European Solar Thermal Industry Federation

Sun in Action II –
A Solar Thermal Strategy for Europe

Volume 1

Market Overview, Perspectives and Strategy for Growth

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.

In addition to the members of the Board of Directors and the Advisory Council of ESTIF, we would like to especially thank for their particular contributions Rainer Berkmann, Uwe Brechlin, Jan-Olof Dalenbäck, Werner Koldehoff, Jan Erik Nielsen and Arthouros Zervos. Many other people have contributed to Sun in Action II – we are grateful to all of them.

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

Executive Summary

Today's solar thermal technologies are efficient and highly reliable, providing solar energy for a wide range of applications – from domestic hot water and space heating in residential and commercial buildings, to swimming pool heating, solar assisted cooling, solar assisted district heating, industrial process heat and desalination.

Benefits
Solar thermal offers many benefits to both the end users and to society as a whole.

Benefits for the users	Benefits for society
• Substantial savings on conventional heating bills	• It provides energy with no emissions
• Higher predictability of heating costs	• It offers CO_2 savings at very low costs
• Autonomous energy production reducing reliance on imported energy	• Energy payback time for solar collectors is less than one year.
• It provides basic heat in case of disruption of conventional energy supply	• It reduces dependency on imported fuels
• Direct contribution to reduction of CO_2 and other emissions	• It saves environmental costs caused by the transport of fossil fuels
• Proven and reliable technology	• It creates local jobs
• Immediately available solutions	

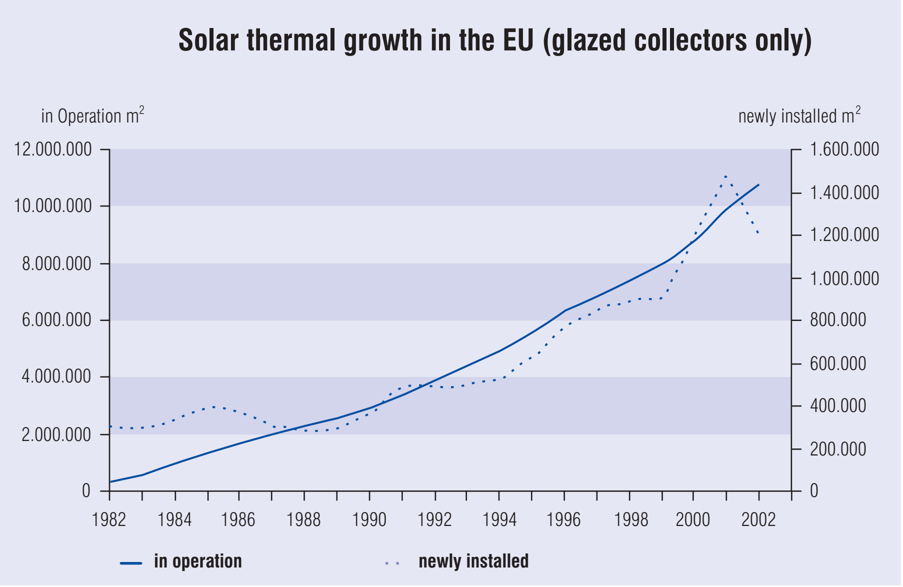
The implementation of the solar thermal potential in Europe will significantly contribute to several political goals of the EU and its member states:

Contribution to EU policy goals
• Security and diversity of energy supply
• Reduction of greenhouse gas emissions
• Reduction of emissions causing urban pollution
• Reduction of other external costs caused by fossil fuels and nuclear power
• Local jobs and SMEs development
• Export of know-how and equipment

Market growth until 2002

The European solar thermal markets have shown substantial growth over the past decade. On average, the glazed collector area in operation increased by 11,7 % per year and the market volume (newly installed collector area) grew by 13,6 % per year.

Solar thermal growth in the EU (glazed collectors only)						
	1985	**1990**	**1995**	**2000**	**2001**	**2002**
Newly Installed	393.415	360.799	624.067	1.162.128	1.470.185	1.196.540
In Operation	1.320.735	2.916.102	5.532.569	8.760.320	9.862.500	10.755.842
Glazed collector area (in m²). See Chapter 1.1. for the definition of "area in operation".						



Target of Campaign for Take-Off nearly reached

Adding the roughly 1,6 million m² of glazed collectors used for heating swimming pool water, the total in operation at the end of 2002 can be estimated at 12,3 million m². The target set by the Campaign for Take-Off launched by the European Commission, 15 million m² by 2003, has therefore nearly been reached.

Strong differences among countries

The collector area in operation is highly concentrated in three countries: Germany, Greece and Austria account for more than 80 % of the EU total. Relating the glazed collector area in operation to the population, the leading role of Greece (264 m² per 1.000 capita) and Austria (203 m²) becomes even more evident, compared with the EU average of 26 m². In recent years there has been a trend towards levelling the big differences between the frontrunners and the countries lagging behind. Spain, Italy and France have been growing faster than the EU average, whereas Austria and Greece have stagnated at a high level. The German market grew very strongly until 2001. Its breakdown in 2002 explains the contraction of the European market in that year.

Potential

The technical-economical potential for solar thermal is estimated at 1,4 billion m² (EU-15). This capacity would generate 682 TWh (58,7 Mtoe) of thermal energy per year. This corresponds to:

- 6 % of the EU final energy consumption (EU-15)
- More than the final energy consumption of a country like Belgium
- 30 % of the EU oil imports from the Middle East in 1999 (EU-15)

Only 1 % of this potential has been realised so far, and most of this in three countries only. The potential for growth in the next future is therefore immense.

Growth scenarios

Four scenarios indicate the possible paths of growth in the current EU Member States until 2015. The level of public support (financial incentives, regulations, promotion campaigns) has been assumed as the main factor influencing the market development.

Overview of the four scenarios

Scenario	2001	2001-2015	2015		
	In Operation m²	Annual growth rate (in operation) in %	In Operation m²	In Operation m²/1000 capita	Annual Energy Output GWh/year
Current Policies	9.862.500	11,7	46.504.429	123	19.137
Active Policies	9.862.500	18,0	99.580.429	264	45.440
Wind Market Comparison	9.862.500	39,6	1.053.995.919	2.795	433.718
Strong Regulation (Residential Only)	9.862.500	23,9	199.133.279	528	92.596

The **"Current Policies Scenario"** assumes that the current level of support for solar thermal is retained. The collector area in operation continues to grow 11,7 % per year. In this scenario the 100 million m² target would not be reached before 2022. This scenario shows the urgent need for more active and systematic policies to promote solar thermal.

The **"Active Policies Scenario"** assumes proactive policies are taken at the EU level and by each of its current Member States. The EU will reach by 2015 the same level of collector area in operation already attained by Greece. This would result in roughly 100 million m².

The **"Wind Market Comparison"** assumes that solar thermal will grow at the same average yearly rate experienced by wind power in the last decade. Such a development in solar thermal would lead to the realisation of 75 % of its technical-economical potential by 2015.

The **"Strong Regulations"** scenario refers to the residential sector only, the single most important market segment for solar thermal. It is assumed that binding regulations require the installation of solar thermal on residential buildings undergoing major renovations or newly built. If all current EU members enacted such regulations between now and 2015, the collector area in operation by 2015 in the residential sector alone would amount to 199 million m².

White Paper 100 million m^2 target

Depending on the time needed to put in place comprehensive policies at EU level, the target of 100 million m^2 set by the White Paper on renewable energies of the European Commission (1997) for 2010 might be reached only some years later. This will represent a major milestone towards the full implementation of the technical potential of solar thermal.

Reasons for success and barriers to growth

Solar thermal successful at all latitudes

Solar thermal can be successfully implemented at all latitudes. Some of the strongest markets (Germany, Austria) are not situated in particularly sunny regions, whereas for instance Southern Italy is clearly lagging behind. Factors like general awareness of the environment, public support (financial, regulative, campaigns) and the quality of the products/services offered by the industry have proven to be at least as important as climatic conditions.

Sun in Action II analyses the reasons for success and the barriers to growth that explain the differences among countries. Success or failure to grow is never due to a single reason, but rather to a mix of conditions. Understanding them is a precondition for developing effective measures to promote solar thermal. Both the analysis and the action plan distinguish among market segments. Such a detailed consideration is necessary because of the specific characteristics of each market segment. The following elements are relevant for solar thermal in general.

Reasons for success

- Regulations making solar thermal mandatory (Barcelona model)
- Stable and well-designed financial incentives to investment
- Expected price increase of conventional heating fuels
- General awareness of energy savings and environment
- Awareness of solar thermal, especially among the relevant decision-makers
- Public campaigns promoting solar thermal
- Highly visible demonstration projects – often with public authorities serving as model
- Availability of motivated and specifically skilled installers
- High trust through quality products and recognised quality label
- Availability of standard products and applications – explaining the success of solar thermal particularly in small residential buildings

Barriers to growth
• High upfront costs and relative long payback times
• Not yet perceived as a standard option for heating – therefore the decision-maker must be specially motivated
• Higher transaction costs (information, procurement, installation works) compared with the conventional heating (default option)
• Low awareness of energy savings and environment
• Low awareness of solar thermal, especially among the relevant decision makers
• Lack of availability of motivated and specifically skilled installers
• Solar thermal not yet fully integrated into mainstream heating and construction sectors
• Harmonised standards, certification and quality labels not yet widely recognised in the market and by public authorities – this barrier being solved through EN standards and Solar Keymark
• Applications with high potential not yet available in standard solutions (combisystems) or still in demonstration phase (solar cooling, process heat)

Action plan

Solar thermal can become a fully self-sustained market. Once larger volumes are reached, substantial economies of scale can be realised at all levels of the value chain. A stable partnership between industry and public authorities is necessary in order to overcome the main barriers to growth. Support for solar thermal should be accompanied by full internalisation of the social costs of conventional heating.

The Action Plan proposes and discusses a series of measures to promote solar thermal.

The first part of the Action Plan is structured along areas of action relevant for solar thermal in general:

- regulations
- financial incentives
- awareness and promotion
- improving market structures / EU market integration
- Research and development

The second part of the Action Plan is structured along market segments and their specific barriers to growth. The most appropriate measures for each segment are identified.

The table below gives an overview of the priority level of each areas of action for each market segment. The values range from 1 (highest) to 5 (low priority). It is based on a short-term perspective: for market segments still at a demonstration stage, high priority is given to research and development. This will change once mass commercialisation will be possible.

Priority actions for each markets segment								
	Sector							
	Residential				Tertiary	Industrial	Other	
Segments	DHW &Space Heating				DHW & Space Heating	Process heat	District heating	Cooling, desalination, drying etc
	One-family houses		Multi-family buildings					
	Existing	New	Existing	New				
Areas of action								
Regulations	2	1	1	1	3	3	1	5
Financial	1	2	2	2	1	1	1	3
Awareness	1	3	3	3	2	3	5	5
Market structures	1	2	4	4	4	4	4	4
R&D	5	5	2	2	2	1	3	1

In order to maximise their impact, effective programs to support solar thermal should:

- Be targeted at overcoming the key barriers to growth.
- Take into account the most important reasons for success.
- Consist of a combination of measures – single actions have hardly any impact.
- Be stable over several years – stop-and-go support leads to straw fires but not to sustained growth.

Regulations

Implementation of EC Buildings Directive

The implementation of the recent EC Buildings Directive will play a key role for solar thermal. In all EU member states, the contribution of solar thermal must be fully recognised in the calculation of the energy performance and in the performance certificates. Minimum requirements should be set dynamically: a long-term, gradual increase of the minimum energy performance will provide the right incentives for investment in solar thermal.

Barcelona model

To fully develop the potential for solar thermal, stronger regulations are necessary. The success of the Barcelona model shows that binding rules have a strong impact and high political legitimacy. In certain market segments, solar thermal is not used where it would be financially sound. Only binding regulations can directly overcome this barrier to growth. By creating larger market volumes, binding regulation leads to higher awareness for solar thermal and indirectly to cost reductions even in other market segments. Such regulation can be implemented at local, regional or national level.

For a renewable heating directive

EU legislation is in place to promote renewable energies in the electricity sector (RES-E directive) and is being developed for the transport sector (biofuels directive). Although heating is responsible for one third of the total energy consumption in the EU, renewables in the heating sector have so far not been systematically promoted at EU level. A discussion about a possible future renewable heating (RES-H) directive is therefore necessary.

The RES-H directive should include:

- National targets for growth of each renewable heating technology
- Strong regulations – based on the Barcelona model and beyond
- Harmonisation of elements of the financial incentives schemes
- Introduction of innovative financial incentives schemes

Financial incentives

Two of the main barriers to growth for solar thermal are of a financial nature:

- High upfront costs - initial investment makes up most of the costs of a solar system
- In many cases, relatively long payback times – depending on prices of conventional heating

Why financial incentives are needed

These barriers will decrease once economies of scale are realised. Until mandatory regulations are in effect, stable and well-designed financial incentives and fiscal measures are necessary to stimulate the market.

Long-term approach

The Action Plan proposes ways to maximise the impact of direct financial incentives. In order to create sustained market growth, incentives should be designed with a long-term perspective: Incentives oriented towards short-term gains create stop-and-go dynamics that disrupt the market. Revenues from levies on conventional heating fuel could be used to finance long-term oriented incentives for renewable heating. Applications for public incentives should be easy to handle – both for the user and the authorities. Based on best practices at national level, elements of the incentives schemes should be harmonised at a European level, particularly the technical requirements for the solar systems.

Fiscal measures

Fiscal measures can be very effective as well. To promote solar thermal in privately owned residential buildings: VAT reductions on solar products and/or deductibility of solar thermal investments from personal income tax. To promote solar thermal in the tertiary sector and in residential buildings owned by corporate investors: deductibility solar thermal investments from the building property tax.

Stop subsidising fossil fuels

Last but not least, the competitive disadvantage of solar thermal is largely due to the artificially low prices of conventional heating fuels. If all environmental, social and political costs were fully internalised, demand for solar thermal and other renewable heating technologies would gain a substantial boost.

Awareness and promotion

In most areas of Europe, solar thermal is not yet perceived as a standard option. Raising awareness among potential users is decisive for market development. The industry is still too small to launch systematic promotion campaigns. Support from public authorities is needed and should be motivated by the contribution of solar thermal to public policy goals.

Campaigns targeted to raise awareness among the general public must be adapted to national/regional conditions. Additional campaigns should focus on specific target groups and address their particular needs (see Part 1). Such focused campaigns can be significantly supported at the European level, by creating specific informational tools and disseminating information on best practices.

Improving market structures
In most countries, the solar thermal market is still at an early stage of development. Once a critical mass is reached, market structures will ripen spontaneously. The Action Plan identifies a series of measures to accelerate this process.

Improving motivation of installers

Most important in this area: the motivation of craftsmen to install solar thermal systems must be improved. The following actions are proposed:

- Installations should be made as simple as possible (Industry)
- Campaigns should be targeted at installers to increase their knowledge about solar thermal, create preference and to motivate them to actively market solar thermal technologies (Industry and public authorities)
- Installers should be encouraged to participate in specific training courses (Industry and public authorities)
- Potential users of solar thermal should be enabled to recognise specially trained installers (Industry and public authorities).

EU Market Integration – Promoting the Solar Keymark
In early 2003 a European quality label for solar thermal products and systems was launched: the CEN/CENELEC Solar Keymark. The Solar Keymark was developed by the industry and test institutes with the support of the European Commission. It certifies conformity with the relevant EN standards.

Promoting the Solar Keymark is a key action towards the achievement of transparent information on product quality, resulting in higher trust among all actors involved. The Solar Keymark should be fully recognised by all national or regional authorities providing financial incentives. This will contribute to the removal of barriers to internal EU trade, resulting in higher integration, cost reductions and easier transfer of know-how within European countries.

Research and development
Substantial progress has been achieved during the last three decades. A broad range of highly efficient solar collectors is now available. While domestic hot water applications are fully developed, further R&D is necessary to fully commercialise other applications, especially large-scale systems and solar cooling.

The Action Plan identifies a series of areas where R&D could have significant impact on market development. In short, the proposed top priority areas for R&D are:

- Medium and long-term heat storage

Cheap seasonal heat storage will make possible the storage of the abundant solar radiation received during the summer to cover the high demand for heat during the winter. Demonstration projects have shown good results. Commercial availability will dramatically increase the economic potential of solar thermal.

- Solar cooling

Systems for solar assisted cooling are already on the market, but technical improvements are still necessary to achieve wide commercialisation, especially for small systems. In the medium-term, solar assisted cooling is an extremely promising application, as peak demand for cooling coincides with high solar radiation.

Part 1 – Market Overview

1.1 DEVELOPMENT AT EU LEVEL AND COUNTRY BY COUNTRY

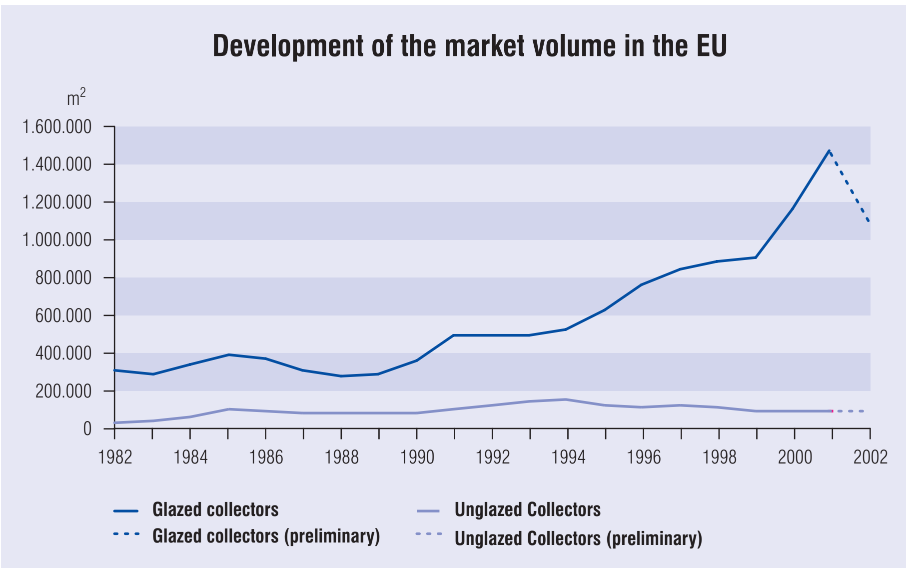
Since 2000, the solar thermal market in the EU has clearly overcome the mark of 1 million m^2 newly installed per year. The market has more than doubled compared to the mid 1990s and is three times bigger than in the late 1980s. Except for other complimentary renewable energy sources, no other energy sector has grown faster than solar thermal in the last decade.

