PREVIOUS CONTENTS NEXT

IEA SHC Solar Activities in IEA Countries Report 1993

Table of Contents

Report Overview

Each country's assessment of the national outlook for solar energy building technologies.

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

PREVIOUS CONTENTS NEXT

IEA SHC Solar Activities in IEA Countries Report 1993

Report Overview

Sheila Blum
International Planning Associates

OVERVIEW OF SOLAR ENERGY ACTIVITIES IN IEA COUNTRIES

The papers in this report on national solar building technology activities in the member countries of the IEA Solar Heating and Cooling Program provide insights into the status of government policies, funding levels, research emphasis, technology advances, and commercial development. Some of the trends and developments in these areas for active solar, passive solar, and photovoltaics for buildings are summarized below.

ENVIRONMENTAL CONCERNS AND NATIONAL ENERGY POLICIES

The primary motivation for development of alternative energy sources is no longer energy supply, energy security, or trade deficits. Since 1988, it has been clear that the driving force in energy policy in most IEA member countries is concern for the environment. There is strong public pressure in many countries--Austria, Denmark, Germany, Japan, Netherlands, Switzerland, for example--to reduce damage to the environment resulting from the use of fossil fuels. Moreover, at the 1992 UN conference in Rio, many countries committed themselves to significantly reducing their CO^2 emissions which will require a variety of measures, including the use of solar energy and other renewable energy technologies to the greatest extent possible. In order to develop reliable and cost-effective renewable energy technologies to help achieve their goal of greater use of cleaner, environmentally-friendly energy, many countries have increased funding for renewable technologies research, development, demonstration, information and market promotion activities.

RENEWABLE ENERGY BUDGETS

It is difficult to discern any clear trend in funding by IEA governments for renewable energy, and solar energy for buildings in particular. While some countries, such as Germany and Switzerland, have large solar energy budgets and have seen funding increase steadily for many years, others have experienced a budget reduction as a result of the recession and government cost-cutting measures. These countries include Canada, Sweden, New Zealand, and Norway. Other countries, Finland, France, Italy and Spain, continue to have small but steady active and passive solar budgets. A final category could be called "newly-resurgent budgets" which comprises two key countries, the United States and Japan. Their increased funding and government support for renewable energy may once again serve as a catalyst for other countries.

The PV budgets in all countries have increased, irrespective of the funding trends for other renewable energy technologies. The exceptions are Belgium and Denmark which have no PV funding.

State/regional/provincial/local governments in many countries also fund solar energy R, D & D activities which significantly supplement the national budgets, but specific amounts were rarely noted in the country papers. Moreover, industry funding is becoming an increasingly important factor in many research programs. (See below for more information.)

While the funding for solar building technologies (and renewable energy in general) has, in some cases, fallen or has remained small in certain others, many countries have clearly learned to do "more with less." The papers in this report demonstrate that, despite limited budgets, they are carrying out some significant activities which are well-focussed on key problems.

Table 1 provides figures on government funding for various renewable technologies in 1992 and 1993. The funding for active and passive solar combined in the 19 countries was $US 68.8 million in 1992 and $US 71.1 million in 1993 (excluding Australia). Total funding for all renewable energy technologies was $US 806.5 million in 1992 and $US 815.6 million in 1993.

MAJOR TECHNICAL ADVANCES

A review of the papers reveals significant work underway on advanced windows, advanced solar buildings with very low energy consumption, solar hydrogen systems, advanced storage technologies, transparent insulation, new integration techniques for PV in buildings, integrated thermal collector roof assembly, advanced industrial process heat systems, high performance thermal insulation materials, a chemical heat pump to boost heat from conventional collectors, combined daylighting/PV building elements, and a new generation of central solar heating plants with seasonal storage.

Information on these and other technical developments can be found in the individual papers.

PASSIVE SOLAR DESIGN VIEWED AS LOW COST OPTION

As indicated in the national papers, passive solar technology is viewed by many countries as an energy option with great potential and cost-effectiveness. At the same time, however, it is difficult to gauge the current extent of usage, whether designs employed are effective, and how much energy is saved. National programs and several IEA Solar Heating and Cooling tasks are providing the knowledge and guidance needed by designers and builders to ensure that passive solar buildings perform properly.

A great deal of "anecdotal" data on the popularity of passive solar design exists, but there is little hard data on the number of buildings incorporating passive features. There is even less information to help distinguish between those which were properly designed and operate well those which simply have large windows or sunspaces.

Nevertheless, passive solar techniques are so widely utilized in Finland in both residential and commercial/institutional practice that they are now widely accepted in the building sector in that country. In United Kingdom, passive solar strategies are seen as the energy technology with the greatest short term potential, and major efforts are in place there to actively promote passive solar and to ensure that passive solar measures are correctly applied. These include (1) the Energy Efficiency Office's Best Practice Programme which has incorporated results of the passive solar work so that passive solar can become part of an integrated energy-conscious design message and (2) the Energy Design Advice Service which gives designers of new or renovation projects a day of free consultation from experts on passive low energy design.

A New Zealand study has estimated that, "The cheapest source of energy is passive solar heating....which by 2002 could be reducing the nation's electricity demand by 240 GWh for costs of less than NZ$ 0.01/kWh." In Belgium and Austria, passive solar design concepts are used extensively by architects, and in Spain, with the development of computer models and guidelines for designers, conditions are seen as optimal for the early expansion of passive applications.

ACTIVE SOLAR SYSTEMS - HIGHER QUALITY

Many countries are reporting that the quality of solar DHW systems has increased significantly. They are more efficient and reliable, and, as a result, consumer confidence has increased. Active solar systems are also less expensive than in the past. However, because a mass market has not yet been established, significant cost reductions have not been possible, and this remains a barrier to wider use. Nevertheless, in certain countries with subsidy programs and major promotion campaigns, the active solar market has increased substantially in the past few years.

USE OF PV INCREASING

Interest appears to be increasing in distributed applications of photovoltaic systems and decreasing in large-scale, centralized, PV electricity generation. This means greater interest in building applications of photovoltaics, both grid-connected and stand-alone.

The use of small PV systems for vacation homes has become quite common in much of Europe. In Norway alone, over 55,000 of these systesms have been installed while large numbers have been installed in Finland, Switzerland, and Italy, among others. In the French overseas territories, more than 4500 families live in homes with PV power systems. R & D is underway in national programs and in the IEA Solar Heating and Cooling Program to expand the use of PV for buildings beyond vacation homes and other remote applications.

STRONG INDUSTRY INVOLVEMENT IN R & D

A decade ago, most research and development for solar energy was undertaken at government laboratories, universities and research institutes. While these organizations are still involved, industry participation is much greater now than in the past. Close cooperation with industry is seen to promote technology transfer and faster utilization of R & D results and increase the likelihood that the resulting products will be appropriate to market needs.

In Finland, for example, R & D is directed to areas that interest Finnish industries, and funding is increasingly allocated through 50-50 cost-shared projects. While industry funding was almost non-existent in Norway five years ago, in 1993 industry contributed over NOK 9.5 million for solar energy R & D, which is 70% of the government funding level, and projects in industry now have the highest priority. Moreover, an industry review committee must approve all new R & D projects. In Canada, Germany, the Netherlands, Sweden, as well as many other IEA member countries, industry cost-shared projects are also a major element of their research programs.

INFORMATION ACTIVITIES GIVEN HIGH PRIORITY

A wide range of information, education, training, and technology transfer activities for solar energy technologies have been undertaken in IEA member countries. These promotional and educational activities are aimed at various target audiences: the general public, building owners, researchers, manufacturers, architects, consulting engineers, builders, utilities, and so on. These activities range from information campaigns in the media, to brochures, handbooks and design guidelines, seminars on system design, training courses for installers, and other information and education mechanisms.

France provides one interesting example. To help users make good energy-conscious decisions, their program uses a number of information instruments: brochures, booklets, targeted campaigns and information on the Minitel (videotext). In addition, a unique training project was initiated which utilizes a mobile PV facility, called PHOTON, for practical training of electricians, fitters and others in 6-day training courses. Since this approach has proved to be very effective, an equivalent facility for active solar, to be called HELIOS, is being prepared for training of plumbers and other building craftsmen.

An effective campaign was undertaken in the Netherlands to promote solar water heaters through advertisements on the radio and in newspapers ("Switch on the sun for a better environment") and through support of the market introduction activities of utilities, municipalities and installation firms. After two years of the campaign, 6000 solar DHW systems have been installed on Dutch roofs.

A final example, although many other interesting activities could be cited, is the Passive Solar Remodeling Guidelines prepared in the United States by the Passive Solar Industries Council and its member organizations, which follows up on the success of the Passive Solar Builder Guidelines (for new residential buildings).

GOVERNMENT INCENTIVES & THEIR IMPACT

The national governments of eleven out of the nineteen countries reporting have financial incentive programs in place to subsidize the purchase of solar energy systems, particularly active solar systems. These take the form of direct grants, loans at favorable interest rates, and tax credits. In some cases, regional governments provide subsidies instead of, or in addition to, national incentives. In certain cases (e.g., Denmark, Italy, Netherlands, Spain, Switzerland), the subsidy is dependent upon the energy performance of the system; this is probably the best way to subsidize solar. Table 2 provides a complete listing of the national incentive programs.

The effects of incentive programs vary, and to a large extent there is not enough data to accurately judge the impact of subsidies. However some general conclusions can be drawn and some specific examples cited. Denmark and the Netherlands have had highly successful experiences. In Denmark, as a result of the 25% subsidy and concentrated campaign by the Agency of Energy, 2000 solar DHW systems were installed in 1992 (double the number in 1989 and 10 times the number in the mid-1980's). A similar campaign in the Netherlands, together with a government subsidy, resulted in the installation of 4500 solar DHW systems in 1993. (Four hundred per year was the average until 1990.)

While incentive programs have been very effective in parts of northern Europe, the outcome has been different in southern Europe, where the solar resource is higher and one would assume a greater potential exists for solar energy technology. In Italy, for example, despite a generous tax credit of up to 50% for renewable energy technology installations, the market has not reacted as expected. Two contributing factors may be lack of willingness of end users to assume the financial risk and public preference for energy saving measures that rely on heating plant controls (e.g. operating time reductions) rather than on new equipment or modification of building structure.

Similarly, while Spain provides a subsidy of 16,000 pts/m2 for active solar systems, the market has not grown as predicted. It seems that larger incentives may be needed, as well as a quality assurance program and a mass promotional campaign.

Perhaps the lesson that can be drawn is that a subsidy alone is not sufficient; a concerted promotional campaign plus awareness of national cultural issues and preferences are also required for successful market development.

France reports that when its active solar subsidies were terminated in 1986, the market declined rapidly. In Australia, the policy is to let market forces prevail, and, given the climate and low energy prices, it is difficult for solar technologies to compete. A similar free market approach is also in effect in Canada, New Zealand, U.K. and the U.S at the present time.

SOLAR MARKET ACTIVITY

The bad news is that the global recession and low conventional energy prices have negatively affected the market for solar energy systems. The relatively high cost of solar equipment, resistance to change, lack of familiarity with solar technologies, and the need for design guidelines have been further impediments. The good news is that the solar industry is still alive and well in many countries!

In the active solar area, despite the barriers mentioned, sales are increasing in about eight of nineteen countries. The success stories tend to be in those countries which have instituted major promotional and incentive programs for solar DHW systems (e.g. Germany, Denmark and Netherlands). Japan writes of a decrease in the market, but nearly 600,000 m^2 of collectors, including the low temperature thermosyphon type, were manufactured there in 1992.

Although the number of collector and active system manufacturers has declined over the past decade in all IEA member countries, the survivors tend to be the stronger companies which are providing better products. Increasing interest of utilities in solar technologies may be a catalyst for a stronger market. In addition, the successful work of do-it-yourself collector building groups has been an important force in Austria and Switzerland.

Interest in passive solar design among the public and designers is reported to be high in quite a few countries. Interestingly, several of these tend to be countries where the active solar market is almost non-existent: Belgium, Finland, and Norway, for example. Training courses, design handbooks and seminars are successfully utilized in many countries to familiarize designers and builders with passive solar design strategies.

The big players in PV manufacturing are U.S., Japan and Germany; others, including Australia, France, Italy, the Netherlands and the U.K., have smaller but significant production levels. Companies in Canada and Sweden have recently begun cell and module manufacturing, and others import and assemble PV components. A major market exists in Europe for small PV systems for vacation homes which number over 75,000 installations. There is clearly a vast potential market for PV in buildings if costs can be further reduced.

See Table 3 for more information on market activity.

OUTLOOK

Each country has provided an assessment of the national outlook for solar energy building technologies. A brief synopsis of the various national perspectives on opportunities and obstacles is presented below.

AUSTRALIA: Outlook is generally positive and opportunities exist in niche markets, but must overcome the obstacles of low conventional energy prices, absence of legislation on energy efficiency, and unwillingness of architects and builders to embrace energy as a key criterion of building design.

AUSTRIA: Despite stagnation of energy prices which has weakened interest in solar technology, the overall positive market development is encouraging. The share of renewables (excluding hydro) in end use energy rose from 7.5% in 1983 to 15% in 1991, and national research policy has made a long term commitment to the development of new energy technologies.

BELGIUM: Active solar is in a major decline, but passive solar is used extensively and has major public support.

CANADA: Outlook for solar energy use in buildings and other applications is positive with growth in sales in all technology areas, in both domestic and international markets. Reduction in costs coupled with increasing energy costs, the trend to higher efficiency standards, greater utility involvement, and increasing concern for the environment are helping to reduce market barriers.

DENMARK: Yearly sales of solar heating systems are increasing dramatically, primarily as a result of government information programs and quality assurance activities which have contributed to increased consumer confidence. Goal is to reach annual sales of 5000 solar DHW systems, which is the level at which manufacturers claim they can reduce costs by 25% and secure the future market.

FINLAND: Solar energy technologies could contribute 5 - 10% of building energy demand without causing large disturbances in infrastructure. For the medium term, niche markets need to be found. Passive solar design and PV for vacation houses have developed well-established markets and are commonly accepted. Seasonal storage solar district heating systems are a promising medium-to-long term option. Government's long term view is positive and helpful.

FRANCE: Market penetration of solar thermal (active solar) and PV remains very low and only limited niche markets have been developed (e.g., PV for remote areas). Adoption of solar technologies has suffered from low energy prices. Passive solar technology does not face the same economic barriers, but lack of user demand is a problem.

GERMANY: The present situation is quite favorable for renewables. Public support for renewable is high because of interest in protecting the environment. Confidence in solar technologies is much higher than 10 years ago, but there is still a need for improved cost-effectiveness.

ITALY: Despite disappointing past experience in bringing solar technologies to the market, there are several reasons for optimism: favorable climate, public interest in solar energy and energy conservation, the positive attitude of designers and the solar industry which recognize the need for better and more reliable products and designs, and growing awareness of the need for more serious interventions if energy savings goals are to be achieved.

JAPAN: The New Sunshine Program reflects the strong determination and commitment of the government to achieve sustainable growth and address serious energy and environmental issues. Large, innovative projects and a large budget are features of the new program. New targets for future contributions from solar are expected to be higher than in the past.

NEW ZEALAND: The climate and low energy prices are not particularly favorable to adoption of solar technologies on a large scale. However, a recent study prepared for the Ministry of Commerce indicated that passive solar heating is the cheapest source of energy, and widespread utilization could reduce the nation's electricity demand by 240 GWh (0.79% of total) for less than NZ $0.01/kWh.

NETHERLANDS: The outlook seems fairly bright. The national goal is for 15,000 active solar installations annually within a few years and total PV installed capacity of 250 MWp by 2010. To ensure continued technology improvements and market development, collaborative agreements between government, utilities, and industry are deemed important.

NORWAY: The potential for solar heating in Norway by 2030 is estimated to be between 5 - 25 TWh, depending upon future cost of conventional energy, technical developments, and competitive alternatives. A special government program was initiated to promote use of solar heating through successful demo projects. There is also a need to educate builders, architects and consulting engineers.

SPAIN: Passive solar technology is beginning to play an important role and is expected to make a meaningful energy contribution in the future. The creation of a significant market for active solar technology requires an institutional market to ensure basic demand, economic incentives, quality assurance, and promotional campaigns.

SWEDEN: The main barrier to market penetration is cost and, secondarily, the need for further technical development in some cases, but there are strong indications that further cost reductions and efficiency improvements are possible. Solar group heating plants and district heating have the potential of contributing 13 TWh/year, which is approximately 25% of the heat now delivered through the district heating network (which supplies around 55% of the total heating demand in the building sector.)

SWITZERLAND: Support for solar energy remains strong despite reduced willingness in the public and private sectors to invest in solar installations. Solar technologies have reached a state of reliability and efficiency that allows them to be considered normal building components. An energy tax is now being discussed which could provide increased funding and incentives for solar energy.

TURKEY: Solar energy could make an important contribution to reducing the trade deficit from imported oil and displace significant amounts of fossil fuels. Barriers to widespread use of solar energy in buildings include the need for passive solar guidelines, demands by owners for unrealistically short payback period for solar and other energy saving measures, lack of importance to municipalities and housing cooperatives. Building regulations need to be revised to encourage use of passive solar heating principles.

UNITED KINGDOM: Passive solar design is viewed as the technology with the greatest short term prospects and is now heavily promoted in the marketplace. PV systems are being assessed to confirm applicability and technical feasibility; small-scale distributed PV systems may be attractive. Solar-assisted district heating schemes may have application in the future if cost reductions are achieved and barriers to district heating overcome.

UNITED STATES: The outlook for renewable energy and solar building technologies is brighter than it has been for a number of years. This is due to increased government support and favorable energy and environmental positions of the current administration as well as increasing support by utilities. The Energy Policy Act of 1992 calls for demonstration of commercial applications of solar DHW and an advanced buildings program. A 20% increase in the use of renewables by 2010 is projected.

TABLE 1: GOVERNMENT FUNDING FOR RENEWABLE ENERGY - 1992 & 1993 (IN $US THOUSANDS)

(for Research, Development, Demonstration and Information)

COUNTRY	ACTIVE		PASSIVE		PV		HIGH TEMP SOLAR THERMAL		WIND		BIOENERGY		OTHER		TOTAL R.E.	
	1992	1993	1992	1993	1992	1993	1992	1993	1992	1993	1992	1993	1992	1993	1992	1993
AUSTRALIA (1)	-	(19)	1070	(19)	189	(19)	837	(19)	-	-	-	(19)	887 (2)	(19)	2983	2800 (19)
AUSTRIA	240	260 (20)	380	300 (20)	1140	800 (20)	-	-	110	100 (20)	1930	1700 (20)	40	30 (20)	3840	3190 (20)
BELGIUM	-	-	200	500	-	-	-	-	-	-	-	-	-	-	200	500
CANADA	600	520	750	670	750	820	-	-	520	450	1720	2470	1420 (3)	670 (3)	5760	5600
DENMARK	3000	3000	2000	2000	-	-	-	-	1500	1400	900	1000	-	-	7400	7400
FINLAND	100	120	720	720	900	900	-	-	1100	1100	6500	7000	-	-	9320	9840
FRANCE	2300	3300	600	600	5500	6000	100	100	1200	1900	5000	4200	5000 (4)	5000 (4)	19700	21100
GERMANY	18750 (5)	18750 (5)	(5)	(5)	59300	60620	8400	6200	15900	22500	24600	4000	56300 (6)	56600 (6)	183250	168670
ITALY	100	300	200	1060	46600	53300	700	70	13300	14500	4200	18200	-	-	65200	87430
JAPAN	2800	3150	1200	1460	58800	76000	-	-	8900	8900	230	240	44700 (7)	46190 (7)	116630	135940
NETHERLANDS	7000 (8)	6500 (8)	(8)	(8)	7000	7000	-	-	23800	23800	4300	4300	2300 (9)	2300 (9)	44400	43900
NEW ZEALAND	5	11	69	43	3	5	3	5	1120	118	81	65	1280 (10)	1250 (10)	2561	1510
NORWAY (11)	1250	1180	590	370	370	370	-	-	1780	630	2010	1940	1480 (12)	1180 (12)	7480	5670
SPAIN	790	0 (21)	770	800	4700	2000 (21)	3570	3800	14220	570 (21)	4870	2460 21	16400 (22)	0 (21)	45320	9630
SWEDEN	2300	2300	300	300	300	400	40	40	3100	7000	6700	10000	200 (13)	200 (13)	12940	20240
SWITZERLAND	6400	5900	6400	7800	8600	9000	5700 (18)	9100 (18)	400	100	4300	6800	2900 (14)	3600 (14)	34700	42300
TURKEY	97	200	70	150	183	370	-	-	128	170	-	5	120 (15)	250 (15)	598	1145
UNITED KINGDOM	18	75	3100	3300	294	270	-	-	13000	10800	4800	4400	14100 (16)	15800 (16)	35312	34645
UNITED STATES	2700	2800	1900	2700	60400	64700	28800	26300	21300	23400	38900	47100	42000 (17)	41600 (17)	196000	208600
TOTALS	48450	48366	20319 (23)	22773 (23)	255029	282555	48150	45615	121378	117438	111041	115880	189127	174670	795586	812103

NOTES TO TABLE 1:

1. Funding by state govts, utilities and other organizations will approx. double the funding.
2. Thermochemical Storage: 210; Assessment: 340; Balance-of-System Components: 340.
3. Advanced House Demo: 1050 and 450; Small Hydro: 370 and 220.
4. Geothermal: 4300 and 4300; Small Hydro: 700 and 700.
5. Includes active, passive and energy conservation in buildings.
6. Southern Climates: 15310 and 16250; Hydrogen: 20900 and 20600; Energy Conservation in Industry: 9400 and 8100; Geothermal: 3700 and 3700; Others: 6900 and 7800.
7. Geothermal: 44600 and 41800; Ocean: 150 and 150.
8. Active and passive solar combined.
9. Geothermal & Aquifer Storage: 2200 and 2200; Small Hydro: 100 and 100.
10. Geothermal: 1242 and 1242; Wave: 38 and 5.
11. Industry funding adds an additonal 70% to these figures.
12. Wave: 690 and 740; Social aspects: 690 and 740.
13. Geothermal
14. Geothermal: 2800 and 2100; Mini Hydro: 100 and 1500.
15. Geothermal
16. Geothermal: 1800 and 1500; Tidal, Wave, Hydro, Marketing: 12300 and 14300.

17. Ocean: 1970 and 947; International: 2000 and 1945; Technology Transfer: 973 and 1945; Geothermal: 26878 and 22812; Hydro: 1028 and 1050; Storage Systems: 7209 and 10041; Policy & Management: 1905 and 2859.
18. For solar chemistry only, not electricity production.
19. Total funding available for 1993 is approximately $US 2800000. Actual funding commitments for the individual R.E. technologies is not yet known.
20. 1993 figures are estimates only.
21. R & D only.
22. Geothermal and Mini-hydro.
23. It should be noted that in Germany and the Netherlands the passive solar budget is combined with active solar.

TABLE 2: GOVERNMENT INCENTIVE PROGRAMS FOR SOLAR TECHNOLOGIES

COUNTRY	INCENTIVES
AUSTRALIA	None
AUSTRIA	National: Tax benefits for solar systems. Provincial Governments: subsidies of 20% for bioenergy, solar and heat pump systems.
BELGIUM	None
CANADA	None
DENMARK	Subsidy of 25% of system cost depending on performance.
FINLAND	Subsidy of 40% of system cost.
FRANCE	In overseas departments: 12-15% subsidy for solar DHW; also subsidies for PV. Some regions in south of France and Corsica: demo program for solar DHW in residential or community bldgs.
GERMANY	Budget of DM 10 million for active solar subsidies in 1994. Demonstration programs of the states totalled DM 25 million in 1992. Under the "1000 roof program," subsidies of 70% (budget of DM 50 million) have been granted for installation of more than 2000 grid-connected roof-integrated PV systems of 1 - 5 kW.
ITALY	Tax credit of up to 50% for renewable energy installations. Grants of up to 40% by provincial governments.
JAPAN	Five year low-interest loans for active solar. Subsidy of 50% for solar, heating, cooling, and DHW systems on schools, hospitals and other public buildings.
NETHERLANDS	Subsidy of up to DFI 600/m^2 (up to 3 m^2) for active solar systems (1994 subsidy may be based on system performance); PV subsidy of 8 Dfl/Wp (6 DFI for 1994) for min. 160 Wp capacity.
NEW ZEALAND	None
NORWAY	Grant of 2.50 NOK/kWh for solar installations, excluding crop dryers.
SPAIN	Subsidy of 16,000 pts/m^2 for solar systems of <20m^2, 3000 pts/m^2 if >50m^2. 20% subsidy for energy cons. in bldgs. including passive solar. Roof-mounted, grid-connected PV receives subsidy of 1200 pts/Wp. Local & regional governments subsidize passive solar systems.
SWEDEN	Subsidy of 35% for smaller solar thermal systems and 25% for larger systems, e.g., district heating.
SWITZERLAND	Subsidy of SFr300/m^2 for solar DHW in apartment blocks; SFr5000 per kWp for PV on school buildings; renovation of public buildings subsidized. Cantons offer additional subsidies.
TURKEY	None
UNITED KINGDOM	None
UNITED STATES	None, except for energy efficient mortgages. Certain states give tax credit for solar installations.

TABLE 3: COMMERCIAL ACTIVITY IN SOLAR BUILDING TECHNOLOGIES

COUNTRY	STATUS
AUSTRALIA	Several major, long-established solar DHW system manufacturers. Two PV manufacturers. Total of over 300,000 DHW systems installed but recession and low energy prices hurting active solar market.
AUSTRIA	Steady increase in solar system installations; 140,000 m^2 in 1992, 60% for DHW, 40% swimming pools. Do-it-yourself groups responsible for 50% of installed collectors. 350 kWp of PV installed through 1992.
BELGIUM	Three active solar companies but little activity. Many sunspaces retrofitted to existing houses.
CANADA	15 small and medium active solar companies. S-2000 Program for residential solar water heating has generated significant utility interest; goal of 10,000 installations by 2000. Sales of perforated solar air collector ("Solarwall") increasing. Total PV installed capacity 800 kWp. First cell manufacturer began production 1993.
DENMARK	Eight small active solar heating manufacturers. Remarkable increase in installations: 100-200/year between 1982-88, 2000 in 1990!
FINLAND	Negligible activity for solar DHW. Thousands of PV systems sold annually for vacation homes; passive solar techniques widely applied in residential bldgs and large glazed sunspaces in shopping and recreation centers. Passive is supported by extensive industries in building & insulation materials and HVAC industry.
FRANCE	Active solar manufacturers down from 30 (early 1980's) to 6 or 8. 13,000 m^2 manufactured in 1992 and 10,000 m^2 unglazed collectors for swimming pools. One manufacturer selling advanced windows. 3 PV manufacturers (2.5 MWp in 1992).
GERMANY	Market has expanded significantly in past few years, but is not yet stable. Lack of reliable yearly production and installation figures. About 100,000 - 150,000 m^2 of solar collectors installed annually in 1991 and 1992 including swimming pool absorbers. About 15 small and 25 larger active solar companies.
ITALY	Fewer than 10 active solar manufacturers. In 1980s collector production exceeded 80,000 m^2 annually, but now down to 5,000 m^2 per year. Sales could increase through establishment of energy service companies which would assume the risks. 2 MW of PV have been installed on 4000 remote homes.
JAPAN	Solar industry has declined since 1981 due to low oil prices and recession. 18 solar component manufacturers and 20 packaged system manufacturers. In 1992, 600,000 m^2 of collectors were manufactured, including the thermosyphon type. Total of 400,000 active solar DHW installed to date (excluding thermosyphon systems which number a few million).
NETHERLANDS	More than 10 companies involved in active solar manufacture and sales. Sales have been growing sharply and are expected to rise from 4500 in 1993 to 15,000 in a few years. Utilities are playing crucial role. 2 PV manufacturers and several modules importers; installed capacity at end of 1992 was 1.3 MWp.
NEW ZEALAND	8 solar water heater companies, up from 3 two years ago. Market increasing because of interest in energy conservation, lower interest rates, and shortage of hydropower in dry year.
NORWAY	Active solar market very limited; total of 250 solar heating systems installed. Over 55,000 PV residential systems of 50-60 Wp installed, with annual sales of 5,000 systems.
SPAIN	Six collector manufacturers--more than needed for present market. 300,000 m^2 collectors installed through 1992 but market has declined because of low oil prices. Two PV manufacturers (about 1 MW/year) which exceeds national demand.
SWEDEN	Commercial activities have decreased as have the manufacturers (fewer than 5). 70,000 m^2 of absorbers produced by one manufacturer in 1992 and most were exported. PV production began in 1992; production capacity 4.5 MW/year.
SWITZERLAND	Over 50 companies manufacture, import, and install active and PV system, plus 55 architects and consultants who design and engineer systems. 139,000 m2 of collectors were installed in 1992 (9,000 installations), plus 96,000 m^2 of swimming pool collectors and 330,00 of collectors for hay drying systems. Significant activities by do-it-yourself collector building groups. 5.2 MWp of PV systems have been installed (about 23,500 installations).
TURKEY	More than 200 private companies involved in solar energy; 11 market their product on national basis.
UNITED KINGDOM	For active solar: approx. 7 collector manufacturers, 4 importers, 16 installers. 13,000 m^2 of collectors sold in 1992, about 70% for DHW. Small PV industry: 2 manufacturers, 6 importers and assemblers, 6 consultants. Tiny domestic PV market; 5.5 MW exported.
UNITED STATES	In 1991, 512,000 m^2 collectors produced for pool heating, 93,000 m^2 for DHW. Market dominated by a few companies. Consumer interest in passive solar remains strong. PV market increasing. Approx. 3 MW of PV modules were used for building applications in 1991, approx. 20% of total production.

PREVIOUS CONTENTS NEXT

IEA SHC Solar Activities in IEA Countries Report 1993

Solar Energy Activities in Australia

Bruce Godfrey
Energy Research and Development Corp.

INTRODUCTION

With increasing recognition of the need for ecologically and economically sustainable development, the potential for renewable energy and sustainable energy systems will increase as we move into the 21st century. Australia needs to have sustainable energy options available for viable and reliable implementation when the economic and environmental conditions dictate. These options likely will have great potential for export to the growing Asia/Pacific market where the limitations imposed by an existing infrastructure for distribution and use are not as great.

Penetration of these existing and new markets depends on the adoption of renewable energy technologies by industry energy suppliers and commercial and community users. The major challenge then is to increase the availability and reliability of renewable energy options at a price which is competitive with energy from fossil fuels, without dislocating the economy.

It is well recognised that Australian researchers have produced a wide range of renewable energy innovations and are abreast or ahead of international competitors in a number of areas. However the record for commercialising these technologies is patchy. While not unique to renewables, a significant problem is moving the technology from the research laboratory to the market place.

PROGRAM STRUCTURE

The Australian Government does not have a specific policy related to solar energy and its incorporation in the energy supply and demand mix. This does not mean that Australian governments - at Federal, State or local levels - are uninterested in solar energy and its use, rather that the necessity to define such a policy is not high in a country with a relatively benign climate and plenty of relatively inexpensive fossil fuelled energy sources.

There are a number of agencies investing in the research, development and demonstration (RD&D) of applicable solar technologies. These include, but are not limited to:

- Energy Research and Development Corporation
- New South Wales Office of Energy
- Energy Victoria
- South Australian Office of Energy Planning
- Minerals and Energy Research Institute of Western Australia
- The Australian Research Commission
- The Australian State electricity utilities
- Various universities.

With so many agencies funding RD&D into solar technologies, and no collection of statistics into how much or what they fund, aggregate data on funding is not available. Further, the practice in Australia is not to define specific programs and allocate defined funds to such. Most energy RD&D here is funded in a more reactive manner. Hence the only figures on renewable energy funding which are presented are those pertaining to the Energy Research and Development Corporation. These are shown in Table 1.

TABLE 1: Renewable Energy Funding by ERDC in Australia

[NOTE: THIS TABLE IS FOUND IN THE ORIGINAL PAPER]

It should be noted that funding by State governments, utilities and other organisations is estimated to approximately double the figures in Table 1, and will continue to do so through 1993 and 1994.

RD&D PROGRAM

The ERDC has two programs under which technologies directly applicable to the IEA Solar Heating and Cooling (SH&C) Program are funded. These programs and their objectives and achievements are the Planned Energy Use Program and the Renewable Energy Sources and Systems Program, as described below:

Planned Energy Use Program

The objective of the program is to minimise Australia's primary and secondary energy use through energy planning, design and management in the built environment, transport and manufacturing sectors in order to:

- increase the efficiency of energy use;
- reduce end user energy costs; and
- reduce adverse environmental impacts.

The achievements of this program to date are:

- Australia re-entered the IEA Solar Heating and Cooling program in an active manner;
- Australia is participating actively in Task 18;
- ERDC is funding significant projects in the development of advanced windows;
- ERDC is funding demonstration projects in cost-effective, solar efficient residential buildings;
- ERDC is working with built environment industries and their representative organisations to develop research and development strategies for their industry sectors. These strategies include definition of priority areas, projects and co-investment in the projects.

Renewable Energy Sources and Systems Program

The objective is to develop cost-competitive (vis-a-vis conventional energy sources) renewable energy sources and systems in order to facilitate their large-scale adoption in the energy market.

The achievements of this program to date are:

- Participation in new renewable energy projects, and funding arrangements for new projects, have changed dramatically towards ERDC's goal of increased industry funding and pooling of resources by funding agencies.

