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and Sustainable Use of Natural Ressources
Component Promotion of Renewable Energies

International Experiences with the Promotion of Solar Water Heaters (SWH) on Household-level

gtz

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International Experiences with the Promotion of Solar Water Heaters (SWH) at Household-level

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DISCLAIMER

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GTZ

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The "Programme for Environmental Management and Sustainable Use of Natural Resources"

A major issue in Mexico is environmental degradation, which is developing into a serious threat due to rapid economic and population growths. The consequences are heavy air pollution, massive accumulations of solid waste and deteriorating water reserves. As agreed by the German and the Mexican Governments, GTZ concentrates its work on the priority area of environmental management and sustainable use of natural resources, covering the following areas:

- Promotion of renewable energy (Sener)
- Solid waste management and contaminated site management (Semarnat)
- Environmental information and monitoring (Semarnat)

"Promotion of Renewable Energy" Promo✓ER"

As one of the major economies in Latin America with a large territorial extension and favourable climatic conditions, Mexico has a high potential to benefit from renewable energies. However, until now, energy supply from renewable sources has been poor, due to the current legal framework and a lack of competition in the energy sector. In general, the energy sector is facing the challenge to minimize its dependence on fossil fuels by diversifying energy sources, and by increasingly using the power of the private sector in terms of innovation and investments. A first important step in this direction represents the approval of the renewable energy bill by the Mexican chamber of deputies in December 2005, which is currently awaiting approval by the senate.

The objective in the area of renewable energies is to support responsible institutions so that these foster the development of a market for renewable energies more effectively. In order to meet this objective and to push the large scale use of renewable energies, GTZ cooperates closely both with governmental players such as Sener, CRE, CFE and Conae and private players providing advisory services aimed at reshaping the legal framework and at developing markets and projects. The following four focal areas have been agreed upon:

- Development of policies and strategies – at the beginning with a focus on biofuels
- Consulting with regards to the legal and regulatory framework
- Development of markets and projects – at the beginning focused on the dissemination of solar water heaters on household-level
- International Cooperation

The Mexican counterparts are: the Secretary of Energy (Secretaría de Energía, Sener), the Energy Regulatory Commission (Comisión Reguladora de Energía, CRE), the Secretary of Environment and Natural Resources (Secretaría de Medio Ambiente y Recursos Naturales, Semarnat), the National Commission for Energy Savings (Comisión Nacional para el Ahorro de Energía, Conae) and the Electric Research Institute (Instituto de Investigaciones Eléctricas, IIE).

Implementation started in June 2005.

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Abbreviations

ADEME	Agence de l'Environment et la Maîtrise de l'Energie
ANME	Agence Nationale de la Mâtrise de l'Energie
BAFA	Bundesamt für Wirtschaft und Ausfuhrkontrolle (Federal Agency for Economy and Export Control)
BMU	Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (Federal Ministry for the Environment, Nature Conservation and Nuclear Safety)
CSTB	Centre Scientifique et Technique du Bâtiment
IDAE	Instituto para la Diversificación y Ahorro de la Energía
EBHE	Greek Solar Industry Association
GEF	Global Environment Facility
MEDREP	Mediterranean Renewable Energy Programme
STEG	Société Tunisienne d'Electricité et de Gaz
UNEP/DTIE	United Nations Environment Programme/ Division of Technology, Industry, and Economics

Table 1: Used exchange rates (23.02.2006)

1 MXN	=	0,08010 Euro	=	0,09535 US$
1 Euro	=	1,19061 US$	=	12,50575 $ MXN
1 US$	=	0,84001 Euro	=	10,50365 $ MXN

Source: http://www.oanda.com

Executive Summary

Solar water heaters on household-level have the potential to contribute significantly to save fossil energy sources. In comparison with other renewable energies, the use of solar water heaters is still relatively low. Although, last years rising energy prices could be a good reason to promote renewable energies. High upfront investment costs for installation represent a significant barrier for large scale use of solar water heaters for households. Promotion mechanisms are used to overcome this obstacle and to expand utilisation of solar water heaters.

At first, this paper will introduce possible promotion mechanisms. Thereafter, criteria for their assessment will be defined. The main focus of this paper lies on the description and evaluation of international experiences with promotion mechanisms for solar water heaters on household-level. Along this way, case studies from Germany, Greece, France, Tunisia, and Barcelona will be analysed. The analysis will show that these implemented promotion programmes were altogether successful and led to a significant increase in installed collector area and capacity.

The main driving force for investment in solar water heaters is the prospect of reducing monthly energy costs. A well-balanced promotion mechanism should take this into account. A long-term orientation of the promotion is as well essential, whereas frequent changes of conditions can be a barrier for sustainable success. With regard to country specific issues, other factors also need attention, such as quality assurance, standardisation, capacity building, and information policy for the public as well as for affected players. It will be shown that attention should be drawn not only to the design of a promotion mechanism but also to accompanying measures. Only comprehensive, country specific concepts can push markets for solar water heaters efficiently and effectively at the same time.

1 Introduction

There is no doubt that the relevance of renewable energies has strongly increased over the last years. The growing awareness of fossil fuels finiteness, political instability in several geopolitically important regions, and the rise in energy prices related to these trends, direct attention more and more to alternatives for energy supply. A modern, forward-looking and sustainable energy policy cannot do without the integration of renewable energy sources.

Besides energy supply for example from wind, water and biomass, solar energy is of crucial importance. It is limitless and quantitatively the largest source of energy, while providing clean and secure energy without interfering significantly with the environment.

Aside from power supply with photovoltaic, not much attention is paid yet to solar thermal energy, although solar water heaters represent a relatively cheap and financially feasible technology, especially in regions without frost, which allow for the use of simple thermosyphon. Payback periods are often very short. Rising energy costs are a good breeding ground for solar water heaters and provide them a comparative advantage, since high prices for alternative energy sources shorten payback periods making solar water heaters even more attractive.

While solar water heaters could gain ground in industrialized countries, this technology is hardly used in developing countries. This is surprising, because these countries possess better, often even excellent, climatic conditions, i.e. higher solar radiation.

However, as already mentioned, market penetration of these systems is still low. Besides an often lower ecological awareness and the ignorance of solar water heaters' added value, economic aspects represent a major barrier for a wider dissemination. High start-up costs for purchase and installation often exceed financial possibilities of basically interested households. This, together with a simultaneous lack of adequate financing mechanisms, can build insuperable barriers, especially in developing countries and countries in transition.

For this reason, it is essential to overcome financial restrictions in order to achieve a wider market penetration. The promotion of solar water heaters on household-level can be an instrument to reduce start-up costs and thereby give a crucial impulse for a higher market penetration.

The objective of this paper is to analyse and evaluate international experiences with the promotion of solar water heaters at household level. During the compilation of this study, it became apparent that responsible organisations did not pay much attention to a distinct monitoring and an explicit evaluation of promotion programmes. The study in hand will therefore show which promotion measures resulted particularly successful, which difficulties occurred during their implementation and how these circumstances possibly could have been avoided.

Chapter 2 gives an overview of several promotion mechanisms. These are on the one hand mechanisms based on financial incentives (2.1 to 2.4) and on the other hand possibilities of police law/ command-and-control regulation (2.5). Chapter 3 presents seven criteria that are used for the evaluation of the promotion mechanisms. In the following Chapter 4, promotion mechanisms are presented in form of five exemplary case studies from Germany, Greece, France, Tunisia and Barcelona. These case studies are evaluated against the criteria introduced in Chapter 3. For this purpose, the country-specific background is presented first, followed by a presentation of the programme and its evaluation, finalizing with individual "lessons learned" for the each case study. Chapter 5 summarises the conclusions and gives a short outlook on possible promotion alternatives for Mexico.

2 Basic models of promotion mechanisms

The core basic models regarding promotion mechanisms will be introduced first, in order to prepare the ground for an analysis of international experiences with the promotion of solar water heaters.

Promotion mechanisms can be categorised into two main groups. On the one hand there are economic promotion mechanisms, which actually provide financial support to the beneficiary for purchasing a solar water heater. Financial support is normally received by the beneficiary via direct grants, tax deduction or low interest/ soft loans (see 2.1, 2.2 and 2.3). Further options in this context are leasing- or contracting-models (see 2.4, 2.5).

On the other hand, police law or command-and-control regulation represent an alternative promotion mechanism, whereas the definition of promotion is delusive, because these mechanisms finally comprehend an obligation for installation of solar water heaters via law or ordinance. Normally, a real financial promotion is not foreseen by police law.

2.1 Direct grants

Regarding the promotion of solar water heaters, direct grants are one of the most frequently observed instruments, whereas such grants are also used for other renewable energy sources, for example within the German Thousand-Roof-Programme for photovoltaic systems.[1]

In most cases the promotion foresees a payment of a certain grant to the beneficiary per installed collector area in square meters. A promotion depending on the maximum capacity of the solar water heater is also possible.[2] Thereby, promotion is normally incumbent on certain restrictions. Direct grants for example are often limited to a certain maximum for promotion regarding the collector area or a maximum with respect to the system capacity. Thus, in general, a maximum amount for the promotion exists.

Different ways are used for the payment of the promotion. One procedure is that the buyer of a solar water heater applies for the payment of the grant by means of receipts for purchase and installation of the system that he already bought at a certain institution; thus proving actual purchase and installation. In case of allowance of the application, the payment might be realised in cash or by transfer on the applicant's bank account.

An alternative to this is that the system installer assumes the application for the appropriation. In case the criteria for promotion are met, the beneficiary pays the installer a respectively lower price for purchase and installation. The institution in charge of the promotion remunerates the installer and incidental transaction costs might be lowered remarkably.