Mark of 1 million m^2/year overcome in 2000

Between 1990 and 2001, the average yearly market growth has been 13,6 %. The peak so far was reached in 2001, with almost 1,5 million m^2 newly installed. Final data for 2002 are not yet available. However the estimates show a reduction in 2002, caused mainly by the strong contraction of the German market. The main reason being the general economic slowdown, with strong impact on the sectors of durable consumables and on the construction industry. Except for Germany, most EU countries have registered growth in 2002. First signals in 2003 indicate a trend to further growth in most EU countries.

13,6 % yearly market growth in the 1990s

Figure 1.1



The timeline for glazed collectors (flat plate and evacuated tube) shows the main trends in the historical development. The data refer to EU without Luxembourg[1]. In the late 1980s, the market suffered in most countries, mainly due to low energy prices but also because of quality problems in solar thermal systems, arising from lack of experience during the first wave of enthusiasm in the late 1970s and early 1980s. From the early 1990s, the market started to recover, thanks to higher quality of products and installations as well as to significant financial incentives to investment in some countries. In the mid 1990s, growth increased, reaching a peak in 2001.

Unglazed collectors

Unglazed collectors for swimming pools are a separate technology and represent a minor market, for which extensive and comparable data are missing. Therefore, in the following, all data refer to glazed collectors only. In the USA, unglazed collectors have a much larger distribution than in Europe where there remains a substantial potential for energy savings through unglazed collectors (see page 79).

Table 1.1 shows the development country-by-country. There is a distinction between "newly installed", i.e. the collectors purchased in a certain year and "in operation" surface. The latter refers to the cumulated installed surface of collectors, after subtracting those that are assumed not to be in operation anymore[2].

New definition of "in operation" area

It must be noted that this method of calculating the area in operation is introduced for the first time by the present publication. So far, the overall estimations of the solar thermal sector were generally based on the cumulated area installed. Even though solar thermal installations have a very long lifetime, they are not eternal. This must be taken into consideration, particularly as the political targets obviously refer to the collectors in operation and should not include those installed 30 years earlier.

At the end of 2001, the surface in operation for glazed collectors was 9,9 million m^2, corresponding to 26 m^2 per 1.000 inhabitants. Considering the latest estimates, the surface in operation at the end of 2002 was roughly 10,7 million m^2. On top of this must be added estimated 1,6 million m^2 unglazed collectors in operation. During the decade from 1990 to 2000, the cumulated surface in operation (glazed only) tripled, growing every year by 11,6 %.

The overall estimated solar yield from glazed collectors was 4,1 TWh (4,1 million MWh) in 2001. This figure is based on estimations of the average solar yield obtained in each country. These estimations have been done by national experts, taking into account solar radiation, the typical applications used and their average efficiencies.

1. All data in this chapter are based on national market reports, published in Volume 2. It has unfortunately not been possible to get a systematic market overview for Luxembourg. The impact on the EU aggregate is negligible.

2. An average lifetime of 15 years is assumed for systems installed until 1989, 20 years for systems installed after 1990. Reality, obviously, is more gradual. Most current systems are designed to work well longer than 20 years, but several factors – including poor installation or maintenance – can cause a reduction in solar yield. Buildings may be demolished or not continuously used during the time period

When comparing these data, it must be noted that solar thermal applications can be very different in terms of technique, costs and solar yield. The difference has also a geographical dimension. For instance, a typical domestic hot water system installed in a one-family residential unit in Greece costs 700 Euro inclusive VAT and installation (thermosiphon system, 2,4 m^2 collector, 150 litre tank). In Germany, a typical system for the same purpose costs around 4500 Euro (forced-circulation system, 4–6 m^2 flat plate collector, 300 litre tank). More about these differences can be found in the Appendix and in the chapter about the market segments. However, it must be clear that using m^2 installed is a simplification necessary to compare different countries, but does not fully reflect the complexity of the market.

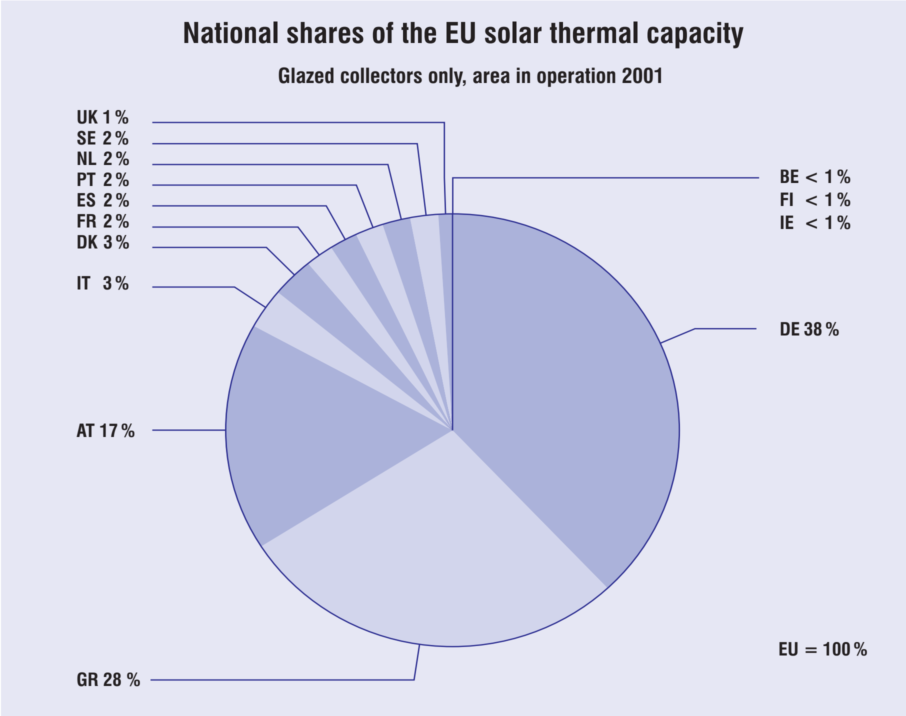
Differences among typical systems

Market growth country by country - glazed collectors only													
	1985		1990		1995		2000		2001				
	Newly Installed m^2	In Operation m^2	Newly Installed m^2	In Operation m^2	Newly Installed m^2	In Operation m^2	Newly Installed m^2	In Operation m^2	Newly Installed m^2	In Operation m^2	In Operation per head m^2/1.000	Energy Output MWh
AT	9.950	37.120	39.885	158.845	160.660	712.908	152.944	1.504.684	160.080	1.651.814	203	583.743
BE	2.325	9.300	1.000	19.600	1.000	23.850	3.230	24.378	4.481	26.534	3	11.156
DE	15.000	48.000	35.000	132.000	193.000	802.000	620.000	2.743.000	900.000	3.634.000	44	1.480.650
DK	1.195	3.185	5.734	17.504	25.490	108.000	30.200	246.165	26.150	271.120	51	108.475
ES	29.100	119.100	9.400	170.700	9.800	207.563	40.487	190.209	46.357	224.666	6	135.800
FI	145	1.645	50	2.145	500	3.645	1.010	6.210	1.110	7.220	1	2.170
FR	41.200	195.500	14.900	287.350	7.700	346.450	23.500	221.150	38.500	230.750	4	138.450
GR	200.000	569.000	204.000	1.482.500	169.000	2.420.500	181.000	2.833.200	175.000	2.790.200	264	1.082.598
IE	0	0	50	170	170	690	380	3.065	270	3.325	1	1.496
IT	36.500	148.000	12.500	239.600	17.850	313.036	45.249	325.885	49.327	335.212	6	236.262
NL	5.300	9.300	1.840	16.420	12.706	61.684	27.661	174.265	30.537	203.877	13	85.628
PT	42.000	121.385	21.960	265.558	9.233	330.448	5.500	239.663	6.000	210.963	21	126.578
SE	5.700	20.200	7.480	58.710	9.362	100.799	19.117	140.256	21.970	158.226	18	47.638
UK	5.000	39.000	7.000	65.000	7.596	100.996	11.850	108.190	15.230	119.420	2	52.309
EU 14	**393.415**	**1.320.735**	**360.799**	**2.916.102**	**624.067**	**5.532.569**	**1.162.128**	**8.760.320**	**1.475.012**	**9.867.327**	**26**	**4.092.953**

Table 1.1

The heterogeneity among countries is striking. Looking at the cumulated area in operation in 2001, 82 % was concentrated in only three countries: Austria, Germany and Greece. A small country like Denmark has a larger in operation surface than France, Spain or the UK.

Figure 1.2



The difference of the area installed per capita is even more striking. If all EU countries had per capita rates in the range experienced in Greece and Austria, the EU would already be very close to reaching the target of 100 million m^2, corresponding to 266 m^2 per 1000 inhabitants.

Few frontrunners show the way ahead

However, large countries such as Italy, France, Spain and the UK still have extremely low levels of solar thermal use. Comparing Italy (6 m^2/1000 capita) with Sweden (18 m^2), or France[1] (4 m^2) with Germany (44 m^2), it becomes clear that climatic conditions are not the main factor to explain different market developments. It is also interesting to note that only four countries (Greece, Austria, Denmark and Germany) are above the EU average of 26 m^2/1000 capita, whereas seven countries, with 63 % of the whole EU population, are below 7 m^2/1000 capita area in operation. The few frontrunners show that there is a huge growth potential at EU level, once the market really starts to grow in the several countries which are still at a very early phase of development.

1. Even more striking, if one considers that a large part of the French systems have so far been installed in its oversee territories, whereas metropolitan France has a really tiny market so far.

Figure 1.3

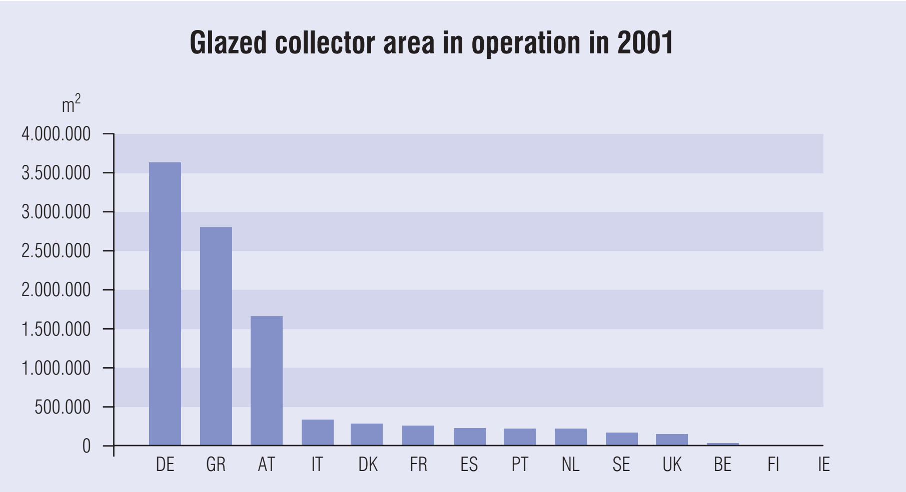
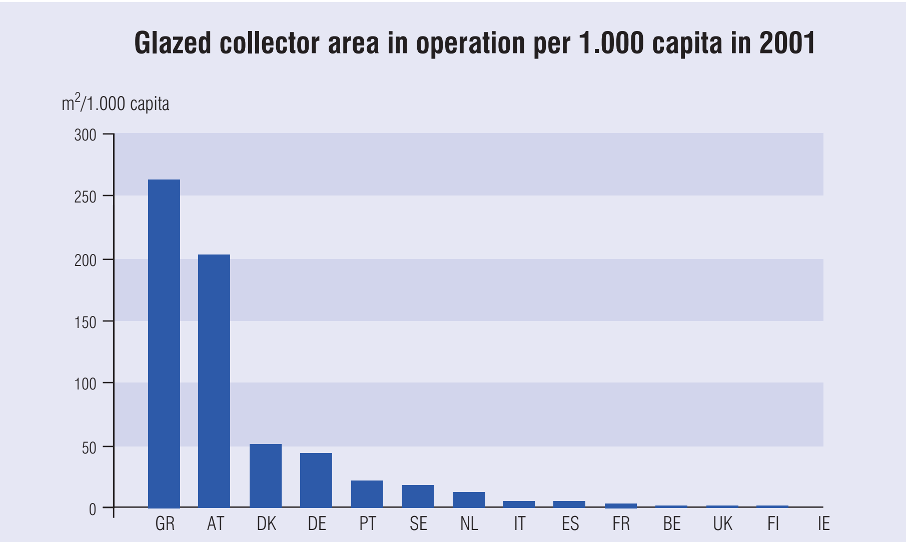


Figure 1.4



The figures "in operation" show a static picture, a result of a long historical development. Looking more carefully at recent trends, very interesting developments can be noted. The following table refers to the years 1995–2000, to avoid any distortion due to the particular peak reached by the German market in 2001. It considers the five biggest EU countries in terms of population, as well as Austria and Greece due to their importance for solar thermal.

Table 1.2

Market growth in selected countries			
	Newly installed 1995 m²	Newly installed 2000 m²	Average annual growth 1995–2000
Spain	9.800	40.487	33%
Germany	193.000	620.000	26%
France	7.700	23.500	25%
Italy	17.850	45.249	20%
Netherlands	12.706	27.661	17%
United Kingdom	7.596	11.850	9%
Greece	169.000	181.000	1%
Austria	160.660	152.944	-1%

High growth in the most promising countries

Comparing the growth rates, one can see that the markets most promising in the long term – large countries in Southern Europe – are growing well, though starting from very low levels. Conversely, the two leading (per capita) countries have been stagnating at a relatively high level. This is not a sign of overall saturation, since, even in Greece and Austria, the technical growth potential is far from being exhausted. However it is noticeable that the Austrian market remains bigger than France, Italy, Netherlands, Spain and UK put together. The high level maintained by the Greek market, despite the weakness or lack of public financial incentives, shows that, once a critical mass is reached, solar thermal can maintain a significant market even under relatively unfavourable conditions.

Key role of German market

Germany is by far the biggest market in Europe. Its high growth rates, combined with the large population, have made developments in Germany decisive for the whole European market.

The German growth shows the high potential of solar thermal in Europe, especially when taking into account that its conditions in terms of climate, built environment and energy prices are not particularly favourable. The key factors for the development of the German market have been a positive political framework (financial incentives, information campaigns), widespread environmental motivation and a well-established network of market actors.

More balanced growth desirable

However, relative to the population, Germany is still far behind Austria and Greece. The full exploitation of its large potential for solar thermal is necessary if the industry is to reach the ambitious growth targets at EU level. Germany will continue to play a key role, although there is a need to ensure a more balanced development at European level. This can be achieved once substantial growth in other promising countries occurs.

Positive developments have been registered in the UK, where the market is finally starting to grow, as well as in the Netherlands, where proactive building regulations resulted in the installation of solar thermal in 15% of new buildings in the last few years. In Denmark, the new government suddenly stopped all public programs to support renewables, resulting in a strong contraction of the market in 2002. Nevertheless, latest estimates show that, even under these conditions, the market in Denmark (per capita) remains bigger than in Italy, Spain or Portugal.

Countries with high potential

The countries with the largest growth potential in the medium-term are Italy, France and Spain. These markets, particularly Spain, are growing very fast, though starting from very low levels. More proactive public policies linked with growing awareness of the solar thermal potential are now stimulating the market. High growth rates can be expected, as market structures mature.

Regional differences

Looking at the strong regional differences within certain countries, two conclusions can be drawn. First, the potential for growth is huge. For instance, in France the largest part of the market has been so far concentrated in the small oversees territories, showing an even larger potential for growth in metropolitan France. Similar in Italy: the small German speaking area of Italy has a collector surface in operation per capita among the highest in Europe, while the rest of Italy is among the lowest. Language and cultural links to areas where solar thermal is more widely used have played a key role for the market development in this area, as well as special financial incentives provided by the regional authority. Once general awareness for energy savings and information networks in local language, strong market developments can be predicted through out Italy.

Main findings for the EU

More detailed information on each EU country can be found in Volume 2 of this publication, where a collection of national market studies is presented. The main findings of the market overview at EU level can be summarised as follows:

- An average yearly market growth of 13,6% between 1990 and 2001 led to overcoming the 1 million m^2/year mark in 1999. The collector area in operation tripled during the 1990s.
- Solar thermal can be successfully applied at all latitudes in Europe – relative to the population, Sweden has a collector surface in operation three times bigger than Italy or Spain.
- There are major variances between countries. 82% of the collector surface in operation is concentrated in Germany, Greece and Austria. On the other hand, France, Spain and the UK together have a smaller area in operation than Denmark alone.
- Relative to the population, the difference between the few frontrunners and the majority of countries lagging behind is even more striking. If the whole EU had the same surface in operation per capita as Austria, it would have already reached 76 million m^2 in operation. Extrapolating the rate per capita of Greece would result in over 99 million m^2. The target of 100 million m^2 set by the EU White Book on Renewables is therefore ambitious, but perfectly possible.
- Within certain countries, regional differences play a significant role in the make-up of the market.
- Once a national or regional market reaches a minimum critical mass, it maintains relatively high levels even under unfavourable conditions.

1.2 UNDERSTANDING THE MARKET – COMMON ELEMENTS

The common principle of solar thermal is to obtain useful heat by solar collectors. However, this technology is used in a broad range of different applications and market segments. To understand the reasons for success as well as the potential and barriers to growth, it is necessary to examine the specific characteristics of each market segment. This is done in the second part of this chapter. As a first step, basic elements common to all market segments are analysed.

1.2.1 Benefits, costs and incentives

The sun does not send any bill

The economic benefit of solar thermal is that it replaces a substantial amount of fuel, thus reducing and making future heating costs more predictable. Hardware, design and installation account for almost all costs of a solar system, as it does not need any fuel and low maintenance costs are to be paid during the use phase. This is the opposite for conventional heating systems, where most of the costs accrue during the lifetime of operation (fuel).

Payback times

Even assuming long-term stable energy prices, in Europe there is a significant potential for installing solar thermal systems with payback times between 5 and 15 years, clearly shorter than the average lifetime of 20–25 years. Thus, in many situations, solar thermal is a rational long-term investment. The potential is even larger, if energy prices are assumed to be growing on the long term and if the social political and environmental costs of the use of fossil fuels are fully included. In fact, a clear positive association between the development of heating fuel prices and the demand for solar thermal collectors was registered in several countries.

However, the largest part of the potential use of solar thermal is not economically viable, under present market conditions. The main barrier to growth is the high level of upfront investment costs. This has a financial and a psychological element, since many people tend to irrationally discount future running costs, whereas immediate investment costs are perceived more acutely.

