European Solar Thermal Industry Federation

Sun in Action II – A Solar Thermal Strategy for Europe

Volume 2

The Solar Thermal Sector Country by Country

21 National Reports

April 2003

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1. ESTIF (European Solar Thermal Industry Federation) is the new name of ESIF (European Solar Industry Federation), after its merger with ASTIG (Active Solar Thermal Industry Group) in December 2002. At time of publication, the formal procedure for the change of the legal name had not yet been concluded. For the purpose of the EC ALTENER contract, therefore, the legal name is still ESIF, but the new name is used, as it will become known during the lifetime of this publication

Foreword

The importance of overcoming our dependence on fossil fuels is becoming more and more evident. Large portions of the fuels imported into the European Union originate in unstable regions – a fact that could lead to major disruptions of supply and sudden price increases in the future. Solar thermal energy offers a reliable alternative, already available all over Europe.

Another strong motivation to foster the use of solar thermal is concern for the environment. By replacing conventional fuels, each solar thermal installation reduces once and for all the environmental damage associated with the use of conventional heating sources. The use of solar thermal energy does not affect the global climate. It does not produce emissions that lead to urban air pollution. It does not leave radioactive waste as a dangerous legacy for generations to come. Solar thermal is a clean and sustainable source of energy for everyone in Europe.

Sustainable heating and cooling can only be achieved if all available renewable energy sources are fully exploited. The technical potential for solar thermal in the 15 current Member States of the EU corresponds to nearly 60 Mtoe per year – more than the total final energy consumption of a country like Belgium. So far, roughly 1 % of this has been realised. Strong measures must be taken in order to accelerate the realisation of this large unexploited potential.

Since Sun in Action I was published in 1996, the solar thermal sector has developed immensely. The market volume has more than doubled. The target of 15 million m^2 installed by 2003, set by the European Commission in its Campaign for Take-Off, has nearly been reached. Achieving the next target, 100 million m^2 installed by 2010, will require long-term efforts and strong political support. Sun in Action II intends to contribute to this process, by providing background information, in-depth analysis, a strategic outlook and specific proposals for action.

Volume 1 contains an overview of the European market. Reasons for success, barriers to growth and strategies to overcome these barriers are identified, both for solar thermal in general and for the main market segments. A detailed action plan to tackle the main barriers to growth is proposed. These actions require the continued efforts of the industry, but also strong and long-term political support at European, national and regional level. Volume 2 provides 21 market reports on EU member states and key markets outside the Union.

We are confident that market actors, energy agencies, policy makers and all those interested in contributing to the growth of renewable heating will find useful ideas in Sun in Action II for the development of solar thermal in Europe and beyond.

We would like to thank the European Commission. Without the support of its ALTENER program, this publication would not have been possible. We are especially grateful to William Gillett, Hans Jacob Mydske and Mari Varho of DG TREN, for their active support and encouragement.

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While the national reports presented in Volume 2 have been drafted by our member associations in the respective countries or by other qualified institutions, ESTIF is the sole responsible entity for the content of Sun in Action II.

April 2003

Ole Pilgaard
ESTIF President

Raffaele Piria
ESTIF Secretary General

CONTENT

Austria

A STATE OF THE MARKET

Overview of the market situation

Austria is one of the leading countries for solar thermal in Europe. More than 150.000 Austrian households are now equipped with solar heating systems, one out of eight single-family houses in Austria features a solar heating system. Since 1998, half of the new installations are combisystem (domestic hot water combined with space heating), showing a clear trend towards more advanced technology and higher solar yields. In multi-family houses, about 600 larger solar heating systems are installed today. In the tourism business, about 2000 systems are in operation. 25 solar assisted biomass district heating systems have been installed in the last ten years. The annual turnover generated in connection with solar thermal systems amounts to approximately 120 million Euro per year, with the plumbing trade accounting for a share ranging between 25 and 30 million Euro. It is therefore not astonishing that already three-quarters of all plumbing companies actively offer solar products, as was shown by a survey commissioned by Austria Solar in 2000.

Austria's market for solar energy applications experienced an enormous growth in the early nineties. From 1990 to 1996, the Austrian market increased seven-fold. By the end of 2001, a total of 1,7 Mio m^2 of glazed solar thermal collectors were in operation in Austria. At the beginning of the nineties, around 80.000 m^2 were installed per year. In 1996, a peak of almost 190.000 m^2 newly installed glazed collectors was reached. Afterwards, the market for new installations decreased. In 2001, the newly installed surface in Austria was 160.000 m^2 of glazed collectors.

Unglazed collectors have been installed in significant quantities during the 1990s, mainly for heating swimming pools. In the last few years, the market for unglazed collectors for swimming pools has declined, as it has become mainly reduced to smaller, private pools.

In the last few years, the national production of solar collectors has grown clearly stronger than the national market, due to high growth of exports. In 2000 an annual growth rate of 86 % was achieved, and in 2001 the growth rate amounted to even 117 %. About 61 % of the flat plate collectors produced in Austria were exported in that year. In 2002, due to the serious decline of the German market, the export of Austrian solar technology has also suffered. Most of these figures refer to glazed collectors, as production of unglazed collectors decreased, following the overall decline of this market segment.

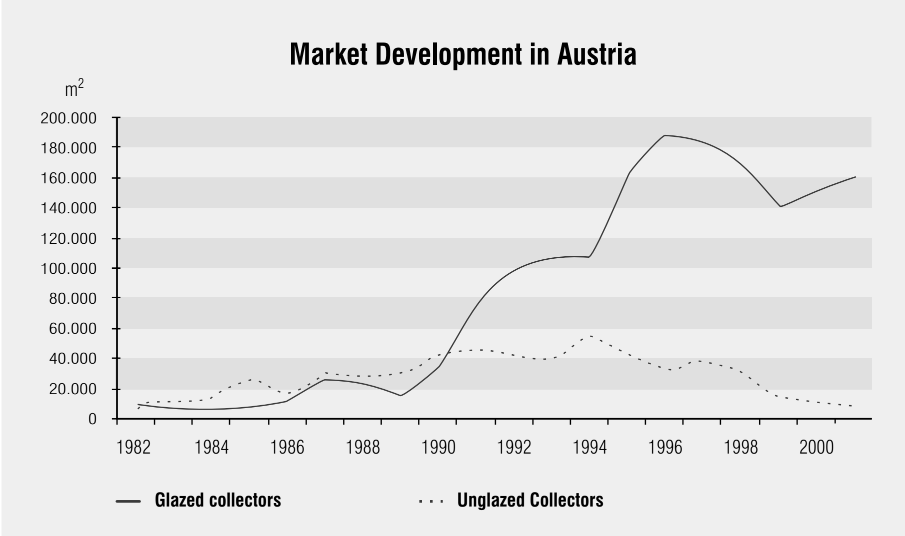
Important success factors for this wide market introduction were the motivation of the population, a high environmental awareness, high energy costs, financial incentives to install a solar system, campaigns to raise awareness and improve the image of solar technology. Also the technical improvement of products has been an important factor for the positive development of the solar thermal market in Austria. Much was achieved by research and development: increasing the longevity and reliability of solar technology, adapting solar thermal applications to household technology, integration of solar technology into existing heating equipment, integration of solar technology into architecture, e.g. in the roof or façade, and cost reduction.

More than 60 different types of collectors are currently being offered on the Austrian market by 35 manufactures and importers.

Solar thermal installations and energy production

Solar collector production and sales in m^2										
	Glazed Collectors									Unglazed Collectors
	Flat Plate Collectors				Vacuum Collectors				Total Glazed	
	A National Production	B Exports	C Imports	D = A-B+C Total Home Market	E National Production	F Exports	G Imports	H = E-F+G Total Home Market	I = D+H Total Home Market	Total Home Market
1982				10.700					10.700	8.000
1983				8.900					8.900	11.500
1984				7.570					7.570	15.500
1985				9.800				150	9.950	23.000
1986				12.700				250	12.950	19.000
1987				25.300				970	26.270	30.000
1988				22.700				1.220	23.920	28.370
1989				18.000				700	18.700	30.380
1990				38.840				1.045	39.885	41.620
1991				77.060				1.550	78.610	44.460
1992				98.166				1.070	99.236	40.560
1993				106.891				835	107.726	40.546
1994				106.981				850	107.831	56.650
1995				155.980				4.680	160.660	42.860
1996	192.600	32.700	24.300	184.200			2.600	2.600	186.800	32.000
1997	197.816	28.746	10.410	179.480			2.860	2.860	182.340	39.900
1998	195.831	41.514	8.707	163.024	1.674	651	1.617	2.640	165.664	32.302
1999	193.286	60.108	5.572	138.750	4.110	4.725	3.013	2.398	141.148	16.920
2000	258.231	112.017	4.329	150.543	4.220	3.009	1.190	2.401	152.944	14.738
2001	399.683	243.637	1.814	157.860	8.278	7.210	1.152	2.220	160.080	9.067

Source: BVS in WKO,
G. Faninger. IFF-University Klagenfurt



Estimated solar park in operation at the end of 2001[1]

Flat plate collectors in m^2	1.623.775	
Vacuum collectors in m^2	28.039	
Total glazed collectors in m^2	1.651.814	= 203 m^2/1000 inhabitants
Unglazed collectors in m^2	500.373	
Grand Total in m^2	2.152.187	= 265 m^2/1000 inhabitants

Estimated annual solar thermal energy production in 2001

Flat plate collectors in m^2	1.623.775	x 350 kWh/m^2·year =	568.321 MWh
Vacuum collectors in m^2	28.039	x 550 kWh/m^2·year =	15.421 MWh
Unglazed collectors in m^2	500.373	x 300 kWh/m^2·year =	150.112 MWh
Total			733.855 MWh

CO_2 emissions avoided in 2001

Flat plate collectors	568.321 MWh/a	x 0,295 tonnes/MWh =	167.655 t
Vacuum collectors	15.421 MWh/a	x 0,295 tonnes/MWh =	4.549 t
Unglazed collectors	150.112 MWh/a	x 0,295 tonnes/MWh =	44.283 t
Total			216.487 t

1. In Sun in Action II, ESTIF uses the following general assumptions to calculate the solar park in operation: systems installed until 1989 have an average lifetime of 15 years; systems installed in or after 1990 have an average lifetime of 20 years.

Product types and solar thermal applications

Solar thermal in Austria is mainly applied for Domestic Hot Water (DHW) production and for heating the water of swimming pools. Apart from these applications, there has also been a market trend towards solar space heating. More and more solar systems are being used in connection with biomass local heating networks. Most systems use flat plate collectors.

Typical applications of solar thermal in Austria are:

Domestic hot water production (market share ~50%)

A typical SDHW system supplies 4 persons with hot water. The collector area is approximately 6–8 m^2 and the storage has a volume of 300–400 l.

Large collective solar systems (market share ~5–6%, of which 80 for water heating and 20% for space heating)

The size of a large collective system can vary greatly, with collector areas between 40 and 400 m^2 and storage volumes between 2 and 100 m^2.

Large collective systems are usually laid out according to the following specifications:

- Centralized system with buffer storage: 1–3 m^2/apartment, 50–75 l/m^2
- Centralized system without buffer storage: 2–4 m^2/apartment, 50–75 l/m^2
- Decentralized system with buffer storage: 2–4 m^2/apartment, 100–200 l/m^2

Space heating (market share ~40%)

For space heating mostly combisystems are used which provide both warm water and space heating. They typically have 2 storage systems (a warm water storage plus a 1.000l buffer storage) and approximately 20 m^2 of collector area.

District heating (market share ~1–2%)

When used in district heating, solar thermal energy usually supports another energy, typically biomass.

Air conditioning and industrial process heating (market share ~0,5–1%)

Only few companies offer such applications. The systems are custom-designed, e.g. with façade or roof integrated collectors.

Swimming pools (market share ~4–6%)

In the last two decades, over 500.000 m^2 of unglazed collectors for swimming pools were installed. In Vienna alone, 22 public swimming pools have been equipped with solar thermal collectors. Under present conditions, the market is limited mainly to private swimming pools, though a very significant potential could still be realised, provided stronger incentives for investors are granted.

Employment

While in certain parts of the value chain – mainly manufacturing – it is possible to estimate fairly accurately the workforce employed, in other parts estimates are less precise. Installers, for example, are involved in the solar thermal sector only for a part of their work time. The Austrian Solar Industry Association Austria Solar estimates following full-time equivalent occupation in the solar thermal sector.

Estimated employment figures in the following sectors (full-time jobs)	
Manufacturing of components of solar thermal systems:	400
Installation and maintenance:	250
Distribution:	200
Sales and marketing:	100
Testing, quality assurance and research:	70
Training:	100
Consultancy:	150
Total:	1.270

B STATE OF PRODUCTION

Product technology and production methods

Deployment of reliable solar systems has been a major prerequisite for the Austrian market success. Serious technical problems with solar systems in the late seventies and early eighties have been recognised. The lesson was laerned to develop and design new technical solutions in order to increase lifetime duration of all components. Besides the introduction of new applications, larger systems and solar combisystems, technical developments were used to reduce costs and to better integrate solar thermal systems into existing heating technology for housing. Today Austrian solar systems show a very high qualitiy level of components. However, technical failures still happen due to poor installation, though important progress is being made in the diffusion of specific solar skills among a wide number of installers.

Product technology description

Typical product technology	
Collectors (usual sizes)	2 – 12 m^2
Absorber material	Copper, aluminium
Surface treatment	MTI, Tinox, Interpane
Insulation	Mineral wool, pu foam
Transparent cover	3 – 4 mm solar glass, clear, structured
Casing	Wood, aluminium tub, aluminium frame
Storage tank	Steel, enamel, synthetic material
Cover	Solar glass

Production technology description

Number of companies involved in collector production	70
Production capacity	500.000 m^2
Capacity utilisation	400.000 m^2 (80 %)
Percentage of manufacturing	a) manually 20 % b) partly automated 80 % c) mainly automated 0 %

Breakdown of solar systems costs

Solar Systems Costs for Typically Sized Systems		
	Individual	**Project (large scale)**
Total costs (excl. VAT)	680 €/m²	600 €/m²
VAT (20 %)	136 €/m²	120 €/m²
Total cost (incl. VAT)	816 €/m²	720 €/m²
Typical size of system	6 m²	80 m²

Percentage cost breakdown of an average system	
Production (materials and labour)	35 %
Marketing/distribution	25 %
Installation	35 %
R & D	5 %

Typical solar domestic hot water system

Characteristics of a typical DHW system	
System type	flat plate collectors
Collector area (m²)	6
Hot water storage (litres)	300
Total installed cost (VAT incl.)	4.900 €
Eventual subsides	1.225 € support – average with strong variations according to the Bundesland (federal state – see below). Larger systems including space heating are accorded lower rates of subsidy per m².

Typical consumer motivation

- High environmental awareness
- High energy costs
- Financial incentives covering part of the investment cost to install a solar system,
- Image campaigns to raise awareness of solar technology
- Comfort

Conventional water heating and energy prices

Conventional Energy Prices		
Date: 2000	**Housing VAT incl.**	**Collective VAT incl.**
Electricity – normal	0,15 €/kWh	n/a
Electricity – low rate	0,09 €/kWh	n/a
Fuel – Oil	0,05 €/kWh	n/a
Bottled gas	0,07 €/kWh	n/a
Natural gas	0,05 €/kWh	n/a
District heating	0,06 €/kWh	n/a

Standards and codes of practice

In Austria, there is currently no obligation for collectors to be tested or certified, but because of the strong competition in the market, almost all collector producers have their collectors tested.

Standards used

Old standards:

- ÖNORM M 7714 (Austrian Standard) – tested by ARSENAL, Vienna
- ISO TC 180 SC5 (for glazed collectors) – tested by SPF, Rapperswill
- DIN 4757 Teil 1-4 (German Standard) – tested by Fraunhofer Institute, Freiburg and ITW, Stuttgart

New standard:

- European norm: EN 12975 (1-2), EN 12976 (1-2), ENV 12977 (1-3)

The introduction of the Solar Keymark, will allow certification of the EN norms by any European certification body authorised to grant the Solar Keymark (www.solarkeymark.org). Each authorised certification body will determine which testing institutes it intends to use.

Level of R & D

Type of R & D activities

Development of solar thermal systems and components, Creation of standards and norms, projects for distribution of renewable energy

Specific programs

Energy Technology Program of Upper Austria (ETP)

- Support for R&D, pilot-, testing and demonstration projects in energy efficiency and renewable energy technologies
- Financing up to 50% for industrial research or up to 25% for pre-competitive development, pilot and demonstration projects; additional funds may be provided up to 75% or 50% respectively
- Companies, research and other institutes which have their seat in Upper Austria are eligible

The Austrian Industrial Research Promotion Fund (FFF)

- General R&D support program
- Most important source of finance for industrial R&D in Austria
- Support mainly through grants and loans
- In 2002 248 Mio Euro were paid to companies working in the development of new products and technologies, including renewable energy technologies.

Other general R&D programs exist, for example the Austrian Science Fund (FWF).

Role of government: Subsidisation.

Role of institutes and universities:

- Project management
- Basic research
- Development work

Level of financing by industry and public funds (EU incl.):
The level of public financing usually varies between 30–100% per project; the rest is financed by industry.

C STATE OF MARKETING

Distribution and marketing methods

About 30 years ago people began to produce their own collectors in self-building groups. There was no conventional market for solar technology. A few years later companies began to produce solar thermal collectors, building their own channel of distribution.

Today the distribution of solar thermal collectors follows two or three steps, either directly from the producer to the plumber or via a wholesaler who takes care of the logistics. For the solar companies the inclusion of solar technology in the product range of heating traders at all levels of the distribution process is very important, because the customer trusts in the heating traders.

In 2000, a public awareness campaign was launched to raise the image of solar technology make known its advantages. Members of this campaign called "Austria Solar" are the most important solar companies in Austria. Austria Solar published some press reports about solar energy and will further develop the campaign in the next few years.

An important factor for success in the comprehensive market introduction was the motivation of the general public. A lot of press reports raise environmental awareness in Austria. Also important are the specialist journals for renewable energy.

Significant journals in Austria:

German name	Translation	Contents	Publisher
Sonnenzeitung	Sun journal	The journal for renewable energy	Ute Stockhammer – Uranus publishing house
N.E.T – Neue Energie Technologien	New energy technologies	Professional journal for renewable energy and ecological heating systems	Publishing house Lorenz
Erneuerbare Energie	Renewable Energy	Journal for an sustainable energy future	Working pool for renewable energy – AEE

In Austria there are a lot of workshops, seminars, conferences and trade fairs relevant for solar thermal. These are the most important trade fairs:

- Energiesparmesse with Biosolar in Wels
- Faktor 4+ in Kärnten
- Gleisdorf Solar
- Aquatherm Wien/Salzburg
- Bauen u. Energie Wien/Salzburg
- Bau & Energie in Wieselburg
- Haustec in Salzburg
- BIOM – Bio and energy fair

Incentives and financing methods

Reliable framework conditions providing stable investment conditions for both companies and final customers are the most important basis for market success. In the nineties, attractive financial incentives granted by the individual federal states and the federal government for solar installations formed the basis for the success of solar thermal systems on the market. The federal states granted direct subsidies for solar heating systems installed in private households. A large number of municipalities offered additional financial support in the range of between 10 and 50 percent of the State subsidies.

As from the mid-nineties, the general financial support to build residential untis (Wohnbauförderung) was employed as an instrument to control the selection of heating systems installed in new buildings. This was a very important step, since the general housing subsidy – with a volume of approximately 3 billion Euro per year – constitutes a powerful control instrument with regard to residential building in Austria. In some of the federal states, the conditions for the housing subsidies were the main factors that enabled the successful market penetration of solar thermal systems. In other states, the market success was mostly achieved through attractive direct subsidies. In addition, citizens can claim their investments in solar heating systems as a tax-deductible expenditure in their annual tax statements.

At the beginning of the nineties, the federal government established a subsidy for solar thermal systems installed in commercial buildings. Up to 30 percent of the investment costs were subsidized with public funds. So far, this subsidy has mainly been utilized by the accommodation trade (guest-houses, B&B's hotels, hostels). To reach other target groups with this subsidy instrument has only proven successful in individual cases. In addition to the government subsidies, some Federal States also offer investment subsidies (direct subsidies or interest and redemption subsidies) for commercial plants.

On the federal level the following incentives are available:
- The retrofitting of a solar thermal system can be declared a special expenditure in your income tax statement.
- Special expenditures are tax deductible up to an amount of 2.920 Euro p.a.

Incentive programs at the regional (Federal State) level:

Burgenland
- 30% of investment cost, maximum: 2.200 Euro
- no technical requirements

Carinthia
- Basic subsidy: 350 Euro
- + 50 Euro per m^2 flat plate collector
- +70 Euro per m^2 vacuum collector
- Maximum: 4.000 Euro
- Minimum volume of the storage 50 l/m^2 (faceplate collectors),
- Minimum volume of the storage 70 l/m^2 (vacuum collectors),

Lower Austria
- 30% of investment cost, maximum: 2.200 Euro
- Minimum collector area 16 m^2 (flat plate collectors) or 12 m^2 (vacuum collectors), minimum volume of the storage 300 Litre

Upper Austria
- Basic subsidy: 1.100 Euro (does not apply if the system replaces an existing one)
- + 75 Euro per m^2 standard collector
- +110 Euro per m^2 vacuum collector
- Maximum: 2.930 Euro
- Nearly all municipalities in Upper Austria offer additional grants of 10–50% of the state grants.

Salzburg
- 1st to 6th m^2 140 Euro, 7th to 10th m^2 70 Euro, each additional m^2 35 Euro
- A minimum of 1.090 Euro must be self-financed
- Technical requirements: minimum buffer storage 100 l/m^2 and/or minimum boiler volume 50 l/m^2, minimum thickness of insulation 200 mm
- Many municipalities in Salzburg offer additional grants.

Steiermark
- 35 Euro per m^2 collector area,
- Maximum 2.000 Euro
- Minimum collector area 4 m^2
- financing of the state only in connection with municipal financing

Tirol
- 120 Euro pro m^2 collector area,
- Maximum 1.920 Euro
- Minimum storage volume 50 l/m^2

Vorarlberg
- Basic subsidy: 1.454 Euro or 2.181 Euro + 73 Euro per m^2 collector area
- Maximum: 2.907 Euro or 3.634 Euro
- Share of solar energy in heating > 15%; higher incentives for >20%

Vienna
- 30% of investment cost, maximum 2.200 Euro
- Minimum collector area 8 m^2, minimum storage volume 800 Litre

D FUTURE PROSPECTS

National energy policy

The federal government of Austria has 4 goals:

- security of the energy supply
- economic efficiency of the energy supply
- environmental compatibility and resource conservation
- social acceptability of the energy supply system

Strategies:
- useful and rational utilization of the used energies
- promoting the use of renewable energy

Main policy actions:
- Liberalizing of the energy market
- Diversification of the energy sources
- Diversification of the import countries
- Prohibition of nuclear energy
- Price controlling
- Energy storage

International co-operation is very important for Austria. The European Union, the international energy agency and the secretary of the energy charter are significant for the global competition, security of supply and environment.

Energy mix of Austria

- Hydropower 14%
- Fossil energy source 71%
- Other renewable energy 24%

Objectives for the solar industry/market

The main applications for thermal solar plants are for example to warm water in preparing water for domestic and swimming pool use for single and multi-family houses. Apart from these applications, there has also been a market trend in the past towards solar space heating. Moreover, more and more solar plants are being used in connection with biomass local heating networks. At the current moment in time solar air heating, another system, has only a very small market share. The system of solar cooling is currently developing. Within the framework of different R & D projects some demonstration plants for solar cooling have been installed. In the sector of transparent thermal insulation only a few isolated projects have been realised in Austria; in other European countries, however, a number of test houses have been installed with TWD façades.

Strategy to overcome the barriers to market development

Description of major barriers by category:

- Technical: combisystems for space heating and domestic hot water not yet gully developed
- Institutional: only a few research and development institutions
- Economic: most costs for solar thermal applications are investment costs
- Training: lack of specialised installers

Description of main measures (actions) needed to extend the solar thermal market by category:

- Technical: Development of compact combisystems at convenient prices
- Institutional: more research and development
- Economic: cost reduction by 30%, keep subsidies
- Educative: solar training for installers, architects and planners

Concluding remarks

In Austria the technical standard of the solar thermal collectors and systems is high. To further improve this standard, Austria plans general building quality standards. The widespread public subsidies and the efforts of solar companies have created a large market. Large parts of the population have started to perceive solar thermal systems as a normal option to be considered when planning a new building or a major renovation of existing buildings. A widespread awareness for the need of reducing use of fossil fuels is the major stimulator for solar thermal investments.

To increase the awareness of the population, Austria Solar (a union of solar companies) started a solar campaign similar to the German campaign.

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www.energytech.at

Contributions to this report

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Belgium

A STATE OF THE MARKET

Historic overview of the development of the solar thermal market

In the beginning of the eighties there were about 20 active manufacturers in Belgium. In 1986 the government stopped all programs on active solar energy and since then activities have decreased. Nowadays there are only a few manufacturers left.

In 1988 the responsibility for energy efficiency and R&D was devolved from the central government to the three regions: Flanders, Walloon and Brussels. In April 1991, the Flemish regional minister for energy published the study "Towards a Long-term Energy Policy for Flanders'. Part of it was the "Memorandum on Energy", including a special report on the situation of the use of solar energy: passive, active and photovoltaic. The region has launched a number of initiatives aimed at promoting the efficient use of energy. However, there is no special program on active solar energy. R&D activities on solar energy are focused on the use of passive energy (University of Leuven) and photovoltaic systems (IMEC IN Antwerp).

The present market situation

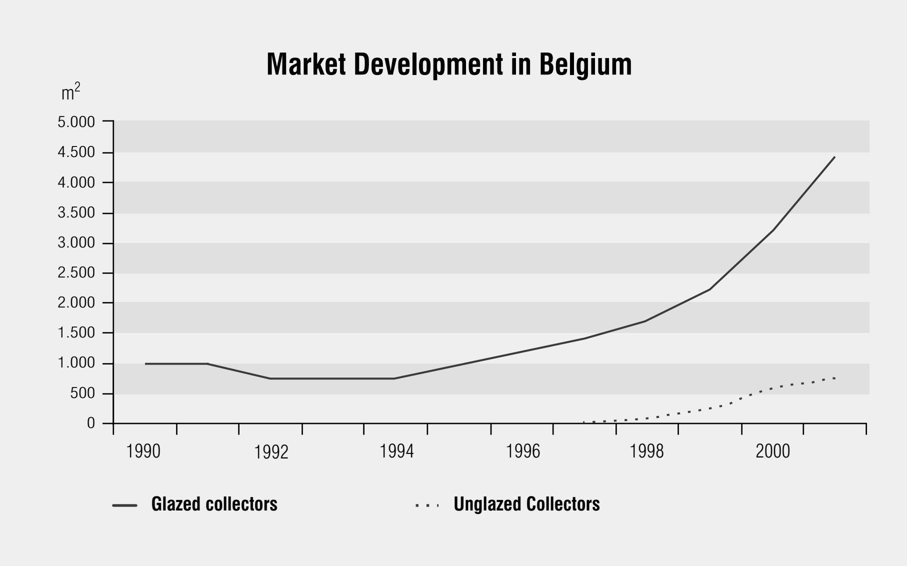
The regions have started to support the use of solar domestic hot water (SDHW) systems by giving subsidies. The Walloon Region provides about 620 Euro in subsidies for an installation. Energy suppliers also provide subsidies on certain conditions. There is also an increasing number of municipalities providing subsidies.

In October 2000 came the State Secretary's statement of intention to take fiscal measures to stimulate energy saving in the sector of private houses. According to this text, one of the elements to seriously reduce energy consumption is the use of solar energy for domestic hot water (DHW). The amount of the incentives granted depend a number of conditions, but on the average, the fiscal benefit for the installation of solar collectors for DHW is about 250 Euro. The government hopes that together with regional and other financial incentives this will make the installation of solar thermal systems much more attractive.

Solar thermal installations and energy production

Solar collector production and sales in m²										
	Glazed Collectors									Unglazed Collectors
	Flat Plate Collectors				Vacuum Collectors				Total Glazed	
	A National Production	B Exports	C Imports	D = A-B+C Total Home Market	E National Production	F Exports	G Imports	H = E-F+G Total Home Market	I = D+H Total Home Market	Total Home Market
Pre 1990	18.600			18.600					18.600	
1990	1.000			1.000					1.000	
1991	1.000			1.000					1.000	
1992	750			750					750	
1993	750			750					750	
1994	750			750					750	
1995	1.000			1.000					1.000	
1996	1.200			1.200					1.200	
1997	1.400			1.400					1.400	
1998	1.716			1.716					1.716	62
1999	2.262			2.262	20			20	2.282	204
2000				3.158				72	3.230	582
2001				4.178				303	4.481	737

Source:
1. up to 1997 the figures are estimations, from 1998 on the statistics are based on data from about 40% of the companies
2. the statistical data is provided by ODEVlaanderen



Estimated solar park in operation at the end of 2001[1] [2]

Flat plate collectors in m^2	26.139	
Vacuum collectors in m^2	395	
Total glazed collectors in m^2	26.534	= 2,6 m^2/1000 inhabitants
Unglazed collectors in m^2	1.585	
Grand Total in m^2	28.119	= 2,7 m^2/1000 inhabitants

Estimated annual solar thermal energy production in 2001

Flat plate collectors in m^2	26.139 m^2	x 420 kWh/m^2·year =	10.978 MWh
Vacuum collectors in m^2	395 m^2	x 450 kWh/m^2·year =	178 MWh
Unglazed collectors in m^2	1.585 m^2	x 300 kWh/m^2·year =	476 MWh
Total			11.632 MWh

CO_2 emissions avoided in 2001

Flat plate collectors	10.978 MWh/a	x 0,45 tonnes/MWh =	4.940 t
Vacuum collectors	178 MWh/a	x 0,45 tonnes/MWh =	81 t
Unglazed collectors	476 MWh/a	x 0,45 tonnes/MWh =	216 t
Total			5.287 t

1. In Sun in Action II, ESTIF uses the following general assumptions to calculate the solar park in operation: systems installed until 1989 have an average lifetime of 15 years; systems installed in or after 1990 have an average lifetime of 20 years.
2. Since pre-1990 data are only available as an accumulated figure it was assumed, that pre-1990 production/sales were equally divided over the period 1982-1989.

Product types and solar thermal applications

Product types

The main applications of solar collectors are domestic hot water and swimming pool systems. The average collector area of a solar domestic hot water (SDHW) system is 4 to 6 m^2, a private swimming pool system has on average 12 m^2.

Applications

Domestic hot water production

The typical solar system for domestic water heating uses a collector which is mounted on the roof of the house. More than 50% of the installed systems are roof-integrated. The storage with the control and safety device is installed in the furnace room. Usually the solar buffer storage replaces the hot water tank of the heating system and will be additionally heated with the existing oil or gas burner by means of a second heat exchanger.

Due to the climatic conditions in Belgium, the systems are often constructed as two cycle systems with a water-glycol fluid circulating through the collector, which charges the solar storage by means of an internal heat exchanger. Nowadays, the drain back system is becoming more important as a way to protect the system against frost.

The collector types in operation are approximately 70% standard flat plate collectors and 30% evacuated flat plate or evacuated tube collectors. The flat plate collectors are installed into the roof as well as roof-integrated. Similarly to the high quality of installations in the heating and plumbing sector, high quality components are usually used for solar systems.

Swimming pools heating system

The economic importance of the swimming pool collectors is the prolongation of the swimming season and the increase of the temperature of the swimming pool water.

Swimming pool collectors are unglazed collectors consisting of synthetic tubes. These systems have a better performance at lower temperature because there is no loss through either the use of a glass cover or through a heat exchanger.

Solar thermal in swimming pool heating has a significant market share in Belgium. In 2001 this market segment accounted for roughly 16% of the total collector area newly installed in Belgium.

B STATE OF PRODUCTION

Product technology and production methods

Product technology description

One company produces easy-to-assemble collectors that people can install on the roof themselves. This reduces the cost of installation. The system is very flexible for making different shapes of collector area. Additionally, this company offers a French storage vessel to complete the solar thermal system.

Another company manufactures strip absorbers that are mainly exported to Germany and Austria. They use the seam welding ultrasonic technology for cold welding the copper, and black chrome coated fin on the copper tubes. This is done in an automated production line.

One company produces unglazed solar collectors for swimming pools. The glass fibre reinforced polyester saucer with spherical form is covered by a flexible hose-like pipe rolled like a serpentine. The collector has a net surface of 4,64 m^2.

Typical solar domestic hot water system

The following system types are used in Belgium

1. **With separate storage tank, circulation pump and the use of glycol**
   This design uses a pump to circulate the fluid through the primary loop. As soon as the temperature in the collectors is a few degrees higher than the temperature of the storage tank, the pump starts the circulation. To avoid the water freezing in the collector during a cold winter night, glycol is added.

2. **With separate storage tank, circulation pump and drain back system**
   This system type also makes use of a pump to circulate the heat exchange fluid in the primary loop. To avoid freezing in winter and overheating in summer, the collector is emptied automatically when the pump is switched off by the control unit.

3. **With separate storage tank en natural flow**
   In Belgium, two versions of this system are used: One uses the thermosiphon effect to circulate the fluid through the collector, the other one uses the heat pipe effect. The latter design affords protection against freezing and overheating in an easy and efficient way. Frost protection in thermosiphon systems is assured through the use of glycol.

Characteristics of a typical DHW system (for a family of 4 persons)	
System type	flat plate collectors
Collector area (m^2)	~4,8
Hot water storage (litres)	~200
Total installed cost (VAT incl.)	~4.500 €
Eventual subsides	depending very much on the availability of regional and/or local incentives (e.g. in Flandern subsidies vary between 620 and 3.720 Euro)

Typical consumer motivation

Currently the main motivation to buy a solar thermal system is to save money. Therefore, the consumer is especially interested in the payback time of the investment.

Concern for the environment is another strong motivation to install solar thermal systems.

Conventional water heating and energy prices

Conventional Energy Prices	
Date: 2000–2001	**Housing VAT incl.**
Electricity – normal	0,1562 €/kWh
Electricity – low rate	0,0751 €/kWh
Natural gas	0,0623 €/kWh (consumption < 4.298 kWh/year)
Natural gas	0,0516 €/kWh (consumption between 4.298 and 19.444 kWh/a)

Standards and codes of practice

Existence of the code for professional installation: the technical information 212 of the BBRI (Belgian Building Research Institute), guideline for the installation of SDHW systems.

The professional association BELSIA vzw (Belgian Solar Industry Association) is working on quality control.

Level of R & D

There are several R&D projects on renewable energy technologies. Solar thermal energy represents only a small part of it.

Main institutes for research on solar thermal:

- The University of Leuven has had some activity on active solar systems, for instance: development of simulation models for heating and drying systems, development of air collectors, comparative studies of solar water heaters.
- VITO institute, formerly SCK, has developed a high-efficiency flat plate vacuum collector.
- The De Nayer Institute Sint-Katelijne Waver conducts DST tests on solar systems to evaluate the efficiency of the system.
- The Faculté Polytechnique de Mons conducts indoor testing of solar collectors and research on the use of solar energy in combination with absorption cooling.

C STATE OF MARKETING

Distribution and marketing methods

Because of the lack of a commercial market there are only few installers who actively offer solar thermal systems. In Belgium, the costumer buys his solar system either from the installer or directly from the manufacturer. In the latter case the manufacturer then finds an installer to install the system or he installs it himself.

Some systems are installed by the consumer, which reduces the overall costs. The manufacturer sells most of these systems directly to the customer to maintain close contact and to keep an eye on the quality of the installation.

One Belgian manufacturer only delivers to installers/resellers, not to the end-user.

The Walloon region has started a Soltherm initiative which promotes special “Soltherm Installers”. These installers have participated in special courses organised by the Walloon administration and in seminars with at least one solar thermal manufacturer.

Promotional Activity
There are several construction fairs where manufacturers and installers, as well as the Regional Government, exhibit solar collectors.

A few times a year there are advertisements in the media (journal, radio or television).

Several programs, e.g. “De Zonne-Arc”, “EH2O” and “VEI”, hold seminars on how to install the collectors.

Guarantee period
The guarantee period for sun collectors differs from company to company between 10 and 30 years.

Incentives and financing methods

The regions have started to support the use of domestic hot water systems by providing financial incentives. The Walloon Region provides around 620 Euro in subsidies for each installation.

Additionally, energy suppliers grant incentives under certain conditions. To receive such incentives, the customer has to present the invoice for the installation to the local energy supplier who then pays between 75 and 150 Euro per square meter of collector area (depending on the energy supplier). The installation should be executed according to the technical information 212 of the BBRI (guideline for the installation of SDHW systems) and the energy supplier has the right to refuse the subsidies in case of bad installation.

The total subsidies range between 620 and 3.720 Euro per installation. No support schemes exist for the heating of swimming pools.

There is also an increasing number of municipalities providing subsidies for SDHW systems.

National energy policy

With regards to the environment, Belgian energy policy focuses mainly on the electricity sector (phase out of nuclear power within 40 years, introduction of green certificates in the electricity market, development of offshore wind farms etc.). Additionally a lot of attention is paid to the rational use of energy. Several programs on the federal and on the regional level are targeted at energy savings. Many of the measures in the field of renewable energies are an integral part of the “Federal Plan for Sustainable Development 200–2004” of 2000 and the “National Climate Plan” of 2002.

As far as solar thermal is concerned, activities exist mainly on the regional level:

Walloon has started a “Soltherm” program which is linked to the Soltherm initiative funded by the European Commission. The target of the Walloon program is to have 200.000 m^2 of installed collector area by 2010.

The Flemish part of the country is starting a similar program called “Vlazon”.

D FUTURE PROSPECTS

Strategy to overcome the barriers to market development

Description of major barriers by category:

- Technical: There are collectors of high quality on the market. However, the existence of cheaper systems with mediocre results make it difficult to convince people of the true potential of solar energy in a country like Belgium.
- Institutional: The local and national authorities do not serve as a model, e.g. no public swimming pool is heated with solar energy; only a few public buildings are using a SDHW system.
- Economic: The fuel prices are not high enough to convince people to use renewable energy sources.
- Cultural: People still have the idea that Belgium does not have enough sunshine to effectively use solar thermal systems.
- Educative: Since there are no real courses in the traditional schools dealing with renewable energy, awareness for these technologies is rather low.

Description of main measures needed to increase the solar thermal market by category:

- Technical: The professional associations and the authorities should develop and impose standards of quality.
- Institutional: Public buildings should have a model function regarding the use of renewable energy sources.
- Economic: More subsidies and/or fiscal benefits
- Cultural: Spots on radio and television should inform the people of the possibilities of using solar energy in Belgium
- Educative: Introduction in schools of courses on renewable energy.

References

ODE brochure : “Warmte uit zonlicht”

ODE brochure : “ENERGIE BESPAREN bij u thuis en in uw bedrijf”

Intention text of the State secretary, Olivier Deleuze to take fiscal measures to stimulate energy saving in the sector of the private houses – October 2000

Contributions to this report

This report is based on information provided by Belsolar. For his valuable contribution we would like to thank Kristof Crucke.

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Manufacturer of condensing solar systems

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Solar research centres and projects

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Denmark

A STATE OF THE MARKET

Overview of the market situation

Solar thermal started in Denmark in 1974. In 1979, the country had 39 companies selling solar systems, both imported and locally manufactured. The government provided financial incentives covering 30% of total installation costs, but as a result of competition with regards to price instead of quality, the market collapsed at the beginning of 1980. This collapse left the market with systems which did not operate, leaking collectors and a very bad image. Guaranties were abandoned as the companies simply disappeared.

In 1986, only 5–6 manufacturers were left, 2 of them from the very beginning of the solar era. At that time the market began to grow.

At the end of the eighties and the beginning of nineties several regional campaigns began. Each campaign started with a 2-day informational meeting for installers, combining installation and sales techniques. Following several advertising campaigns, local exhibitions, direct mails and open-house arrangements, sales began to rise significantly.

Still some installations were not working well, and the following campaign aimed at the certification of plumbers. About 1000 plumbers were taught how to install solar systems properly, and financial incentives were then linked to the certified plumber as well as to the tested and approved components.

Later, the support scheme was changed and linked to the system performance. This change immediately lowered the prices of the sold systems, as the price / performance ratio became a very important figure.

The financial incentives started in 1994 with 0,67 Euro per kWh net performance. 2 years later, the support was reduced to 0,53 Euro per KWh.

In 1994, several gas utility companies started a campaign for combined gas/solar systems. At that time they received large incentives from the government to finance their marketing activities. This campaign resulted in a significant growth of the market. 2.400 systems were sold in 1994 and same in 1995.

A larger and more aggressive campaign in 1996 resulted in a sale of 4.000 systems.

In 1997, the government asked the gas utility companies to pay back the loans they had taken out for marketing natural gas. This meant that they had to pay back when they started making profit from the gas sales which subsequently lead to a decline of their marketing activities. The solar campaign stopped and sales dropped to 2.200 systems.

In 1998 the government ended financial incentives for houses situated in district heating areas. Sales dropped to 1.700 systems in 1998.

This level of solar system sales held until 2001. At the end of 2001 a new government stopped all activities in the field of renewable energy. This was done overnight, and was not clearly stated. The market waited for 4 months until the new budget was approved in April 2002. Customers and plumbers almost entirely forgot solar thermal. No statistics exist for 2002, as there are no support schemes and no registration of sales. The estimated number of systems sold in 2002 is about 600.

In 2002, there are about 16 suppliers of systems in the market, of which some are importers. 7 companies are members of the Danish Solar Industry Association.

In 2001, the government submitted a new law that all public buildings and publicly supported dwellings should install a solar thermal system if feasible within 20 years. This law had to be confirmed by the EU and, when it came back approved by the EU, the new government decided to cancel it. This was the last action by the government concerning solar thermal.

The Danish Solar Industry Association is lobbying for the integration of solar thermal into the building regulations, but as for now, the government isn't showing any interest in changing these regulations.

Over the years, several high-visibility projects were developed in Denmark, amongst them the district heating solar thermal system in Marstal. With a collector area of 9.000 m^2 it is one of the largest systems ever built.

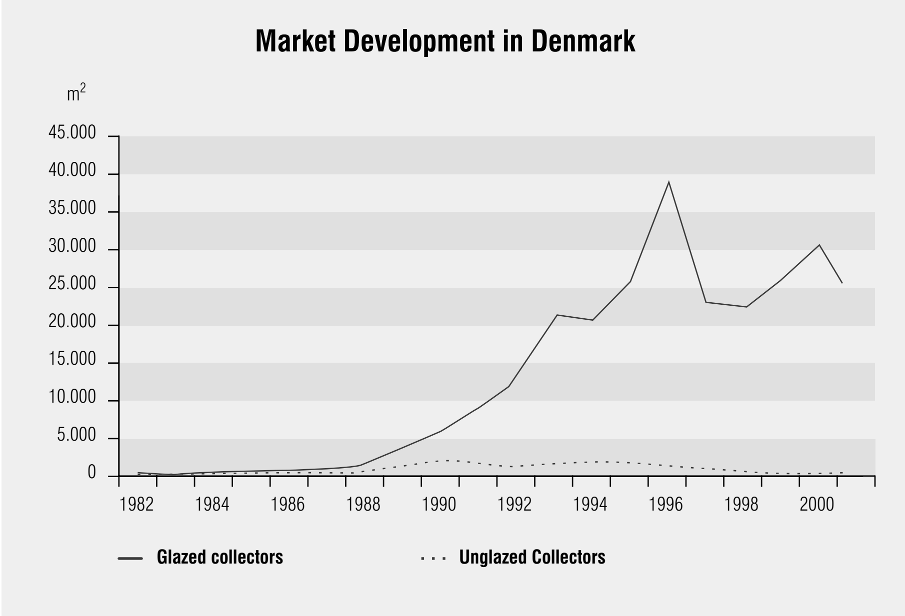
Also the island Samsø declared some years ago that they were building a sustainable energy system. This resulted in a district heating system of 2.500 m^2, along with many small domestic systems all over the island.

Skive Kommune, a town in Jutland, is aiming to build solar systems for as many public buildings as possible. As of now, 80% of all buildings are equipped with solar thermal systems.

Solar thermal installations and energy production

Solar collector production and sales in m²										
	Glazed Collectors									Unglazed Collectors
	Flat Plate Collectors				Vacuum Collectors				Total Glazed	
	A National Production	B Exports	C Imports	D = A-B+C Total Home Market	E National Production	F Exports	G Imports	H = E-F+G Total Home Market	I = D+H Total Home Market	Total Home Market
1982				670					670	200
1983				375					375	200
1984				945					945	200
1985				1.195					1.195	400
1986				1.195					1.195	400
1987				1.400					1.400	400
1988				1.830					1.830	500
1989				4.160					4.160	1.800
1990				5.734					5.734	2.700
1991				8.886					8.886	2.250
1992				14.260					14.260	1.870
1993				21.770					21.770	2.110
1994				20.090					20.090	2.540
1995				25.490					25.490	2.100
1996				39.740					39.740	1.700
1997				23.750					23.750	1.300
1998				22.460					22.460	900
1999				25.000			200	200	25.200	500
2000	29.500		500	30.000			200	200	30.200	600
2001	25.000		700	26.000			150	150	26.150	600

Source: Danish Solar Industry Association; estimations based on the numbers of systems installed under public incentive schemes; Sun in Action I



Estimated solar park in operation at the end of 2001[1]

Flat plate collectors in m^2	270.570	
Vacuum collectors in m^2	550	
Total glazed collectors in m^2	271.120	= 51 m^2 / 1000 inhabitants
Unglazed collectors in m^2	21.870	
Grand Total in m^2	292.990	= 55 m^2 / 1000 inhabitants

Estimated annual solar thermal energy production in 2001

Flat plate collectors in m^2	270.570	x 400 kWh/m^2·year =	108.228 MWh
Vacuum collectors in m^2	550	x 450 kWh/m^2·year =	248 MWh
Unglazed collectors in m^2	21.870	x 300 kWh/m^2·year =	6.561 MWh
Total			115.037 MWh

1. In Sun in Action II, ESTIF uses the following general assumptions to calculate the solar park in operation: systems installed until 1989 have an average lifetime of 15 years; systems installed in or after 1990 have an average lifetime of 20 years.

Product types and solar thermal applications

Most of the systems use flat plate collectors with an area of 2–12 m^2. Some systems use building integrated collectors.

	market share	collector area
Domestic hot water production	~80 %	3–6 m^2 (150–300 litre tank)
Large collective solar systems	~10 %	20–300 m^2
Space heating	~8 %	6 –15 m^2
District heating	~2 %	1000–8000 m^2

The market for solar thermal for air conditioning and industrial process heating is close to zero.

Employment

While in certain parts of the value chain – mainly manufacturing – it is possible to estimate fairly accurately the workforce employed, in other parts estimates are less precise. Installers, for example, are involved in the solar thermal sector only for a part of their work time. The Danish Solar Industry Association Solfangerfabrikantforeningen estimates following full-time equivalent occupation in the solar thermal sector.

Estimated employment figures in the following sectors (full-time jobs)	
Manufacturing of components of solar thermal systems:	85
Installation and maintenance:	50
Other:	10
Total:	145

B STATE OF PRODUCTION

Product technology and production methods

Product technology description

Typical product technology	
Collectors (usual sizes)	2 – 3,5 m^2
Absorber material	Copper, aluminium, stainless steel
Surface treatment	Selective
Insulation	Mineral wool
Transparent cover	Glass, polycarbonate
Casing	Aluminium, stainless steel
Storage tank	Iron, enamel coated
Cover	Steel sheet

Production technology description

Number of companies involved in collector production	13
Percentage of manufacturing	a) manually 80 % b) partly automated 20 % c) mainly automated 0 %
Potential for product improvement	There is potential for improvement, but the realization of this potential largely depends on production numbers.
Present quality and performance standards	The standard is about the European average – high compared to south European products and similar to north European standards.

Breakdown of solar systems costs

Solar Systems Costs for Typically Sized Systems		
	Individual	**Project (large scale)**
Total costs (excl. VAT)	490 €/m^2	400 €/m^2
VAT (25%)	122,50 €/m^2	100 €/m^2
Total cost (incl. VAT)	612,50 €/m^2	500 €/m^2
Typical size of system	6 m^2	100 m^2

Percentage cost breakdown of an average domestic system	
Production (materials and labour)	60–65%
Installation	25–40%

Typical solar domestic hot water system

Characteristics of a typical DHW system	
System type	flat plate collectors
Collector area (m^2)	4–6
Hot water storage (litres)	160–300
Total installed cost (VAT incl.)	4.500 €
Eventual subsides	0 €

Conventional water heating and energy prices

Date: 2000	Housing VAT incl.	Collective VAT incl.
Electricity – normal	0,18 €/kWh	0,18 €/kWh
Fuel – Oil	0,09 €/kWh	0,09 €/kWh
Natural gas	0,09 €/kWh	0,09 €/kWh
District heating	0,05–0,1 €/kWh	0,05–0,1 €/kWh
Bio	0,05–0,09 €/kWh	0,05–0,09 €/kWh

Standards and codes of practice

Until 2001, solar thermal collectors had to be tested/certified according to ISO, EN standards. The tests were performed by the Danish Technological Institute. Since 2002 there have been no more testing institutes in Denmark and no obligation to have systems tested.

Level of R & D

Type of R & D activities
Tank improvement, collector improvement, control systems, material choice.

Specific programs
There are no more public programs supporting R&D in solar thermal.

C STATE OF MARKETING

Distribution and marketing methods

Historically, the most important distribution channel has been through wholesalers and plumbers. Thus, Danish manufacturers marketed their products mainly through exhibitions, seminars and advertising. Direct project marketing and co-operations with utilities were additional marketing methods used.

In general marketing is focused on economical arguments (comparing the cost of solar with that of conventional energies). Additionally eco-friendliness plays an important role in most printed marketing materials. While the manufacturers focus their marketing activities mainly on plumbers, plumbers themselves take over the responsibility for presenting solar thermal to end users when the need to repair/change the existing heating equipment.

In housing projects, solar collectors could not be established as standard facilities. The fierce competition in the housing market draws the buyers' attention mainly to the price, but not to quality and energy consumption. Professionals in the building sector are reached through advertising, fairs and catalogues.

Guaranteed solar results as a marketing incentive have been used only in a few large-scale installations such as district heating.

Estimated percentage of distribution through wholesalers, installers and users:

1. 80% to plumbers

2. 19% to wholesalers

3. 1% to end-users

Apart from the usual maintenance needs there is little after-sales marketing. Maintenance is given mostly on demand; very few customers have a contract. Guarantees for collectors, tanks and installation usually last 5 years, while guarantees on all other components are for 2 years. The retrofit market for existing systems is close to zero.

Other promotional activities:

- Existence of specialist journals and fairs – exhibitions for promotion:
  There are several specialist journals targeted at plumbers, architects and engineers with relevance for the solar thermal industry.
  Two large exhibitions exist which are used by solar thermal manufacturers to promote their products directly to professionals. Additionally, there are many small local exhibitions all over the country directed to end-users.
- Media (TV, radio etc):
  Some plumbers are advertising on local radio programs, but the effect of this is unknown. Because of the high price of TV advertisement and the low effect of such campaigns, TV ads aren't used anymore.

Incentives and financing methods

Currently there are no financial support schemes for solar thermal in Denmark. The national government which used to subsidize each kWh produced with 4 DKK (0,53 Euro) with a ceiling of 30 % of installation costs for large systems has stopped all support for solar thermal. There are no public incentives for new investments in solar thermal.

Third party financing exists only through normal bank financing programs and is thus dependent on the customer's economic situation. Only in few cases, in which systems are sold by utilities, will they also finance the system.

D FUTURE PROSPECTS

National energy policy

Present and past energy policy is to have solar systems installed and to improve systems in quality and price. Priority is given to the integration of solar systems as a part of the building, and to the installation of solar systems in all public buildings in areas which are not covered by district heating.

The driving forces behind the energy policy are concern for the environment and the cost of reducing CO_2 emissions.

Except for the new legislation “Solar on public buildings”, there is no public support on the national level. And the implementation of this program largely depends on the will of the employees and the sympathies of the local politicians.

Objectives for the solar industry/market

Prospects for market development by sector.

There are no signs that the market will recover soon, and the prospects for the market are thus relatively dim. It is expected that approximately 500 systems will be sold on the Danish market per year.

Potential for market growth exists mainly in the large collective solar systems, especially solar district heating. SDHW also has a good potential for growth. But in the absence of any public support, the industry lacks the means to develop this potential.

Even in the case of a growing market for solar thermal, space heating, solar assisted air conditioning and the use of unglazed collectors are expected to continue to play a negligible role.

Strategy to overcome the barriers to market development

One of the main barriers to a positive market development is the lack of interest of plumbers in solar thermal. Only a limited number of them actively promote this technology. It is expected that special training would help get plumbers involved in selling solar thermal systems.

Additionally, the Danish government could jumpstart the use of solar thermal by implementing solar thermal in building regulations.

Concluding remarks

As per 2002, manufacturers lack the tools necessary to enlarge the Danish market. There are no subsidies, no R & D, no test facilities for components and systems, no control of plumbing quality and no public awareness campaigns.

The solar thermal industry lobbies the government for the implementation of energy frameworks in building regulations. However, there are no signs that the current government will use rules or regulations to support the use of solar thermal.

The hope of the industry therefore rests on the plumbers' ability to sell their systems to the end users and on a growing public awareness of the costs of conventional energies.

Contributions to this report

This report is based on information provided by Danish Solar Industry Association Solfangerfabrikantforeningen. For their valuable contribution we would like to thank Emanuel Brender of Solfangerfabrikantforeningen and Jan Erik Nielsen.

E ANNEX: SOLAR THERMAL DIRECTORY

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ED Heating ApS
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Testing and Research Centers

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Finland

A STATE OF THE MARKET

Overview of the market situation

The solar thermal market in Finland is relatively small. In 2000 collector sales were at the level of 1.000 m^2/a. No official statistics on the installed solar collector area and systems exist. The sales figures are based on information provided by the major manufacturers. The total collector area installed during the period 1982–2000 is some 7.800 m^2. In addition to this, it is estimated that around 90.000 m^2 of unglazed perforated absorber plates have been installed in crop and hay drying applications. During the last few years, from 1995 to 2000, the annual sales of flat plate collectors increased from 500 m^2 to 1.000 m^2.

Due to the small market volume and relatively cheap alternatives (such as electricity, fuel oil and district heating) solar heating has not been competitive in Finland.

Some larger scale demonstration projects of high visibility have been implemented with subsidies – often within the framework of various EU-programs. These projects normally have 100–200 m^2 of collector area and are combined with district heating. One larger project, Eko-Viikki with 1.000 m^2 of collector area, was implemented in Helsinki in 2001–2002.

The recent price increase of traditional energy sources, in particular electricity and fuel oil, has resulted in an increased interest in alternative energy sources, including solar energy. This, in combination with increased subsidies of up to 40 % for demonstration projects, is likely to result in a market growth.

A Finnish Solar Industries (FSI) group was established in 2001 to activate companies and activities in the solar energy field. Some 20 organizations are involved in the FSI group.

Solar thermal installations and energy production

Solar collector production and sales in m²										
	Glazed Collectors									Unglazed Collectors
	Flat Plate Collectors				Vacuum Collectors				Total Glazed	
	A National Production	B Exports	C Imports	D = A-B+C Total Home Market	E National Production	F Exports	G Imports	H = E-F+G Total Home Market	I = D+H Total Home Market	Total Home Market
1982	500			500					500	n/a
1983	900			900					900	n/a
1984	100			100					100	n/a
1985	145			145					145	n/a
1986	100			100					100	n/a
1987	150			150					150	n/a
1988	150			150					150	n/a
1989	50			50					50	n/a
1990	50			50					50	n/a
1991	100		50	150					150	n/a
1992	100		50	150					150	n/a
1993	150		150	300					300	n/a
1994	160		240	400					400	n/a
1995	200		300	500					500	n/a
1996	300		300	600					600	n/a
1997	400		400	800					800	n/a
1998	400		400	800					800	n/a
1999	600		400	1.000					1.000	n/a
2000	600		400	1.000			10	10	1.010	n/a

Source: The 1982–1994 figures are based on SOLPROS, "Sun in Action" February 1996. The 1995–2000 figures are based on information provided by the main manufacturers.

Estimated solar park in operation at the end of 2000[1]

Flat plate collectors in m^2	6.200	
Vacuum collectors in m^2	10	
Total glazed collectors in m^2	6.210	= 1,2 m^2/1000 inhabitants
Unglazed collectors in m^2	90.000	
Grand Total in m^2	96.210	= 18,6 m^2/1000 inhabitants

Estimated annual solar thermal energy production in 2000

Flat plate collectors in m^2	6.200	x 300 kWh/m^2·year =	1.860 MWh
Vacuum collectors in m^2	10	x 500 kWh/m^2·year =	5 MWh
Unglazed collectors in m^2	90.000	x 200 kWh/m^2·year =	18.000 MWh
Total			19.856 MWh

CO_2 emissions avoided in 2000

Flat plate collectors	1.860 MWh/a	x 0,35 tonnes/MWh =	651 t
Vacuum collectors	5 MWh/a	x 0,35 tonnes/MWh =	2 t
Unglazed collectors	18.000 MWh/a	x 0,35 tonnes/MWh =	6.300 t
Total			6.953 t

1. In Sun in Action II, ESTIF uses the following general assumptions to calculate the solar park in operation: systems installed until 1989 have an average lifetime of 15 years; systems installed in or after 1990 have an average lifetime of 20 years.

Product types and solar thermal applications

Around 10 larger scale demonstration systems with 100–200 m^2 of collector area were in operation in 2000, often combined with district heating. In addition to this, a large number of smaller systems of 5–10 m^2 collector area, mainly for domestic hot water production, were installed. The larger systems are often owned by energy companies or public organisations.

The most common collectors used are around 2 m^2 flat plate collectors. Some larger collector modules, 6–10 m^2, have been manufactured in smaller amounts. Usually the frame is of aluminium. Aluminium is also the most common absorber material, but some copper is also used. The collectors are covered with low iron glass and insulated with mineral wool.

No statistics are available on the installation figures for different application segments.

B STATE OF PRODUCTION

Product technology and production methods

Product technology description

Collectors (usual sizes)	2–2,5 m^2
Absorber material	Aluminium or Copper
Surface treatment	Selective coating
Insulation	Mineral wool
Transparent cover	Low iron glass
Casing	Aluminium
Typical values of efficiency of collectors:	70 %

Production capacity

Number of companies involved in collector production	3
Production capacity	16.000 m^2/a
Capacity utilisation	10 % in 2000

Breakdown of solar systems costs

Solar Systems Costs for Typically Sized Systems		
	Individual	**Project (large scale)**
Total costs (excl. VAT)	410 €/m^2	310 €/m^2
VAT (22%)	90 €/m^2	68 €/m^2
Total cost (incl. VAT)	500 €/m^2	378 €/m^2
Typical size of system	5–8 m^2	200 m^2

Percentage cost breakdown of an average system

Percentage cost breakdown of an average system in	
Production (materials and distribution)	80–85%
Installation	15–20%

Typical solar domestic hot water system

Characteristics of a typical DHW system	
Collector type	flat plate collectors
Collector area (m^2)	5–8
Hot water storage (litres)	300–400
Total installed cost (VAT incl.)	3.300–4.100 €
Eventual subsides	Eventual subsides: There are no subsidies for solar energy systems in private single houses. Companies and public organisations may receive up to 40% investment subsidies.

Conventional water heating and energy prices

Conventional Energy Prices (Fuel)		
Date: 2000	**Housing VAT incl.**	**Collective VAT incl.**
Electricity – normal	0,10 €/kWh	0,06 €/kWh
Electricity – low rate	0,05 €/kWh	
Fuel – Oil, light	0,05 €/kWh	0,04 €/kWh
Natural gas	0,04 €/kWh	0,035 €/kWh
District heating	0,04 €/kWh	0,03 €/kWh
Other (specify)	0,03 €/kWh	0,02 €/kWh

Incentives and financing methods

Companies and public organisations may receive up to 40% national investment subsidies for the installation of renewably energy systems. There are, however, no subsidies for private persons.

C FUTURE PROSPECTS

National energy policy

- Solar thermal energy is included in the national Promotional Program for Renewably Energy Sources. In this program, the objective is to increase the use of solar thermal energy applications 20 times (equalling 0,004 Mtoe) from 1995 to 2010.
- The main priorities and driving forces influencing the current general national energy policy include a market economy oriented energy sector, environmental considerations, international agreements, and the increased use and competitiveness of renewable energy sources through technological development.