- Two major projects (*Solar Resource Assessment for Australia* and *Demonstration Project of Solar Thermal Electricity Generation Using High Temperature Parabolic Dishes*) have been co-funded with nearly all Australian electricity utilities and other organisations.

- Significant support for solar photovoltaic research continues.

- Significant support for enabling technologies for renewable energy systems continues and is likely to increase.

- A draft research and development strategy for renewable energy, developed with the Australian and New Zealand Energy Society and now out for public comment, has been prepared. The priorities which have emerged from this strategy are shown in Table 2.

TABLE 2: R&D Priorities for Renewable Energies & Associated Technologies From ERDC's Viewpoint

[NOTE: THIS TABLE IS FOUND IN THE ORIGINAL PAPER]

OTHER GOVERNMENT SUPPORT ACTIVITIES

Information

The Federal government is funding a A$2 million renewable energy technologies information and promotional program to encourage the penetration of renewable energy technologies into the market place. A large amount of this funding is going to energy information centres established by various State governments which have had for some time promotional programs for the application of solar technologies, particularly in the built environment.

Subsidies and Incentives

Subsidies and incentives to adopt solar technologies are almost non-existent in Australia. The dominant paradigm here is to allow market forces to prevail. In so doing it is difficult for solar technologies to compete against Australia's generally abundant, widely-available and relatively inexpensive fossil fuel energy sources.

Standards

Some State governments have mandated minimum insulation standards and/or design standards for buildings. These design standards include energy considerations, particularly for residential buildings. Indeed the Federal government, in cooperation with the States, is in the process of establishing a home energy rating scheme for Australia. This is a difficult task which is not helped by Australia's wide range of climates across a very large continent.

COMMERCIAL ACTIVITY

There are a number of manufacturers of solar products in Australia. These include:

- Two Australian-based photovoltaic manufacturers:

  BP Solar (Australia)
  Solarex (Australia)

- and many photovoltaic systems integrators and suppliers across the country.
- Major solar hot water heater manufacturers such as Solahart, Edwards and Beasley, with other specialist DSHW suppliers such as Quantum Link which manufactures solar-boosted heat pump systems.
- Many small builders offer solar efficient residential buildings, with a possible trend to greater interest by bigger building companies.
- However, the Australian architectural profession still is basically unwilling to consider the energy implications of their designs because developers are not particularly interested.
- Australia is an open market, so nearly all major, international solar technology companies are represented in Australia.
- Overall, the market for renewable technologies (including buildings) is growing as public awareness grows. However the recession, high unemployment, low conventional energy prices, and oversupply of electricity generating capacity are not helping this market.

OUTLOOK

The outlook for the development and market penetration of (selected) renewable energy technologies generally, and solar efficient buildings in particular, is generally positive. Opportunities do exist in niche markets where economics already favour such technologies, and these markets are not inconsiderable in size.

However, there remain a number of not significant barriers to be overcome. These include:

- Low conventional energy prices and cross subsidies;
- Unwillingness on the part of governments to legislate for maximum energy-efficiency in the built environment;
- Unwillingness of the architectural and building professions to embrace energy-efficiency as a key criterion in building design; and
- Lack of interest on the part of building developers who are concerned only with building the building; tenants are responsible for operating costs.

The outlook for continued funding of renewable energy technology RD&D remains positive. However, coordination and collaboration must increase among those bodies investing in the development of new, and demonstration of existing, solar technologies. ERDC is playing a significant role in this area in Australia, with some significant success being demonstrated.

PREVIOUS CONTENTS NEXT

PREVIOUS CONTENTS NEXT

IEA SHC Solar Activities in IEA Countries Report 1993

Solar Energy Activities in Austria

Gerhard Faninger
Austrian Research Centre Seibersdorf

INTRODUCTION

The fossil energy resources (oil, gas, coal) in Austria are very small and contribute only about 11.7% to the energy supply: 2.0% coal, 5.4% oil and 4.3% gas. Otherwise, Austria has a long tradition in the use of hydropower, which still provides about 70% of Austria's electricity supply. In the past decades, however, the significance of Austria's indigenous resource endowment has been steadily eroded. Whereas 25 years ago indigenous sources supplied some 80% of Austria's energy requirement, today the share of net primary energy imports is on the order of 70%.

These energy imports, mostly in form of liquid hydrocarbons, impose a heavy burden on Austria's balance of payments and supply security. Thus, Austria's energy policy emphasizes, above all, the need for reducing the dependence on liquid hydrocarbons. In order to achieve this goal, a substantial effort in energy planning and research must be undertaken.

The Energy Concept and Report of the Austrian Government, which was submitted to Parliament in December 1986, and its updating of 1987, 1990 and 1993, endorse the previous goals of the energy policy concept. These are:

- the reduction of energy imports,
- more efficient use of energy,
- substitution of expensive fuels and energy technologies through cheaper alternatives,
- increased use of renewable sources of energy,
- compatibility of energy policy with environmental and social policy,
- sufficient energy supply and energy security.

The Energy Report 1993 again stresses the considerable efforts of the Government to develop an environmentally-acceptable energy strategy. The Austrian Government also emphasizes a 20% reduction of carbon dioxide by the year 2005.

The present energy situation in Austria is illustrated in Figures 1 - 3. From 1973 to 1981, Austria's energy demand showed an annual increase of about 4%. From 1981 to 1983, a slight decrease was noticeable. Since 1983, the annual energy consumption has been rising again, Figure 1.

Since 1973, the share of various energy sources in the total energy consumption has changed. Thus the share of coal decreased and the share of oil increased initially until 1980 and was then superseded by other energy sources--gas and biomass. At present, the share of domestic energy sources in the energy consumption is on the order of about 33%, about half of which is covered by hydropower, Figure 3.

The demand for renewable energy sources has been rising in all sectors. Thus the share of "other" renewable energies (hydropower excluded) in the total energy consumption rose from 7.5% in 1983 to 9.5% in 1988 and 15% in 1991, Figure 4. The share of solar energy has also been rising in the last few years. At present, 78% of Austria's total energy demand is covered by non-renewable (fossil) energy sources, Figure 2.

In Austria the share of renewable energy sources in the end-use requirement is 33%, about 18% from hydropower and 15% from "other" renewable energy sources: fire wood, combustible garbage, straw and pressed straw, wood chips, bark and pressed bark, waste liquor, refuse and other waste, biogas, geothermal energy, solar energy, ambient heat. The share of renewable sources of energy in the end-use consumption increased remarkably in the past few years (Figure 4 and Table 1).

Energy consumption by market sector was as follows (1991):

- industry 28.2%,
- transportation 28.4%,
- domestic use, agriculture, trade 43.4%.

In Austria, CO2-emission from fossil energy sources is estimated to be about 61.8 million tons per year, 32% from industry, 31% from transportation and 37% from the residential/commercial sector.

PROGRAMME STRUCTURE AND EMPHASIS

General remarks

The Federal Ministry for Science and Research is responsible for the coordination of Austria's energy research, development and demonstration (RD&D)-programme at the national level. National energy policy matters are the responsibility of the Federal Ministry for Economic Affairs. The Federal Provinces also have responsibility for certain energy matters.

In the field of energy, Austria maintains bilateral and international cooperation with a great number of countries. Particular attention is devoted to cooperation in energy research and development with member countries of the International Energy Agency (IEA) as well as with developing countries.

The principal aim of the Austrian Energy Research, Development and Demonstration (RD&D) Programme is to reduce the dependence on imported primary energy. The principal objectives focus on the

- optimal exploration and exploitation of indigenous energy resources,
- identification of adequate substitutes for liquid hydrocarbons,
- diversification of sources,
- assessment of the potential contribution of new and renewable sources of energy,
- development, testing and introduction of new, economically and environmentally sound energy technologies.

Major efforts have been initiated in energy conservation, new and environmentally-benign techniques and renewable energy technologies. Austria emphasizes the development of fluidized bed combustion technology and research on the nature and reduction of emissions of airborne pollutants from industry, traffic and combustion of biomass.

The Austrian energy technology programme of the last years has been strongly determined by public pressure to dramatically reduce emissions, particularly from industry and road traffic. For this reason, energy programmes for fluidized bed combustion and application of highly-effective filter technology have been promoted.

The Austrian Government highly encourages close cooperation between the industry and research organisations/universities to promote the direct technology transfer and the quick utilization of RD&D results.

Industry plays a prominent role in the Austrian Energy RD&D Programme. A great many projects are being carried out by industry, partly in cooperation with universities and other research institutes, sponsored by the Promotion Fund for Commercial Research, which is mainly financed by public means.

The industry restricts its engagement to technologies which promise a near-term turn over and market. Examples of product development carried out by government/industry collaborative programmes are biomass-, heat pump- and solar energy systems.

In order to ensure a practically-oriented research as well as basic research, a committee of the Austrian Federal Economic Chamber, composed of representatives of industry and commerce, was established. This committee had an advisory function when the solar energy programme was set up and important technical and financial incentives on solar energy utilization were given.

In general, RD&D for solar energy components and systems have concentrated since 1976 on the development and testing of:

- Economical and efficient collectors and solar systems for swimming pool and domestic water heating with the objective of reaching a lifetime of more than ten years, and
- heating systems with direct (collectors) or indirect (heat pumps) utilization of solar energy with special consideration given to ecological and economic aspects.
- More specifically, solar energy RD&D activities have been carried out in the following fields:
- Creation, improvement and expansion of the meteorological data base, which is indispensable for all solar energy applications in Austria.
- Development and optimization of solar systems for domestic hot water and swimming pool heating.
- Development of solar systems for domestic hot water in households.
- Development of passive solar components and systems consistent with Austria's climatic conditions.
- Development and testing of:
    - solar systems for domestic hot water and space heating, as well as for industrial and commercial applications,
    - concepts for seasonal storage of low temperature heat,
    - solar-assisted heat pump systems for space heating and domestic hot water,
    - solar cooling systems, especially for use in developing countries that have high insulation levels,
    - concentrating collectors and heliostats for application in solar thermal plants (1980-1985),
    - a 10 kWe solar power plant to be used in developing countries (1978-1981).
- Participation in the International Energy Agency (IEA) project "Small Solar Power Systems": construction and testing of two solar thermal power plants of 500 kWe each: 1979-1986.
- Basic research in the fields of photovoltaics, photo-chemistry and photoelectric-chemistry.
- Development of computer programmes for system design and optimization.
- Test stations for the evaluation of solar systems, heat pump and photovoltaic systems performance.
- Demonstration projects, especially in public buildings.
- Joint research with the Republic of Malta at the Austrian-Maltese Research Centre to develop solar technology appropriate to the needs of developing countries; 1981-1985.

The present energy programme puts greater emphasis on informational and educational activities.

Research institutions

The following institutions are at present involved in Austria's solar RD&D programme:

Austrian Research Centre Seibersdorf A-2444 Seibersdorf	programme coordination, technology transfer, demonstration projects
Bundesversuchs- und Forschungsanstalt Arsenal (Federal Testing and Research testing Institute) A-1030 Vienna	solar collectors, solar systems and heat pumps testing
Zentralanstalt für Meteorologie Geodynamik Hohe Warte 38, A-1180 Vienna	meteorology
Institut für Hochbau für Architekten Technical University of Vienna Karlsplatz 13, A-1040 Vienna	passive solar systems
Institut für Wärmetechnik, Technical University of Graz Inffeldgasse, A-8010 Graz	low temperature heat, heat pumps
Institut für Physik für Bauingenieurwesen University of Innsbruck Technikerstraße 5, A-6020 Innsbruck	passive solar systems
Institut für Experimentalphysik, University of Innsbruck Technikerstraße 25, A-6020 Innsbruck	photovoltaics
University of Klagenfurt Institut für interuniversitäre Forschung und Fortbildung Sterneckstraße 15, A-9020 Klagenfurt	information, dissemination
Energiesparverein Vorarlberg Bahnhofstraße 26/4 A-6850 Dornbirn	passive solar systems

Presently, Austrian utilities have become increasingly involved in research and demonstration of photovoltaic systems.

Government Funding

Government funding for energy research is shown for the period of 1976 to 1992 in Figure 5 to 7 and especially for solar energy in Table 2.

The government (state and federal) energy RD&D Budget in Austria was 138 Mio AS in 1990, 245 Mio AS in 1991 and 211 Mio AS in 1992. The Austrian Government energy RD&D budget for 1992 represents a decrease of about 14% over 1991. The Provincial Governments supported renewable energy technologies on the market by about 120 Mio AS in 1992. The RD&D expenditures for renewable energy technologies are of about 21,9% of the total energy budget for 1992. The expenditures of the Austrian industry for Energy RD&D are estimated to be about 122 Mio AS for the year 1991 and 98 Mio AS for the year 1992.

Within the field of solar energy, of passive systems and photovoltaics have larger funding than active solar systems (Table 2).

About 80% of the governmental expenditures have been used for projects within the IEA-Solar Heating and Cooling Programme.

PROGRAMME ACCOMPLISHMENTS

Long-term Tests of Solar Systems

In the past decade, the network of about 90 test stations has provided considerable data and operating experience for various solar systems. Results have been evaluated and disseminated. Standards and guidelines for solar components and systems have been developed.

The testing of solar systems for domestic hot water preparation is done mainly in Carinthia, within the framework of the research programme "Austrian Network for Measuring the Practical Use of Solar Energy," which has been carried out since 1976 on behalf of the Ministry of Science and Research. The results have been assessed and compared with simulated calculations. Recommendations have been developed for the planning, construction and operation of solar domestic hot water systems in households as well as in commercial applications.

The annual energy output is about 330 kWh/m2, year (flat plate collector) to about 420 kWh/m2, year (evacuated tube collector). Long-term tests with larger solar systems for commercial applications showed that the system efficiency and the availability were sufficient at a nearly unchanged annual energy output: about 350 kWh per m2 collector area and year (flat plate collector) to about 630 kWh per m2 collector area and year (evacuated tube collector), referring to an annual efficiency of about 35% and 62%.

Passive solar design elements and systems are being used more and more in dwellings. Advanced concepts are using air collectors in combination with medium term rock storage. This system has been proved so satisfactory that it will be considered for future projects.

OTHER GOVERNMENT SUPPORT ACTIVITIES

Subsidies

Solar systems qualify for tax advantages as energy saving investments when they are used under conditions specified by the national energy policy. Subsidies of 20% of investment costs for biomass-, solar- and heat pump systems are offered to the consumer by the provincial governments.

Standards

Standards for solar collectors are now available in Austria. Guidelines and recommendations for the planning, design, and operation of solar systems have been developed based on the experience gained with existing test facilities.

Reliability, cost-effectiveness, mass production of parts and components, and especially better information on technologies are preconditions for using new and renewable sources of energy. Appropriate documentation, teaching and demonstration materials have been prepared in the last few years in order to provide information to all interested parties and to promote the use of solar systems.

Since the introduction of new technologies requires good training of technical manpower, seminars are held at regular intervals which address the planning, design and operation of solar systems. Between 1977 and 1992 more than 500 of these seminars were held in Austria.

Since 1981, Summer Schools on topics relevant to solar energy technology were organized in Austria in the years 1981, 1985, 1988 and 1992 with the co-sponsorship of a number of organizations in Austria, Finland, Germany, Norway, Spain, Switzerland, Sweden and Finland and, in 1992, also in Croatia and Slovenia. The Solar Energy International Summer School is intended as an extension course for postgraduates and for scientists already employed at research centres, at universities and in industry. The present state of research, development, demonstration and application in the entire field of solar energy are presented and discussed in the panel sessions, each devoted to a specific topic.

The topics were covered included the present role of renewable sources of energy (active and passive solar systems, high-temperature technologies and applications, photovoltaic technologies and applications, wind energy applications, solar fuels and bioenergy), plus economic and ecological aspects of renewable energies.

COMMERCIAL ACTIVITIES **Marketable solar energy technologies**

In the past decade practical research on the use of solar energy and ambient heat has resulted in a number of economical and marketable solutions:

- solar systems for swimming pool heating, hot water preparation and additional space heating,
- heat pumps for hot water preparation, space heating, heat recovery and swimming pool heating,
- solar generators and wind energy converters for special applications.

In most cases flat-plate collectors are applied for the conversion of solar energy. Solar systems are mainly used for residential hot water preparation and swimming pool heating. Due to the improved system technology the efficiency of solar systems has been raised steadily in the past years. The amortization period of a small-scale solar system used for hot water preparation varies between 10 and 15 years as compared to conventional oil-fired systems (without consideration of promotional measures). Consequently, the cost-effectiveness of large-scale systems, used in tourist centres for example, is even higher because of lower investment costs per m2 of collector area.

Today, outdoor swimming pool heating by means of solar systems has proved to be a very economical heating method with amortization periods of 5 years or less.

Status of Commercialization of Solar Systems

The development of the market for solar systems is continuing its positive trend (Figure 8). In 1991 about 123,000 m2 and in 1992 about 140,000 m2 of solar collectors were installed. In 1992 about 41% of the installed collector area was used for swimming pool heating. It is remarkable that the number of solar systems for hot water preparation has been rising. This is mainly due to the successful work of organized "do-it-yourself" groups. In 1992 the share of these systems was about 50% of installed collector area.

At present, the total area of installed collectors is approx. 725,000 m2, 41% of which is for swimming pool heating and 59% for hot water preparation (Figure 9). The annual heating output of solar technology roughly 240 GWh at present, which corresponds to an annual amount of oil saving of about 64,000 tons of oil.

The market penetration of photovoltaic systems is still in its initial stage. These technologies are used for communication and warning systems but since 1991 also for small grid-connected photovoltaic systems for households. About 200 kWp roof- integrated photovoltaic systems (1 to 3.7 kW each) are sponsored by the government and by the utilities (about 30% of the investment costs). At the end of 1992, about 350 kW of photovoltaic systems were in operation.

OUTLOOK

Reduction in greenhouse gas emissions can be achieved in a number of ways: energy conservation, restriction on consumption, the use of renewable energies, the use of nuclear energy, limits on emissions and exchange of fossil fuels.

Energy conservation is given priority, but the use of renewable energy sources is also an important option for the reduction of CO2 emissions. However, decentralized use of solar energy technologies offers little chance to guarantee the future energy needs. A complete transition of energy policy from oil, gas and coal to "renewable" energy source will probably only be attained when it is possible to make use of solar energy on a large scale and in connection with a suitable secondary energy carrier and energy storage.

Nowadays scientists are looking increasingly at the solar-hydrogen option. This option, which the could control the carbon dioxide problem, could lead to a new boom of solar technologies. Future energy policy will have to demonstrate in which cases direct use of solar energy has an economic advantage over hydrogen produced by solar means. In countries with moderate climate (middle and northern Europe) the costs for electricity produced by solar means (through photovoltaic systems) on-site would be comparable with the costs of imported hydrogen produced by solar means from sunny countries in the south. Initial analyses have concluded that, considering the special meteorological conditions in Austria, it might be economically more interesting to use the electricity produced from photovoltaic systems in Austria or provide for seasonal thermal storage of solar energy than to import hydrogen.

Even today we are still not sure if the use of solar-produced hydrogen is the only available guarantee for a future free from toxic emissions and greenhouse gases and a sufficient energy supply. Investigation into the energy production from renewable energy sources at the place of demand will have to be carried out looking at technical, economic, ecological and social aspects. The task for energy research is to promote the introduction of environmentally-neutral solar energy - be it directly or indirectly trough the medium of hydrogen.

To find out the most promising concept for a solar seasonal storage system for Austria, a comprehensive sensitivity analysis was performed. The general findings are:

- Seasonal storage for solar heating systems is a useful new heating technology for Austria with costs approaching an acceptable level in the near future.
- Several technologies are available in practice to realize large-scale solar-storage systems. Two system types would be especially interesting for Austria:

  pipe storage in ground with heat pump and flat-plate collectors
  earth pit water storage with improved selective flat-plate collectors

- a pipe storage system with heat pump has the lowest investment costs and solar costs.

The stagnation of energy prices in recent years has resulted in a weakened interest in solar technology. However, the overall positive market development in Austria is encouraging.

In spite of some past negative experiences with solar systems, it may well be expected that these technologies will succeed on the market. Manufacturers as well as planners and installers have intensified their efforts to improve solar systems. Moreover, training of solar systems designers and plumbers has to be improved.

In terms of lessons learned, there was a certain tendency in the past to put too much emphasis on high-technology solutions in the end-use sector. Experience shows that intermediate-technology solutions which are reliable and easy to handle are of more importance, at least for near-term applications and commercialization.

The national research policy has made a long-term commitment to the development of new energy technologies, including solar technology. Important arguments in favour of further intensified and systematic promotion of solar technology are: the environmental benefits, the substitution of imported energy, and improved energy security.

Table 1: OTHER RENEWABLE ENERGY SOURCES IN AUSTRIA
(excluding hydropower, including combustible garbage): 1988 - 1991
End-use energy in TJ/year

	ENERGY SOURCE	1988	1989	1990	1991
1	Fire Wood	89.249	87.281	86.475	84.745*
	Bioenergy Sources:				
	bark	9.452	8.654	8.588	9.275
	wood chips	9.812	9.068	9.471	10.228
	pressed wood chips and pressed barks	391	477	528	532
	straw and pressed straw	875	862	850	850
	biogas	360	370	313	332
2	Sum of Bioenergy Sources	20.890	19.431	19.750	21.217
3	Biofuels	36	43	386	457
	Ambient Energy:				
	ambient heat	2.812	3.179	3.391	3.632
	solar heat	393	450	547	695
	solar electricity	<1	<1	<1	<1
	wind energy	<1	<1	<1	<1
4	Sum of Ambient Energy	3.205	3.629	3.938	4.327
5	Geothermal Energy	76	79	83	86
	Combustible Garbage:				
	refuse waste	1.143	1.215	2.805	3.205
	waste liquor	17.713	18.386	17.913	17.734
	other waste	2.053	2.982	2.908	3.001
6	Sum of Combustible Garbage	20.909	22.583	23.626	23.940

Table 2: Government Renewable Energy Funding in Austria
(in Million Austrian Schilling, M AS)

Research Area	1988	1989	1990	1991	1992
Active Solar	0.8	0.7	1.5	4.0	3.0

Passive Solar	7.5	4.1	1.0	6.2	4.8
High. Temp. Solar Thermal	0.2	-	-	-	-
Photovoltaics	5.5	2.9	2.0	7.2	14.3
Wind Energy	0.8	-	0.2	0.8	1.4
Biofuels	43.0	25.3	17.0	35.9	24.2
Geothermal	0.3	-	0.8	-	0.5
All Renewable Energy	58.1	33.0	22.5	54.1	49.2
Sum of Renewable Energy Sources		134.523	133.046	134.258	134.772

PREVIOUS CONTENTS NEXT

IEA SHC Solar Activities in IEA Countries Report 1993

Solar Energy Activities in Belgium

Prof. A. De Herde
Université Catholique de Louvain

PROGRAM STRUCTURE

On the national level, the Ministry of Economic Affairs finances the official Belgian representation in the various IEA bodies (at a maximum annual budget per representative of 3,300 USD). Each region in Belgium has the power to direct its own energy policy including whether to participate in IEA annexes. A national and inter-regional committee coordinates the participation in the different R&D programs. In actuality, only the Walloon Region is active in the area of Solar Programs.

FUNDING

Table 1 provides the renewable energy funding in Belgium (mostly from the Walloon Region) for the IEA programs, for R&D, Demonstration and Information (in million USD.)

Technology	1991	1992	1993
Passive Solar	0.175	0.200	0.500
Wind Energy	-	-	-
Biomass	-	-	-
Photovoltaics	-	-	-
ALL RENEWABLE ENERGY	**0.175**	**0.200**	**0.500**

Note : no active solar R&D

PROGRAM SCOPE AND EMPHASIS

Since 1991, Belgium has Increased its R&D Program in the area of passive solar energy. Within the framework of the IEA, Belgium participates in the annexes of "Passive Solar Commercial Buildings" (11), "Advanced Solar Low-Energy Buildings" (13) and "Solar Renovation of Buildings" (20).

Within the framework of the European Community, Belgium participates in the PASSYS program (Passive Solar Components and Systems Testing), the PASCOOL program (Passive Cooling), the SOLINFO program (transfer of research results, production of the European Guide to bioclimatic design "Energy Conscious Design" and of pedagogic valisettes for the European schools of Architecture), the VALUE program (promotion of the use of research results in the Community).

Research Institutions

1. Research Team "Architecture et Climat"
Catholic University of Louvain-la-Neuve
Climatic Architecture, Passive Solar Architecture, Education, Dissemination of Information

2. Laboratory of Building Physics
Catholic University of Leuven
Building Materials, Vapor Diffusion, Moisture

3. Laboratory of Thermodynamics
University of Liège
Heating and cooling systems, Building models

4. Building Scientific and Technical Center
Passive Solar Components, Test facilities

5. Research Team "Energy"
University Foundation of Luxembourg
Buildings models, expert systems

NON R&D ACTIVITIES

The Walloon program for dissemination of information is concerned with the promotion of passive solar design concepts. Another objective of the program is to provide the public authorities with the scientific expertise necessary for implementing certain programs and policies:

- the organization of large campaigns of training and information on the rational use of energy in buildings for those involved in public building maintenance,
- the dissemination of a new energy guide,
- the production of a daylighting guide specifically for architects.

COMMERCIAL ACTIVITY

At the moment, only consultant companies participate in the rational use of energy field, and commercial activity in Belgium is limited to three companies producing equipment and solar installations. However, a considerable number of sunspaces have been retrofitted to existing houses.

ROLE OF THE IEA ACTIVITIES

Table 2 provides the budget for the overall national energy program and international collaboration.

TABLE 2 : BELGIAN ENERGY BUDGET
(in Million USD)

	1991	1992	1993
RENEWABLE ENERGY			
Solar heating and cooling (passive) IEA Annexes	0.175	0.200	0.500
other	0.100	0.150	0.700
Wind energy	-	-	-
Biomass	-	-	-
Photovoltaics	-	-	-
RATIONAL USING OF ENERGY IN BUILDING			

IEA (Energy Conservation in Building Program)	0.150	0.200	0.200
other	0.500	0.750	0.750
(subsides for energy renovations)	3.500	3.500	5.500
RATIONAL USING OF ENERGY IN INDUSTRY	-	-	-
ANALYSIS OF THE BELGIAN ENERGY SYSTEM	0.600	0.650	0.700
TOTAL	5.025	5.450	8.350

OUTLOOK

Although active solar energy is in a major decline, it must be emphasized that passive solar energy is used extensively in contemporary architectural projects, and has considerable public support as well.

PREVIOUS CONTENTS NEXT

IEA SHC Solar Activities in IEA Countries Report 1993

Solar Energy Activities in Canada

Doug McClenahan
Natural Resources Canada

PROGRAM STRUCTURE

Most of Canada's federal activities in solar energy are carried out through the Efficiency and Alternative Energy Technology Branch (EAETB) of CANMET, the Canada Centre for Mineral and Energy Technology. CANMET is the main research and technology development arm of the Department of Natural Resources Canada (NRCan), formerly Energy, Mines and Resources Canada, and has a mandate to find more efficient, effective, safer and cleaner methods to develop and use Canada's mineral and energy resources.

The solar energy program within EAETB is divided among three Divisions as shown below in Figure 1.

[ADD ORG. CHART HERE]

Fig. 1: Organization of the solar energy program in CANMET's Efficiency and Alternative Energy Technology Branch (EAETB)

The Alternative Energy Division and the Energy Efficiency Division, which include the active and passive solar technologies, respectively, are located in Ottawa, while the Energy Diversification Research Laboratory, which includes photovoltaic technologies, is located in Varennes, Quebec.

In addition, the Atmospheric Environment Service of Environment Canada, located in Toronto, continues to manage solar resource measurement and meteorological data base development activities in support of solar technologies.

The federal solar energy program activities are mostly contracted out, with over 75% of the funding directed to the private sector and various research institutions in cost-sharing contracts. An in-house photovoltaic research program has been initiated at the Energy Diversification Research Laboratory, which, at full strength, will have an annual operating budget of around $Cdn 600K.

FUNDING

The funding for renewable energy, as well as for many conventional energy technologies, is much lower today than a decade or so ago due to fiscal restraint policies. The support for solar energy has likewise decreased from a peak of about $Cdn 20M per year in 1984/85 to a low of approximately 2.5 M in 1990. While previous support included funding for extensive demonstrations, current funding is limited to R & D activities and pilot-scale commercialization activities.

More recently, in the past two years, there has been a moderate increase in support of solar energy to an annual level of about $Cdn 3.0M, mainly as a result of an expanded program of in-house research in photovoltaics.

The federal funding for 1992 and 1993 is shown in Table 1.

Table 1: FUNDING FOR RENEWABLE ENERGY R & D
(in M $Cdn)

TECHNOLOGY	1992	1993
Active Solar	0.8	0.7
Passive Solar	1.0	0.9
Advanced House Demo	1.4	0.6
Photovoltaics	1.0	1.1
Wind	0.7	0.6
Bioenergy	2.3	3.3
Small Hydro	0.5	0.3
ALL RENEWABLES	**7.7**	**7.5**

In addition to the increased support for photovoltaics, a new program to demonstrate advanced low energy homes began in 1992 with support from Canada's Green Plan. As a result of the low energy targets of this program, several of the demonstration homes incorporate active, passive and photovoltaic energy technologies.

Additional funding has also been allocated to active solar beginning in 1994 to examine the use of solar heating for the aquaculture industry which has grown in Canada from a business of $Cdn 7M in 1984 to over $Cdn 250M in 1992.

DESCRIPTION OF THE R, D & D PROGRAM

Active Solar Energy

The main focus of the active solar program is on low temperature (<60 deg. C) heating applications excluding space heating. The applications with the highest priority include residential water heating, commercial/industrial ventilation air heating, and heating for the aquaculture industry. These application areas represent the largest near-term market potential for active solar technologies in Canada.

For residential water heating, the focus is on improving the performance and lowering the cost of low-flow solar water heaters. The cost/performance targets to the year 2000 are shown in Figure 2.

Fig. 2: Projected Electricity and Solar DHW Costs

On the market development side, the S-2000 program has been initiated to introduce solar water heaters to homeowners through pilot projects with electric utilities. Long-term, low-interest financing options from major financial institutions are encouraged as part of these projects. Queen's University Solar Calorimetry Laboratory is providing technical support on detailed performance monitoring for the program and the National Solar Test Facility at Ortech International provides product testing and certification services for the qualification of solar DHW products. One of the goals of the S-2000 program is to realize 10,000 solar DHW installations in Canada by the year 2000.

For commercial/industrial ventilation air heating, work is focussed on development and evaluation of a new perforated solar absorber ("Solarwall") developed by Conserval Engineering, shown in Figure 3.

Fig. 3: The perforated solar absorber developed by Conserval Engineering is a highly promising technology for ventilation air heating.

Results to date indicate that the perforated unglazed solar absorber is a 30-40% improvement in cost/performance over earlier glazed air collectors. Efficiencies as high as 80% have been measured for this new solar collector. Successful installations of the product have been made at several industrial plants in Canada including Ford, GM, and Bombadier. In addition to the field monitoring, work is underway with Alcan to develop improved coatings to enhance market appeal and improve performance.

Passive Solar Energy

The passive solar program is focussed on the development and adoption of high-performance windows, advanced window R & D, daylighting, and systems integration to optimize solar energy gains. Activities include electrochromic window research with organizations such as INRS Energie and university research centres, and industry support through the development of computer design tools, window durability test methods and energy performance rating standards.

Highlights of the program include the development of a single-number energy rating (ER) system for windows. Formally adopted as a CSA Standard, the rating system will be used as part of the window industry's product certification and labelling program, similar to Energuide for appliances. Other achievements include the development of the patented Super Space, an insulated silicone foam spacer for windows, which is used today by more than 200 window manufacturers around the world, and the FRAME and VISION computer programs for analysis of window perimeter heat loss and center-of-glass conditions, respectively, which are referenced in national and international standards.

Also of interest is the new advanced houses program which provides cost-shared support to industry for the construction of technologically-advanced homes that consume one-quarter of the energy of conventional housing (see Fig. 4).

Fig. 4. Typical Total Annual Energy Use of houses with various energy saving measures. The houses in the Advanced Houses program are expected to consume one-quarter of the energy of houses built according to the 1975 National Building Code.

Ten homes have now been built under this program which will include a technical monitoring period to determine if the targets are achieved. In order to meet the low energy targets for the program, a number of the homes utilize solar energy. (See Fig. 5 for one example.) Nine of the homes have a passive solar contribution to the heating load of 25% or higher as a result of high-performance windows. Six of the homes have solar domestic water heaters, five of which have photovoltaic-powered pumps. Two of the homes utilize photovoltaic panels for lights and appliances.

Fig. 5: The Saskatchewan Advanced House, with both a solar DHW system and a photovoltaic system.

Photovoltaics

Canada's PV program is aimed primarily at system development rather than cell development. Its priorities are remote systems in both stand-alone and hybrid combinations, water pumping systems and information transfer. The in-house activity carried out at the Energy Diversification Research Laboratory (EDRL) is focussed on balance-of-system components. EDRL provides facilities to a small under-capitalized industry to develop and test new components.