Financial incentives

To help overcome these disadvantages, many national, regional and local governments and in some cases even utilities offer financial incentives for the installation of solar thermal systems. Public incentives are fully justified by the positive external effects of a solar thermal installation.

So far, financial incentives have been a key element for the development of the solar thermal market. Currently, subsidies are provided by most European countries, except Denmark Finland and Greece. Under present conditions, the abolition of the incentives usually leads to a collapse of the market. The experience of the last few years in Greece shows that, the market can be self-sustainable even without financial incentives, once a minimum critical mass is reached.

For financial incentives, quantity is not everything: they must be carefully designed to provide the right incentives for a healthy market growth. Further analysis is provided in the chapter on market segments below and proposals in the action plan.

There is a high potential for economies of scale at different stages of the value chain: for manufacturing, but above all for distribution, marketing and maintenance costs. Once critical mass in the European market is reached and the social costs of the use of fossil fuels are highlighted, the need for financial incentives will disappear.

Economies of scale

1.2.2 Time of purchase

A key barrier to growth is the short window of opportunity, when the best conditions exist for a solar system to be installed. For technical reasons, it is significantly more effective and cheaper to install solar thermal systems during construction of new buildings or when an existing heating system or building is undergoing a major renovation. Installation at other times is possible, but requires more complex works and reduces the economic benefit. As most potential users replace their heating systems only once in ten to twenty years, this is a serious restriction to a fast market growth: if the opportunity is missed, the door is closed for a long period.

Short window of opportunity

Therefore, in most market segments, there is a clear distinction between new and existing buildings, and the latter are more difficult to penetrate for the solar thermal industry. The difference is more substantial for small solar systems, since the integration into the existing heating system usually has a higher share on the total system costs than in large solar systems.

1.2.3 Awareness and promotion

Solar thermal can benefit from its positive image as it gives a chance to integrate clean and renewable energies into the daily energy supply. However, almost everywhere, solar thermal is not yet perceived as a standard option, but rather as an additional feature or a premium product. Most potential users still need to have a special motivation to consider investing in solar equipment. The promotion of awareness for solar thermal is, therefore, a key area of action to support the growth of the sector.

Solar thermal not yet standard option

Promotion can be targeted at the general public, to create basic awareness and provide counter-arguments to misinformation, e.g. that solar thermal is feasible only in sunny Mediterranean countries. The facts described in the last chapter clearly prove the contrary. Other prejudices concern the investment payback time and the reliability. Particularly among architects, the aesthetic impact is often considered excessive. Awareness and information campaigns should, however, mainly be targeted at specific market segments, focusing on the relative technical requirements, decision roles and motivation structures, as discussed below.

Misinformation and prejudices

The best promotion comes from satisfied customers. This has proven to work well for solar thermal, in those market segments and geographical areas where the market has reached significant dimensions. Domestic hot water (DHW) systems in small residential units are quite widespread in certain regions of Austria, Greece, Southern Germany, but also specific areas in Italy or France. Instead of showing saturation, these developed market segments show a high level of new installations per inhabitant even in unfavourable times, if compared with less developed markets.

Spontaneous promotion through satisfied users

Public support for promotion needed

However, this kind of spontaneous promotion does not work if critical mass has not yet been reached. The full potential of professional marketing and promotion campaigns, based on systematic surveys of the potential customers has never yet been applied to the development of solar thermal. This is mainly due to lack of resources within the relatively small and highly fragmented industry. Public authorities at national, regional or local level in almost every EU country have supported solar campaigns. Some of them had very positive results (the German campaign *Solar – Na klar!* was awarded by the Campaign for Take-off for renewables of the European Commission). The latter has directly supported measures targeted to specific sectors or aiming at improving awareness in general, in the same way as the current Soltherm project[1].

1.2.4 Marketing and distribution

Marketing and distribution channels largely depend on the specific market segment, as analysed below.

Distribution chain not yet mature

However, the maturity of the market also plays a key role. In the initial phase, solar thermal is a niche product, mainly distributed outside the mainstream channels of the heating and construction sector. Within a small market, the capacity for active marketing of specialised wholesalers is very limited. Often, producers sell directly to consumers or installers, depending on the market segment. In more mature markets, solar thermal becomes a normal product which is offered by most heating installers, heating wholesalers and through the distribution channels of construction material companies. Germany is a prime example of this market phase. Only in very strong markets specialised solar shops can make a living from this sector. This is partly the case in Greece but most notably in Israel. Several European countries with a high potential for solar thermal are still in the very early phase of the market development.

Mainstreaming solar thermal

A very positive signal in the last few years is that some major European companies involved in the heating and in the construction sector have started to offer solar thermal systems as part of their standard product range. This shows that solar thermal is finding its way into the mainstream and opens the way for a substantial increase in the capacity to build the market.

1.2.5 Quality and standards

The functionality of a solar system is a result of two factors: the quality of its components (collectors, tank, control units etc.) and the quality of the system design and installation. In some countries the market is still in the process of recovering from wide spread faulty installations of the first solar thermal generation in the 1970s and early 80s, which severely damaged the trust in this technology. The solar thermal industry has recognised the problem and invested resources to overcome it. The average product quality on the market is now very good and can be certified based on European standards. Improving the quality of installation remains a key issue to be tackled.

1. Soltherm is supported by the ALTENER program of DG Energy and Transport of the European Commission. One of its main results is the establishment of a web portal very useful for the whole Solar thermal community: www.soltherm.org

Product standards and certification (Solar Keymark)

Lack of common standards hindered the market

In the past, a main barrier to growth for the European solar thermal market has been its fragmentation due to the lack of common standards, certification and testing procedures. However, in the last few years, substantial progress has been achieved in this area. This progress is expected to become an important leverage for market development, provided it will be further consolidated and improved in the coming years.

EN standards

The first progress has been the creation of European standards for solar thermal collectors and systems, set at a good quality level. A list of the existing standards is provided in the text box below. The European standards (EN) have status of national standards since December 2001: CEN member countries are no longer allowed to have different national standards, except for additional requirements necessary due to special national regulation and law.

Existing European standards	
EN 12975-1:2000	Thermal solar systems and components – Solar collectors – Part 1: General requirements. CEN publication date: 18-10-2000.
EN 12975-2:2001	Thermal solar systems and components – Solar collectors – Part 2: Test methods. CEN publication date 06-06-2001.
EN 12976-1:2000	EN 12976-2:2000. Thermal solar systems and components – Factory made systems – Part 2: Test methods. CEN publication date 13-12-2000.
ENV 12977-1:2001	Thermal solar systems and components – Custom built systems – Part 1: General requirements. CEN publication date 25-04-2001.
ENV 12977-2:2001	Thermal solar systems and components – Custom built systems – Part 2: Test methods. CEN publication date 25-04-2001.
ENV 12977-3:2001	Thermal solar systems and components – Custom built systems – Part 3: Performance characterisation of stores for solar heating systems. CEN publication date 25-04-2001.
EN ISO 9488:1999	Solar energy - Vocabulary (ISO 9488:1999). CEN publication date 10-01-1999.

The EN standards are voluntary: it is not forbidden to sell or install systems not complying with them. In practice, however, the technical requirements set by the national or regional authorities granting financial incentives for solar systems, function as mandatory standards, since no customer would choose a product preventing him to get a subsidy available for another comparable product. Some kinds of subsidies are provided in most countries. Therefore, holding the certification of compliance with the relative technical requirements has been a necessary condition for manufacturers to be able to sell their product in a certain national or regional market.

Repetition of tests cause high costs

This situation causes high costs for companies trying to work beyond national borders, not least because they have to deal with many different technical requirements. Two main problems arose in the past. First, the tests done in one country were not automatically recognised by the test and certification bodies of other countries. Testing solar collectors and systems is very costly both in terms of time and money, compared to the market volume. Repeating tests in many countries results therefore in unacceptable costs to operate at European level. Second, a variety of (national) requirements and test methods have been referred to as condition for financial incentives granted by national or regional authorities. This forced the industry to have a broad range of tests in various countries in order to make their systems eligible for subsidies everywhere.

The Solar Keymark

The second element of progress has been the establishment of the Solar Keymark, providing in principle the condition for a solution of this problem, thanks to efforts of the solar thermal industry and of testing institutes, with the support of CEN and of the European Commission[1]. In a multinational project led by ESTIF, test institutes from eleven European countries have agreed on procedures for the mutual recognition of test results. Moreover, solar thermal is now at the forefront of European integration, being one of the first categories of products to hold a CEN/CENELEC Keymark.

The “Solar Keymark” states that the product fulfils the requirements of the EN12975 and EN12976 standards: Manufacturers can apply for the right to use the Keymark certificate. Having obtained the Keymark in one country, means that the major part of all European national regulations and requirements for obtaining subsidy are fulfilled. It is important for the growth of solar thermal that the subsidies are linked to harmonised technical requirements, in order not to present a barrier to trade.

In the action plan (Part 3), ESTIF proposes some measures to make the best use of this important success: first, to make sure that the existence of the Solar Keymark is widely made known to all actors involved; second, to guarantee that all national and regional authorities recognise the Solar Keymark without delay or complications. It is also suggested that national and regional subsidy schemes will refer to Keymark as indisputable source of reference. More information can be found at the Solar Keymark web site: www.solarkeymark.org.

Installation and maintenance

The lack of motivation and knowledge of craftsmen about solar thermal is a major barrier to growth.

Key role of craftsmen

This is particularly relevant in some market segments (one-family houses), where craftsmen often significantly influence the decision of the potential user whether to buy or not a solar thermal system. Households need craftsmen to install a solar system and they will often ask for their advice. If the installer is knowledgeable and motivated to work with solar thermal, he can take over an active role in marketing solar systems. However, if the installer is not motivated, he will often discourage potential users from buying a system.

1. Thanks above all to the Solar Keymark project, financed by the European Commission within the same ALTENER contract which has made possible the present publication.

Lack of motivation

The lack of motivation is often due to a general conservative attitude of craftsmen towards new technologies. For a craftsman, installing a solar system actually means some extra work compared to the installation of a conventional heating system. Thus, in principle, offering solar thermal to customers could be an attractive option. However, as a first step the craftsman or his company need to invest time and money to acquire the necessary extra skills. Almost everywhere in Europe, currently, the demand for solar thermal systems is still too low to represent an incentive for many installers to make this investment. Moreover, many installers still have prejudices about solar thermal, which is sometimes seen as complex and uneconomic.

Training of installers

The lack of motivation is often linked with a lack of the specific skills. Training courses about solar installations are offered in many countries. However, most installers still have to be convinced that it is worth to make the effort. Participation of installers to such training courses should be encouraged as much as possible. This is important also to avoid faulty installations, which have been a frequent problem in certain countries. The result has often been a long-term damage to the image of the solar thermal technology and reduced trust of potential users.

Once the solar thermal market will become a standard option well integrated into the mainstream heating and construction sector, market forces will spontaneously settle this problem. A sufficient number of installers will have an economic motivation to acquire the skills and even actively promote solar systems. Progress can already be seen in the few areas in Europe where solar thermal is already relatively widely used.

1.3 UNDERSTANDING THE MARKET – MARKET SEGMENTS

This chapter analyses the specific characteristics of each market segment. The aim is to identify the specific reasons for success and barriers to growth, on the basis of which the Action Plan below will identify measures specific for each market segment.

The analysis below focuses on the following factors to identify the key reasons of success and barriers to growth specific to each segment:

- Current situation and potential
- Product attributes (availability of standard solutions, cost and benefits)
- The decision process (actors involved, kind of decision, motivations)
- Customer relationships (how the industry can reach the customers)

An overview on the segmentation is provided in Table 1.3 (see below). The percentages represent the share of each segment, relative to the overall solar thermal market in Europe. These figures are best estimates given by ESTIF.

To avoid repetitions, the most important market segment so far (one-family houses) is presented thoroughly. In the following segments, only the main differences compared to one-family houses are mentioned.

Segmentation of the solar thermal market								
	Sector							
Segments	**Residential (90%)**				**Tertiary (8%)**	**Industrial (<1%)**	**Other (< 2%)**	
	DHW (80%) & Space Heating (10%)				DHW & Space Heating	Process heat (<1%)	District heating (1%)	Cooling, desalination, drying etc (<1%)
	One-family houses (80%)		Multi-family buildings (10%)					
	Existing (70%)	New (10%)	Existing (1%)	New (9%)				

Table 1.3

1.3.1 Residential sector

23% of EU final energy consumption

Domestic hot water (DHW) in the residential sector accounts for roughly 7%, space heating for roughly 16% of the EU final energy consumption. Together, they cause an annual consumption of 220 million tons of oil equivalent (Mtoe). Only 0,32 Mtoe (0,15%) were covered by solar thermal in 2001, but the technical-economic potential is at least 100 times larger: at least 15% of heat consumption in the residential sector in the EU could be covered by solar thermal.

Domestic hot water (DHW) and space heating

The difference between DHW and space heating systems concern the product attributes (for technical details see Appendix 1).

DHW applications fully developed

DHW systems for residential buildings make up roughly 80% of the whole solar thermal market. DHW applications are fully developed with a diversified product range. Standard systems are commercially available for one-family houses. EU norms and standards installation practices are well established. However, the growth potential is still very large. Even in Greece, the country with the highest rate of solar thermal in Europe, less than 25% of the buildings are equipped with a solar DHW system. In most countries, the fraction of houses equipped with a solar DHW system is still negligible.

Solar space heating is estimated to have a share of 8% of the overall solar thermal market. This relatively small fraction is also due to the fact that in Southern Europe the energy consumption for space heating does not always justify such an investment in solar technology. Many buildings have no water-carried space heating at all. On the other hand, in Central and Northern European countries, a growing part of the solar systems installed (from 15% in Germany to 40% in Denmark) cover space heating. Usually, space heating systems are combined with solar DHW (combisystems).

High benefits of combisystems

Combisystems have larger economic and environmental benefits, as the solar yield can easily cover the full space heating needs during spring and autumn, but the associated cost of investment is higher. In Central Europe, solar combisystems without long-term heat storage can cover 30% of the overall yearly heat demand of a residential unit.

The specific barrier to growth for space heating is that commercialisation in large scale of standardised applications is still not yet fully developed. There are not yet European system norms and standardised best practices for installation. This means that each system must be individually designed resulting in higher specific costs. The energy savings are higher, but also the upfront investment costs. A further barrier to growth is the lack of commercially available long-term heat storage systems. They could make solar thermal heat available in winter which was accumulated during the summer. The potential for solar space heating is very large, provided the specific barriers to growth are overcome.

Barriers to growth for space heating

One-family houses

One-family houses represent roughly 80% of the solar thermal market in Europe. The main reasons for this are the availability of standard products and the relatively simple process of decision to buy a solar system.

Decision making process

Solar thermal is not yet perceived as a standard option. When considering the purchase of a new heating system, the default choice is a conventional one. Private house owners must have a special motivation, to consider investing in solar thermal, as they have to actively search for information and convince themselves of the benefits and returns. Motivating potential users is easier once solar thermal is widely used: in Israel, 85% of the solar systems sold replace old ones. But in Europe solar thermal is still considered an extra feature.

Solar thermal not yet standard option

Looking at the actors involved in the decision process, their motivation and the timing of the decision, it is useful to distinguish between new and existing buildings.

Table 1.4

Decision making structure (one-family houses)

	Existing Houses	New Houses
Decision maker	• House owner	• Future owner • Real estate developer • Prefabricated house manufacturer
Influencers	• Personal relations • Craftsmen • Solar industry • Public authorities	• Engineers & Architects • Potential buyers / tenants • Solar industry • Public authorities.
Initiators	• Personal relations • Public authorities • Mass media	• Public authorities • Specialised media
Kind of decision	High personal involvement: search and convictions required prior to purchase	
Best Timing	During major renovation of house, heating system and/or roof	During planning and building

The decision makers are different kind of actors. However, new houses directly built by the future owner, are similar to privately owned existing houses, when it comes to motivation of the decision makers and their responsiveness to financial incentives. For these two aspects, therefore, the relevant distinction will be between households and professional actors, like real estate developers or manufacturers of prefabricated houses.

Decision makers

Personal relations play an important role for owners of existing houses. Spontaneous promotion by satisfied neighbours and acquaintances is an explanation of the good market performance of solar thermal in regions where it has reached critical mass.

Influencers and initiators

Local craftsmen

Local craftsmen are key influencers for the segment of existing houses. In most cases, house owners will ask for their advice and will need one to install the system. The availability of local craftsmen well trained and motivated to install solar thermal is a crucial factor for market growth. If craftsmen are not sufficiently motivated and knowledgeable for solar thermal, they will tend to suggest their customers to stick to conventional technology.

Engineers and architects

Engineers and architects are important influencers for the new built segment. It is meanwhile not difficult to find engineers able to design a solar thermal system. However, the fact that solar heating is not yet a standard feature still causes some extra costs compared to the design of a conventional heating system. In the case of architects, the lack of knowledge and experience as well as prejudices about the aesthetical impact of a solar system can be a key barrier to growth.

The industry in most countries is still too small and fragmented to play a strong role as initiator. Direct marketing or use of mass media have so far been possible only when public authorities have directly supported such initiatives, even then they have seldom reached a large scale. Public authorities or energy agencies can obviously play a key role as influencers and initiators not only by promoting information campaigns, but also by implementing regulations and financial incentives.

Timing of purchase

Timing of the purchase shows major differences. A solar system is much cheaper and cost effective if it is integrated during the planning and construction of the house. For existing houses, the best timing is during renovation of the heating system and/or roof or façade. This allows important synergies, reducing the necessary extra works and using the presence on site of relevant craftsmen. However, such favourable opportunities only occur every ten to twenty years. Installation during other times is possible and happens. But it is less convenient and increases the cost of the installation.

Motivations

For one-family houses, some key areas of motivation for buying a solar thermal system can be identified.

- Cost effectiveness
- Personal contribution to clean environment
- Image
- Autonomy from imported fuels
- Regulations

Looking at the motivations, it is useful to distinguish between private owners (households) and professional actors like real estate developers or manufacturers of prefabricated houses.

Motivations: Households

Cost effectiveness

Cost effectiveness depends on the location and specific heat demand of the house, on the costs and performance of the solar system, on the available financial incentives, but also to a great extent on the expected long-term price of conventional heating fuels and long-term interest rates. The key role of expectations shows that the cost-benefit analysis also entails a psychological element.

Based on these factors, the payback times on the investment can vary between less than five and more than twenty years. There is a significant potential for cost effective installations, particularly for DHW in Southern Europe. However in most cases, assuming stable fossil fuel prices, cost effectiveness can be reached only if financial incentives are provided. The responsiveness of households to financial incentives is proven and shows that cost effectiveness is a key motivation area.