Prospects for market development

The interest in solar thermal applications depends to a high degree on the feasibility and the costs of the alternatives. During 2002, the price of electricity has increased and the price of fuel oil has been relatively high. In 2002, the maximum investment subsidies to companies and public organisations were increased from 30% to 40%. The higher subsidies, in combination with higher costs of the alternatives, are likely to result in a market growth. No official targets, however, have been given for the different application segments.

Strategy to overcome the barriers to market development

Major barriers:
- Long pay-back time for solar thermal systems due to
  – small market volume.
  – relatively cheap alternative energies
  – subsidies only for companies and public organisations, not for private persons.
- No established solar thermal culture, that is, solar thermal energy systems are not widely used and rarely considered when deciding on heating systems.
- A limited number of skilled solar thermal planners and fitters.
- No specific promotional program for the solar thermal sector.

Main measures (actions) needed to increase the solar thermal market:
- Extension of subsidies to include private persons.
- Technical development in order to achieve more efficient and competitive systems with shorter pay-back times.
- Promotional actions for solar thermal energy:
  – Highly visible large-scale demonstration projects.
  – A specific promotional program for the sector.
  – Introduction and promotion of do-it-yourself activities.
- Training of fitters, plumbers and other relevant trade persons.

Concluding remarks

The present solar thermal market in Finland is relatively small with annual collector sales of around 1.000 m^2/a in 2000. Future expansion of the market will to a large extent depend on the future price of electricity, fuel oil and district heating. Extension of incentives to include private households, shorter pay-back times and promotional actions are needed in order to improve the market.

Contributions to this report

This report is based on information provided by Bundesverband Solarindustrie (BSi). For their valuable contribution we would like to thank Werner Koldehoff, and Johan Wasberg of MERINOVA Technology Center.

D ANNEX: SOLAR THERMAL DIRECTORY

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France

A STATE OF THE MARKET

Overview of the market situation

After the “first age” of solar thermal (1980–86), in which the national market was approximately 60.000 m^2 during the best year, the period from 1987 to 1999 was regarded as the “age of desert”. The market decreased steadily in metropolitan France, and was concentrated in the French overseas territories.

During 1999, flat plate collector sales were 13.500 m^2; and only 3.500 m^2 of the total was installed in metropolitan France. The remaining 10.000 m^2 were sold in the French overseas territories (Guadeloupe, Martinique, French Guyana, Reunion and New Caledonia).

French overseas “departments” had, and still have, a dynamic market, in which the local councils, the ADEME (French agency for the environment and energy management), and EdF (French electricity supply company) have launched concerted actions with joint marketing schemes and specific subsidies. The long-term solar thermal development plan for the overseas departments should increase this market from the present 20.000 m^2 to 50.000 m^2 by the year 2010.

In 1999, for the metropolitan France, ADEME (French agency for the environment and energy management) has launched “Helios 2006” or “Plan Soleil”. This medium-term solar thermal development plan (six years), envisions the installation of 50.000 domestic solar thermal systems by 2006. This plan promotes the quality of both the systems and the installations. To have the advantage of the subsidies, the solar domestic hot water (SDHW) system needs to be installed by a professional member of “Qualisol Chart,” and the system model must have been approved by a national committee.

The ADEME subsidies are available everywhere in metropolitan France and are sometimes complemented by regional or local funding (30 to 100 %). The ADEME subsidies vary for a SDHW system from 690 to 1.150 Euro, depending on the size of the system.

In 2000, a television campaign was launched by ADEME in 5 regions during 2 months (Provence Alpes Côte d’Azur, Languedoc-Roussillon, Rhône-Alpes, Corse et Midi-Pyrénées). This campaign was extended to 9 regions in 2001 (additional regions: Aquitaine, Alsace, Pays de Loire et Auvergne). The campaign was extended to all regions in 2002. The Plan Soleil campaign has been promoted not only on TV but also in regional newspapers and through local events.

1.500 plumbers are currently members of Qualisol Chart and have participated in specific training. There are Qualisol members in all regions. 10 solar manufacturers are present in the metropolitan market with eligible solar thermal systems (3 French, 3 German, 1 Austrian, 2 Belgian, 1 Australian).

Milestones of the market

In metropolitan France, 100 SDHW systems were installed in 1999, 800 in 2000 and 2.600 in 2001. The area of newly installed collectors rose from 3.600 in 2000 to 12.000 in 2001. The industry target for 2010 is more than 100.000 newly installed systems, equalling 480.000 m^2.

Besides DHW, a promising market for solar thermal in metropolitan France is active solar space heating (Combisystem). Until now, only one company (Clipsol) sold their combisystems with ADEME funding in 5 regions. 250 systems were sold in 2001 ($\sim$4.500 m^2 of collector area). The incentive scheme changed in 2002, and the market for combisystems is increasing: At least 5 companies offer combisystems in metropolitan France. The industry target for combisystems in 2010 is more than 12.000 systems installed in that year, equivalent to 180.000 m^2 of collector area.

Another growing market segment is that of collective systems for DHW. It has not benefited enough from the Plan Soleil and growth has therefore been slow. One problem encountered has been the European restriction on national subsidies to the commercial sectors (hostelry). This situation should be changed in the future. Collective SDHW systems have an additional benefit for the buyer: Such systems are generally offered with guaranteed solar result contracts. After 1.200 m^2 in 2000, 2.500 m^2 were installed in 2001. The industrial target for collective solar hot water systems in 2010 is more than 250.000 m^2 installed in that year.

Solar in France: the new age

2000 is a milestone for the solar thermal market in metropolitan France. After 14 years in which the market decreased each year, the market is now rising. The metropolitan market is the biggest potential solar market for France. The annual market target for 2010 is 1 million square meters. The French overseas "departments" market target for 2010 is only 50 000 square meter installed.

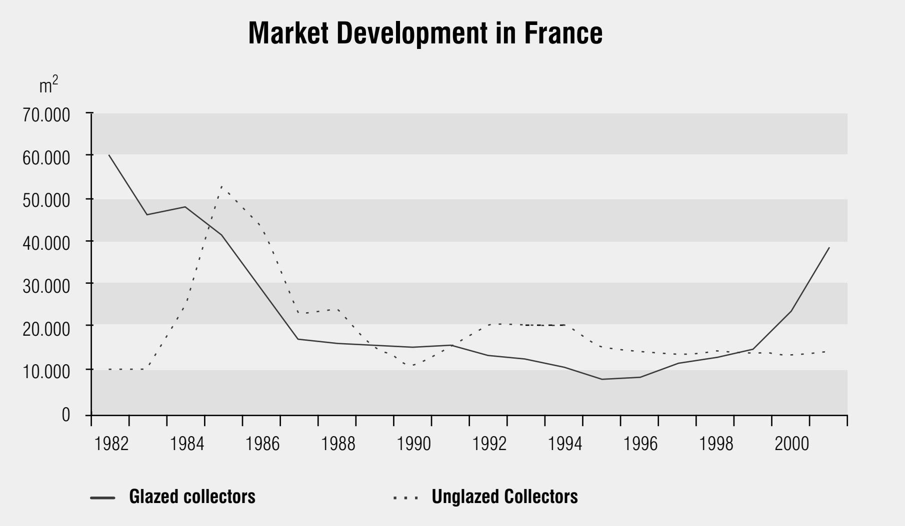
It will be a great challenge to reach the target of 1 million square meters installed in 2010, but the situation is promising. "Plan soleil" is a beginning, and a small change in the energy and building policies could open up a vast market for solar thermal application. The main monopoly energy actors (EdF - Electricité de France et GdF - Gaz de France) are preparing offers that combine solar energy with electricity and gas.

French industries are able to respond to the demand, along with manufacturers and distributors from neighbouring European countries who invest in France. The key for a durable market is to develop high quality and competitive products. The innovative capacity to propose new and attractive offers is likewise crucial.

Solar thermal installations and energy production

Solar collector production and sales in m^2										
	Glazed Collectors									Unglazed Collectors
	Flat Plate Collectors				Vacuum Collectors				Total Glazed	
	A National Production	B Exports	C Imports	D = A-B+C Total Home Market	E National Production	F Exports	G Imports	H = E-F+G Total Home Market	I = D+H Total Home Market	Total Home Market
1982	53.800		6.500	60.300					60.300	10.000
1983	40.400		5.600	46.000					46.000	10.000
1984	43.200		4.800	48.000					48.000	25.000
1985	36.150		5.050	41.200					41.200	52.800
1986	25.500		3.350	28.900					28.900	43.600
1987	16.550	600	1.000	16.850					16.850	23.000
1988	16.200	600	900	15.900					15.900	24.000
1989	15.600	600	900	15.300					15.300	15.000
1990	14.800	1.000	900	14.900					14.900	11.000
1991	14.800	1.000	1.900	15.700					15.700	15.000
1992	12.800	1.200	1.500	13.100					13.100	20.000
1993	12.000	900	1.200	12.300					12.300	20.000
1994	10.000	900	1.200	10.300					10.300	20.000
1995	8.000	1.800	1.500	7.700					7.700	15.000
1996	9.000	3.000	2.000	8.000					8.000	14.000
1997	11.000	5.000	5.400	11.400					11.400	13.200
1998	14.000	6.000	4.800	12.800					12.800	14.200
1999	19.500	10.000	5.000	14.500					14.500	13.500
2000	35.500	20.000	8.000	23.500					23.500	13.000
2001	50.500	22.000	10.000	38.500					38.500	14.000

Source: Enerplan



All recent statistics are based on interviews with manufacturers and distributors and although the resulting figures are partially based on estimations, the overall results and tendencies are considered to be exact.

French home market sales are both the metropolitan France and the French overseas "departments".

Estimated solar park in operation at the end of 2001[1]

Flat plate collectors in m^2	230.750	= 3,9 m^2/1000 inhabitants
Unglazed collectors in m^2	244.900	
Grand Total in m^2	475.650	= 8,0 m^2/1000 inhabitants

Estimated annual solar thermal energy production in 2001

Flat plate collectors in m^2	230.750	x 600 kWh/m^2·year =	138.450 MWh
Unglazed collectors in m^2	244.900	x 250 kWh/m^2·year =	61.225 MWh

CO_2 emissions avoided in 2001

Flat plate collectors	138.450 MWh/a	x 0,5 tonnes/MWh =	69.225 t
Unglazed collectors	61.225 MWh/a	x 0,5 tonnes/MWh =	8.572 t
Total			77.797 t

1. In Sun in Action II, ESTIF uses the following general assumptions to calculate the solar park in operation: systems installed until 1989 have an average lifetime of 15 years; systems installed in or after 1990 have an average lifetime of 20 years.

Solar thermal applications

Domestic hot water production
All kinds of solar water heaters have been and continue to be manufactured and sold.

However, due to the present market conditions, 2 specific markets are apparent:

- Metropolitan France, where the majority of the SDHW installed are separate elements with the collector on the roof. The systems are constructed as two-cycle systems, with a water-glycole cycle, which charges the solar storage by means of a internal exchanger. The storage tank is often “multi energy” (2 or 3 heat exchangers: 1 solar, 1 hydraulic or/and 1 electric).
- French overseas departments, where the majority of sales are limited to thermosiphonic “monobloc” systems, that are installed on a sloping roof. The water supply flows directly through the solar collector area. Water heaters with integrated solar collector storage are also frequently used.

Large collective solar systems
The 10 solar manufacturers present on the metropolitan market offer a modular flat plate collector adapted to collective installations. 2 manufacturers offer roof integrated collectors.

Solar Guaranteed Results are required for eligibility for public funding.

Space heating – Solar Combisystems
Until recently, only one company (Clipsol) could sell their systems with ADEME funding. In 2002 the market increased and at least 5 companies offered combisystems in metropolitan France.

Clipsol uses a roof integrated flat plate collector in connection with a specially designed control system for direct floor slab space heating. The solar heated water is circulated through pipes in a thick concrete floor without intermediate heat storage. This space heating system is available with an optional conventional energy backup heating. The energy supplied by the collector area can also be used for domestic hot water or heating a swimming pool, according to need.

Air conditioning and industrial process heating.
This solar technology is not yet available on the market. R&D actions with a certain number of demonstration projects have been undertaken to prepare the industry for solar cooling.

Employment

Employment in the traditional solar thermal industry is estimated at 400. An additional 100 people are estimated to work in the public promotion of solar thermal (in NGOs, public institutions etc.). Thus, overall employment in solar thermal in France is approximately 500. The potential for employment in France in 2010 is about 14.000.

B STATE OF PRODUCTION

Product technology

Typical product technology	
Collectors (usual sizes)	2 m^2
Absorber material	Copper, aluminium, steel
Surface treatment	Selective (black chrome, copper oxide)
Insulation	Polyurethane, rock or glass wool
Transparent cover	Tempered glass
Storage tank	Between 200 and 300 l

Breakdown of solar systems costs

Solar Systems Costs for Typically Sized Systems		
	Individual	**Project (large scale)**
Total costs (excl. VAT)	800 €/m^2	680 €/m^2
VAT (%) Variable 5,5 to 19,6 %	44 or 157 €/m^2	37,4 to 133,3 €/m^2
Total cost (incl. VAT)	844 to 957 €/m^2	717 to 813 €/m^2
Typical size of system	4,5 m^2	100 m^2

Approximate cost breakdown of an average individual system	
Production (materials and labour)	40 %
Marketing/distribution	25 %
Installation	30 %
R & D	5 %

Typical solar domestic hot water system

Characteristics of a typical DHW system	
Collector area (m^2)	4,5
Hot water storage (litres)	250
Total installed cost (VAT incl.)	3.800 €
Eventual subsides	1.280 to 2.100 €

Typical consumer motivation

The main motivations to buy solar thermal systems are

- to reduce the annual invoice for (conventional) water heating
- to act positively for the environment

Standards and codes of practice

The collectors must be tested and certified to have the benefits of public funding. The following standards are used:

Title of the Standard	European or International Standard	French Standard	Applicable in France since
Solar energy – Vocabulary	ISO 9488	NF EN ISO 9488	20/01/2000
Thermal solar systems and components – Solar collectors – Part 1: General requirements	EN 12975-1	NF EN 12975-1	05/01/2001
Thermal solar systems and components – Solar collectors – Part 2: Test methods	EN 12975-2	NF EN 12975-2	31/12/2001
Thermal solar systems and components – Factory made systems – Part 1: General requirements	EN 12976-1	NF EN 12976-1	30/06/2001
Thermal solar systems and components – Factory made systems – Part 2: Test methods	EN 12976-2	NF EN 12976-2	30/06/2001
Thermal solar systems and components – Custom built systems – Part 1: General requirements	ENV 12977-1	*	
Thermal solar systems and components – Custom built systems – Part 2: Test methods	ENV 12977-2	*	
Thermal solar systems and components – Custom built systems – Part 3: Performance characterisation of stores for solar heating systems	ENV 12977-3	*	
*The national standardisation bodies are not required to publish European pre-standards (ENV) in their catalogues of national standards. However, the publication of these standards is anticipated, in a XP ENV format at a date not yet known.			

The certification is performed by CSTB, the French centre for building technology research.

Level of R & D

Type of R & D activities: space heating, solar cooling, integration of the information technology in the solar systems, environmental analyses

Specific programs
- ADEME call for proposals "préparer le bâtiment 2010"
- Bilateral programs between ADEME and manufacturers
- 6th Framework Program of the European Commission

Role of government (national, regional): Contribution to the industry's own financing of R&D

Level of financing by industry and public funds (EU incl.): Usually the share of the public financing does not exceed 50%.

C STATE OF MARKETING

Distribution and marketing methods

For metropolitan France, the situation has changed significantly since 1999. ADEME and the regions have launched a public campaign for solar energy, and the manufacturers have targeted their marketing at two groups of customers:

- end consumers
- installers, Qualisol and distributors of heating equipment

The low level of mobilisation within the industry is still considered to be an obstacle. Nowhere has marketing and sales developed solidly without public support. Only now is a network of installers developing (Qualisol).

In the French overseas departments, solar thermal systems are distributed directly from the manufacturer to the installer.

For metropolitan France, the situation is improving. With 2.500 Qualisol installers at the end of 2002, the network is growing and important efforts are being made to develop it.

Since 1999, ADEME (French agency for the environment and energy management) has promoted "Helios 2006" or "Plan Soleil" on TV, in regional newspapers and at local events.

- New marketing concepts
  New marketing concepts are being developed with EdF (Electricité de France), GdF (Gaz de France) and solar thermal professionals to promote SDHW.
  Guaranteed solar results contracts have been applied in some regions.
- Role of manufacturers, of specialised installers in distribution and marketing
  – The manufacturers have not been at the forefront of the ADEME campaign. Instead, they have launched their own marketing campaign targeted at end consumers and/or Qualisol installers.
  – Qualisol installers have been strongly involved in the ADEME campaign. They are the main source of information for potential buyers of solar thermal systems.
- Marketing activities towards professional parties in the building industry:

Activities targeted specifically at this target group were started by Enerplan and ADEME in 2002 and will be intensified in 2003.

- Promotion activities:
  – Several specialist journals and fairs exist which are used for promoting solar thermal products
    Qualisol Infos, made by Enerplan for ADEME
    "Plein Soleil" – a new solar journal – was launched in February 2003
    The "Renewable Energies Exhibition", was first held in 2001. In March 2003 a second edition of this exhibition was launched.
    Enerplan regularly presents its "solar exhibition space" at important events, e.g. Interclima (climatic fairs), Congrès HLM (annual meeting of social housing), Salon des Maires et Collectivités Locales (annual meeting for local authorities).
- Usual guarantees (number of years):
  – Minimum: 2 years
  – Standard: 5 years
  – Maximum: 10 years

Incentives and financing methods

The ADEME subsidies for SDHW systems are available everywhere in metropolitan France and are sometimes complemented by regional or local funding (30 to 100 %). The ADEME subsidies vary for a SDHW system from 690 to 1.150 Euro, depending on the size of the system.

A similar scheme applies to collective systems, with ADEME subsidies for installation under guaranteed solar results from 300 to 600 Euro/m^2. Again, these subsidies are complemented by regional or local funding.

Third party financing is not available at this time.

D FUTURE PROSPECTS

National energy policy

Currently, solar energy does not yet have an important role in the national energy policy.

In the overseas departments, solar energy has been promoted for years for the rational use of energy – but mainly for electricity production.

In metropolitan France, solar energy is also considered for its environmental value, more than for the energy value.

This is expected to change in the near future. Hot water is important for housing (30% of the total consumption in a new house), and solar energy could increase the energy efficiency of new houses by 15 to 20% (with average cover of 50% of DHW).

Overall, the development of renewable energies is becoming more popular: A "green mix" is to be introduced into the national policy – partly through the implementation of European legislation (EU directive for E-renewable and EU Directive on building efficiency).

Objectives for the solar industry/market

The prospects for solar thermal in the following sectors:

- domestic hot water production, 110.000 m^2 installed in 2005, 500.000 m^2 in 2010
- large collective solar systems, 41.500 m^2 installed in 2005, 280.000 m^2 in 2010
- space heating, 60.000 m^2 installed in 2005, 250.000 m^2 in 2010

Strategy to overcome the barriers to market development

Enerplan has published a list of recommendations for the strong development of solar thermal in France. This list includes

- Urban development should only take place under the condition of high or very high energy efficiency
- Reference to SDHW should be included in all heating regulations by 2005 (implementation of EU Buildings Directive)
- Launch of a R&D program with ADEME aimed at improving performance of solar thermal systems and at reducing costs of components
- Systematic examination of the possibilities of using SDHW in new social housing projects
- Examination of an obligation to use SDHW in newly built or refurbished public buildings – especially those that have large demand for hot water.

- Stronger integration of solar thermal into all programs aimed at refurbishing the existing building stock
- Setting national targets for the penetration of renewables in the heating of buildings (1 million m^2 of solar collectors newly installed in 2010).

Contributions to this report

This report is based on information provided by Enerplan. For his valuable contribution we would like to thank Richard Loyen.

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Germany

A STATE OF THE MARKET

Overview of the market situation

Market development 1975 to 1995

As in most European Countries, in Germany the use of solar thermal energy started as a reaction to the energy crises in the seventies. After a strong increase up to the beginning of the eighties, the market went down and stabilised at a low level. Only a few small companies continued to work on solar thermal systems and improved the technique involved. Since the end of the eighties the market has risen continuously due to increased environmental awareness and the improved solar thermal systems now available.

Development 1995 to 2002

In the period from 1995 to 2001 the German solar thermal market showed furthermore a very good development. The demand for solar thermal systems rose by an average of 30% per year.

There were three main reasons for this market success. First the public awareness of solar energy and therefore the interest in the use of solar thermal increased . Second the government strengthened subsidies for solar thermal systems. Third the solar branch – with established solar companies and several new companies – worked very hard to build up the market and to activate plumbers to sell and install solar systems.

In 2002 the market dropped by about 40% for several reasons. The consumption in general decreased due to the uncertainty of the public because of the new Euro, the terrorism of 11 September 2001, the general elections and the increasing economic problems of Germany. In addition, the amount of subsidies was reduced in March and July 2001. At the beginning of 2003 the amount of subsidies increased and the interest in solar thermal systems is growing again.

More Public awareness

One further reason for the interest in solar energy is the growing discussion about the danger of climatic change and the end of fossil energy resources. Solar energy is seen as one indispensable future energy resource by the public. Most of the people would use solar energy, if it was not more expensive than oil or gas.

In order to increase the public awareness, the solar thermal campaign, 'Solar – na klar!' ('Solar – that's clear!') was launched in 1999. Under the management of the environmental organisation of the industry, B.A.U.M., the organisations of the plumbers (ZVS-HK), the solar thermal energy branch (BSE and DFS, who merged in 2002 to form BSi), German Section of the International Solar Energy Society (DGS), the architects (BDA) and the environmental association DNR, developed and realised the campaign from 1999 up to 2001. The environment foundation DBU financed 40% of the budget of 10 million DM (5,1 million Euro) over the 3 years. The campaign was under the auspices of the German chancellor Gerhard Schröder and the minister of environment Jürgen Trittin.

The concept was to interest people by means of PR work, mainly with articles in magazines and newspapers, reports from radio stations and presentations on TV. Due to the limited budget, only small advertisement in house building magazines were placed. The interested persons could request a brochure with information about the reasons for the use of solar thermal energy, the techniques of the different systems, the requirements for its use and the subsidies available. A list of the 45 solar companies which were engaged in the campaign was included, giving readers the option to contact them. A further list with plumbers offering solar systems near the home of the interested party gave them all information necessary to take the next step and pursue the offer of a solar system. More than 7.000 plumbers were registered during the campaign. Over the 3 years, more than 200.000 brochures were disseminated by the campaign.

In 2002 the follow up of the solar campaign was planned. Under the direction of the German energy agency (dena), the plumbers and the solar industry associations re-launched the campaign with the new name "Initiative Solarwärme plus" (www.solarwaerme-plus.info). Due to the increased knowledge of the public about solar thermal energy, the new campaign will focus more on the sales process and will provide support to the plumbers for the selling of solar systems.

In addition to this campaign, the solar companies increased their own advertisement activities for solar thermal energy systems and media reports about them. Due to the growing number of buildings with solar systems integrated into their roof, solar systems are now accepted more and more as the mature and reliable technology which they are.

Subsidies

Subsidies for solar thermal systems were given by the government and by the individual German federal states. From 1995 to 1998 the government launched the 'Marktanreizprogramm' (market stimulation program). 100 million DM (51 million Euro) were given out over the whole period of 4 years for solar thermal and other renewable energies. Solar thermal systems for one-family houses were subsidised with 1.500 DM (767 Euro), bigger systems with 250 DM (128 Euro) per m^2, which was about 15% of the system costs. In 1995 and in 1996 about 40.000 m^2 were subsidised by means of this program. Still this governmental program was not able to satisfy the whole demand. Single German federal states subsidised solar collectors as well . In 1999, the newly elected government of the Social Democrat and the Green Party extended the Marktanreizprogramm and increased the total sum of the public funds involved. 200 million DM (102 million Euro) were provided in 1999 and in 2000, 300 million DM (153 million Euro) in 2001 and 400 million DM (204 million Euro) in 2002 and 2003 for the program. About 70% of that amount was provided for solar thermal systems. Therefore the market grew by about 45% per year in 2000 and 2001.

Up to July 2001 the individual subsidy was 250 DM (128 Euro) per m^2 flat plate collector and 325 DM (166 Euro) per m^2 vacuum tube collector. In July 2001, the subsidy amount was reduced to 170 DM (87 Euro) per m^2 for both types. Up to March 2001, every owner of a building got the double subsidy if he replaced a more than 10 year old boiler in combination with the installation of a solar thermal system. The boiler subsidy was reduced in March 2001 to 500 DM (256 Euro) and finally expired in July 2001. About 50% of the requests for subsidies were in combination with this boiler subsidy. This strategy intended to activate the plumbers to sell combined systems and to offer solar systems in every case an old boiler had to be replaced.

In order to give the solar thermal market new impetus after the market decrease in 2002, the re-elected government decided to increase subsidies from February 2003 to 125 Euro per m^2. It is expected that the market will grow again in 2003. Due to limited money for subsidies it has been decided as well to reduce this rate to 110 Euro per m^2 from 1. January 2004 on.

In 2000 subsidies for 750.000 m^2 and in 2001 for 875.000 m^2 were granted. Due to this strong engagement by the government, most of the German federal states ended their individual subsidy programs.

In addition to the market stimulation program, builders of new houses and buyers of residences got the 'ökozulage' (eco bonus), which was 2% of their investment on solar systems in their dwelling over 8 years, in sum 16%, but a maximum of 4.000 DM (2.045 Euro) in total. This program ended in February 2002 synchronously with the start of the new 'Energie-einsparverordnung' (energy saving regulation).

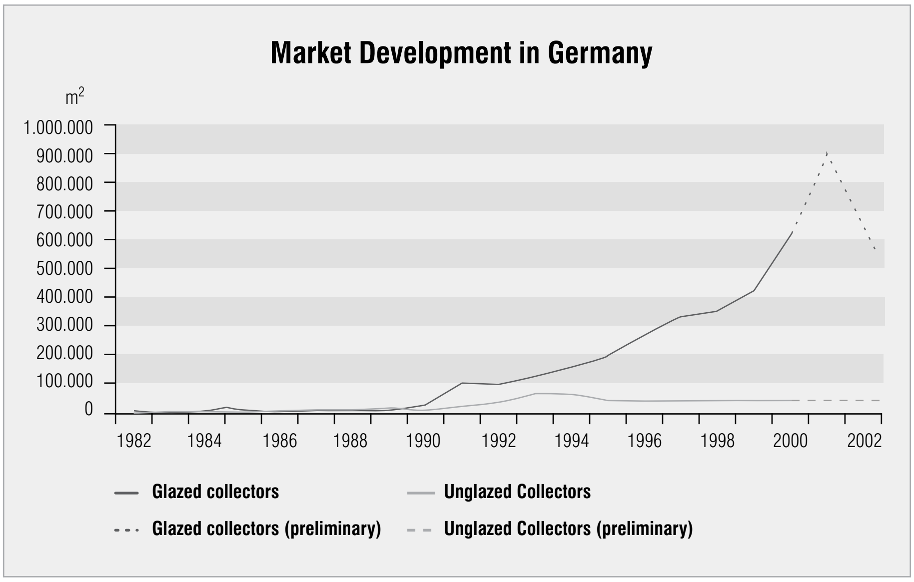
Building the solar branch

In order to meet the challenge of a fast growing market, the solar branch has worked very hard to build up the sales system. In recent years, most of the solar systems were traded by solar companies to specialised solar craftsmen, who installed the systems. Today a bigger part is traded through established trade systems of the heating branch and installed by conventional craftsmen of the heating sector. It was very important to arouse their interest in solar energy and to show them that selling solar thermal systems gives them a chance to share a new market. In the beginning these craftsmen were trained by the solar companies. Then special schools for their training were founded, and the association of the plumbers developed a continuation course for 'solar technicians'.

On the other hand, the production of solar collectors and solar systems was extended and automated. Factories for modern, 'sputtered' absorber coatings were built and factories which prefabricated parts of collectors were founded. Due to the rising number of sold systems, the production of collectors moved from abroad back to Germany through investments in new modern, partly automated collector production lines. These investments were made by established solar companies as well as companies from the heating branch, the branch of roofing, tiles and skylights and from the facade branch which entered the market.

Solar thermal installations and energy production

Solar collector production and sales in m²										
	Glazed Collectors									**Unglazed Collectors**
	Flat Plate Collectors				**Vacuum Collectors**				**Total Glazed**	
	A National Production	B Exports	C Imports	D = A-B+C Total Home Market	E National Production	F Exports	G Imports	H = E-F+G Total Home Market	I = D+H Total Home Market	Total Home Market
1982				13.500					13.500	500
1983				7.000					7.000	8.000
1984				12.500					12.500	9.500
1985				15.000					15.000	7.000
1986				8.000				1.000	9.000	11.000
1987				11.000				2.000	13.000	15.000
1988				11.000				2.000	13.000	15.000
1989				11.000				3.000	14.000	24.000
1990				30.000				5.000	35.000	15.000
1991				85.000				15.000	100.000	30.000
1992				80.000				15.000	95.000	45.000
1993				110.000				17.000	127.000	70.000
1994				135.000				20.000	155.000	65.000
1995	88.500	1.500	83.000	170.000	3.500		19.500	23.000	193.000	50.000
1996	124.000	4.000	118.000	238.000	8.000	1.000	24.000	31.000	269.000	50.000
1997	139.500	7.500	160.000	292.000	12.500	1.500	27.000	38.000	330.000	50.000
1998	218.000	11.000	93.000	300.000	11.500	4.000	42.500	50.000	350.000	50.000
1999	253.000	17.000	124.000	360.000	18.000	7.000	49.000	60.000	420.000	50.000
2000	333.000	27.000	204.000	510.000	46.000	8.000	72.000	110.000	620.000	50.000
2001				750.000				150.000	900.000	50.000
2002				475.000				65.000	540.000	50.000



Source: BSi (former DFS)

The figures for 2001 and 2002 are estimated.

The market of unglazed collectors is estimated since 1995. Half of the absorbers are used in public swimming pools, the other half in private swimming pools.

Estimated solar park in operation at the end of 2001[1]

Flat plate collectors in m^2	3.093.000	
Vacuum collectors in m^2	541.000	
Total glazed collectors in m^2	3.634.000	= 44 m^2/1000 inhabitants
Unglazed collectors in m^2	629.000	
Grand Total in m^2	4.263.000	= 52 m^2/1000 inhabitants

Estimated annual solar thermal energy production in 2001

Flat plate collectors in m^2	3.093.000	x 400 kWh/m^2·year =	1.237.200 MWh
Vacuum collectors in m^2	541.000	x 450 kWh/m^2·year =	243.450 MWh
Unglazed collectors in m^2	629.000	x 300 kWh/m^2·year =	188.700 MWh
Total			1.669.350 MWh

1. In Sun in Action II, ESTIF uses the following general assumptions to calculate the solar park in operation: systems installed until 1989 have an average lifetime of 15 years; systems installed in or after 1990 have an average lifetime of 20 years.

Estimated primary energy savings

Flat plate collectors	1.237.200 MWh/60%* =	2.062.000 MWh
Vacuum collectors	243.450 MWh/60%* =	405.750 MWh
Unglazed collectors	188. MWh/80%* =	235.875 MWh
Total		1.669.350 MWh
*Efficiency of heat production		

CO_2 emissions avoided in 2001

CO_2 emissions avoided in 2001 =	2.703.625 MWh	x 0,27 tonnes/MWh =	729.979 t CO_2

Product types and solar thermal applications

Product types

Collector types
Of the installed glazed collectors, 85% are flat plate collectors. Most of them are modules with a surface of about 2 m^2. Usually, the frame is of aluminium, the front is covered by a low-iron glass and on the sides and the back there is insulation from mineral or stone wool. The absorber is usually of copper and is almost always covered with a selective absorption layer, today typically a sputtered layer.

In recent years, between 10% and 20% of the glazed collectors have been vacuum tube collectors. Beside the traditional tubes with absorber stripes inside the evacuated space, an increasing share of vacuum tubes are tubes which use the thermos flask principle. This type of collectors has a glass tube inside the glass tube and the vacuum is between the outer and the inner tube. The internal glass tube is selective coated and works as the absorber. The solar heat is conducted by the inner glass tube to a sheet of metal combined with tubes that are filled with the liquid, which carries the heat to the storage tank. This metal sheet is slid into the inner tub. The advantage of this system is that the metal sheet and the metal tube are not installed inside the vacuum. Usually a metallic reflector with a parabolic form is installed behind the vacuum tubes and reflects all the radiation which passes between the separate tubes to minimise the losses and increase the whole system efficiency.

Swimming pool absorbers are small black plastic tubes or mats in several forms. They are used to heat swimming pool water which circulates through the tubes.

Storage tanks

Storage tanks for domestic hot water heating for a typical household of four persons have a volume of about 300l. They contain two heat exchangers, the upper one for the auxiliary heating, the bottom one for the solar circuit. The storage tank is made from steel and double enamelled. The storage tank contains the drinking water, which is used as domestic hot water (DHW).

There are a large number of storage tank types for combined systems for DHW heating and room heating support. One common type is the tank-in-tank type. The domestic hot water is stored in a tank within the heating water storage tank. Another typical system is a heating water tank with an external load-side heat exchanger for DHW heating.

One storage tank contains three thermosiphon heat exchangers with stratification devices which allow for charge and discharge without using pumps. The tank operates at atmospheric pressure and is constructed of long-lasting polypropylene material which prevents corrosion problems.

The variety of different types of combisystems and other important information about combined systems are shown under http://www.iea-shc.org/task26/

Applications

Small solar systems for single-family houses

About 90% of the collectors installed in 2002 are working on one- or two-family houses. 80% of them are small systems from 3m² to 6m² collector area for domestic hot water heating. 20% are combined systems for DHW and room heating support with an collector area of usually 8 to 15m². About 450.000 solar systems have been installed i.e. 4% of all houses of this type in Germany are equipped with a solar thermal system.

Large collective solar systems

Large systems are installed on apartment houses or on hotels, hospitals or car washing centres. The systems are usually used as preheating systems with a solar share of about 30% of the energy demand due to the higher yield of the collectors.

District heating

Very large systems are installed for district heating, sometimes in combination with a seasonal storage. Solar collector systems are installed with a surface from 540m² (vacuum tube collectors in Chemnitz) up to 5.600m² (plan for the final expansion stage of a system in Friedrichshafen) and with seasonal water storages from 4.500m² (Hamburg) up to 63.360m² (Neckarsulm). In Friedrichshafen after the final stage of expansion the system will provide the heating for 570 apartments with a floor space of 39.500m². Seven projects were realised in the last 5 years. Today there are about one dozen of these large scale systems successfully in use in Germany.

Air conditioning and industrial process heating

The first solar systems for cooling have been installed in Germany for example on office buildings in Cologne, the ministry of traffic in Berlin or the 'Bundespresseamt', the public relation office of the federal government in Berlin. Typical for these system types are the vacuum tube or high efficient flat plate collectors which produce energy for a cooling machine.

Employment

In 2001, about 8.500 people were working in the solar thermal branch. 2.500 were working in the production sector or in component supplying firms, in marketing and trade.

About 6.000 full time jobs exised in the craft, consulting, sale and installation sectors.

The number of jobs at testing and research centres, in the planning sector, training centres and at consulting offices was approximately several hundred.

B STATE OF PRODUCTION

Product technology and production methods

Product technology description

Flat plate collectors are typically modules with a surface area of about 2 m^2. Only a few models are delivered without the glass, which is mounted after the cabinet is installed to the roof. Mostly the modules are completed by the producer. Absorbers are mostly made from copper and selective coated. For about 5 years, there have been sputtered coatings available in addition to the galvanic produced black chrome layers for collectors. Since the year 2000 the sputtered coatings have had the higher market share.

The pipe battery, which contains a fluid for the transport of the heat collected, is automatically soldered or welded to the sheet metal. Today it is more common to use one absorber sheet of a width of up to 1,2 m per collector instead of some small stripes of absorbers. First of all the frame of the collector is built manually or automatically, the steel back and the insulation set in afterwards. The complete absorber is laid in the frame and then sealed up with the low-iron solar glass panel. Since 2001 there have been collectors available utilising non-reflecting glasses.

The typical solar storage for domestic hot water heating is made of steel and double enamelled. It contains two internal heat exchangers, one for auxiliary heating on the top and one near the bottom for the solar circuit. The auxiliary heating is done conventionally via the oil- or gasboiler that is installed for the room heating. The storage has typically an insulation of mineral wool or polyurethane foam of a thickness of 5 to 10 cm.

Typical efficiency data of a solar system are		
	Flat plate collector	**Vacuum tube collector**
Eta_0 (efficiency)	0,8	0,76
K_1	3,5 W/(m^2K)	1,9 W/(m^2K)
K_2	0,02 W/(m^2K)	0,004 W/(m^2K)
typical collector yield for DHW system with 5 m^2 collector surface	485 kWh/(m^2a)	585 kWh/(m^2a)
typical system yield for DHW system with 5 m^2 collector surface	280 kWh/(m^2a)	330 kWh/(m^2a)
solar share of the heating of DHW	47 %	56%

In the table the collector area is standardised on 5 m^2 to calculate the collector and system yield and make them comparable. Usually for DHW-systems the size of the collector is chosen so that the solar share is about 60 % per year.

Production methods description

About 20–30 companies in the solar branch are producing solar collectors on their own. The capacity has been permanently enlarged and the capacity of these was used fully in 2001, a year with a strong growth rate. Though the production is quite flexible and easily increased, the supply of prefabricated materials such as solar glasses and selective coated absorbers needs handling time. Most of the collectors are assembled partly automated, and some manufactures use robots for the production.

The collectors have a good or very good quality standard; their lifetime is more than 20 years. The efficiency was continuously improved in recent years, e.g. through more efficient absorber coatings like the mentioned sputter layers. Some manufactures achieved further improvements through the optimisation of the geometry of the pipe battery and the use of soldering techniques which improved the heat abstraction to the fluid. Other interesting innovations are the use of non-reflecting solar glasses and in one collector a filling of rare gases.

Breakdown of solar systems costs

Solar Systems Costs for Typically Sized Systems		
	Individual	**Project (large scale)**
Total costs (excl. VAT)	775 €/m^2	345 €/m^2
VAT (16%)	125 €/m^2	55 €/m^2
Total cost (incl. VAT)	900 €/m^2	400 €/m^2
Typical size of system	5 m^2	200 m^2

A typical solar DHW system of 5 m^2 costs about 4.500 Euro, 1.000 Euro or 22% of this amount is needed for installation.

Typical solar domestic hot water system

Typical DHW system for a one-family household (4 persons)	
System type	Forced circulation system
Collector area (m^2) flat plate	4–6
Collector area (m^2) vacuum tube	3–4
Hot water storage (litres)	300
Total installed cost (VAT incl.)	4.500 €
Subsides	625 €

Typical consumer motivation

Most of the consumers are currently owners of one or two-family houses, which they themselves inhabit. Most of the systems are installed in buildings already existing. In new buildings the costs for an installation of a solar system would be a bit lower, but mostly it is turned down due to the high costs of the new building. But often the possibility of a later installation is taken into account by the preparation of piping from the roof to the cellar for a solar circuit.

The main factors which influence consumer motivation are:

- The awareness of environmental problems and of the finiteness of fossil fuel.
- The increasing costs of fossil fuels.
- The subsidies for solar thermal systems.
- The advertisement for solar thermal systems.
- The modernity of solar thermal systems.
- The maturity and technically reliability of the solar thermal systems.

According to a recent survey of 2001, environmental friendliness has been the main reason for the installation of a solar system.

For new buildings the now established EnEV (Energieeinsparverordnung, the regulation for the saving of energy) will be an additional factor of motivation, because it takes into account that solar heat reduces the consumption of conventional energy for the heating of the whole building and thus avoids emissions of CO_2. Therefore the builder can install a solar system instead of increasing the insulation of the building.

Conventional water heating and energy prices

Conventional Energy Prices		
Date: 2000	**Housing VAT incl.**	**Industry VAT incl.**
Electricity – normal*	0,13 €/kWh	0,12 €/kWh
Electricity – low rate**	HR: 0,15 €/kWh LR: 0,08 €/kWh (80€)	HR: 0,15 €/kWh LR: 0,07 €/kWh (80€)
Bottled gas	0,08 €/kWh	n/a
Natural gas	0,05 €/kWh	0,03 €/kWh
District heating	0,05 €/kWh	n/a

* The price for electricity is made up of a basic charge (in round brackets) and a charge for every kWh.
** If a two rate system is chosen, the high rate price increases (HR: High rate, LR Low rate)

Standards and codes of practice

For collectors used in the private sector, there is no obligation for them to be tested or certified. However, almost every collector is tested on the DIN standard, since 2001 on the European harmonised standard DIN EN 12975, before on DIN V 4757.

But in order to get a subsidy from the government, a certificate is necessary that the collector has a minimum yield of 350 kWh per year. The certificate is made out by an institute that is approved by the DIN after the collector was tested on the basis of DIN EN 12975.

In addition, up to 2002, flat plate collectors mostly have the “Bauartzulassung” (permission for the type of construction), which certifies its safety under high pressures. In 2002 the national ‘regulation for steam boilers’ will be replaced by the European Pressure Equipment Directive (PED) 97/23/EG, therefore the Bauartzulassung will not exist any longer.

In Germany there are five institutes, which have the certification of the DIN and are allowed to undertake collector tests (Fraunhofer ISE in Freiburg, ISFH in Emmertal, ITW in Stuttgart, TÜV-Bayern-Sachsen in München und TZSB in Saarbrücken).

Level of R & D

Research and development is carried out by universities, solar institutes and solar companies. Until 1998 public funding was given by the Ministry of Research and is financed since then by the Ministry for the Economy. The amount of public money has been reduced in recent years and therefore the institutes have had to increase their part of the financing from the industry through joint projects.

The most important research program for solar thermal energy is the 'Solarthermie 2000'-program, which started in 1993. It involves three parts:

The first part is a long-range study on the life of solar thermal systems which were installed by the government between 1978 and 1983. The results show that one can assume an average lifetime of more than 20 years for solar thermal systems.

In the second part, the installation of medium-sized systems with at least 100 m^2 collector area on public buildings and the measuring of the systems are subsidised.

Part three is a subsidy program for systems for district heating with more than 1.000 m^2 of solar thermal collectors which have a share of the whole solar energy consumed of at least 50 %. In 2001 seven of these systems were already working and 3 more are in planning. Further information can be obtained on www.solarthermie2000.de and www.itw.uni-stuttgart.de/WWW/Sun/englisch/engl_start.htm.

The solar companies extended their R&D activities distinctly in recent years. The main tasks were to increase the efficiency of collectors and systems, to develop new collectors like the new vacuum types, storages for combined systems for DHW and room heating support, new pumps for the solar circuit, intelligent and easy to handle regulation systems, new absorber coatings, and coated glasses. A lot of projects are done within a corporation between the solar companies and research institutes and universities. Some of these projects are backed with money by the DBU (Deutsche Bundesstiftung Umwelt) or by other foundations.

In 1999/2000 a joint project of 18 firms of the solar branch, the professional association DFS (today: BSi) and research centre ITW was realised about combined systems for DHW and space heating support. Financed through means of the participating firms and the DBU, the aim was to optimise these systems. To develop new test procedures for such systems was the second intention of this study.

C STATE OF MARKETING

Distribution and marketing methods

In the last 10 years the volume of the market has grown by the factor 9, which caused a profound change in the distribution of solar thermal systems. In the years before, these systems were mainly sold by local craftsmen specialising in solar energy. They were carried by sales representatives and provided by companies that manufactured or imported solar thermal equipment. Manufacturers of boilers which also sold solar systems distributed their products also via established distribution channels, but few craftsmen sold solar systems alongside the conventional heating mechanism.

Today solar thermal systems are sold and installed by most plumbers. Manufacturers and importing companies tried intensively in recent years to win over SHK-craftsmen (craftsmen of the sanitary and heating sector) for the marketing of their products.

Simultaneously some of the firms established the distribution via the conventional SHK-wholesalers. Virtually all manufacturers of boilers have in the meantime solar systems in their product range. In recent years they have tried successfully to activate their distribution partners in the wholesale and handicraft sector to offer and sell solar systems beside the conventional heating systems.

In addition some firms of the building material branch entered into the solar thermal market, e.g. firms of the skylight and tiles sector. The knowledge of these led to collectors that are optimised for roof integration and collectors which have the format and design of the skylights applied. After these successes, the Manufacturers of solar systems now try to activate the interest of more of these firms for solar energy.

Sometimes a co-operation is formed between a tiler who installs the collectors and a plumber who installs the tubing to the cellar, the storage and other components. But usually the installation is done only by the plumber.

Furthermore, firms from the facade sector are engaged in the production and distribution of solar thermal collectors. Through the development of system modules for collectors, photovoltaic cells and skylights are optically consistent integrations now possible.

These firms have the chance – beside the companies for heating installation – to activate their distribution channels for the use of solar energy.

Marketing
The main target group for a solar thermal system are the owners of one- and two-family houses, who refit solar collectors to an existing heating system, or do so in the process of the renewal of an old boiler, typically after 15 to 25 years. A second target group are private house builders. Owners of existing houses are reached by professional journals or local magazines. Only the bigger companies of the heating branch are able to place advertisements nationwide. Customers are also informed by regional fairs and via campaigns like 'Solar-na klar!' (solar – that' s clear!) or 'Initiative Solarwärme plus' (initiative solar heat plus). An increasing share of the people inform themselves about solar thermal on the internet.

Owners of houses who think about a replacement of their boiler inform themselves in professional journals and through their local craftsmen. To reach this target group these craftsmen are encouraged to inform them also about solar system technology and to offer in each case a solar system beside the conventional systems.

Newspapers, radio programs and television provide information from time to time on the use of solar energy, which is one final contribution to the marketing of solar thermal systems.

If the customer is motivated he might be persuaded to a solar system by the advantages given (see above, consumer motivation). For many customers the prospect of subsidies is an incentive for the buying of a solar system. However, the most important point is the feeling that they can contribute something to the protection of the environment and a further point is their greater independence from oil or gas.

A further market segment is up to now only little developed. There are only few building companies that regularly use solar systems in their buildings with several floors. Still some buildings are realised. That is why guaranteed solar results contracts are only in few projects of importance.

The warranty on collectors and solar systems in Germany is now regulated by law to a minimum of two years. But many manufacturers and distributors have their warranty raised by themselves to 5 or even 10 years.

Incentives and financing methods

The main subsidy programs for solar thermal systems are as follows:

Kind of incentive/given by	Amount of subsidy/ systems subsidised	Recipient/ reachable market	Comment
'Marktanreizprogramm' (market stimulation program) of the ministry of economy	125 Euro subsidy per m^2 collector area	mostly smaller systems for DHW and room heating support, mainly private investors, about 80 % of the whole market	at the present the most important subsidy program
'Ökozulage' (eco-bonus) for new buildings	for 8 years 2 % of investment amount, total 16 %, max. 250 Euro per year = 2.000	new buildings or newly acquired building used by the owner, about 10 % of the whole market	extremely non-bureaucratic execution, ended in 2002
Incentives of individual federal states or from local authorities	only in some cases if there is no national subsidy, varying conditions similar to national programs	partially aimed at recipients which are not reached by national programs like municipalities	not additional to national subsidy
'Investitionszulage' (investment bonus) in the new federal states	15 % bonus		planning reliability due to legitimate claim
'Solarthermie 2000' of the ministry of economy	subsidy for large systems and district heating on public buildings	demonstrational program for public buildings (residential home for elderly, dormitories etc.) and solar district heating systems	

Because it is not possible to get subsidies simultaneously from the federal states programs as well as from the governmental programs, in Hamburg installers get subsidies for every solar system they install. In this way the systems can be sold cheaper to the customers.

Due to the low subsidy quotas of 10 % to 20 % of the investment costs, these programs usually do not stimulate the owners of multiple homes to install solar thermal systems. New applications like solar cooling systems are not subsidised generally, but there are possibilities to get support for demonstration projects.

D FUTURE PROSPECTS

National energy policy

The German energy policy did change a lot since the start of the Social Democratic-Green government in 1998. The government aspires to make the energy supply sustainable, and has thus taken in the last years following measures,amongst others :

- In 2000 the termination of the use of nuclear energy was decided upon. On average the power stations have to be stopped working in 12 years time, and new reactors will not be build anymore.
- The introduction of renewable energies is subsidised much more strongly now. In the 'Erneuerbare-Energien-Gesetz' (EEG) of 1 April 2000 the reward for the feeding in of electricity from renewables into the integrated network has been improved, e.g. owners of photovoltaic systems get 20 years 51 cent/kWh for solar electricity fed in. In 2003 this amount was lowered for new installed systems to 45,7 cent/kWh for 20 years.
- The funds for the 'Marktanreizprogramm' for solar thermal systems were raised noticeably.
- Photovoltaic systems are subsidised in the 100.000 Dächer-Programm by credits with reduced interest rates.
- The eco-tax has been raised annually since 1999 and will be up to 2003. It is supposed to lead towards a more efficient use of energy. The proceeds are used for the pension insurance plan, so that the contributions can be kept low.
- The 'Klimaschutzprogramm' passed in 2001 in order to achieve the aim of a reduction of CO_2-Emissions by 25% by 2005 compared to the year 1990.In 2002 the 'Energieeinsparverordnung' (Energy feed in law) became effective, that leads to further reductions of energy consumed by new buildings.

In 2000 renewable energies have a share of about 2% of the whole primary energy produced and 5% of the whole electricity produced. The government decided to double the share up to 2010. The Ministry for Environment tries to achieve an increase of 10% per decade to reach a share of 50% in 2050 of the energy supply by renewable sources. Several studies were launched that prove the possibility of these plans.

The seriousness of the energy policy becomes obvious regarding the commission of the Lower House of German Parliament occupied with "Nachhaltige Energieversorgung" (sustainable energy). In addition the 'Rat für Nachhaltige Entwicklung' (Council for Sustainable Development) was established by the government in order to integrate the different points into a sustainable concept and back these plans, and to work on a national strategy.

Objectives for the solar industry market

Solar energy is on the way to being brought widely onto the market and is to be expected to experience steady growth up to 2010. The solar thermal branch works to make the installation of solar thermal systems more common. Before the market dropped down in 2002, the aim was to extend the market to a volume of 10 million m^2 in the year 2010. Now it is expected to reach this aim few years later. A positive side effect would be the creation of 100.000 new jobs. The volume of sales will be about 7.000 million Euro. Costs of about 600 million Euro for crude oil and gas could be saved then.

One premise is a subsidy situation which is stable in the long run. Due to the market success in recent years, the subsidies for the private sector can be reduced in the coming years, but the market for multi-family houses and industrial usage of solar thermal needs a new strong engagement from the government. Solar thermal energy still needs some years of promotion in these sectors before the potentials to reduce its costs, which lie in mass production and further development, can be realised

Prospects for market development

It is expected that in the coming years, the private sector will further dominate the solar thermal market. In 2002 the combined systems for DHW and space heating support had a share of about 20% and this expected to rise permanently.

To achieve the market aims it is necessary to push the market segments of multi-family houses with large collector areas and district heating. Therefore new subsidy programs will have to be established.

Solar assisted cooling is extensively researched by now with first demonstrational projects working. It is to be expected that in the coming years acceptably priced compact systems will be developed. A great demand in Germany and abroad is expected.

It is supposed that the market for unglazed collectors will keep its stability due to the level of energy prices and will grow according to the raising prices of fossil energy.

The roof area suitable for the use of solar energy systems is about 800 million m^2. Considering the half of that area to be used for solar thermal systems – the other half for PV-systems – one can expect an annual 10 million m^2 to be replaced presuming an average lifetime of 20 years for a solar system.

There are reliable scenarios of the DLR (Deutsches Institut für Luft- und Raumfahrt) [Nitsch 2001] which show the possibility of up to 23,5% of the heating energy in Germany required in the year 2050 in total might be produced by solar thermal systems, adequate conditions for its market introduction provided.

Strategy to continue the market development

The German solar thermal market grew very fast until the year 2001 and dropped down in 2002. This shows that it is not common yet, to install a solar system, e.g. if a boiler is replaced. There is a big need to advance the solar thermal technology and the market, in order to hold up the market success of the years before 2002. Some necessary tasks are as follows:

Technical
The solar systems will be further integrated into the conventional heating technique. Particularly, the combined systems for DHW and room heating support will be advanced, e.g. the storage technique. Solar thermal collectors will be more integrated into the products of the cover of the buildings, the roofs and the façades. Products for new applications will be developed, e.g. for solar cooling or industrial applications. Further steps of technical development will be made to make solar systems even more easy to handle and install and simultaneously to cheapen the production.

Economic
The only important reason for most of the people not to use solar thermal energy is that heat from solar thermal energy is still more expensive than from oil or gas today. Therefore the industry will make further efforts to reduce the prices by technical developments and the economy of scale. Second, the solar thermal market will speed up its growth, for the fossil energy prices will rise . Third, the government will subsidise new market sectors in order to achieve the aim of doubling the share of renewable energies up to 2010.

Cultural
People will be learning to understand, that it is necessary and in the long run more economic to invest today and save money over 20 years – as they can do with the installation of solar thermal systems. Since the price of fossil fuels over the next 20 years is unpredictable, the costs of solar and fossil heat are not directly comparable today. But it is necessary to understand that oil and gas will become more expensive in the future and therefore solar thermal energy is more competitive than largely assumed today.

Educative
Today a big share of plumbers are offering solar thermal systems in Germany. Many of them have had a professional training and first experiences in installing solar thermal systems. Schools and special training courses are arranged so that now the craftsmen have to be motivated in joining them.

Another important task is to integrate the knowledge about solar thermal systems into the basic education of the plumbers, the planners and the architects.

Concluding remarks

The German solar thermal market made a singular development in recent years. On the basis of positive surroundings, it left the status as a niche market and became a part of modern heating technology. The professionalism of the solar branch significantly grew and firms of reputation entered into the solar thermal market.

The crafts more and more recognise solar thermal systems as an important market. They have professional training and distribute solar systems actively. Solar systems are recognised to be a mature technology. Most of the house owners are open-minded towards solar thermal technology. In cases that they are not applied, it is so because people are waiting for the price of solar systems becoming cheaper – or the prices for oil and gas more expensive.

Enterprises significantly developed solar technology further with regard to the efficiency of the components, system integration, ease of installation and operation and design. New products were developed, for example new kinds of vacuum tubes, storages for combined systems for water and room heating, or systems for solar cooling.

New developments were also made by other components like the selective coatings of absorbers, regulation systems or anti-freeze liquids. This trend of the last years shows that the potential for development for solar systems is much higher than expected and further potential still remains. New developments are necessary to achieve reductions of costs.

For the future it is of importance to open up market segments beside the one-family house market, such as multi-family residences, solar district heating, public buildings (e.g. hospitals), trade (e.g. hotels) and industrial utilisation (e.g. high temperature applications). Solar cooling is to become an important application, too. To open up this market an initial support by the government will be necessary with subsidy programs, demonstrational projects and information campaigns. On this basis the aim of a market size of 10 million m^2 in 2015 will be achieved.

In 2002 Germany had a share of about 50% of the whole European solar thermal market. In building up the market in recent years a lot of experience was gained. It would be preferable if this knowledge could be passed over to other European countries to accelerate the growth of the markets there.

References

[Nitsch 2001] Nitsch, Dr. Joachim, Beitrag und Struktur erneuerbarer Energien in einer zukünftigen Energieversorgung; available on the internet: www.dlr.de/TT/system/publications.

[ARGE 2001] Arge Solarwirtschaft, Perspektiven der Solarwärme-Nutzung in Deutschland; june 2001, available on the internet:

www.bsi-solar.de/position.html

Contributions to this report

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E ANNEX: SOLAR THERMAL DIRECTORY

Manufacturers and distributors of solar thermal equipment

M: Manufacturers – D: Distributors

Aqua-Solar
Rodensteiner Str.
64385 Reichelsheim
Tel: +49 61 64 91 20 78
Fax: +49 61 64 91 20 79
e-mail: mail@aqua-solar.de
URL: www.aqua-solar.de

Aquasol Solartechnik GmbH
Lindenstr. 27
89077 Ulm / Donau
Tel: +49 73 13 60 89 33
Fax: +49 73 19 35 56 65
e-mail: Gelowicz@aquasol-solartechnik.de
URL: www.aquasol-solartechnik.de
Activity: M: Large size flat plate collectors; D: Complete solar systems.

August Brötje GmbH
August-Brötje-Str. 17
26180 Rastede
Tel: +49 44 02 80-0
Fax: +49 44 02 80-583
e-mail: info@broetje.de
URL: www.broetje.de
Activity: D: Complete solar systems.

Buderus Heiztechnik GmbH
Sophienstraße 30–32
35576 Wetzlar
Tel: +49 64 41 41 80
Fax: +49 64 41 41 81 633
e-mail: info@heiztechnik.buderus.de
URL: www.buderus.de
Activity: M: Complete solar systems.

Bumiller Neue Energien GmbH
Großbeerenstraße 13A
10963 Berlin
Tel: +49 30 21 75 23-41
Fax: +49 30 21 75 23-45
e-mail: info@bumiller-gmbh.de
URL: www.bumiller-gmbh.de
Activity: D: complete solar systems

Buschbeck Solartechnik GmbH
Rathausstraße 5
09573 Augustusburg
Tel: +49 18 0 12 87 611
Fax: +49 37 29 11 77-17
e-mail: service@buso.de
URL: www.buso.de
Activity: M: solar roofs

Christeva Sonnenenergie-Technik GmbH
Wirthfeldweg 10
82054 Sauerlach
Tel: +49 81 04 16 44
Fax: +49 81 04 23 53
e-mail: info@christeva.de
URL: www.christeva.de
Activity: D: Complete solar systems.

Consolar Energiespeicher- und Regelungssysteme GmbH
Dreieichstr. 48
60594 Frankfurt/Main
Tel: +49 69 61 99 11 30
Fax: +49 69 61 99 11 28
e-mail: info@consolar.de
URL: www.consolar.de
Activity: M: Storages; D: Complete solar systems.

Defiso Solar AG
Am Eichenwald 15
09350 Liechtenstein
Tel: +49 37 20 43 42 055
Fax: +49 37 20 43 42 059
e-mail: defiso@t-online.de
URL: www.defiso-solar.de
Activity: M: collectors

ECO SUN GmbH
Implerstr. 55
81371 München
Tel: +49 89 54 38 066
Fax: +49 89 54 38 161
e-mail: ecosun@t-online.de
URL: www.ecosun.de
Activity: D: Complete solar systems.

ECOTEC Solar GmbH
Uerdinger Straße 255
47800 Krefeld
Tel: +49 21 51 50 75 810
Fax: +49 21 51 59 85 59
e-mail: info@ecotech-solar.de
URL: www.ecotec-solar.de

ELCO Klöckner Heiztechnik GmbH
Hohenzollernstr. 31
72379 Hechingen
Tel: +49 74 71 18 70
Fax: +49 74 71 18 74 13
URL: www.elco-kloeckner.de
Activity: D: Complete solar systems.

Elektrolux Haustechnik GmbH – Markenvertrieb AEG
Gutenstetter Str. 10
90449 Nürnberg
Tel: +49 91 1 96 56-0
Fax: +49 91 1 96 56-444
e-mail: info-haustechnik.ddh@electrolux.de
URL: www.aeg-haustechnik.de
Activity: D: Complete solar systems.

energie bau köln GmbH
Madausstr. 1
51109 Köln
Tel: +49 22 19 89 660
Fax: +49 22 19 89 66 11
e-mail: energiebau@tillnet.de
URL: www.energiebau.de
Activity: D: Complete solar systems.

EUROSUN Solartechnik AG
Bouchéstr. 25
12435 Berlin
Tel: +49 30 53 31 23 99
Fax: +49 30 53 31 23 94
e-mail: email@eurosun-solar.de
URL: www.eurosun-solar.de

FK Solartechnik GmbH
Industriepark
01968 Kleinkoschen
Tel: +49 35 73 80 67 25
Fax: +49 35 73 80 67 38
e-mail: fksolar@t-online.de
URL: www.fksolar.de
Activity: M: collectors

GeySol Solartechnik AG
Bahnhofstraße 6
56424 Maschheim
Tel: +49 26 02 95 09 9-0
Fax: +49 26 02 95 099-10
e-mail: verkauf@geysol.com
URL: www.geysol.com

GORNIG
Fachhandel für Haus-u.Industrietechnik
Schillerstraße 82
29410 Salzwedel
Tel: +49 39 01 842-0
Fax: +49 39 01 842-399
e-mail: info@gornig.de
URL: www.gornig.de
Activity: D: building technolgy, including solar thermal systems

Grammer solar + bau GmbH
Wernher-von-Braun-Str. 6
92224 Amberg
Tel: +49 96 21 60 11 52
Fax: +49 96 21 60 12 60
e-mail: info@grammer-solar.de
URL: www.grammer-solar.de
Activity: M: Hot air collectors.