A prominent example for the application of direct grants to the market for solar water heaters is the Federal Republic of Germany. The so-called Programme for Market Stimulation (MAP) led to a manifold increase in the installed collector area. This programme will be subject to analysis in Chapter 4.1.

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[1] The former Federal Ministry for Research and Technology (BMFT), today the Federal Ministry for Education and Research (BMBF), paid a grant amounting to 50 percent, the Federal States normally another 20 percent. The calculation base for the grants are actual costs up to a maximum sponsorable amount of 13,804.88 €.

[2] The maximum collector capacity results from the properties of the system and is declared in thermal kilo watt (kWth). The capacity is an alternative measure to installed collector area and is in the meanwhile often preferred due to better comparability with other technologies.

2.2 Tax deduction

Another frequently used mechanism is providing the opportunity for complete or partial tax deduction of the investment amount for solar water heaters. Tax deduction allows the beneficiary to subtract those costs born and proven with receipts from his income in his income tax return. Thereby, he scales back his tax due by the discharged costs multiplied with his personal tax rate.[3]

Several definitions of deduction ability are possible, for example, whether besides absolute costs for the purchase of collectors also costs for installation are considered. Furthermore, it needs to be clarified, for which period of time the costs can be deduced in the income tax return, i.e. should costs be deductible only in the year of purchasing or starting operation or for several years. Furthermore, it needs to be distinguished between complete and partial deduction ability and possible maximum amounts for attached costs. In the end, there is no limit to fiscal creativity.

Finally, the effect of tax deduction ability of the howsoever defined investment costs is nothing else than a reduction of up-front-investment costs for the beneficiary. In contrast to direct grants, this type of promotion does however not work immediately. After all, cash flow for the beneficiary is delayed, because he somehow needs to fetch back the promotion through his income tax return. In case that the applicant's taxable income amounts to zero, this promotion mechanism will not work.

Exemplary for a promotion via tax deduction ability is the situation in Greece, which will be analysed in Chapter 4.2. The example of France (4.3) shows why and how a country switched from direct grants to tax deduction within the Plan Soleil and which conclusions can be drawn from this.

2.3 Low interest loans

While direct grants and models of tax deduction ability are widely used, low interest loans in connection with solar water heaters are barely used. As the name implies, promotion is done via credits with low interests; usually below market level. This instrument could be called "interest subsidy" as well. In this case several specifications are possible, for example a continuously low interest loan for the complete credit period, interests free periods for certain credit periods or for the full credit period.

Usually, credits are granted by public promotion banks, like the German KfW Banking Group. Two ways of providing credits are most common. On the one hand it is possible that the application for a credit is done directly with the promotion bank. On the other hand the beneficiary could apply directly to its main bank. The latter was very successful within the Thousand-Roof-Programme for photovoltaic systems in Germany.[4]

Besides credit grants by public promotion banks, credits might be placed as well by the private sector. For example, power suppliers could offer low interest loans for solar water heaters and their installation. Repayment of investment costs can be carried out by the gas or electricity bill of the end user, which is leading to relatively low administrative costs.

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[3] Calculation example: with a personal tax rate of 30 percent and full deduction ability, the tax due by the beneficiary is reduced by 30 € at an investment of 100 €.

[4] This programme of the German federal government provided low interest loans for system pre-financing to private individuals, freelancers as well as to small and medium-sized enterprises (1999-2003). Because the target of 300 MW peak capacity was already achieved before the initially foreseen date for the programme's expiration, the programme was closed early midyear 2003.

Another option is that producers of solar water heaters themselves offer their clients low interest loans in order to increase their sales. A variety of such financing models from producer to client can be observed in the automotive sector for example.

For a long time low interest loans for solar water heater were a barely used tool. However, during the last years first attempts could be identified where low interest loans and interest subsidies were used as instruments for promotion. In August 2004 such a programme was adopted for the first time in Tunisia and positive results seem to emerge (4.4), however, it is by far too early for a concluding evaluation.

2.4 Leasing and Contracting

Leasing and contracting models can push the use of forward-looking technologies as well. With the leasing model the leasing commodity, in this case the solar system, is provided by the lessor, i.e. the power supplier or producer, to the lessee, i.e. the energy consumer, for the leasing contract period against payment of a leasing rate, i.e. a compensation fee. Consequently, a leasing contract is similar to a tenancy agreement. However, with the difference that within the leasing contract maintenance and servicing liabilities as well as guarantee requirements merges to the lessee, i.e. the energy consumer. As a reward the client has a purchase right, so that he can take over the solar system for an initially agreed price at the end of the contract period (complete amortisation) so that the system becomes his property then. If the client disclaims his purchase right, the system remains property of the lessor.

Basically, contracting models work similarly to leasing models. Based on the idea of James Watt (inventor of the steam engine), the contractor bears investment, consulting and installation of the solar system at the client's house. Furthermore, the contractor operates the system for an initially agreed period and provides thus a certain energy service to the client. The energy consumer, as the customer, pays a certain price for the energy service to the contractor. This price is a combination of monthly provision charge and price per energy unit dependent on consumption. In contrast to leasing, the solar system and all attached rights and responsibilities remain at the investor, i.e. the contractor.

Leasing and contracting models overcome the barrier of a single payment for up-front investment for the household. The leasing- or contracting-customer needs to pays only a compensation fee to the contractor, while an investor pre-finances the system.

Due to the comparatively low investment costs for solar water heaters, leasing and contracting models appear not very reasonable solutions at household level. Therefore this paper will not dwell on those.

2.5 Police law

In contrast to the so far represented mechanisms and financing models, police law does not represent a promotion mechanism in the true sense of the word, but rather a matter of laws or ordinances, which make installation of solar systems mandatory. In this respect it is less a promotion of individual households, but rather a promotion of the market itself. Practical experiences especially in Spain show that police law-based measures can lead to tremendous growth of installed solar water heater area.

The design of such laws and ordinances is barely limited. Mostly, the installation duty is tied to characteristics like type of house (for example one-family house or apartment building) and height as well as the purpose of use. According to this, households are incumbent on other

responsibilities than commercial buildings. Very common in police law is the distinction between installation on new buildings and retro-fitting of already constructed buildings.

Police law-based methods have attracted a lot of attention during last years, last but not least because of the very successful and publicity-effective Barcelona-model in Spain. This model will be introduced and analysed in Chapter 4.5.

3 Criteria for the assessment of promotion mechanisms

As a basis for the case studies presented in Chapter 4 a couple of criteria is introduced here which are used for an analysis of different promotion mechanisms and an evaluation of selected promotion programmes. In principle a variety of criteria is possible. The present paper concentrates on the following seven:

3.1 Transaction costs for applicants

The simplicity of the promotion mechanism raises the question of the required bureaucratic effort for the applicant, and consequently the potential beneficiary to receive the promotion. A complex and extensive application process can be a barrier because households which are interested in an installation of solar water heaters can possibly been put off by the application for promotion. This would result in an inefficient low degree of promotion and consequently new installed collector area. Therefore the question how to provide an easy way for possibly interested households to obtain the benefits foreseen by the promotion mechanism is essential. Furthermore, it is important, to consider whether the beneficiary gets the payment immediately or if he has to face a time delay.

3.2 Transaction costs for promotion provider

This criterion tries to cover those costs, which arise during the implementation of the promotion process on side of the promotion provider. That clearly distinguishes this criterion from the previous, which aims at the consumer. Here transaction costs are not defined as costs which go in terms of promotion to the beneficiary, but rather costs for administration and monitoring. In this context, it is of great importance if new institutions must be formed for processing, approval and decline of promotion applications or if existing ones can be used for this purpose.

3.3 Market orientation

Furthermore, the degree of private sector involvement is important. That applies for the phase before implementing the promotion mechanism as well as for implementation itself. After all, it can be reasonable to use stakeholders like producers, distributors, architects or installers as communication and distribution channels. That can have a positive effect, especially if the private sector is involved in the elaboration of the promotion mechanism, identifies the benefits associated with the promotion mechanism and thus bears and supports the idea of promotion. Finally, the promotion is an purchase incentive for households and thus an increased investment volume which the private industry should benefit from. The alignment of interests of the promotion institutions and the private sector in the area of installation of solar water heaters would be the ideal situation.

3.4 Adjustment to country-specific conditions

Another important criterion is how far the design of a promotion mechanism considers country-specific conditions. An instrument promotion must be in line with the tax and legal framework as well as with rules of competition. In addition, market structures for solar water heaters differ from country to country. In some countries solar water heaters are already widely known and accepted, whereas in other countries this technology is barely known. Experiences with similar technologies or promotion programmes, general acceptance of renewable energies and other country-specific conditions are determinant for the success of a

promotion programme. Other examples are purchase habits of households, existence of efficient credit markets and constructional conditions. Not every promotion mechanism will work equally well in every country. Rather, it seems necessary to pay a great deal of attention to country-specific conditions.

3.5 Credibility and reliability

A further issue is the credibility of the announcement and implementation of the promotion programme. If households can not rely on a promotion like proposed, it can happen that investments for solar water heaters will not be realized. It can be noticed that a change of government often rules out continuity in promotion. That can keep investment-willed households from an installation, as they do not know, whether or not they get a promotion. In a similar way it occurs, that promotion programmes are stopped sooner as primarily announced, because of used-up promotion budgets. In parallel to such developments, one can often notice an immense decrease in newly installed collector area. Thus, the reliability of a promotion programme is essential.