Payback times

A specific barrier to growth is that exact measurement of solar yield or benefit is often not included as it is usually too expensive to be installed on a small system for a one-family house. Therefore, only reference cases can be used to provide arguments for cost effectiveness and most households do not measure the energy savings produced by the solar system.

Measurement of solar yield

Personal contribution to clean environment is a relevant motivation. Solar thermal gives an opportunity to apply renewable energy sources and reduce emissions in the own home. This partly explains the success of solar thermal in countries like Austria and Germany, with high environmental awareness. However, this motivation area is limited to a relatively small share of households. If other motivation areas are not effective, solar thermal remains a niche market.

Personal contribution to clean environment

Image can become a relevant motivation. In certain areas (Austria, Southern Germany), a solar thermal system is beginning to be perceived as a positive status symbol for one-family house owners. This is linked to two positive associations: clean energy and modern technology. Such a trend requires two preconditions: general environmental awareness and a certain critical mass for solar thermal. Only then, it can be positively associated and recognised.

Image

Autonomy from imported fuels can be a motivation for those who perceive security of energy supply as an issue directly impacting their lives. Due to the latest world political developments, this motivation area can be assumed to become more important, particularly for areas where oil is an important source of heating fuel. So far, however, it has probably been a secondary motivation area.

Autonomy from imported fuels

Regulations can obviously be the strongest motivation if solar thermal installation is mandatory. Such regulations exist in Israel for many years and recently have been approved in some Spanish municipalities, notably the city of Barcelona (see page 51). Even with binding regulations in force, other motivational areas play a role. Decision-makers can determine whether to comply with the minimal requirements or to install a larger or more sophisticated solar systems.

Regulation: the strongest motivation

Motivations: Professional actors

For real estate developers or manufacturers of prefabricated houses, the motivation structure is slightly different.

They are less likely to be motivated by cost effectiveness, as they have to bear the higher investment costs, whereas the future energy savings will benefit the tenants or potential buyers. Efforts to increase the transparency of information concerning the energy consumption of buildings are therefore crucial (see Action Plan, implementation of the EC Buildings Directive), but will probably not completely solve this problem. Professional actors will consider the added value perceived by potential buyers or tenants. Improving the corporate image can be a direct motivation for professional actors wanting to show environmental concern and modernity.

Improving the corporate image

Regulations: particuarly important for professional actors

As professional actors are less responsive to other motivation areas, regulations are even more important for this segment. In many cases, only an obligation to install a solar system (or at least to build pipes to the roof to facilitate a later installation) will provide the necessary motivation to professional actors.

Financial incentives

The main role of financial incentives is to stimulate purchase and improve the cost effectiveness for the potential user. However, particularly for households, they also have an important symbolic value, as they show the commitment of public authorities. By demonstrating in practice that the user is doing something useful for society, financial incentives also reinforce other motivation areas, like contribution to the environment and autonomy from imported fuels.

Financial incentives: households

Investment in solar thermal is relatively large for a household, particularly considering that the return on investment is distributed over more than twenty years. The high upfront investment costs are a key barrier to growth. Financial incentives should help to reduce it.

Besides direct incentives, fiscal measures can play a major role. The VAT has a strong impact on this market segment, as private households generally cannot deduct it. In several countries, the direct financial incentives provided to households do not compensate the VAT paid on the system. Other countries, like Austria and Spain, have currently subsidy schemes strong enough to compensate for all VAT and provide some extra money.

In five EU countries, a reduced VAT rate is applicable on solar thermal installations:

Table 1.5

Reduced VAT rates in 5 EU countries

	Standard VAT rate (%)	VAT rate for Solar Thermal Systems (%)
United Kingdom	17,5	5
France	19,6	Variable: 5,5–19,6
Italy	20	10
Portugal	17	12
Ireland	21	12,5

On the other hand, direct competitors of solar thermal (gas or electricity consumption) benefit in some countries of VAT reductions higher than solar thermal. This gives an incentive to consume fossil fuels rather than renewable energy sources!

In some countries, for instance in Austria, private persons can deduct from their income tax the investment for solar thermal.

Financial incentives: professional actors

Concerning direct incentives to investment, the thinking of the professional actor in this segment does not differ substantially from private owners. Professional actors are not very sensitive to reductions of VAT or of income tax. Instead, reduction of building property taxes, in this case for solar thermal or other renewable energies would probably be more effective.

Reduction of building property taxes most effective

Customer relationships

Convenience. For existing houses, a key barrier to growth is the lack of a network of well-trained craftsmen who can provide positive advice on solar thermal in connection with renovation of buildings and heating systems. For new houses, most architects and the mainstream construction industry do not yet consider solar thermal as a standard option.

Convenience

Trust. As noted above, in areas where solar thermal is more widely used, spontaneous promotion by neighbours and by professional actors is having a positive effect. However, in several European countries (Italy, Spain, UK), there has been a history of poor quality systems, due both to faulty hardware and installation. Even though these problems occurred during the 1970s and 1980s, these experiences caused a loss of trust, particularly among professional influencers such as craftsmen, engineers and architects.

Trust

Responsiveness. Lack of knowledge and experience in solar thermal among craftsmen means that they in general do not automatically promote and offer solar systems in connection with renovation of roofs and/or heating systems.

Responsiveness

There is an economic logic for a conservative attitude towards a new technology: as long as the spontaneous requests for solar systems do not reach a critical mass, most craftsmen will try to avoid the investment in training necessary to acquire the specific skills. Under these conditions, craftsmen may openly discourage potential users and advise them to stick to conventional heating. Once the market reaches the critical mass, at least some of the craftsmen will have an economic incentive to offer solar installations. By offering solar installations, these craftsmen will be able to increase their turnover.

Craftsmen

Architects generally do not favour building components like solar thermal collectors, which restrict their building design possibilities. Particularly applications on the roof tend to dampen their interest in influencing decision-makers in favour of solar thermal.

Architects

Engineers tend to advice the most feasible solutions, from an economic and technical point of view. Given low fossil fuel and electricity prices, active use of renewable energies is not very high on the agenda. When compared to efficiency measures like better insulation often have a stronger economic impact from the individual point of view. From the point of view of society, all measures to reduce the consumption of conventional energies should be implemented, including the full development of the potential use of renewable energies in the built environment.

Engineers

Multi-family buildings

High technical potential

This segment makes up roughly 10% of the overall solar thermal market so far, compared with 70% in one-family houses. The technical potential for solar thermal is actually very high, since larger solar systems have lower costs/kWh compared to small systems for one-family houses.

The main specific barrier to growth concerns the decision process and the ownership structure. For other elements, the analysis of the one-family house sector is valid. The technical barriers to growth for multi-family buildings are very similar to those described for space heating in general (see page 29).

Multi-family – existing buildings

Considering a building with a central heating system, it can have either a single owner with tenants or many owners.

Central heating with single owner

In the first case, the decision maker is the owner, who has no direct economic interest to invest in order to reduce the heating bills of its tenants. The latter can be initiators, but they will in general have a difficult task convincing the owner. The implementation of the EC Buildings Directive will hopefully create more transparency in the market. If the energy intensity of residential units will be reflected in the rent levels, the investment in energy saving technologies will be more rewarding. This will probably be a very slow process. The quick way out of this dilemma can only be regulations obliging the owners to install solar thermal. This is very important considering the very high number of buildings belonging to this category in Europe.

Central heating with multiple owners

In the second case, an agreement of the flat owners about a common investment in a solar thermal system would be necessary. Given the high transaction costs, a positive decision is very unlikely. In this case, the inertia of decision-making is so strong that solar thermal will probably not be installed even when it will offer strong direct economic advantages. Growth in this market can probably be achieved only through regulations making solar thermal mandatory.

Without central heating

In other multi-family buildings, each apartment has its own separate heating system. In this case, each flat owner faces in principle the same decision making-process as the owner of a one-family house. This assumes that he is allowed to use part of the roof. Beyond this restriction, the emotional link to the building is generally lower, reducing the impact of motivation areas such as image or personal contribution to environment. In Greece, it is relatively common that individual flat owners build their own solar DHW system on the roof, directly connected to the flat. In other European countries this is not the case. Also for this segment, binding regulations are certainly more effective than financial incentives, as the main barrier to growth is linked to the difficult decision process.

Multi-family – new buildings

Buildings to be sold

If the investor intends to sell the flats, he will try to anticipate the preferences of potential buyers. If low energy costs and the immaterial value of renewable energy sources make it easier to sell the flat or are reflected in their market price, the investor has an incentive to consider solar thermal. Currently, these conditions apply only to a relatively small market niche. This niche is a bit larger in countries with high levels of energy and environmental awareness (Scandinavia, German speaking area, Netherlands) and almost negligible in Southern European countries and on the British islands.

If the flats are to be rented out, the investor usually focuses on reducing the construction costs, as the burden of running for heating is shifted to the tenants and, in most countries, rent prices hardly incorporate the associated energy costs.

Buildings to be rented out

In both cases, direct financial incentives can have a strong impact as well as more transparent information on the energy performance of buildings. This will indirectly increase the willingness of investors to consider solar heating. However, the implementation of the EC Buildings Directive will not have a significant impact on market prices for a decade. Without binding regulations, the opportunity to install large and effective systems on new multi-family buildings will in many cases still be missed.

Transparency of information

1.3.2 Tertiary sector

Energy usage in the tertiary sector (excluding transport) accounts for approximately 12 % of the final energy consumption in the EU. Of this, 52 % are used for space heating (~ 6 % of final energy consumption) and 9 % for hot water production (~1 %).

Solar domestic hot water and space heating can be easily applied on typical public and commercial buildings but the broad potential has not been fully developed so far: the tertiary sector is estimated to have a share of just 8 % of the overall solar thermal market. The most promising sub-segments in the tertiary sector are those with a particularly high demand for domestic hot water, e.g. hotels, sport centres (showers), hospitals, prisons (constant demand also in summer), swimming pools. For this segment, a broad range of solar DHW applications are available and have often been used already.

In standard office buildings, solar space heating and domestic hot water can be successfully applied. Since office buildings have relatively low demand for domestic hot water, the specific technical barriers to growth are similar to those experienced with space heating in the residential sector (see page 29).

The main specific aspects of the tertiary sector are related to the different motivation and decision-making process. It is useful to distinguish between public and private ownership.

Publicy owned tertiary

When the decision maker is a public institution, the decision making process is collective and often complex and lengthy. It involves both financial and technical departments. The role of initiator can be taken by specific regulations or targets, self-imposing for instance a certain share of energy savings or renewables in the buildings owned by a certain public authority. In this case, solar thermal often offers a relatively cheap option to fulfil such targets.

Complex decision-making process

But this is still seldom the case. If such regulations or targets do not exist, the decision to install a solar thermal system generally requires the strong involvement of one or more civil servants, motivated to successfully go through the decision procedure.

Beyond the personal motivation of individual initiators, a public institution can be motivated by image reasons (improve the own image) as well as by the wish of setting a good example for the public by applying solar thermal on public buildings and facilities. Their high visibility is often very important to develop awareness for solar thermal at local level.

Image and visibility

From the financial point of view, there is a barrier to growth specific to public authorities. The procurement budget (financing the investment in solar thermal) and the operations budget (receiving the benefits from solar thermal) are often under the responsibility of different departments. In times of high public debt, a long-term investment such as solar thermal can be difficult to be approved.

Solutions can be the application of specially designed financial incentives for public owned buildings, but mainly political determined targets for renewable energy applications in the public sector.

Private owned tertiary

The decision maker is the owner. Relevant influencers and initiators are often professional actors involved in the specific business. In certain areas of Greece, hotel managers have become relatively familiar with solar thermal, as they often know a colleague who has installed it. Public authorities can also play a key role as motivator, when they promote awareness campaigns targeted at specific business sectors.

The decision is taken on the basis of a cost-benefit analysis, but improving the image can also be a relevant motivation, when the use of green energy can be communicated to the customers, as in the tourist sector.

1.3.3 Industrial sector

Substantial potential

In many manufacturing processes, there is a substantial heat demand that could be covered by solar thermal applications. Modern solar thermal collectors can easily cover industrial demand for low temperatures and medium temperatures (up to 200–250°C), even though the latter are not yet widely commercialised. Precise data about the heat consumption of the industrial sector at these temperatures are not known, but a large unexploited potential certainly exists, particularly in Southern Europe, where solar heat can be achieved at lower costs.

Demonstration stage

So far, industrial process heat represents a minimal part (<1%) of the solar thermal market. Such systems must be tailor-made to meet the specific requirements in terms of heat demand. Therefore, industrial applications of solar thermal are still in R&D stage and economically viable only with public financing.

The decision process resembles that of the privately owned tertiary business segment. The main motivation factor for investing in solar thermal is economic. Typically, short pay-back times on investment (1–3 years) are required by industrial manufacturers. This represents a major barrier to growth in relation to industrial solar thermal applications.

Regulations or incentives needed

In absence of binding regulations (like quota for the use of renewable energies), financial incentives are needed to make solar thermal attractive to industrial decision-makers, in present market conditions. Image can play a role, but to a lesser degree than in the other tertiary sectors, where consumers can more directly perceive the use of renewable energies. However, image can be relevant also in manufacturing, as more and more large companies publish environmental reports to show their environmental performance to investors and consumers.

1.3.4 Other sectors

District heating

District heating networks deliver heat to over 20 million customers in the EU. They offer an excellent opportunity to benefit in large scale from solar thermal energy. The technology is already well proven. A solar fraction of 5–6 % can be reached without additional storage capacity, using the distribution network as buffer. Solar fractions of up to 25 % may be reached using a conventional short-term storage facility (water tank). Larger solar fractions would require long-term storage facilities that so far have been demonstrated in a few plants only.

Large solar heating plants

District heating networks represent currently roughly 1 % of the overall solar thermal market in Europe. The largest solar thermal installations (up to 18.300 m^2) in Europe are connected to district heating networks. Particularly in Northern, Central and Eastern Europe the potential for solar assisted district heating is huge.

It must be distinguished between plants producing only heat and cogeneration plants providing heat as a by-product of electricity production.

Heat only plants

For the first type of plants the motivation factor is primarily the price of the energy substituted by solar thermal. Experiences in Denmark and Sweden have shown a price for solar energy around 3 Euro cents per kWh. Compared with heat from waste incineration it is not competitive. However, compared to energy sources like pellets, hay or even coal, oil and gas then the business case looks more promising.

Cogeneration plants

Cogeneration plants can of course provide heat at a very competitive level, as it is a by-product of electricity production. However, when the cogeneration plant runs in heat-only modus, the business case for solar thermal is good. A barrier to growth for solar thermal is that electricity plants get the best kWh price during peak hours, which partly coincide with peak solar production, making it less complimentary.

Owners of district heating plants are typically municipalities. The barriers to growth related to the decision process are similar to those analysed for public buildings. In some countries like Denmark small district heating system are owned by groups of house owners.

The main barrier of growth in this segment is, however, raising the capital needed to invest in solar thermal.

Solar cooling

Solar assisted cooling is a highly promising application with very high potential for solar thermal. The benefits in terms of environment and energy savings are particularly high, as the growing demand for cooling is significantly increasing electrical consumption in many European countries.

A number of medium/large systems are already installed throughout Europe. Small systems for one-family houses are being developed and demonstrated. However, further R&D on small systems is essential. Once they are widely available on the market, the potential for saving conventional energies through the use of solar thermal will increase enormously. See Appendix 1 for descriptions of technologies.

Part 2 – Growth Targets, Potential and Scenarios

In this chapter, scenarios for market growth are developed and compared with the growth targets set at EU level as well as with the estimated potential for solar thermal.

2.1 EU TARGETS FOR SOLAR THERMAL

The White Paper for a Community Strategy and Action Plan "Energy for the future: Renewable sources of energy" of the European Commission (1997) sets an indicative objective of 12% contribution of renewables to the EU's final energy consumption, by 2010. The Campaign for Take-Off (CTO) launched by the European Commission set mid-way targets for 2003.

For solar thermal following targets were set at EU level:

- 15 million m^2 installed by 2003 (CTO)
- 100 million m^2 installed by 2010 (White Paper)

CTO target for 2003 nearly reached

The CTO target is close to being reached. As seen above (see page 15), the collector area in operation is estimated at the end of 2002:

Area in operation (new methodology)

Area in operation 2002 (new methodology)

Glazed collectors:	10,7 million m^2
Unglazed collectors	1,6 million m^2
Total	12,3 million m^2

It should be noted, that these figures are lower due to the new methodology introduced by the present publication (see page 16). The figures above refer to the collector area "in operation". The latter is obtained by subtracting the collectors assumed not to be in operation anymore from the cumulative installed area [1].

However, when the targets were set, they apparently referred to the cumulated installed collector area. Using the old methodology, the CTO target would be almost reached already.

1. For systems installed before 1990, an average lifetime of 15 years is assumed. For systems installed afterwards: 20 years.

Cumulated installed area (old methodology)

Cumulated installed collector area 2002 (old methodology)

Glazed collectors:	12,6 million m^2
Unglazed collectors	2,0 million m^2
Total	14,6 million m^2

At the end of 2003, it can be expected that almost 14 million m^2 collectors will be in operation (new methodology) in the EU, while the cumulated installed collector area will be over 16 million m^2 (old methodology).

2.2 TECHNICAL POTENTIAL

Regional differences

The long-term technical potential for solar thermal, in terms of collector area in operation per capita, is higher in northern countries than in southern countries. The main reason is that in colder climates the demand for space heating is substantially higher and to produce the same amount of heat a larger collector area is needed. This obviously implies a higher investment per capita in northern countries. However, this is not specific to solar thermal: regardless which technology they use, Scandinavians have to spend more for heating than Southern Europeans.

In Southern Europe there is a higher economical potential to use solar collectors for industrial process heat, due to the higher radiation. The potential for solar cooling is also higher in Southern Europe. However, these two factors cannot counterbalance the higher demand for space heating in cold climates.