PV is not competitive in most urban regions in Canada due to low energy costs. However, two demonstration projects have been initiated recently. A 100 kWp grid-connected PV system is being installed on a hospital in Toronto to provide power for air conditioning. The objective of this project is to demonstrate to the utilities the utilization of PV for peak load management. The second project features the installation of a 5 kWp system on an advanced house located in Ottawa. The objective of this project is to demonstrate to the public state-of-the-art technologies in the building industry.

Several additional activities in the PV program are indirectly related to PV in buildings. These include the development of new storage technologies, and design tools such as the PV design manual and WATSUN-PV and SYSTEMSPEC computer simulation and design programs.

OTHER GOVERNMENT SUPPORT ACTIVITIES

The federal government, through Natural Resources Canada, is the major player in solar energy development in Canada. There has been some provincial activity, mostly in support of industrial development. The provinces most involved have been Ontario, Alberta, Quebec, and Nova Scotia.

Information

Information and promotion is recognized as a priority for the solar energy program. NRCan provides financial support to industry associations, conferences, workshops, publications, industry directories, fact sheets, etc.

Incentives

There are currently no direct subsidies or incentives for solar energy products except for an accelerated depreciation allowance (Class 34) for certain energy producing equipment.

Standards

Canada has developed several national standards for solar energy products, as well as certification and rating procedures for solar domestic hot water systems and windows and has participated in international standards organizations.

COMMERCIAL ACTIVITIES

Active Solar

The current Canadian active solar industry is comprised of about 15 small and medium-sized companies which manufacture products ranging from residential pool heating collectors and domestic hot water systems to solar preheating ventilation air systems. Sales in 1991/92 were estimated at $2 million. Projected sales for 1996/7 are about $8 million. The S-2000 program for residential solar water heating has generated significant interest with electric utilities. The goal for the program is 10,000 solar DHW installations by the year 2000. Sales of Solarwalls are also beginning to increase with recent installations at Ford, GM, and Bombardier.

Passive Solar

The market for high performance windows increased from about 5% of sales in 1989 to about 17% or about 1.2 million m2 in 1991. One of the main reasons for this was a utility rebate program offered by Ontario Hydro which ran from 1989 to 1993. The market is expected to continue to grow with the inclusion of new window energy performance standards as part of a new energy code for Canada in 1995.

Photovoltaics

The business volume of PV in Canada has been stable for the past few years. Total sales estimates for 1993 are $12 of which about $5 million is expected to be generated through export sales. Most of the activity is in the distribution of PV products produced by others and is directed to stand-alone systems for remote areas. The total installed capacity in Canada is about 800 kWp. The first cell manufacturing company in Canada is beginning production in 1993.

OUTLOOK

The outlook for solar energy use in buildings and other applications in Canada is positive with growth in sales expected in all technology areas--active, passive and photovoltaics for both the domestic and international markets. Anticipated improvements in the cost of solar products coupled with increasing cost of electricity and other energy sources, the trend to higher energy efficiency standards, more utility involvement, and an increasing concern for the environment are helping to reduce the market barriers.

PREVIOUS CONTENTS NEXT

PREVIOUS CONTENTS NEXT

IEA SHC Solar Activities in IEA Countries Report 1993

Solar Energy Activities in the Commission of the European Communities

T. Steemers
D.G. XII - Directorate General for Science Research and Development

GENERAL

All R,D&D activities of the CEC reside under the general umbrella of a "Framework Programme." The current one is the Third Framework Programme and runs from 1991 to 1994, inclusive. The individual R&D-programmes are executed through cost-sharing contracts, generally on a 50/50 basis. For universities and other educational institutions, "marginal cost contracts" have been introduced, whereby 100% of the extra project costs are financed by the CEC. Recently, organisations and institutions from EFTA countries can participate in the programmes. Special funds have been reserved for participation from Middle- and Eastern European countries.

BUDGET

The original budget of the Third Framework Programme was 5.7 billion ECU (6.8 billion USD). In March 1993 the European Council added another 900 MECU (1.08 billion USD). This brings the budget for Non-nuclear Energy R&D (JOULE 2 Program) to 258 MECU (310 M USD). A detailed breakdown has not yet been made, as this will also be determined by the outcome of the current call for proposals, but it is estimated that a budget of 24 M ECU (28.8 M USD) will be available for R&D on topics dealing with active and passive solar heating, cooling and daylighting, including energy conservation in buildings during the current framework programme.

CURRENT R&D PROJECTS

The Solar House

The objective of the Solar House programme is recognition and support for innovation and design excellence in low-energy and solar architecture and promotion of new design concepts in previously-underdeveloped areas. The programme aims to advance energy-conscious and solar architecture in Europe through the establishment of an exemplary buildings network and the development of integrated components and systems. It aims to place energy-conscious architecture at the forefront of the architectural debate.

Currently seven building projects and three component projects are supported under this programme. The total cost is 14.3 M ECU (17.2 M USD) of which the Commission bears 5.6 M ECU (6.7 M USD). The call for proposals issued on 29 April 1993 allows the number of projects in the Solar House programme to be extended.

Project PASCOOL

The main aim of this project is the development of design guidelines and design tools for Mediterranean Member States to prevent overheating in summer by applying passive cooling techniques. Experimental testing in test cells, buildings and laboratories will form the backbone of the project. Test Reference Summers and other meteorological input data will be prepared. A special sub-group will be charged with the preparation of design guidelines to be published as a Passive Cooling Design Handbook. Eleven research teams are working together. The total budget is 2.3 MECU (2.75 MUSD).

Indoor Air Quality Audit Project

This project will establish a common European IAQ audit procedure for office buildings. The participants will examine the practicality and will refine the agreed procedure in a pilot study. Each participant will subsequently execute the procedure in six buildings selected according to agreed criteria. The deliverables from this project will be, in addition to a manual describing the European IAQ audit procedure, a IAQ-Handbook reflecting the experience from the project, e.g.:

- correlation between IAQ and complaints
- pollution load of buildings
- ventilation rate and ventilation performance
- recommendations on ventilation and source control
- do's and don'ts in IAQ-investigations

Eleven research teams are working on this project which has a total budget of 1.5 MECU (1.8 MUSD).

Daylighting Data Project

This project is a follow-up to an earlier activity (JOULE 1) in this area, but this time the project will result in the production of a European Daylighting Atlas, which will answer most of the questions raised by building designers with respect to the performance of daylighting systems. The project will be backed-up by data from six Joule Class Daylight Measuring Stations. Six teams participate in this action and the total budget is approximately 600,000 ECU (720,000 USD).

Project on the Characterization of Glazing for Daylighting Applications

The objective is to characterize available glazing materials in relation to daylighting, to classify glazing materials with respect to daylight application and to develop a quick qualitative and quantitative assessment procedure. Results will be compared with the performance of glazings in monitored buildings. Ten industrial companies will collaborate and provide samples. Architectural critics will be invited to comment on the aesthetic aspects. The information will be compiled and published in a handbook for designers.

The total cost of the project will be 548,000 ECU (658,000 USD). It is most likely that these activities will be extended to include newly developed materials during the course of the current programme (JOULE 2).

Project COMBINE 2

The final aim of this project is the development of an Intelligent Integrated Building Design System (IIBDS). In COMBINE 1, the research was concentrated on data integration resulting in the following deliverables: the conceptual Integrated Data Model (IDM) and its implementation in a software platform and a standard interface kit for interfacing with a variety of energy oriented design tools. COMBINE 2 will build upon these deliverables by combining them into an operational IIBDS. This will involve the extension of the interacting design tools to the areas of costing, building regulations and product catalogues. Additionally, an off-the-shelf CAD tool will be incorporated. The central building model IDM will be extended accordingly. Ten Research teams are collaborating in COMBINE 2. The total cost is 2.5 M ECU (3 M USD).

Project Paslink

Having established fourteen common passive solar test centres during the course of project PASSYS - a project whose main objective was the development of a test procedure for passive solar building components - it seemed appropriate to consolidate the results of PASSYS and to create an operational structure linking the test centres through comparative testing of a limited number of components. The 14 PASSYS teams will participate. The total cost is 220,000 ECU (264,000 USD).

Project COMPASS

Project COMPASS has been established to allow the Mediterranean PASSYS test centres to catch up (because of a late start) with the other centres and at the same time to allow special attention to be given to roof components with an eye on cooling. Six research teams participate and the total budget is 1.26 M ECU (1.5 M USD).

Projects on Advanced Glazing

Three projects are currently underway dealing with advanced glazing:

Evacuated Windows Based on Monolithic Silica Aerogel Spacers - This project aims to develop and investigate highly-insulating window systems using monolithic aerogel as translucent insulation in collaboration with the Swedish producer, Airglas AB. Six other teams are participating. The total cost is nearly 1.0 M ECU (1.2 M USD).

Solid State Electrochromic Variable Transmission Windows - This project is a follow-up to previous work which investigated the feasibility of a five-layer solid state transmission device based on the phenomenon of electrochromism. Assembly aspects of the technological demonstrator (300X300 mm), as well as performance, degradation mechanisms and lifetime will be investigated. The total cost of this project in the current programme is just over 1.0 M ECU (1.2 M USD).

Passive Sun Control with Holographic Optical Elements - The third advanced glazing project aims at the specification and evaluation of design parameters with the computer program GENELUX, the development of the production process for this type of holograms, the production of prototypes up to one sq. meter, and the photometric testing both in the lab and in scale models. The total cost of this project is 330,000 ECU (400,000 USD).

Technology Transfer

Addressing buildings means dealing with the building sector. The building industry is not only one of Europe biggest industries, but it is also the most dispersed and at the same time a conservative industry and consequently slow in picking up new technologies. In two small projects, a modest contribution is being made to technology transfer.

The projects SOLINFO and INNOBUILD are trying to achieve this in the fields of solar architecture and energy conscious design, respectively, by providing educational resource material, by the organisation of architectural design competitions (currently one on passive cooling and one on upgrading apartment buildings), and by the dissemination of information (e.g. through research digests), etc.

FORTHCOMING R&D ACTIVITIES

Besides the extension of current R&D projects mentioned above (Characterization of Glazing for Daylighting Applications and projects in the Solar House programme) the following projects are envisaged in the course of the current framework programme:

The European Solar Radiation Atlas

A new extended and revised European Solar Radiation Atlas will be prepared. The geographical extension will cover Europe from the Atlantic to the Urals and from the Scandinavian territory in the North to Northern Africa in the South. The data provided will be a resource for solar heating, cooling and daylighting technologies. The final data base will be presented in a publication with multi-coloured maps and tables and on diskettes for PC-users. The atlas and diskettes will be accompanied by a guide for architects and engineers supporting the use of the data base for active and passive solar heating, cooling and for daylighting. The atlas will be prepared in collaboration with the World Radiation Centre in St. Petersburg. The total cost is estimated at approx. 1 M ECU (1.2 M USD).

European Data Base for Indoor Pollution Sources

The objective of this project is the production of a user-friendly European data-base on indoor pollution sources, quantified in chemical and sensory terms and taking into account both emission and sorption effects and including potential toxicological consequences of the emissions. The data base will also provide information on the source strength variation under different source and environmental conditions. The data base will cover building materials, building components and systems, e.g. HVAC systems. The total cost is estimated to be 2.0-2.5 M ECU (2.4-3.0 M USD).

Daylighting Design of European Buildings

Daylight monitoring in and around carefully-elected existing buildings and atria with a cheap monitoring equipment package specially developed for this purpose should provide the basis for further development of daylighting technology. The deliverables from this project will be:

the publication of a "Guide to Daylighting in Europe", the development of a cheap monitoring equipment package, introduction of daylight performance assessment into the European simplified correlation method PASSPORT and support of the further development of the LT-method, in particular with respect to the externally-reflected component, validation of ESP, PASSPORT, and the LT-method with respect to daylighting.

The total cost of the project will be on the order of 1.5 M ECU (1.8 M USD).

IEA SHC Solar Activities in IEA Countries Report 1993

Solar Energy Activities in Denmark

Ole Jensen
Danish Building Research Institute

INTRODUCTION

Solar energy research and development is carried out by private and public companies and research institutes. The Ministry of Energy supports the R&D through two different programmes, the Energy Conservation and the Renewable Energy programmes, which are described below.

Energy Conservation including Solar Energy in Buildings

This programme deals mainly with basic and applied research. The main goals are:

- to develop *new buildings* that, under Danish climatic conditions, do not need fossil fuel for heating and that have a minimum electricity consumption and environmental impact
- to develop methods and components for *existing buildings* that make it possible to halve the consumption of fossil fuel for heating, ventilation and domestic hot water without reduction in comfort and health.

Projects of high priority are:

- low energy houses
- vacuum windows
- aerogel windows
- aerogel solar collectors
- solar walls
- daylighting
- environmental aspects

The solar R&D programme was merged with the energy conservation programme in 1988 and includes both active and passive solar heating, but with the main emphasis on passive.

The programme participates in international R&D programmes, especially IEA and EEC programmes. The projects are carried out primarily by research institutes.

Renewable Energy R&D Programme for Solar Energy in Buildings

The objective of the programme is to bring R&D results into practical use. Its projects deal with information, demonstration and industrialization of systems, components etc. The projects are usually carried out collaboratively between industry and research institutes.

A new plan of action for the next three years identifies 3 main areas:

1. Improvement of the price/performance ratio

2. Quality assurance of solar energy plants

3. Information and demonstration

There is only limited international collaboration in this programme, but manufacturers are increasingly working together internationally.

THE GOVERNMENTAL RESEARCH PROGRAMMES

The government has submitted a plan of action for energy policy in Denmark. It calls for intensified energy R&D in the coming years. The main objective is to support the development of sustainable, environmentally-acceptable energy technologies. By the year 2005, the consumption of energy is expected to be reduced by 15% and CO_2 emissions by 20%.

The funding for renewable energy is increasing. For solar energy, there are 2 programmes.

The Danish Solar Energy R, D & D Programmes

	R&D Programme	D&D Programme
Name	Energy Research Programme	Renewable Energy Development Programme
Funding Agency	Agency of Energy	Agency of Energy
Goal	To develop new technologies	To increase the use of renewable energy
Funding	Approx. 12 mill. DKK per year (2 mill. USD/year)	Approx. 18 mill. DKK per year (3 mill. USD/year)
Researchers	Universities, sector research institutes, industry	Industry, sector research institutes, universities
Main activity	Passive solar energy	Active solar energy
Research strategy	Long term	Short term

PROGRAM STRUCTURE

[Organization Chart - Energy R & D Programme]

[Organization chart - Programme for Renewable Energy]

FUNDING

RENEWABLE ENERGY FUNDING

	1992		1993	
	mill. DKK	mill. US	mill. DKK	mill. US
Active solar	18	3	20	3
Passive solar	12	2	12	2

Photovoltaics	0	0	0	0
High temp solar thermal	0	0	0	0
Wind energy	9,5	1,5	8,8	1,4
Bio energy	5	0,9	6,5	1,0
Geothermal	0	0	0	0
Other (specify)	0	0	0	0
All renewable energy	**45**	**7,4**	**47**	**7,4**

SOLAR ENERGY FUNDING 1993
in $US

	R&D, incl. pilot plant, experimental building etc.	Demonstration projects	Market support, e.g. education of practitioners, information	National testing, certification, standardization
Active solar heating	1	2	5	1
High temperature solar thermal	0	0	0	0
Photovotaics	0	0	0	0
Passive solar	2	0	0	0

MAJOR PROGRAMME ACTIVITIES

Solar Houses

Two Danish Task 13 Low Energy Houses

Two rowhouse designs have been developed in connection with the Danish IEA SHC Task 13 project. The two building types face north-south and east-west respectively; thus one type is designed specifically to meet the challenge of an unfavourable building site. The design aim was to achieve a total energy demand lower than 6000 kWh/a including use of electricity, which presupposes a space heating demand lower than 1500-2000 kWh/a. In a normal year, Denmark has 1500 sunshine hours and about 2900 degree days at a 17 C base. A combination of superinsulation, heat recovery, active and passive solar, energy-efficient lights and appliances and water saving devices is used to reach the reduced level of demand.

Figure 1: The two rowhouses facing north-south (A) and east-west (B).

Figure 2: House type A - south facing rowhouse.

Figure 3: House type B - east-west facing rowhouse.

These are two-storey dwellings with a total area of 106 m^2 and a heated volume of 252 m^3. In the base case, the window area is 23 m^2 (13.5 m^2 south-facing and 5.5 m^2 in skylights) which is equal to 22 % of the floor area.

The slight curvature of the lop-sided roof with the one-sided slope creates a special cave-like quality in the inner rooms. All primary rooms are south-facing. The back rooms on the top floor receive sunlight through raised skylights. The vertical south side of the skylight construction is utilized for an array of solar collectors.

The challenge to be met in the design of these houses with the rows running north-south was to achieve satisfactory daylighting conditions and a substantial utilization of solar gains.

Some of the dwellings are one storey and other are two storeys, having a total area of 111 m^2 and a heated volume of 273 m^3. In the base case, the window area is 28 m^2 (8.4 m^2 south-facing, and 6.1 m^2 in skylights), equal to 25 % of the floor area. Under the south-facing windows, there is room for an array of vertical solar collectors.

The large, continuous quarter circular roof construction makes it possible to have some south-facing windows through which direct sunlight is transmitted to the main living rooms, i.e. the deck on the top floor and the family room/kitchen on the ground floor. Thus, substantial solar gains are achieved as well as untraditional rooms and lighting effects.

Calculated energy consumption

East-west running rows, A north-south running rows, B

(north and south facing facades) (east and west facing facades)

Built according to Code 7,240 kWh/a Built according to Code 9,000 kWh/a

Built superinsulated 1,060 kWh/a Built superinsulated 1,520 kWh/a

Built superinsulated^{+++} 520 kWh/a Built superinsulated^{+++} 870 kWh/a

(with aerogel windows everywhere) (with aerogel windows everywhere)

Total energy system for 100 houses in Ballerup

This project (Egebjerggård III) was established in 1991. It is supported by the EC Energy Demonstration Programme and the Energy Council in Denmark. The aim is to reduce the gas consumption to 40 % of the normal consumption in Denmark which would mean a yearly gas consumption of 70 kWh per m^2 housing area per year. At the same time, the intention is to reduce the water and electricity consumption to 30 % of the normal amount. A total energy design concept has been used whereby the total costs for the inhabitants, rent plus operation costs, are optimized as part of the design process for buildings.

These savings are combined with the use of a local co-generation plant and a low-temperature district heating design with pulse operation. Six m^2 of roof-integrated solar collectors per apartment are used for DHW and heating in this project. The extra costs for the total energy design mentioned will be approximately 9 % greater than a normal building project, leading to an improved economy for the inhabitants. In Egebjerggård III, an improved low-energy design for the buildings has been used, compared to the standard in the previous Tubberupvænge II project. This is especially true for the insulation standard, the ventilation system and the windows.

Heat recovery units are used for each 4 apartments. The heat recovery factor is 70 %, and the extra electricity use for this equipment is only 20 W per apartment or 150 kWh per year.

Heat from the small co-generation plant is transferred to six locally-distributed heat storage buffer tanks, which also function as storage for the local solar heating systems. The local storage tanks make it possible to obtain a district heating pulse operation, so heat is only distributed to the local storage tanks when all heat there is used up. This means that it will be possible to avoid nighttime operation of the low-temperature district heating network, and in sunny periods only few pulses or none at all are necessary.

Figure 4: Total energy design for 100 houses at Egebjerg near Copenhagen.

Winning project in the Nordic low-energy house competition

This project consists of three types of two-storey row houses with floor areas varying from 80 m^2 to 120 m^2. The project is entitled "Seven in one blow" because it incorporated a variety of energy conserving and solar energy features.

Figure 5: Model of the "Seven-in-one-blow" project.

The seven "blows" are:

- increased insulation
- low-e windows
- heat accumulating core
- hybrid solar heating
- active solar for DHW
- heat recovery
- common heat supply

Energy calculation for "Seven-in-One-Blow Houses"

	kWh/m^2 year
Room heating and ventilation	34
Domestic hot water	3
Electricity for ventilators	6
Household electricity	21
	64

At this time, 50 houses are under construction.

Solar Walls

Most of the buildings in Denmark have masonry or concrete walls. The old masonry walls are usually uninsulated and massive and thus are well-suited for retrofit with transparent insulating materials. Maintenance is a major problem for many concrete buildings, and a retrofit with solar walls can combine maintenance of the building with energy conservation.

The development of solar walls started in 1984, and 24 projects have been initiated since then for both new and existing buildings as well as ventilated and unventilated solar walls. Different transparent insulation materials have been considered, and market-available materials such as aerogel or vacuum windows may be the best solutions for solar walls. The main problem at present is the high cost. A solution to this could be prefabricated solar walls, and this approach is being tested in six projects.

Figure 6: Gable on existing block of flats retrofitted with an unventilated solar wall. Isoflex is used as transparent insulation while different materials are used in other projects. The yearly heat gain is about 100 kWh.

OTHER GOVERNMENT SUPPORT ACTIVITIES

Information activities

Government activities for information on solar heating include:

- Regional campaigns.
- Courses for HVAC companies.
- Certification of companies.
- Textbooks/design manuals/guidelines for consulting engineers.

Subsidies

Active solar heating systems are entitled to a subsidy of approximately 25 % depending on system performance as measured at the test station for solar heating plants.

Commercial activity

There are 8 manufacturers of solar heating systems, most with less than 20 employees.

Figure 7: Yearly number of subsidised solar heating systems.

OUTLOOK

The yearly sale of solar heating systems is increasing dramatically, due in large measure to local, concentrated campaigns supported by the Agency of Energy. Also, government information activities and quality assurance activities have contributed to increased consumer confidence that has been achieved since 1989.

The goal is to reach annual sales of 5000 solar heating plants. Manufacturers claim that at that level of sales they can reduce the price with 25 % and the future market would thus be secured.

PREVIOUS CONTENTS NEXT

IEA SHC Solar Activities in IEA Countries Report 1993

Solar Energy Activities in Finland

Peter Lund
Helsinki University of Technology

PROGRAM ORGANIZATION

The major goal of the Finnish energy policy is energy security and reduction of energy-related environmental emissions. Energy research brings a long-term perspective into the energy policy. In the 1990's, energy and environment problems are the central fields for national energy research which will focus the following topics:

- energy conservation
- development of new energy technologies
- environmentally-benign energy supply and use

The Ministry of Trade and Industry and its Energy Department is the main government agency for financing of energy R&D in Finland. Some minor funding of technology-specific projects has also been allocated by the Technology Development Center (TEKES).

All energy research in Finland is organized since the beginning of 1993 under 8 major R&D programs which are coordinated by various research organizations. The solar energy activities fall under two national research programmes:

NEMO (Advanced Energy Systems and Technologies)

RAKET (Energy Use in Buildings)

The NEMO-programme is coordinated by the Helsinki University of Technology and the RAKET-programme by the Technical Research Centre of Finland (VTT).

FUNDING

The total public funding for energy R&D in Finland is about 120 million FIM for the fiscal year 1992-1993. The funding level has been quite stable over the last five years. There has been a trend to stress long-term research. Table 1 summarizes the renewable and solar budgets. Passive solar research is classified under energy conservation in Finland.

TABLE 1: Public Funding Levels
(in Million FIM, 1USD=5.5 FIM, May 1993)

	1991	1992	1993
Active solar	0.8	0.6	0.7

Passive solar	4	4	4
Photovoltaics	4	5	5
Total domestic energy sources	52	55	55
Total building energy conservation	25	23	23

DESCRIPTION OF R,D&D PROGRAM

During the last ten years, Finland's energy research has been based on indigenous energy sources, mainly biomass, and energy conservation within both the industrial and residential sectors. Combined heat and power production has been a typical new energy conversion technology and accounts now for 20% of the national electricity production. Solar energy played a marginal role in government energy R&D in the past. The role of solar energy in the long-term has, however, been recognized as important which has resulted in increased R&D efforts and resources since the late 1980's. Environmental problems seem to be a driving force in favour of solar energy.

The basic energy R&D strategy in Finland stresses industry involvement. Industries should be more involved even in those fields in which a longer time horizon is needed, but where special applications or spin-offs may create new business opportunities already. Accordingly, funding is directed more to areas that interest Finnish industries and the private sector and where economic activities can be foreseen. To encourage such development, government funding is increasingly allocated through cost-shared projects in which the share of the private sector is at least 50%.

The NEMO-programme is the major national R&D programme in the field of new energy sources and advanced energy systems. It covers wind energy, active solar heating, photovoltaics and, to a lesser extent, energy storage and hydrogen technology. Major solar activities today relate to seasonal storage questions and photovoltaics. Photovoltaic building applications, district solar heating, and solar-hydrogen storage are some major solar-related projects in 1993.

Passive solar research is conducted mainly under the RAKET-programme. Low-energy buildings is one major research area included. The R&D efforts include work on transparent insulation, window technology, building envelope as well as full-scale experimental buildings.

Major recent R&D accomplishments for solar buildings comprise :

- demonstration of a solar heating system coupled with district heating
- several building-integrated photovoltaic systems
- demonstration of a commercial low-energy building with 50% savings
- demonstration of a solar-hydrogen seasonal storage concept

OTHER GOVERNMENT ACTIVITIES

Information

The Ministry of Trade and Industry supports information dissemination through its Information Budget. In practice, the Ministry allocates funds for various information forms, e.g. seminars, brochures, directly by application. Thus, no separate solar energy information activity exist, though research results on solar developments are publicized through government information channels. The national research programmes such as NEMO have a strong information function. A considerable amount of the research in the universities are also published internationally in various scientific or technical journals.

The Finnish Solar Energy Society plays an important role in informing both the public and its 200 expert members through seminars and a periodical.

Subsidies

Present government subsidies available for new energy systems, including solar, amount to 40% of the total system cost. Private persons may not apply for subsidies, but only legal organizations.

Standardization

In the field of standardization or certification, no active national work exists, and these needs are mainly taken care within the framework of Nordic co-operation (e.g. Nordtest) and the CEC.

European cooperation within the framework of the CEC JOULE-programme is given a high priority in the Government.

COMMERCIAL ACTIVITIES

Industrial activities in small active solar systems or collectors have been negligible except perhaps for agricultural drying applications. The interest in small solar domestic hot water systems is increasing. Storage technologies have been developed for large-scale applications mainly to be used in connection with combined heat and power plants, but the know-how is also applicable for seasonal storage solar heating systems.

Passive solar techniques are widely applied in the design of residential buildings. Large glazed sunspaces are applied to shopping and recreational centers on a large scale. Passive solar is also supported by extensive industries in the field of building and insulating materials and by HVAC industries.

The commercial interest in photovoltaic applications is large. The largest solar market today is found in small-scale PV installations (40-100 W) for summer cottages which are sold by the thousands each year. The national oil company in Finland has maintained a strong interest in developing further solar electricity. Starting with remote power systems with emphasis on photovoltaics and batteries, the expertise today includes manufacturing of thin-film PV modules as complete systems for building applications.

A recent update of the statistics on solar system installations is shown in Table 2.

TABLE 2: Solar System Installations (January 1993)

	number of systems	collector area, m2
Active solar houses	400	6000
Green houses	200	5000
Large glazed spaces		
Drying installations	1500	100000
Photovoltaics in summer residencies	10000	

OUTLOOK

The long-term potential of solar energy in buildings is significant in Finland due to its harsh northern climate. About 35 % of Finland's total energy consumption goes for heating buildings and providing them with electrical power. Solar energy could contribute some 5-10% of the national energy demand without causing large disturbances in the energy infrastructure. Barriers against solar in the long-term run are economic and institutional rather than technical. More effort needs to be directed for the medium-term on finding niches or special markets to increase commercial activities which in the long-term could have a significant energy impact.

The most established solar technologies today are passive solar and small-scale photovoltaics for summer residences. These two market segments are already a part of common business. The commercial medium-term outlook is good.

Active solar heating has not been commercially well-established in Finland although suitable applications exist. Most of the medium-term efforts are of an R&D nature. Seasonal storage technology is attractive on a long-term basis due to its energy independence. Also, large active solar heating systems for summertime district heating to replace oil-burners is a promising medium/long-term option. This special application has a potential for 300,000 m2 of solar collectors.

Photovoltaics in buildings is a new solar energy field that may be of future importance. Today, photovoltaics is mainly used in second residences to provide basic services such as lighting. The next step is to move into larger applications where PV is an integral part of a residential building's construction and energy system.

The Government's long-term view on energy issues may help to promote solar energy, at least in the R&D fields, but ultimately, the degree of solar utilization will depend on industrial involvement and strategies. Energy security, technical developments, environmental, and social issues may also increase solar utilization in the long term.

Figure captions:

1. A district solar heating system at Orivesi. The solar collectors are connected directly through a heat exchanger to an existing heating network.

2. A building-integrated photovoltaic system for vacation houses. The special PV-roof consists of a-Si modules and has an output of 2 kW. The house shown is totally self-sufficient in energy.

3. A solar-hydrogen system. In this unique solar energy system, electricity from PV-modules is stored as electrolytical hydrogen. The solar hydrogen is converted back into electricity in a fuel-cell in the wintertime. The pilot system shown is capable of meeting a 1 kWh/day electric load all year round.

PREVIOUS CONTENTS NEXT

IEA SHC Solar Activities in IEA Countries Report 1993

Solar Energy Activities in France

Yves Boileau
ADEME

PROGRAMME STRUCTURE

French Context

France has made significant progress in energy conservation and reduction of air pollution since 1974. Over a period of more than 25 years--thanks to a voluntary energy management programme--35 million tons of oil equivalent (TOE) have been saved, reducing CO^2 emissions by 30 million tons.

A large part of this has been achieved through medium or long-term government measures involving the building sector, including:

- Three successive sets of Heating Regulations (1975, 1982, 1989), each one resulting in a saving of approximately 25% of the energy needs of new residential buildings;
- Production of design guides and methods for various non-residential sectors, such as offices, medical facilities, hotels and educational buildings, for use of building engineers or architects;
- Research and development programs with industrial firms and builders, to improve energy-efficiency of buildings (through the use of new insulation materials, high-performance glazing,etc.) and appliances (through advanced boilers, smart heat-controllers, low-consumption light bulbs, etc.).
- Building sector energy use (houses, flats, commercial or public premises of all kinds), now accounts for 44% of the total annual energy consumption in France (180 MTOE in 1992). About half is used for space heating needs and 30% for electricity end-use.
- Enlarging the solar energy contribution, especially passive solar in buildings, has been a major concern since the beginning of the 80's. For example, the 1982 Heating Regulations prescribed calculation methods of thermal needs which took into account "direct solar gains," thus encouraging a better building design, and at the same time a wider use of solar components and systems.
- A national competition - significantly called "5000 solar houses contest" - was launched by our Ministry for Housing; it clearly emphasized a new positive approach of thermal building regulations and paved the way to a further step.

Structure

Among other various missions, the French Agency for Environment and Energy Management (ADEME), is responsible for coordination of the development of solar energy in building technologies. This public agency was created at the end of 1991 through the merger of three existing government bodies (1). It is in charge of promoting all new and renewable energies (active and passive solar, PV, wind energy, small hydropower, wood and other biofuels, geothermal and waste energy).

ADEME, which has no research laboratories of its own, receives an annual budget from 3 different funding Ministries (2), in order to support R & D, demonstration or information programs, dissemination and training activities.

(1) AFME (Agency for Energy Management and Renewable Energies), ANRED (Elimination and Recycling of Waste), and AQA (Air Quality)

(2) Ministry for Industry, Ministry for Environment, Ministry for Research

FUNDING

The annual budget of ADEME for all Renewable Energies amounts to about 100 MFF, out of which nearly 50% goes to what can be described as solar building technologies (Thermal and PV).

It must be specified that other national funding - especially for Research work and standardization - are directly allotted to Public Laboratories or Technical Centers, utilizing such national bodies as:

- CNRS (National Organization for Research)
- CSTB (Agency for Building Research and Certification)
- Ecole des Mines
- CEA (Atomic Energy Authority)

The figures indicated in the following chart must be considered as a general estimation. For topics such as modelling or simulation codes, daylighting technologies, building components or others, it is particularly difficult to identify what fraction of funding has to be dedicated to "passive solar."

RENEWABLE ENERGY FUNDING - FRANCE

1992 1993

MFF MUS$ MFF MUS$

ACTIVE SOLAR 14 2.3 20 3.3

PASSIVE SOLAR 3.5 0.6 3.5 0.6

PHOTOVOLTAICS 32.9 5.5 36 6

HIGH TEMP SOLAR 0.5 0.1 0.5 0.1

WIND ENERGY 7.1 1.2 11.4 1.9

BIOENERGY 30 5 25 4.2

GEOTHERMAL 25.8 4.3 26 4.3

OTHER

(SMALL HYDRO) 4 0.7 4 0.7

TOTAL 117.8 19.6 126.4 21.1

National public funding for Research, Development, Demonstration and Market support (training, information, incentives,...)

Figures for 1993 relate to approved initial budgets. These figures are likely to be reduced, due to recent Government decisions.

R, D & D PROGRAMME

Active Solar

In this field, a large number of solar applications have now reached a stage of technological maturity. Testing and standardization induced a global improvement of solar components quality and reliability. Low or medium temperature systems (up to 80-90 °C) have been developed on a semi-industrial level, and are currently commercialized over the territory. For instance :

- Solar heating of open air swimming-pools
- Single-family DHW systems
- Large DHW systems, for residential or commercial use on a year-round basis (hospitals, hotels, barracks,...)
- Active solar space-heating

During the recent years, the major areas of R & D have been:

- Selective coatings for solar absorbers
- High-performance vacuum-tube solar collectors
- Roof-integrated solar collectors
- High-temperature thermal fluids
- Simplified computer calculation methods for solar space-heating systems
- Low-cost monitoring tools
- Knowledge-based design tools
- Solar cooling experiments
- Research Institutions : CSTB (Modelling and computer tools, SDHW performance testing, Certification and Standards), Ecole des Mines (Collector testing, Modelling, Technical survey and monitoring), GENEC-CEA Nuclear Research Center (System testing, Technological studies, Monitoring).
- The public laboratories work in close cooperation with private companies.