Grundfos GmbH
Willy-Pelz-Str. 1–5
23812 Wahlstedt
Tel: +49 45 54 98 71 15
Fax: +49 45 54 98 93 71 72
e-mail: gwsoem@grundfos.de
URL: www.grundfos.de
Activity: M: Pumps.

HEAT Wärmesysteme GmbH
Eisenbahnstr. 36
73235 Weilheim Teck
Tel: +49 70 23 94 980
Fax: +49 70 23 94 98 30
e-mail: info@heat-gmbh.de
URL: www.heat-gmbh.de
Activity: D: Complete solar systems.

HUCH GmbH Behälterbau
Temnitz-Park-Chaussee 22
16818 Werder bei Neuruppin
Tel: +49 33 92 06 72-0
Fax: +49 33 92 06 72-72
e-mail: info@huch.com
URL: www.huch.com
Activity: M: solar storage tanks

Ikarus-Solar
Dieselstr. 45
87437 Kempten
Tel: +49 83 15 75 000
Fax: +49 83 15 75 00 40
e-mail: info@ikarus-solar.de
URL: www.ikarus-solar.de
Activity: M: Complete solar systems and highly selective absorbercoatings.

Interfloat Corporation
Fürst-Franz-Josef-Str. 690
FL-9493 Mauren
Tel: +41 75 37 34 411
Fax: +41 75 37 34 413
e-mail: interfloat.cop@bluewin.ch
Activity: M: Low iron solar-glasses.

Interpane Solar Beschichtungs GmbH & Co
Sohnreystr. 21
37697 Lauenförde
Tel: +49 52 73 80 90
Fax: +49 52 73 80 92 38
e-mail: info@gg.interpane.de
URL: www.iplus.de
Activity: M: Highly selective absorber-coatings.

Kago GmbH & Co Deutsche Wärmesysteme KG Stammhaus:
Pyrbaumer Straße 1–7
92349 Postbauer bei Nürnberg
Tel: +49 91 88 92 00
Fax: +49 91 88 92 01 30
e-mail: info@kago.de
URL: www.kago.de
Activity: D: Complete solar systems.

KBB Kollektorbau GmbH
Köpenicker Straße 325
12555 Berlin
Tel: +49 30 65 760
Fax:+49 30 65 76 27 01
www.kollektorbau.de
Activity: M: Flat plate collectors and absorbers.

Konrad Kleiner GmbH & Co.
Gewerbegebiet Nord
87719 Mindelheim
Tel: +49 82 67 94-0
Fax: +49 82 67 94-402
e-mail: info@kleiner.de
URL: www.Kleiner.de
Activity: D: building technolgy, including solar thermal systems

Lafarge Dachsysteme GmbH
Frankfurter Landstr. 2–4
61440 Oberursel
Tel: +49 61 71 61 22 88
Fax: +49 61 71 61 23 30
e-mail: mail@braas.de
URL: www.braas-dachsysteme.de
Activity: D: Complete solar systems.

Manzenrieder-SOLAR
Raiffeisenstrasse 3
94551 Lalling
Tel: +49 99 04 84 71 090
Fax: +49 99 04 84 71 091
e-mail: info@manzenrieder.de
URL: www.manzenrieder.de
Activity: D: Complete solar systems.

Meibes GmbH
Kokenhorststr. 8
30938 Burgwedel
Tel: +49 51 39 80 69-0
Fax: +49 51 39 80 69-50
URL: www.meibes.de
Activity: D: solar thermal components

NORDWEST Handel AG
Berliner Str. 26–36
58135 Hagen
Tel: +49 23 31 461-172 oder -171
Fax: +49 23 31 46 11 79
URL: www.nordwest.com

ODER-GLAS GmbH
Gewerbeparkring 1
15299 Müllrose
Tel: +49 33 60 68 83-0
Fax: +49 33 60 68 83-12
e-mail: info@oder-glas.de
URL: www.oder-glas.de
Activity: M: solar glass

PARADIGMA RITTER Energie- und Umwelttechnik
Ettlinger Str. 30
76307 Karlsbad-Langensteinbach
Tel: +49 72 02 92 20
Fax: +49 72 02 92 21 00
e-mail: Ritter@paradigma.de
URL: www.paradigma.de
Activity: M: Complete solar systems.

Peter Panno GmbH & Co. KG
Simon-Arzt-Str. 4
53332 Bornheim
Tel: +49 22 22 96 33-0
Fax: +49)22 22 96 33-34
e-mail: service@panno.com
URL: www.panno.com
Activity: D: wholesale building technology, including solar thermal systems

Peter Schön Solartechnik e.K.
Obere Seewiesen 30
71711 Steinheim-Höpfigheim
Tel: +49 71 44 80 20 20
Fax: +49 71 44 80 20 70
e-mail: vertrieb@sol3.de
URL: www.sol3.de
Activity: D: Complete solar systems.

Phönix SonnenWärme AG
Am Treptower Park 28–30
12435 Berlin (Treptow)
Tel: +49 30 53 00 07- 0
Fax: +49 30 53 00 07-17
e-mail: info@sonnenwaerme-ag.de
URL: www.sonnenwaerme-ag.de
Activity: M: complete solar systems.

Plambeck Neue Energien Solartechnik
Industriestr. 1–3
68804 Altlußheim
Tel: +49)62 05 30 920
Fax: +49 62 05 35 28
e-mail: mail@setsolar.de
URL: www.setsolar.de
Activity: M: Complete solar systems.

pro solar ENERGIETECHNIK GmbH
Deisenfangstr. 47–51
88212 Ravensburg
Tel: +49)75 13 61 00
Fax: +49 75 13 61 010
e-mail: post@pro-solar.de
URL: www.pro-solar.de
Activity: M: Complete solar systems.

Pro-KÜHLSOLE GmbH
Maurerstr. 46
52477 Alsdorf
Tel: 49 24 04 93 091
Fax: +49 24 04 93 089
e-mail: prokuehlsole@t-online.de
URL: www.prokuehlsole.de
Activity: M: Cooling liquids.

RES GmbH
Gewerbestr. 20
73539 Lörrach
Tel: +49 76 21 16 45 42
Fax: +49 76 21 16 45 51
e-mail: info@res-solar.com

RESOL
Heiskampstraße 10
45527 Hattingen
Tel: +49 23 24 96 480
Fax: +49 23 24 96 4855
e-mail: info@resol.de
URL: www.resol.de
Activity: M: Controlling systems.

RIESOL Solarsysteme GmbH
Tradt 8
93437 Furth im Wald
Tel: +49 99 73 50 057-0
Fax: +49 99 73 80 11 22
e-mail: riesol@t-online.de
URL: www.riedersolar.de

Ritter Solar GmbH
Kuchenäcker 1
72135 Dettenhausen
Tel: +49 71 57 53 590
Fax: +49 71 57 59 20
e-mail: info@rittersolar.de
URL: www.rittersolar.de
Activity: M: Vacuum tube collectors.

Robert Bosch GmbH Geschäfts-bereich Thermotechnik
Postfach 1309
73243 Wernau
Tel: +49 18 03 33 73 33
Fax: +49 18 03 33 73 32
e-mail: junkers.infodienst@de.bosch.com
URL: www.bosch.de/junkers
Activity: M: Complete solar systems.

Roto Frank Bauelemente GmbH
Wilhelm Frank Str. 38–40
97980 Bad Mergentheim
Tel: +49 79 31 54 90-0
Fax: +49 79 31 54 90-50
e-mail: info@roto-frank.com
URL: www.roto.de
Activity: M: Complete solar systems.

Roth Werke GmbH
Am Seerain
35232 Dautphetal
Tel: +49 64 66 92 20
Fax: +49 64 66 92 21 00
e-mail: service@roth-werke.de
URL: www.roth-werke.de
Activity: M: Complete solar systems.

Sandler Energietechnik GmbH & Co. KG
Kurat-Frank-Str. 19
87600 Kaufbeuren
Tel: +49 83 41 90 220
Fax: +49 83 41 90 22 33
e-mail: vertrieb@sandler-solar.de
URL: www.sandler-solar.de
Activity: D: Complete solar systems.

Schott Rohrglas GmbH
Erich Schottstraße 14
95660 Mitterteich
Tel: +49 96 33 800
Fax: +49 96 33 80 757
URL:
http://www.schott.com/tubing/english/
Activity: M: Vacuum tube collectors.

Schüco International KG
Karolinenstr. 1–15
33609 Bielefeld
Tel: +49 52 17 830
Fax: +49 52 178 34 51
e-mail: info@schueco.de
URL: www.schueco.de
Activity: M: Complete solar systems.

SE-System GmbH
Haardterweg 1–3
66663 Merzig-Schwemlingen
Tel: +49 68 61 75 705
Fax: +49 68 61 77 692
e-mail: info@se-system.de
URL: www.se-system.de
Activity: M: Complete solar systems.

SOLAR Kurt Birnbreier GmbH
Koblenzerstr. 112
57072 Siegen
Tel: +49 27 13 31 561
Fax: +49 27 13 32 775
e-mail: info@solarflex.de
Activity: M: Flexible solar tubes and fittings.

Solar Projekt Energiesysteme GmbH
Am Bläsiberg 13–18
88250 Weingarten
Tel: +49 75 15 60 33-0
Fax: +49 75 15 60 33-79
e-mail: info@solar-projekt.de
URL: www.solar-projekt.de

SolarMarkt GmbH
Lörracher Str. 45
79115 Freiburg
Tel: +49 76 14 73 847
Fax: +49 76 14 43 069
e-mail: info@solarmarkt.com
URL: www.solarmarkt.com

SOLVIS GmbH & Co KG
Grotian-Steinweg-Str. 12
38112 Braunschweig
Tel: +49 18 05 70 30 30
Fax: +49 53 12 89 04 11
e-mail: Info@solvis-solar.de
URL: www.solvis-solar.de
Activity: M: Complete solar systems.

SONNENKRAFT GmbH
Berliner Str. 16a
93073 Neutraubling
Tel: +49 94 01 92 320
Fax: +49 94 01 92 32 32
e-mail: info@sonnenkraft.de
URL: www.sonnenkraft.com
Activity: M: Complete solar systems.

SONNERGIE GmbH
Panoramastraße 3
72414 Rangendingen-Höfendorf
Tel: +49 74 78 93 13 100
Fax: +49 74 71 93 13 150
e-mail: dietert@sonnergie.de
URL: www.sonnergie.de

Stefan Nau GmbH & Co.
Naustr. 1
85368 Moosburg
Tel: +49 87 62 920
Fax: +49 87 62 34 70
e-mail: nau.bb@nau-gmbh.de
URL: www.nau-gmbh.de
Activity: M: Complete solar systems.

Stiebel Eltron GmbH
Dr. Stiebel Straße
37601 Holzminden
Tel: +49 55 31 702-0
Fax: +49 55 31 702-888
e-mail: info@stiebel-eltron.com
URL: www.stiebel-eltron.com
Activity: M: Complete solar systems.

SUNDA Solartechnik GmbH
Donauwörther Str. 27
89420 Höchstädt
Tel: +49 90 74 92 03 97
Fax: +49 90 74 92 03 99
e-mail: sekretariat@sunda.de
URL: www.sunda.de
Activity: D: Complete solar systems.

SUN-PRO GmbH
Pappelweg 1
83361 Kienberg
Tel: +49 86 28 98 60 908
Fax: +49 86 2 98 60 909
e-mail: sun-pro@gaia.de
Activity: M: Complete solar systems.

Sunset Energietechnik GmbH
Industriestr. 22
91325 Adelsdorf
Tel: +49 91 95 94 940
Fax: +49 91 95 94 94 29
e-mail: solarinfo@sunset-solar.com
URL: www.sunsetsolar.com
Activity: M: Complete solar systems.

ThermoLux GmbH
Unterwanger Str. 3
87439 Kempten (Allgäu)
Tel: +49 83 15 80 99-0
Fax: +49 83 15 80 99-90
e-mail: info@thermolux.de
URL: www.thermolux.de
Activity: M: Vacuum tube collectors.

TiNOX GmbH
Schwere-Reiter-Str. 35/2b
80797 München
Tel: +49 89 30 00 720
Fax: +49 89 30 00 72 72
e-mail: info@tinox.om
URL: www.tinox.com
Activity: M: Highly selective absorber-coatings.

TYFOROP CHEMIE GmbH
Hellbrookstr. 5a
22305 Hamburg
Tel: +49 40 61 21 69
Fax: +49 40 61 52 99
e-mail: info@tyfo.de
URL: www.tyfo.de
Activity: M: Liquid coolings.

UFE SOLAR GmbH
Alfred-Nobel-Str. 1
16225 Eberswalde
Tel: +49 33 34 52 570
Fax: +49 33 34 52 57 550
e-mail: info@ufesolar.de
URL: www.ufesolar.de
Activity: M: Complete solar systems

Vaillant GmbH
Berghauser Str. 40
42859 Remscheid
Tel: +49 21 91 18 35 04
Fax: +49 21 91 18 73 504
e-mail: info@vaillant.de
URL: www.vaillant.de
Activity: M: Complete solar systems.

VELUX Deutschland GmbH
Postfach 540260
22502 Hamburg
Tel: +49 40 54 707 0
Fax: +49 40 54 707 707
URL: www.velux.de
Activity: M: Complete solar systems.

VIESSMANN Werke GmbH & Co.
Viessmannstr. 1
35107 Allendorf (Eder)
Tel: +49 64 52 700
Fax: +49 64 52 70 27 80
e-mail: info@viessmann.de
URL: www.viessmann.de
Activity: M: Complete solar systems.

VIVA Solar Energietechnik GmbH
Otto-Wolf-Str. 12
56626 Andernach
Tel: +49 26 32 96 63-0
Fax: +49 26 32 96 63-2
e-mail: info@vivasolar.de
URL: www.vivasolar.de
Activity: M: Complete solar systems.

WAGNER & Co. Solartechnik GmbH
Zimmermannstr. 12
35091 Cölbe
Tel: +49 64 21 80 070
Fax: +49 64 21 80 07 22
e-mail: info@wagner-solartechnik.de
URL: www.wagner-solartechnik.de
Activity: M: Complete solar systems.

WESTFA GmbH
Feldmühlenstraße 19
58099 Hagen
Tel: +49 18 01 47 11 47
Fax: +49 23 31 96 66 300
e-mail: info@westfa.de
URL: www.westfa.de
Activity: D: Complete solar systems.

WILO GmbH
Nortkirchenstr. 100
44263 Dortmund
Tel: +49 23 14 102-635
Fax: +49 23 14 102-543
URL: www.wilo.de
Activity: M: Pumps.

Wolf GmbH
Industriestr. 1
84048 Mainburg
Tel: +49 87 51 740
Fax: +49 87 51 74 16 00
e-mail: info@wolf-heiztechnik.de
URL: www.wolf-heiztechnik.de
Activity: M: Complete solar systems.

Zilmet Deutschland GmbH
Glück-Auf-Weg 10
57482 Wenden-Gerlingen
Tel: +49 27 62 92 420
Fax: +49 27 62 41 013
e-mail: info@zilmet.de
URL: www.zilmet.de
Activity: M: Expansion vessels.

Consultants specialised in solar projects

eclareon GmbH
Stresemannstraße 33
10963 Berlin
Tel: +49 30 24 62 86 90
Fax: +49 30 24 62 86 94
e-mail: cu@eclareon.com
Contact person: Christoph Urbschat
URL: www.eclareon.com

Werner B. Koldehoff Management Beratung
Am Waldbach 7
87657 Görisried
Tel: +49 83 02 92 26 93
e-mail: koldehoff.werner@t-online.de

There are a lot of technical consultants specialised in solar projects in Germany. For contact data please take a look at the directories under: Principal sources of information.

Principal sources of information

BINE Informationsdienst
Mechenstr. 57
53129 Bonn
Tel: +49 22 89 23 79-0
Fax: +49 22 89 23 79-29
e-mail: Ebine@fiz-karsruhe.de
URL: http://bine.fiz-karlsruhe.de

Bundesverband Erneuerbare Energien (BEE)
Lutherstr. 14
30171 Hannover
Tel: +49 51 12 82 366
Fax: +49 51 12 82 377
e-mail: info@www.bee-ev.de
URL: www.bee-ev.de

Bundesverband Solarindustrie e.V. (BSi)
Stralauer Platz 33/34
10243 Berlin
Tel: +49 30 29 77 78 80
Fax: +49 30 29 77 78 899
e-mail: info@bsi-solar.de
URL: www.bsi-solar.de

Deutsche Gesellschaft für Sonnenenergie e.V. (DGS)
Augustenstr. 79
80333 München
Tel: +49 89 24 071
Fax: +49 89 52 16 68
e-mail: info@dsg-solar.org
URL: www.dgs-solar.org

Eurosolar e.V.
Kaiser-Friedrich-Str. 11
53113 Bonn
Tel: +49 62 15 57 232
Fax: +49 62 15 58 07 22
e-mail: inter_office@eurosolar.org
URL: www.eurosolar.org

Deutsche Energie-Agentur GmbH, dena
Chausseestr. 128a
10115 Berlin
Tel: +49 30 72 61 65 60
Fax: +49 30 72 61 65 699
e-mail: info@deutsche-energie-agentur.de
URL: www.deutsche-energie-agentur.de
Further information available on the internet:

Solarpraxis AG
Torstraße 177
10115 Berlin
Tel: +49 30 72 62 96 300
Fax: +49 30 72 62 96 309
e-mail: info@solarpraxis.de
URL: www.solarpraxis.de

Solar Promotion GmbH
Postfach 100 170
75101 Pforzheim
Tel: +49 72 31 35 13 80
Fax: +49 72 31 35 13 81
e-mail: info@intersolar.de
URL: www.intersolar.de

Unternehmensvereinigung SolarWirtschaft e.V.
Stralauer Platz 34
10243 Berlin
Tel: +49 30 44 00 91 23
Fax: +49 30 44 00 91 24
e-mail: uvs@solarinfo.de
URL: www.solarwirtschaft.de

emsolar.ee.tu-berlin.de
www.boxer99.de
www.energie-server.de
www.iset.uni-kassel.de
www.iwr.de
www.solarcontact.de
www.solarinfo.de
www.solarserver.de
www.solartechnikberater.de

Testing facilities and research centers

Fraunhofer Institut für Solare Energiesysteme (Fraunhofer ISE)
Heidenhofstraße 5
79110 Freiburg
Tel: +49 76 14 58 80
Fax: +49 76 14 58 81 00
e-mail: info@ise.fhg.de
URL: www.ise.fhg.de

Institut für Solarenergieforschung Hameln GmbH (ISFH)
Am Ohrberg 1
31860 Emmerthal
Tel: +49 51 51 99 90
Fax: +49 51 51 99 94 00
e-mail: info@isfh.de
URL: www.isfh.de

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70550 Stuttgart
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Greece

A STATE OF THE MARKET

Overview of the market situation

Greece is one of the most successful countries worldwide in the use of solar thermal energy. For many years, the number of installed parks of solar collectors per capita has been the highest within Europe.

The solar thermal market started 30 years ago. At that time, almost all Greek households were using electric heaters; thus, the rising price of electricity has helped the market to develop. The electric water heater is still the main competitor to the solar water heater. The main solar thermal product was then, and still is, the thermosiphonic water heater. Many companies have been started in these years. The advertising campaigns launched by larger firms helped a lot in the initial phase. The Greek Solar Industry Association – EBHE – was created in 1978.

The market was steadily rising, as in many countries, in part due to the oil crisis. In 1984–86 a large advertising campaign supported by the Greek government and the implementation of VAT by the end of 1986 boosted the sales up to 218.000 m^2. There were about 300 "manufacturers" of solar systems at this time. Nearly all the systems were produced locally, except for some which were imported mainly from Israel. Low interest loans and tax credits were available at this time.

Then the market consolidated; the efficiency and reliability of the products were improved, and the number of manufacturers decreased. Standards were introduced on the national level by the end of the eighties. The solar systems' laboratory of 'DEMOKRITOS' and the Centre for Renewable Energy Sources (CRES) have since then been cooperating closely with the manufacturers and have contributed decisively to this direction.

Since 1993, the domestic market has fluctuated between 150.000–200.000 m^2 of collectors, depending on the new building production, electricity prices, incentives etc. Many solar thermal systems are also installed in hotels and in industries, athletic centres and greenhouses.

The main reasons for the success in the solar thermal utilisation in Greece are:

- The conventional source of water heating is electricity, with higher costs than fuel oil or gas, leading to shorter payback periods for solar systems
- Most houses have a flat roof, enabling the easy installation of an inexpensive thermosiphonic water heater
- Favourable climatic conditions
- State support during the start-up phase of solar thermal
- Involvement of dedicated individuals at the early stages of solar thermal

Having reached a certain level of experience and quality and facing difficulties in the home market, some of the manufacturers turned to product development, assisted by EU-supported R&D projects, and to exports. The success of the pioneers has motivated other companies as well. By 2001 more than 40% of the solar collector production of EBHE members was exported, starting from very low percentage (less than 5%) in 1991.

Several demonstration projects have been carried out. The most well known is 'Solar Village' close to Athens, built in 1987 and reliably operating since then, with 435 dwellings and approximately 1.700 inhabitants, featuring several solar systems for hot water production and space heating, cogeneration, heat pumps etc. There are also several demonstration projects for process heating in the diary, wine, textile dyeing/finishing, rice drying and tannery industry. Some of them (Achaia Clauss Winery, Mevgal diary, etc) were installed on a guaranteed performance base.

In recent years a big demonstration project for solar cooling was erected in the Sarantis SA cosmetic industrial complex close to Athens.

The main competitor of the solar water heater is, as mentioned above, the electric heater. In the last decade, the electricity cost decreased in real terms by 28%. Additionally, the VAT for electrical energy and gas is set to 8%, whereas the VAT for solar systems is 18%. This has lead to a decisive loss of competitiveness for solar water heaters.

Currently there is no subsidy for solar systems.

The low price of fuel oil, combined with a lack of subsidies, make solar systems in the industrial sector, solar space heating and cooling, etc., not financially attractive. Hence no new sectors are likely to be added in the near future to the solar thermal market, and solar water heating will probably remain the main solar thermal application in the next years.

Due to the strong competition, the prices for solar systems are low. The profit margins of the manufacturers are not high enough to finance a marketing campaign and marketing budgets are low. There has been no important 'technical innovation' or new marketing method introduced. Solar assisted space heating is not included in any price list of any company.

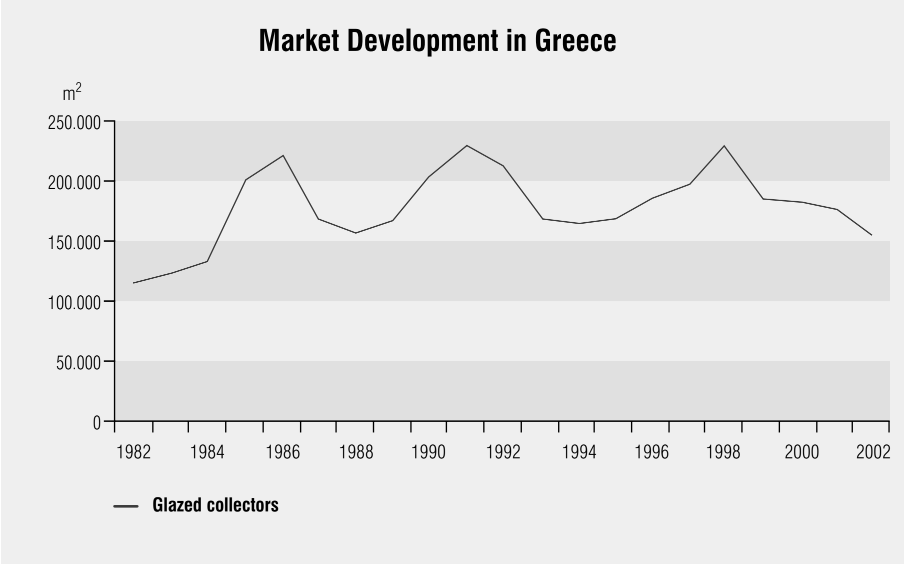
On the other hand, solar water heaters are standard equipment. The consumer is very well acquainted with the product and in many cases (e.g. replacement of an old heater) does buy a solar water heater almost automatically. Therefore the market in Greece is not expected to suffer either a meltdown or to achieve a breakthrough to increased volumes in the near feature.

The fact is that even in Greece, in the absence of subsidies, solar energy is conditionally feasible only for domestic water heating. Without funding from national or EU sources, the spread of solar thermal systems cannot increase significantly.

Solar thermal installations and energy production

Solar collector production and sales in m^2										
	Glazed Collectors									Unglazed Collectors
	Flat Plate Collectors				Vacuum Collectors				Total Glazed	
	A National Production	B Exports	C Imports	D = A-B+C Total Home Market	E National Production	F Exports	G Imports	H = E-F+G Total Home Market	I = D+H Total Home Market	Total Home Market
1982				115.000					115.000	
1983				122.000					122.000	
1984				132.000					132.000	
1985				200.000					200.000	
1986				218.000					218.000	
1987				168.000					168.000	
1988				156.000					156.000	
1989				167.500					167.500	
1990				204.000					204.000	
1991				227.000					227.000	
1992	212.000		5.000	211.000					211.000	
1993	199.000	6.000	4.000	168.000					168.000	
1994	216.000	35.000	4.000	163.000					163.000	
1995	240.000	57.000	4.000	169.000					169.000	
1996	260.000	75.000	5.000	185.000					185.000	
1997	279.300	80.000	3.000	197.300					197.300	
1998	321.300	85.000	2.100	233.400					233.400	
1999	280.250	90.000	4.750	185.000					185.000	
2000	283.600	100.000	7.400	181.000					181.000	
2001	287.550	110.000	7.450	175.000					175.000	
2002	256.500	120.000	5.500	152.000					152.000	

Source: "Collection of statistical data on Solar Energy Applications in Greece", Eurostat contract No 2000 45300002, CRES 2001; EBHE estimations;



Estimated solar park in operation at the end of 2001[1]

Total collector area in m^2	2.790.200	= 264 m^2/1000 inhabitants

Estimated annual solar thermal energy production in 2001

Total	2.790.200	x 388 kWh/m^2·year =	1.082.598 MWh

CO_2 emissions avoided in 2001

Total	1.082.598 MWh/a	x 1,1 tonnes/MWh =	1.190.857 t

1. In Sun in Action II, ESTIF uses the following general assumptions to calculate the solar park in operation: systems installed up to 1989 have an average lifetime of 15 years; systems installed in or after 1990 have an average lifetime of 20 years.

Product types and solar thermal applications

Product types

99% of the installed collector area is for thermosiphonic type water heaters, mainly closed loop systems. The closed loop systems use antifreeze liquid to avoid the freezing of the collector loop. The storage tank can be vertical or horizontal and is mounted higher than the collectors. The average size of thermosiphonic type systems is 2,4 m^2 collector area and 150 l storage tank. The range of the most common used systems is between 120 l–220 l with 1,8–4 m^2 collector area. All the systems are equipped with electric back-up heaters. 30% of them are equipped with an additional heat exchanger connected with the fuel or gas heating system. The solar fraction is usually over 75%.

150.000 m^2 of collectors are installed in hotels, including large collective systems, but there are also thermosiphonic water heaters in studios, apartments, and smaller pensions. There are a large variety of other applications i.e. in industry, commercial buildings, hospitals, athletic centres and greenhouses.

There are some systems with evacuated tube collectors but their market share is insignificant.

Applications

- Domestic hot water production (~99% of installed collector area)
  Mainly thermosiphonic water heaters, including hotel studios, small commercial and industrial consumers.
- Large collective solar systems (~1% of installed collector area) are installed mainly in hotels for hot water production.
- Space heating, district heating, air conditioning and industrial process heating combined have less than 1% of the installed collector area.

Employment

The total number of people employed in the solar branch is approximately 3.000.

Directly employed in the manufacturing sector (production, sales and marketing, development, financial services, etc) are approximately 1.200 people. The supply of material and services to the manufacturers is estimated to account for approximately 200 full time jobs. Retail sales, planning, installation and maintenance account for approximately 1500 full time jobs.

Research, testing and consulting account for approximately 100 full time jobs.

B STATE OF PRODUCTION

Product technology and production methods

Product technology description

Collectors (usual sizes)	1,5–8 m^2
Absorber material	Steel or stainless steel rollbond Aluminium or copper bonded on copper or galvanised steel tubes Copper tubes expanded in aluminium extruded profiles Copper bonded on copper tubes Copper welded or soldered on copper tubes
Surface treatment	Black paint Selective paint Selective treatment
Insulation	Many variations starting with glaswool 30mm to combined hard PU-CFC free + rockwool totally 70 mm.
Transparent cover	Normal window type glass 3–4 mm Solar tempered glass 3–4 mm Plastic
Casing	Aluminium extruded (anodised or polyester painted) Formed Aluminium or steel sheet ABS
Storage tank	Materials: Steel with enamel or epoxy or other 'plastic' inside protection Stainless steel Galvanised steel Copper Insulation: 40–70 mm PU.
Cover	Aluminium, stainless steel, steel painted or galvanised, ABS

It is clear that the efficiency of collectors and systems varies. The test results under the ISO standard for system efficiency are showing output from 350–800 KWh/m^2•a.

Of course in practice the efficiency is heavily dependent on the user's consumption profile.

High efficiency collectors with selective surface on copper, welded on copper tubes, using tempered glass are increasing their market share.

There are also various types of Integral Collector Storage (ICS) and compact systems as well as a compact Heat Pipe system.

Production methods and capacity

There is a large variety of manufacturers from 'back yard manufacturers' to industrial ones.

The back yard manufacturers assemble components they produce themselves and components bought from other manufacturers. They may buy absorbers and complete the collectors themselves, buy the tank ready made or only the inner tank and add the outer casing plus insulation etc.

Manufacturing is usually to some degree automated, but both manual and automated manufacturing exist.

Productivity can range from rather low, up to more than 1.200 m^2 per person per year. The production methods, machinery and general infrastructure, are becoming more industrial.

There are clearly manufacturing over-capacities; the capacity utilisation is less than 50 %, the current production being 250.000 m^2 and 55.000 solar tanks of 120–220 l.

Almost all major manufacturers follow a quality assurance system, certified according to ISO 9000. The product standards are the new CEN standards for collectors and packaged systems.

Breakdown of solar systems costs

Solar Systems Costs for Typically Sized Systems		
	Individual	**Project (large scale)**
Total costs (excl. VAT)	250 €/m^2	200 €/m^2
VAT (18 %)	45 €/m^2	36 €/m^2
Total cost (incl. VAT)	295 €/m^2	236 €/m^2
Typical size of system	2,40 m^2	100 m^2

Percentage cost breakdown

Average thermosiphonic type DHWS, VAT 18% not included, calculations based on retail price.

Materials	33%
Labour	10%
Promotion + general expenses	43%
Installation (labour and materials)	14%

Typical solar domestic hot water system

The typical DHW system is the thermosiphonic solar water heater	
Collector area (m^2)	2,4
Hot water storage (litres)	150
Total installed cost (VAT incl.)	708 €
Eventual subsides	None

Typical consumer motivation

The motivations to buy a solar system are:

- Savings (expected payback period 4–6 years)
- Better comfort (in the conventional case of the electrically heated hot water, the heater is turned on just before consumption is going to take place in order to save energy losses, thus requiring a waiting time for the water to be heated up)
- To buy a solar system in Greece is as easy as to buy an electric heater. As most roofs are flat, the installation is easy, too.

Conventional water heating and energy prices

Conventional Energy Prices		
Date: 2000	**Housing VAT incl.**	**Collective VAT incl.**
Electricity – normal	0,076 €/kWh	0,084 €/kWh
Electricity – low rate	0,042 €/kWh	
Fuel – Oil	0,035 €/kWh	0,025 €/kWh
Natural gas	0,026 €/kWh	0,022 €/kWh

Standards and codes of practice

There is no legal obligation for solar collector testing. Still, for the solar water heaters the tank has to be tested to get the CE marking.

Major manufacturers follow a quality assurance system, certified according to ISO 9000. The product standards in use are the new CEN standards for collectors and factory-made systems.

- EN 12975-1: Thermal solar systems and components – Collectors – Part 1: General Requirements
- EN 12975-2: Thermal solar systems and components – Collectors – Part 2: Test Methods
- EN 12976-1: Thermal solar systems and components – Factory Made Systems – Part 1: General Requirements
- EN 12976-2: Thermal solar systems and components – Factory Made Systems – Part 2: Test methods
- EN ISO 9488: Solar Energy – Vocabulary
- ENV 12977-1: Thermal solar systems and components – Custom Built Systems – Part 1: General Requirements
- ENV 12977-2: Thermal solar systems and components – Custom Built Systems – Part 2: Test methods
- ENV 12977-3: Thermal solar systems and components – Custom Built Systems – Part 3: Performance Characterization of Stores for Solar Heating Systems

Testing is carried out by the Demokritos Centre. Certification bodies include several companies like ELOT, TÜV Southern Germany, TÜV RW, TÜV Austria, Lloyds, etc.

Level of R & D

There is basic research in the universities as well as R&D projects involving manufacturers and institutes or universities. Funding is available from public or EU institutions. Demokritos Centre and the Centre for Renewable Energy Sources are conducting applied research.

The R&D activities aim to develop a new range of systems to meet specific needs and targets (i.e. modular central systems, ICS, compact low visual impact systems, systems integrated in buildings' envelop, desalination, heating and cooling of buildings, natural gas – back up systems). A significant part of the development efforts of the firms in the field is oriented towards collectors and systems aiming at various international markets. The performance and reliability of the products has improved significantly in the last few years.

A lot of efforts aim at reducing the system and collector cost by the investigation of new configurations, production methods and components' development.

Longer term R&D is directed toward cooling, cogeneration of heat and power, or H2 and heat, thermal storage media, ceramic medium and high temperature solar collectors.

C STATE OF MARKETING

Distribution and marketing methods

Domestic solar water heaters are distributed mainly through the HVAC retailers or through wholesalers. They are regarded as standard products like fuel boilers, burners, heating elements etc.

The customer can buy the system through such a retailer, an installer or directly from the manufacturer. Many firms are using parallel all-the-above selling methods.

Some of the larger firms are co-operating with distributors on an exclusive base. This means that the distributor sells only equipment of this manufacturer (solar and heating usually).

The major manufacturers are active almost everywhere in Greece.

A common practice in Greece is the selling of solar systems directly to the users in exhibitions. More than 10 large building material exhibitions and several local exhibitions take place each year. However, the exhibitions are not as effective as in the past.

The marketing of the product is based mainly on quality and price. The technology and materials and also the reputation of the company are promoted. Networks of distributor companies often promote their own brand name.

All the common promotion methods are used. The most important ones for the manufacturers are professional fairs (2 annually), advertising in specialist journals and contact to retailers through salesmen. For the final customer advertisement campaigns in radio, newspapers and magazines, and tables in athletic centres are a common practice.

The yellow pages are full of solar systems advertisements. The budget for solar systems advertising has been minimised in the last years due to falling retail prices.

In the past EBHE organised some collective campaigns.

In 1984 and 1986 a large TV promotion campaign was undertaken by EBHE with financial support from the government. This contributed to a sales increase.

A short TV campaign co-financed by the EU and the manufacturers was presented in October 1994. The results were positive, although the general presentation and the short period of releasing were not market-oriented. A co-operation of EBHE and PPC (Public Power Corporation – electricity utility) to promote DHWS through PPC's outlets started in November 1994. Posters and leaflets were distributed through PPC's service offices and a small informative leaflet was distributed through the bills.

The systems are covered usually with warranty of up to 5 years. The reason is to guaranty the system until it is paid back. There are companies offering longer warranty period as promotion tool (10–30 years). The common maintenance of a system is limited to the electric heating element and anode (cathodic protection for the tank) replacement. According to the manufacturers, the systems retrofit market is less than 5%.

The large systems are mostly installed by the manufacturers or through large distributors who have the capability to cover the engineering needs of the project. For the most of them, grants from the European Commission were applied. The only subsidy system left is based on calls for projects. This is not providing a steady base to develop this market, resulting in a more opportunistic market.

EBHE has organised, also within EU projects, workshops and contacts with various professional associations like Hoteliers, Dairy and Wine industry, etc.

The decreasing domestic market has pushed the manufacturers to include in their product range other products addressing to the same distribution net (i.e. heating and cooling equipment) or to co-operate with distributors.

Less than 25% of houses in Greece have a solar system installed already. The figure is very low compared with the potential, bearing in mind that in similar cases (Cyprus, Israel) the percentage is over 90%.

A wide market survey has shown that more than 90% of the owners of solar systems are satisfied and if they replaced the old solar system they would invest on a solar system again.

Most of the collective systems (150.000 m^2) were subsidised by 50%. These systems are installed mainly in hotels or industries. The low oil price results in payback periods longer than 5 years and makes the solar system less attractive for the investor.

Guaranteed solar results contracts have been used up to now only on a pilot base.

Incentives and financing methods

At the beginning of 2003 no financial incentive scheme exists for solar systems.

For DHWS incentives were established in the early eighties. These were based on a soft loan (available only for solar systems) and tax credit. A constant amount, representing a significant part of the system cost, could be deducted from income tax. Then for some years tax credit was not available.

In the last 6 years 75% of the solar system value could be deducted from taxable income. Unfortunately this incentive was abandoned as of 2003. Soft loans are not available any more.

For industrial and commercial applications only subsidies are at certain times available to support investments on solar systems with grants up to 40%. These subsidies are based on calls and are not available on a constant basis. The result is that when a customer decides or is convinced to buy a solar installation, usually no funding is available.

Third party financing has been used only on a pilot base.

D FUTURE PROSPECTS

National energy policy

The production of energy was and is based on traditional fuels: lignite, oil and electricity generation by hydro. The share of renewable energies (including firewood) is estimated to be 10% of the total energy production, the share of solar thermal energy alone 1,3% of the total energy production.

There are two main priorities in the energy policy in Greece: first the completion of the basic infrastructure for natural gas and the gradual penetration of the market through it, and second the deregulation of the electricity and natural gas market, which is expected to be completed by 2006. In recent years, wind energy and small hydro received strong state support. The installed wind energy power in the beginning of 2003 is 276MW.

Still, since solar energy substitutes for electricity in domestic hot water production, it contributes a lot to the reduction of electricity consumption; it is estimated that 1.150GWh of electricity are saved annually, corresponding to 8,1% of the electricity consumed by the households [3].

The solar water heaters are also contributing a lot to the security of supply of electricity. Due to the extensive use of electric air conditioners, the electricity network is working at close to breakdown during several days of the summer. This situation is more critical on those islands whose electricity network is not connected to the mainland network.

It is estimated that the installed capacity for the generation of electrical energy would have to be increased by approximately 10% if no solar water heaters existed.

Objectives for the solar industry/market

The objective should be not only to increase the use of DHWS for single families but also to disseminate the use of solar systems to other potential users, i.e. industry, commercial and public buildings. Solar space heating is also an objective to be pursued in the next years.

The fact is that even in Greece, in the absence of subsidies, solar energy is conditionally feasible only for domestic water heating. Since no support is expected the prospects are that the situation will remain more or less constant.

Strategy to overcome the barriers to market development

1. **Institutional.** Use of solar energy should become obligatory for domestic water heating. To achieve this, national and EU policy makers should be lobbied to pass regulations requiring the use of solar DHW systems

2. **Economic**

   The main competitor to the solar water heater (main solar product) is the electric heater. The government practically subsidises the electricity price. Additionally the VAT for electricity is 8%, whereas VAT for solar systems is 18%. The solar thermal industry should lobby national politicians to sufficiently level the playing field: solar thermal must have the chance to compete on equal terms with electric water heaters.

   Currently there are no financial incentive schemes for solar systems. It has been shown that public support was important in initially developing the solar DHW market. Especially in the commercial sector, and for applications like solar assisted cooling, public support will be essential in creating a sustainable market.

3. **Cultural.** The environmental consciousness of the general public needs to be awakened. Only then will national and EU policy-makers fully support renewable energy sources, e.g. through financial incentive programs. This environmental consciousness can be achieved by campaigns in cooperation e.g. with environmental NGOs.

Concluding remarks

Under the current conditions the solar market in Greece has reached saturation.

The fact is that even in Greece, in the absence of financial incentive schemes, solar energy is conditionally feasible only for domestic water heating.

Without funding from national or EU sources the market penetration of solar thermal systems will not increase significantly.

The solar thermal community needs to make public the advantages of solar energy, the fact that funding is required to assist the spread of ST but that funding requirements are moderate. Political pressure in this direction should be exercised, both on a national and EU level.

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Contributions to this report

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Ireland

A STATE OF THE MARKET

Overview of the market situation

The Irish solar thermal market has only begun to emerge in the last 5 years from a period of low or stagnant growth. Solar thermal energy has long escaped the attention of national policy-makers, who have focussed on the generation of electricity through the harnessing of wind energy. This situation has begun to improve and research, development and demonstration initiatives are now emerging from the Irish Energy Centre that should assist in both developing the industry and stimulating the market.

In the absence of government support, the nascent industry, consisting of a handful of importers and – until 2001 – a single manufacturer, all of whom design, install and maintain solar thermal energy systems, has struggled to attain critical mass and move from a small niche market to a more mainstream product.

However, increasing media attention to global warming has served to change consumer attitudes to energy consumption. This, combined with the benefits of economic growth and a recent housing boom, has resulted in a period of sharp growth. While the solar/water heating market has quadrupled in size in just 3 years, the solar/air collector market peaked in 1999 and has declined due to a switch in strategy by the producer from manufacturing to research and development of a next generation product.

With regard to solar/water heating systems and solar/air heating systems, the market trends and technologies employed differ significantly. Consequently, an effort has been made to separate discussion on the two throughout this report. The solar/water heating system heats water, which in turn provides domestic hot water and heats the house (usually indirectly). The solar/air collector system heats air, which in turn provides domestic hot water (indirectly) and heats the house (directly).

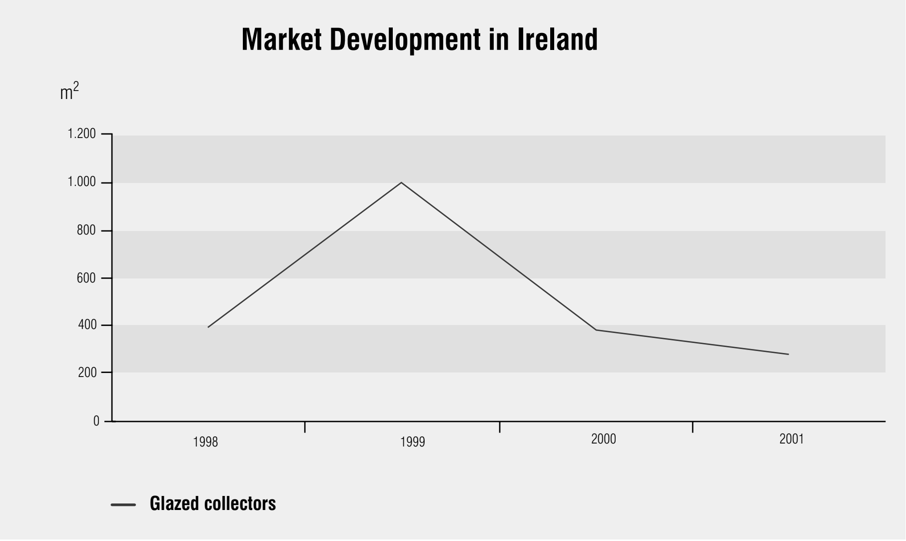
Participating in an ALTENER project (4.1030/Z/98-042), a consortium consisting of the Cork City Energy Agency, the Energy Research Group (University College Dublin), Sustainable Energy Ltd. (Wales) and Energy Centre Denmark produced a Market Development Study for the Solar Water Heating Market in Ireland (September 2000). Many aspects of that report are reflected herein. In addition, a training programme for the installation of solar water heating systems was developed. This reflects the fact that the training of plumbers and heating contractors in such systems is a cornerstone in the development of the market.

Industry and government now face the challenge of continuing to build a solid foundation on which to develop the Irish solar thermal market.

Solar thermal installations and energy production

Solar collector production and sales in m²										
	Glazed Collectors									Unglazed Collectors
	Flat Plate Collectors				Vacuum Collectors				Total Glazed	
	A National Production	B Exports	C Imports	D = A-B+C Total Home Market	E National Production	F Exports	G Imports	H = E-F+G Total Home Market	I = D+H Total Home Market	Total Home Market
Pre 1998	390		400	790			500	500	1.290	n/a
1998	360		25	385			10	10	395	n/a
1999	930		40	970			30	30	1.000	n/a
2000	250		90	340			40	40	380	n/a
2001	60		100	160			110	110	270	n/a

Source: The data on solar collectors sales prior to 1998 is based on estimates presented in Sun in Action (ESIF, 1996). Post-1998 data is based on sales figures collected from the main suppliers of solar thermal systems in the Republic of Ireland. All "National Production" figures based on ERI production of solar air "Kollectaire" collectors.



Estimated solar park in operation at the end of 2001[1]

Flat plate collectors in m^2	2.645	
Vacuum collectors in m^2	690	
Total glazed collectors in m^2	3.335	= 0,9 m^2/1000 inhabitants

Estimated annual solar thermal energy production in 2001

Flat plate collectors in m^2	2.645	x 450 kWh/m^2·year =	1.190 MWh
Vacuum collectors in m^2	690	x 450 kWh/m^2·year =	311 MWh
Total			1.501 MWh

CO_2 emissions avoided in 2001[2]

Flat plate collectors	1.190 MWh/a	x 0,336 tonnes/MWh =	400 t
Vacuum collectors	311 MWh/a	x 0,336 tonnes/MWh =	104 t
Total			504 t

Product types and solar thermal applications

Product types

Solar/Water Heating Systems – Glazed flat plate collectors and evacuated tube collectors are the two "conventional" product types, sharing a similar proportion of both the totalled installed area and the number of solar thermal systems installed annually.

Solar/Air Collector Systems – The solar air collector system, produced by ERI and called "Kollectaire" uses a type of flat plate collector consisting of a matrix absorber coated with low emissivity glass. Air, rather than water, is the medium that heats the house.

Applications

The main applications for active solar thermal systems are:
- Domestic hot water production;
- Space heating/domestic hot water production (combisystems);
- Swimming pool heating.

1. In Sun in Action II, ESTIF uses the following general assumptions to calculate the solar park in operation: systems installed until 1989 have an average lifetime of 15 years; systems installed in or after 1990 have an average lifetime of 20 years.
2. Estimates of avoided CO_2 emissions based on fuel mix for hot water production in Ireland in 1998.

Domestic Hot Water Systems
The main application for solar thermal systems in Ireland is the production of domestic hot water. Sixty such systems were installed in the last 3 years. The system used is an active, indirect one, typically consisting of:

- 4 to 6 m^2 of flat plate collector or 3 to 4 m^2 of evacuated tubes collector;
- a storage tank of 200 to 300 litres, made of enamelled steal or copper with anode protection, pre-insulated in factory, with an internal solar heat exchanger (coil);
- a pre-assembled hydraulic unit often referred to as a “solar station” (circulating pump, valves, …);
- an automatic control unit regulating the circulating pump of the solar loop;
- an auxiliary heat source, either an electric immersion heater or a coil heat exchanger connected to a wood/oil/gas boiler, generally internal to the storage tank.
- a pressurized unvented solar loop filled with a mixture of glycol, antioxidant and water.

Larger systems, capable of providing sufficient heat to last 3 days without any sun, have also been installed.

Combisystems
The number of solar thermal systems for both space heating and domestic hot water production is increasing.

Solar Water Combisystems
Ten solar/water space heating and hot water systems were installed in the last 3 years. A typical solar/water combisystem consists of:

- 10 to 15 m^2 of flat plate collector or 5 to 10 m^2 of evacuated tubes collector;
- a tank-in-tank storage tank of 500 to 1.000 litres, pre-insulated, without internal solar heat exchanger, made of enamelled steal with anode protection and/or stainless steel;
- a pre-assembled hydraulic unit and an automatic control unit
- an auxiliary heat source, generally a wood/gas/oil boiler;
- a pressurized closed unvented solar loop.

Solar Air Collector Systems
The solar/air collector system for both space heating and domestic hot water consist of:

- 12–30 m^2 of flat plate collector, consisting of a matrix absorber coated with low emissivity glass;
- an air handling unit (provides the mechanical heating and ventilation system together with the Heat Recovery Ventilation unit);
- an air/water heat exchanger (provides hot water for the DHW system);
- a storage tank;
- an auxiliary heat source, generally gas or oil boiler, with a water/air coil to heat air in the air handling unit;
- an electronic control system;
- an air duct system to distribute the heat, utilises the hollow core of concrete slabs.

Swimming Pool
A typical solar swimming pool heating system is made of a large array of glazed collectors or an array of polypropylene absorbers without cover. There is generally no storage tank in a solar swimming pool system as the pool itself is used as a large heat store.

Employment

The Irish imported solar thermal market is dominated by four small companies, each having one or two positions engaged in solar thermal heating on a fulltime basis. Some of these companies are also involved in other renewable energy technologies (underground heat pump, hydro, photovoltaic, wind, etc.). A single individual often imports, sells, installs and maintains the units.

A small but growing number of installations are carried out by heating contractors proposing solar thermal systems as part of a complete heating package, especially in the under floor heating market.

The Kollectaire system was produced in Ireland until 2001 by ERI. Manufacturing is now licensed to NuAire (Wales), with ERI engaged exclusively in R&D.

Estimated 2001 employment figures in the following sectors (full-time jobs)	
Manufacturing of components of solar thermal systems	0
Installation and maintenance	6
Distribution, sales and marketing	by installers themselves
Research	4
Consultancy	1

B STATE OF PRODUCTION

Product technology and production methods

At present there are no manufacturers located in the Republic of Ireland. Energy Resources International were manufacturing solar air collector systems for purpose-built new homes. In 2001 they licensed the production of their KollectAir system to NuAire (Wales) and have, since then, been developing a new application.

Breakdown of solar systems costs

Solar Systems Costs for Typically Sized Systems		
	Individual	**Project (large scale)**
Total costs (excl. VAT)	670 €/m^2	n/a
VAT (12,5%)	83,75 €/m^2	n/a
Total cost (incl. VAT)	753,5 €/m^2	n/a
Typical size of system	4–6 m^2	n/a

Typical solar domestic hot water system

Characteristics of a typical SDHW system	
System type	flat plate or evacuated tube collectors, unvented pressurized closed solar loop with circulation pump, indirect heating of the hot water in the storage tank.
Collector area (m^2)	4–6
Hot water storage (litres)	200–300
Total installed cost 12,5 VAT incl.	4.000–5.000 €
Eventual subsides	0 €

Typical consumer motivation

Within the Domestic Hot Water (DHW) segment, the target customer has generally been the owner-occupier who will either request their builder install a solar thermal system or retrofit their existing home. Such a customer is motivated predominantly by environmental concerns, as the financial case (est. a 10 year payback period) is regarded as weak. In addition, consumers who can afford the high initial investment are less likely to be concerned about the payback period. Other factors that influence the purchase decision include: the social novelty of such an installation; the higher level of comfort provided by the availability of cheap hot water; and, increased property value.

To date builder-developers have not emerged as a significant customer type in the solar/water market. However, the current construction slowdown may result in builder-developers offering domestic hot water systems as a unique selling proposition. Within this context, the property boom of the last 7 years has resulted in a significant decline in the cost of solar domestic hot water systems relative to the price of property.

Conventional water heating and energy prices

Conventional Energy Prices		
Date: 2001	**Housing VAT incl.**	**Collective VAT incl.**
Electricity – normal	0,10 €/kWh	0,063–0,14 €/kWh
Electricity – low rate	0,04 €/kWh	0,042 €/kWh
Fuel – Oil	0,045 €/kWh	0,045 €/kWh
Bottled gas (butane)	0,011 €/kWh	0,11 €/kWh
Natural gas	0,022 €/kWh	0,029 €/kWh
Other (coal)	0,03 €/kWh	0,07 €/kWh
Energy costs compiled by the Irish Energy Centre in August 2001		

Standards and codes of practice

There is currently no obligation for collectors to be tested or certified on the Irish market. However the large majority of the collectors available on the Irish market have been certified in their country of origin.

There is currently no national certification or standards specifically developed for solar thermal systems. However, solar thermal systems must comply with relevant regulations regarding sanitary hot water systems and electrical systems.

There is currently no certification or codes of practice specific to the installation of solar thermal systems. However, a training course for system installation was developed in 2000 under the European ALTENER programme.

Level of R & D

Energy Resources International, formerly a manufacturer of solar thermal air collector systems, have been developing a solar air collector system suitable for retrofit of existing houses. It is anticipated that the manufacture and distribution of this product will be licensed.

C STATE OF MARKETING

Distribution and marketing methods

As mentioned above, the Irish solar/water Thermal market is dominated by 4 small companies providing approximately six full-time positions. These companies import, promote, sell, install and maintain the units. All players are primarily focussed on the domestic hot water and, to a lesser extent, the combisystem market segments.

While promotion techniques vary, advertisements in local press, directory listing (yellow pages, Irish Energy Centre) and word of mouth tend to dominate. Internet presence is regarded as increasingly important, with most companies either maintaining, or planning to maintain, a website. Referrals from other solar websites have proved valuable.

Wider interest in the solar/water thermal heating can be generated by national press and media coverage, which can cause erratic booms in customer enquiries. The proportion of such enquiries that result in an eventual sale tends to be lower than normal, with customers being put off by the high initial investment cost. Such booms in enquiries can be disruptive to the small organisations.

On the solar/air side, the distribution and marketing of ERI's Kollectaire system was the majority were based on alignment with two builder-developers, often in multi-unit developments. Other installations were single-unit, custom-built homes.

Incentives and financing methods

Generally, solar thermal systems are financed by the homeowner. To date there has not been any specific financial incentive in the form of grants for solar thermal systems. Public support for investments can be available through broader sustainable energy programmes managed by the Irish Energy Centre:

- **House of Tomorrow Programme:** The main focus of the programme is on stimulating widespread uptake of superior sustainable energy planning, design, specification and construction practices in both the new home building and home improvement markets. Up to 40% of the extra-cost of implementing the energy efficiency solutions can be funded.
- **Model Solutions Investment Support Scheme:** This scheme provides selective investment assistance to public sector organisations who propose to include building energy efficiency technologies or energy saving solutions in new or existing buildings. Up to 50% of implementing the energy efficiency solution can be funded.
- **Design Study Support Scheme:** The main aim of the Design Study Support Scheme is to stimulate public bodies to include improved energy efficiency design specification in new public sector building construction and major refurbishment projects. Up to 50% of the cost of the study can be funded.

D FUTURE PROSPECTS

National energy policy

The following policy documents govern the national energy policy of Ireland:

The National Development Plan 2000–2006, under the Economic and Social Infrastructure Programme, makes provision for the development of renewable energy and the improvement of the housing stock of local authorities in terms energy efficiency.

The Planning and Development Act (2000) requires that planning authorities set out a Development Plan presenting a strategy for the proper planning and sustainable development of their area, which should incorporate a housing strategy.

The National Sustainable Development Plan (1997) makes provision for the reduction of greenhouse gas emissions, the development of renewable energy and energy conservation, in particular in the built environment.

The National Climate Change Strategy (2000) makes provision for limiting the growth in greenhouse gas emissions by 13% above 1990 levels in 2010, in particular by increasing the energy efficiency of the built environment and the supply of renewable energy.

The Green Paper on Sustainable Energy (1999) defines a strategy to meet Ireland's energy requirements in an environmentally and economically sustainable way having regard to forecast economic growth and security of supply objectives. While the focus is principally on electricity generation, the following specific policies could have relevance to the development of the solar water heating market:

- Encouraging community based renewable energy development
- Use of the existing tax relief measure and consideration of other fiscal measures for renewable energy in the context of green tax measures in future budgets
- A revitalised approach to the promotion of research into the development of renewable sources of energy
- A refocusing of the role of the Irish Energy Centre and its Renewable Energy Information Office.

Towards Sustainable Local Communities (2001) set guidelines for the implementation of Local Agenda 21 by local authorities, including in its sustainable energy dimension.

The **European Directive on energy performance in buildings** makes provision for calculating the integrated energy performance of buildings and applying a minimum standard to new and existing buildings in renovation, notably through the implementation of a building certification scheme.

Overall, the emphasis on the role of renewable energy in the national energy policy of Ireland has been on electricity generation. Active solar thermal systems have not been focussed upon in the wider national strategy to reduce carbon dioxide emissions. This is due to a combination of lack of awareness and the predominance of wind energy as a cost-effective, large-scale means of reducing carbon dioxide emissions. In addition, improvement of the national housing stock to reduce energy demand is regarded as a more effective, in terms of both cost and national effort, means of reducing emissions.

Objectives for the solar industry/market

In September 2000 "Solar Water Heating in Ireland – Market Development Study" was published. The study sets out a two-phase strategy for the development of the solar water heating market. The first phase involves a number of measures to establish the broad foundations for future market growth; and the second phase involves measures to stimulate the solar water heating market with a view to integrating the technology into new housing. The study identifies the following benefits of implementing the strategy, which may be regarded as objectives for 2010:

- A reduction in annual energy consumption (relative to 2000 levels) by 24.9MWh/year;
- A reduction in carbon dioxide emissions by 11.500 tonnes per year;
- The creation of approximately 270 new jobs in the industry.

Prospects for market development by sector

Emerging Changes in Market Structure

Consumer awareness is increasing due to media focus on global warming and the promotional efforts of the Renewable Energy Information Office and local energy agencies. In addition to consumer awareness, increasing consumer affluence is also an important factor driving the market.

There are an increasing number of companies offering solar thermal heating systems in addition to their existing offering. The heating industry is becoming aware of the commercial potential of solar thermal systems and some heating contractors and distributors have now incorporated them in their range of products. In addition, some of the Irish solar thermal supply companies are starting to build relationships with local plumbers, thereby extending their market reach and providing them with capacity flexibility (i.e. additional skilled labour). It remains to be seen if this will eventually result in vertical fragmentation of the industry (i.e. the current suppliers moving out of installation and direct sales to become wholesalers that provide equipment, training and technical support for plumbers). Finally, some of the Irish solar thermal system supply companies are indicating that they may begin to focus on other market segments, such as industry applications, hotel and leisure. These three developments – the emergence of interest from the heating industry; the alignment of plumbers with the Irish solar thermal system supply companies; and the switch in focus by some of the solar thermal supply companies are structural changes that may indicate a gradual maturing of the domestic market from a niche area to a more mainstream product. This change not only increases competition, but should also serve to increase the size of the market.

Within the Irish solar thermal heating market there are a number of market segments with particular potential:

- Domestic hot water
- Domestic space heating and hot water (combisystems)
- Swimming pools
- Hotel and leisure
- Nursing homes
- Hospitals
- Local government buildings
- Agriculture

However, at present only the domestic market has a significant number of installations.

Domestic Hot Water (DHW)

The largest current and potential market segment for solar water heating systems in Ireland is within the residential sector, consisting of both existing and new houses. A system designed to provide 50 to 60% of the DHW energy requirements is generally regarded as appropriate. This segment has experienced significant growth over the last 2/3 years, with some installation companies experiencing growth of 300% per annum, albeit from a small base.

The segment may be further broken down into "existing houses" and "new houses". Due to the lower installation cost and the higher insulation standards of new houses, the new housing segment represents the single most significant opportunity for implementing solar water heating in Ireland. This is complemented by a demographic structure that will continue to drive house completion rates at over 40,000 per annum until 2010. The recent construction boom has reduced the incentive for builder-developers to offer DHW systems as a unique selling proposition. However, the current housing slowdown may improve this situation somewhat.

The existing housing segment accounts for a large proportion of sales, but suffers from two main disadvantages over new houses: the marginal cost of such systems is higher than in new houses; and, due to the relatively poor insulation levels of the existing housing stock, many existing houses would benefit more from making the financial investment in improving insulation levels rather than a SDHW system. However, as the customer is also the owner, has made it easier to sell into this market than to a builder-developer.

The vast majority of installations to date have been in single homes, indicating the extent to which the owner is driving the purchase decision, rather than the builder-developer. Multiple installations are more cost-effective, but are dependent upon some incentive to the builder-developer or local government social housing procurement.

Combisystems

Combined domestic hot water and space heating systems represent a smaller market segment, but is expected to become more common as the cost of solar collectors continues to decline.