Table 2.1

Technical - economical potential for solar thermal in the EU					
Country	**Population**	**Potential (per 1.000 Capita)**	**Potential (absolute)**	**Annual Energy Output**	
		m^2	**m^2**	**GWh**	**Mtoe**
AT	8.121.000	3.900	31.671.900	11.193	1,0
BE	10.262.000	3.900	40.021.800	16.827	1,4
DE	82.193.000	3.900	320.552.700	130.607	11,2
DK	5.349.000	6.300	33.698.700	13.483	1,2
ES	39.490.000	2.700	106.623.000	64.448	5,5
FI	5.181.000	6.300	32.640.300	9.810	0,8
FR	59.521.000	3.900	232.131.900	139.279	12,0
GR	10.565.000	2.700	28.525.500	11.068	1,0
IE	3.820.000	3.900	14.898.000	6.704	0,6
IT	57.844.000	3.300	190.885.200	116.543	10,0
LU	441.000	3.900	1.719.900	723	0,1
NL	15.983.000	3.900	62.333.700	26.180	2,3
PT	10.023.000	2.700	27.062.100	16.237	1,4
SE	8.883.000	6.300	55.962.900	16.849	1,4
UK	59.823.000	3.900	233.309.700	102.196	8,8
Total	**377.499.000**	**3.740**	**1.412.037.300**	**682.149**	**58,7**

Table 2.1 shows the technical-economical potential, based on the average heat demand, solar radiation and on the population of each country. In Southern Europe, for instance, the overall potential is estimated to be 2,7 m^2 per demand per capita, (0,7 m^2 for domestic hot water, 1 m^2 for solar cooling, 1 m^2 for heat demand in industry and services). In Northern Europe, the overall potential is estimated to be 6,3 m^2 per capita, (1,3 m^2 for domestic hot water, 5 m^2 for space heating).

These are rough estimations. For certain aspects, the potential might be even higher, as for instance there is certainly some potential for solar space heating also in Southern European countries. But these estimations give a good indication of the dimension of the technical potential.

The technical potential is estimated at 1,4 billion m^2 collectors area, resulting in an annual solar yield equivalent to 682 TWh/y or 58,7 Mtoe. This corresponds to:

- **6% of the EU final energy consumption**
- **More than the final energy consumption of a country like Belgium**
- **30% of the EU oil imports from the Middle East in 1999**

These estimations are based on a long-term view, under following assumptions:

- The potential in the residential and tertiary sector will be fully implemented
- Solar assisted cooling will be fully commercialised
- Solar thermal will be widely used for process heat, particularly in Southern Europe

In other words, this potential estimation assumes that Europe will take the idea of sustainable development seriously, which necessarily implies that the full potential of all available renewable sources shall be fully implemented.

2.3 GROWTH SCENARIOS 2001–2015

Main variable: intensity of public policies

The development of the solar thermal market depends on a variety of factors. Some of them are specific to the technology and industry, such as prices or functionality of the products. Others are external, such as overall economic situation, prices of conventional energy or the intensity of political support for solar thermal. A detailed modelling of the interactions between internal and external factors would go beyond the scope of this publication. Therefore, the focus is mainly put on one variable: the intensity of public policies to support solar thermal.

The four scenarios give an indication of the range in which the market could develop.

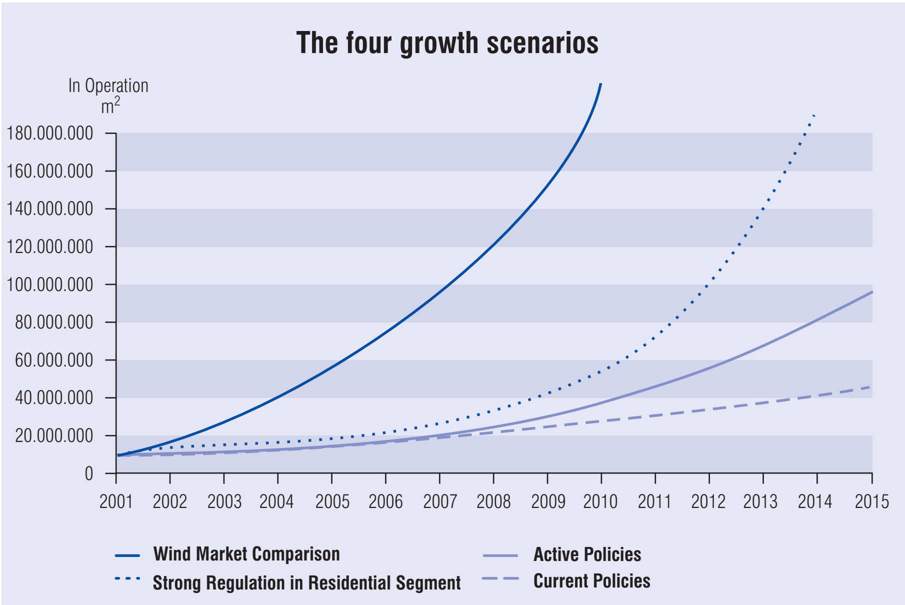
In summary the results are:

- If the current average level of support for solar thermal is retained, the 100 million m^2 target, planned for 2010, will not be reached before 2022.
- The 100 million m^2 can be achieved by 2015, if proactive policies to support solar thermal are implemented throughout the EU.
- If solar thermal grew at the same rate as wind energy did between 1990 and 2001, the installed collector area in operation would grow to more than 1 billion m^2 in 2015, getting relatively close to the technical potential of 1,4 billion m^2.
- To assess the impact of strong regulation, the residential sector was analysed separately: Binding regulations to install solar thermal systems in residential buildings would increase this market segment to roughly 47 million m^2 per year. In the residential sector alone, 199 million m^2 of collectors would be in operation in 2015.

The four growth scenarios						
	2001–2015	2001	2010	2015		
	Annual growth rate (in operation)	In Operation m²	In Operation m²	In Operation m²	In Operation m²/1.000 capita	Annual Energy Output GWh/year
Current Policies	11,7%	9.862.500	26.727.356	46.504.429	123	19.137
Active Policies	18,0%	9.862.500	39.480.088	99.580.429	264	45.440
Wind Market Comparison	39,6%	9.862.500	198.723.378	1.053.995.919	2.795	433.718
Strong Regulation (Residential Only)	23,9%	9.862.500	57.979.729	199.133.279	528	92.596

Table 2.2

Figure 2.1



2.3.1 Methodology

Before discussing each scenario, it is necessary to shortly define some methodological issues.

Collector area in operation

New methodology introduced by ESTIF

As noted above, this study introduces the concept of collector area "in operation": Throughout this study, ESTIF uses the conservative assumption that systems installed until 1989 will be in operation for 15 years, systems installed from 1990 onwards will be in operation for 20 years. This means that systems installed before 1996 will not be considered "in operation" in 2015 (for the EU as a whole this amounts to roughly 5,5 million m^2, which is not included by 2015).

This means that the market volume is larger than the simple difference between the areas in operation in two years. In these models new installations also replace the old ones assumed to have reached the end of their lifetime.

The figures "area in operation per capita" assume a stable population (reference year: 2001).

Glazed and unglazed collectors

Only glazed collectors considered

All data in the scenarios refer to glazed collectors only. Glazed and unglazed collectors can be difficult to compare with each other, for several reasons: different markets, different costs and different solar yield. Specific market data and analysis for unglazed collectors are missing in several countries. Unglazed collectors have a very good growth potential, and can cheaply and simply contribute to energy savings, particularly in open-air swimming pools. However, to keep data comparable, all scenarios focus on glazed collectors only. Unglazed collectors are not considered in the senarios.

EU overall and breakdown by country

Bottom-up approach

In one case, we use a bottom-up approach: the "Strong regulations (residential only)" scenario starts from a series of country specific assumptions, based on the potential for solar thermal in the residential sector. The overall EU figures are the sum of the results at national level. Also the technical potential estimated above is based on a bottom-up approach.

Top-down approach

The other three scenarios (Current policies, Active policies, Wind comparison) use a top-down approach. The starting point is an average growth expected at EU level. This aggregated figure is broken down country by country in the "Active policies" scenario. This approach is chosen to reflect the historical experience of extremely heterogeneous developments in different countries. As the main variable considered is the intensity of policy support measures, it would be arbitrary to predict with which intensity and timing these might be implemented in different countries. However, it can be assumed that national differences will tend to even out at aggregate EU level. This is also shown by the historical experience: while the market development at national level has been in many cases quite irregular, the aggregate curve at European level is very regular.

Constant growth rates

Implication of constant growth rates

2001 is the starting year of the scenarios. In all scenarios, between 2001 and 2015 are assumed constant annual growth rates, both at EU level and for each country. Constant growth rates imply that in the last part of the period considered the annual market volume is assumed to be much bigger than in the first part of the period, as clearly shown by the curves of Figure 2.1 above.

Accurate for the EU aggregate

At aggregated EU level, this assumption is relatively accurate. In most countries, the solar thermal market is still in a very early phase of development. Since important economies of scale will become effective as the market develops, constant growth rates can be assumed. Also the effect of stronger policy measures will partly have a cumulative impact, resulting in higher market volumes in the future.

Constant growth rates also imply that saturation (i.e. the moment when the growth curve begins to flatten) will not be reached before 2015. With two exceptions, this seems to be an accurate assumption, since three of the scenarios remain until 2015 clearly below the technical potential for solar thermal, estimated at over 1,4 billions m^2 at EU level.

Exceptions

The first exception concerns the countries where the market has already reached significant dimensions, like Germany, Austria, Greece and Denmark. In this case, it should be aimed at a steeper growth curve in the first part of the period considered, since the market structures and public awareness are already better developed. However, this is not included in the model. Therefore, the figures for 2010 (see page 42) in these countries should be in reality higher.

The second exception is the “Wind Market Comparison” scenario. In this case, saturation would probably be reached some years before 2015, causing a slow down of growth in the last years of the period.

Solar energy output

The annual energy output (kWh/m^2 collectors in operation) is based on country specific assumptions, done by national experts. These assumptions take into account the solar yield of typical solar thermal systems installed in the country, based on typical technical characteristics and solar radiation. The values range from 300 kWh/m^2 for flat plate collectors in Finland, to 800kWh/m^2 for vacuum tube collectors in Southern Europe. Full data are available in the Volume 2 (national market reports) of this publication.

2.3.2 Current policies scenario

Main assumption

The underlying assumption is that, at aggregated EU level, the intensity of policies to support solar thermal will remain comparable with the last decade: no EU policy framework, relatively strong measures in some countries, almost no measures in many others. The EU average is not disaggregated country by country. Within a context of continuing heterogeneous development, it would be arbitrary to assume which countries could implement stronger policies than others.

Based on this general assumption, the current policies scenario assumes that the area in operation at aggregated EU level will grow by 11,7 % yearly, the same annual rate registered from 1990 to 2001. Since constant growth rates are assumed, more than half of the growth in absolute terms will take place between 2000 and 2015, reflecting growing economies of scale.

Current policies scenario						
	2001–2015	2001	2010	2015		
	Annual growth rate %	In Operation m^2	In Operation m^2	In Operation m^2	In Operation m^2/1.000 capita	Annual Energy Output GWh/a
EU14	11,7	9.862.500	26.727.356	46.504.429	123	19.137

Table 2.3

At this growth rate, the glazed collector area in operation in 2015 will reach 46,5 million m^2 or 123 m^2 per 1.000 capita. The EC target of 100 million m^2 by 2010 will be clearly missed. It will not be reached before 2022. By 2010, just above one fourth of this target will be in operation (26,7 million m^2).

For the purpose of calculating the annual energy output in 2015 (19.137 GWh/a), it has been assumed that each country would grow exactly at the EU average rate of 11,7 %.

2.3.3 Active policies scenario

Main assumption

This scenario assumes that active and systematic policies to promote solar thermal and to reduce the support for fossil fuels and nuclear power will be implemented, both at EU and at national level. The main assumption is that the EU will reach by 2015 an average area in operation per capita at the level reached today by one of its member states. In 2001, the collector area in operation in Greece amounted to 264 m^2 per 1.000 capita. Extrapolated to EU level, this corresponds to nearly exactly the target of 100 million m^2.

This assumption is not unrealistic. As explained above, the long-term technical potential per capita is clearly higher in Central and Northern Europe than in Greece. This shows that the 100 million m^2 target is realistic. However, reaching it by 2010 would imply unrealistic growth rates of the market volume. Therefore, ESTIF assumes it will be reached by 2015.

Active policies scenarios						
	2001–2015	2001	2010	2015		
	Annual growth rate %	In Operation m²	In Operation m²	In Operation	In Operation m²/1.000 capita	Annual Energy Output GWh/a
AT	11,0	1.651.814	4.225.401	7.120.047	877	2.516
BE	34,5	26.534	382.184	1.682.156	164	707
DE	17,5	3.634.000	15.514.069	34.746.819	423	14.157
DK	17,9	271.120	1.197.119	2.731.851	511	1.093
ES	26,6	224.666	1.871.250	6.075.376	154	3.672
FI	42,5	7.220	174.913	1.027.709	198	309
FR	31,7	230.750	2.743.403	10.854.106	182	6.512
GR	7,0	2.790.200	5.129.669	7.194.626	681	2.792
IE	42,4	3.325	80.212	470.181	123	212
IT	26,5	330.385	2.746.654	8.908.300	154	5.439
NL	23,7	203.877	1.378.823	3.987.471	249	1.675
PT	18,1	210.963	945.525	2.175.701	217	1.305
SE	24,6	158.226	1.146.534	3.445.287	388	1.037
UK	36,3	119.420	1.944.332	9.160.801	153	4.013
EU14	18,0	9.862.500	39.480.088	99.580.429	264	45.440

Table 2.4

The following assumptions were used to break down the EU aggregate to each country:

- In the long-term, the current differences in the level of solar thermal usage throughout Europe will vanish.
- The usage will converge towards the technical-economical potential of solar thermal in each country.
- By 2020 most countries will have realized the same percentage of their respective potential.
- Only Austria, Germany and Greece will still exceed this percentage, due to their already strong position.

2.3.4 Wind market comparison

To show that the high growth rates assumed in the "Active Policy scenario" are not at all unrealistic, we compare them with the growth rates achieved by a comparable technology in the last decade.

Analogies of wind energy and solar thermal

The European wind energy market has several analogies with solar thermal. As a future oriented renewable energy technology, also wind power has struggled hard to get sufficient political support in the beginning and to reach the minimal critical mass necessary to achieve first significant economies of scale. But with effective incentives and regulations, wind energy developed at astonishing rates over the past decade: Between 1990 and 2001 the installed capacity grew by 39,6 % per year.

On one hand, it is evident that solar thermal growth has to face rigidities given by the fact that mass use will involve action from million of citizens, whereas wind energy is a less decentralised business. On the other hand, the growth rates of wind energy in the last decade have been achieved to a great extent in only three European countries, like solar thermal so far. This shows that in both cases the potential for growth is definitely higher, if strong policies will be taken at European level.

Wind market comparison						
	2001–2015	2001	2010	2015		
	Annual growth rate %	In Operation m^2	In Operation m^2	In Operation m^2	In Operation m^2/1.000 capita	Annual Energy Output GWh/a
EU14	39,6	9.862.500	198.723.378	1.053.995.919	2.795	433.718

Table 2.5

70% of the technical potential could be reached

If the European solar thermal market grew at the same rate as wind power in the last decade, the 100 million m^2 target will be reached in 2008. By 2015, roughly 1 billion m^2 collectors would be in operation, corresponding to roughly 70 % of the technical potential.

2.3.5 Strong regulations in the residential Sector

To show that regulations could have a very positive impact on the European solar thermal markets, this scenario focuses on what is currently the most important market segment: the residential sector (domestic hot water and space heating).

Assumption

It is assumed that in 2015 all member states will have implemented binding regulations based on the model of the regulation approved by the municipality of Barcelona in 2000 (see page 51), making the installation of a solar thermal system mandatory for new buildings or buildings undergoing a major renovation. However, in this scenario it is assumed that the binding regulation will apply also to small residential buildings, including one-family houses.

The market volume in 2015 has been estimated, based on available projections concerning the housing stock (newly build and renovated) for each EU country. For each dwelling, following collector areas have been assumed:

Table 2.6

Assumption: collector area per dwelling		
	One-family buildings	Multi-family buildings
Northern Europe	10 m^2	6 m^2
Central Europe	8 m^2	4,8 m^2
Southern Europe	4 m^2	2,4 m^2

80% of new houses to have solar thermal

Because of physical restrictions (roof orientation, shading) it will not be possible to reach 100% of the buildings. ESTIF has estimated that 80% of the newly built or refurbished buildings will be equipped with solar thermal systems.

On this basis, a market size for 2015 has been obtained assuming that by then each country will have adopted strong regulations in the residential sector. However, it would be arbitrary to define exactly when each country would implement them. Therefore, it has been assumed that the growth necessary to achieve the market volume obtained for 2015 will take place at constant growth rates (EU aggregate and in each country).

In this case, the collector area in operation in the EU residential sector in 2015 would increase to 199 million m^2, with a solar thermal output equivalent to 92.596 GWh per year.

Strong regulation in the residential sector						
	2001–2015	2001	2010	2015		
	Annual growth rate %	In Operation m^2	In Operation m^2	In Operation m^2	In Operation m^2/1.000 capita	Annual Energy Output GWh/a
AT	12,9	1.651.814	4.908.588	8.989.424	1.107	3.177
BE	43,9	26.534	700.449	4.316.575	421	1.815
DE	22,3	3.634.000	22.165.794	60.528.535	736	24.662
DK	23,0	271.120	1.741.907	4.895.960	915	1.959
ES	32,9	224.666	2.899.762	12.008.464	304	7.259
FI	54,1	7.220	354.417	3.082.801	595	927
FR	42,0	230.750	5.419.034	31.294.389	526	18.777
GR	9,5	2.790.200	6.319.967	9.953.623	942	3.862
IE	58,7	3.325	212.488	2.140.000	560	963
IT	30,7	330.385	3.669.888	13.981.694	242	8.536
NL	31,9	203.877	2.466.580	9.853.949	617	4.139
PT	24,3	210.963	1.492.921	4.427.564	442	2.657
SE	30,3	158.226	1.709.963	6.416.076	722	1.932
UK	47,4	119.420	3.917.970	27.244.225	455	11.934
EU14	23,9	9.862.500	57.979.729	199.133.279	528	92.596

Table 2.7

It must be noted again that these figures refer to the residential sector only. These results should not be confused with the technical potential in the residential sector, which is much higher. Because of the slow rate of major refurbishments, it will take over 20 years to realize the full potential, even in the case of strong binding regulations.

Part 3 – Action Plan for Solar Thermal in Europe

In the medium-term, solar thermal can become a fully self-sustained technology. Provided that the market reaches a larger volume, substantial economies of scales are possible at all levels of the value chain: from manufacturing to marketing and distribution. To achieve this, a stable partnership between industry and public authorities is necessary, in order to overcome the main barriers to growth identified in Part 1.

Further investments needed

The industry has already made important investments to reduce production costs, increase capacity and improve the quality of solar thermal products as well as their integration in the mainstream heating and construction industries. Further investments are necessary to improve production methods, to develop a widespread network of qualified retailers, system designers and installers and to develop new applications to the stage of wide commercialisation.