The above activities have suffered from a significant reduction during the recent years, due to large restructuring of the industrial sector, and failures of firms facing a limited national market.

Passive Solar

As a result of new thermal building regulations, the majority of recent buildings have attained a high-level of thermal insulation and benefit from a wider use of solar gains. This situation results in relatively low energy needs; but it may also lead to mid-season or summer over-heating in most French local climates, if solar input through glazings cannot be properly managed. Consequently, selection of adequate components must take into account a large set of criteria, from heating contribution to day-lighting and human thermal comfort.

Research programs in this field concentrate on the following items:

Electrochromic glazings: CSTB Grenoble(Building material Dept.) and another Public Laboratory cooperate with St Gobain (Research Dept.) to define technical specifications and lead research actions (basic polymer electrolytes, metallic reflexive coatings,...). A first 30 cm x 30 cm prototype is expected in 1994, and larger size panes will then be measured on a test-cell at CEA Cadarache. A demonstration project building will probably be erected as the next step, in order to optimize control systems and solar sheltering.

Highly insulated windows using evacuated monolithic silica aerogels*:* Another 3-year research programme is in progress, in which CSTB, Ecole des Mines and a University of Lyons Lab. are collaborating with two manufacturers (St Gobain and PCAS). The aim is to produce a 30 cm x 30 cm prototype with a U-value of about 0.50 W/m^2K, acceptable manufacturing cost, and high direct transmittance factor.

Characterization and modelling of building components: The objective is to facilitate a greater use by building designers, and to integrate them in CAD tools. Major partners : Ecole des Mines, CSTB, CEA.

Design tools for education and training

Photovoltaics

The French PV programme is dedicated in part to supporting R & D activities on PV materials and cells, also to system testing, promoting and demonstrating PV technologies.

Photovoltaics goals at the horizon of the year 2000 have been proposed by ADEME in a "PV 20 Programme", which means:

- 20% crystalline silicon solar cell conversion efficiency, demonstrated to be achievable with low-cost industrial processes
- 20 FF per Wp selling price of PV modules
- 20 FF per Wp installed cost of large series of 100 kWp grid-connected plant
- 20 year system reliability with basic maintenance
- 20 MWp per year manufactured in France.

The financial aspects of this program are being negotiated with the ministries.

Industry research and development

Two technologies have been commercialized--crystalline and amorphous silicon. R & D on manufacturing cost reduction and conversion efficiency improvement are under study.

Other area of research include:

- Multicrystalline silicon: Casting ("Polix" process) of 70 to 130 kg ingots (16.4 % conversion efficiency has been demonstrated);
- Silicon purification enhancement by 80 kW thermal inductive plasma torch in progress;
- Wafering by wire-saw (0.2 mm thickness in production, and 0.1 demonstrated).
- Thin film amorphous silicon (a-Si): development of 30 cm x 90 cm double junction modules, high productivity CVD transparent conductive oxides, laser scribing and PV module encapsulation.

Public research

Several public laboratories carry out specific programs on crystalline silicon (cast and polycrystalline layers), amorphous silicon and thin-film polycrystalline materials (CIS). Collaborative activities and technology transfer are taking place with industrial firms.

PV modules and system testing

CEA-GENEC, Ecole des Mines, COSTIC (a technical branch of the Builders Federation) and LCIE (Electricity appliances Lab.) are the major partners of ADEME in this field. Long-term testing of a-Si PV modules are currently underway to check the degradation level of the conversion efficiency. Other ageing tests are being performed on associated components (storage battery, inverters), or small stand-alone PV systems. A limited PV-roof programme (six grid-connected PV houses located in the eastern part of France) will be monitored by a collaborative team including CEA-GENEC, CSTB and Ecole des Mines.

Package Systems

Down-stream R & D is also supported by ADEME, in order to help industrialize "PV generator-packages," designed and sized for domestic use (400 to 1000 Wp, dedicated to remote, not grid-connected sites). These PV systems are intended to meet basic electricity needs: lighting, refrigerator, TV set and small electrical appliances. As a result of a national Call for Tenders on this topic, several R & D programs have been selected and funded.

OTHER GOVERNMENT SUPPORT ACTIVITIES

Information

One of the major roles of ADEME is to help users (individuals, private and public decision-makers) to select more energy-conscious solutions, as well as to give them unbiased updated information on technical, legal, economic matters related to the building investment choices they are faced with.

This role is particularly important when it deals with solar products or systems, for these "new" techniques are not commonly well-described or widely-available. For this purpose, ADEME uses a wide range of information instruments: brochures and booklets, targeted information campaigns, videotex services (MINITEL), etc. ADEME's 26 regional branches, including those located in the four over-seas French departments, handle most of this local direct information service.

Training

Another important activity is promoting information exchange and knowledge transfer among professionals of all kinds, and organizing or facilitating specialized technical educational sessions. For instance, ADEME designed and funded "PHOTON," a mobile PV facility devoted to **practical training** of electricians, fitters and others. PHOTON is self-sufficient; a main PV generator allows the simulation of a large array of currently-used PV systems; an auxiliary smaller PV generator supplies power for measurement devices and micro-computers. Several six-day training courses (with 10 to 12 "students" each) have already proved that this pedagogical facility meets a real need in an effective way.

In the field of active solar, ADEME is preparing an equivalent training facility, which will be called "HELIOS", and which will be used by plumbers or other building craftsmen.

Subsidies and Incentives

The question of **subsidies and incentives** is really difficult to present clearly or to summarize, because the procedures are not stable or permanent, and they can depend on different funding levels (European Community, National, Regional and sometimes local). The present situation can roughly be described as follows:

In the **active solar** field, national subsidies for SDHW systems were available from 1979 to 1984. They provided financial incentives for purchasers and were intended to help open the national market. When the French Government decided to terminated them in 1986, the market declined rapidly and a large number of manufacturers disappeared. The subsidies are now restricted to four French overseas departments, namely French Guyana, Caribbean and Reunion Islands, and Corsica; they amount 12 to 15 % of the purchasing price of SDHW systems.

A demand-side-management programme is being prepared between ADEME, the Ministry for Industry and EDF (national electricity utility) in order to promote low-cost solar systems in these areas. In fact, substituting SDHW systems for electric boilers, the penetration of which is growing rapidly, would undoubtedly lead EDF to save operational or new investments costs. (Local production costs are higher than in continental France, but electricity prices are the same all over the national territory).

Some southern regions in continental France and Corsica maintain a certain level of demonstration programme support for solar hot water in residential or community buildings (health, hotels,...), under the "Guaranteed Solar Output" quality label. These projects are generally part of the European Community "THERMIE Programme".

In other eastern French regions characterized by rather long and often sunny winters, subsidies are given to individuals who invest in solar space-heating equipment for their house. This technology is called " Solar Heating Floor", because heat from the collectors is directly circulated in low-temperature polyethylene coils embedded into a thick concrete floor (no storage tanks). More than 200 houses of this type are presently in operation. Although this system shows a significant over-cost and needs auxiliary heating, it works satisfactorily. Reference sizing is 12 to 15 m2 roof-integrated liquid solar collectors for a 100 to 120 m2 floor area. The solar system also delivers domestic hot water, especially during mid-seasons and summer.

In the **Photovoltaics** field, subsidies are now limited to relatively small programs, or apply to limited geographical areas such as French overseas territories. More than 4500 French families live in stand-alone PV houses, installed within rural electrification programs developed on these remote islands (EC, national and regional funding). In addition, a project of 40 PV houses is in progress on both sides of the Pyrenees region, in cooperation with Spain, as part of a THERMIE PV Programme.

On the other hand, a negative decision has been made about extending a pilot demonstration of grid-connected PV houses (6 houses of 1 to 3 kWp located in continental France) to a larger programme.

Standards and Certification

Active solar

Thermal performance measurement standards of solar collectors were first prescribed in 1980, and a rather extensive set of other standards and professional rules now cover different aspects of solar collectors and individual SDHW systems. Most commercial solar equipment apply for a certification procedure ("Avis Technique", or Technical Agreement), which can be easily linked with other European countries' procedures within a unified EC Solar certification process.

Passive solar

Passive components first of all are building components. Among other purposes, R & D modelling of these components (see above) allows a simple way to compare their thermal performance or behavior, from a standardization point of view. Furthermore, it should be noted that new dwellings will soon be legally required to utilize "energy labelling" (similar to those used for electrical appliances such as refrigerators, washing machines...).

Photovoltaics

From the very beginning of France's involvement in PV technology through AFME, emphasis was given to ensuring high-quality and reliability of PV components and systems. In partnership with manufacturers, users and ADEME, UTE (a national organization for standards in the electricity field) implemented standards for crystalline silicon PV modules and components. Some of these modules will probably be soon subjected to a Quality Insurance Procedure. Standardization is current being extended to amorphous silicon PV modules and systems.

COMMERCIAL ACTIVITY

Status of the Industry

Active solar

During the first half of the 80's, there were more than 30 manufacturers or importers of solar thermal collectors in France. Most of them were small firms which commercialized very similar products on a local or regional range. As stated previously, the national market remained too limited, and the majority of those firms ceased activity after 1986.

By the beginning of the 1990's, this number had decreased to 6 or 8 companies which manufactured less than 50,000 m2 of solar collectors. The present situation shows no significant improvement, despite public concern about environmental problems.

Three manufacturers continue to produce and commercialize active solar systems:

GIORDANO - all types of collectors (unglazed, selective glazed, vacuum tubes) and SDHW systems (Integral-Collector-Storage, thermosyphon,...)

T2I - selective roof-integrated collectors for "solar floor heating" and SDHW systems

SUNWIND - ICS Solar Domestic Hot Water Systems

GIORDANO is the only firm to have developed permanent export activities (primarily to European countries and French overseas departements) which amount now to 70 % of its sales.

Passive solar

Very few specialize building products can be identified and commercialized as "passive solar" ones. The building crisis made most manufacturers reduce innovative investments and stick to conventional components marketing.

Frame and glazing manufacturers such as St GOBAIN are the only ones to maintain a high activity level on developing and selling advanced components (high performance windows, sunspace components,...).

Photovoltaics

PHOTOWATT International, NAPS FRANCE and SOLEMS are the French manufacturers of PV cells and modules. They represent approximately 4 % of world production in 1992.

PHOTOWATT (multicrystalline silicon) has just moved to a new manufacturing plant near Lyons. It manufactured nearly 1.8 MWp in 1992 and expects its production to reach 9 MWp by 1996.

NAPS FRANCE (amorphous silicon), located in the north of France, manufactured about 0.6 MWp during the last year. SOLEMS specializes in custom-made modules for mini-power professional applications.

Most of the PV production is exported to foreign countries and French overseas territories.

State of the Market

Market penetration of active solar technologies (thermal and PV) in France remains very low, even if we include the encouraging results obtained during the last decade in the French Caribbean, Reunion, Polynesia and New Caledonia Islands. Generally, only "niche markets" have been detected. For instance, in the case of remote areas where grid extension remains a long-term hope, PV technologies present a real opportunity to bring basic electricity services (light, food-conservation, communication) to the inhabitants.

Adoption of active solar technologies in continental France has suffered greatly from the low prices of competing fuels (fossil fuels and even electricity) over the last years. During the period 1976-1986 period, 250,000-350,000 m2 of solar collectors were installed. It is very unlikely that there could be a market of such size for thermal solar systems today, given today's conventional energy prices.

Passive solar leads is a rather different situation. Even if a great deal of improvement is still to come, technical or economic barriers are not major issues. The problem is the lack of user demand for passive solar design or devices, both by individuals as well as from national or local authorities and town-planners.

PREVIOUS CONTENTS NEXT

IEA SHC Solar Activities in IEA Countries Report 1993

Solar Energy Activities in Germany

V. Lottner
Forschungszentrum Jülich GmbH

PROGRAM ORGANIZATION

R&D on solar energy is carried out in Germany under the "3rd Program on Energy Research and Technologies" of the Federal Government. The energy program was initiated 1974 immediately after the first oil crisis with the aim to reduce the strong dependence on imported oil and to save fossil energy resources. Currently, the main emphasis of the energy policy is on the protection of the environment and the climate. The public as well as politicians have realized that a reduction of the CO2-emissions into the atmosphere is necessary in order to avoid drastic global changes of the climate in the long term. Due to its high risk, nuclear energy is still controversial and has not been accepted by all people. At present, however, 95 % of the energy supply of Germany is based on fossil energies and nuclear energy, and only 5 % is provided by renewable energies (hydropower).

As early as 1990, the Federal Government committed itself to reduce the CO2-emissions by 25 % - 30 % by the year 2005. Therefore it has been agreed by all political parties that all necessary R,D&D efforts will have to be undertaken to achieve this goal. In particular, rational use of energy, energy conservation, and utilization of renewable energies have received an even higher priority than before in the third Program on Energy Research and Technologies. The energy program is funded by the Federal Ministry for Research and Technologie (BMFT) and is managed by Forschungszentrum Jülich GmbH (KFA), Projektträger Biologie, Energie, Ökologie (BEO) which is responsible also for the management of programs on biology and ecology. The organizational structure is shown in Figure 1.

Federal Ministry for Research and Technology
(BMFT)

BMFT

Forschungszentrum Jülich GmbH
Program Management
BEO/Biology, Energy, Ecology,
R&D, D-projects

Industry

Research Institutes
(FhG, MPI, ...)

Universities

Figure 1: Organizational Structure

FUNDING

Table 1 gives the breakdown of the budget allocated for each of the major topics of the subprogram "Renewable Energies and Rational Use of Energy". After a strong decline after 1980, the budget has been continously increased since 1986 (Chernobyl). The present annual budget of 280 million DM (BMFT-expenditures) will be kept fairly constant for the next years despite the severe financial burdens and constraints of the Government.

Table 1: Funding for Renewable Energies and Conservation
(BMFT-expenditures in million DM)

	1991	1992	1993	1994
Photovoltaics	104.9	94.9	97.0	90.0
Wind Energy	17.6	25.5	36.0	40.0
Southern Climates	42.4	38.0	36.0	30.0
Active and Passive Conservation in Buildings	22.2	30.0	30.0	40.2
Secondary Energy Systems	16.8	20.0	13.0	13.0
Hydrogen	23.2	33.5	33.0	31.0
Energy Conservation in Industry	17.1	15.0	13.0	10.0
Geothermal	6.0	6.0	6.0	5.9
Biological Energy Production	16.0	39.4	6.5	4.0
Others	10.7	11.0	12.5	12.5
TOTAL	**276.0**	**313.3**	**285.5**	**279.1**

Industrial projects are funded on a 50 % cost-sharing basis. Basic research is carried out by universities and research institutes of the FhG and the Federal States (Table 2) preferably in close cooperation (compound projects) with the industry. In this way, the program is very much application-oriented. After the unification of Germany, a major policy issue has been the consolidation and integration of research institutes and industrial research of the New Federal States into the program.

TABLE 2: Major Renewable Energy Institutes

Fraunhofer Gesellschaft (FhG)
• ISE-Freiburg Photovoltaics: Solar cells, system technology, fuel cells, solar hydrogen • Active and passive solar technologies • IBP Stuttgart Building research, low energy buildings, daylighting • ISI-Karlsruhe System studies, evaluation
Max Planck Gesellschaft (MPI)
• MPI Berlin Photo(electro)chemistry
Forschungszentrum Jülich (KFA)
• ISI Solar thin-film technology • IEV Hydrogen technology, fuel cells
Deutsche Forschungsanstalt für Luft und Raumfahrt (DLR)
• DLR Stuttgart Solar thermal power plants, solar chemicals
Solar Institutes of the States
• ISFH-Hannover Active and passive solar, photochemistry • ZSW-Stuttgart Solar hydrogen, photovoltaics • ISET-Kassel Photovoltaic system technology, wind energy • ZAE Bayern Active solar, thermal energy storage, Heat pump technology, photovoltaics

The program comprises both basic and applied research, development and demonstration in all significant technology areas. Photovoltaics is given a high priority (Table 1). R,D&D includes investigations and development of high-efficiency solar cells (single and polycristalline Si, CIS), thin film solar cells and the development of new production technologies for the basic material and cells in order to achieve a better cost-effectiveness of photovoltaics. System technology is demonstrated in an extensive field test, the "1000 solar roof program" (see the following section).

Another main topic of the program is wind energy (Table 1). To support the implementation of wind energy converters of medium capacity (50 - 300 kWp), the 250 MW-wind program has been launched. So far, more than 1000 wind energy power plants have been erected mainly in coastal areas with a total installed cpacity of 150 MWp. The surplus energy can be fed into the grid with favourable prices (0.166 DM/kWh) according to a new governmental regulation.

The topic of "Technologies for Southern Countries" deals with the development and demonstration of solar and wind energy technologies which can be applied particularly in southern countries with high solar insolation and an inadequate energy supply in remote areas. Joint bilateral projects include especially cooperation with developing countries. R,D&D comprise both solar thermal power plants (dish, farm and central receiver), photovoltaics (water pumping, telecommunication) and the utilization of process heat for industrial and agricultural applications (e.g. absorption cooling, desalination, drying). The reliability, performance and acceptance of the new technologies is to be proved by pilot installations and extensive demonstration programs in southern countries (e.g. Eldorado: 500 PV-systems with a total installed capacity of 500 kW and wind converters of 20 MW). A main objective of the joint projects is to support technology transfer to developing countries.

Solar hydrogen (table 1) is considered to be a long term option for an energy supply based on solar energy. An extensive R,D&D program includes the test and demonstration of components (e.g. electrolyser, fuel cells) and system technologies. Two large-scale demonstration plants with PV-generators have been erected and are being operated for this purpose, one in Bavaria (280 kWp) and the other one in Saudi Arabia (350 kWp).

The greatest potential for substitution and conservation of fossil energies in Germany still exists in the energy supply of buildings. Rational use of energy, energy conservation, active and passive solar technologies are able to reduce the present energy demand for heating and cooling, daylighting and electric appliances significantly. The following chapter presents the R,D&D activities in this area.

PROGRAM DESCRIPTION

The main activities in active and passive solar energy technologies, as well as energy conservation in buildings, include the following subjects:

Active Solar Technologies

- Long Term Monitoring Programs
- Standardized Dynamic Test Procedures
- R&D on Innovative Components and System Concepts
- Demonstration Program: Solarthermie-2000

Thermal Energy Storage

- Seasonal Storage Technologies
- Innovative Storage Concepts for Heating and Cooling

Passive Solar & Energy Conservation Technologies

- Innovative Materials, Components and Systems
- (Solar) Low Energy Buildings
- Thermal Modeling, Analysis and Design Tools
- Daylighting

Active Solar Technologies

Long Term Monitoring Program

The extensive long-term monitoring and inspection program on solar installations in public buildings is being continued and will be extended until 1995. In the past 10 years, monitoring programs have revealed a great number of deficiences of the plants which were installed between 1978 and 1982. Based on these results, the installations have been repaired and the performance improved considerably. The monitoring programs also provide useful results about the lifetime of materials and components. The results will be used for a improved design and construction of future installations with better cost-effectiveness.

Standardized Dynamic Test Procedures

The high quality (performance, long-term reliability) of the installed solar system is a necessary prerequisite for the market penetration of solar technologies. Standardized performance criteria and test procedures are being developed and validated for the qualification test. Recently, a short-term dynamic test procedure for small solar DHW-systems has been developed in cooperation with the IEA-Solar Heating and Cooling Program Working Group. The short-term outdoor test can be performed in a few weeks at a reasonable cost. The annual solar contribution can be calculated with the experimentally-determined system parameters. Current investigations of the joint effort of DIN e.V. (National Bureau of Standards) and several institutes in cooperation with IEA-Task 14 are focused on test procedures for large-scale installations and in-situ tests.

Innovative Components and Systems

At present the cost-effectiveness of solar technologies is still poor. Therefore, a main goal is to reduce system and installation costs through simplified concepts, integrated storage collectors, roof-integrated collectors. An evacuated tubular solar collector with integrated storage is being developed. New selective absorber coatings (cermets) are being developed which can be deposited very homogeneously in large areas by sputtering. To improve the cost-effectiveness of solar DHW systems, several concepts of new solar preheating systems are tested in pilot installations.

Demonstration Program: Solarthermie 2000

Recently, the demonstration program "Solarthermie-2000" was approved by BMFT. About 100 million DM are allocated for the period 1993 and 2002 to support the installation and monitoring of about 100 large scale solar heating plants. These will be installed in new or retrofitted public buildings mainly in the New Federal States. The program Solarthermie-2000 includes the erection and monitoring of several large-scale solar assisted district heating plants in the western part of Germany. It has been shown that large-scale centralized solar systems (district heating systems) can be constructed at lower specific system costs (Figure 2). Today many municipalities, utilities and housing companies in Germany are interested on this concept for the development of new urban areas. It provides an pollution-free energy supply with reduced CO2-emissions. The pollution-free energy supply improves the quality of life and value of small villages and new suburbs.

Thermal Energy Storage

Seasonal thermal energy storage is an essential component of solar district heating systems. The solar fraction can be enlarged by seasonal storage to 60 - 80 %. So far, the specific storage costs, however, are too high for the application. Ongoing R,D&D is devoted to new innovative storage concepts which show the potential for better cost-effectiveness. The following storage concepts are being developed and demonstrated in pilot plants:

water pit storage

duct storage in soil

aquifers.

An initial pilot plant of a 1000 m3 hot water pit store has been designed and will be erected by the utility of Rottweil. The pilot store can be used as a buffer for the utilization of waste heat of a combined heat and power plant. Thermodynamic and hydrogeological investigations deal with the thermal energy storage in soil (temperatures up to 80 C). The installation of a "high temperature" duct storage and an aquifer storage is being examined in preliminary site investigations.

Duct storage systems can be used for both heating and cooling. During the heating period, the ground coupled heat pump lowers the temperature in the soil. In summer, the generated cold can be used for direct cooling in air conditioning systems. Long-term monitoring programs on some demonstration plants will indicate the performance of this hybrid concept.

The advanced storage technology GALISOL of a new dynamic latent heat store enhances the thermal power considerably. The technical feasibility has been shown in previous pilot installations.

Future R&D deals with new materials which can be used for new applications (high temperatures) and to substitute for the CFCs of the internal storage process.

Passive Solar & Energy Conservation Technologies

The main focus of the program is the reduction of the specific energy demand of new and existing buildings. Priority is given to the development of innovative materials, concepts and system integration including transparent insulation, switchable glazings, advanced windows and hybrid systems. These technologies reduce the heat losses and the specific heating demand of buildings.

The most prominent example is transparent insulation which can be used to cover facades both in new and existing buildings (retrofit). The first pilot installations demonstrate that the specific heating demand can be reduced to a small fraction of its original level. Further R&D is devoted to the integration of the transparent insulation in system modules which avoid overheating in summer (automatic roller blinds). New materials (e.g. glass capillaries, aerogel) are being developed for a higher temperature stability. So far, the commonly-used polycarbonate cannot withstand high stagnation temperatures in solar collectors and cannot fulfill the requirement of inflammability as a building component.

Another concept involves high-efficiency heating systems which are based on hybrid air systems with controlled ventilation and heat recovery from the exhaust air. Solar energy can be collected by windows and facade air collectors and stored in the building mass (floor, wall slabs with air ducts). A joint effort of universities and companies deals with basic investigations and the development of solar-assisted (hybrid) air heating systems.

Another main topic of the program comprises investigations of integrated concepts and strategies for (solar) low energy buildings. The standard of 50 kWh/m2 a of the specific heating demand can already be achieved with commercially-available technologies. This has been shown in recent demonstration projects. In Heidenheim, 5 semi-detached houses were constructed which are equipped with different conservation techniques (improved heat insulation, low-e window) and heating technologies (floor and air heating with heat recovery). New pilot projects will demonstrate the technical feasibility of very low and even zero energy buildings including the energy demand for heating and electric appliances.

Several houses have been designed and are built with an zero (heating) energy demand. The two buildings in Rottweil (demonstration of a low-energy building with a specific demand of 20 kWh/m2 a with existing technologies) and in Berlin ("Ultrahouse Berlin": zero energy heating demand) are the German contribution to IEA-Task 13: Solar Advanced Low Energy Buildings. The well-insulated "Ultrahouse Berlin" is designed to cover the remaining heating demand of about 5 MWh/a with an active solar heating system including a 17m3 seasonal hot water storage tank which is integrated into the house.

Figure 3 shows the Freiburg autonomous energy house which was inaugurated in October 1992. The total energy demand of heating, hot water, electric appliances and cooling will be supplied by active solar thermal and photovoltaic systems. The single family house with a living area of 145 m2 is highly-insulated (twofold double-glazed, low-e windows, south facade covered by transparent insulation) and equipped with innovative technologies, in particular with a new high-efficiency solar collector (14 m2 aperture), 84 PV-modules (34 m2) consisting of monocrystalline solar cells (installed capacity 4.2 kWp), electrolyser, fuel cells and hydrogen and oxygen storage tank. The aim of the project is to test advanced components and the system integration of solar technologies. The results of the extensive monitoring programs will be used for the improvement and development of advanced technologies.

An important subject is the proper design of buildings. Available analysis and design tools have to be evaluated and validated. Daylighting programs have been developed which could be successfully implemented into thermal modeling programs.

Photovoltacis Program: 1000 Solar Roofs

The program is being funded under the Photovoltaics budget with 50 million DM between 1990 - 1994. Actually more than 2,250 grid connected PV-systems of 1 - 5 kW capacity have been installed in one and two family houses. Fifty per cent of the investment costs are paid by BMFT, and 20 % by the Federal States. Surplus energy can be fed into the grid at a favourable price (0.1666 DM/kWh) as in the case of grid-connected wind power plants. To qualify for the subsidy, installation costs may not exceed 27,000 DM/kW. The objectives of this large-scale field test and demonstration program are:

- To acquire installation experience and reliable operating data
- To demonstrate architectural concepts and design of roof integrated panels
- To support and facilitate uniform licensing and commissioning regulations in the Federal States
- To motivate occupants to utilize energy-saving appliances and to optimize energy management (matching of the energy generation and energy demand).

OTHER GOVERNMENTAL SUPPORT ACTIVITIES

Information

A special information service BINE (Bürgerinitiative Neue Energiequellen) in the Fachinformationszentrum Karlsruhe (FIZ) publishes project results and distributes project brochures to the public. Status seminars are arranged periodically by BEO to keep scientific and technical experts informed of developments. The results are published in Status Reports.

Subsidies and Incentives

Until 1991, the implementation of energy conservation and renewable energy technologies was supported by a tax credit program of the Federal Minister of Economic Affairs. A new program prepared for the extension has not yet been approved by the Government due to severe financial constraints of the Governmental budget. Meanwhile the Federal States promote energy saving and renewables by their own demonstration programs. In general, subsidies of 20 % - 30 % of the investment costs are granted. In 1992 more than 8000 solar thermal installations have been commissioned by the States with grants of 25 million DM. Not all submitted applications, however, could be approved due to the lack of available funds.

Standards

A new building code ("regulation of heat protection") has been submitted which reduces the present standards of the specific heating demand of buildings by a factor of 2 to the limit of 50 - 100 kWh/m2a. The new regulation has not yet been approved by the Government.

Recently a standard test procedure for solar DHW systems was established by DIN e.V. It supplements the existing DIN 4757, part 1 - 4. The test procedure has also been submitted to the International Standards Organization (ISO).

COMMERCIAL ACTIVITIES

Figure 4 shows the status of commercialization and implementation. After a strong recession in 1981, the market has expanded significantly, especially during the last few years. According to a survey of manufacturers, about 150,000 m2 solar collectors including absorbers were produced annually in 1991 and 1992. Thus far, about 200 outdoor swimming pools have been equipped with solar heaters totalling 135,000 m2 of solar absorbers.

There are about 15 small manufacturers which are organized in the association DFS (Deutscher Fachverband Solarenergie). The bigger companies producing and marketing PV-systems are organized in BSE (Bundesverband and Solarenergie). The companies are considering enlargement of their production capacities for mass production. However, such a move is viewed as very risky since the market is not yet stable. The industry strongly supports a CO2-tax and the increase of the price of fossil energies in order to increase the economic competitiveness of renewable energies.

OUTLOOK

A decade ago, the market for solar energy technology declined greatly as a result of low energy prices decrease of governmental support for R,D&D. Fortunately, the present situation is much more promising and favourable for renewables. The public awareness for the protection of the environment and the climate generates a strong impetus and support for development of renewable technologies. The Government has committed itself to a CO2-reduction of 25 % by the year 2005 and has given R,D&D a high priority in the energy program.

The basis for the market implementation is the technological progress which were achieved during the last 10 years. Today the public confidence in solar technologies is much higher then ten years ago. However, there still exists the need to improve the cost-effectiveness as a prerequisite for a larger solar market.

PREVIOUS CONTENTS NEXT

PREVIOUS CONTENTS NEXT

IEA SHC Solar Activities in IEA Countries Report 1993

Solar Energy Activities in Italy

Dr. Dario Malosti
ENEA

GOVERNMENT OBJECTIVES

Energy Strategy

The latest version of the National Energy Strategy, issued in 1988, stated a goal of 3% contribution by all renewable energy technologies (RETs) by the year 2000 (equivalent to about 5 MToe) at an overall investment cost of about $US 27 x 10^6. (The share of solar thermal technologies would be about 0.2 MToe.)

Unfortunately, due to subsequent funding reductions and to the limited results of many incentive campaigns carried out in the past, this goal has remained far from its accomplishment.

Realistic evaluations show contributions by RETs in 1992 of no more than 0.2% of all the national energy consumption, which amounts to almost 170 MToe), and updated forecasts now project a contribution by RETs of around 0.3 - 0.5%.

It now appears that the actual importance of renewable energy will be more as a way to augment the energy conservation measures instead of making a significant contribution to the national energy balance.

Energy Saving Potential in Existing Buildings

In Italy there is a stock of almost 25 million existing dwellings; this stock increases at a low rate of about 1% per year. As a result the effects of new energy standards or solar energy technology applications on new buildings have only long-term results, with very limited impact on the current practice of designers and users.

On the other hand, almost one-third of the overall energy consumption goes for residential or commercial building use so there is great potential for energy savings through conservation measures (that are most cost-effective) and solar energy technology utilization.

Nevertheless, the expected results in terms of wider solar energy technology diffusion have been disappointing due to the following reasons:

1. Specific energy consumption (Kwh/m^2) is generally low due to favorable climate conditions.

2. The public favors energy saving measures that rely more on heating plant control provisions (i.e., operating time reductions) rather that on more expensive measures involving new equipment or modification of the building structure.

3. There are wide differences among diverse geographic regions that result in diverse heating requirements (the degree-days in the north are almost three time those of the south.

PROGRAM ORGANIZATION

The most important government agencies involved in RETs and energy conservation research, development and demonstration activities are:

ENEA (National Agency for New Technologies, Energy and the Environment) which has responsibility for RET research, demonstration and applications, specifically for solar thermal energy applications in buildings.

ENEL (National Electric Utility) that has program on RETs for electricity production (with limited applications for buildings) and solar thermal power plant feasibility studies.

CNR (National Research Committee) which carries out some research activities on RET applications and energy conservation.

Some other minor programs are underway by private research organizations funded by manufacturers, mainly in the field of new transparent insulation materials.

FUNDING

Funding for RET activities is difficult to determine precisely due to the economic autonomy practices in each involved organization.; a rough preliminary overview is provided in Table 1.

As shown in the table, funding in the solar field (passive, active and high temperature activities) are quite small and level, just sufficient for maintaining and updating the know-how and for supporting limited R & D. (Subsidies are not included.)

In contrast, the major national efforts are focussed on wind and photovoltaics technologies, with important and costly demonstration programs specifically devoted to remote area applications where favorable cost-benefit ratios exist.

R & D funding is fairly constant for all programs (at an annual total of about M$US 65), but individual values peak where costly demonstration power plants are planned for erection, as for wind and PV technologies.

Table 1. Funding for research, demonstration and information programs.

	1992		1993		1994	
TECHNOLOGIES	10^9 L	10^6 $US	10^9 L	10^6 $US	10^9 L	10^6 $US
ACTIVE SOLAR	0.15	0.1	0.5	0.3	0.5	0.3
PASSIVE SOLAR	0.25	0.2	1.6	1.06	1.6	1.06
PHOTOVOLTAICS	70	46.6	80	53.3	80	53.3
HIGH TEMP. SOLAR THERMAL	1.0	0.7	0.1	0.07	0.1	0.07
WIND ENERGY	20	13.3	22.0	14.5	58	38.6
BIOENERGY	6.3	4.2	27.3	18.2	4.7	3.1
ALL RENEWABLE ENERGY	97.7	65.1	131.5	87.4	144.9	96.4

MAJOR AREAS OF R, D & D FOR SOLAR BUILDING TECHNOLOGIES

The most important areas of research, development and demonstration underway are described below.