In the event that a cost-effective solar thermal air collector retrofit kit is successfully developed by ERI, this could provide a significant boost to the space heating market.

Tackling the barriers to market development

Barriers to Market Development

The most significant barrier to solar heating market development in Ireland is a widespread and pervasive lack of awareness that cuts across all of the potential markets for solar heating. This lack of awareness is compounded by the extent to which the Irish government's renewable energy policy to date has focused on electricity producing renewable energy technologies.

The main factors that have led to this lack of awareness are the very few examples of solar heating systems being used in practice, low levels of publicity and the absence of any high profile companies "championing" the technology.

The other principle barriers to solar heating market development are:

- Approach to energy design of new housing
- Costs of conventional fuels
- A small base of design and installation skills
- Small domestic manufacturing base and lack of research and development (particularly the water heating market)
- Lack of available low cost capital to assist purchases of systems.

Strategy to overcome barriers to market development

"Solar Water Heating in Ireland – Market Development Study" sets out a two-phase strategy for the development of the solar water heating market. The first phase involves a number of measures to establish the broad foundations for future market growth; and the second phase involves measures to stimulate the solar water heating market with a view to integrating the technology into new housing.

Phase 1 – Foundations for future market growth

- Raising awareness through a demonstration and dissemination program, including amongst others the installation of demonstration projects.
- Building design and installation skills through appropriate and publicly supported training courses. Further improvement through guidelines/codes of practice covering the procurement, design and installation of solar thermal heating systems.
- Encouragement of R&D especially in the buildings integration of solar thermal.

Phase 2 – Measures to stimulate the market

- Expansion of the demonstration and dissemination program with focus on targeting builders and architects.
- Existence of an intelligent support program which helps the market achieve a critical mass and thus economies of scale.
- Enforcing higher energy standards through new building regulations.

Concluding remarks

By implementing the strategy for market development, outlined above, the following results could be realised by 2010:

A reduction in annual consumption of conventional energy (relative to 2000 levels) by 24.9MWh/year;

A reduction in carbon dioxide emissions by 11.500 tonnes per year;

The creation of approximately 270 new jobs in the industry.

However, the implementation of such a strategy requires a considerable investment of resources, both financial and human, on the part of the Irish Energy Centre. This investment, in turn, is contingent upon a broadening of national focus on renewable energies from electricity generation to include heat generation. It is likely that this will occur as the Irish Energy Centre gains increased autonomy when it becomes established as the "Sustainable Energy Authority". Indeed, the recent publication of the consultation document "Renewable Energy R, D & D Programme Strategy", with a section on solar energy, is indicative of a broadening of focus. Some of the proposed activities in this document are consistent with the strategy outlined above.

But while it is important for government to provide the appropriate environment in which to stimulate the market, it is also vital that industry rise to the challenge of developing and maturing the market. A vocal body to represent the industry's views and to assist in developing the market in a constructive way continues to be an important requirement.

Finally, the significant growth achieved by ERI's Kollectaire system through alignment with builder-developers perhaps provides a growth strategy to the solar/water system providers.

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Solar thermal barometer 2000. EurObserv'ER, 2001

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Contributions to this report

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Italy

A STATE OF THE MARKET

Overview of the market situation

Italy is one of the European countries with the highest potential for solar thermal, due to high solar radiation levels and high energy costs: nearly 100% of fossil fuels and a significant portion of electricity are imported. In the last few years, the Italian solar thermal market has had one of the highest growth rates in Europe, but starting from a very low level.

After a vertical start in the late seventies and early eighties, the market collapsed and went through a long period of stagnation at a very low level, until the mid-nineties. This long stagnation was due mainly to two factors:

- Inexperience of all the actors involved, both manufacturers with inefficient products and installers with unreliable systems. In the seventies and eighties, the relatively high number of systems which did not work properly had a negative impact on the trust of users and public authorities in the technology. It took a long time to re-build this trust.
- Interruption of financial incentives: From 1987 until the late nineties, there were no financial incentives, except for the small provinces of Trento and Bozen/Bolzano. New programs at national and regional level have been activated only recently.

The new period of strong development since the mid-nineties has been based on the success of solar thermal in other European countries, showing the higher technological maturity of the sector and allowing for know-how transfer. In Italy, the growing awareness of issues like environmental protection and energy conservation gave new impetus to the solar thermal market.

In the last few years, the national Environmental Ministry contributed to market growth through measures such as supporting several demonstration projects and proposing very ambitious programs for emission savings.

The key factors for the positive developments in the last few years have been:

- Increased awareness for the need of energy savings (environment, increasing energy costs)
- Information campaign on solar thermal
- More attractive financial offers for end-consumers to cope with the investment (paying by instalment)
- Public support programs

The main barriers to growth which still prevent the Italian solar thermal sector from getting closer to its high potential are:

- Limited and discontinuous financial incentives to private end-consumers.
- Lack of long-term financial incentives
- High installation costs in the retrofit market (difficult integration of solar thermal into existing heating equipment)
- Awareness of the benefits of solar thermal still very limited
- High costs of promotion
- Lack of national coordination
- In many areas, the permission to install a system comes with heavy administrative burdens, due to urban regulations and bureaucratic administration
- Private users account for roughly 95% of the overall demand, public institutions for only 5%: more projects within public institutions (hospitals, schools, swimming polls, social housing, etc.) would help create more visibility and reach a critical mass.

Solar thermal installations and energy production

Solar collector production and sales in m^2										
	Glazed Collectors									Unglazed Collectors
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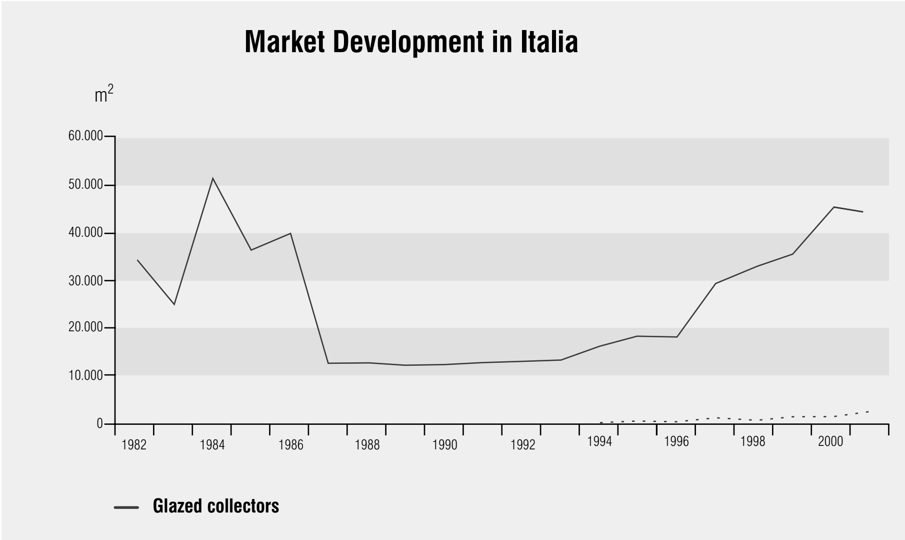
	A National Production	B Exports	C Imports	D = A-B+C Total Home Market	E National Production	F Exports	G Imports	H = E-F+G Total Home Market	I = D+H Total Home Market	Total Home Market
1982				34.000					34.000	
1983				25.000					25.000	
1984				52.500					52.500	
1985				36.500					36.500	
1986				40.000					40.000	
1987				13.600					13.600	
1988				13.000					13.000	
1989				12.500					12.500	
1990				12.500					12.500	
1991				12.800					12.800	
1992				13.200					13.200	
1993				13.600					13.600	
1994	5.560		10.000	15.560				426	15.986	182
1995	5.160		12.100	17.260				590	17.850	787
1996	4.370		11.800	16.170				1.075	17.245	567
1997	6.890		21.300	28.190				1.650	29.840	1.135
1998	7.740		23.200	30.940				2.075	33.015	926
1999	7.460		24.400	31.860				3.640	35.500	1.498
2000	12.090		30.000	42.090				3.159	45.249	1.721
2001	10.900		28.800	39.700				4.800	44.500	2.500

Source: ASSOLTERM[1]



Estimated solar park in operation at the end of 2001[2]

Flat plate collectors in m^2	312.970	
Vacuum collectors in m^2	17.415	
Total glazed collectors in m^2	330.385	$= 5{,}7\,m^2/1000$ inhabitants
Unglazed collectors in m^2	9.316	
Grand Total in m^2	339.701	$= 5{,}9\,m^2/1000$ inhabitants

Estimated annual solar thermal energy production in 2001

Flat plate collectors in m^2	312.970	x 700 kWh/m^2·year =	187.782 MWh
Vacuum collectors in m^2	17.415	x 800 kWh/m^2·year =	13.932 MWh
Unglazed collectors in m^2	9.316	x 350 kWh/m^2·year =	3.261 MWh
Total			204.975 MWh

1. The data are based on extensive research by the Italian solar energy association ASSOLTERM, which combined the findings of three main sources: the analyses of the published accounts of companies representing roughly 80% of the Italian market; a survey sent to all the Italian manufacturers and distributors; statistics provided by the provinces of Trento and Bolzano, where nearly half of the collector surface installed in Italy is concentrated.
2. In Sun in Action II, ESTIF uses the following general assumptions to calculate the solar park in operation: systems installed until 1989 have an average lifetime of 15 years; systems installed in or after 1990 have an average lifetime of 20 years.

Solar thermal applications

Domestic hot water production (DHW) is by far the most common application. Most of the systems sold in Italy are compact thermo-siphon systems (natural circulation) provided in kits made of absorbing plates, boiler and all other accessories. They are typically small systems with a 4 m^2-absorber surface located on the roof and a storage capacity of 200–300 litres, designed for one-family houses, or bigger if used on larger buildings. Compared with countries like Austria and Germany, therefore, the Italian market is characterized by relatively cheap systems with high solar yield in summer.

However, particularly in Northern Italy, there is an increasing trend towards forced-circulation systems. Such systems are more expensive, but they allow for better optimisation and a higher solar yield during the winter season. As forced-circulation systems are more complex, correct installation requires higher specific skills, which are not easy to find among the installers in some Italian regions.

Solar combisystems (DHW combined with space heating) have started to be installed in significant quantities in Italy only in the last few years. Their share within the solar thermal market is still very low, estimated at 3%. However, the progress of the technology and the positive experience abroad, as well as in some demonstration projects in Italy, are expected to stimulate this very interesting market segment, which has a very high potential in Italy. In fact, in many areas of Italy (Alps, internal areas of Southern Italy), the space heating demand is high, despite relatively high levels of wintertime solar radiation.

Large collective solar systems: In the last few years, some demonstration projects have been realised, improving the visibility of the sector in Italy. The most important examples are:

- **The swimming-pool complex in Melegnano** (Milan) completed in March 2002: 200 m^2 of installed collector area to supply hot water to showers and heat-up swimming pools throughout the year.
- **The system in the Rebibbia prison** (Roma), a solar thermal system of 280 m^2 for DHW.
- **Holiday Village Capriccioli di Porto Cervo** in Sardegna, 108 m^2 for DHW.

However, the diffusion of large collective systems in Italy is still extremely limited in comparison to other countries. The main reason is the lack of activity by local authorities, which have to play an important role to stimulate initiative and provide financial support for the investment. The solar thermal research community, which in other countries often plays a key role as initiator for large projects, is very small in Italy.

Unglazed collectors for swimming pool heating. Despite of the huge potential, given the high number of open-air swimming pools in cities and in the tourist sector, very few systems have been realised. Main factors are the lack of awareness for the benefits of such applications, lack of a wide spread net of distributors, and financial issues. Funds available from the Environment Ministry to support local communities have remained to a great extent unused. The reason has been that the subsidy covered only 30% of the costs, but most decision makers in the local authorities do not think long-term enough to make covering the remaining 70% of the investment justifiable by future savings on the energy bill of the swimming pools.

Air conditioning and industrial process heating are hardly sold in Italy currently, though the potential is extremely high: the demand for cooling, as well as the costs, both for the user and for environment, is steadily growing in Italy.

Other applications. Both in the agricultural sector (dairy industry, pre-heating of ground for early-season vegetables) and in desalination (several islands need water containers from the mainland to cover their basic need), there is a significant, but still unexploited potential.

Employment

The total estimated employment in the solar thermal sector in Italy is the equivalent of 540 full-time jobs. This estimation includes manufacturing, import, distribution, installation, planning and consultancy and transport.

B STATE OF PRODUCTION

Product technology and production methods

The most common size of solar collectors is 2000 x 1000 mm. The absorbing material used by domestic producers is in most cases copper or inox iron, but in the market there is also a significant share of iron.

For the selective surface, there is a clear trend towards higher quality products: the share of titanium is still low (~20%) but shows strong growth, black chromos has the biggest share in the market (~50%), whereas the share of black painting is strongly decreasing, but still makes up ~30% of the market.

Casing is mainly made with iron or aluminium. Isolation can be made of mineral wool or polyurethane. The storage tank material is iron or inox iron.

Typical values for the efficiency of solar collectors is $\eta_0 = 0{,}80$.

Today, in Italy there are about 20 manufacturers and 40 distributors in the solar thermal field. In the last 5 years the number of producers and distributors doubled, thanks to the growing demand and expectation of further growth. In general, manufacturing is manual and partly automated. High levels of automation are not yet widespread among Italian manufacturers. There is, therefore, still much potential for product improvement and, especially, for economies of scale if production volumes continue to grow.

Breakdown of solar systems costs

Solar Systems Costs for Typically Sized Systems		
	Individual	**Project (large scale)**
Total costs (excl. VAT)	550 €/m^2	500 €/m^2
VAT (10%)	55 €/m^2	50 €/m^2
Total cost (incl. VAT)	605 €/m^2	550 €/m^2
Typical size of system	4m^2	40m^2

This refers to forced circulation systems.

Installation of solar collector systems allows a considerable saving on energy costs. Considering a typical family, which uses a solar collector for domestic hot water: the average warm water consumption for a 4 person family is about 3.600 kWh/year. With a 4m^2 solar collector, the consumption can be reduced by 75%, allowing the family to recuperate the investment for the solar system in four years, under best conditions.

The percentage cost breakdown of an average system differentiated according to system types is:

	Natural Circulation	Forced Circulation
Manufacturing (materials and work)	50%	40%
Marketing/distribution	25%	25%
Installation	20%	30%
R & D	5%	5%
Total installation costs (Euro)	1.400€	2.200€

Typical solar domestic hot water system

Characteristics of a typical DHW system	
System type	natural circulation system (thermosiphon)
Collector area (m^2)	4
Hot water storage (litres)	200
Total installed cost (VAT incl.)	there is a high variation of installation costs between different regions in Italy. Approximate costs for a total system can vary between 1.200 and 1.800 Euro for natural circulation (thermosiphon systems) and 2.000–2.500 Euro for forced circulation systems

Typical consumer motivation

The main factors which influence the typical consumer to buy solar thermal systems are:

- Economic saving
- Consciousness of environmental problems

Conventional water heating and energy prices

Conventional Energy Prices		
Date: 2000	**Residential VAT incl.**	**Industry VAT incl.**
Electricity[a] – normal consumption	0,20 €/kWh	0,085 €/kWh
Electricity – low rate	0,15 €/kWh	0,085 €/kWh
Fuel	0,085 €/kWh	0,06 €/kWh
Bottled gas	0,075 €/kWh	0,05 €/kWh
Natural gas	0,077 €/kWh	0,051 €/kWh
District heating	0,08 €/kWh	n/a
Oil	0,06 €/kWh	0,035 €/kWh
n/a = Not applicable as it is not diffused in industry.		

a. The economic values considered are national averages for consumptions between 500 (low) and 2.500 (normal) kWh year for the domestic sector. For the industrial sector, an average value was considered.

The prices mentioned above are indicative. About economic index of energy costs in Euro/kWh, we have to take into consideration:

- They refer to national averages, as bottled gas and natural gas prices are different in each province.
- VAT is included both for residential and industrial sector, but it is of course a real cost only for the residential sector.
- Several taxes are not included in these prices, as they vary at regional level and according to the kind of industry and of residence.

Standards and codes of practice

Reliability and durability of collectors is measured through different standards and institutes for certification (e.g. EN 12975-2 2001, ISO 9002).

Research and Development

Only few enterprises have continuous activity in research and development, resulting in some patents obtained by Italian companies.

There are no specific public programs in R&D. ENEA (state-owned research institute for energy and environment) does testing and certification on solar collectors and is involved in studies on systems dimension.

The key areas of R&D activity in Italy are:

- **Product innovation:** improvements in efficiency of boilers, heat exchangers and control units.
- **Solar collectors:** increasing the efficiency and lifetime of selective absorbers.
- **System components:** intended to simplify installation thanks to pre-assembled kits that can improve the system adjustment; it is also oriented to reliability of electronic components.
- **Installers training;** improve quality of installations, diffuse specific skills among installers.

C STATE OF MARKETING

Distribution and marketing methods

The weakness of the distribution structure is at the same time the consequence and main cause of the very small development of the Italian market so far. Most Italian producers and importers are still too small to afford a widespread marketing structure. A well structured network of wholesalers at national level does not yet exist. Most sales are done by the installers, and in a few cases by wholesalers. Marketing activities are therefore mainly done by single producers and importers, facing a public often still sceptical, but showing an increasing interest in solar thermal products.

Marketing is mainly targeted at the final consumer rather than at professional actors in the building and construction industry, such as engineers and architects. This choice is in most cases unavoidable, as the results of marketing towards the industry may be higher, but require long-term investments, which can not yet be sustained by the dimension of the Italian market. However, this is a major limitation of solar thermal marketing in Italy.

The three key arguments for marketing solar thermal systems in Italy are currently: environment, high comfort, and long-term reduction of energy costs. Guaranteed solar results contracts, despite their potential, are not yet often used as an incentive for collective installation.

Promotional activity is mainly conducted through fairs and expositions, and to a small degree through media and specialized magazines.

In the after-sales phase, producers and importers usually offer the following guarantees: 2–10 years for collectors, 5 years for boilers and 2 years for other components. Typically the sellers propose an annual maintenance cycle.

Incentives and financing methods

The Environmental Ministry promoted the definition of the **National Program for the Diffusion of Solar Thermal Technologies.**

The two main objectives of this program are:

- To reach 3 million m^2 of solar collector installed by 2010.
- To help the development of the solar thermal industry act on demand and supply, and giving a guarantee in product quality at all levels of the product chain.

The Environmental Ministry committed itself to promote solar thermal energy and to give incentives for the installation of solar thermal systems:

Regional programs: A decree of the Environmental Ministry assigned about 8,5 million Euro to the Regional authorities, to start a program for the diffusion of solar thermal systems for domestic hot water, swimming-pool heating and space heating. Regions manage the program and should co-finance it by 50%, resulting in 17 million Euro of available funds. The subsidies shall be granted to cover up to 30% of the investments. Target groups are private citizens and publicly owned companies. The Regions were expected to publish the first calls between July and September 2002, however, by February 2003, only four out of twenty Regions (Liguria, Lombardia, Sardegna, Toscana) had published their call for proposals. A positive development is that, meanwhile, a roundtable of representatives of the Regions, of the National governments and the industry have agreed on harmonized technical rules for this program, which should favour a smoother application of the program.

Program “Comune Solarizzato”: This program is targeted at municipalities planning to install water-heating systems. About 9,3 million Euro have been invested in installing 35.000 m^2 of solar collectors. The program also invests in training about 200 youth to operate in the solar thermal market.

Program solar thermal for all public Corporations: this is a program to co-finance 30% of the cost for installing solar collectors in public buildings. Almost 4,1 million Euro have been invested previewing an installing surface of 30.000 m^2.

Solar thermal program for municipal Corporations for the natural gas distribution: About 2 million Euro in incentives are foreseen to cover up to 30% of the cost of installing a total of 15.000 m^2 of solar collectors in the public and private sector.

Solar thermal program Region Lombardia: the Environment Ministry and the Region Lombardia invested about 1 million Euro to co-finance the installation of 10.000 m^2 of solar thermal collectors by private persons with contributions of up to 15%.

Solar National Program for prisons: Under an accord with the Ministry of Justice, almost 2,5 million Euro have been appropriated for installing 5000 m^2 of solar collectors in Italian prisons between 2001 and 2005. The project also included training and qualification of 36 prisoners of the Rebibbia jail to install approximately 600 m^2 of solar collectors by mid 2002.

D FUTURE PROSPECTS

Improving quality levels in the sector

TAs explained above, the poor quality of hardware and installation of many systems installed in the late 70s and early 80s has damaged the image of solar thermal technology in Italy. Unfortunately, in more recent times, the new boom of the market has attracted some non-serious producers. Instead of trying to develop the market for the long term by offering good value for money, they try to exploit the fact that manufacturing low quality systems does not require high investments if they do not intent to stay in the market in the long term.

To protect the professional part of the industry, many of the actors involved in the sector have jointly developed a scheme to increase trust and improve the quality of the products and installations: the Solar Pass. The goal is to create sound conditions for a long-term growth of the market.

Solar Pass is a voluntary quality label, based on a self-imposed code of conduct. It is thought as integrating, and not substituting for European quality labels like the Solar Keymark which will certify compliance with the EN norms for solar collectors and systems and which should be introduced during 2003.

The Solar Pass consists of two separate labels, one for manufacturers or distributors, one for installers. In both cases, the companies holding the Solar Pass commit themselves to respecting the code of conduct, including minimal guarantees and assistance with the products, transparent information on the technical parameters and response to possible complaints of the customer. The installers must have followed specific training for solar thermal products.

The end consumer is the final controller. Whenever he/she is not satisfied with the products or services delivered by a company holding the Solar Pass, he/she can communicate with the Solar Pass Commission, an independent body elected by the industry actors involved in the scheme. If appropriate, the Commission will ask the producer and/or installer to fulfil its commitments. In case of repeated breach of the Solar Pass Guarantee, a company can be excluded from the Solar Pass Scheme.

The industry hopes to have created an important instrument to further increase the level of trust in solar thermal products and, therefore, to contribute to an important breakthrough on the Italian market.

More information is available at www.solarpass.it

Objectives for the solar industry/market

Beyond the efforts of the industry to improve quality, two other areas are decisive for the realisation of the high potential for solar thermal in Italy:

- Support policies from the public authorities
- People's awareness of environmental protection and energy savings.

Despite the increased attention of the Environmental Ministry to solar technology, there is not yet an appropriate regulatory framework able to insure a consistent development of solar thermal in Italy.

The main proposals of the Italian Solar Industry Association ASSOLTERM are:
Regulations: installation of solar systems should be possible without any permission from local authorities (Austrian model); obligation of pre-disposing pipes to the roof in all new buildings to facilitate the installation of a solar thermal system at a later time.

Financial incentives: for families (30% contribution or 40% tax deduction); for companies (50% of credit on taxation or similar incentives); for public sector entities (50% contribution); for manufacturing enterprises (contribution for innovations or other contributions).

Promotion (awareness raising): public campaigns advertising through mass media (TV, radio, magazines); call-centre; dynamic web sites.

Concluding remarks

In the last few years a favourable situation for accelerating the diffusion of the solar thermal market in Italy has been created thanks to collaboration between governmental corporations, associations and actors operating in the field.

Thanks to this effort the national market has developed positively. However, the increase is still not sufficient to achieve the objectives fixed by the White Book of renewable resources of 3 million m^2 of solar collectors installed by 2010.

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- Assolterm reports

Contributions to this report

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The Netherlands

A STATE OF THE MARKET

Overview of the market situation

Historic overview

The Dutch solar thermal market has some specific characteristics, which seem to deviate a little from the rest of the European market.

The Dutch market started in the mid-seventies. In the early days a number of producers began with simple forced circulation systems. It soon became clear that the Dutch Water Authorities objected to the use of single-wall heat exchangers in the solar tanks of systems which were using anti-freeze additives. Dutch producers were thus forced to find a technical means to overcome this specific barrier. The problem was resolved by the development of “drain-back” systems (see detailed description below). These systems use clean water as heat transfer fluid and were accepted by the Water Authorities. Thus since the late seventies more than 95% of all systems installed have been based on this “drain-back” concept.

Another specific characteristic of the Dutch market is the relatively small size of the systems. A typical Dutch solar domestic hot water (SDHW) system consists of a 2,75 m^2 collector and a 100 litre storage tank. The reason that this size has become the standard dates back to the first projects, which were developed by consultant engineers. They calculated the optimum economic size for the Dutch climate, based on a 50% solar contribution. As natural gas is the dominant energy source for heating (and was relatively cheap in those days), the most economic price/performance ratio came from these relatively small systems. As the bulk of the Dutch market since then has been mainly oriented towards large projects, this size has become the unofficial standard.

Despite the fact that Holland Solar, the Dutch Solar Trade Association, was founded in 1983, the market greatly diminished during the eighties. From the 10 producers in 1980, only two or three remained in 1988.

At the beginning of the nineties, the government started to show serious interest in the stimulation of solar thermal. A first subsidy scheme was introduced, attracting more and new suppliers to the market. In the beginning the subsidy scheme was based on the size of the collector. This showed negative effects, as it provided an incentive for larger (sometimes very poorly performing) collectors. After 2 years, the scheme was changed to make solar energy output the basis for the subsidy. This situation still exists. In 1994 the first Long Term Agreement for the Implementation of Solar Hot Water Systems was signed. This unique agreement established a set of commitments between the Dutch government (which committed to continue a subsidy scheme and to provide funding for R&D), the solar industry (which committed to work on developing a thorough sales and installers infrastructure, and to improve the system quality and price/performance ratio) and the energy utilities (which committed to stimulate the use of solar systems in their regions as part of their environmental obligations). In the period of the Long Term Agreement, the number of systems sold per year quadrupled, while the average installed system price decreased by more than 25%. In 1998 the Long Term Agreement was extended for another 4 years, basically within the same structure.

The energy utility companies have played a very constructive role in this process over the past years. Within their environmental obligations to the government (with a specific target to anticipate in CO_2 reductions) they have played an important role in stimulating renewable energies and solar thermal in particular. Utility companies provided additional subsidies, participated in awareness campaigns and were in some cases involved in rental schemes.

Local authorities are also active in stimulating the use of solar systems. In a number of cases they exercise their influence in new-build housing developments by setting specific requirements to include solar systems in the plans in the tendering process for project developers. Apart from stimulation programs in the Long Term Agreement, new energy consumption-related criteria in the building regulation started to have an effect on the solar market beginning in 1996. Since 1996, the energy performance standard in the building code has been updated every 2 years, leading to a situation in which SDHW systems became a close to competitive option in the new-build sector. As a result, since 2001, close to 15% of all new dwellings are supplied with a SDHW system, making solar thermal a standard product in the building sector.

Present Situation

In 2002 a total of 8.500 systems were installed, bringing the total amount of installed systems in the Netherlands to approximately 70.000. The market is currently served by approximately 10 suppliers. The traditional heating-equipment suppliers play a dominant role. Most producers have been acquired by heating industries and suppliers in the course of the last 10 years. Over 300 installation companies have been trained in the installers training centre Intechnium or at the manufacturers training centres. However, only one-third of these (trained) installers are active in solar thermal.

Although no specific statistic exists concerning the division between the individual house owners market and the project market (new-build projects and retrofit projects in the rental sector), it is generally believed that the project markets made up more than 75% of the total market in 2002. New initiatives are expected to stimulate the existing (individual) housing market beginning in 2003.

The new-build sector is expected to maintain its present volume for the next few years. Further tightening of the energy performance standard is expected in coming years, although this requires further political decision making.

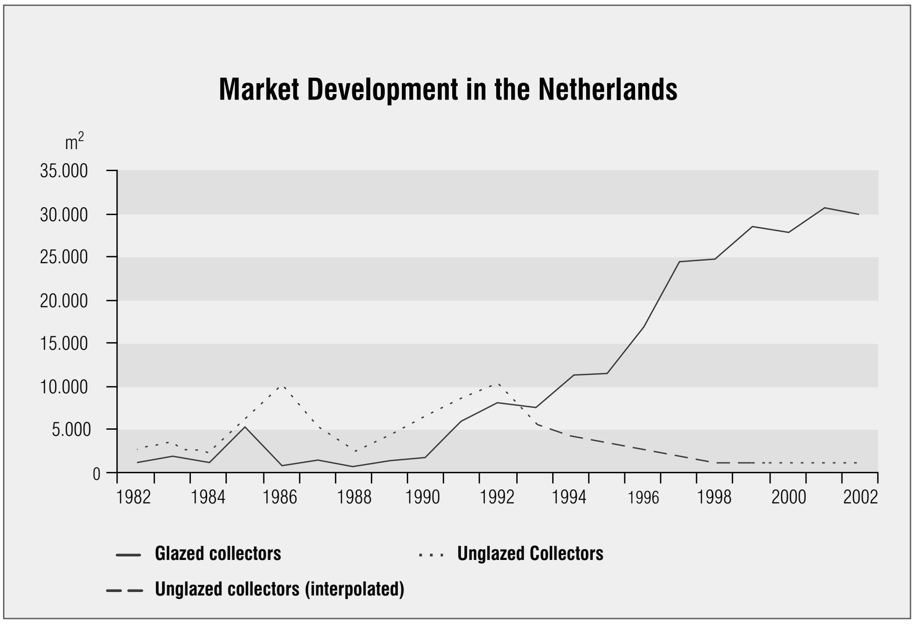
Future perspective

In 1996, the Dutch government presented its plans for the introduction of renewable energy. For solar thermal, the target was set at 400.000 solar systems in 2010 and 1 million systems in 2020. The present speed of development is too slow to reach these goals. However, as the pressure from environmental commitments (i.e. Kyoto-commitments) will increase and energy prices will increase (also due to environmental taxation on fossil fuels), a further increase of the market can be expected. The question appears to be rather when this will happen and not if it will happen.

Solar thermal installations and energy production

Solar collector production and sales in m^2										
	Glazed Collectors									Unglazed Collectors
	Flat Plate Collectors				Vacuum Collectors				Total Glazed	
	A National Production	B Exports	C Imports	D = A-B+C Total Home Market	E National Production	F Exports	G Imports	H = E-F+G Total Home Market	I = D+H Total Home Market	Total Home Market
1982				1.025					1.025	2.750
1983				1.935					1.935	3.800
1984				1.040					1.040	2.085
1985				5.300					5.300	7.850
1986				925					925	10.100
1987				2.340					2.340	5.300
1988				800					800	2.560
1989				1.215					1.215	4.210
1990				1.840					1.840	6.925
1991				6.000					6.000	8.865
1992				8.000					8.000	10.200
1993				7.500					7.500	5.800
1994				11.058					11.058	n/a
1995				12.706					12.706	n/a
1996	15.211*	2.294	4000*	16.917					16.917	n/a
1997	23.048	2.703	4.000*	24.345					24.345	n/a
1998	23.284	2.047	3.600*	24.837					24.837	n/a
1999	25.945	1.124	3.300*	28.121					28.121	<1.500*
2000	26.670	2.009	3.000*	27.661					27.661	<1.500*
2001	30.687	2.850	2.700*	30.537					30.537	<1.500*
2002	31.600	4.000*	2.400*	30.000*					30.000*	<1.500*
* no official statistics, estimate by Holland Solar										

Novem, industry monitoring, Sun in Action I



Apart from the monitoring of the collector area, the number of single family SDHW-systems has been counted. At the end of 2002, 70.000 systems have been installed. This is approximately 1,2% of the Dutch housing stock. In the new-build sector since 2000, the figure is approximately 12,5%.

Estimated solar park in operation at the end of 2001[1]

Flat plate collectors in m^2	201.877	
Vacuum collectors in m^2	2.000	
Total glazed collectors in m^2	203.877	= 12,8 m^2/1000 inhabitants
Unglazed collectors in m^2	65.235	
Grand Total in m^2	269.112	= 16,8 m^2/1000 inhabitants

Estimated annual solar thermal energy production in 2001

Flat plate collectors in m^2	201.877	x 420 kWh/m^2·year =	84.789 MWh
Vacuum collectors in m^2	2.000	x 450 kWh/m^2·year =	900 MWh
Unglazed collectors in m^2	65.235	x 300 kWh/m^2·year =	19.571 MWh
Total			105.260 MWh

1. In Sun in Action II, ESTIF uses the following general assumptions to calculate the solar park in operation: systems installed until 1989 have an average lifetime of 15 years; systems installed in or after 1990 have an average lifetime of 20 years.

CO_2 emissions avoided in 2001

Flat plate collectors	84.789 MWh/a	x 0,4 tonnes/MWh =	33.915 t
Vacuum collectors	900 MWh/a	x 0,4 tonnes/MWh =	360 t
Unglazed collectors	19.571 MWh/a	x 0,4 tonnes/MWh =	7.828 t
Total			42.104 t
based on total saved primary energy			

Product types and solar thermal applications

Product Types

As described in chapter 1, the most commonly used systems in the Netherlands are of the "Drainback"-type. These systems typically use a 2,75 m^2 collector, 100 litre tank and delta T control and pump. The tanks are specially equipped with a built-in drain-back tank of 10–15 litres. Most of the systems are installed in combination with a gas (condensing) combi-boiler, which provides space heating and hot water. Therefore most of the solar systems used are pre-heat systems, without integrated auxiliary heating. In few occasions integrated auxiliary heaters are used, mainly indirect-spiral heat exchangers – very few of them electrical.

Since the mid nineties a number of projects have been using ICS-systems (Integrated Collector Storage). In 2002, there was only one supplier remaining, which sold this kind of system. In total less than 3.000 systems of this kind have been installed up to 2002. Thermosiphon systems are also rare. There has been only one manufacturer selling these systems in the nineties.

For larger systems, flat plate collectors are used. Typical sizes run from 4 – 20 m^2. A number of large systems have been installed with collector areas of up to 2–3.000 m^2 each. The main application area is larger housing blocks / apartment buildings (with a central or an individual hot water supply), elderly homes, hospitals, hotels etc. The industrial applications have been limited (only one 2.400 m^2 system for a candy factory). There is only one solar-supported district heating system installed in 1984, equipped with vacuum tubes and long-term storage.

Applications

Domestic hot water production: Domestic hot water for single-family houses is the dominant application for solar thermal (market share ~85%), mainly in new-build houses.

Large(r) collective solar systems: Systems with more than 6 m^2, this segment addresses mainly larger apartment blocks, elderly homes, hospitals, hotels etc. (market share ~12,5%)

Space Heating: Combisystems (market share ~2,5%), slightly increasing market due to integrated concepts with gas-boilers / storage tank combinations

Air conditioning and industrial process heating: Very few projects exist for these applications.

The market shares are estimates based on installations over the past 8 years.

Employment

No official employment figures are available for the solar thermal industry. An inventory by Holland Solar in the sector indicates the following figures for 2002:

Estimated employment figures in the following sectors (full-time jobs)	
Manufacturing of components of solar thermal systems	~110
Installation and maintenance	~70
Distribution, Sales and Marketing	~25
Testing, Q-work and R&D	~35
Training, Consultancy	~35
Total	~275

B STATE OF PRODUCTION

Product technology and production methods

Product technology description

Drain-back systems

Drain-back systems are most commonly system type used in the Netherlands. More than 60.000 of these systems have been installed since the seventies and have proven to be the most reliable and trouble free, with little need for maintenance.

Drain-back is developed to protect the systems from freezing and overheating by draining the collector circuit into a special drain-back tank (which is integrated into the storage tank). The heat transfer fluid, which is normal water without any additives, is only filled partly in the collector circuit. In standstill condition, the water level in the circuit leaves the collector without water. Only in operating conditions is the water pumped through the circuit moving the solar energy from the collector to the storage tank. The pump is operated through a delta T control, which only switches on if the temperature in the collector reaches a certain degree over the temperature in the storage tank. The controller will switch the pump off in case the collector temperature and the storage temperature are equal or in case the storage temperature reaches a level of 80–85°C.

Once the pump is switched off, the water in the collector circuit will drain back into the drain-back tank, leaving the collector "dry" and safe. The collectors in these systems should be designed to be able to stand stagnant temperatures for longer periods.

Collectors

Flat plate collectors are produced mainly in a modular seize. The majority of the collectors used have a ~2,75 m^2 aperture area. The cover typically consists of 2 layers of low-iron tempered glass. The casing is aluminium. Mineral wool insulation material surrounds the absorber on the sides and back. An aluminium sheet is mostly used to protect the back of the collector. For the absorber two types are most common. Header and riser construction (fin and tube) and serpentine tubing soldered to copper plates. The absorber coating is always spectral selective, either black chrome or sputtered layers.

Most flat plate collectors are suited for roof integration. Some collectors have used a special casing profile to allow waterproof roof integration, some collectors use specially designed flashing kits. As the flat plate collectors are roof-integrated, the connection pipes and sensor connection are located on the backside of the collectors.

Tanks
There are basically three types of tanks used.

Preheat tanks: ~ 100 litres, made of stainless steel or copper, with a build-in drain-back facility. Well-insulated and equipped with a special filling device for drain-back operation.

Integrated auxiliary tanks: ~ 140 – 200 litres, made of stainless steel or copper, with a build-in drain-back facility and either an extra heat exchanger for back-up heating or an electrical element.

Solar combi-tanks: made of stainless steel or copper. These tanks combine a hot water storage and a gas-burner for both, back-up and space heating. The storage content serves the central heating circuit. Tap water is heated through a tap-spiral.

Almost all storage tanks are dedicated to solar applications and some have the delta T control and pump, integrated in the cabinet to allow simple and installer-friendly installation.

ICS (Integrated Collector Storage Systems)
A number of ICS systems have been installed over the years. Not all systems have proven to withstand the typical Dutch climate, which can have severe winters and hot summers. Some designs have been taken out of production or undergone a redesign. Presently an ICS is marketed which can be located in the ridge of the roof.

The ICS is constructed so that the storage vessel is used directly or indirectly as a collector. Heat-pipe type heat transfer principles are used to allow a certain level of insulation between the collector side of the construction and the storage tank.

Production method description

There are four collector or ICS manufacturers active in the Netherlands. Some manufacturers supply OEM-collectors to other suppliers.

The collector production is fairly flexible and is partly automated.

The production of storage tanks is basically an assembling process. A few tank manufacturers supply the basic tanks to the producers, who complete the tank according to their specific design and quality specifications.

The product quality is high. Lifetime expectations are over 20 years, and for collectors, far longer.

Breakdown of solar systems costs

As part of the Long Term Agreements (between the government, the industry, the installers trade association and the utilities) installed prices have been monitored over a period of 8 years. In that period the installed prices have dropped by more than 25%. For the year 2001, the average monitored price levels for a typical DHW system of 2,75 m^2 are indicated in the following table. A distinction is made between 4 categories:

- Solar system – **p**reheater, used in **pro**jects (> 10 units / order) **(Ppro)**
- Solar systems – **I**ntegrated Auxiliary, used in **pro**jects (> 10 units / order) **(Ipro)**
- Solar systems – **p**reheater, used in **ind**ividual sales (**Pind**)
- Solar systems – **I**ntegrated Auxiliary, used in **ind**ividual sales **(Iind)**

Solar Systems Costs (average price level in 2001)				
	Ppro	**Ipro**	**Pind**	**Iind**
Total costs (excl. VAT)	1.580 €/m^2	1.741 €/m^2	1.676 €/m^2	2.113 €/m^2
VAT (19%)	300 €/m^2	331 €/m^2	318 €/m^2	402 €/m^2
Total cost (incl. VAT)	1.880 €/m^2	2.072 €/m^2	1.994 €/m^2	2.515 €/m^2
The installation cost vary from 511 Euro (projects) to 855 Euro (individual).				

Percentage cost breakdown of an average system	
Hardware (production/factory overheads etc.)	45–55%
Distribution, marketing and sales	20–25%
Installation	20–25%
These percentages are highly influenced by the fact that the majority of the systems installed are in projects. This fact strongly influences the costs of distribution, marketing, sales and installation.	

Typical solar domestic hot water system

As indicated previously, the typical SDHW system in the Netherlands is:

Type	Drain-back (estimated > 90% of the market)
Collector area (m^2)	2,75–3,0 aperture
Tank (litres)	~90–100
Control	delta T, pump
Total installed cost	1.880–2.515 €
Subsides	General subsidy: 700 Euro (EPR, for systems > 3 GJ performance) Utility: various, depending on the utility company, ranging from 0–250 Euro Local Authorities: various, depending on the LA; ranging from 0–150 Euro

Typical consumer motivation

In order to understand the role of the consumer in the decision-making process, it must be clear that, for the new-build sector (which contributes largely to the present sales figure), the decisions are made by the project developer or housing association. The main reason for selecting a solar system in the new build sector is the need to comply with the energy performance standard. The end-user is not directly involved in this process, but generally is in favour of the choice for a solar system. It has become a relatively standard option in the new-build sector (12,5% of all new build have a solar systems standard in the package).

Individual consumers / homeowners do buy solar systems, but barriers exist with regard to availability through the installers channel.

Consumers generally have a positive attitude toward renewable energy, as is indicated by the number of households that buy "green" electricity. In 2002, over 1,2 million household had a contract for green electricity (20% of total). The environmental issue is important. New campaign outlines are currently under development for 2003 onwards. Lifestyle elements could play an important role in future campaigns as well.

The economic arguments are presently not part of the rationale, as the price performance ratio is at about a break-even level (under the present subsidy regime). Therefore the investment is considered positive based on environmental rather than economic issues.

Conventional water heating and energy prices

Conventional Energy Prices			
		Low	**High**
Electricity	Tariff	0,05 €/kWh	0,09 €/kWh
	Energy tax	0,07 €/kWh	0,07 €/kWh
	Total	0,12 €/kWh	0,16 €/kWh
Natural gas	Tariff	0,24 €/kWh	
	Energy tax	0,15 €/kWh	
	Total	0,39 €/kWh	
2001/2002 level. Small variance occur in regions / companies.			

Standards and codes of practice

There are no legal requirements or limitations with regard to the sale of solar systems in general. However in order to be able to qualify for subsidy schemes a performance test is required, in order to establish the correct subsidy amount for a system, as the subsidy is linked to the system performance.

Furthermore the “Guarantee Institute for the Housing Industry”, which for participation in the new build sector is generally required, demands a 6 year guarantee on the solar collectors in order to have them covered under the institute’s rules.

Requirements for subsidy: a performance test is required according to BBI-R1456 “description of the Dutch outdoor (DST) test” method for solar domestic hot water systems. The DST method is part of the EN 12975 and EN 12976. Any certified European test laboratory could carry out the test. Test reports will be evaluated by TNO.

Under the subsidy scheme (EPR-subsidy) the systems need to be installed by certified installers according REW 1994 / REG 1994.

This requirement demands that the installer is certified and licensed to establish business for the practice of gas-technical installation work.

The industry is currently engaged in promoting the “Zonnekeur”. This mark is expected to be linked to the solar Keymark in due time and presently refers already to the appropriate EN-standards 12975 and 12976.

C STATE OF MARKETING

Distribution and marketing methods

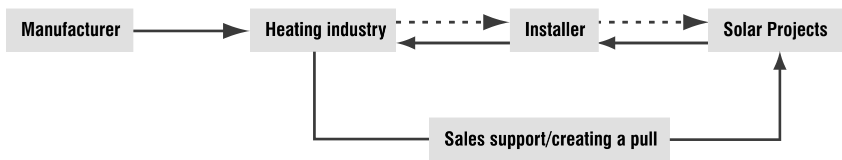
As described in chapter 1, the majority of systems sold are installed in the new-build housing sector. The basic driver for this development is the building regulation, which requires a certain energy performance level for new houses. Solar systems are one of the competing technical options to comply with that requirement.

In the retrofit market, the marketing initiatives have been concentrated on the forming of buyer groups. These initiatives are combined actions by utility companies and local authorities, and are coordinated by consultants. Through these kinds of activities a few thousand systems have been installed in the previous years.

The level of direct sales through installers is relatively low. It is generally felt that the number of active installation companies is limited. The general interest of the public is not seen as the main barrier.

Marketing approaches

The manufacturers sell their products mainly through the heating industry or merchants. In particular the heating industry is effective as the sales, marketing and logistical activities are combined with heating equipment (mainly condensing boilers). More than 80% in 2001–2002 of the sales were carried out according to this approach. The following sales model is the most common:



For 2003 / 2004 a new campaign is under development ("make your own energy"). This campaign focuses on the retrofit market of individual homeowners. The campaign provides a public advertising element and a specific procedure to follow up potential leads through qualified installers. A central call centre is positioned to provide general information and assist potential clients in determining the possibilities to use renewable energy in their homes. The campaign will address not only solar thermal, but also all "building related renewable energy" (like solar thermal energy, PV and heat pumps).

Financial incentives/facilities

The subsidy scheme under the EPR provides subsidies, based on the thermal performance of a system

System performance	2–3 GJ , subsidy 455 €
System performance	> 3 GJ, subsidy 700 €
Collective (large) systems	125 €/m^2

On top of this EPR scheme a 10% bonus can be given in case the solar systems are obtained as part of a "Energy Performance Advice", a kind of energy audit.

Some energy utilities and local authorities provide an extra subsidy, basically following the criteria as the EPR subsidy. These subsidy schemes vary frequently.

Rental and leasing schemes are offered through some utility companies

D FUTURE PROSPECTS

National energy policy

In 1996, the Dutch government presented its plans for the introduction of renewable energy. All forms of renewables were addressed and specific targets were formulated for each technology. For solar thermal, the target was set at 400.000 solar systems in 2010 and 1 million systems in 2020. This should add up to 5 PJ (~1.400 GWh) solar thermal in 2020.

The present speed of development is too slow to reach these goals. This is not only the case for solar thermal; the implementation of all renewables is behind schedule. The various mechanisms to stimulate renewable energy over the past five years have varied and changed a lot. The renewable energy industry is emphasising the need for consistency in policies. Instruments used (and sometimes already abundant) are:

- Subsidy for households (fluctuates, variances in target groups)
- Regulating Energy Tax (Eco-tax). First renewable energies were exempted, but as of 2003, they are taxed at approximately 65% of the taxation on fossil fuels.
- EIA: Special depreciation incentive for environmental and renewable energy investments
- EINP: same for non-profit sector, terminated as of Jan 1st 2003
- Vamil: Flexible depreciation possibility, terminated as of Jan 1st 2003

For R&D programmes yearly funds are available, supporting some research institutes and industries to a percentage of the cost. The topics must fit into the long term R&D requirements.

At present the Ministry of Economic affairs is responsibility for solar thermal. However discussions are taking place to change that responsibility to the Ministry of Housing and Environment.

Objectives for the solar industry/market

For the coming years the following objectives for solar thermal have been set

Sector	Target	Description
Housing sector – retrofit	The retrofit market is highly under-developed. Yearly 250.000 heating boilers are replaced. The target is to combine those replacements with the installation of a solar system.	This requires a strong cooperation between the suppliers, the installers and the government in order to facilitate this market segment. Against the background of the government objectives for 2020 it is essential to engage in these activities at short notice.
Housing sector – new build	A further tightening of the Energy Performance Standard for buildings will lead to a need to include solar thermal systems in buildings in order to meet the goals. An increase (from 12,5%) to 50%+ is seen as realistic in a 10 yr time period.	A gradual reduction of the EPC is required.
Small Commercial sector	Only a small portion of the potential has been used so far. Market penetration to be increased in 10 years.	A consistent stimulation programme is required in the long run, in order to gain confidence in the market.
Industry	Same as Small Commercial. Objectives to be determined.	
Other	New application areas under review. Combined solar/heat-pump, district heating and sophisticated storage options are still under development, but can in due time increase the potential.	Continuation of the Research, Development and Demonstration programs. Preferably carried out within an international setting for optimal effectiveness.

Strategy to overcome the barriers to market development

A strategy must be designed to develop the market in a structural way. Recent experiences in various countries in the world have taught us that sudden peaks in market development can easily tumble down again. Our goal is rather to create a stable, growing, structural and developing market.

As long as the solar markets are to some extent "artificial" with a high political influence on the stimulation and market development, it is essential that such political dependency relate to a consistent policy.

There are 4 issues to address:

Regulation

As the use of traditional energy must be controlled mainly for the security of future energy supply and for environmental reasons, the most structural way to allow for a transition to a renewable energy society is to gradually tighten the regulations, in particular the building codes, to the extent that solar thermal (and other options) will find their way into the market. This should be a constant process in which the industry and the market knows what the future expectation will be in order for them to invest in a substantial economic activity.

Financial incentives

As long as regulations are not developed to the extent that the structural market has evolved, it is essential that adequate financial incentives be provided in order to reach the targets set out. It should never be the intention to depend on subsidies for the long term, but they are essential for the short and intermediate term in order to keep positive growth in the sector.

Market Infrastructure

The market infrastructure requires full attention at various levels. In particular the position of the installation companies is extremely important. They are the window to the clients/ home owners in the retrofit market. Adequate training is essential, as well as quality schemes and marketing support. As the installers might require assistance in this development, support from the suppliers is needed.

Knowledge

Solar technology is relatively young (25 years; it took 35 years for the petroleum industry to develop). Therefore the development of knowledge is important. Both scientific as well as on applied levels, the full potential of solar thermal technology under the present climate conditions in the Netherlands must be developed.

Concluding remarks

The Dutch solar thermal market has developed over the last decades positively in some sectors and disappointingly in others.

The present trend in the new-build sector is positive and should continue for the next few years. The retrofit sector is clearly underdeveloped and needs full attention in order to utilise that potential. There are good examples and experiences in other countries from which the Netherlands can learn. There are plenty of opportunities to work on this high-priority issue.

The basic infrastructure is established and will be used to further develop in the specific areas where growth must be expected.

The Dutch government targets set out for 2020 are within reach, as long as the government, industry and others will work together to make the right decisions according to common priorities.

Contributions to this report

This report is based on information provided by Holland Solar, the Dutch Solar Trade Association. For his valuable contribution we would like to thank Teun Bokhoven.

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Portugal

A STATE OF THE MARKET

Overview of the market situation

The past and the present of solar energy in Portugal

The solar water heating in Portugal has been done primarily using flat plate solar collectors, some imported, some produced in the country.

Evacuated tubes have also been commercialised and, at the end of 1994, one manufacturer has started the production of CPC (Compound Parabolic Concentrators).

The country has several research institutions dedicated to solar energy, the most important of which is INETI and its Renewable Energies Department. It has investigated all of the solar technologies presently being used in the world, including evacuated tubes and CPCs, and it is the institution in Portugal in charge of collector testing for efficiency and quality. INETI participated extensively in the development leading to the past and current effort around European testing standards.

The number of companies on the market has varied over the years. Before 1978 there were only one or two companies on the market. After that there was a growth in the number of collectors sold, which peaked in 1985 at nearly 42.000 m^2/year, with more than 20 companies active in the field. Since then, commercialisation of solar energy for hot water has steadily declined to 22.000 m^2/year in 1990 and to less than 5.000 m^2/year in 2002.

In 1990 the number of companies active in the field was 5 manufacturers and about 50 companies listed as installers, engineering companies or importers, perhaps with only 10 of them dealing in solar energy. Today the number of manufacturers is even smaller, only one showing real signs of ambition and innovative technology.

At the end of 2002, the total collector area in operation is estimated to be around 236.000 m^2.

The reasons for the growth and decline of solar energy in Portugal were much the same as in many other countries

1. Companies capitalising on the speculation around solar energy in the seventies and early eighties, as well as on the subsidies available, many of which were ill-conceived and did not guarantee the delivery of energy;

2. Poor quality control, both for the equipment and for the project and installation, which lead to consumer disappointment and severely damaged the image of solar energy;

3. Companies with the goal of making a “fast buck” and with little concern for the wealthy development of the market;

4. Sudden end of subsidies, without any complementary policies to keep up the interest in solar energy;

5. The fact that fossil fuels never really rose in price as predicted; on the contrary, in relative terms the prices for fossil fuels declined;

6. A recession which slowly crept in beginning in the mid-eighties and damaged the purchasing power of the Portuguese;

7. Very high interest rates, which reached 34% (in some cases with interests deducted at the start of the loan!). Although there were special rates for SDHW, these were, as said above, often poorly conceived and much abused by the installers and the consumers;

8. Solar systems have the disadvantage of high initial investment.

Potential market for solar energy

The potential market for solar energy in Portugal is very large. First of all Portugal is a sunny country with differences in sunshine between regions not differing by more than 15% on an yearly average (Kh>0.6, on an yearly basis, almost all over the territory and Atlantic Islands).

Typically a solar system is designed to produce 75% of the total energy necessary for a given load, simply because not all days are clear days.

The amount of energy consumed for hot water production in the commercial and residential market is about 6% of total final energy consumption; the equivalent figures for hot water production in industry is approximately 4%. To supply 10% of that energy by solar thermal systems, a collector area of more than 3 million m^2 would be needed. But currently only around 5.000 m^2 are newly installed each year.

This figure should be compared to the present size of the Greek solar thermal market – 152.000 m^2/year – since Greece is a country in many ways similar to Portugal, in terms of its energy dependency from fossil fuels, availability of solar energy, size, and income of population.

What can be done to change this situation, and at least allow Portugal to reach the Greek figures in the solar market?

Suggestions for the development of the solar market in Portugal

The first thing to do is to start a solar awareness campaign with the following points in mind

1. Solar equipment is now better and more reliable.
2. People should only buy what has been certified for quality and also from companies which have not been “blacklisted“.
3. Solar energy is clean.
4. Solar energy is not free, but actually will lead to substantial savings during the lifetime of the equipment (in Portugal it is easy to calculate, for the domestic sector and on a 10/12 year basis, that the value of the thermal equivalent of the kWh produced by the solar system is roughly half of its present cost when purchased from the utility).
5. Maintenance contracts should be negotiated with the installer.
6. Solar energy is safe and convenient, in comparison with bottled gas, for instance;

Secondly, uniform testing standards around Europe should be introduced, together with collector and solar tank labelling, the guarantee of results for larger systems, etc. These should be absolutely required in connection with any kind of subsidies.

Subsidies should be implemented to help the consumer bridge the difficulties of the high initial investment. These can be fiscal, or of the type in which a percentage of the investment is covered by it. This percentage may be absolutely free to the consumer, or of the type institutionalised by the Andalusia’s-Spain (PROSOL-Program), in which it is an 100% loan, free of interest. However the important points are the following:

1. It should be as simple as possible to obtain (i.e. with little bureaucracy).
2. It should be indexed to the amount of energy produced by the system (this can be determined on the average, after system certification, and can even be measured for larger systems).
3. There should be no subsidies for products which are not certified.

The market can also be developed in a direct way by the government acting as a client and installing solar collectors on public buildings, schools, hospitals, canteens, military barracks, swimming pools, inns, sports facilities, heat processes in the industry, etc. In fact, it would be easy to make this mandatory.

Banks and other financial institutions should provide special loans for solar energy, with the best rates they can offer, to cover that part of the investment not covered by direct subsidies and the client’s own money, payable in 3 to 5 years. These credits should again be easy to obtain, even presented to the consumer in a package with the equipment.

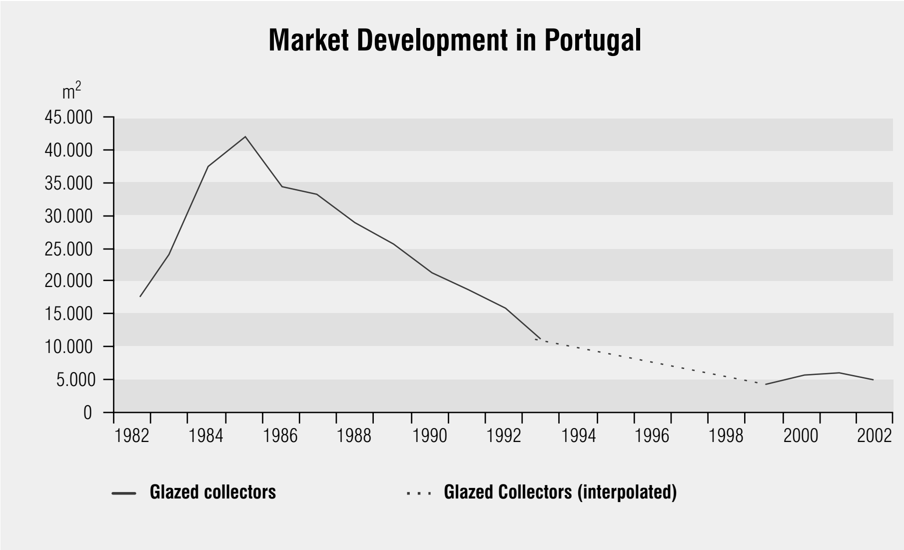
Professional associations and consumer protecting agencies should be involved in the market, acting in their traditional roles, on behalf of the consumer.

Courses for installers, project engineers and other professionals should be implemented on a national basis, with the participation of the technical staff of the active companies.

Solar energy should be an integral part of what is taught to youngsters in primary and secondary school, in connection with the environment and sustainable development.

Solar thermal installations and energy production

Solar collector production and sales in m²										
	Glazed Collectors									Unglazed Collectors
	Flat Plate Collectors				Vacuum Collectors				Total Glazed	
	A National Production	B Exports	C Imports	D = A-B+C Total Home Market	E National Production	F Exports	G Imports	H = E-F+G Total Home Market	I = D+H Total Home Market	Total Home Market
1982				17.590					17.590	
1983				24.265					24.265	
1984				37.530					37.530	
1985				42.000					42.000	
1986				34.700					34.700	
1987				33.133					33.133	
1988				28.690					28.690	
1989				25.690					25.690	
1990				21.960					21.960	
1991				18.600					18.600	
1992				15.040					15.040	
1993				11.600					11.600	
1994									n/a	
1995									n/a	
1996									n/a	
1997									n/a	
1998									n/a	
1999	2.800		1.700	4.500					4.500	
2000	4.000		1.500	5.500					5.500	
2001	4.000		2.000	6.000					6.000	
2002				5.000					5.000	



Source: Data from DGE (Direcção Geral de Energia, Ministry of Economy) and APISOLAR (Portuguese Solar Industrial Association)

Estimated solar park in operation at the end of 2001[1]

Flat plate collectors in m^2	208.463	
CPC solar collectors	2.000	
Vacuum collectors in m^2	500	
Total glazed collectors in m^2	210.963	= 21,0 m^2/1000 inhabitants
Unglazed collectors in m^2	1.000	
Grand Total in m^2	211.963	= 21,1 m^2/1000 inhabitants

Estimated annual solar thermal energy production in 2001

Flat plate collectors in m^2	208.463	x 600 kWh/m^2·year =	125.078 MWh
CPC solar collectors	2.000	x 880 kWh/m^2·year =	1.760 MWh
Vacuum collectors in m^2	500	x 800 kWh/m^2·year =	400 MWh
Unglazed collectors in m^2	1.000	x 300 kWh/m^2·year =	300 MWh
Total			127.538 MWh

1) application is mainly hot water at 45ºC; 2) ambient temperatures are generally high, which means there is not much difference between collector types; in particular evacuated tubes do not show their thermal advantage, and suffer from their low optical efficiency when reported over gross effective area (the definition chosen here)

1. In Sun in Action II, ESTIF uses the following general assumptions to calculate the solar park in operation: systems installed until 1989 have an average lifetime of 15 years; systems installed in or after 1990 have an average lifetime of 20 years.

CO_2 emissions avoided in 2001

Flat plate collectors	125.078 MWh/a	x 1,0 tonnes/MWh =	125.078 t
CPC solar collectors	1.760 MWh/a	x 1,0 tonnes/MWh =	1.760 t
Vacuum collectors	400 MWh/a	x 1,0 tonnes/MWh =	400 t
Unglazed collectors	300 MWh/a	x 1,0 tonnes/MWh =	300 t
Total			127.538 t

This estimation includes the life cycle analyses of the collector plus tank system and 50% recycling of all installed equipment, in addition to the particular characteristics of solar radiation available in our climate.

Product types and solar thermal applications

Product types
Description of the modules and systems used:

Most applications use flat plate collectors and CPC collectors with low concentration. The most common systems used in the domestic sector are the thermosiphon systems, and forced circulation for large systems.