Reliable political framework

However, such investments require reliable political framework conditions. The market should develop all over the EU, to implement the huge unexploited potential in all countries. A combined action is necessary, at EU, national and regional level.

The first chapter proposes a series of general measures for the development of solar thermal. Some of them mainly require action at EU level. Others require a proactive approach of national or regional authorities as well. The second chapter identifies the key actions most relevant to overcome the barriers to growth specific to the market segment analysed in Chapter 1.3. An overview of the proposed actions is presented in the executive summary.

3.1 KEY ISSUES FOR THE EUROPEAN SOLAR THERMAL POLICIES

3.1.1 Regulations

Experiences in and outside the EU show that regulations are the single most effective tool to promote solar thermal. In Israel (see Appendix 2) and in the city of Barcelona, the regulations require a broad range of buildings (new and undergoing major renovations) to cover a part of their heat demand by solar collectors. This has produced very positive results.

The Barcelona model

The Barcelona model

Barcelona shows the way ahead. A regulation of the City Council makes the installation of solar thermal mandatory on buildings undergoing major renovation and newly built. At least 60 % of the domestic hot water consumption must be covered by solar energy. With a few exceptions, the regulation applies to all buildings with average daily domestic hot water consumption larger than 292 MJ, corresponding more or less to the consumption of ten households.

The solar regulation was approved unanimously by the City Council in 1999 and came into force in August 2000. Though it is applied gradually, the results are very positive. In eighteen months, the total surface installed in Barcelona increased from 1.650 m^2 (1,1 m^2 per 1000 inhabitants) to 14.027 m^2 (10,6 m^2 per 1000 inhabitants). The estimated total solar yield is estimated at 11.222 MWh/year, corresponding to the yearly domestic hot water consumption of 20.000 inhabitants of Barcelona.

Similar regulations, often even more stringent, have been approved or are being discussed in several other Spanish municiüalities, including Madrid and Sevilla.

Implementation of the EC Buildings Directive

Key role of the EU Directive

The implementation of the recent EC Buildings Directive[1] will play a key role for the development of solar thermal in the next decade. Within the framework of the directive, a methodology of calculation of the energy performance of buildings must be developed at national or regional level. Based on this methodology, minimum requirements of energy performance must be set for new buildings and for large buildings undergoing major renovation. Furthermore, energy performance certificates will be mandatory every time a building is constructed, sold or rented out.

1. Directive 2002/91/EC of 16 December 2002 on the energy performance of buildings. It must be transposed into national legislation by January 2006.

Full recognition of solar thermal

It is essential that in each EU member state the contribution of solar thermal will be fully recognised in the methodology for calculation as well as in the energy performance certificates. The absence of a solar thermal system should be explicitly mentioned in the certificate, to point out that there still remains an opportunity to improve energy performance. The minimum requirements should be set dynamically. A long-term, gradual increase of the minimum energy performance will provide an incentive to make a long-term investment in solar thermal.

After adoption of the EC Buildings Directive, the ball is at the member states and regional authorities, which have to implement it. However, further action is necessary at the European level as well. Proactive involvement of the European Commission to monitor and disseminate the implementation plans at national level is desirable. Moreover, the European Commission should encourage further regulatory action at national level.

Further regulatory actions

Local action

The example of Barcelona shows that national, regional and local authorities can do much more than simply fulfilling the minimal requirements prescribed by the EC Buildings Directive. The process of its implementation opens a decisive window of opportunity to discuss and implement innovative concepts for the promotion of renewable energies in the built environment. Seizing this opportunity is essential to realise the ambitious growth targets set by the EU White Book on Renewable energies.

Barcelona model

The first and most effective option is to follow the model of Barcelona:

- Obligation to install solar thermal systems on new buildings and on buildings undergoing a major renovation (Barcelona model). However, since solar thermal collectors are widely used also in one-family houses, the regulation should include these as well.

Flanking and alternative regulations

As flanking measures, or as alternatives in case the model of Barcelona is not yet politically feasible, a series of regulations should be considered:

- Permission to start construction of new buildings should be granted only after an assessment of the potential for use of renewable energy sources.
- Obligation to install solar thermal systems, at least for certain categories of buildings with large heat consumption (swimming pools, hospitals) or publicly owned buildings with high visibility.
- Obligation to install hot water pipes up to the roof of new buildings and on buildings undergoing a major renovation. This increases only marginally the costs at time of construction/renovation, but makes it much easier and cheaper to install a solar thermal system later on.
- Abolition of regulations hampering the diffusion of solar thermal. In some areas, it is necessary to ask a permission to install a solar system on the roof. The long procedure discourages potential users. The permission may even not be granted, due for example to aesthetic restrictions, often set without reflecting on the consequences for solar energy.

- Household applications (dishwasher, washing machine) compatible with solar thermal systems (adapted to get hot water from pipes) should be widely available on the market. The highest category in quality labels should be given only in this case. Customers should be explicitly informed if this is not the case. Such measures are useful also to promote other renewable heating technologies and cogeneration used in district heating networks.
- As many heat tanks as possible should be compatible with solar thermal systems to make integration at a later time possible. Customers should be explicitly and clearly informed if this is not the case.

3.1.2 Towards an EC renewable heating directive (RES-H)

Action needed to promote RES-H

Heating is responsible for roughly one third of the final energy consumption in the European Union, without considering the heat used in industrial process. Taking this into consideration, the low level of political attention the heating sector has received so far is surprising.

At EU level, the Renewable Electricity Directive (RES-E) has been adopted in 2001, and a Directive on bio fuels for transport is close to adoption. However, without action focused on the heating sector, the overall target of 12% renewables share in the total energy consumption cannot be reached.

European dimension of promoting RES-H

The discussion about a possible future EC directive to promote renewable heating (RES-H) is welcome. The different RES-H technologies – solar thermal, biomass, geothermal and heat pumps – have combined a substantial potential. Comprehensive policy measures covering all RES-H technologies are necessary, as some key issues to be tackled are common. As seen in the market overview and the market projections, for solar thermal there have been extremely different patterns of development among EU countries. A common effort is needed to reach the overall target of 100 million m^2 installed collectors. The same is true for other RES-H technologies. Though heat is not traded at European level like electricity or bio fuels, promoting RES-H clearly has a European dimension.

Main contents for solar thermal

For what concerns solar thermal, a future RES-H Directive should provide a common framework at EU level in following areas:

- Regulations: the elements described above as integration to the existing EC Buildings Directive
- Financial incentives: to promote a stable European framework by harmonising elements of the financial incentives schemes adopted at national level
- Standardisation: to further reduce barriers to trade within the EU by strengthening the role of EN standards as sole technical reference for national financial incentive schemes

Financial incentives schemes

National conditions and harmonised framework

Certain aspects of financial incentive schemes should take specific national conditions into consideration. However, elements of harmonisation at European level would be useful to facilitate know-how transfer in project financing and to accelerate the creation of market structures at European level. Best practices in the design of financial incentive schemes could be applied at EU level, avoiding the repetition of mistakes in the past. Proposals to improve key aspects of financial incentive schemes can be found in chapter 3.1.3 Financial Incentives to Investment (see page 55).

Innovative financial schemes

Furthermore, two kinds of innovative financial incentive tools could be considered as harmonising elements. First, financial support for RES-H should be financed by revenues from specific levies on conventional heating fuels, based on the model of the German law for the promotion of renewable electricity. This scheme has the advantage to create a double incentive to switch to renewable heating and to be neutral from the point of view of public budgets.

Second, green heating certificates: market oriented mechanisms might be an interesting option to stimulate the growth of solar thermal and RES-H in general. Assuming that a significant market for green electricity certificates will emerge in the coming years, it would be interesting to investigate the potential for linking green heat to that market. However, many questions must find an answer before the feasibility of green heating certificate trade can be assumed.

Pre-normative policy research should be started to investigate in detail the technical and political feasibility of innovative financial incentives schemes.

National targets for renewable heating

It is crucial to break down the overall EU target of 100 million m^2 at national level, following the model of the renewable electricity directive. Indicative national targets for RES-H growth should be set for each member state, within a framework at EU level. This should pave the way for more stringent action in case member states are not in line with their targets after a monitoring period. Overall targets for RES-H (share of renewables in the heating sector), with specific quotas for each RES-H technology, will make sure that the potential for each RES-H technology is gradually developed.

Such a proposal requires two sets of official statistical data: the overall heat production and the heat production of each RES-H technology. The former is in general available, but national statistics should be made fully comparable and become a suitable basis for common RES-H targets.

Building up solar thermal statistics

Concerning the heat production from renewable energy sources, a serious improvement of official statistical data is needed to create the conditions for reliable and constant monitoring at national and European level. So far, official statistics concerning solar thermal (and other RES-H technologies) are hardly available[1]. They will be needed in the future, if national and European institutions take the ambitious growth targets seriously.

1. The figures of this publication are based on extensive studies done by national solar thermal associations and experts.

Due to the decentralised nature of heating, such statistics will inevitably be based on estimations, as it would be anti-economical to measure the energy output of every single heating system. But estimations can be reliable and comparable, provided a solid framework is given, including the following three elements.

- Systematic monitoring of the new solar thermal installations to be linked with monitoring the uptake of financial incentives provided at national level.
- The solar thermal energy production per installed m^2 to be calculated on the basis of the energy performance requirements set in the EN standards and on average solar radiation.
- Surveying solar systems already installed to define their average lifetime

A quantitative oriented policy in the RES-H sector needs to tackle these issues. Public authorities should finance the necessary steps to create reliable official statistics on RES-H at national and European level. Special attention should be given also to the cooling sector, in order to be able to quantify its contribution once commercial use on large scale will start.

3.1.3 Financial incentives to investment

The analysis of Part 1 showed that two of the main economic barriers to growth for solar thermal are of financial nature:

- High upfront costs – initial investment makes most of the costs
- In many cases, relative long payback times – depending on prices of conventional heating

These barriers will naturally decrease once economies of scale can be realised. However, as long as mandatory regulations do not create the critical mass necessary to achieve such economies of scale, the growth of the solar thermal market requires stable and well-designed financial incentives and fiscal measures.

Stability and long-term orientation

Financial incentives have been applied in many European countries. Lessons can be drawn from these experiences.

Stop-and-go disrupts the market
The stability of financial incentives is a key condition for a sustainable growth of the solar thermal market. For this reason, regulation or incentives based on law have stronger effects than short-term incentive programs based on ad-hoc budget decisions.

The latter have often been applied, at national or regional level, but their short-term success can turn into a barrier to growth in the long-term. If the budget of the incentive program does not cover the demands, the program must be stopped long before the end of the period originally foreseen. In this case, potential users often expect a reactivation of the incentive program and postpone the purchase of a solar system. This leads to short-timed overheating followed by breakdown of the market, when incentives are stopped.

The impact of such a stop-and-go dynamic is particularly negative, as the long-term growth of solar thermal relies on the development of a widespread network of specialised distributors, system designers and installers, which is rather discouraged by the instability of the political framework.

Long term perspective

Direct financial incentives should be set in the long-term. The overall budget should be able to support the aimed growth of the installed surface. Innovative financial schemes based on legislation should be developed (see below).

Simple interaction between investors and public hand

The administrative burden linked to direct incentives is often too high. The transaction costs should be minimised. In countries where incentives are provided by different kind of authorities (national, regional, local), the national government should ensure that a potential investor can get all information and apply for all incentive programs by interacting with a single office, such as the national or regional energy agency.

Harmonisation of technical conditions

As discussed in detail below (see chapter see "EU market integration" page 60), the technical requirements that a solar system must fulfil in order to receive a direct incentive should be harmonised as much as possible, to boost the development of an open European market. The CEN/CENELEC Solar Keymark should be the reference for all financial incentives provided in Europe.

Fiscal measures

Fiscal measures have the advantage of being usually more stable than direct incentives, if the latter are not designed to function in the long-term.

VAT exemption or reduction on solar thermal products and services are key measures. As seen above, in some countries a family pays more for VAT than it receives in form of a direct incentive. However, this is relevant only for those market segments (mainly small residential buildings) in which the investor cannot deduct VAT. Another important fiscal measure can be the deductibility of the investment on solar thermal from income and/or building property tax.

Financing schemes

Particularly for larger solar thermal installations (large buildings, solar supported district heating, industrial process heat) facilitated access to credits for investors should be guaranteed. National or regional authorities could provide special financial guarantees. At EU level it must be ensured that state aid rules fully allow such schemes.

Internalisation of social costs (CO_2 and energy tax)

Last but absolutely not least: the competitive disadvantage of solar thermal and renewables in general is to a great extent politically determined. Fossil fuels and nuclear power fuels receive substantial subsidies, directly and indirectly. Society pays for their external costs in terms of environmental damage, health risks and import dependency, with heavy consequences on the international political stability. CO_2 and/or energy taxes, gradually aiming at full cost internalisation are the solution.

3.1.4 Awareness and promotion

As discussed above (see page 23), raising awareness is decisive to overcome the barrier to growth represented by lack of information of potential users. Information and promotion campaigns are therefore essential to stimulate market growth.

Action from public authorities needed

There are good reasons why public authorities should actively contribute to such campaigns:

- Contribution to achieve public policy goals, like reduction of emissions and security of energy supply
- Promotion campaigns are a necessary complement to other measures taken by public authorities, such as financial incentives or regulations.
- The solar thermal industry is not yet big enough to be able to finance and run autonomously campaigns targeted at the general public or high profile campaigns targeted at specific market segments

Main goals of promotion campaigns

The main goals of promotion campaigns can be:

- to create awareness of the use of solar thermal
- to provide knowledge about financial and technical issues
- to motivate potential users to assess the potential for solar thermal in their building
- to assist potential users by providing independent information to facilitate their decision to install a system

National level

Campaigns should be carefully designed to reach the targeted groups of potential users. The latter can be either a specific market segment or a geographical area. Particularly for campaigns targeted at the general public, the specific conditions at national or regional level should be taken into account when planning a promotion campaign. In areas where solar thermal is not yet widely used, demonstration projects can be a very useful tool to support awareness and promotion campaigns.

European level

However, there is a wide scope also for direct involvement of institutions at the European and international level. For example, the European Commission can play an important role as an opinion maker, by enhancing sustainable heating on the political agenda and by providing clear recommendations to national or regional energy agencies. Moreover, projects such as Soltherm[1] can be very useful to boost information transfer about promotional campaigns and other activities and provide a useful framework to learn from each other's experiences. Finally, multinational campaigns aimed at specific target groups can be very effective, by creating specific web information services and disseminate information on best practices.

1. Soltherm is supported by the ALTENER program of DG Energy and Transport of the European Commission. One of its main results is the establishment of a very informative web portal, useful for the whole solar thermal community: www.soltherm.org

3.1.5 Improving market structures

Improving the motivation of installers

As seen above (see page 26), installers play an important role particularly in the one-family house market segment. Following barriers to growth have been identified in this area:

Barriers to growth

- The industry misses a widespread network of craftsmen motivated to install solar systems
- Heating and/or roof craftsmen often lack knowledge about solar thermal systems and are not sufficiently motivated to install them. Negative prejudices are quite common among craftsmen.
- Therefore, installers often do not propose solar thermal systems to their customers or even discourage them from buying one.
- In most areas of Europe, the low market volume of solar thermal does not provide a sufficient incentive for installers to invest time and money in specific training
- Lack of specific training may reinforce the conservative attitude of some craftsmen towards a new technology or may lead to faulty installations, reducing the functionality of single solar systems and damaging the image of the technology.

Within Europe, there are substantial variations in the average qualification, legal context and training structure of the craftsmen sector. Also the specific professional figures involved vary: heating specialists are always relevant, but in some countries and situations, general plumbers or roof specialists are involved as well. Due to this variation, there cannot be a single formula applicable throughout Europe to tackle this problem. However, some common problems can be identified, that should be approached by public authorities and industry associations taking into account the specific context. There is also scope for important actions at European level.

Initiatives should be taken in these areas:

- The industry should continue efforts to make installation of solar thermal systems as simple as possible.
- At the same time, the industry and public authorities should promote special campaigns focused on installers. The goals should be to increase their knowledge about solar thermal, create preference and motivate them to actively offer this option to their customers.
- Public authorities should encourage relevant craftsmen (plumbers, heating and/or roof specialists) to participate to specific training courses. Public financial support, either for the organiser of the course or for the participants, should be considered.
- Potential users of solar thermal should be enabled to recognise specially trained installers, in order to avoid faulty installation of solar thermal systems.

The long-term goal should be that every installer who wishes to install solar thermal systems has taken part in such training courses. However, requirements to attend such courses should come gradually. A strong and useful measure is to make mandatory the inclusion of solar thermal skills in the general training received by craftsmen potentially involved in solar thermal installation.

Another strong measure could be to make specific training of the installer a mandatory condition to grant direct incentives for a new solar system. However, where such a scheme has been used, it partly fired back, as it created a chicken-egg problem: if there are only few installers who qualify, potential investors may find it difficult to find and contact them. The market price of the installation tends to grow. Most installers remain excluded from the subsidy scheme and will therefore prefer to market conventional heating. Such a measure must be carefully examined in collaboration with industry experts, as it may not work well in the initial phase of market development.

Linking training with financial incentives may fire back

In the early phase of market development, solar thermal training should be strictly voluntary. To lower the barrier for installers to attend solar thermal training these courses should be subsidised. Additionally, promotional campaigns targeted at installers could help in attracting their attention and, when the market is more mature, solar thermal campaigns should only include properly qualified installers, if they provide list of installers.

The current SUNTRAIN project[1] aims at developing a criteria catalogue to evaluate the quality of solar thermal training courses. They can undergo a quality audit with certification through an independent institute. Public authorities should consider promoting such schemes, based on the certification of either training courses or directly installers. If such certification is developed, the European dimension should be considered from the very start, to avoid the insurgence of many different standards. On the other side the specific national contexts must carefully be taken into account.

Criteria catalogue being developed

Guaranteed results contracts

The energy savings of a solar thermal system cannot be exactly predicted, as they depend on several variables: the maintenance of the system, the solar radiation available each year, the amount and distribution in time of the heat demand.

This uncertainty can discourage potential investors. This is particularly relevant for larger solar systems, due to the higher investment volume, and for market segments in which cost effectiveness plays a decisive role.

Uncertainty discourages investors

If the potential investor is able to outsource the risk involved to professionals, the barrier to growth is overcome. This is what guaranteed solar results stand for. In this case, the investor buys a service – a certain yearly amount of solar heat – instead of a product. The responsibility for the maintenance of the system is taken over by an external actor, as well as the risk arising from variations of solar radiation. This can be either a solar thermal manufacturer or a specialised energy service company (ESCO).

