering models will use existing standard reporting formats and procedures. The impact of improved building energy analysis tools will be assessed from a building owner perspective.

The audience for the results of the Task is building energy analysis tool developers. 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.

The Task was initiated in January 1996 and is planned for completion in December 1998.

ACTIVITIES DURING 1997

A final Research Work Plan was prepared by the Task Participants and approved by the Executive Committee.

Subtask A: Tool Evaluation

This Subtask is concerned with assessing the accuracy of available building energy analysis tools in predicting the performance of widely-used solar and low-energy concepts. Three tool evaluation methodologies are being employed:

Analytical Tests
Comparative Tests
Empirical Validation Tests

The Energy Resource Station in Ankeny, Iowa, U.S. is a full-scale commercial building test facility being used for the Task 22 "blind" empirical validation exercise.

Work accomplished during 1997 on each of these tool evaluation efforts is summarized below.

- Analytical Tests: A Working Document was completed by the Finnish Task Participants based on information (analytical tests) provided by other participating Task Experts. The Working Document summarizes a variety of closed-form analytical solutions developed to test the accuracy of building energy analysis tools in analyzing specific heat transfer phenomena such as conduction, air flow and shading devices. The Working Document was distributed to tool developers as a set of analytical tests that can be used to ensure the proper modeling of these heat transfer processes.

- Comparative Tests: Using the test cases created in Task 12 as a starting point, a new set of comparative tests have been created to evaluate building energy analysis tools modeling capabilities. The new tests focus on HVAC equipment, zoning and low-energy strategies. Approximately 10 tools are being used in the comparative tests.

- Empirical Validation Tests: Task Participants are engaged in a series of "blind" empirical validation exercises. The first set of exercises uses several test rooms and test houses operated by Electricity of France (EDF). The second set of exercises will be based on a full-scale commercial building test facility. During 1997, the participants selected the Energy Resource Station of the Iowa Energy Center in Ankeny, Iowa as the first full-scale commercial building test facility. The Energy Resource Station completed a series of HVAC tests. The data from these tests will be used in a blind empirical validation exercise.

- EDF has completed a draft final report on the research results from the ETNA and GENEC test rooms. Further analysis of these two test facilities may continue to refine the tests and explore modeling assumptions used by the building energy analysis tools.

Subtask B: Model Documentation
This Subtask is concerned with the collection and documentation of existing engineering models and the creation of a models library accessible by modular tool developers. Task Participants have selected the Neutral Model Format (NMF) as the standard format for "hard" (computer-machine readable) model documentation.

NMF is widely recognized and accepted within the international engineering and model development community. Also, several translators have been developed for converting NMF models into models usable by modular building energy analysis tools. During 1997, Task Participants documented several engineering models in the NMF, translated and ran these models. Also, the Swedish participants created a web site, known as the Simulation Model Network (SIMONE), to store the NMF engineering models and to serve as the link to other web sites where simulation models will be stored. Engineering models documented to date in the NMF by Task Participants include a chiller (TRNSYS type 60), solar collection and domestic hot water system, a single-glazed air collector with a coupled mass wall, and a variety of zone models.

WORK PLANNED FOR 1998

Key Task research activities will be performed during 1998. In Subtask A, Tool Evaluation, the comparative evaluation test cases, will be completed on up to 10 different building energy analysis tools and a draft final report will be prepared. Final reports will be written on the blind empirical validation exercises involving the ETNA and GENEC test rooms and the Lisses test houses. The blind empirical validation exercise will be completed using data from the Energy Resource Station Commercial Building Test Facility. A preliminary report will be prepared summarizing the research results.

In Subtask B, Model Documentation, additional engineering models, such as evaporative cooling and radiative cooling, will be documented in the NMF, and installed in the Models Library server. Existing NMF translators will be used to convert NMF models into models usable by modular energy analysis simulations. The SIMONE web site will be expanded and linked to other web sites, making available the engineering models created under Task 22.

REPORTS PUBLISHED IN 1997

No official Technical Reports were published in 1997. However, the Working Document on Analytical Tests was distributed to the Task Participants and analysis tool authors. Also, draft final reports were created on the ETNA and GENEC test houses. The Simulation Model Network (SIMONE) web site was created and populated with available NMF engineering models.

Task 22 participants touring the Environmental Buildings at the Building Research Establishment in the U.K.

REPORTS PLANNED FOR 1998

Subtask A: Tool Evaluation
HVAC BESTEST Specifications and Comparative Test Results

Final Report on Empirical Validation Exercises – ETNA and GENEC test rooms

Preliminary Report on Results from the Energy Resource Station Blind Empirical Validation Exercise

Subtask B: Model Documentation
Additional Models Documented in Neutral Model Format

SIMONE web site expanded and linked to other web sites

1997 MEETINGS

Third Experts Meeting
April 16-18
Ankeny, Iowa, U.S.

Fourth Experts Meeting
October 8-10
Garston, Watford, U.K.