Design and Analysis Tools

Activities are aimed at the development and validation of analytical tools for building design and energy performance analysis, with the goal of making available:

simplified PC tools for European regulation applications and comparisons with the standard national regulatory body.

Analytical tools for best estimate simulations of the energy behavior of the overall system integrating the building structure and the heating/cooling plant.

To this end, the activities emphasize the implementation within such analytical tools of new components and systems which have the potential for wider national exploitation, e.g., low energy cooling systems, air heating system for the typical local climatic conditions as the Barra-Costantini component, advanced transparent insulation materials, etc. (ENEA, University of Udine).

Other major programs include:

- Design of a new experimental building in tune with southern climatic conditions with specific attention to passive or semi-passive cooling systems (ENEA, Universities of Milano and Palermo).
- The energy and optical characterization and the development of advanced transparent insulation materials (ENEA, Stazione Sperimentale del Vetro, University of Pisa, University of Torino, Galileo Ferraris Institute, etc.).
- Satellite data compilation for local solar radiation mapping of the overall national surface, for designing and solar resources evaluation purposes (ENEA). See Figure 2.
- Participation in IEA activities through many national institutions and research agencies (ENEA, Universities of Milano, Torino, Palermo, etc.)

Fig. 2: Monthly averaged daily global radiation in Italy by satellite data compilation.

OTHER GOVERNMENT SUPPORT ACTIVITIES

Subsidies and Incentives

Diffusion and support activities for new national regulations or local regional rules are the responsibility of ENEA and standard technical bodies (UNI, for example).

There are two main initiatives in place for incentives for the use of solar energy or energy saving technologies:

1. Tax credits for no more than 50% of all the expenses for RET installations.
2. Grants up to 40% of the costs, based on locally-fixed criteria.

At this time there are no systematic evaluations of the market effects of these subsidies; preliminary analysis seems to indicate that the market does not react as expected, due primarily to two negative aspects:

1. The incentive policies have always been oriented to the end user who has to take the overall

financial risk of the renewable energy installation

2. The past incentive policy did not produce any long term positive selection among the different market players.

COMMERCIAL ACTIVITIES

The cumulative effects are now that the overall production of solar collectors, which in the 1980's exceeded 80,000 m^2/year, fell to 5,000 m^2/year with less than 10 manufacturers still left on the market.

Only local authorities seem to maintain an interest in promotional activities in favor of solar technologies (Sicily and northern regions with simplified administrative procedures for incentive mechanisms).

The negative could be reversed through a different incentive system based on the promotion of new energy service companies that supply solar energy and which assume all financial and maintenance risks.

Regarding passive low energy building design, there are only about 150 structures in Italy which could be classified as bioclimatic designs. (See Fig. 1 for one example.) Many of these suffered technical (e.g. overheating) and cost problems due mainly to the mechanical application of design criteria more appropriate to northern Europe than the Mediterranean climatic conditions.

OUTLOOK

Despite the disappointing experiences of the past, there are several reasons for optimism regarding the potential for wider diffusion of solar energy in Italy:

- the favorable climatic conditions
- the interest of people in solar and energy saving technologies despite the low energy consumption for heating in certain southern regions
- the positive attitude of designer and the solar industry which now recognizes the need for better and more reliable solar energy products and validated design methodologies
- Growing awareness that more serious interventions must be taken regarding alteration of the building structure and conditioning equipment if the ambitious goals for energy savings in buildings are to be achieved.

PREVIOUS CONTENTS NEXT

IEA SHC Solar Activities in IEA Countries Report 1993

Solar Energy Activities in Japan

Dr. Sakae Tanemura
Government Industrial Research Institute

DESCRIPTION OF NEW SUNSHINE PROGRAM (NSS)

In early 1993, the Ministry of International Trade and Industry (MITI) combined three programs to form the New Sunshine (NSS) Program under MITI's Agency of Industrial Science and Technology as a comprehensive approach to achieve sustainable growth through simultaneous solution of energy and environmental constraints. The three programs were:

1. *The Sunshine Project* which was intiated in 1974 to develop new energy technology including all new energy technologies .
2. *The Moonlight Project* which was established in 1978 to develop energy conservation technology.
3. *The R & D Project on Environmental Technology* which was initiated in 1989.

The New Sunshine Program will run until 2020 with a total estimated budget of 1,550 billion yen ($US 14 billion). It comprises the following three technology areas:

- Innovative Technology Development - The accelerated development of innovative energy and environmental technology to support the Global Warming Prevention Action Plan. Budget: 500 billion yen (US$ 4.5 billion).
- International, large-scale collaborative research - Promotion of large-scale, innovative technology development projects to support the Earth Regeneration Program. Budget: 900 billion yen (US$ 8 billion).
- Collaborative R & D on appropriate technology - Support for neighboring developing countries through joint R & D on appropriate energy and environmental technologies. Budget: 150 billion yen (US$ 1.4 billion).

This new program reflects the strong Japanese commitment to achieving sustainable economic growth by rigorously addressing energy and environmental issues simultaneously, in response to the Rio de Janeiro Declaration, Agenda 21 (June 92) and the declarations of various summit conferences.

A schematic of the measures projected for the Earth Regeneration Plan is found in Figure 1. Figure 2 indicates the targeted reduction of greenhouse gas emissions under the Global Warming Prevention Action Plan.

Fig. 1: Implementation Measures of MITI's Earth Regeneration Plan

Fig. 2: Projected Impact on Greenhouse Gas Emissions of Various Measures of the Global Warming Prevention Action Plan. Key R & D projects in the NSS

Program for various measures are as follows: Measure 1 - batteries for electric cars, eco-energy city, ceramic gas turbine, and superconducting power generation. Measure 2 - fuel cell, photovoltaics, geothermal, coal liquefaction. Measure 3 - Lean burn denitration catalysis and WE-NET. Measure 4 - Stabilization and storage of CO_2. Measure 5 - Space PV power generation.

The major R & D projects covered under the three technology areas are shown in Table 2. Both photovoltaics and fuel cells are regarded as among the technologies which will be the most cost-effective in the near future as a result of accelerated R & D and which have the potential to make a major contribution to the energy supply. Other promising, innovative R & D projects are:

- Energy use Network System in Wide Regional Area (Eco-energy System City)
- World-Wide Hydrogen Energy System (WE-NET)
- Lean Burn Denitration Catalysis Technology
- Economically and Environmentally Conditioning Coal Conversion Technology.

Table 1: Major Research Activities in the New Sunshine Program

The Solar Energy R & D Programs are noted in Table 2. The targeted contributions from each of the technology areas to the energy supply and to reduction of carbon dioxide emissions, assuming maximum implementation of the NSS program, are shown in Table 3. Figures 3(a) and 3(b) show projected contributions by seven key R & D projects. It should be noted that the projected contribution from renewable energy alone is presented in the Outlook section at the end of the paper, but those projections do not take into account the new NSS Program activities and will be revised in the near future.

Table 2: Solar Energy R & D in the New Sunshine Program

Table 3: Targeted Contributions to Energy Supply and Reduction of CO_2

Figure 3: Projected Contribution of Key R & D Projects of the NSS Program

ORGANIZATIONAL STRUCTURE

The organizational structure of the new solar energy research program under the NSS Program, the non-NSS development and demonstration program, subsidy programs for both active solar installations and PV systems for demonstration plants and test systems in public buildings, testing support, and other related activities is found in Fig. 4.

Fig. 4: Organizational Structure of Solar Energy R,D,&D in Japan

The NSS Program is sponsored by AIST, MITI, in coordination with the Agency of Natural Resources & Energy (ARE) of the Ministry.

Most of the solar-related R, D, & D programs under the NSS Program are implemented by the New Energy & Industrial Technologies Development Organization (NEDO) and its contractors, usually private manufacturers. Three national institutes perform fundamental research: The Government Industrial Research Institute, Nagoya (GIRIN), Electro Technical Laboratory (ETL), and Material Engineering Industrial Research Institute (MEIR), under AIST. The first two institutes are directly responsible for solar energy research described below. The third institute is responsible for the fundamental research on photocatalytic reaction.

The government's demonstration and incentive programs are operated by a rather comprehensive structure as shown in Fig. 4. The Housing Division (HID) of the Consumer goods Industries Bureau (CGIB) in MITI also manages the program for promotion of the utilization of active solar, passive solar or photovoltaics in homes, the incentive program for solar thermal installations for private homes, and the subsidy program for public buildings in regional communities in cooperation with the seven regional bureaus, independent of the Sunshine Project. ARE is also responsible for some of the demonstration programs and subsidy programs, particularly for PV systems for buildings.

Information on research programs funded by the Ministry of Education which covers basic research on PV, active and/or passive solar systems at over 20 universities and technical colleges is difficult to obtain. Similarly, data on R & D Programs of the Ministry of Agriculture and Fishery on solar energy applications in the agricultural sector are not available.

FUNDING

Funding for renewable energy in the years 1991 - 1993 is found in Table 4, and Table 5 presents a breakdown of solar energy funding for 1993. The overall funding for renewable energy by the NSS Program in Fiscal Year 1993 is about 7% higher than in 1991. Funding for active solar R & D has increased slightly from 1992 although it has not recovered to the level of 1991. It should be noted that R & D on advanced glazing for passive solar systems has been newly funded since 1990. Photovoltaics R & D receives 18 time more funding than active and passive solar.

Table 4: Renewable Energy Funding

HID funds the subsidies for solar thermal installations in public buildings in rural communities, in private houses, demonstration of housing with increased use of solar energy, testing standards development, information dissemination, and market research activities. The budget for these activities is 1.4 B Yen in 1993. Some of this figure is not taken into account in Table 5 because of the difficulty of categorizing some of the funding.

Table 5: Solar Energy R & D Funding - 1993

DESCRIPTION OF SOLAR THERMAL R & D PROGRAM

Basic Research in National Institutes

A chemical reactive solar collector system using 2-isopropanol is currently being developed at ETL in Tsukuba.

The research activities at GIRIN in Nagoya focus on passive solar materials (or devices) which have the capability of reducing the electricity use for lighting, heating load, and cooling load through application in housing and building components such as glazings and walls. These materials are:

- chromogenic materials (electrochromic, thermochromic)
- silica aerogel transparent insulating materials
- selective emissive (sky radiator) materials.

R, D, and D on Solar Industrial Process Heat (SIPH)

The total budget for SIPH programs from 1979-1992 amounted to about $US 80 M. The current SIPH projects under NEDO are as follows:

Development of Advanced Process Heat System

This project involves the development of a high-efficiency refrigeration system using the reaction of a hydrogen-absorbing alloy. In a refrigeration system, the demand for the F class temperature level (less than -20°C) is very high. However, conventional levels of cold heat obtained by solar heat range from -5° to -10°C. The technology being developed to achieve the lower temperatures uses a chemical reaction between hydrogen and metal hydride. Advantages of the system include the lack of hazards to the environment from freon and the fact that the system is capable of using remote heat sources because of the easy and high-efficiency transport of metal hydride over a long distance.

Development of Elemental Technology

High Performance Heat Insulating Materials. This project began in 1989 and will terminate in 1993. The purpose is the development of high performance thermal insulating materials to prevent heat losses from piping, heat storage system, etc. particularly for solar thermal applications in IPH where relatively high temperatures, e.g. more than 95°C, are usually required.

The structure, composition, and other characteristics of a new insulation material with 0.034 Kcal/mhr°C at 200°C will be determined after studying various factors affecting thermal conductivity. The fabricating process will also be developed, installation methods studied, and bench scale tests for practical applications conducted.

Energy Conversion Technology Using Chemical Reaction. The most typical temperature for steam boilers in industry production processes ranges from 150 to 200°C. Since solar collectors generally have high efficiency at lower temperatures, innovative ideas are needed to raise collector temperature if solar thermal technology is to apply to the higher temperature range. In a 5-year project which began in 1990, a chemical heat pump is used to boost the heat produced by a conventional solar collector at 80°C. The chemical heat pump uses a hydrogen/2-propanol and acetone system. The targets of the project are 1) recovery of heat higher than 150°C, 2) overall process efficiency of greater than 30%, and 3) demonstration plan capacity of 10^5 kcal/hr class.

Development of Passive Solar System

Advanced Glazing. Following two years of simulation studies on the energy benefit of advanced glazing, particularly electrochromic glazing, the most energy-beneficial glazing was identified as double-glazing composed of an outer electrochromic glazing and an inner low-e glazing. It could save 80 Ml/year of oil if it were installed as south windows in 1.67 million houses and buildings in the Tokyo climatic zone (moderate and oceanic). It is also capable of reducing peak cooling and lighting loads in office buildings by about 40% and 60%, respectively, compared with the typical single glazed float glass and inside venetian blind. This 5-year project, initiated in 1991, aims to improve the transmittance, durability, thermal characteristics, and obtain larger glazing samples. Rapid and low-cost processing is also being developed.

Solar Energy System Research

Solar City Feasibility Study. The purpose of this project is to develop the concept of an energy-efficient city combining active solar systems, photovoltaic systems and other renewable energy systems around a core of passive solar buildings and to identify their related technical problems and assess the possibility of technical development and future diffusion of passive and other solar technologies. The 3-year project began in 1991.

The findings after the first two years are as follows:

1. The feasibility of constructing a totally energy-self-sufficient city has been confirmed, assuming improvement of present solar technologies, cost-effectiveness and performance efficiency of materials, components and systems.

2. Wide use of solar energy in urban human activities, energy conservation and efficient management in buildings and/or zones, and high efficiency energy network systems in heat transport, electric power transport, heat storage, and electric power storage are required in the energy self-sufficient city. An R & D program on key areas of technology development required for this goal has been outlined.

3. In reality, the goal is not 100% energy self-sufficiency but partial self-sufficiency. The four steps necessary to achieve this are:

- development of energy-self-sufficient structures and infrastructure and district heat distribution
- increasing the structures, formation of a district heating network, and creation of a distribution center which stores energy required in the district
- connection of the solar energy plant and components to the energy network distribution systems
- extension of the energy distribution network systems throughout the solar city. An artist's rendering of such a solar city is found in Fig. 5.

Fig. 5: Artist's rendering of a future solar city.

OTHER GOVERNMENT SUPPORT ACTIVITIES

Subsidies and Incentives

A five-year low-interest bank loan program funded by the HID for installation of active solar systems for both residential and commercial buildings was established in 1980. The Japanese Solar System Development Associate (JSSDA) has managed the program. The program was extended to 1993 except for commercial building applications which expired in 1986. For residential active solar systems, a low-interest loan (4.5%) is provided with a repayment term of five years, with a maximum of 2 M yen/system for a small-scale system and 6 M yen for a roof-integrated system. The total annual budget for these loans has decreased drastically in the past five years, having gone from 2200 M Y in 1988 to 464 M Y in 1993.

Subsidies of 50% of solar system cost are given for SHC and hot water systems for local government buildings such as schools, hospitals, nursing homes, and recreation centers. The budget for such subsidies has decreased from 780 M Yen in 1988 to 375 M Yen in 1993 as a result of the reduction in applications by local governments.

JSSDA sponsors a Good Design Contest among the houses and buildings constructed under the incentive program as part of the "Solar Day" campaign held on the first day of spring each year. The Tsurukawa house in Tokyo, which was awarded the 1993 prize, is shown in Fig. 6. It is equipped with 49 m^2 of evacuated tubular collectors for heating and hot water. The tubular collectors are installed on the flat roof and perform the function of shading for the atrium if the skylight-window is opened.

Fig. 6: 1993 prize-winning private house.

The award-winning school is shown in Fig. 7. The solar air system on the Kanayama Junior High School in Yamagata Prefecture is used for heating and hot water supply. It consists of 1,180 m^2 of air collectors on the schoolhouse and 820 m^2 on a separate gymnasium. The project is a good example of a solar installation in a snowy climate.

Fig. 7: Award winning solar air system installation on the Kanayama Junior High School.

Standards and Certification

The Japanese industrial standard for solar water heaters was established in 1980 and revised in 1982. Standards for the testing of solar collectors and water storage tanks were established in 1985 and will be revised shortly.

The certification program for Better Solar Heating and Cooling Installations (solar collectors and storage tanks and DHW systems), which was administered by HID/CGIB, ended in March 1988 as part of the measures taken to respond to concerns about free trade. Since then it has been operated by the Solar System Development Association to improve and verify the performance of products manufactured by members of that association.

Information Activities

AIST/MITI distributes documents such as the "Sunshine Journal" and "Sunshine News" on solar energy R & D achievements through the Japan Industrial Technology Association. HID/CGIB/MITI also disseminates information on SHC and DHW systems. JSSDA acts as an information center, particularly for system installation and manufacturing of components and systems.

COMMERCIAL ACTIVITY

Industry participation in R & D

Industry has participated in NEDO's R, D & D Program on Solar IPH, which is described in an earlier section, and in HID's D & D program, which was not described. Most of the solar manufacturers are involved in their own R & D to improve the cost-effectiveness, performance characteristics, durability and reliability of their products.

Commercial Status

The solar energy industry has continuously declined since 1981 due to factors such as the oil glut, low oil prices, and the economic recession. The current number of solar component manufacturers (18) is half of the number in 1987. Packaged system manufacturers have decreased from 34 to 20 since 1987.

Similarly, the amount of collectors manufactured have decreased gradually, but not to the same extent (Table 6).

Table 6: Collector Manufacturing in Japan (m^2)

[TAKE TABLE 10 FROM ORIG. PAPER, AND USE 1987 AND 1992 FIGURES ONLY (I.E., OMIT 1988 - 1991) **]**

A cumulative total of approximately 400,000 active solar DHW systems (excluding thermosyphon solar water heaters) have been installed in Japan as of the end of 1992. Combined heating and DHW systems number around 1,300. Heating, cooling and DHW systems number around 470.

OUTLOOK

Although the New Sunshine Project has established targets for renewable energy contribution to energy supply and reduction of carbon dioxide emissions, the present figures are based on June 1990 projections. These figures will be revised shortly to reflect the new goals and expected impact of the New Sunshine Project.

In 1988, renewable energy contributed 1.3% of Japan's national energy demand. The 1990 projections predicted that this would increase to 2.9% in the year 2000 and 5.2% in 2010. However, the new projections expected soon are expected to revise these figures upward.

PREVIOUS CONTENTS NEXT

IEA SHC Solar Activities in IEA Countries Report 1993

Solar Energy Activities in the Netherlands

E.H. Lysen
Netherlands Agency for Energy and the Environment (Novem)

GOVERNMENT POLICY

Energy policy in the Netherlands is the responsibility of the Ministry of Economic Affairs. In June 1990, the Ministry issued the "Policy Note on Energy Conservation", which is the basis for government policy in the areas of energy conservation and renewable energy sources [1]. The goal of the policy is an overall efficiency increase of 20% in the period 1990-2000. Presently, the price of energy is not the major incentive for energy conservation, but the increasing pressure on the environment, particularly CO_2 emissions, and action will be taken to reduce these emissions to 1990 by 1994/1995.

The following policy instruments are available:

- Support for information and promoting awareness;
- Support to utilities, provinces and municipalities;
- Agreements with different sectors of the economy;
- Subsidies;
- Support for research, development and demonstration.

The annual budget is 650 million (about US$ 350 million), about half of which is channeled through the Netherlands Agency for Energy and the Environment (NOVEM), which plays a dominant role in the implementation of the Dutch energy policy in the areas of energy conservation and renewables. Table 1.1 lists the policy goals for renewables, expressed in petajoules (PJ) of primary energy saved. For reference, it is useful to note that the national energy consumption in 1991 was 2872 PJ (in 1990: 2740 PJ).

The table shows that the contribution by re-cycling and incineration of waste still outweighs the "real" renewables. The contribution of 5 PJ by solar thermal consists of 2 PJ by solar boilers (300,000) and 3 PJ by other solar thermal options, mainly passive solar.

The 2 PJ contribution of PV corresponds to about 250 MWe of installed PV capacity.

Note: In 1991 about 1 PJ was supplied by renewables (mainly hydro and wind) and 39 PJ from waste incineration and biogas.

Table 1: Netherlands policy goals for the contribution of renewables in 2010.

Source of energy	**Contribution in 2010** (PJ of primary energy)
Wind energy	33

Photovoltaic solar energy	2
Thermal solar energy	5
Geothermal energy	5
Hydropower	5
Subtotal:	**50**
Recycling of waste and waste incineration, incl. biomass	100
TOTAL:	**150**

FUNDING

An overview of renewable energy funding in the Netherlands is provided in Table 2. There are no separate budgets for passive and solar; both are contained in the solar thermal budget. The budgets for 1994 are not yet available, but the indications are that the budgets will not change substantially.

Table 2: Overview of renewable energy funding in the Netherlands
(research, development, demonstration and information programs)
(1 $US = 1.85)

	1992		**1993**	
	M	M$US	M	M$US
Active+passive solar	13	7,0	12	6,5
Photovoltaics	13	7,0	13	7,0
High temp. solar	0	0,0	0	0,0
Wind energy	44	23,8	44	23,8
Bio-energy	8	4,3	8	4,3
Geothermal energy + storage in aquifers	4	2,2	4	2,2
Hydro	0,2	0,1	0,2	0,1
TOTAL	**82**	**44,4**	**81**	**43,9**

Funding for the solar energy programmes (thermal and PV) have been part of multi-annual overall agreements between the Ministry of Economic Affairs and NOVEM for the period 1990-1994. Every year a detailed proposal is forwarded, with a programme and budget in line with the multi-annual programme. The budgets include subsidies to consumers at the level of 7 M/yr for solar DHW systems and 3 M/yr for autonomous PV systems.

A possible increase for the PV programme is under discussion. Since 1990, the PV budget has been raised from about 3 M per year in 1986-1990 to over 13 M (about 7 M$US) yearly. This is motivated by the official statement (1990) of the Ministry of Economic Affairs regarding PV: "*This energy source can in principle become the most important renewable energy option after the year 2010. Because of the potential for the long-term and for the global energy supply a large R&D effort will take place.* ..."

RESEARCH, DEVELOPMENT AND DEMONSTRATION

Solar Thermal

The National Research Programme on Solar Thermal Energy in the Netherlands has three major aims: (1) the development of solar DHW systems which are 40% less expensive (1990 is the reference year), (2) stimulation of market introduction and (3) development of advanced solar applications [2].

It is believed that the aim of the 40% cheaper solar DHW system is within reach. The manufacturers, the Ministry of Economic Affairs, Holland Solar (branch organisation) and NOVEM in early April 1993 expressed the intention to sign to sign an agreement by the end of 1993 to arrive at a fully competitive solar DHW system within 4 to 5 years, i.e. all subsidies with be gradually phased out.

The R&D programme has the following elements:

General:

- computer models, system testing
- extreme climatic conditions
- Materials and components: efficient low-flow pumps
- low-weight and low-flow collectors
- vapour-condensation systems

System development:

- compact pre-heaters
- integrated heating equipment
- advanced applications

Market introduction:

- utilities and consumers

For the development of solar DHW systems, NOVEM stimulates and supports close cooperation between research institutes, such as TNO-Building Research, the manufacturers of solar DHW systems and the manufacturers of equipment for hot water supply and space heating. In the Netherlands, the market share of electrical and gas-fired boilers is declining, whereas equipment which combine the space heating and hot water functions (combi-boilers or attached boilers) show a rapid increase (see Table 3).

Table 3: Market development of hot water equipment in the Netherlands

Hot water equipment	Market share (%)		
	1980	1990	2000
electrical boiler	18%	16%	12%
gas-fired geyser	69%	56%	40%
gas-fired boiler	11%	5%	3%
combi-boiler	8%	23%	35%
attached boiler	0%	4%	10%

On the basis of these market developments, R&D has been initiated on (1) compact preheaters, to be applied with combi-boilers or geysers and (2) integration with space heating equipment, properly adapted for the connection of solar collectors.

Three types of preheaters were developed and are being tested presently:

1. Concentric tubes, with vapour-condensation (field experiments)

2. Flat stainless steel tank, covered with Transparent Insulation Material (prototypes)

3. Low-flow collector (under IEA SHC Task 14, prototypes)

In the area of integration with space heating equipment, suitable for the connection of solar collectors, three options exist:

1. extra heat exchanger for hot water

2. larger storage tank

3. intelligent control system

R&D is also being conducted on a solar-cum-gas-fired boiler, for space and water heating.

Fig. 1: Combined DHW and space heating systems in the Netherlands, in the city of Hilversum. (photo: W.J. Dyksma)

Within the framework of the IEA Solar Heating and Cooling Program, the following projects are being conducted:

Task 13: Minimum Energy Dwellings

An urban villa in the city of Amstelveen has been designed by a team consisting of an architect, a building physicist and an installation expert. The construction of 42 dwellings will begin in autumn 1993, sixteen of which are minimum energy dwellings. Their characteristics are:

- high insulation
- balanced ventilation
- passive cooling and shading
- solar hot water system
- transparent and flexible construction

Monitoring is expected to show that very low energy consumption is possible: less than 100 m^3 of natural gas per year.

Task 14: Advanced Active Solar Energy Systems

The Dutch participation covers the following areas:

1. *Dynamic system testing*, where the collective experience will be brought into the process of realising new CEN norms.

2. *Large systems*: In 1993, a flower bulb drying system will be realised in the city of Lisse, equipped with 1000 m^2 of solar collectors and semi-seasonal heat storage.

3. *DHW systems*: low-flow collectors.

Working Group on Seasonal Storage of Solar Heat

The first seasonal storage system of solar heat in the Netherlands was constructed in the city of

Groningen (Beyum) in the early eighties. The system still functions well and ensures a considerable reduction in consumption of natural gas for space heating and water heating. In the last decade, the development of solar systems as well as the storage of heat and cold in aquifers has been progressing rapidly, so time is ripe for a new generation of Central Solar Heating Plants with Seasonal Storage (CSHPSS). In the Netherlands, which is chairing the working group, three potential projects are being screened for the application of a CSHPSS.

Task 18: Advanced Glazing Materials

Dutch participation emphasizes pre-standardisation of characterization methods for advanced glazings. Our activities in the task focus on the development of measuring methods.

Task 20: Solar Renovations in Buildings

This new task aims at the development of appropriate strategies to develop the large potential for solar retrofitting of existing buildings.

Solar Photovoltaics

Solar Cell R&D

R&D is a major part of the multi-annual solar PV programme 1990-1994, managed by NOVEM, with annual budgets of more than 9 M (about 5 M$US) (SEE IF THIS FIGURE IS MENTIONED EARLIER). About 2/3 of this budget is devoted to solar cell R&D. Cell R&D is divided into three programmatic categories [3]:

1. Present generation solar cells: polycristalline silicon
2. Next generation solar cells: amorphous silicon
3. Long term candidates: III/V and organic cells

The general constraint for projects in the category of *present generation cell types* is that the cell-producing industry is involved in and contributes financially to the project. In this category only projects concerning (flat plate) polycristalline silicon solar cells are carried out. The priority within the R&D programme is strongly on these polycristalline silicon cells, as a pioneer blazing the trail for the possible production of other cell types in the future. The most important parties in this work are the Netherlands Energy Research Center ECN in Petten and R&S Renewable Energy Systems in Eindhoven. The goal is to achieve in 1993 an encapsulated cell efficiency of 15-16 % with Wacker Silso material, on an industrial scale.

The general constraint for projects in the category of *next generation cell types* is the presence of an interested industrial party and the usefulness of results to possible industrial production in the near future. The second priority of the Dutch PV programme is amorphous silicon solar cells, in order to achieve stable high-efficiency tandem cells. The most important institute is in this work the University of Utrecht which has a very well-equipped R&D infrastructure.

A European top initial efficiency of 10.3 %, realised in the multichamber system ASTER, has been confirmed by NREL (USA), while higher initial efficiencies (11.2%) have already realised with the new multi-chamber system PASTA even under unoptimized conditions. Recently tandem cells have been produced with efficiencies of 8%-9%, showing less than 10% degradation. For comparison, single junction cells tend to drop more than 30% in efficiency. NOVEM is stimulating European collaboration on this subject between research institutes and with the European (a-Si) industry NAPS-France.

The third category involves *long-term candidates* i.e. cell types of uncertain but possible importance for energy production in the long term. In the Netherlands, the Catholic University of Nijmegen is carrying out projects on III/V cell types for flat plate terrestrial applications. On the one hand, research is carried out following the so-called "high efficiency route" (state-of-the-art in Holland: 20 % for GaAs cell). On the other hand, an "economic route" is also being pursued. The aim is to study the potential of and obstacles to diminishing the costs of III/V-cells, e.g. using alternate substrates. After the successful growing of GaAs on Ge, cells both from GaAs and GaInP are now being grown on Si-substrates.

Research into organic solar cells has been started in a concerted action controlled by the Agricultural University of Wageningen. Cells will be based on porpherine molecules on a semi-conductor (TiO2, SnO2, Si) and Langmuir-Blodgett films acting as an antenna to improve the light collecting efficiency. The organic cell of Prof. Grätzel will be used as a reference.

System component R&D

Before 1990 only few system-related topics, such as battery research, were supported within the Netherlands PV programme. Since then the budgets for system component R&D and for demonstration and pilot projects have been increased. There are three main subjects within the subprogramme on PV system components.

R&D on technical, economic and aesthetic aspects of the *integration of modules into building construction* will prepare the techniques for near future PV systems in a densely populated country like Holland. Companies working in this field are Ecofys Research and Consultancy in Utrecht and R&S Renewable Energy Systems in Eindhoven.

Another important subject is the *development of small inverters* for grid-connected systems. The objective is further improvement of quality (harmonics, noise, etc.) and efficiency particularly at part and zero load in inverters of state-of-the-art technology. Maximum Power Point Tracking circuits will also be implemented. Results will be used in pilot and demonstration plants to be erected next year. In the field of inverter R&D, research institutes such as the Energy Research Center ECN in Petten and Ecofys in Utrecht are working closely with the inverter industry: Victron in Groningen/Amsterdam (market leader in Europe in small autonomous inverters) and Mastervolt in Amsterdam.

The characterisation and assessment of lead acid *battery behaviour* under in PV systems is almost finished. Two topics, "behaviour at high temperatures (tropics)" and "battery ageing and deterioration" are still under study at R&S Renewable Energy Systems in Eindhoven and TNO Environmental and Energy Research in Delft.

Pilot systems and demonstration

Between 1978 to 1990 only few PV systems were supported within the PV programme. The Terschelling PV Wind Project was erected in 1982 as one of the EC PV Pilot Plants. The system still functions well and was an important link in the build-up of know-how in the Netherlands. The Solar House in Castricum (1989) was also supported. This is an autonomous PV system in the middle of grid-connected houses, showing very clearly that a standard roof with solar cell produces enough energy for a modern family household, if energy-efficient equipment is used.

Fig. 2: View of the first grid-connected PV houses in the Netherlands (10 houses in the city of Castricum.

The general and official goal of this subprogramme since 1990 is: "*The build-up of the necessary know-how and experience at electricity companies and other involved parties to pave the way for the future implementation of photovoltaic systems in the Netherlands energy supply, by means of system studies, practical experiments and pilot and demonstration projects.*" Beside the build-up of know-how on technical matters it is of great importance that future market parties participate in pilot and demonstration projects to give guidance to the development. In this way both technical and non-technical bottle-necks become visible at an early stage.

The budget has grown from 1.2 M in 1990 to 3 M (1.6 M$US) in 1993. This R&D budget should not be confused with the budget for consumer investment subsidies (also 3 MDfl yearly).

The main projects to be supported are in the field of:

- PV systems in the built environment
- roof-mounted systems on houses
- roof-mounted systems on commercial buildings
- PV facades (possibly)
- Autonomous PV systems
- market studies
- demonstration projects
- PV central stations
- studies
- a small central plant (<100 kW_p)

In general, the priority in this subprogramme is the development and realisation of PV systems in the built environment, with emphasis on residences. The size of projects have shifted from one to ten to one hundred and more houses, while the R&D is gradually shifting from technical to non-technical aspects. Examples are the individual PV houses in Castricum and Woubrugge where new integration techniques are demonstrated, while the project of 10 PV houses in Heerhugowaard has chosen a more conservative technique (zinc under-roof). In preparation are two projects with 100 PV houses each, one in a new quarter in Amsterdam and another in the private sector. The first project will be closely coordinated together with the cities of Madrid and Kopenhagen. Some of the above mentioned projects will be carried out within the framework of the IEA Solar Heating and Cooling Programme. In addition to PV projects with houses, two (10 kW_p) PV projects on the flat roofs of office buildings are being realised. The distribution utility sector is strongly involved in the PV systems subprogramme.

The goal for the R,D&D of autonomous PV systems is the further development and support of existing and future applications and markets. The emphasis will be shifted from R&D and field experiments more and more towards real demonstration projects and market development. Good examples are the realisation of PV systems on houseboats and barges by Ecofys in Utrecht (EC demonstration project) and the development of PV systems for the traction of small electro boats in recreational areas. Attention is also paid to transfer of know-how to developing countries.

Studies to examine the potential of PV central power plants are being undertaken. Surprisingly, the installation of PV on sound barriers along highways turns out to be attainable if the PV modules have enough weight per square metre and are integrated in the construction in order to contribute to the noise reduction. A 55 kW PV sound barrier near the city of Utrecht, with a length of 550 m, will be realised in 1993/1994.

OTHER GOVERNMENT SUPPORT ACTIVITIES

Solar Thermal

The market introduction of solar hot water systems is stimulated by (1) a consumer subsidy by the Ministry of Economic Affairs and (2) a promotion campaign orchestrated by NOVEM.