3.6 Sustainability

The criterion of sustainability is closely linked to the previous criterion of credibility and reliability. It is crucial for a sustainable impact of a promotion mechanism that a market for solar water heaters evolves and persists beyond the completion of the promotion period. for this reason, a promotion programme should ideally arrange for decreasing levels of promotion for households (phase-out). Experiences show, that non-consideration of such a promotion strategy can lead to abrupt and significant retracement of sales and installation figures once promotion phases out. Strategies aiming purely at short-term market growth should be avoided in view of a sustainable strategy for a broad market launch of solar water heaters.

3.7 Efficiency/Cost-benefit ratio

As the last evaluation criterion serves the assessment of the mechanisms' efficiency. It seems particularly interesting to find out to which degree the intended promotion effect actually materialized, thus to figure out the relation between promotion effort, overall-investment volume for installation of solar water heaters and newly installed collector area. This also raises the question to what extent the used resources justify success, i.e. newly installed collector area, saved energy or reduced CO^2-emissions. Of course, the private sector benefits from a positive sales trend. The development of a strong solar water heaters industry including suppliers as well as an increased demand for consulting and installation services can deliver significant impulses for labour market and other macro-economic figures (for example increased tax revenue).

3.8 Assessment Scheme

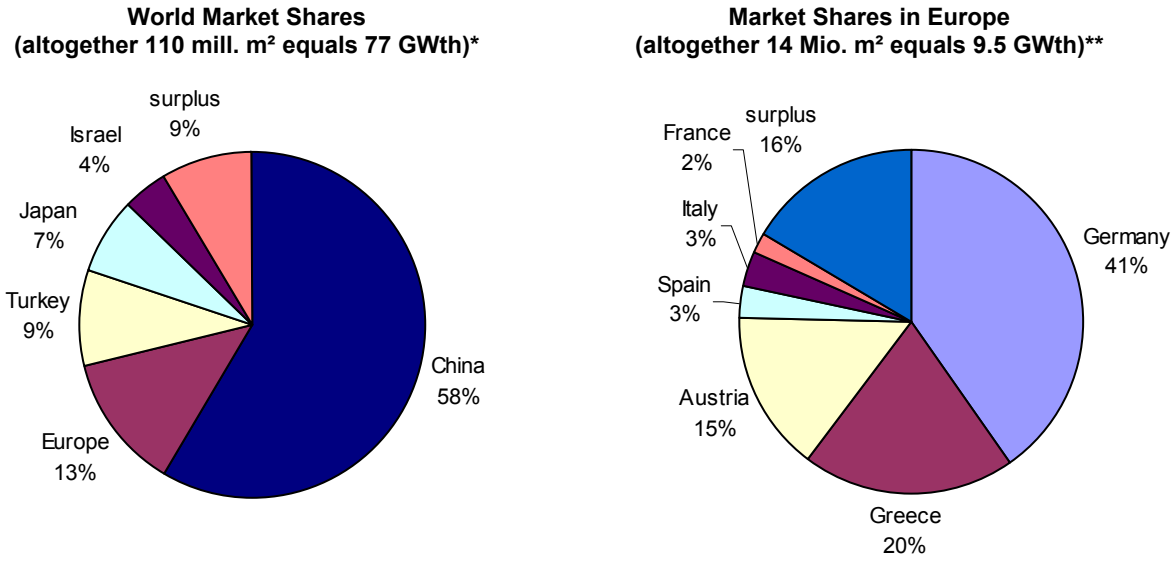
Like already mentioned at the beginning of the present study, the analysis of the case studies showed a lack of attention in several cases regarding proper monitoring and evaluation mechanisms for the promotion programmes. For this reason and the associated lack of explicit data, the evaluation of promotion programmes was not always straightforward. In the frame of the case studies an evaluation is made based on an own assessment scheme. The analysis in line with this scheme is rather an estimation of trends than a profound scientific evaluation. The promotion programmes are assessed against the different evaluation criteria and by using scores in the categories positive (+), neutral (o) and negative (-). This allows for statements in terms of trends regarding the performance of the different programmes.

4 Case studies

This chapter shows based on five case studies how some promotion programmes in different European countries have given significant impulses for the dissemination of solar water heaters.

In 2004, worldwide installed collector area amounted to 110 million m^2. About 40 million households used solar water heaters. Converted to a worldwide estimated number of 1.6 billion households, that means a penetration of solar water heaters of about 2.5 percent.[5]

Figure 1: Market Shares (2004)

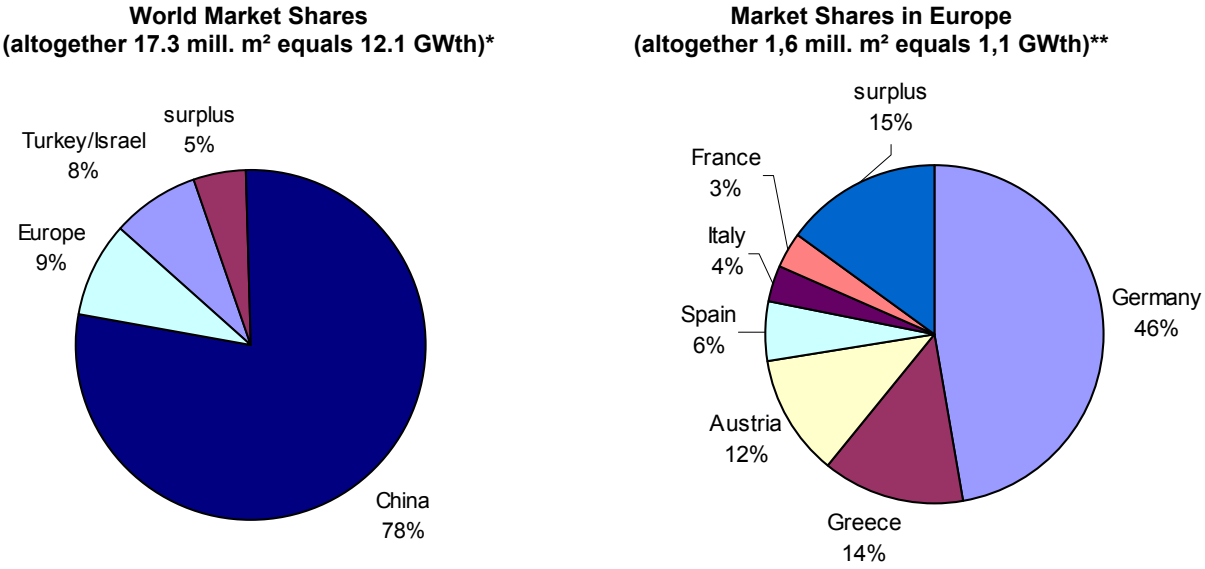


Sources: REN 21, Global Status Report, 2005.*
ESTIF, Solar Thermal Markets in Europe (Trends and Statistics 2004), 2005**

The People's Republic of China is by far world market leader, in both, absolute installed collector capacity (approx. 58 percent of the worldwide installed collector area; see Fig. 1) and newly installed collector capacity (78 percent of the world market; see Fig. 2). Remarkable is the absence of financial incentive systems on the buyers-side, both in the presence and in the past. Only research activities were supported. This applies also for Turkey where in 2004, approx. 9 percent of the worldwide collector area was installed. Solar water heaters have been used since the beginning of the 1950's in Japan (market share of approx. 7 percent). Until the year 1997, solar water heaters were promoted with low interest loans. Turn-over for these systems decreased strongly after the promotion mechanism was terminated. In Israel (market share of approx. 4 percent), prosperity of solar water heaters traces back to a police law-based measure. Since 1980, installation of solar water heaters is mandatory for a major part of new buildings. This resulted in a sustainable market with a strong and exporting solar industry in Israel. In the meanwhile, the vast majority of new installations (approx. 80 to 90 percent) happens voluntarily for substitution or expansion of already existing systems.

[5] REN 21, Global Status Report, 2005.

Figure 2: New installed collector area (2004)



Sources: REN 21, Global Status Report, 2005.*
ESTIF, Solar Thermal Markets in Europe (Trends and Statistics 2004), 2005**

Although Europe, as measured by installed collector capacity with 1.6 million m^2 newly installed collector area in 2004, achieves only a market share of 13 percent of absolute installed collector area,[6] the European market is interesting because of its worldwide leading position in significant areas of solar thermal technologies. In absolute collector area and capacity the European market is dominated by Germany, Greece and Austria. Spain, Italy and France exploit only a small portion of their potential.

Observing installed collector area and capacity per 1,000 inhabitants delivers a different picture however (see Table 2). In Cyprus solar water heaters are installed on more than 90 percent of all buildings. Direct grants for investment costs accelerated market development in a way that Cyprus has a twice as high collector density as for example Greece or Austria, and even more than the eightfold density of Germany.

In order to strengthen the role of renewable energies in a country's energy-mix and last but not least to preserve the strong role of a technology-precursor, several countries of the European Union imposed promotion programmes. This study is referring to these programmes with case studies from Germany, Greece, France and the Barcelona-model. Furthermore, first experiences with a current promotion programme in Tunisia are evaluated. The study is limited to selected and demand-driven promotion programmes.

[6] REN 21, Global Status Report, 2005.

Table 2: Installed collector area and collector capacity per 1,000 inhabitants in Europe

	Installed collector area (m²/1,000 inhabitants)	Collector capacity (kWth/1,000 inhabitants)
Cyprus	582.4	407.7
Austria	297.0	207.9
Greece	263.9	184.7
Germany	74.8	52.4
Denmark	60.8	42.5
Slovenia	52.4	36.7
Malta	38.3	26.8
Netherlands	30.8	21.6
Luxemburg	25.4	17.8
Sweden	25.0	17.5
France	13.2	9.2
Portugal	10.7	7.5
Spain	10.7	7.5

	Installed collector area (m²/1,000 inhabitants)	Collector capacity (kWth/1,000 inhabitants)
Slovakia	10.6	7.4
Italy	7.9	5.6
Belgium	5.0	3.5
Czech Republic	4.9	3.4
Hungary	4.8	3.3
Rumania	3.0	2.1
Poland	2.5	1.7
Finland	2.3	1.6
Ireland	1.9	1.3
Latvia	0.7	0.5
Lithuania	0.5	0.3
Estonia	0.4	0.3
EU 25	33.7	23.6

Source: EurObserv'ER, 2005.