1998 MEETINGS

Fifth Task Experts Meeting
March 30-April 1
Golden, Colorado, U.S.

Sixth Experts Meeting
September 1998
To Be Determined

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TASK 23:

Optimization of Solar Energy Use in Large Buildings

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TASK DESCRIPTION

Objectives

The main objectives of Task 23 are to ensure the most appropriate use of solar energy in each specific building project for the purpose of optimizing the use of solar energy and of promoting increased use of solar energy in the building sector.

This is done by enabling the building designers to carry out trade-off analyses between the need for and potential use of energy conservation, daylighting, passive solar, active solar, and photovoltaic technologies in systematic design processes.

In addition, the objective of the Task is to ensure that the buildings promote sustainable development. This is done by including considerations of other resource use and of local and global environmental impact in the trade-off analyses to be carried out.

Scope

The work primarily focuses on commercial and institutional buildings, as these types of buildings clearly need several types of systems. In particular, office buildings and educational buildings are addressed. The same issues are relevant for many other commercial and institutional buildings. However, some of these, such as for instance hospitals, require rather specialized design teams and would broaden the scope of the Task tremendously. They are therefore excluded from the Task in order to ensure concentration and focus in the work carried out.

Means

The work in the Task is divided in four subtasks:

A: Case stories
Subtask Lead country: Denmark

B: Design process guidelines
Subtask Lead country: Switzerland

C: Methods and tools for trade-off analysis
Subtask Lead country: USA

D: Dissemination and demonstration
Subtask Lead country: Netherlands

Subtask A provides the knowledge base to be used in the development of guidelines, methods, and tools in Subtasks B and C, while Subtask D ensures that the results of the work are disseminated to the appropriate audiences.

Duration

The Task entered into force on June 1, 1997 and will last five years, until June 1, 2002.

ACTIVITIES DURING 1997

Task 23 has only been active for a few months. Some work was initiated during the Project Definition Phase, however. This work, which consists of developing and presenting a number of Case Stories, is well under way.

The Case Stories are based on the study of a set of low energy and solar buildings and consist of information about how the buildings were designed, about which criteria the designers used in their decision making, and about what energy conservation and solar technologies were eventually chosen. This information is to be used in Subtasks B and C.

Results of the First Experts Meeting

The first official Experts meeting in the Task took place in Glion, Switzerland, on September 11-13, 1997. The main objective of this meeting was to discuss the progress of Subtask A work and to initiate work in Subtasks B and C. The meeting therefore primarily consisted of presentations and discussions of the Case Stories. The emphasis in these discussions was on the results usable in Subtasks B and C. In addition, the meeting included a presentation of a first survey on multi- criteria decision-making methods, and of a computer tool potentially usable for trade-off analysis. After the meeting, most of the participants made a very interesting and informative visit to the two Swiss Case Story buildings, the OFS building in Neuchâtel and the Landis & Gyr building in Zug.

The Case Stories presented at the meeting provided good arguments for the need to develop methods and tools for trade-off analysis. Most Case Story building design teams had attempted to develop designs that included several low energy and solar technologies, and they had struggled with many, often conflicting, criteria when making their decisions. Based on the Case Stories, a list of the criteria most often used has been developed, they are:

The Brundtland Centre in Denmark, one of the Task 23 Case Story buildings.

- annual energy use
- annual energy cost
- construction cost
- operation and maintenance cost
- life cycle cost
- maintainability
- thermal/visual comfort
- indoor air quality
- materials and resource use
- environmental impact
- flexibility
- functionality
- aesthetics
- PR value (corporate image)
- regulations
- demand on energy infrastructure

It will probably be impossible to include all these criteria in the methods and tools to be developed in the Task. The list will therefore be reevaluated at the next Experts meeting in order to select those criteria that can potentially be used. This exercise will include ranking the criteria in order of priority.

Summary of Completed Work

- A program of work for the whole Task has been produced.
- An initial set of 20 buildings to be used for Case Stories has been selected.
- A format for presentation of the Case Stories has been developed.
- First drafts of 12 of the Case Stories have been produced.
- The lessons learned in the Case Stories have been presented and discussed.
- Plans for conducting a survey of existing design process guidelines have been finalized.
- The decision-making criteria used in the design of the Case Story buildings have been identified.
- An initial survey of multi-criteria decision-making methods has been carried out and presented.
- A candidate computer based tool has been presented.
- Plans for conducting a survey of existing methods and tools have been finalized.