Government Subsidy

The annual budget of the consumer subsidy is 7 M (3.8 M$US). In 1993, a consumer receives 600 per m^2 of solar collector, up to 3 m^2 of collector. As a part of the process leading to solar systems certification and also in view of the performance differences in the systems appearing on the Dutch market, it is proposed that in 1994 the subsidy will be based on the GJ performance of the system. This will be determined by internationally-accepted test procedures, such as carried out by TNO-Building Research.

Information

Novem coordinates and partially funds a nationwide campaign to promote the use of solar boilers. Until 1990, not more than 400 solar DHW systems per year were installed, but after two years of the campaign, 6,000 solar DHW systems have been installed on Dutch roofs. The installation of the 10,000th solar DHW system is expected by the end of 1993. The 1993 campaign involves advertisements in national and regional newspapers, radio spots, and activities to support utilities, municipalities and installation firms in the market introduction efforts. The slogan is "*Switch on the Sun for a Better Environment*."

Solar PV

Government Subsidy

In order to stimulate the market for photovoltaic systems in the Netherlands, an investment subsidy of 8 Dfl/W_p (10 /W_p in 1992) is given for autonomous PV systems, with a budget of 3 M. In 1992 the total sales were above 300 kW_p; the total installed peak power increased to 1.3 MW_p in 1992. The incentive scheme can be considered a success, opening a new market in the Netherlands. Applications for holiday houses and caravans/mobile homes are particularly popular. Other important systems are PV pumps for drinking water for cattle, light buoys and boats.

The Ministry of Economic Affairs has indicated its intention to end the subsidy scheme for autonomous systems by the end of 1993, and possibly to replace it with a new support scheme for individual roof-mounted, grid-connected systems.

COMMERCIAL ACTIVITIES

Solar Thermal

More than ten industries and importers are currently involved in the manufacture and sales of solar DHW systems in the Netherlands. Installation used to be done by the manufacturers in the past, but presently more than 90% are installed by traditional installation firms, who received prior training.

It is expected that the annual number of installations will grow from about 3,000 in 1992 and 4,500 in 1993 to more than 15,000 annually within a few years. The utilities play a crucial role in this process. A good example is the utility PGEM, which supports a "thousand roof" programme in their service area, to be installed in the period 1994-1996.

Solar PV

In the Netherlands, there are two manufacturers of PV systems, one of which (R&S) also participates in the R&D programme managed by NOVEM. In addition, several firms import modules and sell them on the Dutch market. The total installed capacity towards the end of 1992 amounted about 1.3 MWp, mainly in the form of autonomous systems for holiday houses, boats, water pumps etc.

With two 100-roof projects planned for the period 1993-1994, the installed capacity of grid-connected systems is growing quickly and will soon dominate. Plans have been made to implement the goal of the Ministry of Economic affairs, i.e. to have about 250 MWp installed by the year 2010. This will require substantial efforts from the industry, the Ministry and the utilities involved.

OUTLOOK

The outlook for solar energy building technologies in the Netherlands seems fairly bright, but to ensure a continued development of the market a number of agreements have to be made with the parties involved, particularly the utilities. Also, support must continue for R&D, both from industry as well as from the government.

REFERENCES

[1] "Nota Energiebesparing" (Note on Energy Conservation); Netherlands Ministry of Economic Affairs, The Hague, 14 June 1990.

[2] K.W. Kwant, A.F.J. van de Water: "Het Nationaal Onderzoekprogramma Zonne-energie Thermische Conversie" (The National Research Programme on Solar Thermal Energy). Netherlands National Solar Energy Conference, Veldhoven, April 1993.

[3] E.W. ter Horst, J.T.N. Kimman, E.H. Lysen: "Photovoltaics in the Netherlands: the first MWp in 1992 and beyond", Proceedings of the 11th EC Photovoltaic Solar Energy Conference, Montreux, 1992.

PREVIOUS CONTENTS NEXT

PREVIOUS CONTENTS NEXT

IEA SHC Solar Activities in IEA Countries Report 1993

Solar Energy Activities in New Zealand

Michael R Donn
Victoria University of Wellington

PROGRAMME STRUCTURE

In mid-1992, the Government announced an energy policy framework which outlines its broad approach to energy. It aims to *ensure the continuing availability of energy services, at the lowest possible cost to the economy as a whole, consistent with sustainable development*. In renewables, this translates to facilitating the development of cost-effective forms of renewable energy sources. A framework policy statement which re-affirms the Government's commitment to renewable energy and emphasises the initiatives it is undertaking in this area is being prepared. It will focus on the following goals:

- *helping to ensure the continuing availability of low-cost energy by encouraging alternative forms of energy that can compete with non-renewable fuels (essentially fossil fuels);*
- *increasing the diversity of New Zealand's energy supply which will improve energy security;*
- *helping to ensure that energy services remain accessible to all members of New Zealand society;*
- *minimising adverse environmental effects of energy use, including greenhouse gas emissions.*

A number of steps are being taken in order to introduce commercial systems with competitive incentives which should go a long way to place renewable energy on an equal footing with traditional energy forms. These include the enactment of legislation permitting gas and electricity traders to compete to supply nationally; the separation of the company running the national electrical grid from the electricity generation company into separate enterprises; the prospective establishment of a wholesale market in electricity; and the corporatisation, and establishment of information regimes for the electricity retailers The aim is also to establish appropriate, market-based prices for each energy source.

In October 1992, the Minister of Energy announced the establishment of the Energy Efficiency and Conservation Authority (EECA). It is founded on what was the Energy Management Group of the Ministry of Commerce. EECA is mandated by Government to:

> *...promote the conservation of energy resources in New Zealand. Conservation in this context means the management of the nation's energy resources such that their productivity is increased through the adoption of energy efficient practices and technology, and that economic, social and environmental considerations are taken into account.*

Although EECA has no direct mandate for renewables, its major functions are described as:

- *to develop, implement and promote strategies for energy conservation; and*
- *to advise the Government and the New Zealand energy industry ..;*
- *to monitor known energy sources... together with the economic, social and environmental*

impacts...

The authority is responsible directly to the Minister of Energy.

FUNDING

Table 1 has been compiled by Foundation for Research Science and Technology staff and covers Government (Public Good Science Fund and Universities) research, but not private sector research. The figures in the table are for July to June funding periods.

Table 1: Government Renewable Energy Funding
(for Research, Demonstration and Information Programmes)

$(000)	1992		1993		1994	
	$NZ	$US	$NZ	$US	$NZ	$US
ACTIVE SOLAR						
PASSIVE SOLAR	98	53	50	27	50	27
PHOTOVOLTAICS						
HIGH TEMP. SOLAR THERMAL						
WIND ENERGY	81	44	20	10.8	20	10.8
BIOENERGY	150	81	100	54	100	54
GEOTHERMAL	1,800	972	1,800	972	1,800	972
OTHER						
ALL RENEWABLE ENERGY	**2129**	**1150**	**1970**	**1083.8**	**1970**	**1063.8**

Table 2 represents the investment of the Electricity Corporation of New Zealand (ECNZ). In the 1992-93 year, they invested NZ$2.6m (US$1.4m) in renewables research, development and information programmes excluding their hydro-electricity programme. The figures in the table are for the financial year. It is worth noting that NZ$ 2.0m of that is a single research, demonstration and information project placing a 225 kW wind turbine on a prominent hill in the capital city. ECNZ (formerly the Electricity Division of the Ministry of Energy) was, and remains, the dominant generator. ECNZ is now a corporation in which the Government currently holds all the shares and which generates electricity. Transpower, the national grid company, is responsible for high voltage transmission, and electricity supply companies are mostly responsible for distribution to end-users.

Table 2: ECNZ Renewable Energy Funding[(1)],
(for Research, Demonstration and Information Programmes.)

$(000)	1992		1993		1994	
	$NZ	$US	$NZ	$US	$NZ	$US
ACTIVE SOLAR	10	5.4	20	10.8	50	27
PASSIVE SOLAR	30	16.2	30	16.2	80	43.2
PHOTOVOLTAICS	5	2.7	10	5.4	20	10.8

HIGH TEMP. SOLAR THERMAL	5	2.7	10	5.4	20	10.8
WIND ENERGY	2,000	1080	200	108	500	270
BIOENERGY			20	10.8	20	10.8
GEOTHERMAL	500	270	500	270	500	270
OTHER (wave)	70	37.8	10	5.4	20	10.8
ALL RENEWABLE ENERGY	**2620**	**1414.8**	**800**	**432**	**1200**	**648**

RESEARCH, DEVELOPMENT AND DEMONSTRATION PROGRAMME

The Government's *Statement of Science (Research) Priorities: 1993/94 - 1997/8*, which resulted from a long-term science research priority setting exercise undertaken in 1992, provides for a 25% increase in funding for energy research from the Public Good Science Fund, and identifies as one of two specific output topic themes for energy the following:

New and improved processes, systems and products for increased efficiency in the use and conservation of energy including solar, wind and geothermal energy.

Currently Industrial Research Limited (IRL) at Gracefield is conducting research into daylight and solar availabiity in New Zealand funded from the Government's Public Good Science Fund. This work being conducted by Dr Bittar forms a contribution to the IEA Solar Heating and Cooling Programme's Task 17 and has the following objectives:

- to measure diffuse, direct and global illuminances and irradiances in New Zealand;
- to derive and model New Zealand values for the luminous efficacy of the sky in New Zealand.
- to measure spectral radiance, luminance and polarisation of the New Zealand sky
- to develop an accurate all-sky radiance model in New Zealand
- to investigate solar concentrators for application in New Zealand
- to ascertain the accuracy of the predicted daylighting in estimating lighting energy savings.

These objectives have been only partially-funded by the Government's public good research Foundation. Figure 1 shows an instrument cluster constructed by IRL for measuring the sky luminance and radiance.

Figure 1: IRL instrument cluster for measuring the illuminace and irradiance of the New Zealand sky.

OTHER GOVERNMENT SUPPORT ACTIVITIES

As part of its commitment to renewable energy, the Government has established the following initiatives:

1. Commissioning of a two-stage investigation, first into the opportunities for renewable energy development, and then into the barriers to the greater adoption of cost-effective renewable energy technologies. The report on the first stage, opportunities for renewable energy development including solar energy, will be released shortly. A list of priority research areas will be included in this report. Stage 2 of the study has now begun.

2. The Resource Management Act, which governs development of all resources, natural, physical and manufactured, emphasizes sustainable management of resources. It affects every aspect of

development in the country from providing a framework by which Regional Authorities approve building developments to forest management. It is expected that over time the implementation of this Act will lead to greater interest in renewable energy.

3. The Government is in the process of developing a CO_2 Reduction Action Programme.

Subsidies and Incentives

Government policy seeks to address the creation of a market where renewables are placed on an equal footing with traditional energy forms. Subsidies and grants for solar or other renewable energy developments are not part of that policy.

Standards and Certification

With the recent coming into force of the regulations for a new national building code which only specifies performance requirements at the legislative level, standards have become means of compliance, rather than mandatory. The Code is largely designed to mandate for the health and safety of people in New Zealand, but energy-efficiency has been included in the enacting legislation. There is no clear understanding yet of how the energy-efficiency clauses of the Code may affect the uptake of renewable energy by building owners and designers.

COMMERCIAL ACTIVITY

There are currently eight manufacturers of solar water heaters operating in New Zealand, up from three two years ago. These companies are Transheat; Solar Systems; Thermocell; Solarmaster, Sola60, Solar Solutions; and Sunmate.

The market size is unknown, but is estimated to be on the order of one to two hundred domestic installations per year. The systems include pump circulated, thermosyphon and "once through" models, and most are roof-mounted, but one company is promoting "integral" systems with collectors incorporated into the structures of new houses.

There is some private R&D reported to be going on in small companies but no major publicly-funded work. Interests range from the heat-pipe steel flat plate collector which Thermocell has been selling for some years, to a flexible membrane covering on Sola60 collectors and prismatic covers on yet another brand. No independent organisation currently collects statistics on the proportion of these firms' budgets which is devoted to Research and Development.

The steady improvement in the market for solar water heating has been accelerated by three factors:

1. a shortage of hydro-electricity generating capacity during an unusually dry year in 1992;
2. declining interest rates;
3. and an increasing general awareness of the need for conservation.

In addition to these markets for "conventional" solar water heaters for domestic installations and factories (e.g. farms and dairy factories), there is an active market in low-cost solar water heaters for swimming pools.

There are, as far as can be ascertained, three manufacturers' agents for imported solar products in the country selling Australian systems. One Rotorua agent for a heat pump-driven solar water heating system has sold 50 units in that area alone.

ECNZ Investigations into solar/heat pump systems for both space and water heating are underway and marketing support potential is being developed.

A brief survey of the 40+ electricity retailers who have had to prepare for the competitive environment for electricity sales established on 1 April, revealed a wide range of renewables developments. One has already established two landfill gas generating plants, and two others are actively investigating opportunities for this in their areas; four more are exploring or developing small hydro schemes; one has been doing design work for photovoltaic applications; a further three are involved in wind energy schemes, particularly for Remote Area Power Systems, though two are investigating wind farms; the Taupo area authority has a goal to have several geothermal stations, and plans a 14 MW plant within the next 2 years. No-one mentioned solar energy as a research or development priority.

The market for photovoltaics is small and involves small systems for remote area lighting and low-current applications. A grid-connected PV system is planned for two industrial projects in the South Island. With the involvement of the Waikato electrical supply authority in a solar car project, and the establishment of an electric vehicle association (based on renewable hydro power) this area may develop more in the future. At present it is difficult to ascertain what is being invested in R&D by the private sector.

Assistance with low-energy/passive solar design of commercial and institutional buildings by ECNZ will continue. North of Auckland, at Matakana, a Japanese concern is building a demonstration autonomous house. There is considerable interest and significant implementation of passive solar space heating in housing through sunspaces added to new and existing homes. And, in some parts of the South Island, double glazing (as opposed to the standard single glazing) is being used more widely on the solar collecting windows.

OUTLOOK

The Ministry of Commerce published a forecast in 1992 for the energy "baseline" through to the year 2020.[2] This document, which it is proposed to review annually, noted that there is unlikely to be a large-scale uptake of renewables within this forecast period. The forecast takes a conservative approach towards alternative sources of energy, as it assumes a *business-as-usual* economy. It is anticipated that this forecast will be altered in future years to include consideration of the opportunities and barriers report on renewable energies currently in preparation.

In regard to the prospects of solar energy, it is expected at a policy level that New Zealand's climate is not particularly favourable to adoption of solar renewable energy on a large scale. It is also clear that, even in a de-regulated energy market with no price control and removal of the political incentives to keep domestic prices for electricity low, our energy prices are low so the cost-effectiveness of renewable and solar systems is improving. It was recently estimated[3] that, *"The least cost (<NZ$0.10, US$0.054/kWh) blocks of electricity potential from hydro, geothermal and wind power add ... over 125% more electricity than used presently...*" Solar energy is referred to: *"The cheapest source of energy is passive solar heating. Building features into new houses may (add) little or nothing to construction costs. ... By the year 2002 passive solar heating (*in houses) *could be reducing the nation's electricity demand by 240GWh* (.79%) *for costs of less than 1c/kWh and by a further 200 GWh for less than 10c/kWh..."* It concludes that *"solar, biogas and landfill gas resources could add 1000 GWh of cheap power to the nation's energy resources by the year 2002*."

1. The figures for 1994 are guesstimates.

2. *An Energy Baseline Forecast to 2020: Supply and Demand Interactions in New Zealand's Energy Markets*, Ministry of Commerce, 1992

3. *Renewable energy opportunities for New Zealand*, Report for Ministry of Commerce by Eden Resources Ltd, Feb 1993, in print.

IEA SHC Solar Activities in IEA Countries Report 1993

Solar Energy Activities in Norway

Fritjof Salvesen
Det Norske Veritas Industri Norge AS

PROGRAM STRUCTURE

The Norwegian Solar Energy Program is a program within the body of the Research Council of Norway, Department of Scientific and Industrial Research (NTNF) in collaboration with the Norwegian Water Resources and Energy Administration (NVE). The program is funded mainly by the Ministry of Industry and Energy (NOE).

The current program was started in 1989 and will end in 1994. The program has two main elements:

Research and development

> basic research, doctorate courses for researchers, and the development of solar energy products and systems up to the prototype stage.

Market introduction

> demonstration projects, information activities and education of building professionals (architects, engineers, plumbers etc.)

The program is organized with an Executive Committee, whose representatives are from research institutes, industry and governmental bodies. Det Norske Veritas Industri Norge A/S (DNV Industri) is the program secretariat.

The major solar energy research organizations are:

- SINTEF (The Foundation for Scientific and Industrial Research at the Norwegian Institute of Technology), Trondheim
- Institute of Physics at the University of Oslo
- The Norwegian Meteorological Institute, Oslo
- The Geophysical Institute at the University of Bergen.

In addition, a few architects and consulting engineers are involved in some of the experimental building projects.

A Solar Energy Research Center (SOLFORSK) has been established at SINTEF in Trondheim. The main objective of this center is to coordinate the solar R&D activities which take place at the University and the several research institutes of Trondheim, and market their broad expertise to the industry.

FUNDING

The funding for solar energy R,D&D in Norway since 1980 is shown in Figure 1. The figure shows a substantial increase in the last 5 years. The most interesting aspect is the industry involvement which was non-existent five years ago, but in 1992 amounts to close to 40% of the total budget.

Figure 1: Funding for solar energy R,D&D in Norway, 1980-1993 (1 $US = 6.80 NOK)

The present solar program, which runs from 1989-1994, has a total budget of 110 mill.NOK over the 6-year period. The government budget is 70 mill.NOK while 40 mill.NOK is from grants and activities in the industry. The table below shows the total government funds for all renewables for 1992 and 1993, and some projected numbers for 1994 for solar energy.

Table 1: Government funding for renewables in Norway.
The numbers for 1994 are not confirmed.
(1 $US = 6.80 NOK, All numbers in millions)

	1992		1993	
	NOK	$US	NOK	$US
Active solar	8.5	1.25	8.0	1.18
Passive solar	4.0	0.59	2.5	0.37
Photovoltaics	2.5	0.37	2.5	0.37
High temp. solar	0	0	0	0
Wind energy	12.1	1.78	4.3	0.63
Bioenergy	13.7	2.01	13.2	1.94
Geothermal	0	0	0	0
Waves	5.4	0.79	3.0	0.44
Social aspects	4.7	0.69	5.0	0.74
All renewables	**50.9**	**7.49**	**38.5**	**5.66**

In addition to government funds, the industry puts a certain amount of resources into specific projects in terms of person-hours, equipment and money. For solar energy, the contracted industry funds amounted to 9.2 mill.NOK in 1992, and a similar number is expected for 1993.

It is interesting to note that while the overall government funds for renewables have been reduced by 25% from 1992 to 1993, the decrease for solar energy is only 13%. The funding decrease in solar activities is mainly for the market introduction part of the program, while R&D is at the same level as for 1992. The decrease for renewables is based primarily on an evaluation of the need for government funds in the different programs. For wind energy, for instance, a demonstration plant was finished in 1992, and there were no plans for additional installations in 1993.

The table below shows another breakdown of the government budget for solar energy in 1993. In addition to these figures, the industry involvement is approximately 70% of these numbers, which for 1993 corresponds to approximately 9.5 mill.NOK.

Table 2: Government funds for solar energy in 1993, budget figures.
(1$US=6.80 NOK, All values in millions)

	R&D incl. pilot plant, experimental buildings		Demonstration projects		Market support e.g. education, information		Nat'l testing, certification, standardisation	
	NOK	$US	NOK	$US	NOK	$US	NOK	$US
Active solar heating	4.8	0.71	2.5	0.37	0.5	0.07	0.2	0.03
High temp. solar thermal	0	0	0	0	0	0	0	0
Photovoltaics	2.3	0.34	0.1	0.02	0.1	0.02	0	0
Passive solar	2.3	0.34	0.1	0.02	0.1	0.02	0	0

RESEARCH, DEVELOPMENT AND DEMONSTRATION (R,D&D)

The solar energy program is based on the following vision for solar energy in Norway by the year 2010:

- A profitable Norwegian solar industry is established.
- Solar heating is commonly used in some areas.
- Photovoltaics is a realistic energy alternative for remote installations.

The industry development is expected to take place in areas where Norway traditionally has a strong industry, for instance products based on silicon and aluminum. Pre-fabricated low-energy houses should also have some advantages due to the high thermal standards of the Norwegian building tradition.

The main objectives for the Norwegian solar energy program are:

- to develop a profitable Norwegian industry for both solar heating and photovoltaics.
- to develop economically-viable solar systems which can be competitive with conventional energy sources in the long-term and decrease the use of fossil fuels.

These general objectives form a basis both for the research and development and the market introduction activities. R&D projects in the industry have the highest priority, and the solar program can cover up to 50% of the total project cost. With the exception of small exploratory projects and doctorate studies, it is very difficult for research institutions and universities to get funds for projects without any industry involvement.

<u>Research and development</u>

As a result of the increased funding over the last years, some new areas have been included in the program.

Great emphasis has been given to new materials research because new technological developments very often are based on the development of new materials. Interesting materials are transparent insulation (monolithic aerogels), electroactive polymers, and solar grade silicon.

The research institute SINTEF has developed a new patented industrial production process for monolithic aerogels. The final product is named Xerogel. The production process eliminates the need for high pressure and high temperature. The company Norsk Hydro is involved in the further development of the process.

A higher priority has also been given to photovoltaics. Norway produces approx. 40% of the silicon materials on the world market, and the main production company in Norway, Elkem A/S, is developing a new production process for solar grade silicon.

Contrary to most other IEA-countries, only a relatively small percentage of buildings in Norway are heated by water heating systems. Most residential buildings have direct electrical resistance heaters. This is due to the traditionally low price of electricity, as well as cheap installation and maintenance cost for electric heating systems. To be able to compete with these low costs, the solar R&D activity is concentrating primarily on simple and cheap building-integrated active and passive systems.

The SOLNOR company was formed a couple of years ago to commercialize a low-cost solar system which was developed at the University of Oslo. The SOLNOR system is based on a simple open-loop water system with water as the heat fluid. The basic material in the system is aluminum. Taking into account that the solar collector replaces the normal roof, the total cost of the system is in the range of 600 - 1200 NOK/m^2. The cost includes heat storage, controller, pumps and tubes, which is considerably lower than conventional commercially-available solar heating systems. Another company which was established a couple of years ago, is developing a wall component which combines an active solar air heating system with the dynamic insulation principle.

The program will also look into the use of solar energy in developing countries. The approach will be to develop simple, cheap and reliable solar energy systems based on known technology. A high priority will be given to systems which can be produced locally without any advanced technical production facilities.

Market Introduction Activities

Since 1990 a special governmental fund has been allocated to establish a solar energy market in Norway. For demonstration purposes, the program focuses on a certain market segment of the building sector, mainly buildings or installations with a great demand for low-temperature heat also in the summer season. Typical areas of interest will be swimming pools, hot water consumption in hotels, hospitals, etc. Up to 50% of the costs for design and installation can be obtained from the solar program.

In 1992, the solar program funded a survey of builders, architects and consulting engineers. The project revealed a great lack of knowledge of solar energy systems. In spite of this lack of knowledge, a typical statement was, "Solar heating is not a realistic energy alternative in Norway." As a result of this project, the solar energy program will place a very high priority on building good reference solar installations in the niche areas where solar heating can be an economic good solution. Several training courses and information seminars for the building sector will be arranged.

OTHER GOVERNMENT SUPPORT ACTIVITIES

Subsidies and Incentives

In 1992 a new incentive was introduced whereby every solar installation with an annual solar output of more than 1000 kWh was entitled to a grant of 3 NOK/kWh. More than 30 installations were supported in 1992 with an estimated total annual solar output of 630,000 kWh. Seventy percent of the installations were solar dryers for hay and grain.

For 1993 the grant has been reduced to 2.50 NOK/kWh, and solar dryers are not included in this incentive program in 1993.

Standards and certification

There are no codes for certification of solar energy components in Norway, but reliability and durability will be evaluated for those installations which receive grants from the solar energy program.

Information

Information on solar energy is transferred to professionals and the public through conferences, seminars and technical magazines like "Sun at Work in Europe" and the Nordic newsletter "SOLARIS". These activities are often sponsored by the solar energy program.

Solar energy courses are offered for students at the Institute of Technology in Trondheim and at the School of Architecture in Oslo.

COMMERCIAL ACTIVITY

The big commercial market up to now has been photovoltaics. More than 55,000 systems have been installed all over Norway, and the annual sale corresponds to approx. 5000 systems. Most of the installations are for electricity supply in remote cabins and holiday houses up in the mountains and along the coastline. A typical system is a do-it-yourself-kit with a PV-panel of 50-60 W_p, lead-acid battery of 110Ah, a controller, some lamps, plugs and wire. The price for a typical system is 5000 - 6000 NOK including VAT.

Up to now, the commercial market on solar heating has been very limited. A rough estimate indicates that approx. 250 solar heating systems have been installed. This includes all kinds of solar heating systems: passive, active, residential houses and commercial buildings as well as swimming pools.

OUTLOOK

The recommendations of the UN Brundtland report have been the subject of follow-up investigations regarding Norway's prospects for reducing its dependence on fossil fuels in the domestic energy system. Several reports have been prepared on the potential for renewables in Norway.

The potential for solar heating in Norway is estimated at 5 - 25 TWh by the year 2030. The big range between the low and the high estimate is due to uncertainties on the future cost of conventional energy sources, technical development and competitive alternatives (energy conservation, heat pumps, wind energy, etc.). Nevertheless, a market based on just a small portion of these figures represents, after all, a substantial industry potential.

A report produced by DNV Industri in 1990 calculated the potential for solar energy utilization in the years 2000 and 2020 under different energy cost scenarios. The analysis was limited to solar heat as it is not expected that photovoltaics will play a significant part in the Norwegian electricity supply until 2020.

Project Contribution of Solar Energy in Norway

Energy Cost	2000	2020
Below 0.45 NOK/kWh	1.4 TWh	4.5 TWh
Below 0.70 NOK/kWh	3.9 TWh	11.8 TWh
Below 1.00 NOK/kWh	10.1 TWh	26.4 TWh

CAPTIONS

1. The Xerogel monolithic aerogel product developed by SINTEF. The transparency of the product is obvious in this photo.

2. An example of an installation containing the SOLNOR Company's energy roof in which the collector replaces the normal roof.

PREVIOUS CONTENTS NEXT

IEA SHC Solar Activities in IEA Countries Report 1993

Solar Energy Activities in Spain

Manuel Macías
CIEMAT-IER

PROGRAM ORGANIZATION

The Spanish Solar Buildings Program is managed by the Ministry of Industry, Commerce and Tourism (MICYT) through several agencies. Other ministries are also responsible for various activities carried out within the solar heating and cooling program. A list follows of the most relevant government institutions and their corresponding functions.

Ministry of Industry, Commerce and Tourism

SGERM: General Secretary of Energy and Mineral Resources

Prepare and revise National Renewable Energy Plan

CIEMAT-IER: Center for Research in Energy, Environment, and Technology - Institute for Renewable Energies

Coordinate and execute R & D projects. *Evaluate demonstration projects*

IDAE: Institute for Conservation and Diversification of Energy

Promote renewable energies . *Fund demonstration projects, information, and dissemination*

OCIDE: Coordination Office of Electric Research

Coordination and Finance I + D & D programs on electricity production, transport and rational use

Ministry of Infrastructure

INM: National Meteorological Institute

Testing and qualification, *Resource studies*

DFAV: Directorate General of Architecture and Housing

Building regulations

Ministry of Education

UNIVERSITIES & RESEARCH CENTERS (IES, CSIC)

Coordination and execution of R & D projects

In addition, the national Institute of Aerospace Technology (INTA) has a program for testing and qualification of solar collectors.

It should also be noted that regional governments, perform R & D and/or demonstration with the field of solar heating and cooling.

FUNDING

Solar energy R & D projects are funded by the Institute for Renewable Energy and the contribution of the CEC DG XII Joule Programme. Regional governments also have a small budget for passive solar and PV activities.

The demonstration programme is funded by the Renewable Energy Plan (PER-89) and the contribution of the CEC DG XVII, Thermie Programme. The new Renewable Energy Plan was approved in 1989 and the funding for the period 1989-1995 has been established. An estimated figure for total funding for renewable energy is presented in Table 1.

TABLE 1: RENEWABLE ENERGY FUNDING*

	1992		1993	
	Mpesetas	M$US	Mpesetas	M$US
ACTIVE SOLAR	95	0.8	95	0.8
PASSIVE SOLAR	100	0.87	85	0.74
PHOTOVOLTAICS	235	2.04	250	2.17
HIGH TEMP. SOLAR THERMAL	438	3.81	450	3.91
WIND ENERGY	70	0.61	85	0.74
BIOENERGY	247	2.15	320	2.78
OTHER	45	0.39	50	0.43
ALL RENEWABLE ENERGY	**1135**	**9.87**	**1135**	**11.57**

*For research, development

DESCRIPTION OF THE R, D, & D PROGRAM

R & D activities in active and passive solar energy are carried out by the Institute for Renewable Energy (IER). In recent years, considerable effort has been put into passive solar. Since joining the CEC, Spain has participated actively in the PASSYS II and PASCOOL programs. A brief description of the program areas and major projects follows.

Passive Solar - International

EC Joule Program: PASSYS II 1989-91, PASCOOL, COMPAS AND PASLINK 1992-1994, Subprogram Rational Use of Energy in Buildings.

EC Thermie Program

IEA Solar Heating and Cooling Agreement - Participation in Tasks 11, 12, and 18.

Passive Solar - National Activities

Spanish Test Cell for Testing Components

Following the general guidelines given by the EC PASSYS program, with some modifications to take into account Spanish climatic conditions, two test cells have been built, instrumented and calibrated in Almeria on the South Mediterranean coast. These two cells, together with the PASSYS cells, are use for testing component "Council Directive 89/106/EEC Construction Products."

Fig. 1: Passive Solar Test Cells at Almeria

Simulation and Calculation Method for Passive Systems

The first result of this project is the S3PAS code, which is a detailed simulation method. Transference to the commercial sector is underway.

Design Handbook for Passive Construction

The first phase of this project has been completed with the publication of a book entitled "Clima, Lugar y Arquitectura: Manual de Diseno Bioclimático" which included a computer program "CLA" to evaluate a building's natural energy performance from the first phase of the design. This book is a good resource for architects in developing their designs.

Passive Solar Building Monitoring

A book has been published showing the results of the monitored buildings. Monitoring buildings are continuing for different climatic areas by IER-CIEMAT staff in collaboration with regional governments.

Active Solar

The National Institute of Aerospace Technology is responsible for certifying solar collectors; at present, the collectors are being tested at INTA's facilities in southern Spain.

A project dealing with solar thermal desalination is presently being carried out at the Plataforma Solar de Alméria. This project, which involved the study of the integration of a conventional multiple effect system with a solar system, and an absorption heat pump will be finished this year.

Photovoltaics in Buildings

Two demonstration projects are carrying out and the results will be the contribution to Task 16, Photovoltaics in Buildings.

Fig. 2: Partial View of 4 photovoltaic grid-connected dwellings at Pozuelo, Madrid, which are part of IEA SHC Task 16.

Industry is not much involved in R & D activities.

OTHER GOVERNMENT SUPPORT ACTIVITIES

Incentives

Two different types of subsidies are presently available through the Ministry of Industry, Commerce and Tourism:

Technological improvements: for industries that want to improve their products, a percentage of the development cost is subsidized, but the industries must make a significant contribution.

Subsidies to collector users: A fixed amount of 14,000 pts/m^2 is provided for any type of installation, providing they perform according to specific standards.

Local and regional governments promote passive solar systems with subsidies.

COMMERCIAL ACTIVITY

The amount of collectors installed in recent years was less than expected. This is due primarily to declining oil prices. The total amount of collectors installed in Spain by 1992 was approximately 300,000 m^2.

Since the market has not grown as predicted, national manufacturers did not achieve the expected cost reductions from mass production. However, component reliability is increasing.

Presently, the market consists mainly of solar domestic hot water systems with some swimming pool heating applications. Industry participation in R & D activities is very small.

The number of collector manufacturers are similar to past years. The six manufacturers currently in the market are probably too many in relation to actual demand.

Residential PV is still in the demonstration phase. Two Spanish companies manufacture about 1000 Kw/year of PV modules which is in excess of the national demand. These companies are ISOFOTON and BP Solar.

OUTLOOK

Passive solar technology is beginning to play a very important role, even though its net contribution to national energy savings is still very small. However, its future contribution is potentially very important. The activities performed in recent years regarding theoretical models, installation monitoring, and active dissemination of information to professionals are creating optimum conditions to allow this technology to be expanded.

- Active solar technology requires certain action to create a significant market:
- An institutional market (i.e., sport and military facilities, schools, hospitals) to ensure a basic demand.
- Economic incentives such as energy tax deductions and subsidies.
- Quality assurance for installations, through guarantees and adequate maintenance.
- Mass media and advertizing campaigns.

PREVIOUS CONTENTS NEXT

IEA SHC Solar Activities in IEA Countries Report 1993

Solar Energy Activities in Sweden

Michael Rantil
Swedish Council for Building Research

PROGRAM ORGANIZATION

The Swedish energy research program commenced in 1975. The overall goals of research have undergone several changes since that time. A number of events - ranging from the oil crisis to political decisions regarding energy policy - have contributed to these changes in the goals.