An interesting detail observing the world market is that – different from what one might suppose – market shares measured in installed collector capacity are mostly independent from solar radiation in the respective country. Germany for example, a country with an annual solar radiation of approx. 1,000 kWh/m^2 shows a thirteen fold collector capacity compared to solar-spoilt Italy with average 1,500 kWh/m^2, although climatic conditions in Italy are essentially superior.

Noticeable is, that in surveys circulate different numbers on collector area, per capita-installed collector area, market shares and similar specifications. Therefore, references should be regarded to avoid the impression of inconsistency. Furthermore, during last years presentation in m^2 became less popular. Instead, specification of power is done in thermal gigawatt hours (GWth). This eases comparability as well as statistic presentation of solar water heater with other energy sources. A uniform conversion factor does not exist yet.[7]

[7] ESTIF for example uses the factor 0.7 kW/m² to calculate the nominal solar thermal capacity out of the installed collector area.

4.1 Germany

4.1.1 Background

Until the year 2010, the Federal Republic of Germany aims at increasing the share of renewable energies of total primary energy consumption to 4.2 percent. Until 2050, the aim is to generate 50 percent of total energy supply from renewable energy sources. In order to achieve these very ambitious aims, Germany committed itself to fulfilling climate protection targets, phasing-out of nuclear energy and replacement of fossil energy sources with renewable energies.

Germany disposes of an average annual solar radiation of about 1,000 kWh/m^2. Because of rapid growth in the 1990's (annually 30 to 40 percent, 2005: approx. 10 to 15 percent), Germany is – measure in installed capacity – the indisputable market leader in solar water heaters in Europe, with a market share of approx. 41 percent[8] and 6.199 million m^2 installed collector area[9]. Installed collector area amounts to 74.8 m^2 per 1,000 inhabitants (equivalent to 52.4 kWh/1,000 inhabitants).[10] However, at present thermal solar technology contributes only 0.1 percent to the supply of heat energy in Germany. [11]

In 2004, five of the major suppliers for solar collector systems had a market share of more than 50 percent. In total, about 36 suppliers were present at the German market. The import share declined from 50 to 35 percent between 1999 and 2003. This indicates that principally national companies benefited from market growth.[12]

Flat collector systems for hot water supply have the widest dissemination on household-level (approx. 85 percent of the installed systems).[13] Several equipments' costs decreased significantly due to economies of scale effects. For common two circuit systems at household level up to 6 m^2 investment costs amount to approx. 700 €/m^2. Appropriate tanks contain approx. 300 litres, so that total costs for such a system including their installation amount to approx. 5,000 to 6,000 €.

Solar water heaters for hot water supply were primarily used in Germany as a reaction to the oil crisis in 1973. After a positive development till the beginning of the 1980's, the market stagnated on a low level. However since mid 1990's, several promotion programmes were implemented by the Federation as well as by the States and development regained momentum especially in the sector of solar water heaters on household-level.

In 1995, the so-called "100-million-programme" was introduced, which for the first time provided promotion of solar thermal systems. This programme was attended by the Federal Ministry for Economy and Technology (*BMWi*). The total amount of 100 million DM (equivalent to approx. 51 million Euros) was used to promote a collector area of 40,000 m^2 in 1995 and 1996 alone.[14] Since demand went beyond the scope of promotion, the government, consisting of the Social Democratic Party and the Green Party, decided to extend the

[8] ESTIF, Solar Thermal Markets in Europe (Trends and Market Statistics 2004), 2005.

[9] BMU, Umweltpolitik. Erneuerbare Energien in Zahlen, 2005.

[10] EurObserv'ER, 2005.

[11] BMU, Umweltpolitik. Erneuerbare Energien in Zahlen, 2005.

[12] BMU, Evaluierung von Einzelmaßnahmen zur Nutzung erneuerbarer Energien, 2005.

[13] ESTIF, Sun in Action II – A Solar Thermal Strategy for Europe. Volume 2, 2005.

[14] ESTIF, Sun in Action II – A Solar Thermal Strategy for Europe. Volume 2, 2005.

promotion and to issue a follow-up programme as of September 1st 1999. This promotion programme, called "Measures for the Utilisation of Renewable Energies (briefly: Programme for Market Stimulation or *MAP*), attended by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, is evaluated in the present paper. Besides *MAP*, numerous other promotion programmes by the Federal States as well as by the Federation can be found in the German promotion scenery. But with no doubt *MAP* is by far the largest and most outstanding programme with respect to promotion of solar thermal systems.

4.1.2 Programme-outline

Programme generals: *MAP* promotes installation of systems for heat generation as well as electricity generation from renewable energies. Emphasis is placed on market launch of heat generating technologies. Besides solar water heaters, which this paper is limited to, biomass-boilers are promoted. Promotion guidelines were adjusted manifold since introduction of *MAP* in 1999. Smaller systems, commonly used at household-level, are mainly promoted with direct grants, whereas larger systems are promoted rather via low interest loans. As the focus of this paper lies on the promotion measures at household-level, only the mechanism of direct grants is discussed.

Promotion-details: According to the present promotion guidelines for the installation of solar water heaters and/or for provision of process heat, which came into force on July 1st 2005, promotion subsidy amounts to 105 € per started square meter of installed gross-collector area. This rate applies for systems up to 200 square meters. Each additional square meter as well as extensions of already existing systems are subsidised with 60 €. First-time since July 1st 2005, solar systems for combined hot water provision and radiator are subsidised with 135 € per square meter of newly installed collector area.[15]

Promotion coverage: Private individuals, freelancers and small and medium-sized commercial enterprises (SMEs), the latter according to the definition of the European Communities, are authorised for application and promotion. However, approximately 99 percent of all promoted systems are operated by private households.[16]

Application: Appropriations are to be applied for via an application form at the Federal Office for Economy and Export Control (*BAFA*), which is a federally owned authority. It is not permitted that delivery or service contracts for purchase and installation of a solar system have been concluded at the time of application. The request of cost estimates and consulting-services is allowed. A further requirement is that promoted systems must be operated at least seven years. Acceptance of promotion expires, if the system is not installed ready for operation within the approval period of nine month, beginning with the benefit notification. Necessary forms can be downloaded from the homepage of *BAFA* or requested directly at *BAFA*. Another possibility is to contact *BAFA* by telephone for questions concerning the promotion procedure.

Origin of budget: Funds for promotion payments originate from the income generates by the German Government's Ecological Fiscal Reform. Thereby, promotion volume is geared to

[15] Required are a minimum collector area of 10 m² (flat collectors) and 8 m² (tube collectors) as well as a buffer storage of 50 litres/m² (flat collectors) and 60 litres/m² (tube collectors). When failing to fulfil these requirements, promotion paid is 105 €/m².

[16] In addition, municipals, special purpose associations, other public corporations and registered associations, which are owners, renters or tenants of the property, on which the system will be installed, are authorised to receive promotion.

additional incomes from the electricity tax. The budget is tied to the federal budget and requires a new funds release each year.

Promotion payment: If application is approved, the subsidies are transferred in a single payment to the household. The promotion is only offered once per any square meter installed. Summing up appropriations for solar water heaters from further promotion programmes at Federal, Federal State or Municipal-level is not permitted. At the time of the compilation of this study, *MAP* was still in force. Applications to the named conditions are possible until October 15th 2006.[17]

Campaigns/ Information strategies: The announcement of MAP is carried out by the Federation via publication in the federal bulletin, press releases as well as at appropriate homepages from the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), the Federal Office for Economy and Export Control (BAFA) and the German Development Bank (KfW). However, the majority of applicants finds out about promotion possibilities through craftsmen, architects or consultants. Furthermore, it was observed that above all those people that already benefited from the MAP recommend it further. Private campaigns like "Solar-na klar!" as well as governmental-supported initiatives like "Solarwärme plus" contributed to widen openness regarding solar energy in the population in general.

Quality assurance: Although promotion for domestic applications does not require specific quality standards, the offered systems show good technical rates and high quality. Slight improvements in quality are come along with increased reliability and declining prices. Professional installation and start up of the systems by qualified personnel is done mostly without problems.

Particularities: Several modifications of the promotion guidelines, especially adaptation of promotion rates, led partially to immense fluctuations of application numbers. In the course of an increase in the subsidy in February 2003 for example (increase from 92 €/m^2 to 125 €/m^2) a triplication of the average application numbers could be noticed. In contrast the decrease of subsidy to the turn of 2003/2004 (decrease from 125 €/m^2 to 110 €/m^2) caused a converse effect. At the end of 2003 there was an increased demand for promotion, a classical effect of pre-drawing. However, promotion demand declined dramatically in 2004. This can be seen as a sign for a strong sensitivity of demand in dependence of promotion.

Results of promotion: Between January 2002 and August 2004, which is considered by the study of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, 124 million € of subsidies were paid to beneficiaries for solar thermal systems. With an average promotion rate of 14 percent, investments amounting to 853 million € were realised. The predominant part of the systems was equipped with flat collectors (86 percent). The share of systems up to 6 m^2 amounted to more than 50 percent, the portion of systems between 7 and 20 m^2 amounted to another 45 percent.[18] By far the major share went, as mentioned before, to private one- or two-family households.