Outsourcing uncertainty

Guaranteed result contracts have been so far applied in relatively few cases, but it might be a decisive tool for the development of solar thermal in the tertiary sector as well as for large residential or industrial applications.

1. SUNTRAIN is co-financed by the ALTENER program of the European Commission. ESTIF is a project partner. Another relevant ongoing EC project in this area is QUALISOL.

There are three areas of actions that could facilitate the diffusion and standardisation of guaranteed results contracts for solar thermal.

- Information about the experiences with such contracts should be widely disseminated to ESCOs, energy agencies, specialised public authorities, and specific segments of potential users as well as within the solar thermal industry.
- Demonstration projects in different market segments and in each country would strongly contribute to increase the use of guaranteed solar contracts. Energy agencies could contribute developing standard elements for the contracts compatible with the national legal context.
- Research and development is necessary to develop cheaper techniques to measure the solar yield, a necessary condition for guaranteed results contracts.

Strenghtening industry associations

The solar thermal industry is still relatively small and very fragmented. Several of the measures proposed in this chapter require a proactive involvement of the industry in partnership with public authorities. There is a wide range of common interests that cannot be successfully pursued by single companies. This is particularly true for raising awareness and developing market structures, but also to advice and support public authorities in designing successful policies for solar thermal.

Strong industry associations needed

Strong industry associations are therefore necessary tools to develop the market, both at European level and in each country. The success of solar thermal in certain countries is partly due to the intense support activities promoted by the national industry associations. Unfortunately, however, in most European countries the industry associations are still very weak structures, often not even able to sustain full-time staff. It is a task of the industry to strengthen its own trade associations, but also public authorities can contribute by supporting their activities.

3.1.6 EU market integration

Standards and certification

Benefits of the Solar Keymark

As analysed in detail above (see page 26), promoting the Solar Keymark and reducing to a minimum the additional requirements set by national or regional authorities is a key area of action to reduce the fragmentation of the European solar thermal market. The results expected from these two areas of action are:

- More transparent information on product quality, resulting in higher trust of all actors involved
- Removal of barriers to internal EU trade
- Higher integration of EU market, resulting in more competition at European level, economies of scale, cost reductions and easier transfer of know-how (technical, marketing, integration in heating system) within European countries

The first area of action concerns the promotion and dissemination of the Solar Keymark. As a first step, as many national or regional certification bodies as possible should be empowered to certify the Solar Keymark, resulting in easier access to them for producers in every part of Europe. At the same time, the Solar Keymark is a new quality label which must be made known to all actors involved in the sector (manufacturers, wholesalers, users, energy agencies, public authorities etc.), in order to guarantee a rapid diffusion alongside the pre-existing national labels. Support from public authorities, particularly the European Commission is necessary to integrate the limited resources that the European solar thermal industry – through its association ESTIF – is already investing in this action.

Promoting the Solar Keymark

The second area of action concerns the full recognition of the Solar Keymark by all national or regional authorities. If this is not guaranteed, repetition of tests or unjustified additional tests will still be necessary and the positive effects of the Solar Keymark will be lost. ESTIF proposes that:

Solar Keymark must be fully recognised by national authorities

National or regional authorities must recognise the certification of quality requirements through Solar Keymark. Repetition of same tests may not be asked and should be considered an infringement of the EC internal market rules.

National or regional authorities are encouraged to refer to the CEN/CENELEC Solar Keymark for acceptance criteria in any subsidy scheme. They will have to duly motivate in writing any additional technical requirement (beyond the EN Standards certified by the Solar Keymark) they may want to set as condition to grant financial incentives for solar thermal applications. The additional technical requirements shall be set in a way apt to minimise additional test requirements. The European Commission shall guarantee that any unmotivated barrier to trade shall be abolished.

3.1.7 Research and development

Substantial progress has been achieved during the last three decades. A broad range of highly efficient solar collectors is now available. Domestic hot water applications for different climates and conditions are fully developed and will undergo only evolutionary changes. For other applications, however, important steps are still necessary to develop commercially available systems able to realise the huge potential for use of solar thermal energy. This is particularly relevant for solar space heating, solar assisted cooling and applications for industrial process heat. Concerning the latter, within a decade breakthroughs can be expected with a revolutionary potential for energy savings.

Substantial progress achieved

The main barriers to successful research and development in the solar thermal sector are:

Why public support is needed

- The bulk of the industry still consists of small and medium enterprises, lacking financial resources for medium and long-term R & D activities.
- Available public funds are in general too low, in some countries not existing at all.
- Public research programs with a specific focus on solar thermal are very seldom.
- Public research programs with general focus on energy efficiency and/or renewable energy sources are often not easily accessible for small and medium enterprises.

Investments into R&D will pay off

If the European Commission considers security of energy supply, climate change and sustainable development as serious issues, a clear priority for renewable energies should be set. The whole potential should be made exploitable as soon as possible. Compared to the very large sums invested by the EU for research on energy technologies, most notably for nuclear fusion, many of the following areas of research for solar thermal could be successfully tackled with relatively small investments.

Medium and long-term heat storage

Pure solar heating possible

Solar energy is most available in summer, when the demand for heating is lower. Cost effective heat storage allows the accumulation of heat during high radiation periods (sunny days, summer) to be used during low radiation periods (cloudy days, winter).

Each year a building receives from the sun ten times more energy than its consumption for domestic hot water and space heating. Good seasonal heat storage could make pure solar heating possible, reducing to zero the need for conventional heating fuels. It is particularly relevant for large solar system in all sectors. Long-term heat storage can be useful also to expand the potential for cogeneration applied to district heating systems.

Experimental long-term storage facilities are being tested and developed with very promising results. However, there is still much to do before seasonal storage will be available on a commercial basis at reasonable costs.

Specific priorities for R&D action in this area are:

- Compact storage systems
- Thermal storage
- Chemical storage

Solar cooling

Extremly promising application

In the medium-term, solar assisted cooling is an extremely promising application of solar energy. Peak demand for cooling coincides with high solar radiation. The first systems for solar assisted cooling are already on the market, but substantial technical improvements are still possible and necessary to achieve wide commercialisation.

Specific priorities for R&D action in this area are:

- Development of cooling applications using low-temperature solar thermal output (50–80°)
- Development of small units (3 to 10 kW)
- System integration with domestic hot water and space heating

System integration

Adaptable systems

Solar thermal systems must be integrated into existing heating and construction technologies. In order to achieve high market penetration, solar thermal systems must therefore be adapted to fit different conditions. The large unexploited potential for solar thermal can be only implemented if convenient solar thermal solutions are available for all possible applications. Integration of solar thermal into a variety of heating backgrounds still requires research and development, particularly the following areas:

- Space heating and combisystems (System development and simplification, control algorithms, standardisation)
- Combination with other renewable energies (biomass, heat pumps)
- Integration into district heating systems
- Cost effective applications for industrial process heat
- Small heat tanks (increase effectiveness by better focus on thermal stratification, standardisation)
- Standard roofs with integrated collectors
- Façade collectors as standard building components

Standardisation

Solar Keymark to integrate European market

As seen above, European standards exist for solar thermal collectors and factory made systems. Through the CEN/CENELEC Solar Keymark, harmonised testing and certification are now available. By reducing barriers to trade, the Solar Keymark is expected to boost the development of a true European market.

In other areas, however, technical standards must still be defined. Pre-normative research is needed. Co-ordination of efforts taken at national level would be highly desirable from the very early stage, to avoid the development of discrepant standards and the need for harmonising them afterwards.

Specific priorities for R&D action in this area are:

- Completing the revision of existing EN standards
- Establishing EN standards for solar thermal fluids
- Progress on EN standards for custom built systems

Monitoring

Reliable montioring devices needed

Measurement of the solar yield is necessary to provide clear data to users and potential investors about the energy savings produced by a solar thermal system. Both for guaranteed results contracts and for advanced policy measures designed to support the solar energy output rather than the area of collectors installed, cheaper and more reliable monitoring devices are needed.

Desalination

Further R&D needed

Solar thermal collectors can be effectively used for desalination and disinfection of drinking water. The potential demand is high, as areas lacking drinking water often have high solar radiation and difficult access to conventional energy sources. Solar applications already exist, but further research and development is necessary to achieve wide commercialisation at competitive prices.

Specific priorities for R&D action in this area are:

- System design and application
- Materials resistant to corrosion
- Design of specific collectors
- Development of system know-how

3.2 ACTIONS FOR EACH MARKET SEGMENT

This chapter sums up the key actions proposed to stimulate growth of each solar thermal market segment. These proposals are based on the analysis of the reasons for success and barriers to growth for each market segment (see page 27).

The table below gives an overview of the priority level of each areas of action for each market segment. The values range from 1 (highest) to 5 (low priority). It is based on a short-term perspective: for market segments still at a demonstration stage, high priority is given to research and development. This will change once mass commercialisation will be possible.

Priority actions for each markets segment

	Sector							
	Residential				**Tertiary**	**Industrial**	**Other**	
Segments	DHW &Space Heating				DHW & Space Heating	Process heat	District heating	Cooling, desalination, drying etc
	One-family houses		Multi-family buildings					
	Existing	New	Existing	New				
Areas of action								
Regulations	2	1	1	1	3	3	1	5
Financial	1	2	2	2	1	1	1	3
Awareness	1	3	3	3	2	3	5	5
Market structures	1	2	4	4	4	4	4	4
R&D	5	5	2	2	2	1	3	1

Table 3.1

3.2.1 Residential sector

Actions for one-family houses

Regulations
- Mandatory installation of solar thermal in occasion of major renovation (Barcelona model)
- Implementation of the EC Buildings Directive: full recognition of solar thermal contribution, minimum energy performance should be set gradually growing to give incentives for long-term investments in solar thermal
- Abolition of aesthetic regulations hampering solar thermal

Financial incentives
- Direct incentives to investment
- Reduced VAT rates for solar thermal products (for households)
- Deductibility of solar thermal investment from income tax (for households)
- Reduced building property tax (for investors)

Awareness
- Promotion campaigns targeted at the general public and households (existing houses)
- Promotion campaigns targeted at engineers and architects (new houses)

Market structures
- Training and involvement of craftsmen (existing houses)
- Stronger integration of solar thermal into mainstream heating and construction industries (new buildings)
- Promote the CEN/CENELEC Solar Keymark to reduce barriers to trade
- Strengthen industry associations at national and European level

Actions for multi-family buildings

Regulations
- The same as one-family houses
- Regulations and targets of renewable energy supply for publicly owned residential buildings (social housing)

Financial incentives
- Direct incentives to investment
- Reduced building property tax

Awareness
- Promotion campaigns targeted at the general public
- Promotion campaigns targeted at housing companies

Market structures
- Dissemination of guaranteed result contracts
- The same as one-family houses

Research and development
- Further development of combisystems (combined DHW and space heating)
- Long-term heat storage

3.2.2 Tertiary sector

Regulations
Specific regulations for heat intensive structures (hotels, swimming pools)

Regulations and targets for renewable energy supply for publicly owned buildings (offices, swimming pools, prisons etc.)

Financial incentives
- Direct incentives to investment
- Reduced building property tax
- Deductibility of investment from corporate income tax
- Develop guaranteed results contracts

Awareness
- Promotion campaigns targeted at specific sectors (hotels, swimming pools, corporations with large office buildings etc.)

Market structures
- Dissemination of guaranteed result contracts
- Development of specific EU technical standards

Research and development
- The same as multi-family buildings

3.2.3 Industrial sector

Regulations
- Specific regulations or quotas for renewable energy supply for heat intensive manufacturing

Financial incentives
- Direct incentives to investment
- Deductability of investment from corporate income tax

Awareness
- Demonstration projects to be realised in different manufacturing sectors and geographical areas

Market structures

- Systematic survey of the potential areas of use
- Dissemination of guaranteed results contracts

Research and development

- Improvement of medium and high temperature solar collectors
- Development of standard applications
- Development of technical norms

3.2.4 District heating

Regulations

- Binding quotas for solar thermal energy for district heating providers

Financial incentives

- Direct incentives to investment

Market structures

- Demonstration projects in countries with strong district heating infrastructure, but no tradition of solar thermal (Central and Eastern Europe)

Research and development

- Further improvement of integration of solar energy into district heating networks
- Long-term heat storage

3.2.5 Others

Research and development

- Development of solar cooling to the stage of wide commercial availability
- Research and development on desalination, solar drying, solar thermal electricity

Awareness

- Solar cooling: Widespread demonstration projects, in all geographical areas, both in the residential and tertiary sectors.

Appendix 1 – Applications and Technology

The basic principle common to all solar thermal systems is simple: solar radiation is collected and the heat is transferred to a heat transfer medium, usually a fluid or – in case of air collectors – air. The heated medium is used either directly – for instance to heat swimming pools – or indirectly, by means of a heat exchanger which transfers the heat to its final destination – for instance: space heating.

Solar thermal can be successfully applied to a broad range of heat demand including domestic water heating, space heating, and drying. New exciting areas of applications are being developed in particular solar assisted cooling. System design, costs and solar yield are being constantly improved.

APPLICATIONS

Domestic hot water (DHW)

One-family detached house

This is currently by far the largest application for solar thermal in Europe. These systems are normally designed to cover 100% of the hot water demand in summertime and 50 –80% of the total annual hot water demand.

There are two main types of solar DHW systems, those designed as thermo-siphons or those designed with forced circulation.

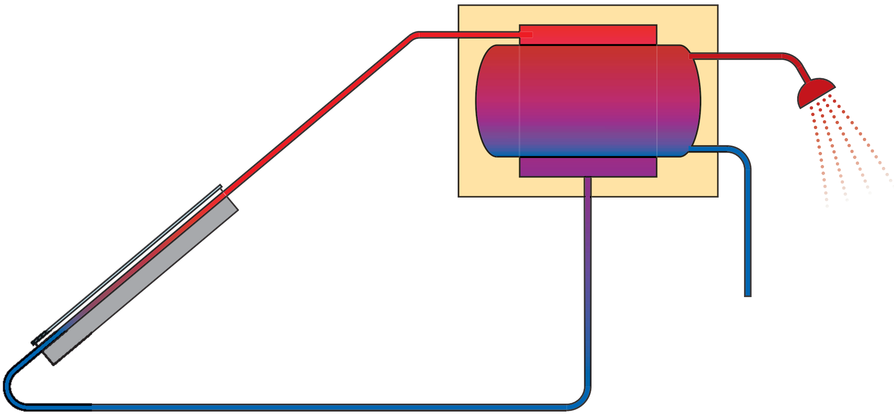
Thermo-siphon circulation (also known as natural flow)
Thermo-siphon systems are most common in the frost-free climates in the south of Europe but developments have now made the systems suitable for all of Europe including frost areas.

Thermo-siphon systems use gravity to circulate the heat transfer medium (e.g. water) from the collector to the tank, as hot fluids are lighter than cold. The medium is heated in the collector, raises to the top of the tank and cools down on its way back to the collector as the heat is transferred to the DHW. A thermo-siphon system is thus rather simple as it works without pump and controller but it requires on the other hand that the tank be placed above or beside the collector, which in most cases means on the roof. A thermo-siphon system can be operated as pre-heater or cover the whole DHW demand if it is equipped with a supplementary heater (often an integrated electric heater). A well-designed thermo-siphon system shows high and reliable performance.

DHW thermo-siphon systems for a one-family house have typically a 2–5 m^2 collector and a 100–200 litres tank.

Thermo-siphon system

Figure A 1 Source: Solarpraxis AG



Forced circulation

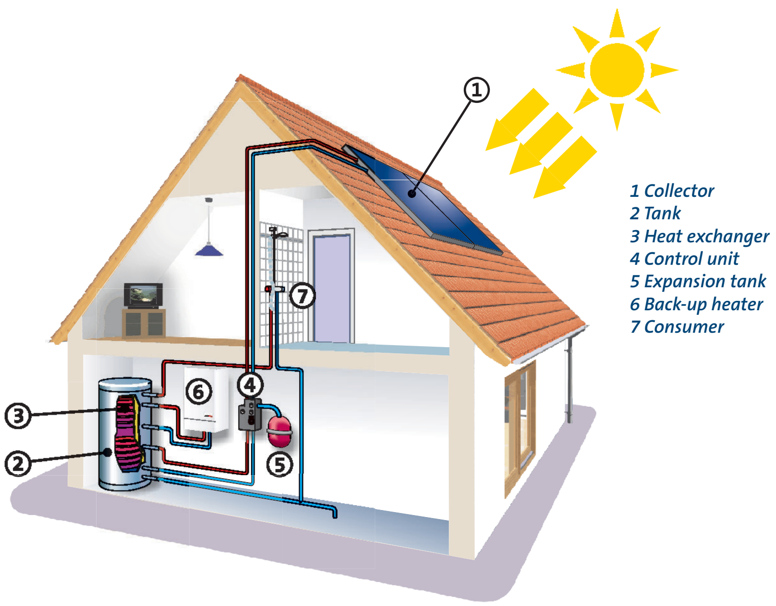
Forced circulation systems are most common in Central and Northern Europe. The forced circulation makes it possible to separate the tank and the collector as the heat transfer medium (fluid) is pumped between the tank and the collector. This means for example that the tank can be placed inside the building or even in the cellar, which often makes it easier to integrate the solar system with a heating system (see combisystems below). The aesthetics of avoiding a tank on the roof is another advantage.

A forced circulation system is more flexible but also more complex than a thermo-siphon system, because it needs a pump and a controller. A forced circulation system can be operated as pre-heater or cover the whole DHW demand if it is equipped with a supplementary heater (e.g. an integrated electric heater or gas burner). A well-designed forced circulation system shows the same high and reliable performance as a thermo-siphon system.

DHW forced circulation systems for a one-family house have typically a 3–6 m^2 collector and a 150–400 litres tank.

Figure A 2 Source: Solarpraxis AG

Forced circulation system



Large (collective) DHW systems

High system performance

Larger DHW systems for multi-family houses, apartment blocks, hotels, office buildings etc. are also common throughout Europe. The collector surface of such systems varies from ten to several hundred square meters. Larger DHW systems are generally designed for a low solar fraction (low solar coverage of the hot water demand) and operate on a lower temperature resulting in a high system performance (thermal output/m^2 of solar collector). Most large DHW systems are designed with forced circulation but multiple thermo-siphon systems are also used when the conditions are suitable.

Combined DHW and space heating (Combisystems)

More complex system design

In Central and Northern Europe it has become common to install solar thermal systems that provide heat both for domestic hot water and for space heating. The collector size of these so called combisystems is typically in the range of 7–20 m^2 and the tank(s) in the range of 300–2000 litres. Combisystems are often more complex, than solar systems supplying DHW only. As a consequence, system design must be adapted to the specific requirements of the building. Different practices are used in different countries. In Southern Europe, combisystems are still rarely used, but there is a big potential for systems generating space heating in winter, air-conditioning in summer and DHW throughout the year.