One goal of the Swedish energy policy has been to reduce dependence on oil. In the area of energy for buildings this has been achieved thus far by energy conservation and the use of other fuels. The introduction of nuclear energy also made it possible to increase the use of electric heating and heat pumps. However, as a result of a referendum and a parliamentary decision, nuclear power is to be gradually phased out by the year 2010. Therefore, Sweden's effort is now directed towards R&D of domestic energy sources. In recent years, the reduction of electricity for building heating has been emphasized.

During the period 1990-93, attention was focussed on climatic issues, and reduction of the discharge of greenhouse gases formed part of the goals for this period. The programme concentrated on basic research and long-term applied research.

Today, the State no longer has the principal responsibility for development, demonstration and market launching of new technologies. These tasks will now be transferred to other players closer to the market, for instance the power generation companies. This is partly compensated for by support for new energy technologies and technology procurement in order to meet short-term goals.

The research program for solar energy in buildings is managed by the Swedish Council for Building Research. Market support for domestic how water and solar heating in housing is administered by the National Board of Housing and Planning. The Swedish National Board for Industrial and Technical Development has a coordinating role and also funds demonstration projects and allocates market support for larger systems. In addition, their program for technology procurement could be used for the development and introduction of solar energy technologies. At the governmental level, the Ministry of Industry and Commerce has the main responsibility for energy R,D&D.

FUNDING

The approximate funding for the Solar Buildings Program and other renewable energy technologies is shown in table below. The three-year plan for 1990/91 - 1993/94 represents a minor reduction compared to the previous three-year plan. For 1994/95 - 1997/98, a reduction of up to 20% is expected for research, except for bio-energy. On the other hand, funding for development and demonstration of solar energy will increase.

TABLE 1: RENEWABLE ENERGY FUNDING

(in $US million)

	1992	1993	1994
ACTIVE SOLAR	2.3	2.3	1.5*
PASSIVE SOLAR	0.3	0.3	0.3**
PHOTOVOLTAICS	0.3	0.4	0.6**
HIGH TEMP. SOLAR THERMAL	0.04	0.04	0.04**
WIND ENERGY	3.1	7.0	1.7**
BIOENERGY	6.7	10.0	4.8**
GEOTHERMAL	0.2	0.2	0.2**
ALL RENEWABLE ENERGY	**12.9**	**20.2**	**8.1**

*Includes funds for development
**Funds for development will be added

DESCRIPTION OF THE RD&D PROGRAM

The Solar R&D program is reviewed every third year and the Swedish Council for Building Research recently ended the planning of RD&D for the period 1993-1996. The planning process is based on evaluations of the previous period, made by a group of solar energy researchers, users and industry representatives. The group also suggests research areas and program priorities for the Council to consider. Basic research is carried out mostly at universities, system design at consulting firms, and component development within industry.

Passive Systems

Sweden's energy consumption in buildings is expected to be reduced by 20-30% over the next 10-15 years. It is estimated that passive systems will provide 20-25% of this reduction. "Passive" systems tend to be hybrid systems in most Swedish full-scale projects. The passive component is usually highly-integrated with other systems.

Presently, passive R&D activities are concentrated on the evaluation of several full-scale systems and on simulation program development. Other areas include: methods for quality control, glass technologies, transparent insulation, atria, daylighting and design handbooks.

Active Systems

Since the beginning of the eighties, the Swedish research program has focused on the development of larger solar systems eg. larger collector arrays with or without seasonal storage, connected to a local or district heating network.

System technology has been developed considerably in experimental installations. Today, methods of seasonal storage of heat in large uninsulated heat store are so well-known in Sweden that they are regarded as requiring only minimum refinement to become operationally acceptable.

Solar heating systems for domestic hot water production and space heating are technically feasible in both detached houses and apartment buildings. Swedish-designed and manufactured systems have been commercially-available for detached houses since the middle of the 1970s. However, they are not economically competitive with conventional heating systems. One important reason is that domestic hot water demand during the summer is reduced by holidays and absence during weekends. There is no diversity to even out this demand, as in an apartment building or centralised systems. Thus, utilization of available solar heat is low. Another reason is, of course, the extremely low level of solar radiation during four winter months.

A number of carefully metered and monitored installations for domestic hot water production in apartment buildings have returned more favorable results. A multi family house in Gothenburg is one good example - 1700 m^2 of flat-plate roof-mounted collectors supply domestic hot water to 380 apartments in a building built in 1960s. The system has been in operation since 1985, and operating experience to date is good.

Large solar heating systems have been tested in a number of experiments. The systematic combination of R&D work and experimental building activities has made it possible to carefully evaluate the true useful thermal yield and the real total installation costs.

Nine larger solar heating installations have been commissioned in Sweden since 1979. Collector areas vary between 1300 m^2 and 7500m^2. In four of the installations, heat is seasonally stored in water tanks, excavated pits or rock caverns. Two systems are connected only to the return side of a district heating system, while two others have a short term heat store connected to the district heating system.

The Falkenburg plant (Fig. 1) is the second largest central solar heating plant in Sweden. It has a collector array of 5,500 m^2 and is connected to the district heating network. Energy delivered to the network is 1.53 GWh/year and the cost is SEK 0.57/kWh (US$ 0.07), with a calculated lifetime of 25 years and a real interest rate of 4%.

Fig. 1: Collector field of the Falkenburg plant.

Continued development of solar heating technology needs to concentrate on achieving higher yields, but the main focus must be further reduction of collector costs. The objective is to bring about a cost reduction of 20% per unit of energy supplied within 4 years, achieved by R&D in addition to the approx. 30% reduction due to the economics of large-scale production of collectors. Reduction of costs of insulated heat stores in the intermediate size range are also needed. Other elements in a solar heating system are conventional, even though cost reductions are possible and necessary.

As far as seasonal storage of heated water is concerned, the size of the system is important in determining overall operating economics. As a result of the experience obtained through the widespread construction of large rock caverns for use as strategic oil stores in Sweden, the methods of building such stores are well known, and geological conditions throughout the country are generally favorable. Experience with storage of heat in full-scale water-filled rock caverns is already available.

Among water-based thermally-insulated storage systems, the use of pit or trench stores is regarded as interesting. The main problem is to find suitable combinations of sealing layers and thermal insulation at low cost. Again, experimental projects have provided valuable experience, but further technical development is needed if this method of constructing heat stores suitable for use with group-heating-size systems is to become commercially viable.

Photovoltaics

The Swedish funding for research on photovoltaic has, compared to many countries, been on a rather low level. Despite this situation, very promising results have been achieved for thin-film cell development during the last year. Some work is also carried out on the G-cell (or wet cell). Some activities are underway on integration of photovoltaics in buildings.

Research organizations

Names and Location	Main areas of research

Studsvik Energiteknik	Seasonal storage
National Testing Institute	Collector testing & certification, Borås material research (durability)
University of Falun	Borlänge, Collector development, DWH Borlänge system dev
Swedish State Power Board	Collector development, Alvkarleby long-term performance
Royal Institute of Technology	Active and passive system studies
Lund Institute of Technology	Passive systems, atria
Chalmers University, Dept. of Bldg / Dept. of Physics	System studies, evaluation, Glass coating, selective surface
Swedish Institute for Building Research	Passive systems, atria, Gavle daylighting
Swedish Institute for Meteorology and Hydrology	Solar radiation measurement and research
University of Uppsala	Glass coating, selective surface, transparent insulation
Dept of Physics and Chemistry	Photovoltaics - G-cell
Swedish Institute for Microelectronics	Photovoltaics - thin film
Swedish Geotechnical Institute	Seasonal storage

Research Priorities

Important research areas in the next three years are:

- selective surfaces on absorbers
- convection barriers on collectors
- optimization of flat-plate collectors
- booster mirrors for flat plate collectors
- development of "new" collectors - CPC, konc., vacuum
- improvement of large system design
- new materials: plastic and polymers
- studies on low - temperature systems
- solar retrofit
- testing methods
- solar systems combined with bio-plants, and heat and power production.

OTHER GOVERNMENT SUPPORT ACTIVITIES

Grants and Subsidies for Market Introduction

The subsidies available for smaller solar systems are 35% and the budget is SEK 5 mil/year until 1995. During 1992, grants were provided for approx. 5500 sq m of which approx 2 000 were "do-it-your-self" systems. In addition, some 2 000 sq m collector area are sold yearly for swimming pools.

Information Activities

Information activities are concentrated on systems which are most competitive in the market.

Handbooks have been produced for solar DHW for multifamily houses and for swimming pools. R&D is documented by The Swedish Council for Building Research in standard reports. Experimental plants are also presented in leaflets. Workshops and conferences are organized primarily for researchers.

Certification

Testing standards exist for collectors and a certification will guarantee only high quality collectors on the market. In order to receive funding for market introduction collectors must be certified, according to the Swedish P-certification. The test includes standards on thermal performance, reliability, durability and material quality. An important part of the certification system is that the manufacturer is responsible for continuous quality control, according to the requirements of ISO 9002, and when appropriate, supplementary requirements.

COMMERCIAL ACTIVITY

Direct industry involvement is an important feature of the experimental program.

Commercial activities have decreased as have the numbers of manufacturers (now fewer than five). However, some of those still on the market keep up development activities. During 1992 approximately 70,000 m^2 of absorbers were produced by one manufacturer and most of them were exported.

Solar Cell production started in Sweden 1992. The production capacity is 4.5 MW yearly.

OUTLOOK

The main barrier to market penetration is cost and, in some cases, the need for further technical development.

In government legislation, solar energy R&D funds and incentives have suffered decreases. On the other hand, there are strong indications that further cost reduction and efficiency improvements are possible. In the short run, government will continue to be the major funder of solar energy activities in Sweden.

The potential for active solar systems is presented below. These figures can be compared with the total heating demand in Sweden for the building sector of 90 TWh of which approx 50 TWh is delivered by the district heating network.

Assessment of the potential for active solar heating systems

Type of Solar Heating System	TWH/Year
DHW for detached houses and apartment buildings	3-6.9
Group heating plants and district heating	without storage 1.3
	with storage > 2MW 6
	< 2MW 6

IEA SHC Solar Activities in IEA Countries Report 1993

Solar Energy Activities in Switzerland

Gerhard Schriber
Swiss Federal Office of Energy

PROGRAM STRUCTURE

Broad support is provided for energy research activities in Switzerland by various government departments. Research, development and demonstration in the field of solar energy are coordinated by the Federal Office of Energy. Support, particularly in the applications area, is organized by the Federal Office for Economic Policy. The following diagrams provide an overview of the activities and the R, D & D programs in the area of solar energy in buildings.

Figure 1: Programs of the Federal Office of Energy

[ENTER ORG. CHART HERE]

* These programs are integrated in the overall "Energy 2000 Program"

Figure 2: Programs of the Federal Office for Economic Policy

[ENTER ORG. CHART HERE]

PACER = impulse program for renewable energy
RAVEL = rational use of electricity program
IP-Bau = building technology impulse program (including retrofit)

The government supports basic and applied research and development projects. It also supports pilot and demonstration systems and provides consultancy and information services. In certain application areas, subsidies and incentives are provided both by federal agencies and by regional, cantonal and local councils. Details of these activities are discussed later in this paper.

This wide range of governmental support in the energy scene includes many activities which are not directly concerned with the use of solar energy in buildings (for example: reduction of fossil fuel demand, nuclear safety, social/economic aspects, etc.). However, such activities form the "backdrop" for renewable energy activities, and play an important supporting role in the efforts to provide Switzerland with efficient and environmentally-justifiable energy systems.

The remainder of this paper concentrates specifically on the solar research, development and demonstration programs.

FUNDING

Table 1 shows the breakdown of public funding in Switzerland for solar and other renewable R, D & D including information services, subsidies and incentives. Solar energy R, D & D represents about 75 percent of all renewable energy funding and about 20 percent of the total energy research budget.

Table 1: Solar and other renewable R, D & D Funding

Funding will remain nearly constant for the coming years. In the future, a funding increase can be expected as soon as revenues earmarked for energy activities (CO2-tax, etc.) become available.

RESEARCH, DEVELOPMENT AND DEMONSTRATION PROGRAM

Most of the energy R, D & D activities are to be found in the Federal Council's Research Program. This strategy is prepared for four-year periods by the Federal Commission on Energy Research (CORE), an advisory body which assists in the definition of research goals and programs. Each Program is managed by a Program Director, who is supported as necessary by experts. The individual projects are carried out by various state institutions, private organisations and contractors. This ensures that research is performed by the people and organisations most qualified for the task.

Figure 3: Management structure of the Energy Research Program

In 1992, the Federal Council published the strategy for energy research for the period 1992 - 1995. Guidelines in this strategy reflect the consequences of the revised federal energy legislation. (A new Energy Article in the Swiss Constitution came into force in autumn 1990.) This meant that the financial support for pilot and demonstration installations could be extended to cover not only government projects but also those in the private sector. This support is now included in the government's energy research expenditure.

Also, the "Energy 2000 Program", launched by the Federal Council in February 1991, has influenced the priorities set in the strategy. An important aspect of the current energy research program in general is research into the efficient use of energy. This is propagated and supported as a major contribution to the reduction of primary energy demand in Switzerland.

Aims and Objectives

The main objectives of the Energy Research Program's solar activities for the period 1992 - 1995 are:

Solar Chemistry:

- Investigation into solar-driven photo-chemical and photo-thermal processes
- Further development of promising, ecologically-acceptable concepts for the solar production of fuels and chemicals

(Solar chemistry is regarded as an important long-term research activity).

Photovoltaics:

- Further improvement of invertor technology
- Research into improving amorphous silicon cells
- Investigation into ageing processes and the influence of climatic conditions and cell encapsulation

- Development of new PV building construction elements

Solar Architecture:

- Research into solar air systems and the use of natural lighting (daylighting)
- Better integration of active (thermal and photovoltaics) and passive (storage, sunspace) components in buildings.

Active Solar Space-Heating and Domestic Hot Water:

- Reduction of costs by the use of new materials including absorber coatings
- Introduction of standardised technologies

Role of Industry

As in most countries, the role of Swiss industry in the R, D & D programs is that of turning ideas and concepts developed at research institutions into viable products. Unfortunately, the larger Swiss industrial companies are rather conservative with regard to renewable energy sources. Their traditional determination to be fully independent of the government impedes their integration into federal research projects. The involvement of smaller enterprises is much easier, though. Small and mid-size companies are also much more innovative in general than big industry.

In Switzerland, it is unfortunately very difficult for smaller companies to obtain "venture capital," which means that many good ideas are left waiting to be implemented. The present recession, of course, does not improve matters. Luckily, the recently-added opportunities for government funding of product development has improved the transfer of R & D activities to industry. Private industry's overall budget for solar energy research (almost exclusively product development and promotion) is estimated to be on the order of 80 million $US per year.

OTHER GOVERNMENT SUPPORT ACTIVITIES

As mentioned above, research, development and demonstration activities are also supported by various other programs. The accent of these programs lies more on applications and incentives.

Energy 2000

The Energy 2000 Program has four action groups: heating fuels, motor fuels, electricity and renewable energy. The renewable energy group is particularly involved in the promotion of solar energy in all its forms.

Recent additions to the Energy 2000 activities include the "Start-Programs" which, for a restricted period, directly subsidise the use of solar and energy-saving technologies. The four categories of subsidies are as follows:

Solar collectors for DHW pre-heating in apartment blocks with more than four dwellings are given a subsidy of SFr 300 per m2 collector.

Photovoltaic installations on school buildings receive a subsidy of Sfr 5,000 per installed kilowatt peak power.

Although not strictly a pure form of solar energy use, heat-pump installations receive subsidies, if used to substitute for fossil-fueled heating systems or to replace electric storage heating (Sfr 300 per kilowatt heating power).

The renovation of public buildings is subsidised provided that stringent conditions on the reduction of energy demand are fulfilled.

Other Federal Office of Energy Programs

The DIANE (Breakthrough of innovative applications of new energy technologies) and Promotion Programs support applications such as low-energy houses and daylighting.

The Pilot and Demonstration Program supports selected installations with an exemplary or model character, but only up to 30 percent of non-amortizable costs are covered. (Individual cantons may add a further 20 percent to this amount.)

Further activities consider the various accompanying measures such as energy pricing, taxes, and regulations.

Federal Office for Economic Policy Programs

The Federal Office for Economic Policy's programs emphasise education and training. Various courses for trade and industry provide know-how transfer in the areas of renewable energy sources (PACER), rational use of electricity, heat-pumps and daylighting (RAVEL) and building technologies (IP-Bau).

ACCOMPLISHMENTS

The following list is by no means complete, but describes a few examples of some interesting achievements:

Results of the Swiss Collector Test and Certification Facility in Rapperswil have been incorporated into various computer algorithms providing the basis for an easy-to-use PC-based utility (POLYSUN).

The pigment solar cell (Graetzel Cell) has been further refined to attain an efficiency of 14 percent.

Standardised, efficient, low-cost, solar domestic hot water installations have been developed with complete installations (5m2 collector area) costing less than SFr. 8,000.

An integrated facade, which not only generates electricity using photovoltaic modules but also provides heating and shading of south-facing offices, has been completed for an industrial workshop and office building (Fig. 4).

Figure 4: Integrated solar usage on an industrial building in Kirchberg, Switzerland.

Application of daylighting and other passive techniques in various buildings. Fig. 6 shows the passive lamina system on the main railway station in Lucerne, which provides good office lighting while functioning as a sunshade and preventing overheating in summer.

Figure 5: Functionality and good architectural design combined at the main railway station in Lucerne, Switzerland.

The combination of daylighting and photovoltaics produces interesting results. Fig. 6 demonstrates the concept of "Shadovoltaic Wings" which, depending on the prevailing weather, can be positioned either to guide daylight into the room or provide shading. In the shading mode, PV elements on the wings produce electricity.

Figure 6: Synergy: Daylighting and PV combined.

With the addition of several new support programs, solar chemistry is receiving greater emphasis. Research and development in this area is receiving a major push, and it is expected that solar chemistry will become an important theme for Swiss R & D activities in the long-term.

COMMERCIAL ACTIVITY

Trade and Industry

The world-wide recession and the extremely low (fossil) energy prices have had their effect on commercial activities in the solar field. Despite this situation, many manufacturers of solar thermal and PV systems have survived the "shake-down" and compete in somewhat leaner markets.

The Swiss Solar Energy Specialists Association, SOFAS, lists over 50 members who actively manufacture, import and install active solar and PV systems in Switzerland. Planning, engineering and consultancy are provided by a further 55 architects and consultants. It is estimated that in 1991 more than 66,000 m2 of flat-plate and evacuated collectors (approximately 3,900 installations), over 72,000 m2 of swimming-pool collectors (about 28,900 installations), and around 180,000 m2 for hay drying (about 21,600 installations) were installed. This area of thermal collectors was supplemented by over 39,200 m2 of photovoltaic panels in about 15,500 installations. Growth-rates can be seen in the following diagram, which shows the installed area per year for the various collector types.

Figure 7: Solar System Installations

"Grass Roots" Activities

The traditional solar trade and industry has been supplemented by self-help groups and co-operatives which enable people and organisations with limited financial resources to invest in solar installations.

Collector building groups, originally an Austrian idea, have been set up in various parts of Switzerland with federal and cantonal financial help. The groups are provided with regionally-based experts, small workshops and construction drawings to help members build their own solar installations. These organisations have been formed primarily by the regional groups of the Swiss Society for Solar Energy, SSES, which has more than 8,500 members. Interestingly, the building groups are not in direct competition with the solar trade. On the contrary, in areas where "do-it-yourself" collectors have been installed, the number of "professional" installations has also increased!

The annual "Tour de Sol", a solar vehicle rally, has become an established part of the Swiss solar scene. Both experimental vehicles powered directly by solar-cells and cars for daily use with "decentralised" PV-generators take part. The aim is not to reach the highest speeds but to drive as economically as possible. Swiss solar vehicle technology has proved itself by the success of the "Spirit of Bienne" in the World Solar Challenge in Australia. The promotional effects of such activities for the whole solar scene is worth its weight in gold.

The Working Groups on Decentralised Energy Supply (ADEV) and similar co-operatives enable private and public investors to financially participate in solar or renewable energy projects. Examples of solar projects include roof- and facade-mounted photovoltaics, which enable investors to produce their own "ecologically-compatible" electricity.

SOLAR 91, a foundation set up in the centenary year 1991 (700 years of Switzerland), provides a basis for information and motivation at the local council level. A prize is awarded each year to the community with the best solar installation.

Energy Pricing

An important factor for solar electricity generation is the price paid by electric utilities for power produced using renewable energy. After long and hard discussions, an average price of 16 cents per kWh was agreed. By comparison, domestic consumer tariffs average about 14 cents per kWh, PV-produced electricity costs between SFr 1.20 and 1.50 per kWh, and electricity from other newly-built power sources between 18 and 25 cents per kWh.

OUTLOOK

The pioneer spirit of the solar scene in Switzerland is still alive and well, despite reduced willingness in the public and private sectors to invest in solar installations. It can be said that solar technologies have now reached a state of reliability and efficiency that allows their use as "normal" components for housing and industry. There is, of course, always room for improvement and there is no complacency to be found in Swiss R, D & D circles!

Energy has attained acceptance as a primary factor in ecological and environmental protection discussions. As a result of the commitment of the Swiss Federal Council to the reduction of carbon dioxide emissions (based on the outcome of the UNCED Conference in Rio de Janeiro), an energy tax is now been discussed. What effect this will have on the funding of R, D & D activities in the solar field is still unknown, but a possible redistribution model for the revenues should provide increased funds and incentives for the growth of solar energy use.

PREVIOUS CONTENTS NEXT

PREVIOUS CONTENTS NEXT

IEA SHC Solar Activities in IEA Countries Report 1993

Solar Energy Activities in Turkey

Melih Tan
Greater Ankara Municipality

PROGRAM STRUCTURE

The Turkish Government has not yet established a formal policy in the area of solar energy. National support is available to renewable energy projects through the State Planning Organization (DPT) and the Scientific and Technical Research Council of Turkey (TUBITAK).

The sixth Five-Year Development Plan (1990-1994) of DPT gives a primary role to hydroelectric power. For solar and other renewable energy technologies (RET), there are intentions and expectations for more extensive utilization.

The Turkish Section of the International Solar Energy Society (UGET-TB) and the Turkish Branch of the European Wind Energy Association (AREB-TS) have been operational since 1992 by permission of the Turkish government.

These recently-established associations of solar and wind energy are trying to provide a platform, to evaluate and develop policies and approaches for integration of renewable energy technologies in the Turkish energy sector.

UGET-TB and AREB-TS are trying to get organized and take the initiative to remove the existing obstacles for extensive utilization of solar, wind and other renewable energy technologies in Turkey. Members are representatives of various private and government institutions and universities.

An organization chart of the government agencies responsible for RETs is given in Fig. 1.

Fig. 1. Government Agencies Responsible for Renewable Energy

Until the late 1980's, solar energy and energy conservation research was carried out at the Mechanical and Energy Engineering Departmemt (MESAB) of the Marmara Scientific and Industrial Research Institute (MRI) and the Building Research Institute (YAE), but these were abolished due to administrative difficulties.

Today, there is no government institution responsible for solar energy for building technologies. The Greater Ankara Municipality is taking the initiative to organize and conduct studies on passive solar applications as a local authority.

The Turkish Electricity Authority (TEK) is working on its infrastructure to include RETs in its Annual Implementation Program. The Electricity Power Survey Administration (EIEI) is taking responsibility for small-scale renewable energy applications. The State Meteorological Directorate (DMI) is responsible for organizing reliable solar and wind power resource measurements in the country. The Turkish Standards Institute (TSE) produces standards for solar energy collectors.

FUNDING

The following chart shows funding for solar building technologies and other RETs for 1992.

TABLE 1: RENEWABLE ENERGY FUNDING* - 1992

TECHNOLOGIES	$US
ACTIVE SOLAR	97,000
PASSIVE SOLAR	70,000
PHOTOVOLTAICS	183,000
HIGH TEMPERATURE SOLAR THERMAL	--
WIND ENERGY	]
BIOENERGY	--
GEOTHERMAL	120,000
OTHER	--
ALL RENEWABLE ENERGY	**598,000**

*For research, development, demonstration and information programs.

R, D & D ACTIVITIES

R, D, and D activities in Turkey in the fields of solar, geothermal, biomass, and wind energies are carried out primarily by government institutions and universities with very limited contribution from private institutions.

Table 2: Government Institutions Involved in Renewable Energy

Table 3: Private Institutions Involved in Renewable Energy

Table 4: Universities Involved in Renewable Energy

The ever-increasing deficit in Turkey's energy balance calls for long-range planning in energy-related R,D & D activities and a better coordination and cooperation among the institutions involved. In this perspective, assigning application-oriented, long-term projects with intensive capital and large personnel requirements to government institutions, whose designated duty is research, is the best and recommended policy. In turn, these institutions, which will specialize in one or two fields, should be in close cooperation with:

Universities which will supply much-needed support in theoretical and fundamental research,

The ***industrial secto***r which will supply know-how and a suitable environment for pilot studies, and

Other ***government institutions*** which will provide help in widespread implementation of results.

The underlying principles of the R,D, and D policy described above served as guidelines for the period between 1977 and 1985 during which R,D,&D activities were organized and conducted by the Mechanical and Energy Engineering Department (MESAB) of Marmara Research Institute (MRI).

Previous Research Activities

The R,D & D activities carried out between 1977 and 1985 on renewable energy at MRI can be grouped under three major headings:

Project I - Low Temperature Applications of Solar Energy

The goal of this project was to ensure maximum utilization of solar energy in low-temperature applications and consisted of four subprojects:

1. Updating Solar Radiation Measurement Network
2. Design, Construction, and Evaluation of Solar Hot Water Production Systems
3. Development of Selective Surfaces
4. Design and Construction of a Solar Simulator

Project II - Modelling Thermal Energy Requirements of Turkish Process Industries and Assessment of the Potential for Solar Industrial Process Heat

Accomplishments of this project include:

- Completion of a survey on IPH requires which covered all twenty major industrial subsectors. The survey was conducted by visiting more than 200 individual plants in eighteen different geographical sites. The compiled data are now being evaluated.
- Development of an insulation model and computation of long-term annual performance of principal solar collector types based on this model.
- Completion of a market survey on Turkish solar collector manufacturers and development of a market penetration model.
- Completion of a more-detailed survey on IPH requirement of the chemical industry.

Project III - Investigation of Wind Energy Utilization Options in Turkey

Recent Activities

In 1986, the Project Team at MRI moved to Marmara University. Marmara University Solar Energy Plant (MARSOL) became operational in 1992. MARSOL, with a rated power of 170 kW was designed to produce IPH at 290°C. R, D, & D activities are in progress and the heat produced will be supplied to local loads in the campus.

TUBITAK Ankara Electronics Research and Development Institute, established in 1986, is capable of designing and manufacturing systems for PV applications. Research scientists are specialized in electronic inverters and control units.

Ege University Solar Energy Institute is also active in passive solar research. Solar cooling and greenhouse heating are other fields of activities.

A very efficient passive solar air heating system has been developed in Ankara. This new system, developed by Melih Tan, the Energy Counselor of the Greater Ankara Municipality, aims to use solar energy in multi-story buildings in densely populated urban areas.

In this system, the solar energy gained in the southern sunspace is not transferred to the dwelling but to the northern greenhouse by by means of air ducts placed in the ceiling and floor (see Fig. 2). Therefore, the dwelling is surrounded by a glazed envelope and the solar energy is imposed on this limited volume of air between the building surface and the glazed envelope. This feature provides a very high efficiency due to the decrease in the heat losses from the internal spaces.

Fig. 2: Thermal Flow Diagram of Ankara Solar House

Fig. 3: Exterior view of Ankara Solar House

Fig. 4: View of sunspace created by glazed envelope of the Ankara solar house.

The Greater Ankara Municipality constructed a solar house to test and demonstrate this new technique. The Ankara Solar House simulates a multistory building. It has been observed that the natural thermal air circulation overcomes a distance of ten meters and flows from the southern sunspace to the northern greenhouse through the air ducts in the ceiling and returns back through the air ducts in the floor. (See Figures 3 and 4.)

The new system may also be applied to eastern and western sunspaces around a dwelling, transferring the solar heat gain in the eastern sunspace to the west in the morning and from west to east in the afternoon. Thus the system provides flexibility in positioning the buildings with respect to the sun.

COMMERCIAL ACTIVITY

The most recent PV applications of Turkey are realized by PTT General Directorate in Ismir, Kirikkale and Elazig.

Turkey presently utilizes only 21% of its economic hydroelectric potential. It is expected that this value will reach 60% by 2010.

The first geothermal power plant with an installed capacity of 20 MW is operational in the Denizli-Kizildere field. Another unit with 20 MW is planned. The Aydin-Germenci field has potential of around 100 MW. 90% of the geothermal fields in Turkey have good characteristics for space heating. Geothermal energy is also used for greenhouse heating.

More than 100 private companies in Turkey are involved in the solar energy area; 11 of these market their products all over the country. The main product is the flat plate collector for water heating.

OUTLOOK

In Turkey, almost half of the energy is imported, mainly as oil, constituting one-tenth of the national imports. Furthermore, the oil bill, which is around $US 2.0-2.5 billion per annum, is a major factor contributing to the nation's continuing foreign trade deficit. Solar energy can be is a domestic energy source, a highly desirable situation for the equilibrium of foreign currency.

Primary energy resources production estimates published by the Ministry of Energy and Natural Resources for the period 1992-1994 are given below in Table 5.

The residential and commercial sectors of the economy account for 38% of Turkish energy use. If solar energy technologies were widely adopted in new construction, they could displace significant amounts of fossil energy (lignite, petroleum and natural gas).

The barriers to widespread use of solar energy building technologies in Turkey can be summarized as follows:

1. Cooperation between architects and energy engineers is not a common practice.

2. Such cooperation is not encourage by the local authorities responsible for guiding and controlling the new construction activities. Passive solar design guidelines are not widely available to home builders.

3. Life-cycle energy costs are not taken into account during building or purchasing a new home. Firms often have little incentive to incorporate passive solar designs into buildings since they do not pay the cost of heating and cooling the buildings in later years. Owners often demand an unrealistically short payback period (as little as 2 - 3 years) for investments in passive solar technologies and other energy-saving measures.

4. Passive solar technologies have not been adopted by the construction industry. In addition, solar building technologies which are commercially available are not yet known by the architects. It takes time for new designs and building techniques to infiltrate the industry.

5. Energy-efficient building designs do not have a priority in the agenda of municipalities and housing cooperatives.

6. The market is insensitive to the environmental and social benefits of the renewable energy sources.

The future of solar building technologies in Turkey seems promising. Municipalities are interested in and more willing to implement renewable energy technologies. The Ankara Municipality's Ankara Solar House is designed to demonstrate the advantages of solar building technologies in Turkey. It identified the potential difficulties and barriers to be faced due the National Law of Development and Construction. It develops the actions and measures necessary to overcome these difficulties.

The development of reliable, easily-implemented and cost-effective solar energy building technologies in Turkey is the main contribution expected from the project.

IEA SHC Solar Activities in IEA Countries Report 1993

Solar Energy Activities in the United Kingdom

A.J. Cole
Energy Technology Support Unit

PROGRAMME STRUCTURE

The Solar Energy Programme is one of the Renewable Energy programmes managed by the Energy Technology Support Unit (ETSU) on behalf of the Department of Trade and Industry (DTI). The policy aims of the renewable energy programme are to stimulate the development of renewables to the fullest practical extent where they have prospects of being economically attractive and environmentally acceptable. The solar energy programme encompasses Passive Solar Design, Photovoltaic Systems (PV), Active Solar Heating, and some photoconversion processes.

A range of measures is being undertaken covering the spectrum of assessment, research, development, demonstration and deployment, with each technology covered according to its judged potential and status. These measures are broader than purely technical ones and, where appropriate, work to address non-technical barriers is being undertaken.

The Department of the Environment (DoE) carries out several programmes concerned with energy efficiency in buildings including the activities of the Energy Efficiency Office, the Building Regulations and the Building Research Establishment. The co-ordination of the DTI solar energy programme with these is discussed later in this paper.

The Science and Engineering Research Council (SERC) is the principal body for sponsoring fundamental research activities in higher education institutes and supports a broad range of R&D projects including energy in buildings.

The DTI programmes are closely coordinated with the relevant activities of the European Commission, primarily DG-XII and DG-XVII.

FUNDING

The funding for the various elements of the DTI's renewable energy programme are shown in the attached tables.

DTI RENEWABLE ENERGY FUNDING

	1992/3		1993/4**	
	£ UK	$ US*	£ UK	$ US
ACTIVE SOLAR	12 K	18 K	50 K	75 K
PASSIVE SOLAR	2.1 M	3.1 M	2.2 M	3.3 M

PHOTOVOLTAICS	196 K	294 K	180 K	270 K
HIGH TEMP SOLAR THERMAL	0	0	0	0
WIND ENERGY	8.7 M	13.0 M	7.2 M	10.8 M
BIOENERGY	3.2 M	4.8 M	2.9 M	4.4 M
GEOTHERMAL	1.2 M	1.8 M	1.0 M	1.5 M
OTHER (TIDAL, WAVE, HYDRO, MARKETING)	8.2 M	12.3 M	9.5 M	14.3 M
ALL RENEWABLE ENERGY	23.7 M	35.5 M	23.0 M	34.6 M

*Using an exchange rate of $1.5 = £1
** Budget as of 1 April 1993

DTI SOLAR ENERGY PROGRAMME FUNDING 1993/4
In £ thousands ($ thousands)

	R & D	DEMONSTRATION	MARKET SUPPORT	TESTING & CERT.
ACTIVE SOLAR	-	-	25 (37)	25 (37)
PASSIVE SOLAR	360 (540)	360 (540)	1,400 (2,100)	50 (75)
PHOTOVOLTAICS	180 (270)	-	-	-
HIGH TEMP SOLAR THERMAL	-	-	-	-

These breakdowns are indicative only.