[17] BMU, Geld vom Staat für Energiesparen und erneuerbare Energien, 2005.

[18] The promotion of systems with a collector area of more than 20 m² plays only a minor role with regard to direct grants (2 percent). Those systems were mainly sponsored by KfW loans.

4.1.3 Criteria-based assessment

Based on the detailed description from Chapter 4.1.2, which already contains an implicit assessment, the main aspects related to each criterion will be listed down and evaluated in a table on the basis of the assessment-schema in Chapter 3.8. This same procedure will be used in the following chapters.

Case Study Germany (direct grants)

Transaction costs for applicants	+	• plain promotion modalities
Transaction costs for promotion provider	o	• already existing infrastructure of the Bundesamt für Wirtschaft und Ausfuhrkontrolle (*BAFA*) could be used • relatively low bureaucratic effort • fast processing of applications
Market orientation	+	• craftsmen, architects and consultants were involved as multipliers of the programme • installers frequently supported households with application • partly private image-campaigns (”Solar – na klar!“, ”Solarwärme plus“)
Adjustment to country-specific conditions	+	• due to a well working German banking system, transfers were carried out smoothly
Credibility and reliability	-	• frequent modifications of promotion rates • strong fluctuations of promotion demand as a consequence of volatile promotion rates (pre-drawing and waiting effects) • dependency on annual fund releases
Sustainability	o	• through MAP and the resulting increase of demand for solar thermal system solar thermal industry could evolve well • high acceptance within the population led to sustainable growth and stabilisation of demand • no declining promotion rates (no phase-out)
Efficiency/Cost-benefit ratio	+	• 124 million € of promotion could generate 853 million € in investments, with an average promotion rate of 14 percent (January 1st 2002 to March 6th 2004) (the MAP does not aim for qualitative targets) • prevention of 88,783 tons of CO^2-emissions by systems promoted through MAP (January 1st 2002 to march 6th 2004) • 241,879 applications with high, but fluctuating promotion rates (2002: 66.7 percent, 2003: 97.7 percent) [19](January 1st 2002 to March 6th 2004) • high satisfaction among beneficiary households (97 percent of customer satisfaction)[20]

[19] BMU, Evaluierung von Einzelmaßnahmen zur Nutzung erneuerbarer Energien, 2005.

[20] REACT, Solar-thermal Energy-Market Incentive Programme, 2004.

4.1.4 Lessons Learned

The example of Germany shows that in worldwide comparison a strong ecological awareness is indeed relevant, but less important for investment decisions as initially expected. Moreover, the experience from Germany shows that most households decided for investment because of economic reasons. Frequently, promotion was the catalyst for investment. This could be observed in other countries as well and should be considered during the design of a promotion mechanism. In this respect, a financial stimulation in terms of a promotion seems both necessary and reasonable to overcome certain psychological barriers related to the utilisation of renewable energies.

Furthermore, the example Germany clarifies that a promotion, which leads to a strong growth of demand for solar systems, can impact significantly on the local solar industry. Immense cost reductions could be observed because of an increasing industrialisation of production and economies of scale in the distribution of the system. Thus, attention should be paid on realising economy-of-scales-effects during the design of the mechanism. In this way solar industry can evolve into a successful, seminal and sustainable industry sector like in Germany. Major effects on the labour market prove this.

Nevertheless, there is criticism on the German *MAP*. Critics complain that the release of funds needs to be decoupled from the respective budgetary situation in order to assure prosperity of the programme and higher investment security. A reliable regulation beyond the respective election period is as well of great importance for a sustainable development of the solar market, both on the supply and the demand-side. [21] Also because of that, possibilities are discussed at present for a binding utilisation of renewable energies for heat supply, similar to the Barcelona-model presented in Chapter 4.5. An advantage of such a model would be a high probability of achieving set targets and planning reliability both for consumers and producers. A new promotion instrument should minimize demand-fluctuations, like the ones observed during *MAP* due to the obviously high sensitivity of demand on financial incentives.[22] Another suggestion foresees an apportionment system, which stresses financially the use of fossil energies and thus favours renewable energies.[23] Furthermore, a new instrument should consider stimulations for tenancy households.

In finalising it should be noted, that over the last years German households received a quite generous promotion. As mentioned before, strong fluctuations of demand resulting from adjustments of promotion rates resulted problematical. Therefore, a stable and possibly declining promotion should be preferred. Since the German market could be characterised as a self-supporting one in the meanwhile, it is worth raising the question, whether a promotion is from an economic point of view still necessary or if abandoning promotion or at least a declining phase-out would seem more reasonable with regard to a sustainable development.

[21] BEE, Erneuerbare Energien: Offensiv in den Wärmemarkt, 2005.

[22] The demand fluctuation mentioned above led to a triplication of application numbers in 2003 compared to the previous year.

[23] Janzing, Ökowärme für Bauherren bald Pflicht?, 2005.

Selected references

- Federal Agency for Economy and Export Control (BAFA) http://www.bafa.de
- Federal Association for Renewable Energies (BEE) http://www.bee-ev.de
- BINE Information Services http://www.bine.de
- Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) http://www.bmu.de
- Federal Solar Industry Association (BSI) http://www.bsi-solar.de
- German Society for Solar Energy (DGS) http://www.dgs.de

4.2 Greece

4.2.1 Background

In 2000, Greece aimed at a 10 percent share of renewable energies of total primary energy consumption, but achieved only a share of 5.2 percent.[24]

Within Europe, Greece occupied with a total installed collector area of 2.8 million m^2 the second place after Germany in 2004. In that year a growth of 34 percent of newly installed collector area was achieved. For 2005, similar growth was expected. For many years Greece had the highest per capita-collector area within Europe. Currently, Greece occupies the third rank behind Austria and Cyprus (see Figure 2) with an area of 263.9 m^2 per 1,000 inhabitants (equals 184.7 kWth/1,000 inhabitants).[25] The inner-European market share lies at approx. 20 percent. [26]

While during the 1980's about 300 companies of predominantly smaller producers were active, a strong concentration process was observed in last years. At present, there are approx. 45 producers of solar water heaters. Between 150,000 and 200,000 m^2 collector area out of the annually produced 250,000 to 300,000 m^2 were installed on Greek roofs yearly since 1985. Also due to the over-capacities that originated during last years the export share increased to approx. 40 percent.[27] Imports do not play a role for the Greek market.

Almost all installed solar water heaters for households in Greece are simple thermosyphon systems with electrical back-up function for domestic applications.[28] The average collector area amounts to approx. 2.4 m^2 in connection with a 150 litres tank. These systems cover about 80 percent of a household's total hot water demand. Normally, the systems dispose of a warranty claim of 5 years. The period of amortisation is about 4 to 6 years. Costs per square meter collector area amount to approx. 250 € plus value added tax (vat). A complete system of this size including its installation costs the end-user approx. 800 to 900 €. Less than 1 percent of the systems are installed at hotels, swimming-pools or commercial companies, whereas in contrast about every fourth household has a solar water heater.

Since the 1980's, solar water heaters are widely disseminated in Greece. Rising electricity charges were the catalyst for the emergence of solar thermals in the mid 1970's. Until today, heating of water is usually carried out with electricity. High annual solar radiation of average 1,560 kWh / m^2 provides furthermore a good breeding ground for the prosperity of solar thermals in Greece. A barrier for solar water heaters were and are still declining electricity charges since the middle of the 1980's (from 1993 to 2003 minus 28 percent) as well as a for solar thermals adverse purchase tax (power and gas 8 percent, solar water heaters 18 percent). Solar thermals became relatively more expensive, which led to decreasing sales numbers.

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[24] EREC, Promotion and Market Stimulation of RES in EU and Candidate Countries, 2004.

[25] EurObserv'ER, 2005.

[26] ESTIF, Solar Thermal Markets in Europe (Trends and Market Statistics 2004), 2005.

[27] Fawer-Wasser, Plinke, Solarenergie – heiter oder bewölkt? Aktuelle und zukünftige Aussichten für Photovoltaik und Solarthermie, Basel (2003).

[28] If demand for hot water exceeds the quantity provided by the thermosyphon system, water can be heated with electricity as well.

Nevertheless, the Greek solar system market could evolve well, given the impulse provided by several financial promotion measures. Apparently the market for solar thermals had reached a critical size and is now self-supporting. However, saturation is observed now to a large extent. Presently there is no governmental promotion of solar water heaters on household-level. For this reason, the programme for tax deduction of investment costs is analysed. This programme was valid until the end of 2002.

Currently, more attention is paid on installations within the commercial sector, which, as already mentioned, barely uses the advantages of solar water heaters. Respective promotion programmes are defined in the "development law". Due to the observed saturation of the market growing efforts are noticed since a few years in the area of solar cooling..

4.2.2 Programme-outline

Programme generals: In Greece, a variety of factors contributed to the success of solar water heaters. Of crucial importance, however, was the promotion of solar water heaters through deduction ability of investment costs from the personal income tax since the end of the 1970's (Law 814/1978, Law 1473/1984) until 1991.

Promotion-details: By setting off investment costs (maximum 30,000 and 40,000 drachms respectively) against his taxable income, the customer could reduce investment costs for a system up to 40 percent.[29] Thus, he did not receive promotion immediately, but he could fetch back the indirect promotion via his income tax return. As between 1991 and 1993 a clear decline in sales was observed, the Greek Ministry for Development introduced another programme for the period from 1995 to 2002. This programme gave households the possibility to extract 75 percent of investment costs from their taxable income and thereby lower private investment costs. This offered a reduction of investment costs of up to 30 percent.