Applications
Installation figures according to the following application segments:

- Domestic hot water production: market share ~66,5% (thermosiphon and few forced circulation systems)
- Large collective solar systems: market share ~16,5% (forced circulation systems, used for hotels, sport facilities, hospitals, industry, etc)
- Air conditioning and industrial process heating: 15% (forced circulation systems)
- Space heating: market share ~0,05% (forced circulation systems)
- Swimming pools: 2% (forced circulation systems)
- District heating: 0%

Employment

Estimated employment figures in the following sectors (full-time jobs)	
Manufacturing of components of solar thermal systems:	50
Installation and maintenance:	80
Distribution:	8
Sales and marketing:	5
Testing, quality assurance and research:	3
Training:	2
Consultancy:	10
Total:	158

B STATE OF PRODUCTION

Product technology and production methods

Typical product technology	
Collectors (usual sizes)	2 m^2 flat plates and CPC's
Absorber material	Copper, aluminium
Surface treatment	Normal black paint, black nickel sputtering (selective) imported
Insulation	Rock wool, inject polyurethane, CFC free
Transparent cover	Low iron temperate glass
Casing	Stainless steal, anodised aluminium
Storage tank	Copper with internal heat exchanger, with or without Sn coating, stainless steal with and without heat exchange, iron tanks with enamel
Cover	Stainless steal, and fibre glass reinforced UV resistant tops, painted steel plates, plastic tops

Typical values of efficiency of collectors and systems manufactured in Portugal
$F\eta_0$: from 0,79 to 0,7,

FUL: from 2,5 to 8,5 W/m^{2}ºC,

Overall system efficiencies: from 0,3 to 0,50

Production technology description

Production methods and capacity	
Number of companies involved in collector production	6
Production capacity (today, no further investment)	25.000 m^2/year
Capacity utilisation	<20%
Percentage of manufacturing	a) manually, 90% b) partly automated, 10%
Present quality and performance standards. Portugal has one of the best technologies in solar thermal which is the CPC collector and its quality, also almost all Portuguese manufacturers have their products certified according to the European standards.	

Breakdown of solar systems costs

Solar Systems Costs for Typically Sized Systems		
	Individual	**Project (large scale)**
Total costs (excl. VAT)	700 €/m^2	550 €/m^2
VAT (12%)	84 €/m^2	66 €/m^2
Total cost (incl. VAT)	784 €/m^2	616 €/m^2
Typical size of system	4 m^2	120 m^2

Percentage cost breakdown of an average system

	Small systems	Large system
Production (materials and labour)	70%	60%
Marketing/distribution	4%	7%
Installation	25%	30%
R & D	1%	3%

Typical solar domestic hot water system

Characteristics of a typical DHW system	
System type	Flat plat collectors, thermosiphon type
Collector area (m^2)	2–4
Hot water storage (litres)	190–350
Total installed cost (VAT incl.)	12%
Eventual subsides	Personal income tax reduction (IRS) covers 30% of the investment up to a maximum deduction of 700 Euro; corporate tax (IRC) can be calculated with the investment in a solar system for the company amortised in just 4 years.

Typical consumer motivation

The main factors influencing consumer motivation to buy solar thermal are

- Economy of energy
- clean energy
- quality of life

Conventional water heating and energy prices

Conventional Energy Prices		
Date: 2000	**Housing VAT incl.**	**Collective VAT incl.**
Electricity – normal	0,0886 €/kWh	0,0723 €/kWh
Electricity – low rate	0,0494 €/kWh	0,0494 €/kWh
Bottled gas	0,95 €/kg	0,90 €/kg
Natural gas	0,6624 €/m^3	0,5497 €/m^3

Standards and codes of practice

In order to receive subsidies a collector has to be tested/certified according to the European (EN) standards. The tests are carried out by INETI-LECS, Laboratorio de Ensaios de Colectores Solares, an accredited institution.

Level of R & D

Type of R & D activities
Most research in the area of solar thermal has taken place at INETI, the Renewable Energies Department, as already mentioned.

Main topics have been: Non Imaging Optics-CPC and evacuated tube collectors, high temperature applications of Non Imaging Optics, solar system engineering and design, methods for solar system design, solar radiation statistics, solar drying, agricultural applications of solar, desalination, solar cooking, solar absorption and adsorption cooling, solar UV applications, solar ponds, solar collector testing methods and solar collector testing. The area of Solar Passive technologies has also been investigated;

Another institution, the Faculty of Engineering at the University of Porto, should also be cited; other institutions with R&D in solar: Universidade de Évora-Physics Department, IST. Instituto Superior Tecnico in Lisbon, Physics Department; Universidade do Minho.

Recently there has been investment by companies in solar R&D.

Specific programs
There are no specific R&D programs for energy, much less for renewable energies or solar energy.

Role of government
Apart from the fact that the institutions referred above receive funding from the government to operate, the researchers in the field get some extra funds mainly from European programs; there are only a few instances of national programs in other areas financing solar or renewable energy projects in general.

Role of institutes and universities
As explained above it has been a crucial role

C STATE OF MARKETING

Distribution and marketing methods

- The market is practically non-existent today; at best it can be said that it is being revived, with the commitments resulting from the Kyoto Protocol an other European directives and recommendations in this area.
- There is a current change in policy with the new E4 Program: Energy Efficiency, Endogenous Energies. It is expected that an awareness campaign, in particular for solar thermal energy, will be started; the E4 plans for 1 million square meters of solar collectors in 2010.

A public announcement for the New Program E4 was made at the end of 2001. E4=Energy Efficiency Endogenous Energies. For solar thermal the rules are being defined but the idea is to have at least 1.000.000 m^2 more by 2010; subsidies are being defined, indexed to the energy delivered by the system; also a strong promotion of solar energy is planned.

Incentives and financing methods

In the past, Portugal had the “VALOREN” program (from 1987 to 1992) which financed up to a maximum of 70% of the total investment, non refundable; the total number of solar collectors installed through this program was about 4.300m^2. Then came the “ENERGIA“-program, which ran from 1994 to 2000, was available to companies and institutions, and could finance up to a maximum of 50% of the total investment, non refundable. With regards to solar energy no more than 1.300m^2 of collectors were installed as result of the program.

At the present we have the new program E4 referred to above, whose rules and terms for financing are being established.

Support for investment comes only from the Ministry of Economy (national level), third party financing is not used in Portugal.

D FUTURE PROSPECTS

National energy policy

TIn a picture dominated by fossil fuel imports, with oil accounting for about 70% (primary energy), but which also includes coal and natural gas, which can reach a total of about 90% in dryer years, the main concerns are:

- security of supply
- an increase in the penetration of natural gas

At the end of 2001, the priorities established by the socialist government included for the first time energy efficiency and endogenous (renewable) energies as main points in the energy policy. This came to be known as the E4 Program. In the beginning of 2002 a new government was elected. The energy policy on paper was not changed, and E4 is still on.

E4 established a goal of at least 39% contribution of renewable energies for electricity production by 2010 and 1 million square meters of installed solar collectors by 2010.

At present renewable energies provide about 12% of the country's final energy, 6% coming from large scale hydro (on average-wet/dry years) and 6% from traditional use of wood and industrial residues. All other renewable energies (solar, small scale hydro, wind, biomass, wave, geothermal) have a joint contribution of less than 0,5%). The present contribution of renewable energy to electricity is on average about 35%.

Portugal signed a commitment in the context of KYOTO which limits the allowed emissions until 2010 to an amount which is already about to be exceeded.

Objectives for the solar industry/market

E4 objective is 1 million installed square meters of solar collectors by 2010.

Present size of market is only on the order of 5.000 m^2/year. The total number of collectors installed is between 200.000 and 300.000 m^2.

The market consists mainly of small domestic systems (from 2 to 4 m^2, with a predominance of thermosiphon systems in "kits").

There are about 5 manufacturers in Portugal of flat plate solar collectors – mainly non-selective or weakly selective (selective paint) types and one manufacturer producing stationary concentrators, non-evacuated and selective, of the CPC type.

There is an Industrial Association of Solar companies, including these manufacturers and installers/distributors. It is called APISOLAR.

The Government is thinking of starting a campaign to promote solar (Agua Quente Solar para Portugal) (www.aguaquentesolar.com) starting March/April 2003.

The incentives that exist are

- deduction up to 700 Euro on personal income tax
- amortisation of the investment made by companies on solar systems in just 4 years, when calculating corporate income tax
- subsidies (MAPE program) of up to 40% of the investment on solar systems, when purchased by companies or institutions (i.e. not in the domestic sector), half of it as a zero interest loan, payable back in 9 years, with no reimbursement on the first three; lower performing collectors will have a smaller subsidy, i.e. part of it is indexed to energy performance of the system

There are strict demands on quality for collectors (only collectors tested under the European standards and by an accredited institution are accepted) and for the training of installers, if any subsidy is to be attributed.

Strategy to overcome the barriers to market development

The main barrier to market development is certainly the fact that solar is either not known at all by the public, or has gained a bad reputation from the many faulty installations done in the eighties.

Another obstacle is the fact there never was a commitment to develop solar energy on the part of the government, while natural gas, a new energy vector, has been (and still is) thoroughly promoted and has benefited from strong government investment and dedicated subsidies.

Solar equipment has VAT of 12% while natural gas and electricity has a VAT of 5%!

There are no building regulations promoting solar energy, such as the compulsory pre-installation of pipes to and from the roof, as a means to encourage the decision in favour of solar energy by owners in the future.

Institutions have little money to invest on equipment; thus they need help to pay for the large initial investment on a solar system. Afterwards they save on their operational budgets; however rather than experiencing this as a benefit, they may see their budgets reduced accordingly in the years that follow!

The existing incentives – not bad if taken as whole – were the result of patient long term action taken by a few people in the field with influence on energy policies, and not the result of a conscious, strategic choice on the part of the government. By and large these incentives predate the E4 Program.

A strong awareness campaign is absolutely essential, and the visible support of the government is a must for people to believe and act.

Special loans for solar investments are also very important.

Reduction of bureaucracy in the attribution of subsidies is essential.

The VAT reduction is necessary to establish equilibrium with other energy forms.

References

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FORUM Renewable Energy in Portugal (Out. 2001);

Água Quente Solar para Portugal (Nov. 2001) (Solar Hot Water for Portugal) Ministery of Economy

Contributions to this report

This report is based on information provided by APISOLAR. For his valuable contribution we would like to thank João Correia de Oliveira.

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Spain

A STATE OF THE MARKET

Overview of the market situation

Brief historic overview of solar thermal market development in Spain

The Spanish solar thermal market has finally overcome the situation characterized in Sun in Action I with the words "small size and unable to grow". The change is due to the following factors:

- A greater sensitisation of the population to the dangers of urban pollution and the potential of renewable energies to solve them.
- A reduction of the interest rate on private and commercial loans (from 14–18% down to 6–8% within two years) which directly improved the competitiveness of solar thermal. Manufacturers are beginning to use the good return on investment as a marketing argument.
- The impulse stemming from the Plan for the Development of Renewable Energies (PFER), which was approved by the Spanish Government on 31 December 1999. This plan is the central instrument to achieve the 2010 targets set for Spain by the European Commission. The results of this impulse are already evident.
- New regulations in some municipalities which require the use of solar thermal in new buildings. Barcelona was the first to enact such a regulation: new buildings with more than 22 dwellings must use solar thermal if their daily hot water consumption exceeds 2.500 litres at 45°C. The experience of the city of Barcelona is already showing considerable success (the annual installed collector area has risen from 500 m^2 before the new regulation to 13.000 m^2 in October 2002). This has motivated other cities to announce that they will follow the example of Barcelona (amongst them Pamplona, Madrid, Seville, and Valencia).

The newly installed collector area has risen from nearly 40.000 m^2 in 2000 to more than 51.000 m^2 in 2001. It is assumed that a similar increase has taken place in 2002, but the official data is still not available. Provisional data shows the 2002 market at 70.000–80.000 m^2. But this development – which should be regarded a big success in comparison to previous growth rates – is still far from reaching the objectives outlined for 2010. To accomplish these objectives, an average of more than 400.000 m^2 need to be newly installed each year between 2001 and 2010.

This shows that a stronger drive is needed. The administration could then achieve two goals: establish a good image through the promotion of solar thermal and nurture an emerging industry which still battles with the bad image it earned through faulty installations in the 1980s.

Problems encountered

The problems described in Sun in Action I prevailed until the year 2000. Two main events changed this situation: the government endorsed more money for solar thermal (6 million Euro) and detailed regulations covering both technical and economic quality became mandatory for installers. This stimulated the market, as consumers received much better quality. The publication of this regulation also signified the strong determination of the Spanish government to support the solar thermal market.

It seems that these regulations had the expected impact, at least for medium and large scale installations. For smaller installations it proved to be quite complicated, as installers had difficulties with the complexity of the regulation. These installers were allowed to prove their qualification by showing a “sufficient number” of systems they had previously installed.

This regulation also sparked actions by other authorities; municipalities especially realised that their support for solar energy could improve their image, and thus established their own solar thermal regulations (beginning with the city of Barcelona). However, as these are mostly linked to building constructions (new built or major refurbishment) it takes at least one year for the results to show.

Reasons for success or failure

The main reason for the recent success of solar thermal has been the clear support from the Spanish government.

Demonstration projects of high visibility

The number of high visibility projects is scarce but growing. They are mainly installed by active supporters of solar thermal, and serve as demonstration projects to make visitors familiar with the technology and encourage them to invest in solar thermal as well.

The most important installations were done in the tourist industry. Their main effect is not to demonstrate this technology to the local population but to serve as a promotional argument in the advertisements of hotels. The collector area of such installations usually exceeds 100 m^2 and the systems are installed generally due to economic reasons and the availability of (third party) financing.

Overall, the visibility of solar thermal is increasing. A positive example is the inclusion of a “Sustainable Construction” section at the 2003 CONSTRUMAT, the International Building Exhibition in Barcelona. More than 50 companies will present their products and activities on solar thermal systems and other solar devices which help reduce the use of conventional fuels.

Description of the present situation

Apart from the beginning of the solar thermal market in Spain – after the oil crisis – the situation for solar thermal has never been better. The technology has been significantly improved and the number of companies active in solar thermal has grown dramatically.

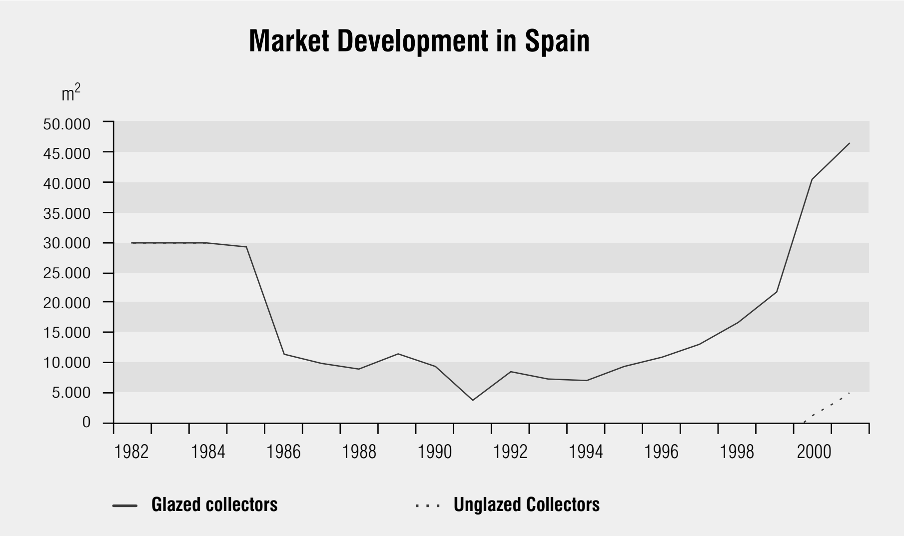
The PFER program is administered by the Institute for Diversification and Energy Saving (IDAE) which has improved the availability of financing for and information on solar thermal. The full text of PFER can be found on the IDAE website (http://www.idae.es), which includes a chapter on low temperature solar energy systems developed jointly with the Spanish Solar Industry Association ASENSA. IDAE is responsible for the distribution of 6 million Euro of direct investment subsidies for solar thermal. In 2000 and 2001, the installation of more than 30.000 m^2 of solar collectors was subsidised at 30–35% of total installation cost.

The actions on the national level have largely replaced activities of regional governments and have served to facilitate the application for incentives. At the same time, autonomous municipalities are allowed to continue supporting solar thermal with own programs as long as they are inline with Spanish and EU regulation. Surprisingly, the municipalities – following the example of Barcelona – have become the main actors in this field, making solar thermal mandatory for domestic water heating in medium and big buildings. This could only be achieved by securing support from the building developers. The political support from the local authorities is clearly more than just a “fashion”, and is largely based on the positive image of solar energy amongst citizens. Being seen as supporting renewable energies could therefore improve the government’s chances of being re-elected. At the same time they must balance local energy policy to also include the electric and natural gas industries, which have received the most attention in the past.

The availability of information on solar energy has been further improved through the new ASENSA website (http://www.asensa.org). It features a wide range of basic information on solar thermal energy and monthly updated news on technical and economic developments in the industry. The ASENSA site complements information published by other institutions like IDAE and several universities and technical bodies.

Solar thermal installations and energy production

Solar collector production and sales in m^2										
	Glazed Collectors									Unglazed Collectors
	Flat Plate Collectors				Vacuum Collectors				Total Glazed	
	A National Production	B Exports	C Imports	D = A-B+C Total Home Market	E National Production	F Exports	G Imports	H = E-F+G Total Home Market	I = D+H Total Home Market	Total Home Market
1982				30.000					30.000	
1983				30.000					30.000	
1984				30.000					30.000	
1985				29.100					29.100	
1986				11.900					11.900	
1987				10.000					10.000	
1988				9.100					9.100	
1989				11.200					11.200	
1990				9.400					9.400	
1991	5.180			3.984					3.984	
1992	10.898			8.382					8.382	
1993	9.599			7.384					7.384	
1994				7.313					7.313	
1995				9.800					9.800	
1996				10.600					10.600	
1997				12.677					12.677	
1998				16.400					16.400	
1999				21.582					21.582	
2000				40.487					40.487	
2001				41.357				5.000	46.357	5.000



Source: ASENSA, IDEA, EUROSTAT; the 2000 and 2001 data are still "preliminary" but will probably be declared "official" soon.

Estimated solar park in operation at the end of 2001[1]

Flat plate collectors in m^2	219.666	
Vacuum collectors in m^2	5.000	
Total glazed collectors in m^2	224.666	= 5,7 m^2/1000 inhabitants
Unglazed collectors in m^2	5.000	
Grand Total in m^2	229.666	= 5,8 m^2/1000 inhabitants

Estimated annual solar thermal energy production in 2001

Flat plate collectors in m^2	219.666	x 600 kWh/m^2·year =	131.800 MWh
Vacuum collectors in m^2	5.000	x 800 kWh/m^2·year =	4.000 MWh
Unglazed collectors in m^2	5.000	x 300 kWh/m^2·year =	1.500 MWh
Total			137.300 MWh

CO_2 emissions avoided in 2001

Flat plate collectors	568.321 MWh/a	x 0,22 tonnes/MWh =	28.996 t
Vacuum collectors	15.421 MWh/a	x 0,22 tonnes/MWh =	880 t
Unglazed collectors	150.112 MWh/a	x 0,22 tonnes/MWh =	330 t
Total			30.206 t

1. In Sun in Action II, ESTIF uses the following general assumptions to calculate the solar park in operation: systems installed until 1989 have an average lifetime of 15 years; systems installed in or after 1990 have an average lifetime of 20 years.

Product types and solar thermal applications

Product types

The most common product in the Spanish market is the domestic hot water system using flat plate collectors. The share of vacuum collectors is estimated at 2–3%, and is roughly the same for unglazed collectors, which are used for swimming pool heating.

Applications

- Overall, domestic hot water production has a market share of over 90–95%, of which large collective systems have 28–30%.
- Space heating accounts for 6–7% of the market (usually used in combination with domestic water heating)
- Swimming pool heating has a market share of 5–10%
- The market for district heating, air conditioning and industrial process heat is marginal but growing.

Employment

Estimated employment figures in the following sectors (full-time jobs)	
Manufacturing of components of solar thermal systems:	150
Installation and maintenance:	500
Distribution:	100
Sales and marketing:	150
Testing, quality assurance and research:	20
Training:	25
Consultancy:	200
Total:	1.145

B STATE OF PRODUCTION

Product technology and production methods

Collectors (usual sizes)	1,5 – 2 m^2
Absorber material	Stainless steel, copper, aluminium.
Surface treatment	Selective paint, black chrome, “blue” selective coatings
Insulation	Rigid polyurethane foam, cellular glass
Transparent cover	Standard float and special solar glass
Casing	Galvanised iron, painted iron sheet, Aluminium and polyester
Storage tank	Stainless steel, vitrified steel, Teflon covered steel and Reinforced glass fibre

The typical energy output of a residential DHW (2 m^2) system is 1.500 kWh/a, of a collective system (173 m^2) 140.000 kWh/a.

Production technology description

- Thirteen companies are involved in collector production.
  – Production capacity is more than 200.000 m^2 per year.
  – Capacity utilisation is much less than 50%.
- The production is partially automated, and has high potential for improvement.

Breakdown of solar systems costs

The breakdown of solar system costs varies significantly but the figures given below – which were confirmed in the solar thermal chapter of the PFER – provide the range for two typical system sizes.

Solar Systems Costs for Typically Sized Systems		
	Individual	**Project (large scale)**
Total costs (excl. VAT)	420–600 €/m²	270–420 €/m²
VAT (16%)	67,20–96 €/m²	43,20–67,20 €/m²
Total cost (incl. VAT)	487,20–696 €/m²	313,20–487,20 €/m²
Typical size of system	2 m²	173 m²

Percentage cost breakdown of an average system		
	Small systems	**Large system**
Production (materials and labour)	50%	40%
Marketing/distribution	15%	10%
Installation	30%	40%
R & D	5%	10%
Total	100%	100%

Typical solar domestic hot water system

System type	lose system with heat exchanger inside the storage tank.
Collector area (m^2)	1,5–2
Hot water storage (litres)	200
Total installed cost (VAT incl.)	625–1.380 Euro (depending mainly on the size)

Typical consumer motivation

The motivation is usually the same for private and commercial installations, in this order of importance:

Economic: Direct subsidies have been decisive in developing the market, especially in the case of big installations (e.g. in hotels). As the interest rates decreased in 2002, solar thermal systems became economically viable even without subsidies. Payback times are estimated at 6–8 years.

Growing ecological awareness.

Conventional water heating and energy prices

<table>
<tr><th colspan="3">Conventional Energy Prices</th></tr>
<tr><th>Date: 2000</th><th>Housing VAT incl.</th><th>Collective VAT incl.</th></tr>
<tr><td>Electricity – normal</td><td>0,23 €/kWh</td><td rowspan="5">In collective systems the prices are very different, depending the consumption level.
In electricity it can sink to 0,05 €/kWh</td></tr>
<tr><td>Fuel – Oil</td><td>0,22 €/l</td></tr>
<tr><td>Bottled gas (12,5 kg Butane)</td><td>8,47 €</td></tr>
<tr><td>Propane Tank of 11 kg</td><td>7,45 €</td></tr>
<tr><td>Natural gas (m^3 + fix charge + VAT)</td><td>0,57 €/m^3</td></tr>
</table>

Standards and codes of practice

Until EN 12975-1/2000 are fully applied, certification of solar thermal systems will not be mandatory in Spain.

In theory, every manufacturer can declare the quality of his products by himself, but in order to receive public grants, independent testing is obligatory. This leaves some flexibility for very small producers, who may waive this opportunity.

In practice, obtaining certification from one of the independent testing institutes (INTA, Laboratori General D'assaigs de Catalunya, ITER of Canary Ilands or some of the Technical Colleges) is indispensable. In order to receive support from the different administrations, EN12975 must be applied.

It is hoped that the Solar Keymark will facilitate the free trade in solar thermal equipment throughout the EU. Tests/certification should be performed only once and accepted everywhere.

Level of R & D

- The R & D activities: Practically all Spanish manufacturers have their own R&D programs, but the details of them are not publicly known.
- The role of the government: Two years ago, the Ministry of Science and Technology published in its Plan Nacional de Energia/PROFIT, two support schemes for R&D (basically a non-refundable subsidy and a 5-year-loan). But the PROFIT program has not been very successful in obtaining proposals from the industry. The same seems to be true for regional R&D programs. Now the PROFIT is supposed to be improved in 2003.
- At the universities and technical colleges there is some research in photovoltaics, but solar thermal does not seem to be studied at all – perhaps because of the low profile of this technology until the introduction of PFER. The Spanish official body for research (CIEMAT) has been involved in several solar thermal programs, but not much of it has been used by the industry.

C STATE OF MARKETING

Distribution and marketing methods

For years, the basic distribution channels have been installers, who are usually linked to a certain manufacturer, and consultants who specialise in the management of public grants. Since mid 2000 some installers have started specialising in solar thermal (and frequently also in PV) again.

The new regulations of some municipalities which support the use of solar thermal energy in new buildings has strongly influenced marketing. Construction companies as well as professionals from the conventional heating and ventilation business are considering entering the solar thermal market at a level never experienced before. But the legal implications of requiring the use of solar thermal in the absence of financial support are very complex. Therefore, IDAE has analysed the legal aspects and developed a proposal for municipal regulations which may be used by other municipalities to speed up the process.

For all installations that receive public grants, a minimum guarantee period (including free maintenance) of three years is obligatory; many manufacturer offer up to eight years.

All the classic promotional activities are employed in Spain. Additionally, there are two important trade fairs with relevance for the solar thermal industry: CLIMATIZATION in Madrid and CONSTRUMAT in Barcelona. The number of specialised magazines is growing and the internet is increasingly used for the promotion of solar thermal equipment. Advertisement in the general print media, on TV or radio has not been used very much, but this is beginning to change.

Incentives and financing methods

The marketing efforts of the solar thermal industry are supported through very favourable financing schemes. IDAE, SINAE and other institutions supply “third party financing”. Although these schemes work well, they are applied only in small numbers. With the better prospects for solar thermal several banks are preparing special offers for their customers. Additionally, the Instituto de Credito Official (ICO) has signed agreements with IDAE and several banks to subsidies loans which are related to solar thermal installations. Institutions of autonomous regional governments (Andalousie, Catalonia) have taken similar measures.

At the moment of writing, the details of the subsidy scheme for 2003 are not known, but it is expected that it will be at a level similar to 2002. But this means that the target of reaching 400.000 m^2 of new collector area will not achieved unless more municipalities follow the example of Barcelona and make the use of solar thermal mandatory without providing subsidies.

D FUTURE PROSPECTS

National energy policy

Brief description of the present and past energy policy and the role of solar energy

The Spanish government has made IDAE the spearhead of the PFER, but the authorities have not exactly specified how the targets should be reached. It is clear that the market needs much more support if the target of 4,5 million m^2 of installed collector area is to be reached by 2010. At the current level of annual new installations it would take more than 20 years to reach this target. But this may only be attainable if the overall budget was increased (e.g. to 20 million Euro, up from 10 million in 2001 and 2002).

Even if the advanced efforts of Andalousia, the Balearic and Canary Islands Autonomies, the possibilities of reaching the 4,5 million m^2 target in 2010 seem dim. The time and effort it takes other authorities to copy good examples seem to have been underestimated.

Priorities of the current general energy policy

The ever increasing consumption of electricity and natural gas – which was especially visible at the peak of the cold winter of 2001 – is seen as a major problem. Tackling this problem is the main priority of Spanish energy policy today. It opens a lot of opportunities to solar thermal energy and the “bioenergetic” buildings approach which has been promoted by ASENSA for years.

Energy mix of Spain.

Primary energy consumption in Mtoe						
	Year 2001		Year 2000		Year 1999	
Coal	19,5	15,2%	21,6	17,3%	20,5	17,2%
Fuel	66,7	52,2%	64,3	51,7%	63,0	52,8%
Gas	16,4	12,8%	14,8	11,9%	13,5	11,3%
Hydraulic	3,5	2,8%	2,5	2,0%	2,2	1,9%
Renewable	4,7	3,7%	4,6	3,7%	4,3	3,6%
Nuclear	16,6	13,0%	16,2	13,0%	15,3	12,8%
Electric rate	0,2	0,2%	0,3	0,3%	0,4	0,4%
Total	127,3	100,0%	124,3	100,0%	119,4	100,0%

Source: I D A E/Ministry of Science and Technology.

The consumption of renewable energy has grown over the last few years, but because the overall energy demand is growing as well, the share of renewables has remained rather constant.

Objectives for the solar industry/market

The primary objective is to reach the official target of 4,5 million m^2 of installed collector area by 2010. This will not be easy, and several members of the Spanish government have already expressed their worries that the target will not be reached. This is where the new role of the municipalities could have strong impacts: municipal authorities should promote solar thermal as well as bio climatic and sustainable construction. Also, authorities should team up with the solar thermal industry to launch a campaign to raise awareness for solar thermal.

It is essential that strong actions be taken by all administrations (national, regional and municipal) to fully integrate solar thermal into the energy supply mix. This will be especially important if solar thermal is not to be damaged by the liberalisation of the Spanish electricity and natural gas market 2003–2007.

Prospects for market development

Every year 500.000 new dwellings are built in Spain, and that number is unlikely to change – even during economic recessions – due to the needs of the population. At the same time, the number of big refurbishments of existing buildings is increasing (currently estimated at 50.000 per year). If only 50% of these were equipped with solar thermal systems using 2m^2 of collector area, 550.000m^2 could be newly installed every year. This does not seem unrealistic if broken down into the different segments:

- Domestic hot water production: This application is already supported by IDAE and several municipalities. The target has been stated above.
- Large collective solar systems. This application is not very common in Spain, but the new kind of subsidy provided by IDAE and the regulations enacted by several municipalities could significantly increase demand for these products.
- Space heating: With a minimum of additional support, space heating could be added to domestic hot water production. The collector area per dwelling would be increased by one square meter; thus the total collector area newly installed each year would increase from 550.000 to 700.000 m^2.
- District heating: The new awareness of solar thermal could be used to also develop this segment. The Nordic European countries have clearly shown that this is possible.
- Air conditioning and industrial process heating: Air conditioning has great potential in Spain, especially in the tourist sector. Strong actions are needed in the initial phase of introducing this new technology. Industrial process heat will probably develop only after solar assisted air conditioning has taken off.
- Unglazed collectors: Even though swimming pool heating accounts for roughly 5–10% of the newly installed collectors, the potential has not nearly been realised so far. This is mostly due to the low profile of solar thermal in the past. The new awareness of solar thermal could lead to a significant increase in the demand for unglazed collectors.

With the current level of awareness and policies, the ambitious targets will not be achieved. But with the right "culture" huge steps could be made towards the widespread use of solar thermal.

Strategy to overcome the barriers to market development

To overcome the current barriers concerted actions are needed. A proposal for concrete actions is discussed in section 4 of the solar thermal chapter of PFER; in summary, they are:

- Regulatory: Continuation of the successful new buildings regulations. The regulations should make solar thermal mandatory in newly built buildings, but should avoid creating new bureaucratic burdens. A model for such a municipal regulation has been developed by IDAE to be used by interested municipalities.
- Institutional: Achieving a better coordination of the efforts of national, regional and municipal authorities.
- Economic: The collaboration between the different market actors needs to be improved. The Solar Industry Association ASENSA is already closely co-operating with the Installers Federation CNI and with financial institutions to make solar thermal systems easier to buy and to reduce the overall costs of installing a solar thermal system.
- Educational: A closer co-ordination of the numerous but separate actions in this field must be achieved, including education on solar energy from elementary school to higher education.

Concluding remarks

The future for solar thermal in Spain looks more promising then ever, due to the sensitisation of both political decision makers and the general public. With the support for the Foundation "Seguir el Caminar del Sol" ("Following the Path of the Sun"), ASENSA is trying to create a broad vision of sustainability, based on the intelligent use of solar energy (active and passive). Only through such a change in the culture will the negative trend towards an increasing energy demand be overcome. The current preference for conventional fuels (primarily oil and gas) could be counterbalanced by a growing awareness that, in the longer term, solar energy can strongly contribute to meet the energy demand in Spain.

References

Plan for the Development of Renewable Energies (PFER) adopted by the Spanish Government on 30 December 1999. This document can be found on the IDAE website: http://www.idae.es.

Information on current support schemes are also published on the IDAE website.

The specifics of the 10,8 million Euro subsidy program administered by IDAE in 2003 have not been published yet. The 2002 specifications were published in the Official Paper of the State (BOE) on 27 March 2002.

On the web page http://www.asensa.org, a briefing of the new elements of the market situation can be read every month, apart from other analysis and considerations.

Contributions to this report

This report is based on information provided by the ASENSA, the Spanish Solar Industry Association. For their valuable contribution we would like to thank Julio Rafels Persiva and Eric Brea.

E ANNEX: SOLAR THERMAL DIRECTORY

Manufacturers and distributors of solar thermal equipment

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Activity: Manufacturer and installer of small domestic systems.

ACV ESPAÑA S.A.
Polígono. Ind. El Cros
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08349 Cabrera de Mar (Barcelona)
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Fax: +34 93 75 93 498
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ALB S.A.
Polígono Industrial L'Abornar
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43710 Santa Oliva (Tarragona)
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ALWEC, S.A.
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ATESA (ALTERNATIVAS DE TRANSFORMACIÓN ENERGÉTICA S.A.)
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Tel: +34 97 33 54 101
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URL: www.atesa-solar.com
Activity: Manufacturer of high performance solar thermal collectors.

CHROMAGEN ESPAÑA SL.
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Activity: High performance thermal solar collectors distribution; Specialist on high volume installations for hot water, heating and to heat swimming pools .

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ENERCOM S.A.
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ESE.
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Technical consultants specialised in solar projects

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Fax: +34 93 20 34 947
e-mail: montsandoval@coac.es
Activity: Bioclimatic building architecture projects.

INGENIERÍA ISMAEL CABALLERO SL.
Plaza de los Porches 8 3ª A
31240 Ayegui (Navarra)
Tel: +34 94 85 46 536
e-mail: meic@ctv.es
Activity: All kinds of R.E installations.

ORGANIZACIÓN UNIVERD (OU)
C/. Provenza, 86 2º 4ª
08029 Barcelona
Tel: +34 93 43 06 478
Activity: R.E. Thematic and demonstration park promotion (near Castillo de Palafolls)

SOLAR INGENIERIA 2.000, S.A.
Av. de la Pineda, 2,
08860 Castelldefels – Barcelona
Tel: +34 93 63 61 824
Fax: +34 93 63 60 685
Contact person: Mr. E. Oistrach
Activity: All kind of R.E. engineering , projects.

TTA. (TRAMA TECNOAMBIENTAL SL.)
C/ Ripollès, 46
08026 Barcelona
Tel: +34 93 45 04 091
Fax: +34 93 45 66 948

Principal sources of information

AFIDAC
(Asociación de fabricantes, distribuidores y comerciales de climatización y calefacción.)
C/. Deu i Mata 121 , 3º 1ª
08029 (Barcelona)
Tel: +34 93 32 19 163
Fax: +34 93 42 97 142
Contact person: Sr. Pere Serra.
e-mail: afidac@eresmas.es
Activity: All kind of components production for R.E. installations

APERCA
Associació de Professionals de les Energíes Renovables de Catalunya
Av. Diagonal, 453 bis (ICAEN)
08036 Barcelona
Tel: +34 93 43 92 800
Fax: +34 93 41 97 253
Contact person: Ms. N Reol
e-mail : Aperca@suport.org

ASENSA
Asociación Española de Empresas de Energía Solar y Alternativas
C/ Numancia 87–89, 6º-A, 3ª
08029 (Barcelona)
Tel: +34 93 32 19 163
Fax: +34 93 41 97 241
Contact person: Mr. J. Ràfels
e-mail: asensa@eresmas.net
URL: www.asensa.org
Activity: Spanish association of industrialists and professionals for all kind of renewable decentralised energy.

CENSOLAR S.A.
Centro de estudios de la energía solar
Parque Industrial PISA (C/. Comercio, 12)
41927 Mairena del Aljarafe (Sevilla)
Tel: +34 95 41 86 200
Fax: +34 95 41 86 111
e-mail: central@censolar.edu
http://www.censolar.edu
Activity: Technical R.E. Teaching (agreed by Education Ministry)

CIEMAT
Instituto de Estudios de la Energía del Centro de
Investigaciones Energéticas, Medioambientales y Técnicas
(Centre of the Ministry of Industry and Energy for technologies research and diffusion-dissemination)
Av. Complutense, 22
28040 Madrid
Tel: +34 91 34 66 486
Fax: +34 91 34 66 005
Contact person: Ms. A. Claver.

CNI
(Confederación Española de instaladores y mantenedores)
C/ Príncipe de Vergara, 74, tercero
28006 Madrid
Tel: +34 91 41 12 410
Fax: +34 91 56 48 690
Activity: Veteran Association with more of three thousand of installers.

ERA SOLAR
"Energías renovables-medio ambiente-ahorro energético"
Costa Rica, 13
28016 Madrid
Tel: +34 91 35 05 885
Fax: +34 91 34 59 313
e-mail: erasolar@erasolar.es
URL: www.erasolar.es
Activity: The first Spanish publication exclusively dedicated to the Renewable energies, energetic efficiency and the environment.

EREN
Ente Regional de la Energía de Castilla y León
Edificio E. Empresariales, Planta baja
Parque de San Francisco, 11
24004 León
Tel: +34 98 78 49 393
Fax: +34 98 78 49 390
URL: www.jcyl.es/jcyl/cict/eren/info/

EUROSOLAR
Asociación de servicios integrales de energía solar.
Contact person in Sevilla: Marisa Andujar
Tel: +34 95 41 83 363
Contact person in Córdoba: José Carlos García
Tel: +34 95 77 71 720
e-mail: divisio@clientes.unicaja.es

EVE
Ente Vasco de la Energía
San Vicente, 8 planta 14, Edificio Albia I
48001 BILBAO
Tel: +34 94 40 35 600
Fax: +34 94 42 49 733
URL: www.eve.es

HELIOS
Asociación de fabricantes, importadores e instaladores de energía solar.
Apdo. 4078,
29080 Málaga
Tel: +34 95 26 57 167
e-mail: helios-pascual@teleline.es
Activity: Andalousian Association constitued in 1.998 for manufacturers, importers and installers of Solar energy systems

ICAEN
Institut Català D'energia
Departament d'industria I Energía
Avda. Diagonal 453 bis, àtic
08036 Barcelona
Tel: +34 93 43 92 800
Fax: +34 93 41 97 253
URL: www.icaen.es

I.D.A.E.
Instituto para la Diversificación y Ahorro de la Energía (A Dept. of the Ministry of Industry and Energy for the promotion of energy Management, OPET member)
Paseo de la Castellana, 95, pl. 21
28046 Madrid
Tel: +34 91 55 68 415
Fax: +34 91 55 513 89
URL: www.idae.es
Contact person: Ms. A. Fresneda

IMPIVA
Instituto de la Mediana y Pequeña Industria de la Generalitat Valenciana
Pl. del Ayuntamiento, 6
46002 VALENCIA
Tel: +34 96 39 86 200
Fax: +34 96 39 86 201
e-mail: info@impiva.m400.gva.es
URL: www.impiva.es

ITER
Instituto Tecnológico y de Energías Renovables
38611, San Isidro, Tenerife,
Islas Canarias
Tel: +34 92 23 91 000
Fax: +34 92 23 91 001
e-mail: iter@iter.rcanaria.es
URL: www.iter.rcanaria.es

SODEAN, S.A.
C/ Isaac Newton s/n.
Antiguo Pabellón de Portugal
(Isla de la Cartuja).
41092. Sevilla.
Tel: +34 95 44 60 966
Fax: +34 95 44 60 595
Contact person: Mr. Lobo
URL: www.sodean.es
Activity: Consulting, designing and doing PROSOL programme

Testing facilities

INSTITUTO DE LAS CIENCIAS DE LA
CONSTRUCCIÓN EDUARDO TORROJA
(Only official body for testing the performance of heating and air conditioning products, roofs and other building structures – not solar collectors)
Serrano Galvache, S/n
28033 Madrid
Tel: +34 91 30 20 440
Fax: +34 91 30 20 700
Contact person: Mr. J. L. Esteban

INTA – Laboratorio del Instituto Nacional de
Técnica Aeroespacial "Esteban Terradas"
Carretera de Ajálvir, km. 4, 28850 Torrejón de Ardoz / Madrid
Tel: +34 91 52 01 937
Fax: +34 91 52 01 939
Contact person: Mr. E. Mezquida
Activity: Only officially recognised organisation for collector performance testing.

5. Solar research centres

CIEMAT – Instituto de Estudios de la Energía del Centro de Investigaciones Energéticas, Medioambientales y Técnicas.
(Centre of the Ministry of Industry and Energy for technologies research and diffusion-dissemination)
Plataforma solar de Almería. CIEMAT-PSA
Carretera general– s/.n.
(apartado correos, 22)
04200 Tabernas–Almería
Tel: +34 95 03 65 315
Fax: +34 95 03 65 300
Contact person: Manuel Sanchez
Activity: "Plataforma Solar de Almería", is a research center for high and medium solar energy temperature, water desalinization, etc.

Sweden

A STATE OF THE MARKET

Overview of the market situation

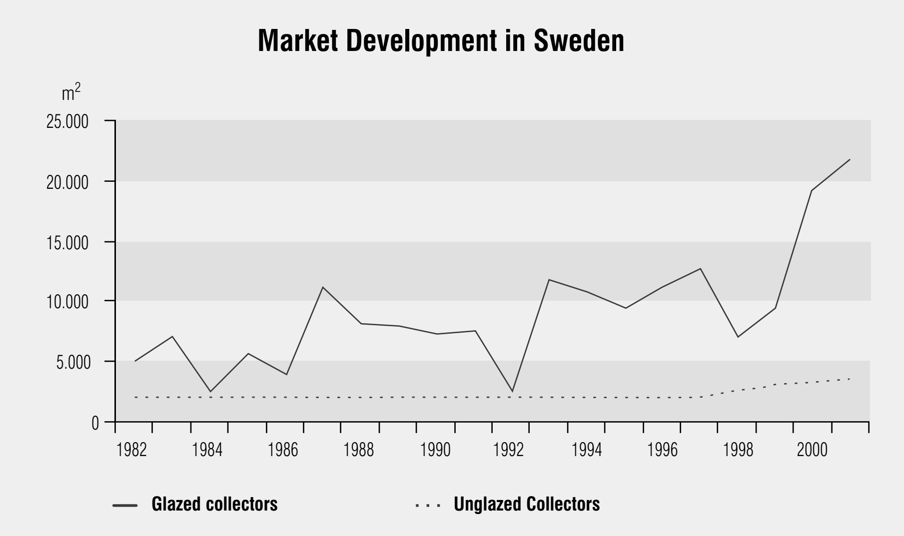
The market has been influenced negatively by shortsighted investment incentives, either in the form of market subsidies or support for demonstration projects. Since 1978 there have been about 10 different types of national incentive schemes.

The present market situation is weak due to the low interest of installers and house owners and low energy prices, in combination with a relatively large number of small manufacturers with limited resources for rational manufacturing and marketing due to the low market penetration.

Early development was focused on large plants, and 25% of the installed collector area is related to large plants ($>500\,m^2$), e.g. one of the largest plants in Europe so far with $10.000\,m^2$ of ground mounted collectors in Kungälv 20 km north of Göteborg.

Solar thermal installations and energy production

Solar collector production and sales in m²										
	Glazed Collectors									Unglazed Collectors
	Flat Plate Collectors				**Vacuum Collectors**				**Total Glazed**	
	A National Production	B Exports	C Imports	D = A-B+C Total Home Market	E National Production	F Exports	G Imports	H = E-F+G Total Home Market	I = D+H Total Home Market	Total Home Market
1982	4.250	n/a	750	5.000	0	0	n/a	n/a	5.000	2.000
1983	6.000	n/a	1.000	7.000	0	0	n/a	n/a	7.000	2.000
1984	2.150	n/a	350	2.500	0	0	n/a	n/a	2.500	2.000
1985	4.850	n/a	850	5.700	0	0	n/a	n/a	5.700	2.000
1986	3.400	n/a	600	4.000	0	0	n/a	n/a	4.000	2.000
1987	9.300	n/a	1.800	11.100	0	0	n/a	n/a	11.100	2.000
1988	6.780	n/a	1.200	7.980	0	0	n/a	n/a	7.980	2.000
1989	1.950	n/a	6.000	7.950	0	0	n/a	n/a	7.950	2.000
1990	6.380	n/a	1.100	7.480	0	0	n/a	n/a	7.480	2.000
1991	3.520	n/a	4.000	7.520	0	0	n/a	n/a	7.520	2.000
1992	2.048	n/a	500	2.548	0	0	n/a	n/a	2.548	2.000
1993	9.750	n/a	2.000	11.750	0	0	n/a	n/a	11.750	2.000
1994	8.959	n/a	1.950	10.909	0	0	n/a	n/a	10.909	2.000
1995	7.662	n/a	1.700	9.362	0	0	n/a	n/a	9.362	2.000
1996	9.169	n/a	2.000	11.169	0	0	n/a	n/a	11.169	2.000
1997	10.300	n/a	2.300	12.600	0	0	n/a	n/a	12.600	2.000
1998	5.354	n/a	1.650	7.004	0	0	265	265	7.269	2.630
1999	8.097	n/a	1.260	9.357	0	0	145	145	9.502	2.932
2000	12.415	n/a	5.830	18.245	0	0	872	872	19.117	2.983
2001	13.918	n/a	7.630	21.548	0	0	422	422	21.970	3.386



Source: Solar Energy Association of Sweden
1997: Statistics based on statistics for systems with investment incentives.
1998: Statistics based on reported sales from the companies.

There is some collector export, but it is too small to be considered. However, one Swedish industry has a significant export of absorber strips and absorbers, about 70.000 m^2 in 2001.

The figures for imports of FP collectors are estimated, the high numbers 1989, 1991 and 2000 are related to three large plants.

Sales of unglazed collectors are estimated to be on the order of 2.000 m^2 per year for many years.

Estimated solar park in operation at the end of 2001[1]

Flat plate collectors in m^2	156.522	
Vacuum collectors in m^2	1.704	
Total glazed collectors in m^2	158.226	= 18 m^2/1000 inhabitants
Unglazed collectors in m^2	33.931	
Grand Total in m^2	192.157	= 22 m^2/1000 inhabitants

Estimated annual solar thermal energy production in 2001

Flat plate collectors in m^2	156.522	x 300 kWh/m^2·year =	46.957 MWh
Vacuum collectors in m^2	1.704	x 400 kWh/m^2·year =	682 MWh
Unglazed collectors in m^2	33.931	x 300 kWh/m^2·year =	10.179 MWh
Total			57.818 MWh

1. In Sun in Action II, ESTIF uses the following general assumptions to calculate the solar park in operation: systems installed until 1989 have an average lifetime of 15 years; systems installed in or after 1990 have an average lifetime of 20 years.

CO_2 emissions avoided in 2001

Flat plate collectors	46.957 MWh/a	x 0,2 tonnes/MWh =	9.391 t
Vacuum collectors	682 MWh/a	x 0,2 tonnes/MWh =	136 t
Unglazed collectors	10.179 MWh/a	x 0,2 tonnes/MWh =	2.036 t
Total			11.564 t

Product types and solar thermal applications

Product types

The market is dominated by small and large flat plate collectors combined with short-term storages using water.

Applications

Typical applications of solar thermal in Sweden are
Domestic hot water production and space heating (market share of SDWH < 75 %, of which 95 % include space heating)

The most common system in detached houses is a so called ‘combisystem’ with 10–15 m² FP collectors in combination with a buffer storage tank of 500 – 1.500 litre also used for a wood boiler.

Large collective solar systems (market share ~ 10 %)

The large collective systems comprise 50 – 1.000 m² roof-integrated collectors for pre-heating domestic hot water or connected to a local block heating network for both domestic hot water and space heating.

District heating (market share ~ 15 %)

The district heating systems comprise 500 –10.000 m² of ground-mounted collector arrays connected to small district heating plants.

Air conditioning and industrial process heating (market share 0 %)

In Sweden, there is currently no market for solar thermal for air conditioning and industrial process heating.

Employment

Overall employment in the solar thermal sector is estimated at 150–200.

B STATE OF PRODUCTION

Product technology and production methods

Product technology description

Collectors (usual sizes)	2 – 20 m^2 per module
Absorber material	Aluminium and Copper
Surface treatment	NIOX and black chrome
Insulation	Mineral wool
Transparent cover	Low iron glass
Casing	Galvanized steel, wood
Storage tank	Stainless and galvanized steel, iron plates (large tanks)

Typical values of efficiency of collectors and systems
(The three types relate to actual systems used in the Swedish market.)

Collector		Type 1	Type 2	Type 3
Coefficients	($G = 800\ W/m^2$)			
η_0		0,79	0,78	0,77
k_0	W/m^2K	3,04	3,56	2,92
k_1	W/m^2K^2	0,02	0,01	0,02

Production technology description

Production methods and capacity	
Number of companies involved in collector production	About 10
Production capacity	50.000 – 70.000 per year (based on facilities and equipment)
capacity utilization	10.000 –15.000 per year
Type of manufacturing	Absorbers are ‘partly automated’, collectors are all ‘manual’. (Note that there is one Swedish company that has a ‘mainly automated’ production of about 70.000 m^2 of absorber strips where production utilization = capacity).
The potential for product improvements is considerable	
Present quality and performance standards	CEN + National certification

Breakdown of solar systems costs

Solar Systems Costs for Typically Sized Systems		
	Individual[a]	**Project (large scale)**
Total costs (excl. VAT)	400 €/m^2	200 €/m^2
VAT (25%)	100 €/m^2	50 €/m^2
Total cost (incl. VAT)	500 €/m^2	250 €/m^2
Typical size of system	10 m^2	5.000 m^2

a. The typical system is a combisystem producing heat for DHW and space heating.

Percentage cost breakdown of an average system		
	Small	**Large**
Production (materials and labour)	70%	35%
Marketing/distribution	>5%	5%
Installation	<20%	5%
R & D	<5%	<5%

Typical solar domestic hot water system

Characteristics of a typical DHW system	
System type	DHW tank with electric back-up heater
Collector area (m^2)	5
Hot water storage (litres)	300
Total installed cost (VAT incl.)	3.000 €
Eventual subsides	0,25 €/kWh•a ~500 €/a

Typical consumer motivation

Most buyers belong to the category of 'early adopters'; interested in solar energy and the environment.

Conventional water heating and energy prices

Conventional Energy Prices		
Date: 2000	**Housing VAT incl.**	**Collective VAT incl.**
Electricity – normal	0,08 €/kWh	0,06 €/kWh
Fuel – Oil	0,06 €/kWh	0,05 €/kWh
Natural gas	0,06 €/kWh	0,05 €/kWh
District heating	0,05 €/kWh	0,04 €/kWh
Wood chips Wood briquettes Wood pellets	0,025 €/kWh	0,012 €/kWh 0,016 €/kWh 0,022 €/kWh

Standards and codes of practice

All collectors on the Swedish market are tested according to CEN (ISO) + National certification scheme (the so-called P-marking) by SP Swedish National Testing and Research Institute. There is no obligation to test, but the collector has to be tested in order for the buyer to obtain financial support.

Level of R & D

There was a rather low-level (governmental) RD&D program managed by the National Energy Administration from 1996 to 2002, co-financed by some large utilities and some housing facility managers that might be prolonged for another three years. Several solar industries participate in the RD&D program with the main driving force at various institutes and universities. Several large plants and research projects have received EU-funding.

A (governmental) investment subsidy program began in 2000 and will continue at least until 2004. This program is managed by the National Energy Administration, with representatives from the National Board for Housing and the Solar Energy Association of Sweden constituting a review group.

C STATE OF MARKETING

Distribution and marketing methods

Even with investment subsidies the market interest is still rather low, but rising. Manufacturers and SEAS are so far the main driving forces. Some manufacturers have used or use traditional installers, but a large part of the systems are installed by the manufacturers.

The usual component guarantee is 2 years, sometimes 5 years (for selective absorbers up to 10 years). Guaranteed solar results contracts are not used as marketing incentives, but the thermal power output has been guaranteed for some large plants.

Incentives and financing methods

Previously a 25–35% investment subsidy for small systems together with special loans for large systems were used as financial incentives.

At present an investment subsidy related to thermal output, e.g. 0,25 Euro/kWh/a•m^2, is used for small systems, while large systems may receive specific investment subsidies on the order of 25–35%.

D FUTURE PROSPECTS

National energy policy

The oil crises introduced improved building codes and initiated a shift from oil to domestic bio fuels in district heating plants and electricity and heat pumps for individual heating. The solar R&D funding was rather high during the eighties; now, however, it is back to a low level.

The share of renewables is about 25 or 40% depending on how nuclear energy is calculated. The share of solar thermal energy is about 0,0002.

The goal of present energy policy is to achieve a sustainable energy system/supply, taking the environment and security of supply into account. The priorities of the current general energy policy are e.g. deregulation of the electricity market and electricity savings (aiming at the closing down of nuclear plants) and increased use of domestic bio fuels.

There are some regional policies/initiatives mainly related to the use of domestic bio fuels.

Objectives for the solar industry/market

The market needs long-term stable incentives in order to grow significantly.

Prospects for market development by sector.

The overall potential for solar heating can be estimated at 5–10 million m^2 of solar collectors within 10–20 years (1–3TWh/a). There is a rather large potential for individual solar domestic hot water (DHW) systems, as there are a large number of detached houses (about 400.000) with electric DHW heaters that need to be replaced. There is also considerable potential for individual combisystems (DHW + space heating) – the most common system so far.

Furthermore, large collective solar systems could replace oil and/or electricity during the summer in small district heating plants (in combination with wood fuels used during the heating season). There is also potential for large collective solar systems in new building areas with collective heating, as well as in connection to roof renovation on existing multi-family buildings.

Air conditioning and solar process heating will continue to play a negligible role in the future. The potential for unglazed collectors is not known

Strategy to overcome the barriers to market development

Technical barriers regarding the installation of small systems may be overcome by focused development and standardization.

Institutional barriers, especially the fact that there are too many small manufacturers, may be overcome by an increased market. This would pave the way to a more industrial-style production.

Economic barriers such as lack of market, low energy prices, etc. may be overcome by far-sighted incentives and market support.

Cultural barriers such as low interest and solar's bad reputation may be overcome by informational and marketing campaigns.

Educational barriers, including lack of knowledge amongst installers, engineers, users, etc., may be overcome by certified installers, specified courses and information/marketing campaigns respectively.

Concluding remarks

More far-sighted incentives on the national level, as well as on the European level, are necessary in order to achieve significant market growth in Sweden.

References

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Contributions to this report

This report is based on information provided by the Solar Energy Association of Sweden. For his valuable contribution we would like to thank Jan-Olof Dalenbäck.

E ANNEX: SOLAR THERMAL DIRECTORY

Manufacturers and distributors of solar thermal equipment

Arnes Plåtslageri AB
Oskarsvägen 38
702 14 Örebro
Tel: +46 19 32 09 05
Fax: +46 19 32 05 17
e-mail: Aquasol.bjorn@telia.com
Contact person: Björn Ståhl
Activity: Manufacturing and sales of solar collectors and systems (incl. large)

Boröpannan AB
AB Bangårdsv. 1
95231 Kalix
Tel: +46 92 31 66 80
Fax: +46 92 31 37 97
e-mail: info@boroe.com
Contact person: Bo Rönnkvist
Activity: Manufacturing and sales of solar collectors and tanks

Derome AB
Bjurumsvägen 14
430 20 Veddige
Tel: +46 34 06 66 400
Fax: +46 34 06 66 439
e-mail: bertil.ivarsson@derome.se
Contact person: Bertil Ivarsson
Activity: Wood industry group. Manufacturing of (large) roof module collectors

Effectapannan AB
Rågdal 6699
434 96 Kungsbacka
Tel: +46 30 02 23 20
Fax: +46 30 02 23 95
e-mail: effectapannan@swipnet.se
Contact person: Erik Andersson
Activity: Manufacturing and sales of wood/pellet boilers and tanks. Sales of solar systems

Finsun Energi AB
Gäddvägen 8
612 37 Finspång
Tel: +46 12 21 52 43
Fax: +46 12 21 52 43
e-mail: gunnar.wilson@swipnet.se
Contact person: Gunnar Wilson
Activity: Development and manufacturing of solar collectors

Focus Värme AB
Box 89
433 22 Partille
Tel: +46 31 44 08 70
Fax: +46 31 44 85 20
e-mail: info@focusvarme.se
Contact person: Gerhard Wichers
Activity: Sales of solar collectors, boilers, tanks and systems

Inka Energi
Stala 6591
474 96 Nösund
Tel: +46 30 42 09 59
e-mail: inka.energi@swipnet.se
Contact person: Håkan Gustavsson
Activity: Manufacturing, sales and installation of solar collectors and systems

Ingenjörsfirma Leif Karlsson AB
Strandlyckan
517 91 Bollebygd
Tel: +46 33 28 59 59
Fax: +46 33 28 58 09
Contact person: Leif Karlsson
Activity: Manufacturing and sales of solar collectors and tanks

Miljökonsult Energi AB
Box 152
771 24 Ludvika
Tel: +46 24 05 92 922
Fax: +46 24 05 92 925
e-mail: miljo-konsult@telia.com
Contact person: Sten Dahlberg
Activity: Sales of heat pumps and solar systems. Manufacturing and sales of control systems.

Milton AB
Box 50440
202 14 Malmö
Tel +46 40 66 05 050
Fax: +46 40 93 11 80
e-mail: ah@milton.se
Contact person: Åge Haugen
Activity: Sales of solar systems

Solentek AB
Djurmo 29
780 41 Gagnef
Tel: +46 24 11 01 11
e-mail: info@solentek.se
Contact person: Klaus Lorenz
Activity: Manufacturing of solar collectors

SolNor AB
Tingetorp
597 97 Åtvidaberg
Tel: +46 12 02 03 63
Fax: +46 12 02 03 83
e-mail: magnus.danielsson@swipnet.se
Contact person: Magnus Danielsson
Activity: Sales of solar systems

Solsam Sunergy AB
Hornsbruksgatan 28
117 34 Stockholm
Tel: +46 86 52 30 41
Fax: +46 86 52 79 80
e-mail: info@sunergy.se
Contact person: Göran Bolin
Activity: Manufacturing and sales of solar collectors and systems (incl. large)

Sunstrip AB
Skäggebyvägen 29
612 44 Finspång
Tel: +46 12 28 66 61
Fax: +46 12 28 66 69
e-mail: stefan.gustavsson@sunstrip.se
Contact person: Stefan Gustavsson
Activity: Manufacturing and sales of strips and absorbers

Svenska Solgruppen ek.för.
Björneröd, Pl 6215
452 93 Strömstad
Tel: +46 52 63 23 20
Fax: +46 52 63 23 20
e-mail: solenergi.linje3@swipnet.se
Contact person: Anders Jernelius
Activity: Ass. of self-builders. Manufacturing, sales and installation of solar collectors and systems

Texsun Energy AB
Lagergatan 3
931 36 Skellefteå
Tel: +46 91 07 17 880
Fax: +46 91 07 17 889
e-mail: hans.lindqvist@texsun.se
Contact person: Hans Lindqvist
Activity: Manufacturing of (polymer) absorbers

Thermoenergi Örnsköldsvik AB
Svedjevägen 34
892 34 Domsjö
Tel: +46 66 05 18 60
Fax: +46 66 05 18 90
Contact person: Ove Croon
Activity: Sales of solar systems

Uponor AB
513 81 Fristad
Tel: +46 33 17 25 00
Fax: +46 33 17 26 17
e-mail: bjorn.cedenblad@uponor.com
Contact person: Björn Cedenblad
Activity: Plastic industry group. Manufacturing and sales of solar collectors and systems

Viessmann Värmeteknik AB
Gunnebogatan 34
163 53 Spånga
Tel: +46 87 50 60 20
Fax: +46 87 50 60 28
Contact person: Sven Ove Axelsson
Activity: Sales of boilers, etc. and solar systems

Technical consultants specialised in solar projects

Andersson & Hultmark AB
Amerikaskjulet
114 63 Göteborg
Tel: +46 31 70 42 500
Fax: +46 31 77 50 707
e-mail: Anders.bernestal@aohab.se
Contact person: Anders Bernestål
Activity: HVAC system design. Design of solar systems for buildings and district heating

Energianalys AB
S. Strömgatan 9
441 30 Alingsås
Tel: +46 32 26 11 754
Fax: +46 32 26 33 680
e-mail: gunnarl@energianalys.net
Contact person: Gunnar Lennermo
Activity: Design of solar systems for buildings and district heating

FLK AB
Box 43
351 03 Växjö
Tel: +46 47 07 00 943
Fax: +46 47 07 00 999
e-mail: Stefan.olsson@flk.se
Contact person: Stefan Olsson
Activity: HVAC system design. Design of solar systems for buildings and district heating

ZW Energiteknik AB
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Fax: +46 15 52 82 545
e-mail: zinko@algonet.se
Contact person: Heimo Zinko
Activity: Design of solar systems for buildings and district heating

Research and Testing Institutes

SP - Swedish National Testing and Research Institute
PO Box 857
50115 Boras
Tel: +46 33 16 56 62
Fax: +46 33 13 19 79
e-mail: peter.kovacs@sp.se
Contact person: Peter Kovacs
URL: www.sp.se

Principle sources of information

National Board of Housing, Building and Planning (Boverket)
Box 534
371 23 Karlskrona
Tel: +46 45 53 53 000
Fax: +46 45 53 53 100
e-mail: Peter.johansson@boverket.se
Contact person: Peter Johansson
Activity: Building codes, etc. Administration of subsidies

Swedish Energy Agency (Energimyndigheten)
Box 310
631 04 Eskilstuna
Tel: +46 16 54 42 000
Fax: +46 16 54 42 099
e-mail: stem@stem.se
Contact person: Arne Andersson
Activity: Funding RD&D projects, administration of subsidies, representatives in EC, IEA, etc

FORMAS
Box 1206
111 86 Stockholm
Tel: +46 87 75 40 00
Fax: +46 87 75 40 10
e-mail: Michael.rantil@formas.se
Contact person: Michael Rantil
Activity: Funding research projects, representatives in IEA, EC, etc.