R,D&D PROGRAMME

Passive Solar Design

The economically-achievable primary fuel savings which it is estimated could be made by the widespread application of passive solar design in the UK could be as high as 12 TWh/yr by 2025. The correct application of passive solar design measures can significantly reduce the energy consumption of most kinds of buildings, but the route to achieving energy savings can require a different strategy according to the building's use, occupancy etc.

For the simplest direct gain approaches in houses, the technical understanding is now thought to be fairly complete. More complex daylighting and indirect gain approaches, especially in non-domestic buildings, are less-well understood or proven. The DTI programme has therefore carried out R,D&D activities targeted toward different building types and covering different PSD strategies. These are outlined below:

Housing

DESIGN STUDIES. Approximately 60 individual design studies of houses have been carried out. These have covered a range of market sectors from large single-family houses through to multi-residential sheltered housing and renovation. Each design has been developed by architects with appropriate briefing and cost and energy analysis support and has been steered by a quasi-client from a house builder or developer. A synthesis of this wealth of results and design experience is currently underway but a large number of successful low-energy design has been produced, many with high solar fractions for their space heating requirements (see Fig 1).

Figure 1: Comparison of space heating energy use for a "standard" UK house type and a re-designed passive solar house. The indicated annual energy savings are about 1300 kWh.

FIELD TRIALS. Sixteen houses with some passive solar design features have been extensively monitored within the Energy Performance Assessment project. These studies have covered measured energy use, internal temperatures and occupant interaction and satisfaction, as well as analyses of cost and energy performance. The houses encompassed a number of features from simple direct gain approaches (see Fig. 2) to fan-assisted air collector systems. Solar space heating fractions of up to 35% were measured. However, an important message from these studies is that occupants must be properly briefed on how to use their homes if the maximum benefits are to be realised.

Figure 2: A simple 3-bedroom direct gain passive solar house at the Bournville Village Trust in Birmingham. The measured solar space heating contribution was over 500 kWh per year.

CONSERVATORIES. The use of conservatories or attached sunspaces presents something of a dilemma. In principle, if properly designed, installed and used, such spaces can be an energy benefit to a house. This has been confirmed in several of the field trial houses and also by means of test cell measurements on an EC PASSYS facility at Strathclyde university. These measurements showed that up to 1200 kWh per annum could be extracted from a typical conservatory and be provided as space heating to the attached space. A recent survey of more than 4,800 owners of conservatories in the UK has revealed that more than 90% of them use some form of space heating to their conservatories to extend the period of comfortable occupancy.

However, a simple calculation shows that, for the UK climate, heating an average-size conservatory to a 15°C set point can consume nearly the same amount of energy as heating the rest of a typical medium sized well-insulated house to 21°C. Clearly there is a need for basic information to owners on the energy consequences of their decisions on the way they use a conservatory space. An initial step has been made by incorporating some simple guidance in the Energy Efficiency Office's Helping the Earth Begins at Home booklets.

Non-Domestic Buildings

DESIGN STUDIES - DIRECT GAIN. These studies have focused upon office and light industrial buildings and are exploring the potential for significant energy savings from electric lighting displaced by daylight by means of window and roof light design coupled with consideration of internal space layout and orientation. Design models have been extensively tested under an artificial sky to measure daylight levels and uniformity. Where possible, opportunities for solar space heating have been taken but only if this does not compromise the daylighting design.

A major emphasis has been the attention given to the control of overheating in occupied spaces and the use of solar-driven natural ventilation to control temperatures. Sophisticated analysis techniques, including Computational Fluid Dynamics, have been used to confirm the success of the designs. Quasi-clients, including speculative developers and owner-occupiers, have again been used to provide realistic brief to the design teams and to critically assess the designs for letable floor space, functional compliance etc.

DESIGN STUDIES - ATRIA. These studies have taken the approach of modifying an existing building design to include an atrium space. Extensive computer simulation has been carried out using the ESP (Environmental Systems Prediction) model to determine the energy impacts of the atrium on the surrounding space in terms of heating, lighting and ventilation. This work has highlighted the difficulties faced by designers in properly integrating highly- glazed spaces into commercial buildings in such a way as to reduce the energy consumption without reducing the thermal comfort of the occupied spaces. The need to dynamically couple the atrium into the HVAC system is of great importance.

FIELD TRIALS. A wide range of non-domestic building types have been monitored within the EPA project. The fifteen buildings studied include offices, schools, hostels, sports halls, a hospital and an engineering workshop (see Fig 3). The passive solar design measures incorporated into these buildings include direct gain, light shelves, top lighting, a conservatory and an atrium. Unlike the domestic studies, there has been a particular emphasis on daylight and ventilation measurements. The majority of these buildings have been shown to successfully utilise solar energy but some instances have been found where either the controls or the occupants have not been able to respond to the potential benefits.

Figure 3: This building is used as an engineering training workshop at Warshash near Southampton. The building includes high levels of roof lighting to provide daylight into the workshop space and intricate shading for overheating and glare protection.

DAYLIGHTING. The use of natural lighting to offset the use of artificial lighting is a powerful PSD measure in many building types. In order to back up the design studies projects and further explore the potential of daylighting design measures, a number of studies are being carried out specifically on daylighting issues. Among these is support for a daylight measurement station in Edinburgh as a part of the International Daylight Measurement programme. This will provide the first measurements of daylight levels in the northern UK and be an important step in determining the efficacy of these design measures in Scotland and northern England.

NATURAL VENTILATION. The use of natural ventilation instead of conventional air-conditioning is finding increasing favour in the UK with both designers and building occupants. Some PSD measures such as light wells and atria can provide opportunities for assisting natural ventilation mechanisms. The DTI programme is working with the Building Research Establishment to seek ways of identifying and assessing these mechanisms.

Advanced Glazing Systems and Materials

A number of new glazing materials are currently being researched around the world, and there are prospects that many of these will be developed as marketable products in the near future. These range from development of existing multi-pane coated glazings through to electrically-controlled variable transmission films and evacuated windows. The DTI has carried out a programme of assessment of the technical and market issues for some of these systems in a project called Fenestration 2000. This has been a joint exercise with Pilkington Glass, the US Department of Energy and others. Test cell studies have been carried out to investigate the use of transparent insulation materials as insulating wall cladding elements for houses. These studies have indicated that typically 200 kWh/m2/yr of heating benefit can be obtained - depending on the insulation levels in the rest of the construction. An important issue however, is the provision of means to control summertime overheating.

A good understanding has now been achieved of the issues involved in developing and deploying some of these systems and the likely design and energy impacts that will arise from their use. This work is being used as a basis for determining whether any further DTI action is required in this area.

Photovoltaic Systems

Semi-conductor device R&D and developments in manufacturing techniques have, over recent years, reduced the cost per Watt-peak (Wp) and increased the photoconversion efficiency of photovoltaic (PV) cells. In response to this, a review of the technology was carried out within the DTI programme. This review, carried out in 1990, concluded that large-scale centralised generation of electricity for the grid using PV is unlikely to be economically attractive in the foreseeable future in the UK. Distributed generation using small-scale systems and remote sites was identified as more attractive. The review developed scenarios which indicated the possibility of generation by PV at a cost comparable with other sources, in particular for systems integrated into buildings. As a result of this review, an initial programme of assessment studies is being undertaken within the DTI programme.

The objectives are:

- to assess the potential for distributed PV generation in the UK
- to identify the barriers to the installation and use of PV systems.

A range of activities are being carried out to address these objectives including a national resource estimation, design issues for PV modules as building cladding, cost refinement, pre-prototype testing under a solar simulator and an assessment of the grid connection issues. Results from the first study show that the UK national resource from PV systems integrated into buildings could be significant. By analysing the existing building stock, identifying appropriate buildings, allowing for shading and orientation etc., and factoring in an average PV efficiency, the following estimates for the UK were made:

	1995			**2020**		
Building Category	Power Capacity per km^2 (MW)	Total Power Capacity (GW)	Electrical Energy per Annum (TWh)	Power Capacity per Km^2 (MW)	Total Power Capacity (GW)	Electrical Energy per annum (TWh)
Commercial	107	8	26	131	15	50
Industrial	76	14	46	76	26	85
High Rise Residential	43	1	2	-	-	-
Housing	38	40	133	38	70	228
TOTAL		**63**	**207**	**245**	**111**	**363**

It should be noted that these estimates are necessarily fairly crude but they do give a sense of the upper limit on the accessible resource from this mode of deployment for PV systems in the UK. This is not, of course, the economic resource which would be much smaller and determined by a range of other factors including additional capital cost, investment criteria, conventional fuel prices etc. The change in resource size with time is a result of predicted changes in building stock (e.g. reduction in high rise houses) and increases in the performance of PV systems.

These resource estimates reflect an annual average output; clearly there will be issues of macroscopic inter-seasonal variation and microscopic time and location variations. These will be important factors if PV ever becomes a significant contributor to the UK national energy supply.

Active Solar Heating

In order to monitor the status of the technology and the market, the DTI programme has recently completed an extensive review of Active Solar technologies. The main conclusions of this were:

> High temperature solar thermal processes for electricity generation are inappropriate for the UK.
>
> Solar-assisted district heating schemes in the UK may have application in the future if forecasts for cost reduction can be achieved and social barriers to district heating overcome.

A significant number of domestic hot water and swimming pool low-temperature heating systems have been installed in the UK. The current market size is small with a total annual sales of about 15,000 m^2 of collector. There are signs that the market is beginning to expand.

The review identified a number of non-technical issues facing active solar heating and outlined a set of measures which could help stimulate the market. Consideration is currently being given to these measures where they are appropriate to the DTI. Even with a significant increase in the market size, however, the estimated UK maximum-accessible resource size for active solar is modest at about 12 TWh per year, and, as in the case of PV systems, the economic resource is likely to be a small fraction of this.

Photoconversion Processes

Photoconversion is a term for various processes which convert sunlight directly into either electrical power or a chemical fuel. These include photo-biological, photochemical and photo-electrochemical processes. The main attractions as an energy source are:

They use freely available solar energy to drive the reactions

They often use water as a substrate for many of the required reactions.

They have low ecological and environmental impact.

Within the DTI programme, a review has been carried out of the current status of a wide range of these processes. Photoconversion technology is still at the laboratory research stage. Several processes are being actively investigated world-wide but the review identified only two of these as being candidates for possible future energy options for the UK - electrochemical photovoltaic cells (ECPV) and photo-biological systems to produce hydrogen.

ECPV cells are functional equivalents of conventional solid-state semiconductor PV cells, producing direct current electricity on illumination. They are significantly less-developed than solid-state PV cells but their photoconversion efficiencies are comparable and they may have the advantage of simpler, lower cost production.

Many laboratory-scale systems capable of continuous hydrogen production have now been developed in various parts of the world. The efficiency of the conversion of solar energy into hydrogen by anaerobic photosynthetic bacteria has been estimated at 5% with prospects for significant improvement. Such a system might, for example, be located at a municipal waste water treatment site as a parallel stream to an existing anaerobic digestion plant. This would facilitate access to a suitable growth substrate and provide an effluent disposal route to the anaerobic digester as well as producing hydrogen.

The prospects for further development of such systems in the UK is currently being assessed within the DTI programme.

International Activities

Solar energy R,D &D programmes are being actively pursued in many countries. There are benefits to the national programme from participating in relevant collaborative programmes in order to gain from the access provided to knowledge and expertise in other countries and also to feed experiences and skills from the UK programme to others. The DTI programme is making full use of these advantages in the following ways:

Within the International Energy Agency activities, the UK is currently participating in three activities in the Solar Heating and Cooling Agreement:

- Task 18 on advanced glazing materials for solar applications
- Task 16 on photovoltaic systems in buildings
- Task 13 on Advanced Solar Low Energy Buildings.

The DTI programme is also involved in Annex 21 of the Building and Community Systems Agreement.

In addition, the UK has recently joined the new Photovoltaic Power Systems Agreement and is planning to participate in several of the Tasks being developed.

A large number of UK organisations are contractors within the European Commission programmes on solar energy, both within the non-nuclear energy research projects of DG-XII and the energy demonstration projects of DG-XVII. In some cases, the DTI programme has supported these activities, including, for example, the PASSYS test cell project.

The DTI programme has a bilateral agreement with the US Department of Energy and joint activities have been undertaken on solar building monitoring, advanced glazing materials and more recently, photovoltaic systems.

OTHER GOVERNMENT SUPPORT ACTIVITIES

Information Dissemination and Market Support Measures

Many of the barriers to the widespread adoption of passive solar design techniques are non-technical and are associated with a lack of awareness of possible measures and how to properly apply them. The DTI programme is carrying out a number of initiatives to overcome these information and skills barriers.

In order to get information into the market place in an effective and targeted manner the results of the DTI passive solar work are being fed into the marketing activities of the Energy Efficiency Office's Best Practice programme (BPp) for energy efficiency in buildings. This is operated by the Building Research Energy Conservation Support Unit (BRECSU). This ensures that passive solar become part of an integrated energy-conscious design message and is not viewed in isolation from other measures.

A major DTI scheme which has recently been launched is the Energy Design Advice Service. This is a national initiative which will use regionally-based advice centres to reach the design community and enable them to benefit from the wealth of R,D&D results from government and international programmes in low energy design. Specifiers and designers of new buildings and refurbishment projects of greater than $500m^2$ floor area can approach a regional centre and get a day of free consultancy and advice from resident experts. If there are prospects of reasonable energy savings being achieved then the client can be directed to more specialist consultants as appropriate to the building type. This further consultancy is offered with up to a 50% government subsidy.

The model for this scheme is a pilot project which has operated in Scotland for over three years, funded by the DTI and the Scottish Development Agency. The project was managed by the Royal Incorporation of Architects in Scotland and the regional centre was established at the University of Strathclyde. This pilot proved to be a success with an annual level of activity of over 125 initial one-day consultancies and over 25 extended consultancies. It is estimated that the value of the annual energy savings arising from the pilot scheme amount to over £700,000. This is nearly twice the government investment in the project. This level of achievement provides a good spring-board for the expanded national scheme.

The scheme is managed on a day-to-day level by BRECSU (Building Research Energy Conservation Support Unit) which has responsibility for setting up the scheme, auditing the advice given, monitoring the performance of the regional centres and master-minding the high level of marketing that will be carried out both regionally and nationally.

The first two regional centres under the national scheme are now operating in Scotland and the South East England region. Up to three others are planned across the UK.

COMMERCIAL ACTIVITY

Active Solar

The UK active solar heating industry currently consists of the following numbers of mainly small commercial enterprises:

- collector manufacturers 7+
- collector importers 4+
- system installers 16+
- controller suppliers 2+

In 1991, the UK sales of collectors was 13,000 m^2, 9000 m^2 for water heating and 400 m^2 for swimming pool heating.

Photovoltaics

The UK PV industry is smaller, comprising:

- module manufacturers 2+
- module importers & system assemblers 6+
- consultants 6+

There is at present little robust data on the sales of PV systems in the UK. Estimates for 1992 indicate a total home market of only 50 kWp with non of this for residential power applications. The total UK commercial activity in PV is much greater, estimated at about 5.5 MWp. The majority of this involves products sourced and deployed outside the UK. A significant fraction of this would be for remote power and grid-connected residential use.

Passive Solar

The passive solar design market activity is very difficult to define and measure. Nearly all buildings make some use of sunlight to contribute to their energy use. It has been estimated that this existing use of solar energy is displacing on the order of 145 TWh/yr of primary energy in the UK. It is difficult, and possibly unhelpful, to try and define when solar gains become "planned" benefits from passive solar design. The marketing of passive solar design is probably best done as part of a holistic low-energy design message to the professions. Highlighting passive solar design may even have detrimental consequences; at best it may result in unrealistic expectations, at worst it may result in it being marginalised and dismissed as too difficult or cost-ineffective.

One of the ways of advancing passive solar design as part of a low- energy design approach is by means of statutory regulation. In England and Wales, the Conservation of Fuel and Power is covered under Part L of the Building Regulations. The standards required to satisfy these regulations are periodically reviewed. Proposals have been made to include in a forthcoming review the following solar design measures:

- allowance for solar heating gain from windows oriented south
- credits for the provision of natural lighting
- guidance for the correct specification of new domestic conservatories

- allowance for the specification of active solar water heating systems.

The inclusion of these or other similar measures in future regulations will help drive the adoption of these solar energy technologies.

A recently announced initiative of the electricity and gas utilities in the UK is the establishment of the Energy Savings Trust. This body, funded by the utilities, will sponsor investments in energy-saving measures primarily in the domestic sector. Although not specifically directed at solar energy measures, the activities of the Trust will help to raise the overall consciousness about energy issues.

OUTLOOK

The solar energy programme of the UK Department of Trade and Industry is comprehensively addressing the solar technologies with the best prospects for deployment. Passive solar design is seen as the technology with the greatest short term prospects and by means of a targeted set of measures, robust design messages are now being actively promoted in the market place. An extended programme of assessment of photovoltaic systems is underway in order to confirm the applicability and technical feasibility of these systems in the UK. Active solar heating is being kept under review and new technologies within the photoconversion area are being investigated. It is intended that these measures ensure that solar energy plays an appropriate role in the future energy scene in the UK.

PREVIOUS CONTENTS NEXT

PREVIOUS CONTENTS NEXT

IEA SHC Solar Activities in IEA Countries Report 1993

Solar Energy Activities in the United States

Mary-Margaret Jenior
U. S. Department of Energy

GOALS AND OBJECTIVES

The driving-force behind the United States government-sponsored solar heating and cooling research effort is a vision of buildings that can be made virtually energy self-sufficient through the effective incorporation of solar technologies and design options in combination with other renewable energy and energy efficiency technologies. The goal is to develop solar technology options for water heating, space conditioning, and daylighting that can deliver energy at costs competitive with conventional technologies. The program objectives are:

In the near-term, to provide industry with information required to improve solar system performance, and to enable the attainment of acceptable service life and reliability.

In the long-term, develop solar technologies that can provide on average 75% of the requirements for water heating, space conditioning, and lighting for new buildings, and 30%-50% of the requirements for water heating, space conditioning, and lighting for existing buildings, at competitive costs.

STRATEGY ELEMENTS

In order to achieve its goals and objectives, the strategy is to target research and development activities with the broadest applicability and with potential for energy contributions on a national scale. In doing so, however, the Department of Energy (DOE) recognizes that the needs of local and regional markets must be met in order to establish early success. Consequently, the initial focus is on niche-markets where local conditions -- solar resource, utility costs -- weigh in favor of state-of-the-art solar technologies. In particular, DOE and its researchers are working in collaboration with the buildings industry and the utilities to accelerate the introduction and acceptance of solar buildings. The incorporation of solar technologies in utility demand-side management programs is a key strategy element.

There is a continuing increase of industry direct involvement with the program from its planning through participation in the R&D. Under this partnership, there is reliance on the industry to package the results of program-sponsored research in forms suitable for use by the industry, and for communicating the results of this research through its established networks. In addition, program participants continue to work with other government agencies, and with other nations through bilateral and multilateral international agreements.

SOLAR BUILDINGS R & D

For the past three years research on solar buildings technologies has resided within the Office of Building Technologies, which is under the Assistant Secretary for Energy Efficiency and Renewable Energy (formerly Conservation and Renewable Energy -- see Figure 1). The active solar work as well as that on photovoltaic applications for buildings (building-integrated PV) is managed by the Building Equipment Division. The photovoltaics work is coordinated with related work undertaken within the Office of Utility Technologies. Work on passive solar technologies and on electrochromic windows is managed by the

Building Systems and Materials Division. Both divisions are within the Office of Building Energy Research.

The principal federal research organizations continue to be the National Renewable Energy Laboratory (NREL, formerly the Solar Energy Research Institute) and the Lawrence Berkeley Laboratory (LBL). NREL supports virtually all the solar research areas, while LBL focuses on daylighting and electrochromics research.

Total funding has increased from $3.8 million in 1990 to $7.4 million in 1993 largely as a result of increased funding for electrochromics and photovoltaics for buildings. The former represents an expansion of activities that had been traditionally supported under the solar program, while the latter represents a revival of interest in an area that had largely been relegated to the utility sector and utility applications (e.g., central station photovoltaics).

During the 1990-1993 period, support continued on work in active solar water and space heating -- building on its rating and certification work -- to aid industry in enhancing the credibility of state-of-the art systems with utilities and consumers. The work on active solar cooling was scaled-back with the principal emphasis continuing to be on desiccant systems.

Passive solar work, exclusive of electrochromics research, re-emphasized "whole buildings research" by focusing on systems and design strategies, rather than materials and component work. This work is performed under a passive solar and energy technology integration program element. Current efforts are continuing along these lines with activities in the areas of technology potential studies -- evaluations of advanced concepts; exemplary buildings -- design, construction, and testing of buildings incorporating advanced concepts; and design and analysis tools -- methods by which practitioners can readily adapt the concepts to their own particular needs.

1991-1993 Activities

Described below are activities in each of the DOE program's principal research areas: Active Solar Heating and Cooling, Passive Solar and Energy Technology Integration, and Electrochromics.

Active Solar Heating and Cooling

Active solar heating and cooling has two principal thrusts: (1) improving the performance and reliability of state-of-the-art systems to enable the industry to make inroads in the current (primarily niche) markets, and (2) developing innovative systems that will enable systems to reach wide-spread competitiveness. Work in the active solar water heating area concentrated on efforts directed at near-term reliability improvement through the development of test standards, and rating and certification methods.

The availability of a widely-recognized rating and certification method capable of accurately predicting the performance of various solar domestic hot water (SDHW) systems is an important step in achieving the required "credibility" and confidence to increase acceptance of state-of-the-art systems. Program participants have worked with various utilities under a "USH_20" initiative that utilizes the DOE-sponsored rating and certification method (designated as OG-300 by the

Solar Rating and Certification Corporation or SRCC) as a means of qualifying systems for inclusion in their demand-side management (DSM) incentive program. The innovative systems work has involved research to enhance the performance of unglazed transpired air collectors for preheating ventilation air, and on methods to model/optimize their design.

The solar-activated desiccant cooling research of prior years -- most notably the work on lower temperature solid desiccants (regeneration temperatures below 95 C)--has been largely concluded, with many of the most promising desiccant materials characterized. This work has pointed to the need for desiccant materials that are not only low in cost and have the desirable performance attributes, but could also be easily made into desiccant wheel structures. A significant effort has been made to work with commercial suppliers of desiccant materials and developers of desiccant components.

Most recently, a review has been undertaken of the entire active solar cooling area to determine what types of systems (desiccant or other) and specific activities should be supported in the future. This review includes analyses of not only cooling system type, but also the solar collector and balance-of-system requirements. For example, integrated compound parabolic concentrating collectors (ICPC) are again being examined to determine their potential in higher temperature solar cooling applications.

Passive Solar and Energy Technology Integration

Work in whole building passive solar and energy technology integration involves efforts on three fronts: technology potential studies, exemplary buildings research, and work on design and analysis tools. During the past two years, technology potential studies have been launched to determine the energy contribution of advanced passive solar and energy efficiency technologies in new and existing buildings. This has included trade-off analyses of solar vs. energy efficiency levels in residential buildings to determine "energy targets" along with specific studies of various technologies in different building applications (e.g., different advanced glazings for daylighting applications in nonresidential buildings). These analytical studies are designed to determine the impacts of individual technologies and combinations of passive solar, other renewable energy technologies, and energy efficiency technologies within a "whole buildings" context.

The objective of the exemplary buildings effort is to design, build, and test the most promising concepts based on the results of the technology potential studies and other sources. The most recent efforts have been directed at residential dwellings. Thus far, two exemplary buildings have been designed and will be constructed in 1994. These are new residential buildings that are projected to use 82%-86% less heating energy than comparable well-designed conventional buildings. One of the two will use 98% less cooling energy than a comparable well-designed conventional building in a cooling load-dominated climate. The other uses only natural ventilation strategies. This effort is being conducted in conjunction with IEA/SHC Task 13.

The design and analysis tool work is aimed at developing the methods by which researchers and practitioners -- builders, architects, and designers -- can design and evaluate solar buildings. Simplified design tools for home builders, that were developed previously, were used as the basis for additional tools targeted at the remodeling industry and the small commercial/institutional buildings market. The Passive Solar Design Strategies: Remodeling Guidelines for Conserving Energy at Home was specifically developed at the request of the National Association of Home Builders' Remodelers Council. It is anticipated that this work will be useful in IEA/SHC Task 20, Solar Energy in Building Renovation.

Work on analysis tools is currently focused on enhancements to daylighting/thermal performance predictions tools, evaluations of analysis codes for verification of home energy rating systems (HERS), and the tool for smaller commercial and institutional buildings. This work is linked to U.S. efforts in support of IEA/SHC Task 12.

Electrochromic Materials

Research on electrochromic materials centers on the development of a laminated and a solid-state electrochromic device capable of modulating daylight transmittance from 10% to 70%, depending on daylighting/heating/cooling requirements. Various materials are currently being evaluated for this purpose including tungsten oxide, molybdenum oxide, and nickel oxide films. The work involves modeling material behavior and the testing of prototype devices. An important element is evaluating the long-term durability and performance of electrochromic devices, accounting for thousands of switching cycles anticipated.

Photovoltaics for Buildings

Work on photovoltaics for buildings (PV-Buildings) involves the integration of photovoltaic products in buildings to meet specific end-use loads or building-wide electrical power needs. Work on the photovoltaic devices and specific products is the focus of the Photovoltaic Program. The PV-Bonus Program was recently launched by the Photovoltaic Program Office to solicit PV-Building concepts from the industry that could be suitable for niche markets today.

Within the Buildings Program Office, the activities have been focused on integration issues -- e.g., how to incorporate the PV array in the building structure, and balance-of-system issues. Evaluations of PV-Building opportunities focusing on specific building applications -- e.g., PV-powered air conditioning for meeting peak cooling loads -- have been conducted. A formal program planning effort has been initiated to ensure that the specific activities sponsored by the Buildings Program Office are well-conceived and properly implemented.

FUNDING

Tables 1 and 2 present funding information for solar buildings research and for other renewable energy programs. Note that solar buildings research, as well as most of the Renewable Energy Programs, have been targeted in the President's Request to Congress for increases in FY 1994. However, the final budget has not been established.

RECENT ACCOMPLISHMENTS

Since the last IEA/SHC national program review meeting in 1990, program activities have resulted in a number of accomplishments.

The Sacramento Municipal Utility District (SMUD) has adopted a rating and certification procedure for qualifying SDHW systems, based on the DOE-sponsored OG300 methodology. SMUD is in the forefront of U.S. utilities involved in promoting the use of solar technologies as a means of reducing electricity demand. A number of other utilities have also signed on to the USH20 initiative. A model for optimizing the design of transpired air collectors was completed, which will be the basis for a design guide on this technology. The collector has great potential for energy savings in the commercial/industrial sector by reducing conventional energy requirements for heating ventilation air.

The exemplary building designs at two U.S. national parks -- Grand Canyon and Yosemite -- indicate that buildings using solar energy and energy efficient systems can substantially reduce reliance on conventional fuel sources, and be economically competitive. The simplified design guidelines for passive solar buildings continued to generate interest throughout the industry. The "Remodelers Guidelines" have been well received, and the small commercial/institution buildings guidelines are generating considerable interest. A prototype of the guidelines for smaller commercial buildings software currently known as ENERGY-10, has been developed. The software enables easy and rapid development and evaluation of designs incorporating passive solar heating, natural cooling, daylighting, and energy efficiency measures.

Electrochromics research continued to advance the prospects that full-scale windows are technically achievable, with prospects for economic viability as well.

The initiation of the PV-Bonus program, and the selection of 5 initial firms, will help launch appropriate PV building technologies into the market. Many utilities now believe that PV-Building technologies, not central-station PV utility plants, hold the most promise for cost-effective applications of PV technology.

OTHER GOVERNMENT SUPPORT ACTIVITIES

In addition to the federal government's research programs, there are a number of other activities carried out by the federal, state, and local governments, as well as financial institutions, that facilitate the development and adoption of solar energy technologies. These include financial incentive programs, standards development and certification procedures, and information programs.

Financial Incentive Programs

The federal government is sponsoring several joint ventures with industry to promote the utilization of advanced renewable and energy efficiency technologies. This includes joint ventures for photovoltaics and for industrialized housing. Tax credits are available from certain states and utilities for the purchase and installation of solar energy systems in buildings. Energy efficient mortgage (EEM) programs are available to help finance the cost of more energy efficient residences. These mortgages take into account the reduced utility bills associated with buildings that incorporate solar or energy efficiency features. Consumers who purchase homes that qualify for EEMs, are able to obtain larger loans than their income levels would normally qualify them for under standard loan conditions. In actuality their total outlays remain the same due to their reduced utility bills. The DOE program is supporting this effort by assisting in the development of methods to test and evaluate Home Energy Rating Systems (HERS) -- the method by which homes are to be certified to qualify for EEMs.

Standards and Certification Programs

The Interstate Solar Coordinating Council (ISCC) operates the Solar Rating and Certification Corporation (SRCC) to standardize the rating and certification process on a national level. This helps streamline the introduction of new solar technologies in various jurisdictions. The National Fenestration Rating Council (NFRC) has developed an initial testing and labeling process for windows. This will help consumers, as well as designers, make better informed decisions on window selection for various applications, and help them determine the performance/cost trade-offs.

Information and Technology Transfer Programs

The Department of Energy has several information and technology transfer programs in addition to those activities sponsored by the individual laboratories and the DOE R&D Program offices. The Conservation and Renewable Energy Inquiry and Referral Service (CAREIRS) provides general purpose information on all renewable energy and energy efficiency technologies. The National Appropriate Technology Assistance Service (NATAS) provides tailored information and technical assistance designed to aid in the commercialization of renewable energy and energy efficiency technologies.

The Technical Information Program develops or assists in developing publications for industry which outline progress made and results stemming from renewable energy and energy efficiency R&D programs. In addition, the solar buildings research activities provide technical reports and information on specific research efforts for articles in various technical and trade journals.

All federal laboratories with annual budgets of at least $20 million, including those managed by DOE, are required to establish Offices of Research and Technology Applications (ORTA). These offices interact with industry and state and local governments in order to encourage and facilitate the development of products and processes based on federally-funded research. Various state and local governments and the National Science Foundation sponsor economic development programs based on science and technology. In addition, the ongoing partnership between the building industry and the solar buildings technology programs serve to facilitate industry use of advancements.

COMMERCIAL ACTIVITIES

Pool heating and domestic hot water applications continue to be the predominant end-uses of active solar systems. In 1991 approximately 512,000 square meters of collectors were shipped for pool heating, and 93,000 square meters for domestic hot water. This represents an increase in the pool heating market and a leveling off of the solar domestic hot water market. However, with the recent increase of utility activities in the demand-side management area -- promoting the greater use of energy efficiency and renewable energy technologies through financial incentive programs -- solar domestic hot water sales are expected to increase. The total shipments of collectors has decreased when the parabolic concentrating collectors shipped by LUZ are included in prior year totals (see Figure 2). The number of solar collector manufacturers has remained steady, with the market dominated by a few companies. Exports continue to significantly exceed imports.

Passive solar market figures are not available; however, consumer interest remains strong, and the availability of high performance building materials, and improved design methods is increasing acceptance. The market continues to be largely residential, although daylighting/atria systems for nonresidential buildings continues to be popular in nonresidential buildings. The glass industry continues to sponsor R&D on improved glazings, including work on electrochromic materials, and reduced heat loss window designs.

The market for photovoltaics is increasing, particularly in the residential sector. It is estimated that approximately 3175 kW (peak) of PV modules were shipped for building applications in 1991, representing approximately 20% of total shipments. PV-buildings represent the single largest end-use market for PV technology.

OUTLOOK

The outlook for renewable technologies and solar building technologies, in particular, is bright in the near-future. There is increased government support for the technologies as evidenced by various provisions of the Energy Policy Act (EPAct) of 1992, and the new administration's energy and environmental positions. There is a call for increased energy efficiency and greater use of renewables on the part of the federal government. This should result in an increase in federal sector market opportunities.

Furthermore, EPAct requires a demonstration of commercial applications for technologies such as solar domestic hot water systems and factory-made housing. It also calls for an "Advanced Buildings for 2005" program to increase building energy efficiency, while maintaining affordability by the year 2005. The increased availability of energy efficient mortgages should encourage the greater use of solar and energy efficiency technologies in residential buildings. These efforts are expected to result in a 20% increase in the use of renewables by the year 2010.

The utility industry is also expected to increase its support of renewable energy technologies to meet their environmental requirements, as well as their demand-side management program goals. A number of utilities are already offering financial incentives for solar systems, and more are expected to follow suit. These efforts will help give the industry a sufficient market foundation upon which to build their next generation of products and designs.

PREVIOUS CONTENTS NEXT