WORK PLANNED FOR 1998

In 1998, the work in Subtasks B and C, on the actual development of guidelines, methods, and tools, will start. In addition, some time will be spent on developing and discussing concrete plans for the work in Subtask D, on dissemination and demonstration. The main activities are:

- A second set of Case Stories will be documented, presented, and discussed.
- The design processes used in the design of these Case Story buildings will be documented and evaluated.
- A survey of existing design process guidelines will be conducted.
- The development of a Task 23 design process guideline will start.
- A survey of existing multi-criteria decision-making methods and of existing computer based tools for trade-off analysis will be conducted.
- The decision-making criteria to be used in the methods and tools to be developed in the Task will be selected.
- The development of a Task 23 multi-criteria decision-making method will start.
- Candidate computer based tools will be presented and evaluated, and a tool will be selected for further development into a Task 23 tool.
- Development of this tool will start.
- A brainstorm on ideas for dissemination and demonstration of the Task results will be conducted.

REPORTS PUBLISHED IN 1997

IEA Task 23: Optimization of Solar Energy Use in Large Buildings. Programme of Work

The Optimization of Solar Energy Use in Large Buildings - a New IEA Task," Proceedings of ISES Solar World Congress, Taejon, Korea, 1997

MEETINGS IN 1997

Second Project Definition Phase workshop
February 3-4, 1997
Toftlund, Denmark

First Experts meeting
September 11-13, 1997
Glion, Switzerland

MEETINGS PLANNED FOR 1998

Second Experts meeting
March 2-4, 1998
The Netherlands

Third Experts meeting
October 22-24, 1998
Vancouver, Canada

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Working Group on Materials in Solar Thermal Collectors

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DESCRIPTION

The Working Group was established in the autumn of 1994 as an extension of work which had been conducted on solar collector absorbers in Subtask B of Task 10 (Solar Materials R&D).

The objectives of the Working Group are:

- To develop or validate durability test procedures for solar collector materials.
- To generalize test procedures for standardization.
- To develop guidelines for solar collector design to achieve the most favorable microclimate conditions for materials.

The following areas have been identified for joint research work:

- Durability and life-time assessment of solar absorber coatings.
- Antireflecting devices for solar thermal applications.
- Methods for characterization of microclimate for materials in collectors.
- Durability aspects on the use of polymeric materials in solar collecting devices.

In each of these areas a number of well defined projects are being conducted. The activities of the Working Group were initiated in October 1994 and will conclude in October 1998. The leadership of the working group was handed from Bo Carlsson (Sweden) to Michael Köhl (Germany) according to a respective agreement at the start of the work.

ACTIVITIES DURING 1997

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

- Project A2: An interlaboratory comparison on durability testing of absorber coatings was executed to refine the test procedures for the service life estimation of solar absorber coatings so that the reproducibility of tests can be further improved.
- Project A3: The experiences gained in project A2 were used for recommended test procedures for the service life estimation of solar absorber coatings in the form of a draft international standard proposal in ISO TC 180, number ISO CD 12 952.2. The final report was approved by the Working Group.
- Project A5: The interest in evacuated collectors is growing. A new project initiated will develop durability test methods according to the appropriate degradation factors and load profiles.

B: Antireflecting Devices for Solar Thermal Applications

- Project B1: A state-of-the-art report was prepared to be used for selecting materials for further studies. This review covers both cover plate materials, such as soda lime, low iron, borosilicate glasses, and transparent polymeric materials, such as acrylic, fluorocarbon, polycarbonate and polyester thin sheets and foils. The next phase of work will focus on cost benefit analysis of the materials selected.
- Project B2: During the second phase of work, optical properties of selected materials were mea-

sured, accelerated tests for durability assessment of materials were drafted, and samples of iron-free glass and PMMA with anti-reflected surfaces were prepared for outdoor-tests.

C: Methods for Characterization of Microclimate for Materials in Collectors

- Project C1: A round robin test on test procedures for the assessment of rain tightness and air tightness of collectors was initiated in the autumn of 1995. These procedures are being discussed in the work of CEN and ISO on solar collector testing.
- Project C2: Two different approaches for the simulation of ventilation and condensation in flat plate collectors were developed. Both the Danish model, based on an analytical physical model, and the German approach, based on numerical computational fluid dynamics, showed very good agreement with measured data.
- Project C3: The final report was approved by the Working Group.
- Project C4: The measurement of microclimate parameters in collectors started in June 1996 at outdoor test facilities and continued until June 1997. Work continues on the evaluation and interpretation of the data.

LINKS WITH INDUSTRY

All participants of the Working Group work closely with solar material and solar collector manufacturers, therefore, many industry representatives participate indirectly in the work being undertaken. There are also informal links to industry via the ongoing standardization work on solar collector and solar collector materials in CEN TC 312 and in ISO TC 180. Efforts also are being made to establish a liaison with CEN 312 in the area of solar collector materials.

REPORTS PUBLISHED

A list of working documents can be obtained from the Working Group Leader on request.

1997 MEETINGS

Fifth Experts Meeting
June 6-7
Held in conjunction with the North Sun '97 conference in Helsinki, Finland.

Sixth Experts Meeting
December 1-3
Golden, Colorado, U.S.

1998 MEETINGS

Seventh Experts Meeting
April
U.S.

Eighth Experts Meeting
September
Switzerland

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