SEAS
c/o SERC, Högskolan Dalarna
781 88 Borlänge
Tel: +46 24 31 90 70
Fax: +46 34 61 60 40
e-mail: seas@du.se
Contact person: Lars Andrén
Activity: Solar Energy Association of Sweden – ISES Sweden

United Kingdom

A STATE OF THE MARKET

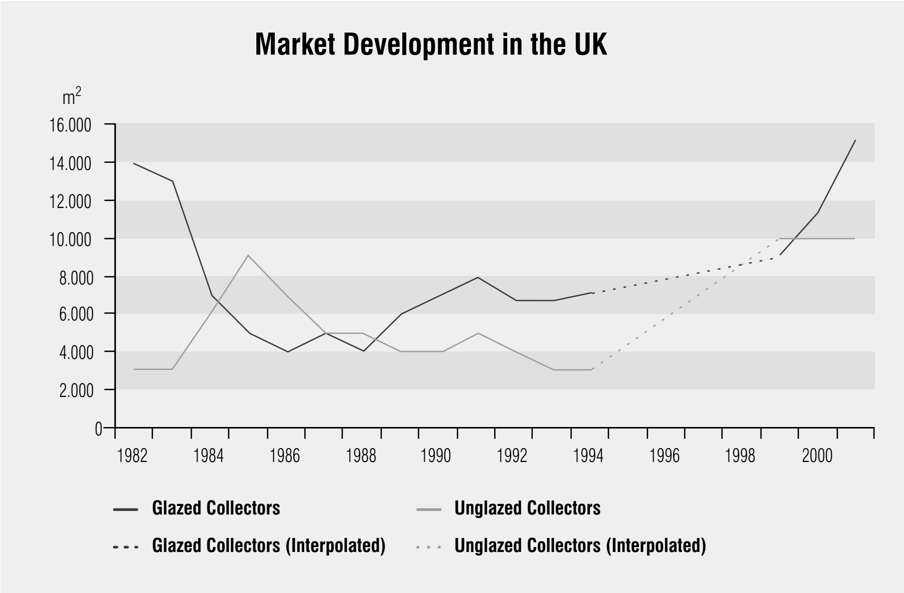
Overview of the market situation

The market for solar thermal in the UK has changed little in the last 20 years. With cheap fossil fuel prices and little government support, it is difficult to make an economic case for solar water heating.

The solar industry is rather fragmented. The largest manufacturer, Thermomax, is a member of the Solar Trade Association, as are a number of medium sized manufacturers, importers and suppliers. However there are a number of medium sized suppliers who are not members. This makes the gathering of intelligence about the market difficult.

Solar thermal installations and energy production

Solar collector production and sales in m^2										
	Glazed Collectors									Unglazed Collectors
	Flat Plate Collectors				Vacuum Collectors				Total Glazed	
	A National Production	B Exports	C Imports	D = A-B+C Total Home Market	E National Production	F Exports	G Imports	H = E-F+G Total Home Market	I = D+H Total Home Market	Total Home Market
1982				14.000					14.000	3.000
1983				13.000					13.000	3.000
1984				7.000					7.000	6.000
1985				5.000					5.000	9.000
1986				4.000					4.000	7.000
1987				5.000					5.000	5.000
1988				4.000					4.000	5.000
1989				6.000					6.000	4.000
1990				7.000					7.000	4.000
1991				8.000					8.000	5.000
1992				6.100				500	6.600	4.000
1993				6.100				500	6.600	3.000
1994				6.200				1.000	7.200	3.000
1999	14.300	9.000	550	5.850	50.500	48.800	1.630	3.330	9.180	10.000
2000	12.800	8.400	2.200	6.600	50.500	48.800	3.550	5.250	11.850	10.000
2001	15.000	8.400	1.400	8.000	80.500	78.800	5.530	7.230	15.230	10.000



Source: Sun in Action I; Solar Trade Association (data is based on communications with manufacturers, suppliers and installers)

Estimated solar park in operation at the end of 2001[1]

Flat plate collectors in m^2	92.950	
Vacuum collectors in m^2	26.470	
Total glazed collectors in m^2	119.420	$= 2{,}0\,m^2/1000$ inhabitants
Unglazed collectors in m^2	89.000	
Grand Total in m^2	208.420	$= 3{,}5\,m^2/1000$ inhabitants

Estimated annual solar thermal energy production in 2001

Flat plate collectors in m^2	92.950	x 427,5 $kWh/m^2 \cdot year$ =	39.736 MWh
Vacuum collectors in m^2	26.470	x 475 $kWh/m^2 \cdot year$ =	12.573 MWh
Unglazed collectors in m^2	89.000	x 285 $kWh/m^2 \cdot year$ =	25.365 MWh
Total			77.674 MWh

1. In Sun in Action II, ESTIF uses the following general assumptions to calculate the solar park in operation: systems installed until 1989 have an average lifetime of 15 years; systems installed in or after 1990 have an average lifetime of 20 years.

CO_2 emissions avoided in 2001

Flat plate collectors	39.736 MWh/a	x 0,24 tonnes/MWh =	9.537 t
Vacuum collectors	12.573 MWh/a	x 0,24 tonnes/MWh =	3.018 t
Unglazed collectors	27.360 MWh/a	x 0,24 tonnes/MWh =	6.088 t
Total			18.643 t

CO_2 Assumptions	
Electricity	0,44 t/MWh
Gas	0,19 t/MWh
Weighted average (20 % electricity, 80 % gas)	0,24 t/MWh

Solar thermal applications

Applications of solar thermal in the UK are:

- Domestic hot water production: Vast majority of systems are solar domestic hot water systems.
- Space heating: There are only few examples of this application in the UK.
- Air conditioning and industrial process heating: Very few examples of industrial and agricultural use of solar for process heating.
- Large collective solar systems as well as district heating: No examples of these applications in the UK.

Employment

Estimated employment figures in the following sectors (full-time jobs)	
Manufacturing of components of solar thermal systems:	356
Installation and maintenance:	9
Distribution:	28
Sales and marketing:	63
Testing, quality assurance and research:	27
Training:	4
Consultancy:	4
Total:	491

B STATE OF PRODUCTION

Product technology and production methods

Typical product technology	
Collectors (usual sizes)	2,5 – 4,5 m^2 Vacuum collectors are smaller and flat plates larger
Absorber material	Selective surfaces are used on aluminium, copper or steel
Transparent cover	Includes toughened glass, polycarbonate, tedlar
Casing	Plastic, aluminium
Storage tank	Copper, twin coil

Breakdown of solar systems costs

Solar Systems Costs for Typically Sized Systems		
	Individual	**Project (large scale)**
Total costs (excl. VAT)	1.500 €/m^2	n/a
VAT (5 %)	75 €/m^2	n/a
Total cost (incl. VAT)	1.575 €/m^2	n/a
Typical size of system	3 m^2	n/a

Give the percentage cost breakdown of an average system in: estimated as typically	
Production (materials and labour)	50 %
Marketing/distribution	20 %
Installation	25 %
R & D	5 %

Typical solar domestic hot water system

Give the following characteristics of a typical DHW system	
System type	High efficiency flat plate or vacuum tube collectors
Collector area (m^2)	2,5–3,5
Hot water storage (litres)	150–180
Total installed cost (VAT incl.)	3.500–7.000 €
Eventual subsides	795 €

Conventional water heating and energy prices

Conventional Energy Prices		
Date: 2000	**Housing VAT incl.**	**Collective VAT incl.**
Electricity – normal	0,115 €/kWh	0,1155 €/kWh
Electricity – low rate	0,04 €/kWh	0,042 €/kWh
Fuel – Oil	n/a	n/a
Bottled gas	n/a	n/a
Natural gas	0,023 €/kWh	0,024 €/kWh
District heating	n/a	n/a

Standards and codes of practice

In order to obtain Enhanced Capital Allowances then collectors or systems must comply with the latest British Standard. However, there is no test institute for solar thermal collectors/systems in the UK and most collectors are not tested.

Level of R & D

In the UK, there is very little R&D in the field of solar thermal. Except for some public funding of system monitoring in the field, financing by industry and public funds is very low.

C STATE OF MARKETING

Distribution and marketing methods

Present situation and current tendencies
Most systems are sold by wholesalers and installers through advertising and direct mailing. The Solar Trade Association operates a telephone enquiry service and also a web site. Enquiries from potential customers are passed onto members (provided the customer gives permission) or they are sent a list of members to contact themselves.

The Solar Trade Association has a Code of Ethical Practice which members have to follow. The Code sets out ethical marketing guidelines including the requirement to give customers a "cooling off period" allowing them to change their minds up to 7 days after a sale. A number of companies not in the Association do not give a cooling off period and this is bringing the industry into disrepute.

New marketing concepts
The leasing of systems has been experimented with recently. But the results from this are not yet known. Guaranteed solar results have not been used in the UK so far.

Marketing principles
Solar water heating is sold mainly on its environmental benefits and its ability to save money.

Use of solar collectors as standard facilities in housing projects.
Some local authorities are looking to promote solar energy systems through the planning system. Housing Associations are leading the way in actually installing solar systems into new housing.

Marketing activities towards professional parties in the building industry.
Social Housing Associations have been targeted in the past.

After-sale methods:
- Usual maintenance needs: Minimal
- Percentage of system retrofit market: Minimal

Promotion activities:
- Existence of specialist journals and fairs - exhibitions for promotion.
  None specifically for solar thermal, though there are energy exhibitions and housing exhibitions which solar companies attend.
- Media (TV, radio etc).
  The mis-selling of solar has been featured a number of times in recent years on national programmes. Local or regional TV and Radio is usually keen to report the environmental benefits of new solar projects.

Incentives and financing methods

There has been very little support from the government. Recently the VAT rate for solar systems was reduced from 17,5% to 5% in line with other energy efficiency products. In 2003, solar was added to the list of equipment which qualified for Enhanced Capital Allowances. This is equivalent to around a 5% saving, but is only available for companies paying tax and not for domestic customers.

A small number of local authorities have given small grants (5% to 10%) for systems or arranged group discounts. A national grant of around 25% is proposed by the Department of trade and Industry to be implemented February 2003.

D FUTURE PROSPECTS

National energy policy

Energy policy in the UK is currently under review. The current policy is focused on renewable energy electricity targets (10% by 2010). In terms of renewables the priorities are off-shore wind, biomass, PV and developing marine technologies such as tidal and wave power. Solar thermal does not feature strongly in current UK government thinking.

The driving forces of UK energy policy are security of supply, diversity and environmentally friendly forms of energy.

Currently, renewable energy currently supplies around 3% of the electric and 1% of the total energy. Solar thermal does not register.

Regional policies are developing which whilst prompted by the 10% of electricity from renewables target are also tending to include policies on renewables for heating including solar thermal. At a local level there is much more emphasis on including solar thermal, particularly where there are plans for new housing.

Objectives for the solar industry/market

The solar thermal industry in the UK has an opportunity with the new national Grant for Community and Household Renewables (called Clear-Skies) to increase the market in the domestic sector and to raise standards and increase the number of professional installers.

Prospects for market development by sector.

- Domestic hot water production: Large new opportunities arise through new grant system and also through local plans and new housing.
- District heating: Some limited opportunities could arise in connection with new housing.
- Space heating, large collective systems and other applications of solar thermal are not expected to grow within the near future.

Strategy to overcome the barriers to market development

Description of major barriers by category:
- Technical: No testing centres in the UK. Not easy to obtain reliable performance comparisons between systems. No coordinated accreditation system or training schemes for installers (outside of STA membership)
- Institutional: Need support for solar in the planning system. Some local planning authorities are anti-solar.
- Economic: Current fossil fuel prices in the UK are very low.
- Cultural: People move house frequently. Solar is not yet seen as an asset on a house.
- Educative: Public are not generally aware of the capability of solar thermal and are confused about the difference between photovoltaics and solar thermal

Description of main measures (actions) needed to extend the solar thermal market by category:
- Technical: Need to develop installer accreditation and training. Need independent testing station to provide more reliable performance information.
- Institutional: Need support from planning system.
- Economic: Need grant aid to develop market and reduce capital costs.
- Cultural: Need to raise awareness and develop an appreciation for existing installed solar systems.
- Educative: Need much more independent and impartial information for the public.

Concluding remarks

The solar thermal industry in the UK is underdeveloped, under financed, and largely ignored by the government. However the potential market is huge. The proposed large increase in house building provides an excellent opportunity to expand the solar thermal market.

Contributions to this report

This report is based on information provided by the Solar Trade Association (STA). For their valuable contribution we would like to thank Christine Ballard and Gareth Ellis.

E ANNEX: SOLAR THERMAL DIRECTORY

Manufacturers and distributors of solar thermal equipment

AES Solar Limited
AES Building
Lea Road
Forres
Scotland
IV36 1AU
Tel: +44 13 09 67 69 11
Fax: +44 13 09 67 10 86
e-mail: info@aessolar.co.uk
Contact person: George Goudsmit
URL: www.aessolar.co.uk
Activity: Manufacturing of solar water heating systems.

Alternatives Wales Ltd
Geuwan Goch
Eglwyswrw
Crymych
Pembrokeshire
SA41 3SE
Tel: +44 12 39 89 12 71
Fax: +44 12 39 89 12 71
e-mail: alternatives.solar@virgin.net
Contact person: Colin Luker
URL: www.solarenergywales.co.uk
Activity: Dealer of solar thermal systems.

Atmos Heating Systems
West March
Daventry
NN11 4SA
Tel: +44 13 27 87 19 90
Fax: +44 13 27 8719 05
e-mail: jthomason@skaino.co.uk
Contact person: John Thomason
URL: www.atmos.co.uk
Activity: Distribution of domestic and industrial heating systems.

Construction Resources
16 Great Guildford St
London
SE1 0HS
Tel: +44 20 74 50 22 11
Fax: +44 20 74 50 22 12
e-mail: casimiri@ecoconstruct.com
Contact person: Casimir Iwaszkiewicz
URL: www.ecoconstruct.com

CPV Ltd
Woodington Mill
East Wellow
Romsey
Hampshire
SO51 6DQ
Tel: +44 17 94 32 28 84
Fax: +44 17 94 32 28 85
e-mail: sales@cpv.co.uk
Contact person: M.W. Wood
URL: www.cpv.co.uk
Activity: Manufacturing of low temperature collectors.

Energy Engineering
Herons Reach
Cound Moor
Shrewsbury
Shropshire
SY5 6BB
Tel: +44 16 94 73 16 48
Fax: +44 16 94 73 16 96
e-mail:
energyengineering@btinternet.com
Contact person: Geoff Gough

Filsol Solar Ltd
15 Ponthenri Industrial Estate
Ponthenri
Llanelli
Carmarthenshire
SA15 5RA
Tel: +44 12 69 86 02 29
Fax: +44 12 96 86 09 79
e-mail: info@filsol.co.uk
Contact person: John Blower
URL: www.filsol.co.uk
Activity: Manufacturing and supplying of solar thermal systems and components. Training and consulting services.

I T Power Ltd
The Manor House
Chineham Court
Chineham
Hampshire
RG24 8AG
Tel: +44 12 56 39 27 00
Fax: +44 12 56 39 27 01
e-mail: itpower@itpower.co.uk
Contact person: Rebecca Gunning
URL: www.itpower.co.uk
Activity: Consulting services in renewable energy technologies including SWH.

Imagination Solar Limited
10-12 Picton Street
Montpelier
Bristol
BS6 5QA
Tel: +44 11 79 42 89 98
Fax: +44 11 79 42 01 64
e-mail: enquiries@imaginationsolar.com
Contact person: Jon Walker
URL: www.imaginationsolar.com

Lyons Green House
Lyons Green
Waldron
East Sussex
TN21 0PJ
Contact Person: N P Parkinson

Magpie Technologies Limited
Crabtree Farm
The Warren
Crowborough
East Sussex
TN6 1UB
Tel: +44 18 92 66 73 20
Fax: +44 18 92 66 76 22
e-mail:
enquirires@magpie-technologies.co.uk
Contact person: Geoff Fox
URL: www.magpie-technologies.co.uk
Activity: Research, design, manufacturing and direct selling.

Powersun Solar Systems Ltd
9 Bardfield Gardens
Rise Park
Nottingham
NG5 5AY
Tel: +44 11 59 27 08 80
e-mail: powersunsolar@amserve.net
Contact person: Richard G. Whittle
URL: www.powersun.co.uk
Activity: Specification and installation of solar thermal systems.

Powertech Solar Ltd
171a New Road
West Parley
Ferndown
Dorset
BH22 8ED
Tel: +44 87 07 30 01 11
Fax: +44 87 07 30 02 22
e-mail: sales@solar.org.uk
Contact person: Eric R Hawkins
URL: www.powertech-solar.co.uk
Activity: Selling of solar systems.

Riomay Renewable Energy Ltd
1 Birch Road
Eastbourne
Sussex
BN23 6PL
Tel: +44 13 23 64 86 41
Fax: +44 13 23 72 06 82
e-mail: tonybook@pavillion.co.uk
Contact person: Tony Book
URL: www.riomay.com
Activity: Supplying, installing, designing of solar hot water systems.

Secon
17 Business and Innovation Centre
Wearfield
Sunderland Enterprise Park East
Sunderland
SR5 2TA
Tel: +44 19 15 16 65 54
Fax: +44 19 15 16 65 54
e-mail: info@secon-uk.com
Contact person: Iain Calderwood
Activity: Distribution of differential temperature controllers.

Solar Sense B9NRG
Sandy Lane
Pennard
Gower
Swansea
SA3 2EN
Tel: +44 17 92 37 16 90
Fax: +44 17 92 37 13 90
e-mail: info@solarsense.co.uk
Contact person: David Lloyd-Jones
URL: www.solarsense.co.uk
Activity: Solar water heaters.

Solar Store
1 Bush Farm Cottage
Acrise
Folkestone
Kent
CT18 7EA
Tel: +44 13 03 89 24 91
Contact person: B E Brisley

Solar Twin Ltd
15 King Street
Chester
CH1 2AH
Tel: +44 12 44 40 34 04
Fax: +44 12 44 40 36 54
e-mail: hi@solartwin.com
Contact person: Barry Johnson
URL: www.solartwin.com
Activity: Manufacturing, installing of solar water heaters; consulting.

Solarmatt Ltd
82 The Ryde
Hatfield
Hertfordshire
AL9 5DL
Tel: +44 17 07 26 61 97
Fax: +44 17 07 88 17 82
e-mail: solarmatt@ntlworld.com
Contact: David Johnson
URL: www.soalrmatt.com
Activity: Manufacturing of solar thermal systems for swimming pools.

Solarsense Ltd
8 Copford Lane
Long Ashton
Bristol
BS41 9NF
Tel: +44 12 75 39 41 39
Fax: +44 12 75 54 01 13
e-mail: solarsense@blueyonder.co.uk
Contact person: Steve Barrett
Activity: Designing, installing vacuum tube solar systems.

SolarTech (UK) Ltd
Tudorleaf Business Centre
2 - 8 Fountayne Road
London
N15 4QL
Tel: +44 20 88 01 21 98
Fax: +44 20 88 08 56 05
e-mail: anything@solartech-uk.co.uk
URL: www.solartech-uk.co.uk
Activity: Manufacturing and supplying of solar thermal systems for water heating, space heating and air conditioning.

Spectrum Energy Ltd
190 Charminster Road
Bournemouth
Dorset
BH8 9RL
Tel: +44 12 02 51 98 25
Fax: +44 10 25 19 834
e-mail:
headoffice@spectrum-energy.co.uk
URL: www.spectrum-energy.co.uk
Activity: Manufacturing of vacuum tube collectors.

J R Stammers
19 Priory Park
Backheath
London
SE3 9UY
Tel: +44 20 88 52 51 48
Fax: +44 20 82 97 03 01
e-mail: j.r.stammers@btinternet.com
Contact person: Judith Stammers
Activity: Consulting.

Sun Power Technology Ltd
44 Old Way
Bishopston
Swansea
SA30 3DJ
Tel: +44 17 92 23 37 93
e-mail: greg@sunpowertech.co.uk
Contact person: Gregg Wild
URL: www.sunpowertech.co.uk

Sundwel Solar Ltd
1 Tower Road
Glover Industrial Estate
Washington
Tyne and Wear
NE37 2SH
Tel: +44 19 14 16 30 01
Fax: +44 01 91 41 54 297
e-mail: solar@sundwel.com
Contact person: Keith Wilkinson
URL: www.sundwel.com
Activity: Manufacturing, supplying, installing solar water heating systems.

Thermomax Ltd
7 Balloo Crescent
Bangor
Co. Down
Northern Ireland
BT19 7UP
Tel: +44 28 91 27 04 11
Fax: +44 28 91 27 05 72
e-mail: info@thermomax.co.uk
Contact person: Kathy McVeigh
URL: www.thermomax-group.com
Activity: Manufacturing of vacuum tube collectors.

TJC Central Heating
14A Mungle Street
West Calder
West Lothian
EH55 8BX
Tel: +44 15 06 87 28 91
Contact person: Scott B Crookston

VELUX Company Ltd.
Woodside Way
Glenrothes East
Fife KY7 4ND
Scotland
Tel: +44 15 92 77 22 11
Fax: +44 15 92 77 18 39
URL: www.velux.com

Viessmann Limited
Hortonwood 32
Telford
Shrops
TF1 4EU
Tel: +44 19 52 67 50 00
Fax: +44 19 52 67 01 03
e-mail: jon@viessmann.com
Contact person: Hugh Jones
URL: www.viessmann.co.uk
Activity: Manufacturing of heating equipment.

Winsund International Ltd
Priory Farm
Muggleswick
Co. Durham
DH8 9DW
Tel: +44 12 07 25 53 65
Fax: +44 12 07 25 56 28
e-mail: info@winsund.com
Contact person: Michael Seeley
URL: www.winsund.com

Australia

A STATE OF THE MARKET

Overview of the market situation

Solar Water Heating developed during the late 1940s in Australia to supplement water heating in remote regions where energy costs where expensive or in some cases in remote locations where conventional energy sources electricity or gas used for water heating didn't exist. The first solar water heater design was developed from technology pioneered by the CSIRO (Commonwealth Scientific and Industrial Research Organization) this technology was mainly found in coastal and northern tropical latitudes of Australia. Product development quickly evolved into passive thermosiphon design due to lower cost of product and the lack of pumps and controllers suitable for active solar pump systems.

Australia is a large continent with diverse climatic conditions and in the course of urban development during post World War II various forms of water heating were adopted within contemporary housing construction. This often manifested itself with regional characteristics which were suitable for local conditions. Fuel sources were a common outcome of this evolution with country Australia using solid fuel combustion type heaters and metropolitan regions using either gas or electric heating. In one of the more remote state capital cities of Australia, Perth quickly adopted the use of solar water heating due to the consistent warm sunny climatic conditions prevailing in this part of the Australia. Another reason behind the adoption of solar water heating in Western Australia was the high cost of energy and limited availability of gas within Perth and surrounding regions.

During the course of the 1960s various local manufactures established themselves within Western Australia manufacturing solar water heaters. These companies supplied local markets prior to expanding interstate and setting up networks in other Australian state capital cities.

Market expansion was slow with numerous obstacles impeding growth within the Australian market. Consumer objection to adoption still revolved around the cost of the product and the lack of awareness of the technology. Sales continued to grow during the 1960s but it wasn't until the first of the OPEC oil shocks which like the rest of the world took hold within Australia in 1972. Awareness of the finite resources which the world precariously depended on took centre stage for the first time and subsequently provided public awareness for developers of alternative energy sources such as solar water heater systems.

The market for solar water heaters quickly grew during the 1970s but was still small compared with electric and gas water heater segment. Over the course of this time product development became more refined with various versions of the thermosiphon system being developed to suit construction standards of housing and more streamline manufacturing methods. The emergence of more mainstream industrial manufactures in this industry saw better equipped and resourced companies participate within the solar water heater segment. Capital intensive industries which were not focused on these products started to invest and in turn brought a more mature business strategy to this segment.

The second OPEC oil shock in the late 1970s saw a rapid escalation of competitors which included at one stage up to twenty companies manufacturing solar water heaters. The expansion of the industry was also extremely rapid in 1980 through until 1985. Modern marketing methods characterised by aggressive sales activity saw the industry increase output in systems to over 150.000 m^2 per year. The largest demand for these systems was still in the domestic cottage industry with export markets being developed from 1979 onwards in the equally rapidly developing United States market and Southern European region.

However the rapid growth saw an equally rapid decline due to emergence of national energy policies which saw the development of coal for electricity production and natural gas taking a more aggressive focus on water heating within Australia. The emergence of natural gas reticulation in 1960s and 1970s provided an aggressive and powerful competitor to the once dominant electricity utilities. Aggressive discounting of energy tariffs to domestic users with equally aggressive offers such as free water heaters or soft loans for products did not allow the solar water heater companies equal opportunity within this energy segment. The outcome of this saw the solar water heater industry caught in a cross fire between large competing monopolies and eventually it took its toll on the industry within Australia and many companies exited never to return.

Early consumer adopters purchased solar thermal products but without the normal secondary late majority segment which most consumer products depend on. Due to this solar water heater market share began to decline within the more populated states of Australia. During the 1980s more and more solar water heater companies closed their doors for good leaving the inevitable dissatisfied consumers with no product warranties and no after sales service. Aggressive sales techniques used during the boom days attempted to convince consumers that one company's product was far superior to another's. Often the promise of life time guarantees where brandished around the market to attract consumers or to close sales. The upshot of this resulted in many dissatisfied consumers finding out that the technology they purchased wasn't up to their expectation.

Market growth declined and at the end of the 1980s only six manufactures remained. The industry moved gradually during this period from a core domestic focus to increased export focus to maintain volumes and existence. Various companies had domestic and commercial electric and gas water heating business to sustain their business activities and saw the passing of solar water heating industry as an inevitability but one or two maintained a more aggressive focus and held production volumes stable over the next five years until other factors such as the environment and global warming emerged as the next major impact on the industry.

The industry has remained stable through the 1990s with various mergers taking place in an already consolidated industry. Other impacts on the industry such as the Sydney Olympic Games which allowed the industry to showcase various renewable energy technologies took place with some benefit but the greatest benefit to emerge from this new enlightenment was the introduction the Renewable Energy (Electricity) Act (REEA). This was an Australian Federal Government initiative supported by all political parties to ensure the mandate and use of renewable energy within the Australian electricity grid. By 2012 two percent renewable energy is to be included within the Australian distribution grid accounting for 9.500 GWh of renewable energy. Within this REEA the goal is to have renewable energies covering 20% of the total energy supply in 2020.

This initiative is open for qualified renewable energy sources which solar thermal water heating is approved under this act. There is also a new subsidy scheme ("Certified Programm") for solar thermal where the subsidies are related to performance of the solar system.

Under this new scheme various companies have rapidly increased their sales within Australia. The market is still concentrated but has grown and will continue to do so over the coming decade based on recent forecasts for Renewable Energy Certificates.

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Solar collector production and sales in m²										
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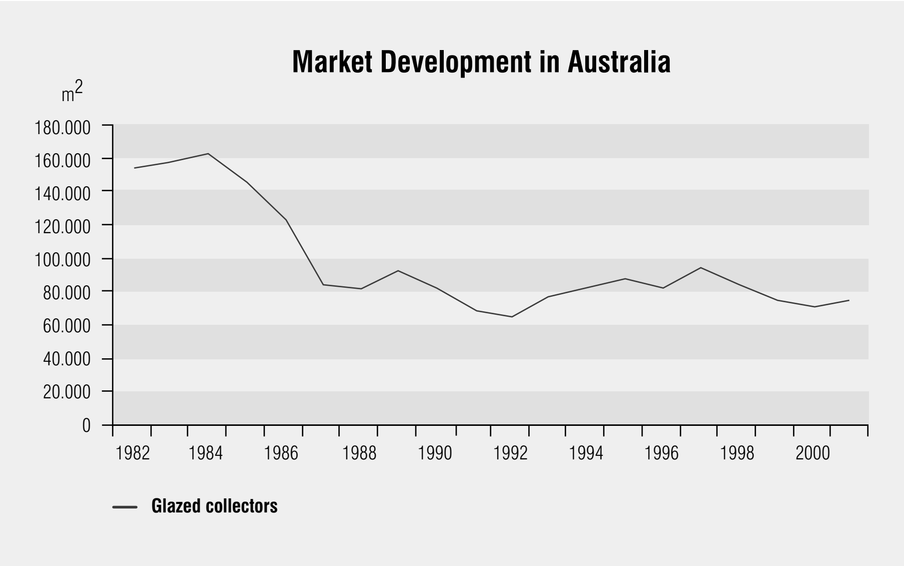
1982	172.000	17.000	0	155.000					155.000	n/a
1983	174.000	17.000	0	157.000					157.000	n/a
1984	190.000	29.000	0	162.000					162.000	n/a
1985	180.000	36.000	0	144.000					144.000	n/a
1986	164.000	41.000	0	123.000					123.000	n/a
1987	120.000	36.000	0	84.000					84.000	n/a
1988	126.000	44.000	0	82.000					82.000	n/a
1989	141.000	49.000	0	92.000					92.000	n/a
1990	124.000	44.000	0	81.000					81.000	n/a
1991	105.000	37.000	0	68.000					68.000	n/a
1992	100.000	35.000	0	65.000					65.000	n/a
1993	118.000	41.000	0	77.000					77.000	n/a
1994	126.000	44.000	0	82.000					82.000	n/a
1995	135.000	47.000	0	88.000					88.000	n/a
1996	126.000	44.000	0	82.000					82.000	n/a
1997	144.000	50.000	0	93.000					93.000	n/a
1998	138.000	55.000	0	83.000					83.000	n/a
1999	136.000	61.000	small	75.000					75.000	n/a
2000	142.000	71.000	small	71.000	<1.000			<1.000	71.000	n/a
2001	155.000	80.000	small	75.000	<1.000			<1.000	75.000	n/a

Source: Australian Bureau of Statistics, CAP-AUS, Graham Morrison (University NSW), Solahart



Product Life

Product life has a major effect on the extent to which solar water heaters can displace electricity, as part of current production is required for product replacement. In the major population areas of Australia conventional electric water heaters have a guarantee of 5 to 7 years and a typical life of 12 to 15 years. Solar water heaters have a tank life that is generally better than conventional electric water heaters and the solar collector life is longer than the tank life, particularly for copper absorber collectors. Since 1997 solar water heaters have been sold with a 12 year guarantee and are expected to have a life approaching 20 years. Outside of the hard water areas in central Australia a large proportion of solar water heaters installed in the 1980's are still operating. A thermosiphon system operated and monitored at the University of NSW since 1978 is still achieving 85% of the original performance.

In Sun in Action II, ESTIF uses the following general assumptions to calculate the solar park in operation: systems installed until 1989 have an average lifetime of 15 years; systems installed in or after 1990 have an average lifetime of 20 years.

Estimated solar park in operation at the end of 2001

Flat plate collectors in m^2	1.198.000	= 61 m^2/1000 inhabitants
Unglazed collectors in m^2	2.000.000	(estimated)
Grand Total in m^2	3.198.000	= 164 m^2/1000 inhabitants

Estimated annual solar thermal energy production in 2001

Flat plate collectors in m^2	1.198.000	x 700 kWh/m^2·year =	836.600 MWh
Unglazed collectors in m^2	2.000.000	x 300 kWh/m^2·year =	600.000 MWh
Total			1.436.600 MWh

CO_2 emissions avoided in 2001

Flat plate collectors	828.600 MWh/a	x 1,0 tonnes/MWh =	836.600 t
Unglazed collectors	600.000 MWh/a	x 1,0 tonnes/MWh =	600.000 t
Total			1.436.600 t

Product types and solar thermal applications

Product types

The domestic solar water heater design within Australia has focused on closed couple thermosiphon systems utilizing flat plate collectors. Selective surface collectors became more common from 1984 onwards and remain widely used but standard painted absorber surfaces are also equally used throughout Australia and in particular within the Northern savanna and tropical regions of Australia. Two principle sizes are used these being 300 litre storage tank with 4 m^2 of collectors and 180 litre with 2 m^2 collector surface.

Solar water heater design has more recently focused on active systems with the advent of more reliable low energy pumps and electronic controllers with numerous features to increase performance of the system. Cost reductions in both solar controls and solar pumps have made this system more appealing for house designers and installers.

Flat plate collectors have remained the most cost effective collector available for domestic application and until one Australian company commenced manufacturing concentrating evacuated tube systems in 2001 the market was void of any local ETC manufactures. However since 2002 this production has also stopped being manufactured.

Applications

Installation figures according to the following application segments:

- The vast majority of systems installed within Australia are used for domestic application and within this application domestic hot water usage is 99% of the requirements. Australian climate and housing construction does not use solar water heaters for space heating.
- Various large scale installations have been undertaken both on a residential as well as commercial basis but these types of systems still remain low volume compared with the single dwelling domestic applications within Australia. Projects such as the Sydney Olympic Athletes Village are a case in example of such a project.
- Climatic conditions within Australia rarely lend itself to the use of solar thermal for space heating. This application is almost non existent and is considered too expensive for main stream application.
- District heating is not used within Australia.
- Various small scale demonstration projects have been attempted over the years but air conditioning and industrial process heating applications still remain very much small scale within Australia. The strict hurdle costs of return for this type of application remain too tough for solar thermal applications.

Employment

- Within the industry approximately 300 people are directly employed in manufacturing and management of the 4 main companies involved. Upstream employment relating to the supply of raw materials and services to the industry would have in excess of a 500 people directly employed.
- Dedicated distribution and service industry has a further 400 people employed within the industry who derive the main income from sales, service and installation of solar water heaters.
- Various testing institutions exist within Australia and direct employment not including students would be approximately 20 full time staff. The duties for these staff do not include 100% activity on solar water heaters.

B STATE OF PRODUCTION

Product technology and production methods

Product technology description

Currently 95% of all glazed solar collectors are 2m^2 flat plate collectors. The absorber material consists of various materials but for open circuit type systems copper tube and aluminum fin with painted surface remain the most common. Pressed steel envelope absorber panels used for closed circuit systems were introduced in the early 1980s by Solahart and remain a staple of this manufactures design. However it has limited application other than with use in their thermosiphon product.

Surface treatment used includes black paint using electrostatic powder coat as well as black chrome. More recently sputtered surface collectors incorporating Tinox or Interpane have been developed but remain in small quantities compared with paint and chrome surfaces. The absorber panel is housed within folded tray usually aluminum or zinc coated steel and insulated internally using polyester or fiberglass insulation. A standard industry wide glazing is used within Australia incorporating reduced iron content for greater transmission and toughed for safety and to decrease breakage due to hail and storms.

The collectors are connected to a storage cylinder usually incorporating a closed couple thermosiphon method using either two or one collector depending on the size of the storage cylinder. The internal lining of the storage cylinder is either vitreous enamel or stainless steel. Both types of cylinders are insulated using a high pressure polyurethane insulation and incased in either an aluminum outer weather proof case or zinc and painted steel case. Each cylinder has an incorporated electric element and thermostat for boosting purposes.

Performance of these systems is covered under an Australian standard and under average conditions are approximately 70% efficient.

Product technology description

Unlike most European manufactures all of the Australian companies are fully vertically integrated manufactures also manufacturing storage tanks as well as collectors. Since the acquisition of Solahart by Rheem in 1999 Solahart have been manufacturing all collectors for both Solahart and Rheem at their Welshpool site. Edwards are also a Western Australian manufacture and manufactures a wide range of flat plate product as well. Other manufactures include Beasley based in South Australia and two other companies Solco and SolarKlean also manufacture in Western Australia.

Whilst all manufactures with exception of Solco incorporate standard manufacturing methods Solco have adopted a unique rotational molded method which incorporates the storage tank into the collectors.

Total output on a single eight hour shift is currently capable of 170,000 m^2. However all manufactures are able to increase production above this by adopting an increase in shifts worked per 24 hours. Capacity is able to be doubled with reasonable time frame and only minor production amendments.

Manufacturing methods vary within various processes with state of the art manufacturing automation in steel absorber production at Solahart but remains very labour intensive when it comes to collector case assembly and final assembly.

Product improvement will be largely restricted to material science improvements but more importantly with volume growth larger scale automation can be incorporated which could include fully automated tray processing and absorber insertion and assembly methods.

System manufacturing has evolved to a suitable standard for most applications and current standards covered under Australian Standard AS2712 allows for construction standard of a nature more than suitable for world wide application. Supporting these standards is a common ISO 9000 accreditation system which is now compulsory for any manufacture wishing to participate in the Federal Governments Renewable Energy certificate Program.

Standards and codes of practice

The Australian standard applicable to solar domestic hat water systems is AS 2712. Independent testing is carried out at the University NSW in Sydney. Under the new REEA scheme no subsidies can be claimed for collectors that have not passed testing.

References

Australian Bureau of Statistics

CAP-AUS

Graham Morrison (University NSW)

Solahart

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China (PRC)

A STATE OF THE MARKET

Overview of the market situation

China is by far the world's largest solar water heater manufacturer and user. By the end of 2002 the accumulated installed area of solar domestic hot water systems in China was about 40 million m^2. Clearly driven by the state strategy of sustainable development, China today has a well established solar thermal industry with over a thousand manufacturers producing and selling ST-systems. During recent years, in particular, water heater manufacturing technologies have become increasingly mature under the policy of "striving for industrial scale, high technological level, quality products and standardised market". Thanks to joint efforts by research institutes, universities and enterprises over the past 20 years China's solar energy industry has made great progress – especially during the last 5 years.

The annual amount of solar energy radiation exceeds 5,02 million kJ/m^2 (~1.400 kWh/m^2). More than 66 % of the area of the country has sunshine time in excess of 2200 hours per year. Solar thermal provides people in urban and rural areas with cost-effective energy.

In most provinces of China the solar solution for domestic hot water (DHW) supply is viewed as the most economical one. As the infrastructure for DHW – especially natural gas and electricity – in most cities is not well developed, the natural solar resource makes solar DHW systems an excellent alternative in providing hot water to households. The market potential is there for hot water – a fundamental aspect of modern civilized, hygienic and healthy life – to a population of 1,3 billion, 75 % of whom reside in rural areas. According to a government agency's (State Economic and Trade Commission) long-term planning, renewable energies and new energy resources are expected to make up 2 % of the overall energy resources supply in 2015. This planning also assumes a 17 % annual growth on average for solar thermal systems, and would then reach the targeted figure of 230 million m^2 – accumulated total installed area (more information in section D).

There are more than one thousand manufacturers producing and selling solar thermal systems. The 33 biggest companies alone employ probably > 50.000 people directly, engaging indirectly > 100.000 people in marketing, installation and after-sales service of solar water heaters. According to incomplete statistics this industry realised a total turnover in 2000 of more than 6 billion Yuan (about 1 billion Euro).

The main markets for solar thermal systems are in the Shandong, Jiangsu, Yunnan, Anhui, Hebei, Guangdong and Zhejiang provinces, and in Beijing. Of them Shandong, Guangdong, Jiangsu and Zhejiang are economically advanced coastal provinces. Yunnan is rich in solar energy resources, and in Hebei and Beijing the traditional manufacturers of solar thermal systems are located.

The annual production and sales volume was expected to reach about 8 million m^2 in 2002 (including about 6–8% "Drying Heaters"), up 15% from 2001 and soaring 66% over 1999 – and will clearly continue with strong growth. Less than 1% of the national production (finished products such as systems and collectors as well as semi-finished products or glass vacuum tubes only) was exported – mainly to Japan, Germany, South-East Asia and other EU countries.

Because of the expected increasing demand of solar thermal systems world-wide, and due to improving quality and advanced technology – especially for vacuum tube collectors (VC's) – the export sales will most probably increase at a fast pace.

Solar thermal installations

Solar collector production and sales in m^2										
	Glazed Collectors									Unglazed Collectors
	Flat Plate Collectors				Vacuum Collectors				Total Glazed	
	A National Production	B Exports**	C Imports	D = A-B+C Total Home Market	E National Production	F Exports**	G Imports	H = E-F+G Total Home Market	I = D+H Total Home Market	Total Home Market
1986	~140.000			~140.000	~40.000			~40.000	180.000	
1990	~370.000			~370.000	~350.000			~350.000	720.000	
1996	1.150.000	1.000	0	1.149.000	1.250.000	1.000	0	1.249.000	2.398.000	
1998	1.360.000	1.000	0	1.359.000	1.530.000	7.000	0	1.523.000	2.882.000	
1999	1.580.000	1.000	0	1.579.000	2.640.000	12.000	0	2.628.000	4.207.000	
2000	1.530.000	1.000	0	1.529.000	4.060.000	26.000	0	4.034.000	5.563.000	
2001	1.610.000*	2.000	0	1.608.000	4.900.000**	43.000	0	4.857.000	6.465.000	

* does not include "Drying Heaters" (presently about 6-8% of the total production/sales)
**estimated (no exact figures available; Export incl. glass vacuum tubes only)

Sources: Annual report 2000 "China Solar Water Heater Development"; ZERI; NOVEM; ASTIG

Product types and solar thermal applications

Product types

Solar thermal systems in China are mainly of three types: flat plate collectors (FP), vacuum tube collectors (VC) and combined storage tanks.

Flat plate collectors

The absorber is the key component for the FP type of water heater, which is made mostly of copper-aluminium (~85%), all copper, or anti-corrosion aluminium plates. The copper-aluminium plate is the most popular type in China. The most common system consists of an FP and a hot water tank with natural circulation (thermosiphon). The collector is the usual framework or box-type with metal absorber, a transparent cover (normal glass) and a back/side insulation layer.

Vacuum tube collectors

There are 2 kinds of vacuum tube water heater on the market. One is the all-glass vacuum tube (also knows as "Sydnes-Type"), and the other (first sold ~1996) is the one with bigger tubes (100 mm diameter; also known as "Dornier-Type") – both are produced as heat-pipe vacuum tube or direct flow vacuum tube.

The first one is a double layer, coaxial glass tube made of borosilicate glass. Its features include high temperature capacity (up to 250°C at stagnation) and an easy coating process (the inner tube is completely coated outside with a highly adhesive coating). This system can be used year-round for households in cold climates too.

The second type is combined pipe and vacuum technology – also made from borosilicate glass. This one is characterised by a limited thermal loss factor, high temperature resistance (>260°C at stagnation), good freeze resistance performance, and good pressure resistance. However, its price is high compared with the first type. Therefore a limited volume is sold in China only – most of the production is exported, mainly to Europe (>80%) and some to other foreign markets.

Aside from DHW, both types are also suitable for use in industrial applications, such as industrial process heat, drying, air conditioning, seawater desalination and so on.

Combined storage tanks

The combined storage tank type is not very popular in China and is mainly produced by small and medium-sized companies. In this system, the solar collector is combined with the hot water tank, which is black in colour and without insulation. The characteristics of this type are its simple structure, easy installation and low cost. It is suitable for use between May and October in the northern part of China, and from March to November in southern regions. On average, about 2–3 m^2 of collectors could provide sufficient hot water for a family of three to four members. The disadvantages of this type of heater are heat-loss in the night, and that it is sometimes unable to provide hot water during the night and or in winter. As it is lower in cost, it is suitable for low-income families, and is mostly used in rural applications

Applications

There is a rapidly increasing demand of households for hot water. Over the past decade, with sustained growth of the national economy and continued increase of people's living standards, indoor water supply and washing facilities in urban areas have improved continuously. Although gas water heaters are still most widely used in urban areas, here and especially in more rural provinces solar DHW systems have an enormous potential.

About 75% of the solar collectors are installed for DHW in individual residential houses – mainly in the more rural areas/provinces. An estimated 20% are installed for DHW jointly shared by a number of residential houses and only ~ 5% are used for engineering or industrial projects. Combisystems (systems providing DHW and space heating) and solar assisted cooling are not so common at present, but there are signs from the government to focus on those applications as well in the near future.

Employment

As already stated the 33 companies mentioned above employ and indirectly engage more than 150.000 people (not considering the manufacturers of components).

Even an estimate for the total number of people employed by the solar thermal industry is not available.

B STATE OF PRODUCTION

Product technology and production methods

Product technology description

Collectors (usual sizes)	FP ~ 1.5 m^2, VC ~ 2.0 m^2 per DHW-system
Absorber material	Copper-aluminium (~75%), Copper and anti-corrosion aluminium
Surface treatment	FP black paint and black chrome; VC selective coatings
Insulation	PU, mineral fibre and other materials
Transparent cover	FP float + cast glass (no "solar glass"); VC boro silicate glass
Casing	aluminium, wood and partly steel sheets
Storage tank	steel, stainless steel and aluminium

Production

There are more than 1.000 manufacturers in China. It is estimated that of these 1.000, the 33 biggest companies (about 10 of them are going to be "blue chip" solar companies) have a market share of >80% in 2000 (a more detailed list can be found in the Annex).

Except for these big companies manufacturers are mostly small- and medium-sized companies of private ownership. In 2000 a survey was made among the 102 major manufacturers – 74 were collectively owned (73%), 21 were state owned (21%) and 6 were stock-listed enterprises. Over the past few years manufacturers of solar thermal systems have concentrated in Shandong, Beijing and Jiangsu. According to one investigation these 3 regions account for ~ 70% of the country's total output.

The national annual production capacity was 9 million m^2 in 2000 – divided in up of 5 million m^2 of vacuum tube systems, 3 million m^2 of flat-plate systems, and about 1 million m^2 of combined storage tank systems. Those numbers have certainly increased over the last 2 years.

In 2001, there were about 300 production lines nation-wide for manufacturing vacuum tube systems alone. More detailed figures for 2000 are shown in the table below. This was a 30% increase over the 1998 figures and represents a production capacity of about 50–60 million tubes/a. Such high growth led to a significant boom in the vacuum tube business.

The growth of production capacity for flat plate systems however has been very stable and moderate compared to the development of vacuum tube systems. In 1998 the capacity was ~ 2.700.000 m^2/a and in 2001 it was estimated at about 3.100.000 m^2/a.

The production of flat plate systems is mainly concentrated in Yunnan, Guangdong in the South, as well as in Beijing, Tianjin and Hebei in the North.

The government has forced progress in the development of an industrial scale of production, standardised products and establishment of standardised systems.

Production capacity in 2000			
Type	Geographical Location	Number of production lines	Production capacity
Vacuum tube	Shangdong Beijing Jiangsu Hebei Zhejiang Anhui Others	141 62 34 26 21 8 8–12	5 million m^2
Flat plate	Yunan Guangdong Sichuan	28	3 million m^2
Source: Annual report 2000 "China Solar Water Heater Industry Development"			

Typical solar domestic hot water system

The vacuum tube type is the most popular system in China. However, flat plate types are less expensive.

The price normally depends on the type of the system, its size, the materials used and brand name. In general, the price of vacuum tube type systems is about RMB ¥1000 (140 Euro) higher than the flat-plate type, and well-known brands with a stainless steel water tank are also about RMB ¥1000 more than the less well-known brands – and thus relatively expensive (see table below) – given the following characteristics of a typical DHW system:

Type (2 m^2 collector)	Price	
Vacuum tube system	Using 180 litre water tank of normal material – RMB ¥3000 (430 Euro)	Using stainless steel 180 litre water tank – RMB ¥3700 (528 Euro)
Flat-plate system	RMB ¥2000 (286 Euro)	

Typical consumer motivation

Although there are no government subsidies in China the solar thermal market is profitable and still on the rise. The main source of consumer motivation is that in rural areas solar thermal systems are the most economical means to heat water, because of the rather poor infrastructure for other energy resources. Many of the manufacturers target the local market and customers, and thus solar thermal systems are available almost everywhere.

Standards and codes of practice

To ensure long-term performance (today there are still quite a few systems of rather low quality) and to secure a fast growing export (those collectors/systems must conform with international standards) and to increase the nation-wide market penetration, the government of China recognised that it was essential to develop a series of comprehensive technology and quality standards.

The current standards in China cover small solar fields, but do not yet apply to the whole industry sector. These standards are as follows:

Two basis standards
- terminology for solar energy utilization I, GB/T12936.1 – 1991
- terminology for solar energy utilization II, GB/T12936.2 – 1991.

Four test standards
- thermal characteristics test method of SWH for household, GB/T12915 – 1991
- assessment method of elastic material for solar absorber, fittings and accessories for solar water heater, GB/T15513 – 1995
- solar spectrum irradiation standards for various geographical areas I, GB17683.1 – 1999
- performance test method on flat-plate absorb collector, GB/T4271 – 2000.

Three product standards
- technical condition for flat-plate absorb collector, GB/T T6424 – 1997
- full-glass vacuum tube collector, GB/T17049 – 1997
- vacuum tube collector, GB/T17581 – 1998.

One additional standard
- technical condition of solar water heater for household, NY/T343 – 1998.

Level of R & D

In many places there are ambitious R & D activities going on. Most of them are mandated by the central or local government; others are initiated by the big companies in the DHW industry. Almost all of the R & D work is done within or closely connected to the various manufacturers. Also the R & D done in universities and some institutes is done in close co-operation with the industry – in fact sometimes even the production itself is directly linked. The focus clearly is on vacuum tube systems as they have the greatest market potential.

What is noteworthy is that e.g. Qinghua Sun Company, Beijing and Huangming Company, Shandong have been investing heavily in technical & technological innovation. Funding of these efforts has been strengthened.

- **Flat plate collectors**
  specific programs to develop quality selective coatings on copper and aluminium, solar glass (low iron) and transparent insulating material
- **Vacuum tube collectors**
  all glass tubes with built-in metal passages, improved heat pipes and vacuum type drying water heaters

C STATE OF MARKETING

Distribution and marketing methods

The marketing networks for solar thermal systems are not complex, as the majority of manufacturers sell their products through agents instead of through big department stores. Furthermore the SWH market mainly targets local markets and customers/end-users. However, due to the rapid expansion of the market and intensifying competition, a trans-regional and even nation-wide operation has emerged.

A number of manufacturers have more than 300–400 dealers – some even have as many as 1000 dealers nation-wide. Walking along a shopping street, e.g. in Kunming, Yunnan Province, one can find a number of shops – dealers – next to each other, selling solar thermal systems as well as parts and plumbing supplies such as pipes or taps. The products are more or less the same, and are similarly priced.

More than 1000 brand names, countless dealers working as neighbours in cities, towns and villages in China – this is competition at its best, and certainly one reason for the "success story".

In order to promote renewable energy, the government, governmental agencies and sector associations sponsor and organise trade fairs.

A number of manufactures seek to survive by investing in promotional campaigns. These manufacturers also spend a certain amount of capital on registering their patents, so as to avoid today's innovation becoming a neighbouring dealer's product tomorrow.

Financially, the sector could be fairly described as a "cash cow," and it is looking for potential markets for further growth, both nationally and internationally.

The solar thermal sector is also taking initiative to work together with house developers and architects to maintain the expansion of applications in the residential building sector. It has been shown that buyers who purchased systems individually which they installed on their roofs themselves, do not in general consider the aesthetics of the building or the living environment. In the construction of new buildings, the main considerations for solar thermal systems collectively installed on the roof are harmonisation of colours or positioning to reduce visibility – they are mostly quite acceptable.

To further expand the market share, public awareness campaigns and demand-side stimulation techniques are used, but still on small scale. The national campaign, radio and TV programmes, national publicity, national information centres, studies on the value of the consumer market and so on have a positive impact on market development. The government and industry will work together on communication with consumers to build awareness of solar thermal technology and the environment.

Incentives and financing methods

There are currently no officially expressed support policies for solar thermal utilisation, though the government has provided finance for administration and research. Research on solar thermal utilisation has been included on the list of key national priorities to be addressed in every Five Year Plan. The government has allocated special funds to support the establishment of an advanced laboratory and testing facility.

D FUTURE PROSPECTS

National energy policy

Over a long period of time, hot water supply in China has relied mainly on coal burning and oil-burning boilers. With the introduction of stringent state policies for curbing air pollution, however, medium- and small-sized coal-burning boilers will gradually be eliminated, or their use will be restricted. Meanwhile the hikes in oil prices have further dampened the development of oil-burning boilers. Obviously the solar thermal industry, which save energy and are environmentally benign, will be considerably further developed. In fact most of the provinces of the country have mapped out policies for the popularisation of solar thermal.

The industry will save 1,25 million tons of coal annually by the end of 2005, 2,7 million tons in 2010, and 4,45 million tons by the end of 2015.

At the same time the industry will reduce CO_2 emissions by 90.000 tons; SO_2 emissions by 25.000 tons and dust by 250.000 tons at the end of 2005. Respectively 1,1 million tons of CO_2 in 2010 (3,2 million in 2015); 50.000 tons of SO_2 in 2010 (90.000 in 2015) and 500.000 tons of dust in 2010 (900.000 in 2015).

At least it is considered to reduce the excessive VAT of 17% for renewable energy products and especially for solar DHW systems. This would make solar thermal even more attractive.

Objectives for the solar industry/market

China has a population of more than 1.3 billion people – 75% of whom reside in rural areas. That means that the rural market for solar energy utilisation will be enormous.

Continued economic growth in China, with rising living standards, urbanisation and the privatisation of the housing sector, has created a significant demand for high-quality residential space and therefore a high demand for DHW as well. The construction industry completed 13,7 billion m^2 of new residential buildings from 1981 to 1995, and the Ministry of Construction projected an additional 15 billion m^2 in the 'Ninth Five Year Plan' and 'Outline of Long-term Objectives for 2010 for the Construction Industry and Project Construction'. Construction of about 7,74 billion m^2 of new building is planned for the next ten years.

More importantly, the government agencies concerned have mapped out long-term specific plans towards the development of industries of new energy resources and renewable energy resources – including solar energy.

According to the State Economic and Trade Commission's planning for 2015 – setting up a task of "building up a large-scale and highly efficient industry for producing hot water with solar energy" – and assuming that by then 20–30% of the households across the country will have access to solar domestic hot water, the market volume would reach about 230 million m^2 total area installed i.e. in average an increase of ~17%/year considering the production of ~ 8 million m^2 in 2002.

The prospects for overseas markets are excellent, too. The use of energy-efficient, environmentally friendly solar thermal systems has become an irreversible trend. In China solar DHW systems are produced at low cost. It is however urgently necessary to raise their technological level and quality to the extent that they measure up to international standards, and thus gain a bigger presence in the international market.

Strategy to overcome the barriers to market development

Services
The strategy for expanding business in China's old economy was product-focused, while the new economy is service-focused. The inputs for product improvements and services are not balanced in China's solar thermal sector; for instance, qualitative installation could guarantee a system's operation and the manufacturer (or their subsidiary) could help provide buyers with a quality installation. The sector needs to provide quality assurance and offer a guarantee of maintenance and service. Provision of service is the major weakness for development of the whole sector – the industry has to invest in building capacity in terms of 'after-sales' staff, installers, and maintenance technicians. The industry has to educate consumers not only on why to buy solar DHW systems, but also on how to use them.

Industrial scale
The majority of the manufacturers (>80%) are small to medium-sized companies. Creating a number of "big players" leading the solar thermal manufacturers in the country would most probably boost the development of the industry. Most manufacturers also have not sufficiently funded technical innovation and lack stamina.

Standardization
As the quality level of most of the products needs to be improved, it is unavoidable to demand strictly-monitored production processes as well as adequate quality measurements according to national/international standards. A national institution for product inspection and supervision has yet to be established. A reputation for reliability must be the basis for the expected and planned enormous growth in China and for boosting export.

Wider applications

The value of the consumer market for space cooling and space heating in rural and urban areas would lead to a revolution in the solar thermal industry in China in product and market development!

Governments at both national and local levels should create policies, statutes and technical standards in an effort to expedite the process of integrating solar thermal systems into the construction industry.

Raising public awareness

The economic value of solar thermal is well recognised in China, but awareness of its environmental value needs to be improved. In China, it costs as much to invest in a solar DHW system as a mobile phone, but market penetration for the latter is much higher than for solar thermal systems. The government and the solar thermal sector need to communicate with consumers and professionals to raise awareness of the systems' positive impact on the environment and climate change.

Strategic partners in product- and technology improvement

Whether satisfying domestic or international consumers, product quality and technology must improve. The Chinese sector is looking for technology co-operation with European partners. In as far as quality – and test standards (EN Standards), material improvement and production technology is concerned – especially for FP's – European companies have made fundamental progress and from this the Chinese solar thermal industry could benefit in the short term.

Joint Ventures

Decreasing production cost would help solar thermal penetration in Europe and other parts of the world. Several European companies have started at looking into cooperating with Chinese manufacturers.

One example is the German company Paradigma Ritter Energie- und Umwelttechnik GmbH, which has a joint venture in China – whereby the products are mostly sold in the Chinese domestic market, but exported as well. The joint venture is going to launch a new product that is same as a system in common use in Germany, with a natural gas auxiliary unit and all-copper water piping. The proposed sales price of new system is similar to that in Germany.

Financial issues

The main challenge is to attract commercial banks to invest in the industry, against the background of a generally bad financial record in the renewable energy business in China. It is very difficult to get long-term loans in China – most banks are looking for quick returns. Investment companies providing long-term equity financing might be explored as an alternative source.

Commercial banks can only afford to support very mature companies, and renewable energy business are generally not developed enough to compete for commercial bank loans.

On the other hand, solar thermal financing is a problem because the industry suffers from its growing number of cases producing poor quality products. This needs to be changed first.

Concluding remarks

Since solar DHW systems first appeared on the market in China they have become a big success. China today is by far the largest market, and has established a solar thermal industry with more than 1.000 factories manufacturing and selling solar thermal systems. Significant growth is projected for the future, and with the measurements and planning by the government in progress, as well as the fact that China now has reached “economies of scale” for this industry, it could well be that China will eventually dominate this market.

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Data provided by ASTIG (Active Solar Thermal Industry Group)

Contributions to this report

This report is based on information provided by Bundesverband Solarindustrie (BSi). For his valuable contribution we would like to thank Werner Koldehoff.

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India

A STATE OF THE MARKET

Overview of the market situation

Solar thermal technologies have a special relevance in India due to the high availability of resource; average radiation is 4,5–6 kWh/m^2 per day with a yearly average of 280 clear days. Further, in view of the increasing energy demand in all sectors, there is immense potential, especially in the domestic and industrial sector, to meet thermal energy demands through solar.

Activities in this field were begun in India by the Department of Non-Conventional Energy Sources (DNES), which was created in 1982 to encourage developments in the field of renewable energy through various R&D and demonstration projects. The solar thermal programme was started with capital subsidies and demonstrations in the initial years. This initiated manufacturing activities and raised awareness. The major barriers faced at that time were lack of awareness, lack of reliability in the working of the solar thermal systems, and high initial costs. The demonstration programme was aimed at overcoming the barriers of awareness and to build confidence. The subsidies from government during the initial period helped to overcome the cost barrier. In 1987 Indian Renewable Energy Development Agency (IREDA) was created to finance renewable energy projects. To overcome the barrier of high costs, the low interest loans were introduced through IREDA in 1987. In case of low interest loans, the government provides the difference between the market interest rate and the interest rate charged to the user; this is called an 'interest subsidy.' Realising the importance of the role of renewable energy technologies, the government upgraded the DNES to the Ministry of Non-conventional Energy Sources (MNES) in 1992. To promote solar water heating technology, the MNES has continued the efforts of the DNES. These include technological development, standardisation and quality control, financing, special area demonstration, publicity and awareness-raising, training, amendments to the building bylaws, establishment of sales and service networks etc. With the increasing popularity and viability of solar water heating systems, the subsidy was reduced gradually over the years and completely removed in 1993/94. However, the interest subsidy continues and is expected to continue until 2007. In addition to this, other incentives such as tax benefits etc. are being provided.