Promotion coverage: Authorised for promotion in line with these programmes were all solar water heaters for private households which served for hot water generation on household-level.[30]

Application: Apart from the deductible limits of 30,000 and 40,000 drachms respectively, the promotion contained no restrictions and required only the presentation of purchase and investment receipts of the solar water heaters together with the income tax return. The documented costs were then extracted from the total taxable income of the household. Dependent on the personal tax rate the costs for households were thus reduced by the personal tax rate multiplied with actually emerged and documented costs. Indeed the household had to pre-finance total investment costs but could recover them partially via the income tax return.

Campaigns/ Information strategies: Parallel to the tax deduction ability, the Greek solar industry association *EBHE* established shortly before arranged intensive publicity and information campaigns. With governmental support *EBHE* broadcasted commercials in 1984 and 1986 and started collaborating with "Public Power Corporation (*PPC*)", a large utility, in 1994/1995 in order to push the distribution of solar water heaters. Posters and leaflets in the branches of *PPC* as well as material attached to the power bill promoted solar thermals. The

[29] 40 percent because the maximum tax rate in Greece at that time was exactly at that percentage.

[30] Enterprises were authorised for promotion as well under the programme between 1995 and 2002.

information work was not limited to households, but also informed the construction industry and their relevant players.

Quality assurance: Although research and technical advances of systems played a minor role, a variety of national quality standards were defined at the end of the 1980's and continuously adjusted. Nowadays, almost all products fulfil these standards which in fact are not binding. When implementation of the promotion started, there were almost no qualified personnel which could have guaranteed a professional installation. Therefore, mostly large producers decided to establish shops where they offered not only their systems but also installation, maintenance and required reparations of their products.

Results of promotion: Pushed and accompanied by the possibilities of tax deduction, the Greek market experienced a growth from 1.7 million m^2 installed collector area in 1990 to 2.8 million m^2 in 2004.[31] Therefore, about 25 percent of all households dispose of a solar water heater which covers more or less 80 to 90 percent of total hot water consumption. Accumulated energy generation with solar water heaters amounts to 4.32 PJ, which is equal to an annual saving of 280 GWh (substitute electricity/sun). Although, nowadays the Greek market receives no financial support in terms of a governmental promotion anymore, the second biggest market in Europe did not experience a slump with regard to newly installed collector area. With a new installed collector area of 215,000 m^2 or 151 MWth the market grew approx. 34 percent in 2004. Besides the self-supporting market it must be considered in this context that the hard winter of 2003/2004 with snow and frost destroyed several simple thermosyphon systems and drove households to replacement investments.

4.2.3 Criteria-based assessment

Case Study Greece (tax deduction ability)

Transaction costs for applicants	+	• extremely simple mechanism
Transaction costs for promotion provider	+	• already existing infrastructure of the tax authorities could be used for the processing within the income tax return • extremely low bureaucratic effort
Market orientation	+	• Greek solar industry association (*EBHE*) made a valuable contribution in form of private campaigns and information of the population • Greek solar industry association (*EBHE*) played a crucial role in guaranteeing installation and product quality
Adjustment to country-specific conditions	o	• non-consideration of high inflation rates reduced promotion significantly
Credibility and reliability	+	• households were independent from administrative decisions, since all systems were supported through tax deduction ability
Sustainability	+	• solar industry could evolve well because of long-term support of solar water heaters • high acceptance in population lead to a sustainable growth and a stabilisation of demand • self-supporting market

[31] ESTIF, Solar Thermal Markets in Europe (Trends and Market Statistics 2004), 2005.

Efficiency/Cost-benefit ratio	+	• increase of total installed collector area from 1.7 million m^2 (1990) to 2.8 million m^2 (2004) • presently, 25 percent of Greek households dispose of solar water heaters • accumulated energy production with solar water heaters 4.32 PJ equals an annual saving of 280 GWh (substitute electricity/sun)

4.2.4 Lessons Learned

The example of Greece shows how important it is not only to promote solar thermals via a promotion mechanism, but to implement an overall concept with high participation of the private sector. In Greece, especially this co-action and meshing of several elements were crucial for success. This lesson is essential and should be considered in the promotion of solar water heaters. In this respect, the promotion initiative of Greece can offhand be understood as a very felicitous example for success.

The experiences from Greek clarify that during the design of a promotion mechanism its simplicity and financial attractiveness must be kept in mind. Although households did not receive promotion at the point of time they incurred the investment in the solar systems, tax deduction ability proved an effective tool. When considering a promotion via tax deduction ability in further countries, attention should be paid stringently to conditions of the existing fiscal system. The effect of such a mechanism most likely is moderated in countries with bad fiscal morality. Moreover, the promotion has to be adjusted to eventually arising social injustice since high income households would benefit disproportionately high compared to lower income households in the case of progressive tax rates. The consideration of maximum amounts seems reasonable. However, declining impact of high inflation rates should not be disregarded.

Another success factor is the high degree of reliability, which could be assured for systems as well as for their installation. The case study of Greece shows the importance of the active participation and instrumentalisation of the solar industry for the distribution of solar water heaters. After all, the high dedication of the national solar industry association in Greece (*EBHE*) contributed to high quality standards and helped as well to overcome the population's scepticism. Bad experiences due to inadequate quality or installation deficiencies, which should be avoided in terms of a sustainable and successful market launch, are therefore barely known of.

Exemplary and recommended for imitation was as well the target-oriented and partly government-supported information work of EBHE which sensitised the population as well as the construction industry for solar thermals and informed about personal added value and benefits related to the utilisation of the systems.

It must be regarded, that in Greece ecological considerations played a minor role as well. Decisive factors for households were rather anticipated financial savings, higher comfort through the continual availability of hot water and the prospect of a problem-free and secure use of the system. During implementation of a promotion mechanism these aspects should definitely be considered.

The development of solar water heaters in Greece shows that a sustainable and self-supporting market can emerge, if promotion of solar water heaters is understood as a comprehensive overall-concept. After all, a high awareness for the use of solar energy could evolve, also against the background of favourable climatic conditions and high alternative

energy costs, so that the solar water heaters are now seen as a solid part of Greece energy supply at household-level.

Selected references

- Greek Solar Industry Association (EBHE) http://www.ebhe.gr
- Centre for Renewable Energy Sources (CRES) http://www.cres.gr
- Ministry of Development http://www.ypan.gr

4.3 France

4.3.1 Background

Renewable energies played a minor role in France until the end of the 1990's. Mostly dominated by nuclear power, the government and the public utility Energie de France (*EdF*) were barely promoting renewable energies. This has changed in the meanwhile. The view over the border to Germany and its development, as well as other influences changed public and political opinion. The aim is now to cover 21 percent of national electricity demand with renewable energies till 2010.

It must be considered that the French market is separated into two independent sub-segments. On the one hand there are the overseas-territories with approx. 300,000 m^2 installed collector area. On the other hand, and this is what this study focuses on, there is continental European France. Average annual solar radiation in France amounts to approx. 1,250 kWh/m^2 and provides favourable conditions for the use of solar water heaters. Approx. 280,000 m^2 of collector area are installed in France thanks to rapid growth during the last years (20 to 30 percent per year). In 2005 alone an area of about 100,000 m^2 was newly installed. However, in comparison with other European countries the market share of France of only 2 percent remains at a very low level.[32] The installed collector area amounts to approx. 13.2 m^2 per 1,000 inhabitants (equals 9.2 kWth/1,000 inhabitants).[33]

At present the French market for solar water heaters consists of approx. 30 national producers and importers. Due to strongly rising demand the number of players presently active in the market has increased considerably. However, the share of imported solar water heaters is still high. While mainly simple thermosyphon systems are used in the overseas-territories, continental France is dominated by two circuit indirect systems with a collector area of usually 4.5 m^2 and a tank of approx. 250 litres. Costs per square meter amount to about 900 €.[34] In average such a system costs about 5.000 € excluding installation.

In France, solar water heaters have been used since the beginning of the 1980's. After an initial phase with up to 60,000 m^2 newly installed collector area per year the market of continental France shrank continuously till insignificance between 1987 and 1999.[35] In contrast, the market in the overseas-territories evolved much more dynamic thanks to appropriate promotion mechanisms.

In order to give solar thermals a growth impulse as well in continental France, a national promotion programme was agreed upon, the "*Plan Soleil*", which contains besides financial stimulations mainly quality aspects. Moreover, some regions and local authorities offer additional financial appropriations which can be cumulated with those from the *Plan Soleil*. This intense promotion leads up to a duplication of granted subsidies from *Plan Soleil* in some regions. However, it is mostly the initiative at national level which is responsible for latest growth developments and which is for this reason analysed in this study.

Mainly the already mentioned favourable climatic conditions in connection with the so far barely tapped potential are the reasons which make France one of the most interesting

[32] ESTIF; Solar Thermal Markets in Europe (Trends and Market Statistics 2004), 2005.

[33] EurObserv'ER, 2005.

[34] ESTIF; Solar Thermal Markets in Europe (Trends and Market Statistics 2004), 2005.

[35] In effect, more collectors were removed than newly installed.

growth markets in Europe. Therefore, France close ranks with the leading solar thermal nations Germany, Greece and Austria in the course of the next ten years.