Solar energy for district heating

District and block heating applications offers good conditions for the use of solar thermal for existing buildings and there are a number of demonstration plants with ground-mounted as well as roof-mounted collector arrays. A major advantage is that the solar plant can be of considerable size that leads to lower specific costs. The largest solar district heating plant comprises 18.300 m^2 of collector area (~10 MW thermal capacity). The main barriers to growth are low alternative fuel costs and lack of confidence for solar heating in thermal utilities. Once cost-effective seasonal heat storage will be widely available, large-scale applications will become more competitive, resulting in a strong increase of the potential for solar thermal.

Largest solar system world-wide

Solar cooling and air-conditioning

The most common heat operated cooling process is the vapour absorption process. The working media in such a process are a mixture of a refrigerant and an absorption medium. The most common working media are (H_2O/LiBr) and (NH_3/H_2O) where the first medium is the actual refrigerant. The operational heat for the cooling process is required to separate the refrigerant and the absorbent in the generator. Normally, the operational heat must be high temperature heat ($>100°C$) to receive a high cooling capacity and coefficient of performance. Traditionally solar collectors designed for high temperatures thermal output (e.g. evacuated tube collectors) are used to generate this heat. With some changes of the machinery design, the required temperature of the operational heat can be reduced. By those means the operational heat can be generated by ordinary (high performance) flat-plate solar collectors.

Vapour absorption most common

A desiccant cooling process is a heat (and water) operated air-cooling process used for air conditioning. In a first process stage, the air is dehumidified by way of a solid or liquid desiccant. By this mean, the air can be cooled to a relatively low temperature by indirect and/or direct evaporative cooling, i.e. cooled via humidification by liquid water. The operational heat for the desiccant cooling process is required for the regeneration of the desiccant. This process requires normally moderate temperatures ($<100°C$). Ordinary (high performance) flat-plate collectors can be used when the desiccant cooling process is used for air conditioning.

Desiccant cooling also used

The heat operated solar cooling concepts shortly described above are the two most common. Other heat operated cooling processes possible to operate by solar heat are a vapour jet or a vapour adsorption cooling process. In the former a “thermal compressor”, a heat operated ejector device, replaces the compressor of a conventional vapour compression process. A vapour adsorption process is a discontinuous working sorption/desorption process (often) using a solid absorber.

Other applications

Solar drying

Solar drying of crops has been used for centuries – simply spreading out the crops for exposure to sun and wind. Using simple solar thermal technology, the efficiency of the drying process increases significantly. Also drying of wood and fish can be done by solar systems. Significant savings of conventional fuels can be achieved.

Air heating systems

Air heating systems use, for instance, the principle of sucking air through an uncovered perforated solar collector. The collector serves at the same time as the outer part of the wall. These systems are well suited in industrial buildings with high demand for fresh air ventilation. Very simple and effective air heating systems are available on the market.

Solar desalination

Availability of drinking water is a top priority in many countries all over the world. Lack of drinking water often exists in areas with high solar radiation or where the costs of conventional energies are high (e.g. on islands). Using solar thermal to desalinate marine water therefore seems a natural choice, and several demonstration plants have already proven the viability of this application. Commercial systems are already available and a big growth in this field is expected.

Solar cookers

Small solar cookers are becoming widespread in developing countries. More information on solar cookers can be found at: www.solarcooking.org.

High temperature solar thermal

Most of the applications described above are based on a low to medium temperature output of the solar collector, for which single-covered or even uncovered collectors with or without selective absorbers can be used. But, as the technology is developing quickly, solar thermal enters more and more into high temperature applications. "High-temperature collectors" enter into medium temperature applications, offering solutions for situations where the area to install collectors is scarce.

Non focusing

200°C easily reached

Even without focusing the sunlight, modern collectors can be designed to easily reach temperatures above 200°C. At these temperatures, efficiencies up to 40% have been reached. This makes solar thermal an option for process heating in many industries. The availability of higher temperatures can also be used to improve the efficiency of certain applications, e.g. thermal cooling machines.

Focusing

Temperatures above 200–300°C are obtained by focusing the sunlight. So far, high temperature collectors have been mainly used in solar thermal electricity generation. But high temperatures can be useful in industrial applications as well. In principle there is no limit for the temperature that could be achieved through the focussing of solar radiation. This is utilised e.g. in solar tower ovens receiving radiation from ground placed mirrors, to create temperatures of several thousand degree Centigrade in the focal point for material testing.

Temperatures above 200–300°C

Solar thermal electricity

High temperatures (>300°C) have been used mainly to generate electricity. The most common collector design for this application has been the parabolic trough, which focuses the sunlight towards a pipe in which a heat transfer fluid is circulated. Through a heat exchanger, steam is produced which powers a standard steam turbine. Several multi-MW plants of this type are currently in operation worldwide. Another design, the solar tower has been developed and tested in several places. It uses hundreds or thousands of mirrors (so called heliostats), which reflect the sunlight towards a central receiver, which is elevated on a tower. Both designs can be easily combined with conventional electricity generation technology.

Parabolic trough focuses the sunlight

A completely different approach to use solar thermal energy for electricity production is the solar chimney. It uses the natural effect of hot air flowing up a chimney to propel several wind turbines. The heat is generated by solar radiation, which is trapped under a large glass cover similar to a green house. The heated air escapes through a gigantic chimney in the middle of the glass cover. The solar chimney has been successfully demonstrated in the 1980s in Spain but has so far failed to win enough support from public and private investors to reach the next step: the construction of a 1km high solar chimney with an electrical capacity of 200 MW.

Solar chimney

Solar yield and heat demand

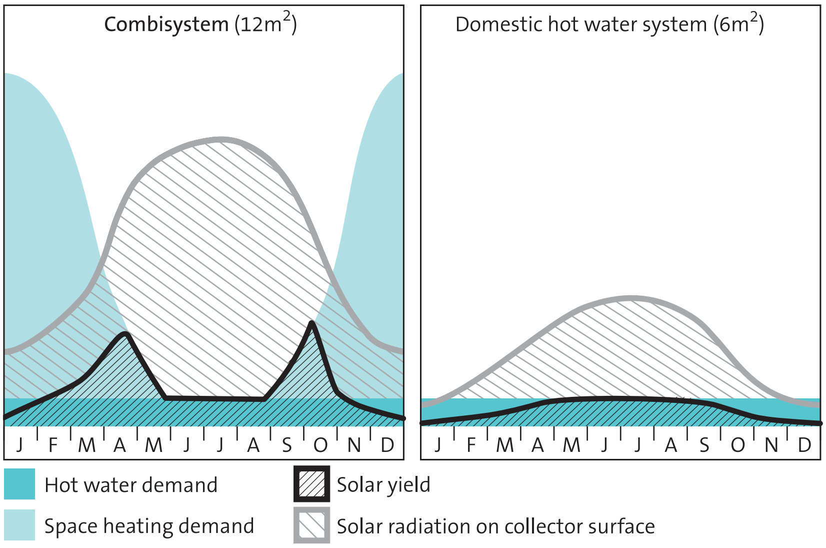
Unlike renewable energy technologies that produce electricity, which is fed into the public grid, solar thermal can produce heat only for local consumption. Therefore, one of the challenges of solar thermal technology is the disparity between local heat demand and the availability of solar radiation. The highest amounts of solar thermal energy are produced at daytime in the summer – whereas the highest heat demand occurs at night in winter. Parts of the variation can be accommodated for through buffer storages (e.g. in summer enough water is heated during the day to provide domestic hot water for the following morning). However, seasonal variations are yet to be tackled. The economic value of the generated heat is increased immensely in cases where heat demand and the availability of solar radiation are positively correlated, e.g. in air conditioning, swimming pool heating, hotels which are used mainly in summer.

Seasonal variations to be tackled

DHW demand stable thoughout the year

Figure A 2 show the relationship between heat demand, possible solar thermal energy output and solar radiation in Central Europe (one-family house). The demand for domestic hot water is rather stable throughout the year. A solar DHW system with 6 m² collector area can cover the whole demand in the summer, a significant portion in the spring and autumn and a lower portion in the winter. A combisystem (DHW + space heating) with 12 m² collector area can cover almost completely the demand for DHW, except the three darkest months in winter. Moreover, it can cover a substantial part of the space heating demand, reaching 100 % during spring and autumn.

Figure A 3 Source: Solarpraxis AG



Simple monitoring devices should be standard

Measuring the solar thermal energy produced is not as easy as measuring electricity generation. Exact heat meters are rather expensive and thus not used in most standard solar DHW systems. Since only the heat actually consumed is measured, measuring the solar thermal yield may even confuse normal end users of solar thermal systems: the measured heat increases with demand and the rational use of domestic hot water could lead to a decrease in measured solar thermal energy output. Nevertheless, in the long-term most solar thermal systems should be equipped with at least a simple measuring device. For the user it is often the only possibility to check that his system is working correctly. Measurement of the solar yield is also a necessary precondition for guaranteed result contracts and advanced policy support schemes based on the solar energy output rather than on the installed collector area.

Integration into existing heating technology

Integration has matured

In most cases, solar thermal is used in conjunction with conventional heating technologies (gas, oil, electricity or biomass). The combination of two technologies makes the overall system more complex. For domestic hot water, good integration of solar thermal has become a standard feature. For combisystems the integration has matured well. Studies are currently being carried out to develop suitable and cost effective standard solutions.

Different needs for storage tanks

The control unit plays the key role in the integration of solar thermal and conventional heating technologies. It takes care of starting the circulation pump for the solar loop or the back-up heater when it is necessary to balance the solar yield with the heat demand. Another main issue with integration is the different needs for storage tanks: While water tanks should be sufficiently large to serve as thermal buffer for the solar thermal energy, it should be prevented that the back-up heater heats up the whole storage resulting in unnecessary thermal losses. Therefore, storage tanks have been designed to provide enough buffer for the solar thermal energy while at the same time limiting the back-up heating to the upper part of the tank.

Further research in the integration of solar thermal is needed, especially for non-standard applications (e.g. industrial process heat).

SYSTEM COMPONENTS

The key component of a solar thermal system is the solar collector, which converts solar radiation into useful heat. There are two main types of collectors: glazed and unglazed collectors.

Glazed collectors

Most common type

Glazed collectors are the most common type in Europe. Two different designs exist for glazed collectors: Flat Plate Collectors (FPC) and Evacuated Tube Collectors (ETC or simply "vacuum collectors"). FPC are usually rectangular boxes covered by glass and containing a heat absorbing material inside. The absorber typically consists of copper or aluminium and is treated to better absorb the heat. Such treatment ranges from simple black paint to special selective coatings. Little pipes, which carry the heat transfer fluid are built in or welded on the absorber plate. ETC consist of long glass tubes which are usually mounted parallel in one row. Inside the tube an absorber similar to the one in FPC is connected to the pipes carrying the heat transfer medium. A vacuum inside the tube or – in the case of two walls, between the two glass walls – is designed to insulate the hot absorber from the outside environment. This design is therefore suitable for higher temperatures.

Unglazed collectors

Heating open air swimming pools

Unglazed collectors have been used for over 30 years, mainly to heat open-air swimming pools. The collector area consists of long thin tubes made of black synthetic material. The solar system is a part of the hydraulic circuit used to filtrate the pool water, which is heated when flowing directly through the collector. Therefore, no heat exchanger is needed. Unglazed collectors for swimming pools are cheap, easy to install and very effective.

Substantial savings on or even complete substitution of other heating sources, as well as a prolongation of the swimming season, can be obtained, depending on climatic conditions and temperature requirements.

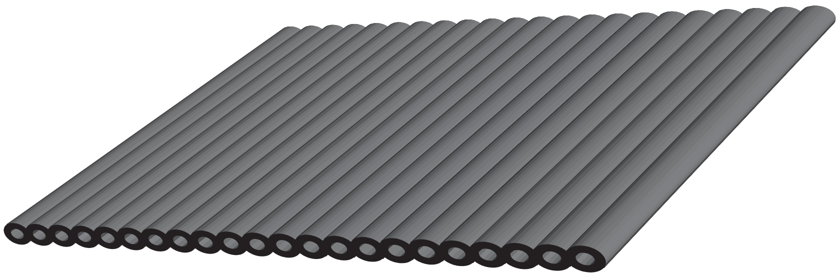
Not considered in market growth scenarios

Because of their completely different technological nature glazed and unglazed collectors are hardly comparable, and since unglazed collectors are used only for a few specific markets, they are not considered in Volume 1 of this study. Since in some countries they have a significant market share, they are considered in the country by country assessment of Volume 2.

Unglazed collectors are used most notably in the US, where they are the predominant type of solar thermal collectors. Approximately 15 million square meters of unglazed solar collectors have been installed in the USA since the mid 1970s. Practically all of them are being used for the heating of private swimming pools. In Europe the main users of unglazed collectors are situated in Austria. More than half a million square meters of unglazed collectors have been installed in Austria over the past 20 years, most of them in public swimming pools.

Figure A 4 Source: Solarpraxis AG

Unglazed solar thermal collectors



Heat storage and back-up heating

The system for heat storage varies according to the application. For domestic hot water (DHW) applications, the heat obtained from the solar collector is generally stored directly in the hot water tank normally used for DHW. In some countries, more complex systems are used, storing the heat in a buffer tank and then taking out hot drinkable water in a separate circuit.

In most cases, the solar yield must be backed up by other sources of energy, either an electrical heater directly in the tank or a heat exchanger using energy from a separate burner running on oil, gas or bio-mass. Particularly low consumption of the back-up fuel can be reached when the burner is directly integrated into the solar tank.

Appendix 2 – Key Developments in non-EU Countries

Israel

True success story

The use of solar thermal energy in Israel is a true success story: Today, approximately 80 % of the residential buildings in Israel are equipped with solar thermal systems – nearly all of them for the preparation of domestic hot water (DHW). It is expected that in the future solar assisted air conditioning will gain a significant share of the solar thermal market.

The secret: regulation

The success is in part due to a 20 year old regulation requiring every new building with a height of less than 27 m to have a solar thermal system on the roof. The large part of the systems sold today (~85 %) are installed on existing buildings – and thus voluntarily. With an average solar irradiation of 2.000 kWh/m^2 per year, the installation of a solar DHW system is an economically sound investment allowing the user to save approximately 175 Euro of conventional fuels per year.

Since 1982, all systems produced, sold or installed in Israel must comply with the official SI standards and bear a Mark of Conformity.

Turkey

Wide spread use for DHW

Solar thermal is widely used for DHW. The official figures put the market for newly installed collectors at 630.000 m^2 yearly. The systems are manufactured locally by approximately 12 medium-sized companies and a lot of small workshop-like companies. Most of the systems are of relatively low quality, as customers prefer simple and cheap technology to more sophisticated ones. A typical SDHW system costs around 200–250 Euro (including installation and VAT). But the low quality has led to bad experiences by the customers and high maintenance costs after a couple of years. Standards exist, but are not strictly enforced.

India

With 50.000 m^2 of collector area newly installed in 2001, the solar thermal market in India is still very small relative to the size of the country. The government actively supports the installation of solar thermal systems. Domestic consumers are eligible for low interest loans and commercial and industrial consumers, which currently account for 80 % of installed collectors, receive tax benefits for the installation of solar thermal systems.

The low share of domestic users is due to lack of awareness and distribution channels: 90 % of the systems are still sold directly from the manufacturer to the end-consumer. With the expected growth in the domestic sector, installers are starting to offer their services to the manufacturers.

Government aims at serious growth

Low interest loans require certification by the Bureau of Indian Standards. The Ministry of Non-conventional Energy Sources (MNES) has set ambitious targets for the further development of solar thermal: an additional 5 million m^2 shall be installed in India between now and 2012.

China

Biggest solar thermal market worldwide

China is the biggest solar thermal market worldwide. In 2001, the market was estimated at 5,5 million m^2 of collector area, mostly vacuum collectors. 75 % of the systems are installed in individual residential houses, 20 % are collective systems jointly used by several residential houses and 5 % are used in commercial/industrial environments.

More than 1.000 manufacturers produce and sell solar thermal systems. The 33 largest ones employ 50.000 people, with additional estimated 100.000 working in marketing, installation and after-sales services. Currently only about 1 % of the production is exported to other countries, but the high quality of the products and mass production will contribute to increasing export figures.

While the government does not subsidise the installation of solar thermal systems, it strongly supports R&D in solar thermal, included in a list of key national priorities to be addressed in every 5-Year-Plan.

Japan

15 % of households have solar DHW systems

In 2001, 314.000 m^2 of solar thermal collector area were newly installed in Japan – less than half of the area sold in the mid nineties. The market declined considerably after the government ended subsidies for solar domestic hot water systems in 1997. Today, subsidies are only granted for larger scale solar thermal installations in public and commercial buildings. Still, 90 % of the installed collector area is used for DHW in single-family houses. Roughly 15 % of the Japanese households are equipped with solar DHW systems.

A set of standards for solar thermal equipment exists but they are not obligatory. However, all members of the Solar System Development Association have their systems certified by an official authorized testing institute.

Australia

Following the first oil crisis, solar thermal grew quickly in Australia. However, most of the 20 manufacturers that were active in the late 1970s have quit the market which is now highly concentrated. Some companies were able to compensate the decline of the Australian market with increasing exports.

Domestic hot water for one-family houses is the dominant application for solar thermal in Australia. Several large-scale installations exist, but this segment has not yet gained a significant market share. The glazed collector area in operation is estimated at 1,2 million m^2. The market for unglazed collectors to heat swimming pools is larger, with an estimated cumulated surface of 2 million m^2.

Subsidy schemes related to performance

Recent legislation has sparked an increase in solar thermal installations. Along with the Renewable Energy (Electricity) Act, new support schemes were introduced for solar thermal. The subsidies are related to performance of the solar system. Under this new scheme, various companies have rapidly increased their sales within Australia.

USA

Swimming pool heating dominant

The US solar thermal market is dominated by low-temperature systems used for private swimming pool heating. As a consequence, the market for unglazed collectors (over 900.000 m^2 yearly) is between fifteen and twenty times bigger than the unglazed market in Europe. For glazed collectors with only ~25.000 m^2, the market is negligible.

Some US states provide subsidies for solar thermal, but usually for special applications only. The low level of subsidies, combined with very low prices for conventional fuels reduce the competitiveness of solar thermal systems based on glazed collectors. The situation could improve if system benefit funds would support solar thermal as is currently done for photovoltaic.