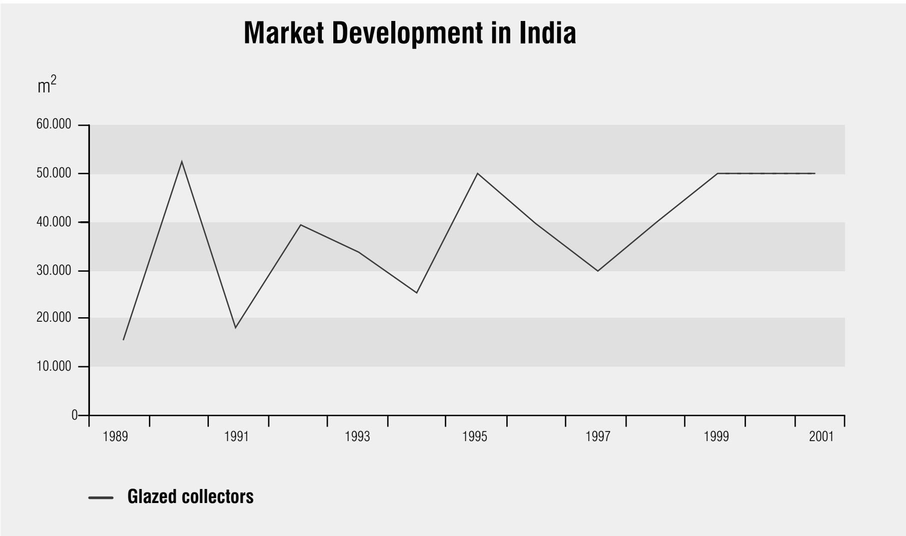
Solar water heating systems (SWHS) are the most commercialised renewable energy systems in India, presently requiring minimal government support compared to other renewable energy technologies. There are two distinct markets for SWHS in India: (i) domestic and (ii) commercial and industrial. In the commercial sector SWHS are used to meet the hot water demands of hotels, hospitals etc., whereas in the industrial sector these systems are used for pre-heating boiler feed water, or to meet process heating requirements. In the domestic sector SWHS's are used primarily to meet the domestic hot water demand. So far, the majority of installations in India are in the commercial and industrial sector, with 80% of the collector area installed in this sector, in contrast to Europe, where the focus is mainly on the domestic sector.

The penetration levels of solar thermal systems are distinctly different in northern and southern regions of India. This can be attributed to the climatic conditions and resultant hot water usage patterns. In the southern region there is high penetration of solar water systems as a result of the use of hot water for 9 to 10 months each year due to relatively lower ambient temperatures. On the other hand due to higher ambient temperatures in the northern region, the use of hot water is limited to 4–5 months, which reduces the economic viability of solar thermal systems. Thus the solar thermal industry is relatively well established in the southern region. Furthermore, the focus of the solar thermal programme in India has been on the bigger systems for industrial and commercial use. But due to an increase in the price of electricity and the improvement of the economics of solar systems, the market for solar domestic water heating systems is increasing in India, and the focus is shifting towards the domestic sector. As per MNES, the technical potential of solar water heating systems in the country, based on current population and commercial and industrial activity, is around 140 million m^2 of collector area. The distribution of this total potential in the domestic, commercial and industrial sectors is 70 million m^2, 35 million m^2 and 35 million m^2 respectively. The MNES policy (draft) has set the goal of installing an additional 5 million m^2 of collector area by the year 2012, with an equal distribution of collector area in the domestic sector and commercial and industrial sectors (MNES 2001). As a result of various promotional efforts a substantial manufacturing base has been established. Presently there are around 60 manufacturers of solar water heating systems, offering solar collectors as per the standards set by the Bureau of Indian Standards.

Solar thermal installations and energy production

Solar collector production and sales in m^2										
	Glazed Collectors									Unglazed Collectors
	Flat Plate Collectors				Vacuum Collectors				Total Glazed	
	A National Production	B Exports	C Imports	D = A-B+C Total Home Market	E National Production	F Exports	G Imports	H = E-F+G Total Home Market	I = D+H Total Home Market	Total Home Market
1989	15.720			15.720					15.720	
1990	52.530			52.530					52.530	
1991	18.000			18.000					18.000	
1992	39.730			39.730					39.730	
1993	34.650			34.650					34.650	
1994	25.620			25.620					25.620	
1995	50.000			50.000					50.000	
1996	40.000			40.000					40.000	
1997	30.000			30.000					30.000	
1998	40.000			40.000					40.000	
1999	50.000			50.000					50.000	
2000	50.000			50.000					50.000	
2001	50.000			50.000					50.000	

Source: MNES 1989–2002



The majority of solar collectors produced and used in India are single glazed flat plate collectors. Unglazed collectors are very limited in number and are generally not used India. The vacuum tube collectors have been introduced very recently in the Indian market; the total installed area would be in the range of 100–200 m^2. In case of the vacuum tube collectors, the vacuum tubes are imported and the collectors and systems are assembled locally. The flat plate solar collectors are manufactured indigenously and there is no import of solar collectors.

Estimated solar park in operation at the end of 2001

Total collectors area in m^2	550.000	= 0,5 m^2/1000 inhabitants

Estimated annual solar thermal energy production in 2001

Total in m^2	550.000	x 570 kWh/m^2·year =	313.500 MWh
Based on the assumption of an average of 280 sunny days in a year and a 35°C increase in the water temperature during day			

CO_2 emissions avoided in 2001

Flat plate collectors			
Domestic	62.700 MWh/a	x 1,3 tonnes/MWh =	81.510 t
Commercial/industrial	250.800 MWh/a	x 0,33 tonnes/MWh =	82.764 t
Total			164.274 t
Based on the assumption that 80% of the collectors used in commercial and industrial applications replace commercial fuels like oil and that 20% of the collectors used in domestic usage replace electricity			

Product types and solar thermal applications

There are two major categories of applications of solar water heating systems in India: the domestic hot water applications and industrial and commercial applications. The breakup of the installed collector area for these two different applications has not been reported separately in the recent years. But based on the trends of previous years the share of domestic sector in the total installed collector area is approximately 20%, i.e. around 120.000 m^2. The industrial and commercial application contributes almost 80%, i.e. approximately 480.000 m^2 of the total installed collector area. There are no district heating applications in India. Use of solar thermal systems for space heating applications is also very limited.

Domestic solar water heating systems
The domestic hot water systems are mainly of the thermosiphon type; the major components of are the flat plate collector and storage tank. The capacities range from 100 litres per day to 2000 litres per day.

Large solar thermal systems
These are mainly used in the commercial sector, such as in hotels, hospitals etc., and in the industrial sector. In the case of the commercial sector the systems are used to meet the demand for hot tab water, whereas in the case of the industrial sector the solar thermal systems are either used for process heat applications or to heat the boiler feed water. These systems are designed as per the thermal energy requirement and the capacities vary from 1.000 litres per day to 100000 litres per day. The number of collectors depend upon the requirements and the radiation level. The large solar thermal systems are mainly of the open loop type and use pumps, controlled by the temperature sensor, for circulating water in the collector as shown below.

Employment

In India the manufacturer undertakes the manufacturing of components of solar thermal systems, installation and maintenance, distribution, sales and marketing. The number of people employed for the above activities is approximately 800. The testing centres for collector employ 20–25 people and the number of people involved in research and development in the area of solar thermal is approximately 100. The figures are mainly based on the interaction with manufacturers and the research institutes and are thus approximations, since no data on employment generation in the solar thermal sector is available.

B STATE OF PRODUCTION

Product technology and production methods

Product technology description

Collectors (usual sizes)	2 m^2
Absorber material	copper (plastic collectors are introduced recently)
Surface treatment	selective coating
Insulation	Glass wool/PUF
Transparent cover	toughened/tempered glass
Casing	Aluminium/MS
Storage tank	SS/polyethylene/copper for domestic systems MS in case of high capacity system $>$1000 LPD

The efficiency of the collector and the system is a function of the inlet and outlet water temperatures. Further the efficiency varies between different manufacturers. However, typical collector efficiency is 60%, in the operating temperature rage of 25–30°C as input temperature and 55–60°C as output temperature.

Production technology description

In India there is one manufacturer of absorber fins for the collector which supplies to the majority (60%) of the collector manufacturers. Several manufacturers make their own absorbers. The manufacturing of absorbers is for the most part automated, whereas the manufacturing of collectors is mainly manual.

Breakdown of solar systems costs

Solar Systems Costs for Typically Sized Systems		
	Individual	**Project (large scale)**
Total costs[a] (excl. VAT)	195€/m²	152€/m²
VAT*	–	–
Total cost (incl. VAT)	195€/m²	152€/m²
Typical size of system	2–4m²	As per requirements
*Presently there is no VAT in India		

a. All price/cost figures in this report are based on the average 2002 exchange rate of 46,04 INR/EUR.

Percentage cost breakdown of an average system

	Small	Project (large)
Production (materials and labour)	74%	85%
Installation	17%	11%
Marketing/distribution	9%	4%

Typical solar domestic hot water system

The solar domestic hot water systems in India typically have a capacity of 100 litres per day working on thermosiphon principle. The collector area is 2m² with a storage tank capacity of 100 litres. The storage tank is insulated to reduce overnight heat loss. The total cost of a domestic solar thermal system is 390 Euro (there is no VAT in India). There is no direct subsidy for solar domestic hot water systems in India. Low interest loans are available. There are no further income tax benefits available for individual users.

In case of large systems for industrial and commercial application the system sizes vary from 1.000 litres per day to 100.000 litres per day. The typical industrial solar thermal system has a capacity of 10.000 litres and a collector area of 160 – 180m², depending upon the radiation availability. The typical cost of such a system is 3.040 Euro. Solar thermal systems do not receive any direct subsidy, but low interest loans are available. In addition, tax benefits are available for commercial and industrial systems.

Typical consumer motivation

The strongest motivating factor is that in the case of solar water heating systems there is the reduction in the energy costs. Other factors which motivate consumers towards adopting solar systems include environmental concerns, user-friendliness, maintenance-free technology etc.

A study entitled "Developing quality service on solar thermal systems", sponsored by the Ministry, was conducted by the Consumer Coordination Council (CCC), New Delhi in the city of Bangalore during 1999–2000. Out of a total of around 6.000 domestic solar water heating customers in the city, 618 were contacted in order to obtain feedback. Some of the highlights of the survey are as follows:

- 78% of the customers rated the product good or excellent.
- 99% of the customers found the product satisfactory at the time of purchase.
- 100% of the customers readily agreed to recommend the product to others.
- 77% of the customers bought the product directly without any loan or subsidy.

Conventional water heating and energy prices

Conventional Energy Prices		
Date: 2000	**Domestic**	**Commercial and Industrial**
Electricity – normal	Average tariff ranges from 0,02 to 0,08 €/kWh (The power tariff varies from state to state)	Average tariff ranges from 0,04 to 0,12 €/kWh (The power tariff varies from state to state)
Fuel – Oil (HSD)	Retail price ranges from 0,30 to 0,37 €/l	
Bottled gas (LPG)	Retail prices range from 4,26 to 4,81 €/cylinder of 14.2 kg	

Standards and codes of practice

Standards for flat plate collectors (IS12933: 1992) have been developed by the Bureau of Indian Standards (BIS). These standards are presently being modified to incorporate the latest technological developments. Standards are also being formulated for complete solar water heating systems. In order to obtain the low interest loan it is mandatory to use BIS certified collectors in the solar water heating systems. The solar thermal systems using the BIS certified collectors are eligible for the low interest loans provided by the IREDA and nationalised banks. Apart from the Solar Energy Centre, which it situated near New Delhi, six regional test centres have been established by the MNES in various parts of the country for the testing of solar collectors. While testing is carried out by the abovementioned testing centres, the certification is carried out by the BIS.

Level of R & D

During the Sixth Five Year Plan (1980–85), the programme implemented by CASE/ DNES led to the development of indigenous technologies for conversion of solar radiation to low temperature heat for various applications. The R&D projects assigned to various institutions also led to the development of a human resource base in the area to some extent. The deployment of the products developed under the R&D programme in the field under a government cost-sharing scheme contributed to the development of the initial infrastructure for the design, manufacture and installation of solar thermal products. The Seventh Plan (1985–90) envisioned better product design, cost reduction, and expansion of the scope of utilisation of these devices and systems in order to make some of the systems acceptable to the public as commercial products. The efforts made and the R&D projects undertaken during the Sixth and Seventh Five Year Plans have made major contributions with regards to the indigenous development of a few specific devices and systems for low-grade solar thermal energy conversion. These include solar flat plate collectors and solar water heating systems, solar cookers, solar stills and solar timber kilns. During the Eighth Five Year Plan (1992–97), projects were taken up to further improve the technologies, enhance their reliability, and to reduce the cost of the devices and the systems developed earlier. In this planning period, a total of 22 projects were assigned to various universities, institutes and research organisations. By the end of the eighth planning period, the technology of solar flat plate collectors being marketed in the country had mostly changed from black painted absorbers to selectively coated absorbers. The workmanship, finish, piping and system design were improved. During the Ninth Plan (1997–2002) the emphasis was to promote the research of new technologies. Presently the activities are focused on the promotion of solar thermal systems. Product improvement and cost reduction of solar thermal systems are focus areas for R &D supported by the MNES. The government’s role is to identify specific areas for R&D and/ or to support the R&D projects proposed by various organisations. Since the industries in the solar thermal sector are mainly small-scale, the contribution of industrial R&D is minimal. There are number of organisations and university departments which are involved in the developmental activities in the field of solar thermal. The six regional test centres for solar collectors are run by different university departments.

C STATE OF MARKETING

Distribution and marketing methods

Historically the solar thermal sector has been oriented towards larger size industrial and commercial systems. These systems are designed as per requirement; thus off-the-shelf products were not available in the initial years. As a result, development of dealer's as well as after-sales networks was very slow. The absence of a dealer's network has affected the penetration of solar thermal systems, especially in the domestic sector. Until recently the manufacturer undertook all the activities of marketing, arrangement for financing, installation of systems and after sales services in addition to the manufacturing of the solar thermal systems. Furthermore there was no concept of specialised installers for solar thermal systems, especially in the domestic sector. Presently installers of solar thermal systems are emerging and have begun offering their services to the manufacturers. Similarly a few manufacturers are also in the process of appointing dealers in different regions. Still the majority (90%) of sales and installation is done directly by the manufacturer. Since the domestic sector is becoming a focus area, the manufacturers have begun discussions with the builders about offering solar thermal systems as a part of standard apartment package. Some solar thermal systems are already installed as a part of the standard facility offered by the builder in the city of Pune. The marketing of solar thermal systems is mainly focused on the energy savings and resultant reduction in energy costs. Concepts such as third-party financing and Guaranteed Solar Results are new to the Indian market and have not yet been tried.

The manufacturers provide after-sales services from their centralised location. The manufacturers enter into an annual maintenance contract (AMC) with the user for providing after-sales services.

The awareness-raising and promotion of solar thermal systems is mainly undertaken with the government's support. There are no special exhibitions for solar thermal systems, but the systems are shown in different exhibitions related to energy and household consumer items. Furthermore, print media are used for the promotion of solar thermal systems. There are two types of print media promotions; one is undertaken by the government, which explains solar thermal systems in general and their benefits. The other type involves the MNES partially supporting advertising by individual manufacturers.

Incentives and financing methods

In the initial years of the solar thermal programme in India the main financial incentive was the direct subsidy from the national government. With growth in the sector and increased viability of the solar thermal systems the direct subsidy was reduced gradually over the years. The direct central subsidies for solar thermal devices were withdrawn during 1993 & 1994. However, to promote solar water heating systems and other solar thermal devices, the MNES has been implementing a soft loan programme under an interest subsidy scheme through Indian Renewable Energy Development Agency (IREDA) and seven designated banks. The rates at which the loans are available to the end-users for solar water heating systems and other solar thermal devices are provided in the following table:

Technology	Implementing organisation	Category of end-user	Rate of interest
Solar water heating system (up to 2.000 litres capacity)	Banks/Housing And Urban Development Corporation etc.	Individual, institution, association, small business establishment	5% (to end-user)*
Solar water heating system (up to 2.000 litres capacity)	IREDA (through financial intermediaries). IREDA provides loans to financial intermediaries @ 2.5% rate of interest	Individual, institution, association, small business establishment	5% (to end-user)*
Solar water heating system (any capacity), solar air heating system, solar desalination system, solar swimming pool	IREDA (direct or through financial intermediaries)	Institutions, trust, charitable organisations etc. (non-profit organisations)	5%*
Solar water heating system (any capacity), solar air heating system, solar desalination system, solar swimming pool	IREDA (direct or through financial intermediaries)	Industry, hotels and other commercial organisations (profit making)	8.3%
*End-users (other than individuals) required to give an undertaking that no tax benefits are claimed			

One of the major incentives provided by the government of India for solar thermal systems is 100% accelerated depreciation, i.e. a tax benefit in the first year of installation of the system itself. After this year the incentive has been reduced to 80%, i.e. the tax benefit claimed in the first year is 80% of the total cost of the systems. However, there is no provision of tax benefits for individual consumers. The solar thermal systems are exempted from the Central Sales Tax and General Sales Tax. In some states in India, the owners of domestic solar thermal systems get a rebate in their electricity bill, in terms of a 2 to 3% reduction in tariff.

D FUTURE PROSPECTS

National energy policy

India accounts for 3% of world's primary energy consumption. The per capita energy consumption remains low at 486 kg of oil equivalent, compared with world average of 1.659 kg of oil equivalent. Coal dominates the energy mix in India, contributing 70% of the total primary energy production. The share of natural gas has been increasing in the last few years, from 10% in 1994 to 13% in 1999–2000. There has been decline in the share of oil in primary energy production from 20% in 1994 to 17% in 1999–2000 (TERI 2002). The share of renewables in the primary energy production is very small; however the share of renewables in the installed capacity for power generation is above 3%. Issues that concern the energy sector in India are energy security, socio-economic dimensions and environmental concerns. The imports of oil and coal have been increasing at the rates of 7% and 16% per annum. The energy imports are projected to increase because of the large gap between production and demand. Moreover, to bridge India's peak power shortages of 13–15% and average shortages of 8–10%, in the BAU scenario, nearly 100.000 MW of new capacity addition would be required by 2012, more than 75% of which is likely to be coal based. The use of new technologies, such as coal gasification, could improve the energy security by effectively utilising the domestic coal reserves, and renewable sources of energy are also being considered as means to tackle the energy security issue. There has been neither an integrated energy policy nor a comprehensive renewable energy policy in India until now. However, the components relating to renewable energy are framed by the Ministry of Non-conventional Energy Sources (MNES). A draft of the renewable energy policy statement has been drawn up outlining the policy and programme interventions required to achieve the goals of meeting the minimum rural energy needs, providing decentralised off-grid energy supply for certain applications, and generating grid quality power based on renewables. The draft also sets the medium-term goals for achievement by 2012. These include coverage of 30 million households with improved chulha (cook stove), installation of an additional 3 million family size biogas plants, deployment of 5 million solar lanterns and two million solar home lighting systems, provision of electricity to at least 25% of the 18.000 unelectrified villages, deployment of solar water heating systems in 1 million houses and achievement of a 10% share for renewables in the new power capacity projected up to 2012. Once the draft gets the necessary approvals and is implemented in earnest with active participation of all the stakeholders, a visible change in the quality of life, particularly in rural and remote areas, can be brought about.

Objectives for the solar industry/market

The objective behind promoting the solar thermal industry in India is to supplement the conventional energy supply through harnessing of non-fossil based environment friendly renewable energy. The objective of the consumers is mainly to reduce energy costs.

The cost of conventional energy in India is increasing quickly. The effect is clearly noticeable in the consumers' positive attitude towards the usage of renewable energy based systems. In this context it is certain that the solar water heating system has great prospects in India. In addition to these plans for solar water heater systems, it is also planned to install 1.000 medium temperature solar concentrator based process heating systems, each equivalent to 10 ton per day of steam generation capacity, by 2012.

Strategy to overcome the barriers to market development

There are several barriers to solar thermal systems in India:

- The solar water heating systems are not readily available, particularly at the retail level. This means that even for those users who are interested in installing solar systems, it is difficult to get the desired systems.
- There is a lack in the required level of sales, services, and maintenance infrastructure, which becomes an obstacle for market penetration.
- The high up-front cost of the solar systems as compared with the conventional systems for same end-use
- The absence of pervasive micro-credit networks at present makes it difficult for the consumer, especially in peri-urban and small towns, to use the credit.
- There is a lack of technical capacity to help the potential users (i) in designing properly sized solar systems and (ii) in integrating them with the existing systems/processes. Since, for most of the industrial and commercial clients, solar heating is not an area of core competence, absence of such technical consultancy inhibits the growth of the sector.
- Though different agencies have been propagating solar water heating systems for over two decades, the awareness among potential users is still low. In a survey conducted in the state of Haryana, it was observed that just over half of the respondents were aware of solar thermal systems.
- Another major barrier relates to the reliability of the suppliers of solar systems, in terms of after-sales service and maintenance. This is perceived to be very low amongst the potential market.

The other problems which have been encountered include effective communication to the branches of the banks, awareness amongst the officers in the branch level, and absence of adequate publicity around the system.

Corrective Measures
In order to improve the credit availability, the low interest scheme was extended to nationalised banks, since IREDA is a centralized agency located in North Delhi. The strategy is to increase number of banks from present level of 7 banks with branches in different cities, so that financing is easily available. Efforts are also being made to expand the scheme through more banks and financial institutions like Housing and Urban Development Corporation so that a broad-based network for providing soft loans throughout the country is achieved. Training programmes for the officers of the banks at branch level are also being conducted so that the officers at the level of implementation can understand the basic technology and the mechanism of the system. Measures are also being taken to publicize the system through the distribution of pamphlets, posters and advertisements in national newspapers.

In order to ensure quality products, a decision has been taken to extend the soft loan facility only to those products which are certified by the Bureau of Indian Standards (BIS). For improving the quality of the products, initiatives have also been taken to revise the existing BIS standards for solar flat plate collectors. Furthermore, the standards for the complete solar water heating system are under development.

Concluding remarks

It is clear that India does offer a vast market for solar water heating systems. The estimations show a good growth rate. If there are concerted efforts, coupled with an innovative approach, to tap the vast potential that is available in the commercial and industrial sectors, the growth could be much greater. India has the advantage of already having the required policy framework in place. However, in India the domestic industry is already well developed, although comprising mostly small and medium-scale enterprises. The need, therefore, is not only for better products in terms of technological innovation, reliability and cost-effectiveness, but also for better overall packaging, including post-sales service and easy credit-financing. These, along with a widespread dealer/service network will go a long way towards positioning the ‘brand’ vis-à-vis other small-time players. Essentially, in order to realise the market’s vast, untapped potential, the consumer must be assured about the quality, reliability and availability of products as well as of services, thereby establishing right kind of differentiation. For the industrial and commercial sector in particular, the better way may be to provide ‘energy services’ rather than products.

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TERI 2002 Teri Energy Data Directory and Yearbook (2001–2002), New Delhi:
Tata Energy Research Institute

Contributions to this report

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E ANNEX: SOLAR THERMAL DIRECTORY

List of manufacturers

List of manufacturers of solar thermal systems, approved by Bureau of Indian Standards (BIS)

Ankur Scientific Energy Technology Pvt. Ltd.,
'ANKUR' , Near Old Sama Jakat Naka,
Baroda–390008
Tel: +91 26 57 93 098
Fax: +91 26 579 40 42

Bharat Heavy Electricals Ltd.
16th Floor, Hindustan Times House,
18–20, Kasturba Gandhi Marg,
New Delhi–110 001.
Tel: +91 11 33 23 199
Fax: +91 11 37 21 680

Bipin Engineers Pvt. Ltd.,
Survey No.143, Wadgaon Dhairy,
Sinhgad Road,
Pune–411041,
Fax: +91 21 28 02 064

Deccan Electro Works Panel Division,
G–76, MIDC Gokul Shirgaon,
Taluka Karveer,
Dist Kolhapur–416 234
Tel: +91 23 16 72 984

Dheemanth Industries,
No.35, Kamakshipalya,
(Behind Check Post),Vijayanagar,
Bangalore–560 079
Tel: +91 80 33 59 377

Divya Industries,
814, Chowdeshwari Nagar,
Laggeri Main Road, Laggeri Peenya, Post,
Bangalore–560058
Tel: +91 80 83 98 471

Emvee Solar Systems,
No.253, 5th Main road,
10th Cross, Vasanthappa Block,
Bangalore–560 032
Tel: +91 80 33 37 033
Fax: +91 80 33 34 804

Enolar Systems,
No. 1567, 7th Cross, 2nd Main,
Govinda Raja Nagar,
Bangalore–560 079 (Karnataka)
Fax: +91 80 33 55 333

Erena Technologies (India),
No.52, Doddanna Industrial Estate,
Near Peenya 2nd Stage,
Bangalore–560 091(Karnataka)
Tel: +91 80 83 64 014

Ganga Industries,
No.4020/3562,
B.M. Shankarappa Industrial Estate,
Sunkada Katte, Magadi Main Road,
Vishwaneedam Post,
Bangalore–560 091.
Tel: +91 80 32 85 031

Honey Hills Synergy Systems,
No.365, IV Phase, Peenya Industrial Area,
Bangalore–560 058

Inter Solar Systems (P) Ltd.,
Plot No.39, Industrial Area, Phase-II,
Chandigarh–160 002.
Tel: +91 17 26 55 349
Fax: +91 17 26 52 319

Jain Irrigation Systems Ltd.,
Solar Division, Jain Park, Mohadi Road,
Jalgaon 425001
Tel: +91 25 72 20 033
Fax: +91 25 72 21 133

Jay Industries,
D–64, M.I.D.C.,
Miraj–416410 (Maharashtra)
Tel: +91 23 33 44 658
Fax: +91 23 33 44 464
e-mail: jaysolar@yahoo.com

Jyothi Solar Equipments Pvt. Ltd.,
No.1, Tatanagar, Kodigehalli,
Nagashetty Halli Main Road,
Sahakara Nagar Post,
Bangalore–560 092

Kaushal Solar Equipments (P) Ltd.,
767/7, Neel-Kusum,
Near P.Y.C. Gymkhana,
Pune–411004
Tel: +91 20 56 76 379
Fax: +91 20 56 77 789

Khambete And Khambete,
65–66, Audyogik Vasahat, Ajintha Road,
Jalgaon–425 003.
Tel: +91 25 72 10 650
Fax: +91 25 72 10 948

Kotak Urja Pvt. Ltd.,
226, Ist Floor, Opp.Sai Baba Temple,
14th Cross, Sampege Road,
Malleshwaram,
Bangalore–560 003.
Tel: +91 80 35 60 456
Fax: +91 80 35 62 233
e-mail: kotakurja@vsnl.com

Kraftwork Solar Private Limited,
Door No.VI/99-A, Major Industrial Estate,
PO Kalamassery D.P.,
Kochi–683 109 (Kerala).
Tel: +91 48 45 42 337
Fax: +91 48 43 70 073

M. Laxman & Co.,
15-A/2, PWD Colony,
Near Varunraj Hotel,
Erandwane, Karve Road,
Pune–411004.

Machinocraft,
15/4A, Vasudeo Estate,
Opp.Shankar Maharaj Temple,
Pune-Satara Road, Pune–411043
Tel: +91 21 25 71 457
Fax: +91 21 25 74 623

Marut Energy Equipments Pvt. Ltd.,
D-1/18, MIDC, Ambad,
Nashik–422 010
Tel: +91 25 38 04 910
Fax: +91 25 33 84 061
e-mail: marketing@solarecindia.com

Master Engineers,
SI.No.139, Warje Malwadi,
Dudhane Estate,
Pune–411 052
Tel: +91 20 52 90 499

N R G Technologies
989/6, G.I.D.C., Makarpura,
Vadodara–390 010 (Gujarat)
Tel: +91 26 56 42 094

Namsi Solar Private Limited,
No.240, 2nd Floor, 32nd Cross, 7th Block,
Jayanagar, Bangalore–560 082.
Tel: +91 80 66 47 308
Fax: +91 80 66 44 429

Nuetech Systems,
Post Box No.9167,
B.M. Shankarappa Industrial Estate,
Sunkadakatte, Vishwaneedam Post,
Magadi Main Road, Bangalore–91
Tel: +91 80 34 83 766

Peenya Alloys,
No.248 III Phase III Cross,
Peenya Industrial Area, 18th Main,
Bangalore–560058
Tel: +91 80 83 94 259
Fax: +91 80 83 96 536

Pittie Solar Pvt. Ltd.,
37/1B, Vadgaon Sheri,
Pune–411014
Tel: +91 20 70 33 417
e-mail: pittie@vsnl.com

Prabhu Energy Systems,
2nd Floor, Hameed Complex,
Kuloor Ferry Road, Alake,
Mangalore–575003
Tel: +91 82 44 91 967
Fax: +91 82 44 58 315
e-mail: prbengsy@sancharnet.in

Rashmi Industries,
No.60 & 61, Begur Road, Hongasandra Village,
Bangalore–560 068
Tel: +91 80 57 34 115
Fax: +91 80 57 32 309

Sabha Solar Energy,
Flat No.1/D, No.5, 9th Main Road,
(Behind Rajmahal Mini Market),
Rajmahal Vilas Extn., Sadashivnagar,
Bangalore–560080
Tel: +91 80 33 40 245
Fax: +91 80 33 45 62 21

Savemax Solar Systems Pvt. Ltd.,
Jayaprabha, Jadhavnagar, Vadgaon Bk.,
Pune–41.
Tel: +91 20 43 58 613
Fax: +91 20 43 58 613
e-mail: savemax@vsnl.com

Shringar Engineering &
Energy Systems Pvt. Ltd.
C-74, III Stage, Peenya Industrial Area,
Bangalore–560 058.
Tel: +91 80 83 62 304

Sigma Steel & Engineers (P) Ltd.,
225/11, Bagmari Road,
Calcutta–700054
Tel: +91 33 35 15 942

Solar Catcher,
9/10, Bendrenagar,
Subramanyapur Main Road,
Bangalore–560 070
Tel: +91 80 66 63 129

Solar Energy Services,
Plot No.303, Savli GIDC Estate,
Savli, Near Village Manjusar, Savli Road,
Dist. Vodadara–391775
Tel: +91 26 53 37 674

Solar Product Co.,
II / 61, Mukund Nagar, Pune–411 037
Tel: +91 21 24 64 182
Fax: +91 21 23 69 815

Solchrome Systems India Limited,
161, Sukhdev Vihar,
New Delhi–110 025
Tel: +91 11 68 38 365
Fax: +91 11 68 35 160

Solker Industries Ltd.,
No.436, Sidco Industrial Estate,
Behind Telephone Exchange,
Ambattur, Chennai–600 098
Tel: +91 44 82 74 142
Fax: +91 44 82 73 435
e-mail: solker20@hotmail.com

Standard Products Mfg. Co.,
2/14, Marol Coop. Indl. Estate,
M. Vassanji Road,
Sakinaka, Andheri (E),
Mumbai–400 059.
Tel: +91 22 85 00 970
Fax: +91 22 85 06 703

Standards Engineering Co.,
131/7B,
'Chandan' Hadapsar Industrial Estate,
Pune–411 013.
Tel: +91 21 26 70 237
Fax: +91 21 267 04 14

Steelhacks Industries,
9A/1, GIDC,
Vithal Udyognagar–388 121 (Gujarat)
Tel: +91 26 92 36 156
Fax: +91 26 92 36 534

Sudarshan Saur Shakti Pvt. Ltd.,
35, Bhagya Nagar,
Aurangabad–431001
Tel: +91 24 03 33 491
Fax: +91 24 03 56 197

Suncare Solar Systems Pvt. Ltd.
3 & 4, Buddanna Indl.Estate,
Vidyapeetha Road,
Kengeri, Bangalore–560 060
Tel: +91 80 84 83 044

Sunrise Solar Pvt. Ltd.
P.B.No. 2130, 1190/8, 13th Main Road,
Prakash Nagar, Bangalore–560021.
Tel: +91 80 33 28 533

Suntrap Devices,
B–49, N.G.O. "B" Colony,
Tirunelveli–627007 (Tamilnadu)
Tel: +91 46 25 53 693

Surya Jyoti Devices (India) Pvt. Ltd.,
Village Challon, PO Kurali,
District Ropar, Punjab.
Tel: +91 18 88 32 039

Surya Shakti,
739, Industrial Area, Phase-II,
Chandigarh
Tel: +91 17 26 53 299
Fax: +91 17 27 71 576

Suryakiran Pvt. Ltd.,
Development Area,
Binanipuram PO, Edayar,
Kochi–683 502
Tel: +91 48 45 59 184

Suryodaya Hi-Tech Engineering (P) Ltd.,
1-10-68/4, Chikoti Gardens, Begumpet,
Hyderabad–500 016.
Tel: +91 40 77 65 831
Fax: +91 40 77 67 813

Swamy Solar Systems,
"Sapthagiri Nivas",
117/10, Main Channel Road,
Lingahinapalya, Ulsoor,
Bangalore–560008
Tel: +91 80 55 45 131
Fax: +91 80 55 61 250

Tata BP Solar India Ltd.,
Plot No.78, Electronics City, Hosur Road,
Bangalore–561229
Tel: +91 80 85 20 082
Fax: +91 80 85 20 972
e-mail: tatabp@solar.ind.bp.com

Technomax Solar Devices,
No.4 A, Venkateshwara School Street,
R.M.V. II Stage, Nagashetty Hally,
Bangalore–560094
Tel: +91 80 34 18 723

Vijaya Industries,
166/2, Katapady–574 105
Udupi Dist, Karnataka
Tel: +91 82 52 57 127
Fax: +91 82 52 57 700
e-mail: vijaya-vip@zetainfotech.com

Yeshoma Industries,
No.59 (New No.8), 3rd Cross,
Ittamadu Village Extn.,
Banashankari 3rd Stage,
Bangalore–560 085
Tel: +91 80 22 35 029

Israel

A STATE OF THE MARKET

Overview of the market situation

Energy consumption and production

Economic development and the rise in the living standard in Israel, on one hand, and continuous population growth on the other, have lead to a rapid increase of energy consumption. Israel lacks local resources of oil and coal, and it depends entirely on imports for these fuels. In 2001, the total energy requirement of Israel was 19,59 million tons of oil equivalent (toe), of which 60,9% was supplied by crude oil and oil products, 36,2% by coal, and about 3% by solar energy. Compared to 1997 these figures reflect a total increase of 19% in energy requirements and an increase of 11% in crude oil requirements, of 30% in coal requirements and of 8,8 % in solar energy requirements. The solar energy used in 2001, expressed as toe, was about 600.000 or 0,1 toe per capita, a very high figure.

At the end of 2001, the installed electrical generation capability of Israel was about 9,7 GW (about 1,5 kW per capita). The total electricity energy supplied in 2001 to all consumers was 36.360 million kWh, representing approximately about 5.600 kWh per capita and an increase of 2,5% over 2000. Of these 36.360 kWh, 33,9% was supplied to households, 30,3% to trade, 25,4% to industry and 10,4% was used for agriculture and water pumping. The electricity development plans aim at reaching a generation capacity of 11,65 GW by the end of 2005. The price of electricity to households is about 0,082 Euro per kWh (VAT not included).

Solar energy in Israel

Israel is located approximately between the latitudes 29°30' N and 34° N, where the annual incident solar irradiation is about 2.000 kWh/m^2. The southern part of the country is "blessed" with a continuous summer of practically 360 sunny days and even the northern part, the rainy and "cold" part, has more than 300 sunny days per year. These conditions make Israel an ideal place for the development and use of solar energy. The most common use of solar energy is the domestic water heating by solar collectors. Other methods of solar exploitation are photovoltaic cells for rural lighting; generating electric power from saline solar ponds; and the use of parabolic-trough collectors for the production of industrial process heat.

The use of solar collectors in Israel started in the 1950s as a result of the pioneering work of Prof. Harry Tabor. Nowadays, more than 80% of the roofs of the residence buildings in the Israel are covered by solar collectors, saving the country annually about 600,000 toe and each user, on the average, about 2.000 kWh which, at the present electricity prices, is worth about $165 (174 Euro[1]).

This widespread use of solar collectors is attributable to two factors

- The wish of the people to save money by using a free source of energy;
- A regulation begun in 1980 compelling the installation of domestic hot water systems (DHWS) in every new residential building not higher than 27 m.

The fact that 75%–80% of the solar collectors production is aimed at the replacement of old collectors proves that the use of DHWS in Israel is done for the most part voluntarily.

Legal and market considerations

The Standards Institution of Israel (SII) has published a standard for solar collectors and another standard for the storage tanks of solar systems. Both standards became mandatory (Official Standards) by a proclamation of the Minister of Industry and Trade (MoIT) forbidding the production, importation, sale and use of solar collectors and of storage tanks unless they conform with the Official Standards. In addition, the MoIT issued another order forbidding the production, sale and use of solar collectors and storage tanks unless they are marked with the Mark of Conformity (Standards Mark) of SII. By the end of 2002, only five manufacturers of storage tanks, one manufacturer of solar collectors and nine manufacturers manufacturing both products received from SII the permission to mark these products with the Standards Mark.

According to a regulation published by MoIT, manufacturers of solar collectors and of storage tanks must furnish consumers with a warranty ensuring the quality of these products for at least 5 years.

In practice, there is no import of solar collectors or storage tanks to Israel. However, any importer of these products would have to obtain the approval of SII to ensure they conform with the Israeli Official Standards, before they could be released from customs. Some of the manufacturers export flat plate collectors, mainly to European and African countries.

One consequence of the economical recession in Israel (and in the world) has been a decrease in new building projects, with the result of a decrease in the demand for new DHWS and a decrease in the number of manufacturers. Of the 14 manufacturers of solar collectors that in 1999 were under the technical supervision of SII, only 10 still exist. If this trend continues, the concentration of production in the hands of fewer manufacturers may lead to the increase in the efficiency and competitiveness of the remaining manufacturers.

1. Based on the average 2002 exchange rate of 0,946 USD/EUR

Technical considerations

Most of the DHWS in small buildings are of the thermosiphon open-loop type, with an electrical backup for cloudy days. Every family in the building has its own individual system. The average size of the storage tank is 150 litres and the average size of the collector is 2,5 m^2. Practically all of the collectors are coated with selective coating or painted with black paint. Both the storage tank and the collector are insulated using injected polyurethane.

In tall buildings use is made of collective solar systems in which an array of forced close-loop type collectors are connected to individual storage tanks having heat exchangers and electric backups.

Solar thermal installations and energy production

Solar collector production and sales in m^2										
	Glazed Collectors									Unglazed Collectors
	Flat Plate Collectors				Vacuum Collectors				Total Glazed	
	A National Production	B Exports	C Imports	D = A-B+C Total Home Market	E National Production	F Exports	G Imports	H = E-F+G Total Home Market	I = D+H Total Home Market	Total Home Market
1994	345.000	25.000		320.000	0	0	0	0	320.000	
2000	450.000	60.000		390.000	0	0	422	422	390.000	0

Estimated solar park in operation at the end of 2001

Total collector in m^2	3.500.000	= 580 m^2/1000 inhabitants

Estimated annual solar thermal energy production in 2001

Total	3.500.000 x 1 MWh/m^2·year =	3.500.000 MWh

Based on an annual incident solar irradation of 2.000 kWh/m^2 and an average system efficiency of 50%

CO_2 emissions avoided in 2001

Total	3.500.00 MWh/a x 0,835 tonnes/MWh =	2.922.500 t

Based on a factor of 835 g CO_2/kWh (as published by the Israel Electric Company)

Product types and solar thermal applications

Applications

Typical applications of solar thermal in Israel are

- Domestic individual thermosiphonic systems for hot water production: Market share in existing systems: 70–75%; in new projects: 60%
- Large collective forced circulation systems for hot water production: Market share in existing systems: 20–25%; in new projects: 30–35%
- Domestic individual forced systems for hot water production: 5% market share
- Space heating, district heating and air conditioning: 0% market share

Employment

Estimated employment figures in the following sectors (full-time jobs)	
Manufacturing of components of solar thermal systems	1.200
Installation and maintenance	3.000
Distribution and marketing	300
Testing and quality assurance	20
Training and consultancy	30
Total	4.550

B STATE OF PRODUCTION

Product technology and production methods

Product technology description

Collectors (usual sizes)	1,5/2,0/2,5/2,75
Absorber material	Steel; copper
Surface treatment	Black painting or selective coating
Insulation	Polyurethane
Transparent cover	Ordinary or tempered glass
Casing	Galvanized steel; aluminium
Storage tank	Steel tank with enamelled or epoxy or cement internal coating
Storage tank cover	white painted galvanised steel
Typical system efficiency	0,50

Typical collector efficiencies at the point:

$$X = \frac{\frac{T_{in} - T_{out}}{2} - T_{air}}{G} = 0,029 m^2 K^0 / kcal$$

- Collectors with 0,2 mm copper absorber; 3 mm glass; copper pipes; absorber welded to pipes by ultrasonic welding; selective coatings: $\eta = 0.623$
- Collectors with 0,2 mm copper absorber; 3 mm glass; copper pipes; absorber welded to pipes by ultrasonic welding; black painting: $\eta = 0.568$
- Collectors with 0,5 mm steel absorber; 3 mm glass; steel pipes; absorber connected to pipes by compacting; selective coatings: $\eta = 0.55$
- Collectors with 0,5 mm steel absorber; 3 mm glass; steel pipes; absorber connected to pipes by compacting; black painting: $\eta = 0.523$
- Collectors with 0,5 mm steel absorber; 3 mm glass; copper pipes; absorber connected to pipes by compacting; black painting: $\eta = 0.514$

Production technology description

Number of companies involved in collector production (November 2002)	10
Number of companies involved in tank production (November 2002)	14
Manufacturing methods	Most of the collectors are manually produced Most of the storage tanks are automatically or semi-automatically produced

Quality and performance: Taking into account the price of the solar systems (see following section), the present quality and performance of the solar systems are satisfactory. As specified in the previous article, the typical efficiency of the best solar collectors is about 0.6 and some of them may approach 0.7. In a sun flooded country like Israel, any effort to increase this efficiency will involve a disproportionate increase in the price of the collectors with a limited advantage to the consumers. An effort to increase efficiency may be justified when there is a limited space for installing the collectors, like on tall buildings. The mandatory Israeli Standard 579 Part 1 compels the manufacturers to reach a minimum collector efficiency of 0.43.

The existing regulation that compels the manufacturers to guaranty the quality of the collectors and storage tanks for a minimum period of 5 years and the supervision of the Standards Institution of Israel also contribute to the quality of the solar systems.

In recent years the high competition brought about a reduction in the number of manufacturers. This healthy trend, if continues, will enable the implementation of modern and automatic production methods, resulting in a reduction in production costs.

Breakdown of solar systems costs

Solar Systems Cost for Typically Sized Systems		
System	**Thermosiphonic, individual**	**Forced; collective**
Total price (excl. VAT)	200 €/m^2	240 €/m^2
VAT (18 %)	36 €/m^2	43,20 €/m^2
Total price (incl. VAT)	236 €/m^2	283,20 €/m^2
Typical size of system	2,5 m^2	

Typical solar domestic hot water system

Characteristics of a typical DHW system			
System type	Thermosiphonic		
Storage tank volume (litre)	120	150	200
Collector area (m^2)	2	2,5	2 x 1,5 = 3
Total installation price	590 €		
Subsides	None		

Typical consumer motivation

One should differentiate between systems installed in new buildings and systems installed in existing buildings. In new buildings the installation of DHW systems is compulsory. According to a regulation published in 1980, the contractor has the obligation to install solar systems in any new building the height of which is less than 27 m. This type of installation accounts for about 15% of the annually sold systems. Replacement of worn out systems and new installations in old buildings are done at the initiative of the consumers who wish to continue to save money by using a free source of energy – the sun.

Conventional water heating and energy prices

Conventional energy prices (VAT included)	
Electricity	0,097 €/kWh
Fuel – Oil	0,083 €/kWh
Bottled gas (LPG)	0,1 €/kWh
Gas (LPG) sold in bulk	0,03 €/kWh

Standards and codes of practice

- Israeli Standards:

  SI 579 Part 1 – Solar water heating systems: Flat plate collectors (Official)

  SI 579 Part 2 – Solar water heating systems: Storage water tanks (Official)

  SI 579 Part 3 – Test methods for solar collectors: Thermal performance of glazed liquid heating collectors including pressure drop (Based on ISO 9806-1)

  SI 579 Part 4 – Solar water heating systems: Thermosiphonic systems – Design, installation and testing

  SI 69 Part 1 – Electric water heaters: Thermostatically controlled and thermally insulated heaters (Official)

  SI 69 Part 3 – Electric water heaters: Accelerating heating devices for solar heaters (for vertically installed storage tanks)

- When an Israeli standard is declared official by the Minister of Industry and Trade (MoIT), it is forbidden to manufacture, import, sell and use a product covered by the Official Standard unless the product conforms to the requirements of this standard.
- The MoIT published in 1982 another Order forbidding the manufacture, sale and installation of solar collectors and storage tanks (among other products) unless they are certified by the Standards Institution of Israel (SII) and marked with its Mark of conformity.
- All the activities connected with the product certification are held by SII – It prepares and publishes the standards, performs the tests in its laboratories, supervises the manufacturers' quality systems, issues the permission to mark the products with the Mark of Conformity and annually re-tests these products to ensure that they continue to conform to the requirements of the standard.

Level of R & D[1]

Most R&D activities in Israel are carried out in universities and research centres. The annual R&D budget of the MoNI is about 2 million Euro, half of it devoted to solar energy. There are other financial sources for solar energy R&D – the Ministry for Science, the US-Israel Bi-national Science Foundation, and the EU.

A vast solar systems industry for supplying hot water to domestic consumers has been developed in Israel as a result of the R&D in the 1950s. Nowadays the quality and efficiency of these systems, based on flat plate collectors, has reached a high level. The economic advisability of further investment in research with the aim of improving the efficiency of the collectors is questionable.

Luz Industries Israel Ltd developed and installed a 354 MW power plant in California, based on single-axis parabolic-trough collectors. The plant is still operating despite the company's bankruptcy. The Luz concept is now being followed up by a new Israeli company, Solel Solar Systems Ltd, which is committed to maintaining its world leadership in commercial solar production.

Much progress is being made in the central receiver technology at the Solar Research Center of the Weizmann Institute. 64 "heliostate" mirrors, 50 m^2 each, re-direct the sun's rays to a receiver mounted on a tower some 50 m high. The combined effect of so many mirror surfaces, when focused onto a relatively small receiver, can obviously produce extremely high solar concentration. The facility's pioneering status is widely recognized and has brought about the establishment of a consortium for developing the industrial phase of those technologies which have indicated possible economic viability.

A wide range of R&D activities are being carried out at the Ben-Gurion National Solar Energy Center in Sde-Boker. In addition, the Center, in collaboration with the Israel Meteorological Service, is carrying out a multi-year project to establish an insulation database for the Negev Desert, using radiation data from eight meteorological stations.

1. Based on a Report to the United Nations on Sustainable Energy Development in Israel presented by the Israel Ministry of National Infrastructures, prepared by Amnon Einav and H. Avraham Arbib, September 1999.

C STATE OF MARKETING

Distribution and marketing methods

The solar systems distribution is divided between two sectors:
- Systems intended to be installed in new buildings (about 15% of the market);
- Retrofit sector for the replacement of existing systems or their components (about 85% of the market).

In the new buildings sector, the marketing, negotiations and the final agreement are arranged directly between the solar system manufacturer and the constructor. The architect and the installation consultant of the building are responsible for the design of the system in accordance with requirements of the Israeli Standard. In general, this design is made in consultation with the manufacturer of the solar system that is responsible for its installation.

In the retrofit sector there are four marketing channels:
- Direct selling by the manufacturer to the end consumers (about 10% of this sector);
- Selling through dealers that specialize in selling solar systems (about 50% of this sector). Each such a dealer may represent more then one manufacturer. These dealers are also responsible for installing the systems, generally through sub-contractors;
- Selling through installers/plumbers that buy the systems from the manufacturers or from the dealers (about 30% of this sector);
- Selling through hardware shops (about 10% of this sector).

Promotion of solar systems is done primarily through the Yellow Pages, newspapers and radio by the manufacturers, dealers and installers.

No special journal on solar systems/solar energy exists.

By law, the guarantee period for the storage tanks and the collectors of domestic solar systems is five years. Some manufacturers extend this period.

Incentives and financing methods

At the present there are no financial incentives for solar system applications.

The Energy Division of the MoNI gives grants of up to 30% to demonstration projects on new solar technologies. Existing demonstration projects include: solar energy for domestic use; passive solar homes; solar energy applications in hospitals and industry; solar drying; cogeneration of heat and electricity; energy management in buildings; energy management of city lighting; and many others.

D FUTURE PROSPECTS

As mentioned earlier, Israel lacks local resources of oil and coal, and it depends entirely on importing these fuels. In 2001 the energy requirements in Israel were supplied by crude oil (60,9%), coal (36,2%), and solar energy (2,9%). A great deal of money is being invested in searching for oil and gas fields, but for the time being without significant success.

Lately natural gas fields were discovered. This gas will be used as the main fuel in some electric power stations, reducing Israel's dependence on oil and coal. In addition natural gas is imported from Egypt. Plans are made to distribute the natural gas through pipes that will enable its use by consumers who at present depend totally on the use of LPG.

For many years, Israel's energy policy has been aimed at providing energy consumers with the necessary amount of energy at the required level of reliability, in the appropriate location and at the appropriate time. Following this broad policy outline, the MoNI ensured on one hand the secure importation of fuels to Israel, and on the other hand determines the energy prices the consumers must pay.

The MoNI has initiated the restructuring of the energy market so as to ensure free competition between energy companies operating in Israel, also enabling the penetration of independent electricity power producers. This policy is facing great difficulties as the result of the objections of some strong interested parties.

The MoNI has long ago recognized the importance of energy conservation. The Ministry is continuously promoting energy conservation by developing a governmental strategy as contribution to the sustainable development of Israel. Accumulated energy saving between 1981–2000 is estimated at 13 Mtoe or about 3 billion US Dollars. The Ministry is implementing a wide range of programs and activities including information to consumers, standardization, legislation and enforcement.

There is a statutory obligation for large companies and institutions to appoint an Energy Conservation Officer whose task is to carry out energy conservation activities. These Officers are obliged to participate in specified training consisting of 200 hours of formal instruction.

In August 1998 the Israeli Government resolved to encourage the development and application of alternative energy technologies. By that resolution an inter-Ministerial commission was appointed to recommend ways to increase the development and use of alternative energy sources. In its report to the to the MoNI the Commission urged the Government:

- To support R&D programs based on unique innovation technologies developed in Israel;
- To support demonstration projects;
- To quantify the environmental impacts (or damages) caused by by-products of electricity generation;
- To implement a wide-ranging conservation program;
- To encourage "fair competition" between energy producers.

Strategy to overcome the barriers to market development

The thermosiphonic DHW system has reached a saturation level, both technically and economically. The existing regulation that enforces the installation of a solar system in any new building (up to 27 m height) brought about a sudden increase in demand and the establishment of many factories, some of them relatively small. A reduction in this number is essential to increase production efficiency, using automated production methods.

A change in the Obligatory Israeli Standard with the purpose of increasing the minimum collector efficiency (which stands now on 0.43) should be considered. This change will force the manufacturers to invest in R&D and might contribute to the reduction in the number of manufacturers.

One sector which has a very high promising potential for development is the air conditioning sector. Israel, a hot country with 8–9 months summer, represents a great market for air-conditioners. Nowadays every second household in Israel is using at least one air-conditioner unit and this number is rapidly increasing. It is estimated that at the moment more than one million air conditioner units are in use in households using energy in the order of 2,6 MWh/year. In addition, central air conditioners are in use in every office building, commercial centres, entertainment halls and in many factories. The application of solar air conditioners depends on the development of reliable units that will be able to compete with the existing electrical units. Incentive grants from the Government for the development of such units and for their use might catalyse the process.

Large collective solar systems for heating water will continue to be used in tall buildings. Because the space on the roofs of these building is limited, a pressure to increase the collectors' efficiency will be exerted on the manufacturers, resulting in an increase in the quality of the systems.

Concluding remarks

Indigenous energy sources in Israel still make an unacceptably modest contribution to Israel's energy balance as compared to the available technical potential. The source base is much better understood today. Considerable technological progress has been achieved in recent years. Costs are dropping and the first sign of large-scale implementation are appearing.

Market forces are presently being brought into play in the energy sector, which has been traditionally dominated by monopolies. This will create a challenging new environment for alternative energy, thus providing more opportunities.

Contributions to this report

This report is based on information provided by ISOL the Israeli Solar Industry Association. For his valuable contribution we would like to thank Eli Shilton and Eli Hadar.

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Japan

A STATE OF THE MARKET

Overview of the market situation

The Japanese solar energy industry got started in the early-1950s, when manufacturers began producing the first Solar Hot Water Systems (SHWS). The early models were basically copper or stainless steel cylinders of the so-called breadbox type and were primarily used in farming and fishing villages to create hot water for bath and showers. Most of SHWS are installed in the South and South-East/East areas, facing the Pacific Ocean, where plenty of solar radiation is available throughout the year (with a yearly average global solar radiation of about 3,5–4,0 kWh/m^2 day). Other areas in the North or generally facing the Japanese Sea have less sunshine and have difficulties in the effective utilization of SHWS.

The type of water heaters which are produced in Japan today are based on the thermosiphon principle and were first developed in the mid-1970s. Around that time many manufacturers – some of whom still exist – developed and began producing active SHWS.

Following the first oil crisis in 1973, solar thermal systems have spread quickly, as the householders in Japan have used solar energy for domestic hot water supply (DHW). Again after the oil crisis in 1979, which triggered anxious anticipation of rising energy prices and possible energy shortages, sales of SHWS expanded significantly in the market.

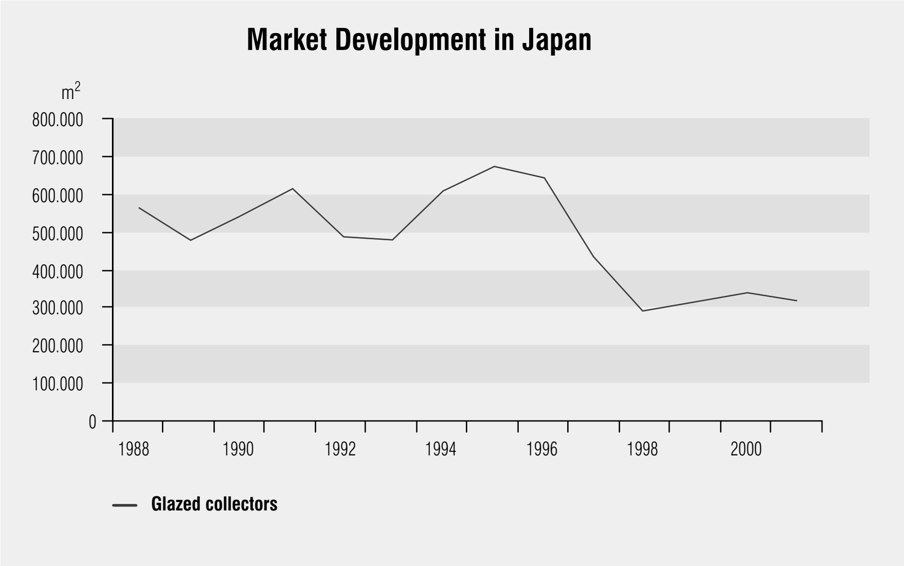
Most of the systems used today are based on improvements made on this original technology. Both, SWHS as well as forced circulation systems, are mainly used for DHW. Only a small portion of these systems is being used for heating and cooling in solar houses and in a few solar buildings. Very recently, local house builders and construction companies in Japan have taken an interest in active solar heating and SHWS. An increasing number of solar houses are also being built with active solar systems installed.

In 1980 the production and sales of SHWS in Japan reached a peak, but after that production declined with falling energy prices, and after 1989 production even became rather sluggish. However, it recovered, and in 1995 reached the highest level of sales since 1987. Unfortunately, in the last 5 years production suffered a significant decrease – partly as illegal sales of major manufacturers were disclosed. Furthermore, solar collector production showed a sharp drop in 1998, in line with the government's termination of low interest loans.

At the same time, however, the Japanese government revised the "Long-term Energy Supply and Demand Outlook," and set a target of 3,1 % of the Japanese local energy demand being met by renewable energy sources by the end of 2010.

Solar thermal installations

Solar collector production and sales in m²										
	Glazed Collectors									**Unglazed Collectors**
	Flat Plate Collectors				**Vacuum Collectors**				**Total Glazed**	
	A National Production	B Exports	C Imports	D = A-B+C Total Home Market	E National Production	F Exports	G Imports	H = E-F+G Total Home Market	I = D+H Total Home Market	Total Home Market
1975-1987	7.000.000			7.000.000	240.000			240.000	7.240.000	n/a
1988	551.779			551.779	12.994			12.994	564.773	n/a
1989	469.418			469.418	10.812			10.812	480.230	n/a
1990	530.039			530.039	12.788			12.788	542.827	n/a
1991	593.534			593.534	12.913			12.913	606.447	n/a
1992	482.413			482.413	11.155			11.155	493.568	n/a
1993	474.782			474.782	7.531			7.531	482.313	n/a
1994	599.781			599.781	6.806			6.806	606.587	n/a
1995	671.943			671.943	6.685			6.685	678.628	n/a
1996	640.981			640.981	5.995			5.995	646.976	n/a
1997	429.451			429.451	8.542			8.542	437.993	n/a
1998	281.624			281.624	14.029			14.029	295.653	n/a
1999	298.473			298.473	8.283			8.283	306.756	n/a
2000	332.881			332.881	5.891			5.891	338.772	n/a
2001	310.000			310.000	4.000			4.000	314.000	n/a



Source:S.S.D.A. (Solar System Development Association), YAZAKI Corporation, ASTIG

Estimated solar park in operation at the end of 2001[1,2]

Flat plate collectors in m^2	7.218.878	
Vacuum collectors in m^2	141.418	
Total glazed collectors in m^2	7.360.296	$= 58 m^2$/1000 inhabitants

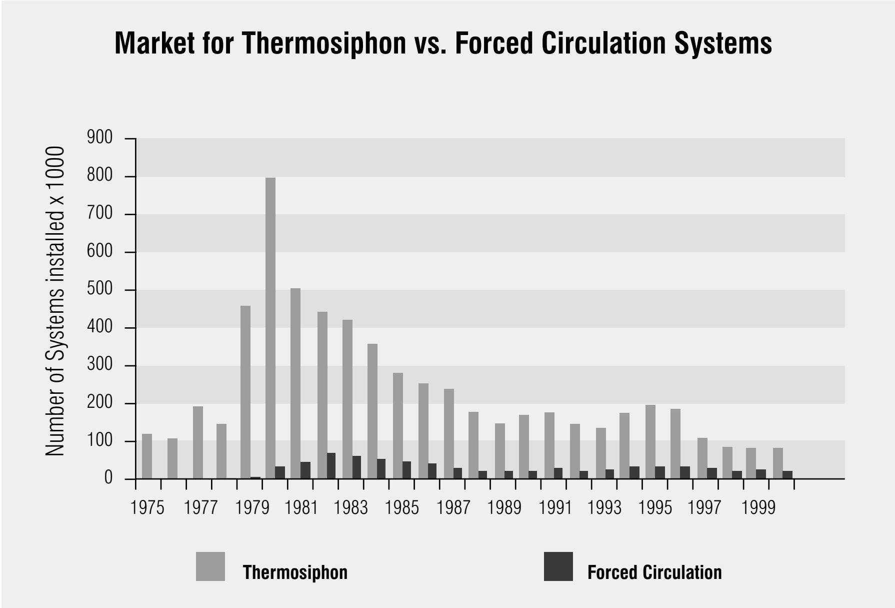
Product types and solar thermal applications

Product types

Ever since solar thermal systems were launched in Japan, the most popular type has been the thermosiphon system – which is usually called a "passive solar system" in Japan. The following diagram shows the number of thermosiphon vs. the number of forced circulation systems (in thousand units).

1. In Sun in Action II, ESTIF uses the following general assumptions to calculate the solar park in operation: systems installed until 1989 have an average lifetime of 15 years; systems installed in or after 1990 have an average lifetime of 20 years.

2. Since 1987 data market data were not available, 1988 data were used instead.



Most common systems in Japan
At present there are 3 types (not including forced circulation systems) of SHWS manufactured in Japan, which are mostly used for DHW among householders:

1. **Thermosiphon systems** which use a flat plate collector (FPC)
   The most popular SWHS is a FPC with an area of 2 to 3 m^2, mounted together with a 200 to 250 liter storage tank.