4.3.2 Programme-outline

Programme generals: The *Plan Soleil*, originally named „*Helios 2006*", was created in 1999 on initiative of the later French environment minister Yves Cochet and came into force in 2000. The original duration period was seven years. In the meanwhile the *Plan Soleil* was extended until 2008. The national French energy agency (*ADEME*) is in charge of programme coordination. In addition to solar water heaters on household-level the *Plan Soleil* also sponsors collectively used solar water heaters for apartment buildings, hospitals, hotels, etc., as well as combined systems for heating support. In this paper, however, only implementations for domestic applications will be analysed. New installations per year shall increase till 2006 up to 112,000 m^2 and till 2010 even up to 200,000 m^2.[36] Overall installed collector area shall rise till 2010 up to 1,000,000 m^2. 50 percent hereof shall be in the sector of hot water supply at household-level.[37]

Promotion-details: At first, the programme supported private households with flat-rated, direct grants. From the beginning of the programme until December 31st 2002 promotion on household-level was provided with a flat-rate that amounted to 900 € per solar water heater . Since 2003, promotion is staged depending on collector area. Systems up to 3 m^2 were sponsored with a flat-rate of 690 €, systems between 3 and 5 m^2 with 920 € flat and systems between 5 and 7 m^2 with 1,150 € flat . That equals more or less a reduction of 30 percent in investment costs. Since January 1st 2005, grants were changed from direct to indirect grants. In 2005, it was possible in France to extract 40 percent of the system costs (excluding installation costs) from the personal taxable income. Since 2006, deduction ability was increased up to 50 percent of purchase costs.

Promotion coverage: Promotion instruments of the *Plan Soleil* are mainly targeting private households and the investment in solar water heaters . However, industrial understakings and local authorities can benefit from the promotion in the frame of the *Plan Soleil*. In these cases apply different promotion rates.

Application: *ADEME* as the coordinating authority was also responsible for processing the promotion applications for direct grants. The present promotion via tax deduction ability of a part of the system costs proceeds in line with the common income tax return of the household and is accordingly handled by responsible tax authorities.

Origin of budget: Appropriations are financed out of the national budget. An explicit contra-financing method does not exist.

Promotion payment: Direct grants, before the change to tax deduction ability, were transferred to the beneficiary household. Presently, promotion occurs via reduction of tax duty. This can lead to an income tax refunding if applicable.

Campaigns/ Information strategies: Since 2000, *ADEME* has performed wide information campaigns to publish the possibilities of financial promotion and to present the use of solar water heaters in general. Besides commercials in TV and print media there are attempts to arouse interest of private households and business for solar thermals by participating in trade

[36] REACT, Best practice policies to develop Renewable Heat markets, 2004.

[37] ESTIF, Sun in Action II – A Solar Thermal Strategy for Europe. Volume 2, 2005.

fairs and similar events. Additionally, producers of solar water heaters initiated publicity campaigns on their own.

Quality assurance: A core element of the *Plan Soleil* is guaranteeing levels as high as possible regarding the quality of the system and its installation. In order to obtain the permission to offer households an installation that qualifies for promotion, installers are required to participate in the qualification programme "*Qualisol*" and to obtain the respective certification. Moreover, only systems approved by CSTB, a verification institute, are authorised for promotion. Besides the standards developed by *CSTB* EU-quality standards are used as well for certification purposes. Until October 2005, more than 9,000 installers could document their qualification with the official *Qualisol*-seal.[38] *Qualisol* forms a fundamental element of the information campaign of *ADEME* referred to above. The minimum warranty period amounts to 2 years. Usually, producers grant a 5 years warranty however.

Particularities: Although the *Plan Soleil* is explicitly a programme at national level, it was not introduced nationwide at once, but firstly in 5 regions, and then extended to additional 4 until finally extended to all 22 regions as of 2002.*ADEME* is represented through branches in all 22 regions of France.

Results of the promotion: While in 1999 sales of flat collectors still amounted to 3,500 m^2, in 2001, installations reached already 10,000 m^2. This equals more or less a triplication. In 2004, this number could be increased up to 52,000 m^2. For 2005, the French solar association *Enerplan* anticipated another duplication of newly installed collector area to 100,000 m^2, more than two-thirds hereof in the sector for hot water supply on household-level. Since its introduction in 1999, the *Plan Soleil* has provoked an increase of collector area of approx. 250.000 m^2. This equals a newly installed capacity of 176 MWth since 1999.[39] So far there are no official numbers from *ADEME,* but *CSTB* estimates, that newly installed collector area induced by the *Plan Soleil* led to a prevention of approx. 13,000 tons of CO^2.

4.3.3 Criteria-based assessment

Case Study France (change from direct grants to tax deduction ability)

Transaction costs for applicants	+	• plain promotion modalities for direct grants (flat-rates) • extremely simple mechanism for tax deduction ability
Transaction costs for promotion provider	o	• already existing infrastructure of *ADEME* could be used for processing of promotion applications for direct grants • already existing infrastructure of fiscal authorities can be used for handling of promotion applications in the frame of income tax return (tax deduction ability) • tax deduction ability requires a particularly low bureaucratic effort
Market orientation	+	• producers developed own marketing concepts oriented towards households • French solar association *Enerplan* developed own marketing concepts for information of the building industry • Certificated *Qalisol*-installer are main contact persons for households and serve as well as multipliers of the promotion programme

[38] Enerplan, Dossier de presse l'actualité du marché solaire en France, 2005.

[39] Enerplan, Dossier de presse l'actualité du marché solaire en France, 2005.

Adjustment to country-specific conditions	+	• intense campaigns to underline the relevance of renewable energies against the background of low environmental and energy awareness
Credibility and reliability	+	• long-term orientation (six years) of programme created confidence • standards for quality of installation (*Qualisol*) and systems enlarged confidence in quality • enlargement of installers' know-how increased reliability through good quality of systems and installation
Sustainability	+	• change from direct to indirect grants (tax deduction ability) to antagonise market overheating
Efficiency/Cost-benefit ratio	+	• increase of newly installed collector area per year from 3,500 m^2 (1999) to 100,000 m^2 (2005) • increase in overall installed collector area of 250,000 m^2 (1999) and newly installed capacity of 176 MWth (2005) • prevention of about 13,000 tons of CO^2-emissions since introduction of *Plan Soleil*

4.3.4 Lessons Learned

Experiences made in France show once more that financial incentives can positively influence the market for solar water heaters. In case of France this led even to a boom which still seems unbowed. Main motivation of the majority of French households, which decided to invest in a solar water heater, was the reduction of energy costs, i.e. the monthly electricity- and gas-bill. Just this motivation should be stringently considered during the design of a promotion mechanism.

Particularly successful and recommended for imitation is the system used in France which earmarks financial incentives to compliance of quality standards; both regarding system installation (*Qualisol*) as well as the system itself. Through this quality assurance, bad experiences with installation and products and a resulting negative repercussion on demand could be avoided in France, a market that was characterised by a low level of know how when the the *Plan Soleil* was first introduced. In this context, the quality assurance regarding the installers inheres an outstanding position. Such a procedure can be named as exemplary and seems especially essential for barely developed markets.

Moreover, it seems reasonable to agree not only on a national but rather on an international standard in terms of product quality. Otherwise foreign companies can be disadvantaged and too many different national standards and certification processes seem barely reasonable for producers. This could hinder competition on customer's account and affect prices negatively. Europe is already moving in this direction with the "Solar Keymark"-seal, which approves the conformity with EU-standards.[40]

In the context of France, a further key to success represent all those intensive efforts regarding information and convincing from both the governmental *ADEME* as well as from producers and installers. This shows once more, that it is advisable to mind active participation of all relevant players during the implementation of promotion programmes for solar water heaters. Especially in countries where solar water heaters and renewable

[40] Further information about „Solar Keymark": http://www.estif.org/solarkeymark/.

energies are hardly distributed and/or confronted with scepticism this aspect seems fundamental.

The example of France shows furthermore how important it is to ensure at least a mid-term perspective for the realisation of a promotion programme in order to enable a sustainable development of industry and market. It seems reasonable to keep open possibilities for modifications of the promotion modalities as noticed in France. After all, a possibly too attractive promotion may lead to booming demand and market overheating. At the same time, the promotion's reliability must be secured.

Against this background, the change from direct over to indirect subsidies in France can be understood. It must be considered, that indirect grants obviously seem less attractive than direct grants and can contribute to a moderation of demand.[41] In addition, the shift contributed to significantly reduce administrative efforts. Such a procedure seems to provide for an effective steering tool in combination with a declining development of promotion rates, and should thus be considered during the design of a promotion mechanism.

Selected references

- Agence de l'Environment et la Maîtrise de l'Energie (ADEME) http://www.ademe.fr
- Centre Scientifique et Technique du Bâtiment (CSTB) http://www.cstb.fr
- Association Professionnelle de l'Energie Solaire http://www.enerplan.asso.fr

[41] The behaviour of households suggests that an amount X has a higher value today for the households than an equivalent amount at a later point of time. Financial restrictions may explain this for a part of the households. However, considering low inflation rates this seems to be rather a psychological effect for the majority of households.

4.4 Tunisia

4.4.1 Background

Presently, in Tunisia approx. 3 percent of total energy is generated from renewable energy sources. The Tunisian government plans to increase this share considerably over the next years. For example, till 2010 all rural areas shall be electrified. Thereby, a share of photovoltaic of approx. 3 percent is aimed at.

Tunisia disposes of an average annual sun radiation of approx. 1,700 kWh/m^2. This equals a solar radiation of about 2,800 to 3,200 hours per year. This shows that Tunisia possesses excellent climatic conditions for the utilisation of solar water heaters. Nevertheless, in May 2005 total collector area amounted only to about 120,000 m^2.

Simple thermosyphon systems with a tank volume of 200 and 300 litres are most common in Tunisia. The largest producer on the Tunisian market for solar water heaters is the enterprise Giordano France, which produces solar water heaters in Tunisia since a few years. In addition, a couple of importers is active on the Tunisian market. Through activities of the governmental energy agency „Agence Nationale de la Mâtrise de l'Energie (*ANME*)" technology of solar water heaters was pushed during the last years. The average costs per square meter of collector area amount to approx. 260 € (2005).[42] These investment costs represent a core barrier especially for low and middle-class households.