2. **Thermosiphon systems** which use an evacuated tube collector (ETC)
   With this type of ETC (there is another type described below) the space between each of the glass tubes is enclosed in a vacuum, and on the inner glass tube surface there is a selective coating. The water flows through the glass tubes. Above the collector is a storage tank, and the water rises to the thermosiphon before being circulated.

3. **Storage systems** which use an evacuated glass collector
   A stainless steel tank with a selective coating is built into the vacuum-sealed glass tubes, which have a diameter of about 126 mm. This type of SWHS is installed on the roof or veranda and sometimes in gardens as well.

Other systems used in Japan
For Residential Forced Circulation Systems, the solar collectors are installed on the roof, while the storage tank can be installed inside the house or in the garden – the water travels between them through the circulation pipe. The solar collectors are either FPC's or ETC's.

The other type of ETC's, used mainly for this application, differs from the one described in point 2 above. This ETC has typically a diameter of about 100 mm and is made from borosilicate glass (wall thickness ~ 2.5mm) with a vacuum-tight stainless steel lid on one side of the tube. The copper absorbers inside have a selective coating and the heat transfer fluid flows directly through the coaxial absorber-tubes. A variation of this type uses the Heat Pipe Principal.

Although these collectors are often more expensive, they have a few significant advantages, such as higher operating temperatures (e.g. for industrial process heat or solar assisted cooling), reduced thermal losses, higher energy yield (an advantage if only small set-up areas are available) throughout the year and a closed compact construction.

Applications

The solar thermal systems are usually installed on the roof of the single-family residential house. The diffusion ratio for households in Japan amounts to about 15%, and that ratio is higher in local cities and towns as well as villages rather than in big cities.

About 90% of the SHWS, in terms of square meters, are used for DHW in single-family residences. The domestic application for combined heating and cooling purposes, as well as the application of solar thermal systems in multi-family houses /middle scale installation systems, has been rising for the last 3–5 years, but still does not have a significant share.

Installation by Application: Number of Solar Thermal Systems (1973-1998 F.Y.)

	Forced circulation system				Thermo-siphon	Total	Shares (%)
	Hot Water	Heating	Cooling	Others	Hot Water		
Single-Family Residential houses	523.567	1.020	88	9	6.063.767	6.588.451	(99,9)
Business/ Public	6.074	288	375	115	0	6.852	(0,1)
Industrial	331	23	16	71	0	441	
Total	529.972	1.331	479	195	6.063.767	6.595.744	(100,0)

Sources: Yearbook of Industrial Production (MITI), Solar System Data Book (S.S.D.A)

Middle-Scale Installation Systems are becoming more and more common nowadays, e.g. in multi-family residences, welfare facilities and hospitals, as well as in small office buildings.

Large-scale Installation Systems are rather an exception than the rule in Japan – especially for office buildings to have such solar energy collectors installed.

B STATE OF PRODUCTION

Product technology

The following technologies and materials are typically used in Japanese solar thermal systems:

Collectors (usual sizes)	ETC and FPC (mostly thermosiphon), with typical area of 2 – 3 m^2
Absorber material	Copper, copper-aluminium, galvanized-/ stainless steel
Surface treatment	Black chrome and selective coatings (mainly ETC)
Insulation	Mainly mineral fibre, partly PU and Styrene foam
Transparent cover	Float or cast glass (partly low iron), ETC: borosilicate glass
Casing	Mostly aluminium, partly galvanized steel
Storage tank	Stainless steel, steel and polyethylene

Breakdown of solar systems costs

Solar Systems[a] Cost for Typically Sized Systems		
	Individual (Thermosiphon)	**Individual (Forced Circulation)**
Total costs (excl. VAT)	1.939 €	6.511 €
VAT (5 %)	97 €	326 €
Total cost (incl. VAT)	2.036	6.837 €
Typical size of system	2 x 2 m^2 FPC & 200 l	3 x 1,36 m^2 ETC & 300 l

a.Based on the average 2002 exchange rate of 118,1 JPY/EUR

Typical solar domestic hot water system

System type	Thermosiphon system
Collector area (m^2)	2–3
Hot water storage (litres)	200–250
Total installed cost (VAT incl.)	2.100–2.500 €
Eventual subsides	For DHW there are no subsidies on the national level, but on the regional level some financial support schemes exist
Usual guarantee	Two years

Standards and codes of practice

Members of the Solar System Development Association (S.S.D.A.) are required to have their systems certified. To be certified or approved a system must meet the requirements of the Japanese Industry Standard (J.I.S.) and pass a test by an official authorized testing institute.

At the present time the following standards are used in Japan:
- J.I.S. A 4111 (Solar Domestic Hot Water Equipment for Residential)
- J.I.S. A 4112 (Solar Collectors)
- J.I.S. A 1425 (Test method of Heat Collection Performance of Solar Collectors)
- J.I.S. A 4113 (Solar Storage Tanks)
- J.I.S. A 1426 (Test method of Heat Storage Performance of Storage Tanks)

Level of R & D

National Programs for R&D of Renewable Energy Technology

- The SUNSHINE Project (440 billion Yen [1]) started in the 1970s and was followed by the MOONLIGHT Project (140 billion Yen) in the 1980s and finally the Global Environmental Technology Development Program (15 billion Yen).
- The NEW SUNSHINE Project (part of the MITI "New Earth 21 Project") – is a "Renewable Energy and Environmental Technology Development Program" focusing on 6 major tasks (directed also to PV-Systems):
  – Innovative technology development (500 billion Yen)
  – International large scale collaboration research (900 billion Yen)
  – Collaborative R&D on appropriate technology (150 billion Yen)
  – Action Plan on Global Warning Protection
  – Promotion of the Earth Regeneration Program
  – Support for neighbouring development countries

National Program for Solar Thermal Application Technology R&D

- Solar Heating and Cooling Program (SHAC)
  – Cost reduction of SHAC & DHW systems including installation costs, especially mounting with simplified mechanism
  – Development of innovative solar cooling technology
  – Establishment of testing procedures for durability and reliability of solar heating and cooling component and materials
  – Improvement of system efficiency, reliability and durability
  – Testing & monitoring of SHAC components and materials
- Basic Research Goals
  – To improve system efficiency, reliability and durability
  – To improve system analysis methodology and optimisation of solar integrated/hybrid systems
  – Architectural design for environmental sustainability
  – To promote cost analysis of renewable and conventional energies based on social and environmental costs
  – Single-family solar house, retrofit system
  – Passive systems and components for single-family & multi-family solar houses as well as office buildings
- NEDO (New Energy & Technology Development Organisation)
  – Advanced solar technology
  – Solar industry process heat
- Solar Desalination
  – Basin type and evacuated tube collector systems
  – Solar pond and salt-gradient

1. No Euro exchange rate is available for this time as the Euro was introduced only in 2001. The average excange rate in 2002 was 118,1 JPY/EUR

Incentives and financing methods

Until 1997, subsidies and low-interest loans were available, as well as certain tax incentives – for all applications. For domestic applications this was stopped. Today only for large-scale installations in public buildings and business facilities does this policy continue. The subsidy rate varies between 30% and 50% – depending mainly on the size and type of building.

In addition subsidies are available for SHAC projects, as well as for SDHW systems for advanced energy saving residential use.

Regionally there are promotion programs in combination with subsidy programs as well.

C FUTURE PROSPECTS

National energy policy

There is a “Popularisation Assistance Policy for Solar Thermal Energy Systems” from the “Ministry of International Trade and Industry”

- Implementation of promotion works
  - Promotion of installation in government buildings and subsidies for installation in such buildings (local government buildings or public facilities)
  - Public relations
  - Consulting & advice for local communities
  - Establishment of unified performance systems
- Preferential measures on tax & finance
  - Loan for the establishment of medium and small business (Small Business Finance Corporation)
  - Preferential measures for solar system business
- Promotion of economic cooperation and technology exports

Objectives for the solar industry/market

The Japanese Government is putting pressure on the renewable energy industry in order to reduce future dependency on imported energy sources, and also in order to achieve the Kyoto-commitment regarding the worldwide reduction of CO_2 emissions.

Its goal is to increase the present energy supply from renewables by about 5 times for solar thermal, 23 times for PV and 38 times for wind energy.

Solar Energy Installation Targets

In order to ensure that renewables become a stable source of energy as an alternative to oil, and to promote environmental protection by regulating the volume of permissible CO_2 emission in regional environments, in 2001 the Japanese government released "Outlook of Energy Supply and New Energy Installation Targets". The Outlook for solar energy installation targets is as follows:

	2010 F.Y. target	
	Usual action	**Positive action**
Solar Thermal Systems	720 x 10^3 kl (~7,8 TWh)	4.390 x 10^3 kl (~47,3 TWh)
PV Systems	2.540 MW (620 x 10^3 kl) (~6,7 TWh)	4.820 MW (1,180 x 10^3 kl) (~12,7 TWh)
New Energy Total (Shares of total primary energy supply)	8.780 x 10^3 kl (~94,6 TWh) (1,4 %)	19.100 x 10^3 kl (~205,8 TWh) (3,1 %)

Strategy to overcome the barriers to market development

- To achieve substantially higher volume in the domestic market a cost reduction – mainly on production cost but also regarding distribution in most cases – is necessary
- Solar thermal systems must deliver more competitive energy costs in comparison to fossil fuels
- More subsidies from the government (METI and others) for R&D is required – especially but not only for new developments e.g. SHAC and hybrid systems
- National campaigns should be initiated to increase public awareness
- New programs of general and regional subsidy schemes are needed to accelerate the sales of solar thermal.

References

S.S.D.A. (Solar System Development Association)

YAZAKI Corporation

ASTIG

Contributions to this report

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Turkey

A STATE OF THE MARKET

Overview of the market situation

The leading solar technology in Turkey is that of the flat-plate solar collectors. Flat-plate solar collectors were first employed at the beginning of 1970's in tourist hotels and summer houses located in western coastal areas of Turkey. Simple technology, brought from neighbouring Mediterranean countries in Europe (Italy, Greece), was copied and adopted to the local economical capacities of small workshop manufacturers. The urgent need to supply hot water in touristic towns and coastal vacation houses in summer months mushroomed the production of the flat-plate solar collectors and the number of manufacturers. Major companies for the production of these systems could not have arisen in Turkey, because of the instability of the market and the availability of cheap labour for small-size manufacturers in isolated resort areas. Production was rapidly expanded from the Aegean (Izmir, Kusadası, Ayvalık) region to the south-west (Marmaris, Fethiye, Mugla) and southern coastal areas (Antalya, Alanya, Mersin, Adana, Hatay) and, in the last decade, to south-eastern towns (Diyarbakir, Gaziantep, Urfa). This inexpensive method of hot water production from the sun for domestic use was welcomed by the public in seventies and eighties when Turkey was struggling with a serious energy crisis along with political and economical turbulences. This led to an increase in the number of collector production companies and growing collector sales. As can be seen from governmental data, collector production in Turkey grew rapidly year by year. The nineties, however, witnessed a decline due to poor technology, leading to negative experiences, and also due to the recovered economy, which has encouraged the employment of modern electrical heaters. The total production number of 1.000.000 up to 1985 in the table in the following section is an incorrect estimation, based on the government organization EIEI's (General Directorate of Electrical Power Resources Survey and Development Administration) method of predicting the annual number of glazed collectors produced from the annual consumption of tempered glass in Turkey. Resistant tempered glass is used in glazed thermal solar collectors for covering the surface area. Tempered glass is produced in major by the largest Turkish glass firm of TSCF-Turkiye Sise Cam Fabrikaları A.S.; but small workshop-type producers mostly prefer to use window glass instead of expensive tempered glass. Thus the real number is believed to be much higher, in addition to unaccountable rate of window glass glazed solar collectors and unregistered small production units.

To examine the progress in the use of solar collectors in Turkey, an alternative approach could be to view the trend in the total collector capacity. The total installed capacity in the world is approximated to be 35–50 million m^2, according to various sources. The installed capacity in Turkey by the end of 2001 is estimated to be at least 8 million m^2, which is about 15–20% of the total capacity installed all over the world. This shows that, compared with the developed countries of USA, Japan, and the Sun Belt countries, Turkey is a major user of solar technology, especially for solar thermal systems. If one may assume that this capacity of about 8 million m^2 has been reached since the beginning of application of thermal solar collectors in Turkey, that would add up to about 4 million independent collector units, with an average of 2 m^2 surface area for each flat-plate solar collector. Thus in rough approximation, 2–3 million domestic units (houses, hotels) are thought to employ solar thermal systems in Turkey, taking into account that each solar collector unit would satisfy a family's house hot water needs during the summer months.

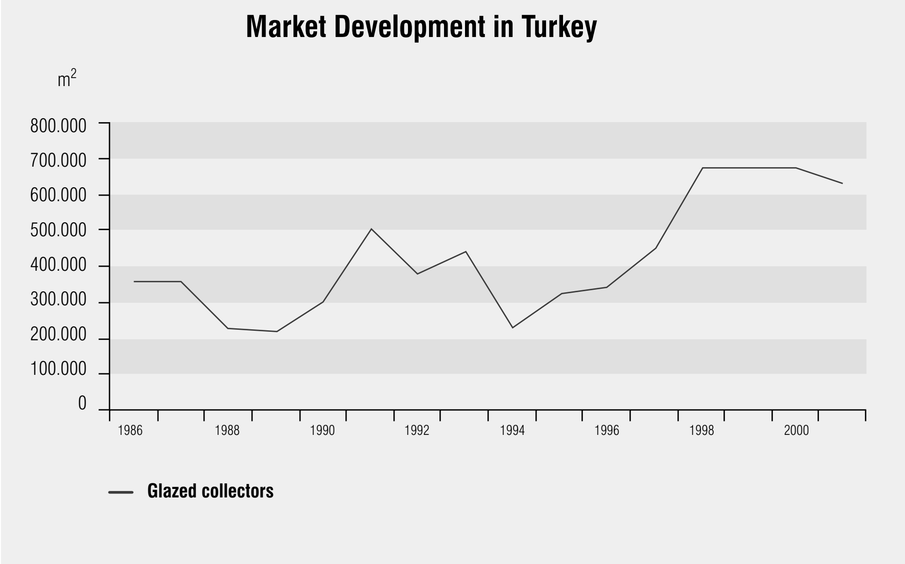
There are now about a dozen medium-size major companies producing solar collectors in the market, and countless small and workshop-type manufacturers. The number increases when one takes into account the dealers and firms that purchase both solar collectors and other necessary solar thermal system equipment for both domestic and industrial use; but for that reason, exact data is rarely obtained. Most of the production is used domestically. The number of solar collectors exported to neighbouring countries is roughly estimated to be 10% of total production each year since 1995. It is difficult to get the exact figures due to complicated barter-type trade with ex-Soviet Republics.

The solar collector market now is based on two different types of solar collectors: technologically poor traditional collectors and technologically advanced high efficiency ones. Technologically poor collectors are marked by low efficiency and bad quality, while high efficiency types consist of selective surfaces raising overall system performance and, with it, the price. However, end-users are usually not able to understand the difference, which leads to negative experiences and dissatisfaction. Since the main criterion in choosing the type of collectors to be installed is the price rather than knowledge, traditional-type systems persist.

Solar thermal installations and energy production

Solar collector production and sales in m²										
	Glazed Collectors									Unglazed Collectors
	Flat Plate Collectors				Vacuum Collectors				Total Glazed	
	A National Production	B Exports	C Imports	D = A-B+C Total Home Market	E National Production	F Exports	G Imports	H = E-F+G Total Home Market	I = D+H Total Home Market	Total Home Market
Until 1985	1.000.000			1.000.000					1.000.000	
1986	360.000			360.000					360.000	
1987	360.000			360.000					360.000	
1988	230.000			230.000					230.000	
1989	220.000			220.000					220.000	
1990	300.000			300.000					300.000	
1991	500.000			500.000					500.000	
1992	380.000			380.000					380.000	
1993	440.000			440.000					440.000	
1994	230.000			230.000					230.000	
1995	350.000	~10%		~315.000					~315.000	
1996	380.000	~10%		~342.000					~342.000	
1997	500.000	~10%		~450.000					~450.000	
1998	750.000	~10%		~675.000					~675.000	
1999	750.000	~10%		~675.000					~675.000	
2000	750.000	~10%		~675.000					~675.000	
2001	700.000	~10%		~630.000					~630.000	

Source: Approximate data obtained from General Directorate of Electrical Power Resources Survey and Development Administration (EIEI), 2002 and Clean Energy Foundation, 2002)



Estimated solar park in operation at the end of 2001

Flat plate collectors in m^2	6.422.000	$= 95 m^2/1000$ inhabitants

Estimated annual solar thermal energy production in 2001

Flat plate collectors in m^2	6.422.000 x 614 kWh/m^2·year =	3.943.108 MWh
Total Solar Radiation per m^2 x Average Collector Efficiency = 1.365 x 0,45 = 614 kWh/m^2 • year		

Product types and solar thermal applications

Heat-absorbing solar collectors basically consist of an absorber plate, glass cover, back insulation and outer coverage. The absorber plate, which absorbs the solar radiation and transfers the heat to the operating fluid, is usually made of a conductive material such as aluminium, copper, stainless steel and some special plastics. In order to maximize absorption (ap) and minimize surface emission (ep), and thus to prevent heat loss by radiation, the plate is painted black. The heat loss from the back of the plate is prevented by back insulation. Unironised (not containing iron-oxide) tempered glass is used as the front cover in order to prevent the convection heat loss caused by the free air movement, to cause greenhouse effect by behaving transparently towards short wave and opaquely towards long wave radiation, and to protect the front face from rain or dust. All of these components described generally are contained in an aluminium bodywork.

Product types

Solar energy technologies can generally be categorized as thermal, passive and electrical systems. As interest, thermal and passive systems, which may be counted as a part of thermal systems, will be summarized in this section.

Thermal solar systems can be divided into two groups: low temperature applications and high temperature applications. Low temperature applications consist of units producing heat energy at low temperatures by using both direct and diffuse components of solar energy. The main applications of this group are flat-plate collectors, which are used to generate hot water for domestic and/or industrial use. Collectors are also used in heating domestic or commercial buildings. R&D projects continue in this field in Turkey, while they are becoming fully commercialised day by day. High temperature systems contain applications such as concentrating collectors which are used in a wide range as solar thermal power plants and solar ovens. This type of application has no working field in Turkey yet.

Low temperature applications are widely installed in Turkey, and mainly serve the purpose of domestic water heating. Nowadays, some attempts have been made to use the sun as a natural heat source by building solar houses. Below are the descriptions for each of the application type used in Turkey:

Domestic hot water production (DHW)
This type of application, as its name would suggest, is used in heating water for domestic use. The system generally consists of a solar collector, a storage tank, pipes and other connection material, and some subsystems. According to the heat transfer process to the fluid, these systems are described as forced and natural circulation systems. Both systems have direct and indirect types. The collector is directly connected to the storage tank, and the same fluid is used to collect and store the solar energy in direct systems (open-loop systems). In indirect systems, a heat exchanger is used to transfer the heat between water and the unfreezing fluid (closed-loop systems).

Space heating (solar buildings)
Solar buildings are the subject of solar architecture. Solar architecture deals with designing buildings in order to create warmer space in winter, cooler space in summer and a well-lit space all year through the use of solar energy – all naturally. Solar buildings are designed to use both active and passive systems.

Active systems are used to obtain hot water, which is used as a heating medium in heat generators. The system consists of pumps, fans, controlling valves, temperature controllers, heat storage tanks and other controlling equipment. Passive systems take advantage of various architectural properties, such as building orientation, and structural designs.

In Turkey, solar buildings are beginning to find a place in new building designs and developments.

Employment

As solar technology development is distributed for the most part to small workshop unregistered-type producers in Turkey, too little commercial and official data is available. Therefore, precise information cannot be given in this section. However, given a rough estimation of an average of 50 employees per company among those dealing with solar energy, and 5–10 employees at small workshop-type producers, and taking into account the dealers and firms that purchase both solar collectors and other necessary solar thermal system equipments, the total number of employees in the field can be approximated to be roughly 15.000–20.000, including all types of producers.

B STATE OF PRODUCTION

Product technology and production methods

Product technology description

The collectors used in solar DHW systems are usually about 2 m^2 in size (~1,1 m x 1,9 m). The absorber plate which absorbs the solar radiation and transfers the heat to the operating fluid is usually made of a conductive material such as aluminium, copper, stainless steel and some special plastics. In order to maximize absorption (α_p) and minimise surface emission (ε_p), and thus to prevent heat loss by radiation, the plate is painted black. For this purpose, while increasing surface absorption, surface emission should remain low. In simple cover paintings, like mat black colour coatings where $\alpha_p \approx \varepsilon_p$, the overall collector efficiency is negatively affected. A good absorber plate is thought to have far less surface emission while having greater absorption, namely $\varepsilon_p << \alpha_p$. Absorptive coatings are classified into three groups according to the ratio of absorption to emission. According to this classification, surfaces of which $\alpha_p / \varepsilon_p > 4.5$ are called selective surfaces, where $\alpha_p > 0.90$ and $\varepsilon_p < 0.2$. Selective surfaces are known to give the best results. The second group consists of surfaces having a ratio of 1.8–4.5, which are called semi-selective surfaces. The last group, with a ratio of 1–1.8, is known as non-selective surfaces. In Turkey, collectors used usually contain traditional black coloured, non-selective absorber plates. But nowadays, some manufacturers are beginning to work with selective surface coating.

The insulation of the collector is another important subject. Generally, glass-fibre or glass-wool is used as insulating material. Insulation is installed on the back side of the collector under the absorber plate to prevent conductive back heat loss.

The collector is covered with tempered glass. This type of glass is used in order to prevent the convection heat loss caused by the free air movement, to cause the greenhouse effect by behaving transparently against short wave and opaquely against long wave radiation, and to protect the front face from rain or dust.

The casing is usually made of aluminium, which covers and protects all of the components of the collector system.

The operating fluid, which usually is water, is stored in a storage tank. The tank is the unit in which heat is stored through use of the operating fluid. The size of the tank is chosen according to the hot water needs and the amount of heat energy to be stored. The tanks are usually made of galvanized iron sheets, although nowadays stainless steel and strengthened glass fibre are also used as tank material.

Product technology description

There are now about a dozen medium-size companies producing solar collectors on the market, with about 50 registered small companies and hundreds of workshop-type manufacturers which cannot be registered. The number increases when one takes into account the dealers and firms that purchase both solar collectors and other necessary solar thermal system equipment for both domestic and industrial use; but for that reason, exact data is rarely obtained. Most of the production is used for domestic needs, as seen in the tables, and the number of solar collectors exported is predicted to increase year by year due to increases in production in non-coastal areas of Turkey (i.e. south-east). In rough estimation, 10% of the total production is exported every year.

Breakdown of solar systems costs

Solar Systems Costs for Typically Sized Systems		
	Individual	**Project (large scale)**
Total costs (excl. VAT)	200 €/m^2	175 €/m^2
VAT (18%)	36 €/m^2	31,50 €/m^2
Total cost (incl. VAT)	236 €/m^2	206,50 €/m^2
Typical size of system	~4m^2	Various
(1 Euro = ~1,000,000 TL in 2001, yearly average)		

The percentage of cost reduction increases when the system size is larger than 4m^2. Total cost of the system may be reduced by ~5–10% when the system size is >4m^2.

Typical solar domestic hot water system

The system generally consists of a solar collector, a storage tank, pipes and other connection material, and some subsystems. According to the heat transfer process to the fluid, these systems are described as forced and natural circulation systems. Both systems have direct and indirect types. The collector is directly connected to the storage tank and the same fluid is used to collect and store the solar energy in direct systems. In indirect systems, a heat exchanger is used to transfer the heat between water and the unfreezing fluid. In Turkey, direct systems are called open-loop systems while indirect systems are known as closed-loop systems.

Usually, two collectors are used in DHW systems, which means $\sim 4\,m^2$ collector area per system in small scale individual types. The amount of hot water stored depends on energy needs, but is usually taken to be about 50 liters/person.

Total installed cost of a domestic system may be about 200 – 250 Euro/m^2 (VAT included).

Typical consumer motivation

Turkey is located in the Sunbelt and is therefore rich in solar energy. Using solar energy for various purposes already attracts consumers. People are using solar energy mostly in domestic hot water systems, as well as electricity production. Solar collector producers take full advantage of this situation in influencing consumers. In many congresses and/or fairs, producers attend to advertise their products. Also, TV ads and advertising papers attract consumer attention to solar thermal systems.

Consumers use such technology and take full advantage of their installed systems, especially in their summer resorts, for the rapid availability of hot water for their daily needs, for free heating of water and for low-cost of maintenance of production systems. Industrial users, such as hotels and industrial facilities, improve their image through the employment of clean energy based systems and of course lower energy-related expenses.

Conventional water heating and energy prices

Conventional Energy Prices		
Date: 2001	**Housing VAT incl.**	**Collective VAT incl.**
Electricity – normal	0,078 €/kWh	0,048 €/kWh
Electricity – low rate	0,052 €/kWh	0,040 €/kWh
Fuel – Oil	0,221 €/kWh	0,121 €/kWh
Bottled gas	0,57 €/kWh	n/a
Natural gas	0,15 €/kWh	0,115 €/kWh
Other	0,044 €/kWh (Wood) 0,090 €/kWh (Lignite) 0,400 €/kWh (LPG)	0,039 €/kWh (Wood) 0,060 €/kWh (Lignite) 0,392 €/kWh (LPG)
1 Euro = ~1,000,000 TL in 2001, yearly average		

Standards and codes of practice

The aim of collector testing is to control the collector performance produced by various manufacturers and to compare different collectors with each other. Some standards used for this purpose are:

- TS 4801: Turkish Standard for solar energy collectors – thermal performance testing methods.
- ASHRAE 93 – 77: Methods of testing to determine the thermal performance of solar collectors.
- ISO 9806 – 1: Thermal performance of glazed liquid heating collectors including pressure drop.
- NBSIR – 74 – 635: Method of testing for rating solar collectors based on thermal performance.

In Turkey, mainly TS 4801 is used for testing the performance and efficiency of solar collectors. The other standards mentioned here have a further field of application in various testing facilities. The tests are performed at various institutional and governmental testing facilities, some of which are Solar Energy Institute of Ege University, The Scientific and Technical Research Council of Turkey (TUBITAK) and General Directorate of Electrical Power Resources Survey and Development Administration (EIEI).

Level of R & D

R & D is insufficient in this area. However, some of the big manufacturers maintain average R & D activities. As soon as the subject is better understood, R & D will take a more important place in the solar thermal sector.

Universities and institutes spend more time on R & D. But unfortunately, because there is inefficient communication between universities and the industry, projects can rarely be transferred to manufacturers. However, demonstrating the importance of the subject, many events such as symposiums, congresses and meetings are arranged by various universities and institutes to attract attention to solar energy and of course to other renewable energy sources.

Governmental institutions and universities carry out most of the research activities on solar energy systems, with very limited contribution from private establishments or firms.

Some of the universities studying on solar energy systems are:

- Cukurova University in Adana:
  – water heating
  – selective surfaces
- Dicle University in Diyarbakır:
  – solar collectors
- Diyarbakir Technical University: solar collectors.
- Ege University in Izmir:
  – Solar Energy Institute (Gunes Enerjisi Enstitusu):
    solar cooling
    parabolic collectors
    solar cooker
    PV power plants
    solar drying
    other renewable energy sources
- Erciyes University in Kayseri:
- Istanbul Technical University (ITU)
  – Chemistry Department
    selective surfaces
    solar cooling
    PV cells
  – Meteorology Department
  – Mechanical Engineering Department
- Erciyes University in Kayseri:
- Middle East Technical University (METU) in Ankara:
  – Chemical Engineering Department
  – Electrical Engineering Department
- Mugla University in Mersin:
  – PV Systems

Remaining universities in the country conduct also research on complementary fields such as passive solar energy systems, other renewable energies, or public health issues.

In addition to the universities and academical studies, public institutes also produce theoretical and applied research on solar collectors and PV cells, some of which include:

- TUBITAK (Turkish Scientific and Technical Research Council), Marmara Research Center (TUBITAK–MAM): TUBITAK is the main public R&D organisation in Turkey, and it co-ordinates scientific R&D activities all over the country. At the Marmara Research Center, research projects on solar energy technologies are being carried out, including theoretical and applied research on PV cells, solar cooling, and solar collectors.
- High Technology Institute (Yuksek Teknoloji Enstitusu), Izmir: the department of Mechanical Engineering is doing research on solar energy in fields such as photovoltaic cells and hydrogen energy, and offers postgraduate lectures in energy engineering.
- General Directorate of Electrical Power Resources Survey and Development Administration (EIEI) (Elektrik Isleri Etut Idaresi Genel Mud.), Solar Energy Division: under the Ministry of Energy and Natural Resources, EIEI is responsible for studies on energy efficiency and renewable energy sources since 1981. The solar energy division provides informational background to the Ministry, who is then in charge of making political decisions. This division has research projects including PV pumping, street lighting, house electrification with PV, water heating and house heating. It has installed various PV systems (lighting, pumps, traffic warning signals), and the first PV grid-connected system in the country. They carry out the official tests for solar collectors at the Turkish Standards Institute.
- State Meteorological Institute (DMI) (Devlet Meteoroloji Isleri.): As was previously mentioned, DMI is responsible for organizing solar power resource measurements in the country. TUBITAK, EIEI, and some universities have also contributed to the measurement of the solar radiation potential in the country.

C STATE OF MARKETING

Distribution and marketing methods

The distribution and marketing of flat-plate solar collectors produce by major companies are conducted through representative units in large cities and coastal towns in Turkey. The sale to individual summer houses is carried out in general first by an examination of installment conditions by the firm or workshop technical representative, to determine the additional items, connections, pipes etc, needed, and followed by bargaining as to the total costs. Adjudication process is pursued for sale to hotels, factories, public buildings (schools, hospitals) for large scale application of thermal solar collectors. Installment and thermal efficiency technical conditions are first examined and an average cost of the whole system is determined prior to adjudication agreement, which is settled in a competitive bargaining meeting in presence of several companies. A maximum guarantee of one year of the solar collector is given by major companies. Small size firms and workshop type manufacturers avoid guarantees, because the severe atmospheric alterations in winter months in Turkey cause additional maintenance costs for installed collectors. One factor threatening the marketing of flat-plate collectors in Turkey is the high cost of maintenance after 3–5 years of use, especially for poor quality products.

D FUTURE PROSPECTS

National energy policy

Turkey expects an aggressive growth in energy demand in parallel to its economical expansion, especially for electricity and natural gas. The International Energy Agency (IEA) has reported Turkey's electric power consumption growth to be 9% per year between 1973 and 1995. Turkey has adopted a policy of encouraging foreign investment in power plants and natural gas pipelines to meet the anticipated demand.

In 1999, Turkey changed its constitution to permit international arbitration of disputes involving foreign investors. Prior to this change, the issue had been a sticking point for financing projects in Turkey. In January 2000, Bill No. 4501 was passed, implementing the constitutional amendment into associated law.

The Turkish Ministry of Energy and Natural Resources (MENR) (Enerji ve Tabii Kaynaklar Bakanligi) is currently studying ways to restructure the electricity market and increase privatization. Turkey intends to include government auditing and regulation in the new structure. These privatisation studies began in 1997, financed by the World Bank. It is expected that a bill based on the studies will be introduced into the Turkish Grand National Assembly in the future. The objectives of the bill are to encourage private investment, promote reliable low-cost electricity, and develop competition with a more transparent structure.

The energy bill is expected to set up a new regulatory body to oversee the electric sector, and will include the separation of generation, transmission, distribution and commercial services. It will also set up a National Transmission Company to handle electricity transmission. There will be a State Generation Company to run nuclear power; other generation capacity is expected to be privatised eventually. The State Distribution Company will perform distribution in regions that have not been privatised. There will also be a Central Buyer-Seller Company, responsible for wholesale purchases and sales of electricity. The energy bill is expected to bring about a major restructuring of electric power in Turkey.

In late 2000, Turkey suffered another serious economic crisis when several major banks went bankrupt. The International Monetary Fund (IMF) assisted Turkey in the crisis but insisted on various reforms to assure stability. As a result, Turkey announced a new policy of no longer offering sovereign guarantees to finance future BOT (Build-Own Transfer) power plant construction. This is expected to make it more difficult to obtain financing for new BOT plants that do not already have their sovereign guarantees.

In late 2000, the Ministry of Energy and Natural Resources (MENR) had also been seeking approval of sovereign guarantees for 35 additional projects, but the Treasury has not agreed to them. In September 2000, MENR had sought approval for a list of 13 projects, which have been forwarded to the State Planning Organization (SPO) (Devlet Planlama Teskilati) for finance programming. These 13 projects included thermal and hydroelectric plants with a combined capacity of 2,952 MWe. MENR had also sent a list of 22 projects to the SPO in November 2000, consisting of 5 thermal power plants, 9 wind power plants, and 8 hydroelectric power plants.

Objectives for the solar industry/market

Combined and integrated use of new and renewable energy sources should be planned as an extension of the general energy planning of the country. Solar energy finds favourable conditions all over the country, except the Eastern Black Sea Region. It is planned to use solar energy widely in the Southeast Anatolian region, which is entirely favourable for solar energy.

The major barrier to the expansion of the field is the absence of a legal arrangement. This handicap prevents users. The most likely objective is to arrange a Solar Energy Law, or a Law of Renewable Energy Sources.

Prospects for market development by sector

At present, about 8 million m^2 of collectors are assumed to be built on roofs. With an average annual production of 750.000 – 1.000.000 m^2, the country will presumably have over 10 million m^2 by 2005 and 15 million m^2 at the end of 2010, which translates into a huge potential. Nearly 10% of the total production is exported every year. This simply means that every year, 600.000 – 900.000 m^2 of collectors are installed on roofs in the country.

On the other hand, there is no one dominant tendency in large scale systems. The largest systems are hot water production systems installed in residential large scale housing and apartments. As solar-energy consumers tend to live in such residential housings, the tendency to use larger scale solar thermal systems will also increase in further years. Space heating with solar energy is mostly an architectural problem. Therefore, new constructions will rule the usage of passive space and district heating. Thus, nearly the same situation exists in using the sun as a space and district heater. Heating and air conditioning in industrial processes have been discussed and considered, but no distinct application exists yet in Turkey. But green-house heating applications of the flow of hot water from thermal solar collectors in winter months are seen in rich agricultural areas of southern Turkey.

Strategy to overcome the barriers to market development

The major barriers preventing growth in the sector are legal conditions. As mentioned above, currently there is no comprehensive legal arrangement containing all kinds of renewable energy sources. Of course, the most necessary field for progress is the law. Further barriers which influence the solar energy market are described below by category:

- Technical: As mentioned above, too few R & D activities are being developed. This is a great handicap in sector development. Various institutions including some universities carry out research which looks to be more widespread and useful in the near future.
- Institutional: Lack of funding hinders progress in institutional development. Besides, the number of researchers and scientists is another factor affecting progress. As soon as these problems are overcome, rapid development is likely to occur.
- Economic: Economic issues have been the major problem in the country for a long time. Unless the funding necessary for R & D is provided, no technological improvements can be made. Therefore, the solution seems to lie in improving economic conditions first.
- Cultural: People are likely to use solar energy for their energy needs. The main problem is to inform the public about what benefits this would have.
- Educative: Some educational activities happen in various university and institutions. One of them is the Solar Energy Institute of Ege University which gives postgraduate education and takes part in R & D activities. Other universities have also R & D projects dealing with solar energy and other renewables. In order to make improvements and take full advantage of the subject, collaborative studies should be made by the institutions and manufacturers together. These actions again depend on the funds supplied by either the government or the companies.

Concluding remarks

- The solar energy potential of Turkey has to be seriously examined with regards to all the regions of the country.
- Exact solutions and arrangements have to be made for the usage of solar energy. Also, guidance and encouragement are necessary.
- Standards exist about flat-plate collectors and hot water systems, but are not exactly enforced. Foreign customers do not tend to buy Turkish-made collectors which fit these standards and usually come with further wishes. Even the standards are new; they seem to remain behind relative to technological improvements. Therefore, they have to be updated rapidly in order to raise competition and maintain customer pleasure.
- In order to enlarge and develop solar energy applications all over the country, to form institutional infrastructures, to encourage the industry and consumers to expand the use of solar energy, legal agreements have to be made rapidly.

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Contributions to this report

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E ANNEX: SOLAR THERMAL DIRECTORY

Manufacturers and distributors of solar thermal equipment

AY-SOLAR ENERJI MLZ. SAN. ve TIC. A. S.
Yesillik Cad. 5901 Sok. No: 1/3
Karabaglar Izmir
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Activity: Solar Collector System

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Necatibey Cad. No.:207
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USA

A STATE OF THE MARKET

Overview of the market situation

The solar thermal industry as a whole has not experienced the growth or support that has been achieved in the photovoltaic sector (quote: "Presently in the US, photovoltaic is more sexy") or the consumer acceptance witnessed in the low-temperature collector sector. This fact seems to be due to high inertia in the market, which makes it very difficult to successfully launch a new product, and also to the past reputation of the industry for the excesses that occurred between 1979–1985. While several of the companies from that era remain in business, the volume is but a fraction of what it was in the heyday of 1985. The Fortune 500 companies that led the thermal industry in its peak such as: Grumman, Daystar (Exxon) Revere Copper and Brass, Reynolds Aluminum, Phelps Dodge, Carrier, Rheem, State Industries, American Solar King, Novan, Honeywell, Johnson Controls, have retreated from the solar thermal market following the abrupt collapse of incentives in 1985.

The Energy Information Administration (EIA) of the U.S. Department of Energy (DoE) puts the 1984 area at almost 1,1 million square meters. The last year of the tax credit incentives in 1985 was also a great year, but unfortunately data is not available for that year. At its peak, 200–250 companies were involved in the production of the various types of products that were actively marketed at that time.

Many of these companies were fabricating products for their regional markets. Some producers were driven out of business by more aggressive marketing programs that used seminars or customer incentives to attract other customers to purchase air and water-based solar heating systems. Some collectors were produced for a single commercial solar project and never entered the residential sector of the market, such as medium temperature vacuum tubes and some parabolic trough collectors.

Problems occurred at many levels of the industry. Some can be attributed to manufacturing, system design, and application design considerations. Many systems were oversized and created very high temperatures during summer months, increasing the risk of overheating and degradation of rubber components such as expansion tanks, pumps, valves and controllers. Many of the projects were sold solely for the financial benefits from federal (40%) and state incentive programs for installing solar systems. These systems were not well cared for and not viewed as creating an appreciable savings by lowering energy prices for gas and electricity. People forgot why they installed solar systems and began to feel burdened by servicing them, in particular when facing the replacing of roofing materials, requiring removal and replacement of collectors and draining and refilling of antifreeze.

Of the one million buildings that were fitted with solar collectors, it is likely that close to 40% have been removed due to poor equipment, lack of maintenance contractors and problems associated with re-roofing. It is likely that more systems are being removed than are being installed in those regions of the country where incentives are not in existence and energy costs are low.

Solar Thermal Installations

Total shipments of solar thermal collectors (all types included) were 1,0 million m^2 in 2001. This represented an increase of 34% over 2000 shipments. There were 26 companies shipping solar collectors in 2001. Import shipments totalled 325.000 m^2, while export shipments were 78.000 m^2.

Low-temperature solar collectors (non-glazed collectors, mainly for swimming pool heating in the private sector) represented 98% of total shipments, while medium-temperature collectors (glazed collectors, of which about 98% FPC and only 2% ETC) were responsible for almost 2 percent. High-temperature collectors are used by utilities and non-utilities in experimental grid electricity programs and represent less than 1% of total shipments.

U.S. manufacturers from 6 States (California, New Jersey, Florida, Hawaii, Texas, and New York) and Puerto Rico currently produce more than 2/3 of U.S. solar thermal collectors. Shipments included both components and integrated solar collector systems.

Domestic shipments were sent to 46 states, the District of Columbia, Puerto Rico, and the Virgin Islands. 54% of total shipments were sent directly to wholesale distributors, 36% to retail distributors, 4% to exporters, 3% to other end users, and 2% to installers. Compared with 2000, retail distributors gained at the expense of installers.

Exports (almost 100% low-temperature collectors) went mainly to Canada (31%), Mexico (24%), Austria (10%), France (9%), Brazil (8%), and Czechoslovakia (5%).

The residential sector continues to be the prime market for solar collectors, totalling nearly 941.000 square meter, or 90% of total shipments. The commercial sector was the second largest with 94.000 square meter (9%). The largest end use for solar collectors shipped in 2001 was for heating swimming pools, consuming 1,0 million square meter (96%) of total shipments. The second-largest use was for domestic hot water heating (2%). This marked a slight decline from 2000, when domestic hot water heating represented approximately 4 percent of total shipments. The value of shipments of complete systems decreased from 14,2 million Euro[1] in 2000 to 9,4 million Euro in 2001.

Of the 26 active companies shipping solar collectors, four are planning to introduce new low-temperature collectors, three are planning new medium-temperature collectors, and two expect to introduce high-temperature collectors. In 2001, the industry remained highly concentrated, i.e. the 10 largest companies accounted for 99 percent of total shipments. Employment decreased 10% in 2001 from 2000. A total of 21 firms were involved in the design of collectors or systems, 12 were involved in prototype collector development, and 11 were active in prototype system development. Twenty companies had 90 percent or more of their total company-wide sales in solar collectors, while 4 companies had 50 to 89 percent, and 2 companies had less than 10 percent.

1. All price/cost figures in this report are based on the average 2002 exchange rate of 0,946 USD/EUR.

Solar Thermal Collector Shipments 1974-2001 (in square meters)							
	A Low-Temperature Collectors[1]	B Medium-Temperature Collectors[2]	C High-Temperature Collectors[3]	D Total Shipments[4]	E Imports	F Exports	G=D-F Total home market sales
1974	105.631	12.728	n/a	118.358	n/a	n/a	118.358
1975	281.124	66.611	n/a	347.736	n/a	n/a	347.736
1976	360.092	178.838	n/a	538.930	n/a	n/a	538.930
1977	440.639	517.377	n/a	958.016	n/a	n/a	958.016
1978	545.526	463.400	n/a	1.008.927	36.790	78.039	930.888
1979	779.828	544.040	n/a	1.323.961	26.942	79.432	1.244.529
1980	1.136.482	665.650	n/a	1.802.132	21.832	103.587	1.698.546
1981	806.119	1.064.297	n/a	1.963.319	18.209	71.628	1.891.691
1982	694.543	1.035.404	n/a	1.729.947	38.833	42.271	1.687.676
1983	450.858	1.112.513	n/a	1.563.372	47.473	14.772	1.548.600
1984	416.113	1.109.169	773	1.597.095	57.693	32.330	1.564.765
1985	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1986	348.479	103.215	417.878	869.572	43.943	20.210	848.762
1987	293.295	88.908	293.109	675.312	64.196	16.908	658.404
1988	308.995	68.005	382.389	759.389	75.623	14.679	744.710
1989	397.904	184.784	483.932	1.066.712	114.549	42.828	1.023.884
1990	338.631	234.766	486.533	1.059.930	145.114	22.761	1.037.169
1991	518.863	91.881	93	610.744	143.349	30.844	579.901
1992	574.791	83.334	186	658.311	15.329	29.357	628.953
1993	559.741	86.493	1.115	647.348	189.429	38.183	609.165
1994	633.877	74.601	186	708.571	168.619	37.626	670.945
1995	632.948	78.039	1.208	712.194	189.243	49.239	662.956
1996	633.691	72.929	929	707.549	17.930	42.178	665.371
1997	699.002	56.299	650	756.045	195.282	35.210	720.834
1998	677.449	41.156	1.951	720.556	204.944	33.445	687.111
1999	757.345	39.670	372	797.386	218.508	49.889	747.498
2000	738.393	37.161	465	776.112	204.480	46.080	730.032
2001	1.014.408	24.898	186	1.039.492	325.346	78.039	961.453

[1]Low-temperature collectors: Operation temperature below 110°F (~43°C); these are typically unglazed collectors used for swimming pool heating.
[2]Medium-temperature: Operation temperature usually between 140 to 180°F (~60 to 82°C); Special collectors are included in this category. Special collectors are evacuated tube collectors or concentrating (focusing) collectors. They operate in the temperature range from just above ambient temperature (low concentration for pool heating) to several hundred degrees Fahrenheit (high concentration for air conditioning and specialized industrial processes).
[3]High-temperature collectors: Operation temperature above 180°F (~82°C)
[4]Total shipments include all domestic and export shipments and may include imports.
Source: Based on data provided by the US Energy Information Administration (EIA), (http://www.eia.doe.gov/emeu/aer/txt/ptb1003.html, http://www.eia.doe.gov/cneaf/solar.renewables/page/rea_data/table11.html, http://www.eia.doe.gov/cneaf/solar.renewables/page/rea_data/table12.html)

Estimated solar park in operation at the end of 2001[1,2]

Medium-temperature collectors in m^2	1.262.923	
Medium-temperature collectors in m^2	1.653.302	
Medium/High-temperature collectors in m^2	2.916.225	$= 10 m^2/1000$ inhabitants
Low-temperature collectors in m^2	8.212.068	
Grand Total in m^2	11.128.293	$= 40 m^2/1000$ inhabitants

Product types and solar thermal applications

The US market uses several types of solar hot water systems (SHWS) depending on the climate zone of the building or application. Direct systems include flat plate (FPC), Integral Collector Storage (ICS) and theromsiphon (mostly imported by Solahart, Lordan and others). Indirect systems are usually glycol-based or drainback systems using water as the heat transfer mechanism.

Heat exchangers are often side arm or thermosiphonic heat exchangers or plate and some immersion heat exchangers e.g. Vaughn SEPCO tanks. Only one company (Rheem) offers tanks specifically designed as "solar storage" (80 gallons/300 l). As FPC's have been the leaders in the past, three manufacturers are still producing these types and additionally ICS systems based on 4" copper tubes in a serpentine flow pattern. Typical hvolumes for ICS are 40 gallons (150 l) or 65 gallons (240 l).

1. In Sun in Action II, ESTIF uses the following general assumptions to calculate the solar park in operation: systems installed until 1989 have an average lifetime of 15 years; systems installed in or after 1990 have an average lifetime of 20 years.
2. Since nearly all exports are low-temperature collectors 100% of the exports have been subtracted from this collector type.

Applications

Shipments of solar collectors by market sector, application, and collector type in 2001 (in square meter)

<table>
<tr><th></th><th colspan="6">Collector Type</th><th rowspan="4">Total</th></tr>
<tr><th></th><th>Low-Temperature</th><th colspan="4">Medium-Temperature</th><th>High-Temperature</th></tr>
<tr><th></th><th>Liquid/Air</th><th>Air</th><th colspan="3">Liquid</th><th></th></tr>
<tr><th></th><th>Metallic and Nonmetallic</th><th></th><th>ICS/ Thermosi-phon</th><th>Flat-Plate (Pumped)</th><th>Evacuated Tube</th><th>Parabolic Dish/Trough</th></tr>
<tr><td>Market Sector</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Residential</td><td>918.346</td><td>279</td><td>7.432</td><td>14.307</td><td>93</td><td>0</td><td>940.643</td></tr>
<tr><td>Commercial</td><td>91.695</td><td>93</td><td>*</td><td>22</td><td>*</td><td>93</td><td>94.018</td></tr>
<tr><td>Industrial</td><td>1.115</td><td>0</td><td>0</td><td>465</td><td>0</td><td>0</td><td>1.579</td></tr>
<tr><td>Utility</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>93</td><td>93</td></tr>
<tr><td>Other[1]</td><td>3.159</td><td>0</td><td>93</td><td>0</td><td>0</td><td>0</td><td>3.252</td></tr>
<tr><td>Total</td><td>1.014.408</td><td>372</td><td>7.525</td><td>16.815</td><td>186</td><td>186</td><td>1.039.492</td></tr>
<tr><td>Application</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Pool Heating</td><td>1.001.680</td><td>0</td><td>0</td><td>1.486</td><td>0</td><td>0</td><td>1.003.074</td></tr>
<tr><td>Hot Water</td><td>3.902</td><td>0</td><td>7.525</td><td>13.843</td><td>93</td><td>0</td><td>25.455</td></tr>
<tr><td>Space Heating</td><td>5.667</td><td>372</td><td>0</td><td>0465</td><td>*</td><td>0</td><td>6.503</td></tr>
<tr><td>Space Cooling</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Combined Space and Water</td><td>0</td><td>0</td><td>0</td><td>1.115</td><td>0</td><td>0</td><td>1.115</td></tr>
<tr><td>Process Heating</td><td>3.159</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>3.159</td></tr>
<tr><td>Electricity Generation</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>186</td><td>186</td></tr>
<tr><td>Total</td><td>1.014.408</td><td>372</td><td>7.525</td><td>16.815</td><td>186</td><td>186</td><td>1.039.492</td></tr>
</table>

Source: Based on data provided by the US Energy Information Administration (EIA), (http://www.eia.doe.gov/cneaf/solar.renewables/page/rea_data/table18.html)
Totals may not equal sum of components due to independent rounding.
[1] "Other" market sectors include shipments of solar thermal collectors to sectors such as government, including the military but excluding space applications.
* = Less than 500 square feet (46,5 m^2)
ICS= Integral Collector Storage

Commercial size SHWS

There has been one large installation recently on a prison in Gettysburg, Pennsylvannia. The system consists of 100 40 square feet (3,7 m^2) collectors and was designed as a drainback system, but uses a standard pressure vessel as the storage container. For hotel systems layout is even more complicated due to the hotellery's various water needs: Hot water for rooms, laundry, restaurants, and spas makes the loads much more varied and hence the solar system becomes more expensive.

Other commercial systems have been used e.g. on armed forces facilities. But the design review in general is not completed yet.

For the future, the solar thermal industry needs to develop generic designs and specifications for new constructions. Otherwise the cost of design is prohibitive.

Space Heating
Considerable potential for space heating exists in the niche market for radiant floor heating systems. Solar thermal systems operate very nicely in the required temperature range and can be easily integrated with other heating systems. Radiant floor heating has been growing steadily over the last five years and is a preferred method for home heating. It is hoped that solar thermal will return in this market segment once fuel prices increase further. Then this field of application could become a rather large one.

In addition to liquid systems, sales of air collectors based on the use of transpired collectors are increasing in today's market. Applications for pre-heating garages, airplane and helicopter hangers, drying agricultural crops such as grains, nuts, and fruit is being tested with excellent results.

District Heating
This application is not typically related to SHWS in the US. All district systems usually involve steam and chilled water distribution.

Other Applications
One company, Duke Solar, is considering a higher temperature system that could generate electricity or drive an absorption cooling system. This technology could also be applied to industrial process heat.

Employment

It is assumed that the employment in manufacturing is less than two hundred persons. Several of these work part time on assembly and part time on service and installations.

For the servicing of the systems and for new installations it is likely to be 500 people in the US, Puerto Rico and Hawaii.

Very few distributors exist that sell solar technology exclusively. In sales and marketing of SHWS an estimate of about 100 persons are involved. For testing, teaching and training less than 50 are employed.

B STATE OF PRODUCTION

Product technology and production methods

Product technology description

Collectors (usual sizes)	various sizes (widths)
Absorber material	Ultra sonic welded & soldered fin tubes
Surface treatment	Semi-selective coatings e.g. KROSOL, Sole-Coat, Black Christal
Insulation	Mineral fibre
Transparent cover	Float & cast glass (partly solar/ low iron glass)
Casing	Aluminium frame, powder coated steel
Storage tank	Stainless steel and others

Production technology description

Current production capacity usage is approximately 30%. Additional capacity has been mothballed. Most production systems are partly automated.

ICS units are constructed of standard DWV (drain, waste, vent) copper tubing, and rolled and sonic welded copper tubes.

Product improvement is an objective of the industry, and greater volumes of production could achieve significant savings in materials by bulk purchasing. Reduced prices for metals, copper primarily and aluminium have also helped defray cost increases.

Performance standards are established and supervised by the Solar Rating and Certification Corporation (SRCC) operating in conjunction with the Florida Solar Energy Center to rate collectors under Operating Guidelines, OG-100, OG-300 an OGO-400.

Based on the guidelines of the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) these tests are applied to collectors and complete systems. They provide performance ratings and have several installation guidelines associated with them.

Breakdown of solar systems costs

A rough estimation of the cost break-down is:	
Production	50%
Marketing	3%
Installation	47%

Typical solar domestic hot water system

System type	Active system (small to medium type)
Collector area (m^2)	~2,5
Hot water storage (litres)	~300
Eventual subsides	Varies from state to state

Typical consumer motivation

Due to the extremely low energy prices and the very low availability of subsidies (except for some special applications), financial aspects are not a motivation to buy solar thermal systems in the US. The main motivation is concern for the environment.

Conventional water heating and energy prices

Energy prices vary widely across the US. Some regions still have high percentages (30%) of use of oil heating systems with heat exchangers for hot water production. Energy rating labels on water heating appliances generally range from 370–420 Euro per year for electric water heating. Natural gas is typically half that cost. Gas prices have experienced several increases lately, now ranging 1,8–3,2 Euro-cent/kWh. Average annual costs typically range from 100–210 Euro per year.

Standards and codes of practice

Generally there are voluntary codes that in some cases are held as requirements for incentives from building agencies. Technology is rated by states or by SRCC, and the manufacturers bear most of the cost of these programs, although some assistance is provided from the US DoE.

In the 1970s, some states with potentially large solar markets, such as California and Florida, were the first entities to establish such a mechanism by establishing state testing and rating programs for solar collectors. However, since there was little consistency between each state's testing requirements and approach to rating solar equipment, such programs soon became an impediment to manufacturers who marketed their products in more than one state.

The need for a single national program which manufacturers could test their equipment to and which would benefit consumers by providing a uniform, national approach for rating and comparing solar equipment soon became evident. In an unprecedented move, the trade association for the solar energy industry and a national consortium of state energy offices and regulatory bodies joined together to lay the groundwork for such a program which would soon lead to the founding of the Solar Rating and Certification Corporation.

In 1980 the Solar Rating and Certification Corporation (SRCC) was incorporated as a non-profit organization whose primary purpose is the development and implementation of certification programs and national rating standards for solar energy equipment.

The corporation is an independent third-party certification entity. It is unique in that it is the only national certification program established solely for solar energy products. It is also the only national certification organisation whose programs are the direct result of combined efforts of state organisations involved in the administration of standards and an industry association.

The Solar Rating and Certification Corporation currently administers a certification, rating, and labelling program for solar collectors and a similar program for complete solar water and swimming pool heating systems.

Equipment which has been certified and rated by SRCC is required to bear the SRCC certification label which shows the performance rating for that product.

In addition, each certified product is published by SRCC in a directory. Each product's directory listing contains information on the product's materials and specifications as well as the certified thermal performance rating.

SRCC's certification program operating guidelines, test methods and minimum standards, and rating methodologies require the performance of nationally accepted equipment tests on solar equipment by independent laboratories which are accredited by SRCC. The test results and product data are evaluated by SRCC to determine the product's compliance with the minimum standards for certification and to calculate the performance ratings.

Detailed information on the standards and the certification process can be found on SRCC's website (http:// www.solar-rating.org).

Level of R & D

R& D mainly depends on the companies – some is still in a true research phase but most (~95%) is related to existing products/production. Manufacturers of standard conventional technologies show only little interest in solar thermal R&D and most companies are still developing their own technologies.

- Some private research is underway, but generally those companies interested in technology development are working with the ZERO Energy Homes programs or the Sandia National Labs Solar Thermal Design Assistance Center.
- There is some cost shared research into an advanced collector technology to reduce the cost of materials in solar collectors and storage tanks. Some assistance is available for product improvement. Several such teams bring together companies and universities to conduct research. Cost shared programs from the government are rare and must be merited by sufficient research and validation. Not much funding is available to the smallest companies and many small accessories are still missing in the market, such as properly coated pipe insulation.
- Water quality issues are various and impact the operation and life expectancy of solar systems, particularly direct systems.

C STATE OF MARKETING

Distribution and marketing methods

In the past, solar systems were marketed with a three tier distribution system, i.e. manufacturer, distributor and dealer. This system has been reduced depending on the market size. There are few stocking distributors (wholesalers) in the east coast states – so many collectors shipped to the mid-Atlantic from Florida. Markets are so low that dealers are working directly with manufacturers.

Except for low-temperature systems the current market status is mostly dormant. There are a few states and utility programs offering incentives for solar water heaters, but in comparison with the 7–8 million electric and gas fired water heater tanks the solar utilization is insignificant. The plumbing industry has never embraced solar technology and they are chiefly responsible for replacing water heaters when they fail. These are generally emergency replacements so consumers don't shop for solar systems, they just buy another tank. Tanks could be serviced to extend life, removing sediment and or replacing sacrificial anode rods; however this is not actively marketed either.

Some thermal rehabilitation – so called weatherisation – programs for low-income households have been successful in the warmer climate zones of Florida, where freeze protection is not a concern. However, these programs have not been replicated in spite of the excellent results from monitored systems. There have been some activities in Philadelphia, PA for low-income systems, but it again appears to be an isolated demonstration with no replication programs in place.

Some manufacturers have made efforts to reach out to new home builders who are building communities and can offer home builders with solar heating appliances rather than conventional water heaters. Marketing efforts are generally not targeted at consumers when solar heating is concerned. Some general radio advertising is occurring in California in regards to photovoltaic installations but not for solar thermal.

Incentives and financing methods

Few federal incentives exist other than the 10% commercial tax credit for business owners and accelerated depreciation (5 years). Some utilities are offering incentives for demand reduction. States with renewable portfolio standards are not generally providing incentives for thermal systems, however so called system benefit funds (funds accumulated from collecting ratepayer's money) are being made available for PV system buy downs (discounts). Public support has been focused on specific communities who insist on using renewable for ecological reasons; however often PV is utilised and not solar thermal. The high penetration of natural gas for water heating has weakened the economic advantage of SWH.

There are however some initiatives, e.g. the USH2O (Utility Solar Water Heating Initiative) supported by US DoE. It is a collaboration of utilities, energy service providers and the solar thermal industry working together to encourage the use of solar technologies in today's changing markets. It helps to make end-users familiar with the benefits of solar thermal technology and assists companies implementing solar thermal programs.

Regional incentives differ from state to state. A database with information on incentive schemes is available at http://www.dsireusa.org/.

D FUTURE PROSPECTS

National energy policy

Most has been covered in the beginning of this report regarding the past and present energy policy.

Currently, the Solar Energy Industries Association (SEIA) is working with the Federal Energy Regulatory Commission (FERC) to determine appropriate language for national net metering laws and system benefit funds to meet a portfolio standard for those states that do not adopt their own restructured legislation.

The Bush Energy Plan has not been approved and is likely to provide barriers to its own acceptance due to provisions for oil exploration in the Arctic National Wildlife Refuge (ANWR). Provisions for renewable energy are neither expanded nor reduced greatly. Current funding for solar water heating is positioned in the Energy and Water appropriations and is at about 5,3 million Euro, focusing on Zero Energy Buildings, and other funding from US DoE to the National Renewable Energy Laboratory (NREL) and a minor grant to Sandia National Labs. No funding from US DoE is allocated to market conditioning, consumer education, market research or installation training requirements for certification.

Objectives for the solar industry/market

The prospects seem rather bleak for the near future. However, if some system benefit funds begin to provide incentives, some funds for marketing might be available to motivate consumers for SHWS/DHWS. The production of generic system designs for commercial systems could provide designers with a significant cost reduction when planning solar thermal on commercial new construction projects. Space heating opportunities could expand if and when the connection to radiant floor heating and pre-ventilation air heating for commercial and agricultural projects is recognised.

Air-conditioning and industrial process heating will evolve depending on the success of Duke Solar, the principal force in this effort. Unglazed collectors such as the transpired perforated collector are expanding quickly. Use of polypropylene collectors for low-temperature applications will continue but it is unlikely that continued expansion will occur in this economic climate.

Growth targets until 2005 are less than 5% per year only. Hopefully from 2005 to 2010 figures may reach 5–10% per year.

Strategy to overcome the barriers to market development

Description of major barriers by category:

Technical
Technical improvements are necessary to reduce hardware costs and to improve economics. Specific institutions have to begin to embrace the use of solar thermal systems once more for water heating loads and space heating where appropriate.

Institutional
Demonstration projects must lead to replication in the near future.

Cultural
Cultural sensitivity about energy usage and a more future orientated "ecological thinking" needs to become a higher priority to the energy consumer as well as to most of the officials being responsible for energy policy.

Educative
Education of regulators and consumers is critical to future expansion of solar thermal. The North American Board of Certified Energy Practitioners has established a technical committee to develop a task analysis to establish some guidelines on what a certified solar installation foreman should know on the job. This will allow the formation of training classes that will be better suited to the needs of the installation contractor.

References

SEIA (Solar Energy Industry Association), EIA, EREN, US DoE

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