Solar water heaters have been used in Tunisia since the beginning of the 1980's. In the period between 1982 and 1994 approx. 30,000 m^2 of solar water heaters were installed. There were several problems, which resulted mostly from the monopoly of one producer of solar water heaters in Tunisia (no technical progress, rising costs, quality deficiencies). Between 1995 and 2002 several promotion programmes led to a vitalisation of the market (installation of approx. 56,200 m^2). Sales numbers increased, mainly driven by a project of the "Global Environment Facility" (*GEF)*, which allowed for a promotion of about 35 percent of installation costs. The *GEF*-project contained as well measures for capacity building in the area of solar water heaters and sensitisation of the population. However, the banking sector was not involved in this promotion programme. As the budget was used up in 2002, sales numbers for solar water heaters declined strongly. After a transition period of two years without promotion, the so-called "*PROSOL Interest Rate* Facility"[43] was decided, which is implemented by the "United Nations Environment *Programme*" (*UNEP/DTIE*)[44] in 2004. This promotion programme is part of the "Mediterranean Renewable Energy Programme" (*MEDREP*).

4.4.2 Programme-outline

Programme generals: The interest rate subsidy facility, created by the *MEDREP*, aims at supporting the financial sector in order to expand credit portfolios in the area of renewable energies. For this purpose, an interest subsidy is paid for a fixed share of the loan amount.

[42] GTZ, Solarenergie in Tunesien. Markt und Perspektiven, 2005.

[43] The name PROSOL is the abbreviation for Programme Solaire.

[44] The complete name is UNEP/DTIE: United Nations Environment Programme/Division of Technology, Industry, and Economics.

Core players of the *PROSOL*-programme are *UNEP/DTIE*, *ANME* as well as the public power utility "Société Tunisienne d'Electricité et de Gaz" (*STEG*). Presently, consumer loans are not yet a common form of financing in Tunisia. The pooling of thousands of micro-credits helps to overcome this market inefficiency temporarily at least for solar water heaters by means of the *PROSOL*-programme and enables households to access the capital market.

Promotion-details: The promotion of households occurs via low interest loans. The difference between the interest rate, which the participating banks would commonly charge, and the interest rate, which is actually paid by households, bears the *PROSOL*-promotion programme. The procedure used is the following. In a first step, banks grant loans to producers of solar water heaters, who transfer these loans in turn to households. Producers sell their systems directly to households and offer at the same time the facility for financing the system. Repayment of the solar water heater occurs via the monthly electricity bill of the public power utility (*STEG*). Over a period of 5 years, households are charged constant amounts monthly for loan repayment via the electricity bill. Thereby, the risk of default can be reduced extremely.[45] The amount of the monthly rate depends on the solar water heater that needs to be paid.[46] Monthly rates are covered by energy savings, in the ideal case completely, but at least partly, so that the household has not to pay a higher invoice amount as it was the case before borrowing. *STEG* collects monthly payments and transfers the total amount to a bank, which in turn divides the money to the credit-allocating banks. Households repay the credit amount plus interests, which was originally received by the producer. The interest rate of such a loan is 7 percent and thus below market level.[47] At the beginning of the *PROSOL*-programme in March 2005 the interest subsidy was as well 7 percent, so that households had not to pay any interests. Since April 2006, the interest subsidy was reduced to 4 percent, resulting in an interest rate for households of 3 percent. During next years a phase-out of the interest subsidy is foreseen aiming to culminate in a subsidy-free loan market.

Promotion coverage: The promotion programme is limited to private households. The promotion is incumbent on restrictions insofar that only a limited number of producers are allowed to participate in the promotion programme. Moreover, households may choose between a system with a tank volume of 200 or 300 litres.

Application: Households interested in a solar water heater may first contact the preferred producer. In a next step, a standard application form for the promotion needs to be filled out together with the installer. Besides this form, the only requisites are an up-to-date bill from *STEG* and a proof of identity. This shows that the household does not need to enter a bank for applying to the programme. Application and approval are rather carried out directly by the producer. Installation of the system by the installer can occur immediately. A waiting period is not required.

Origin of budget: Total funds of the *PROSOL*-programme amount to 2 million US$ and are provided by the Italian Ministry of Environment and Territory. Thereby, 1 million US$ is used by *UNEP* for interest subsidies and another million by *ANME* as capital cost subsidies.

Promotion payment: Payment of the promotion for the customer occurs in a decrease of the interest rate. This reduces the interest charge to be beared by the household.

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[45] The default ratio noticed so far is close to zero.

[46] Systems with a tank volume of 200 litres and a purchase price of 550 US$ require for example a monthly rate of 9 US$ (analogue: tank 300 litres, price 700 US$, monthly rate 11.50 US$).

[47] PROSOL-loans are thereby cheaper than mortgage credits. The present interest rates for consumer loans are more than triple of the PROSOL-interest level.

Campaigns/ Information strategies: Besides commercials in TV and advertising over radio, the publicity campaign included as well announcements in several print media. In banks and governmental buildings the programme was promoted with leaflets and posters. Moreover, a raffle was initiated, where solar water heaters were provided gratis by producers. Additionally, seminars about solar water heaters were organised. The campaign was arranged and co-financed by *ANME* and *UNEP/DTIE*.

Quality assurance: In the frame of the programme, a quality-verification was carried out by *ANME.* Technical requirements were published in a so-called performance specification sheet. In addition, ANME performed installation checkings. Moreover, ANME is responsible for technical attendance of the project and may cancel producers from the list, which contains producers approved for the programme. Another element in the course of quality assurance provided by the programme is training for installers of solar water heaters.

Results of the promotion: *UNEP/DTIE* hopes to enable Tunisian households the financing of up to 30,000 solar water heaters throughout the next three to four years. From the beginning of the programme in April 2005 until December 2005 already 13,675 m^2 of new installed collector area could be financed with the interest subsidy facility. 4,150 households could finance in that way a solar water heater. From the programme-launch until March 2006, 29,000 m^2 of new installed collector area are forecasted. That would equal 8,800 households benefiting from the promotion. Until 2011 a total collector area of 220,000 m^2 shall be installed and financially supported by the promotion programme. It is assumed that each US$ subsidy can generate more or less 5 to 6 US$ of additional credit volume.[48]

4.4.3 Criteria-based assessment

Case Study Tunisia (low interest loans)

Transaction costs for applicants	+	• extremely simple mechanism
Transaction costs for promotion provider	+	• already existing infrastructure of the public utility *STEG* can be used for payback of credits • extremely low bureaucratic effort, because banks and producers can be involved as well
Market orientation	+	• participation of banking sector, producers, the national energy agency as well as the public utility *STEG*
Adjustment to country-specific conditions	+	• well established banking system facilitates the programme's implementation
Credibility and reliability	o	• credible tool, because conditions remain unmodified for households for the complete duration (constant rates) • middle or long-term commitment of public utility is required to avoid excessive indebtedness of producers (lack of credit assurance tools)

[48] UNEP, Mediterranean Renewable Energy Programme, 2005

Sustainability	+	• financial sector is strengthened and shall gain confidence, so that banks finally offer credits directly to households • promotion programme shall contribute to establishment of solar thermal industry • phase-out through declining interest subsidy over 2 to 3 years (increasing interest rate for households)
Efficiency/Cost-benefit ratio	+	• increase of newly installed collector area from April 2005 to December 2005 of 13,675 m^2 (equals 4,150 households) • forecasted increase of newly installed collector area from April 2005 to March 2006 of 29,000 m^2 (equals 8,800 households) • forecasted increase of newly installed collector area to 220,000 m^2 till 2011 since the star of the programme in April 2005 • per US$ subsidy a credit volume of 5 to 6 US$ shall be generated

4.4.4 Lessons Learned

The programme seems promising, although there are only few experiences due to the programme's duration of approx. one year until today. The *PROSOL*-programme can contribute via its interest subsidy facility mainly to mitigate the problem of high up-front investment costs for solar water heaters on household-level in connection with limited access to credit markets .

Crucial for success in Tunisia seems the involvement of the Tunisian government in the design of the promotion mechanism. The fact that the public utility *STEG* could only be persuaded to participate in the programme through dedication of the government underlines this fact. The involvement of *STEG,* as the main player regarding the repayment of loans over the electricity bill, is at the same time the key to success for the system in Tunisia. Such an approach seems very efficient and is applicable as well in other promotion programmes since it facilitates to reduce the risk of loan default on the one hand and, which is particularly favourable, the implementation of a declining trend regarding the promotion on the other. In the ideal case this would imply that during the phase-out of the promotion a publicly-accessible credit market for solar water heaters would emerge, which enables private households to receive loans for the purchase of solar water heaters.

Another success factor is the banks' willingness to invest in renewable energies, although the offered interest rate of 7 percent is under market level. The promotion programme shows, that banks definitely can be motivated for commitment in new markets. This experience can be valuable for future programmes.

Although success reached so far with the *PROSOL*-programme exceeds the original expectations and although producers count with significant additional sales, exactly this represents the programme's core problem: The stronger the increase of producers' sales numbers, the higher their entered debts for production of solar water heaters. Indeed producers see their four or fivefold increase in sales positively. However, they do fear a system breakdown in case that *STEG* steps back from its role as collection agency. In the course of such a promotion programme it should be considered how the risk of excessive indebtedness can be avoided. In case of Tunisia, insurance tools could be a solution.

The example of Tunisia shows that the involvement of the banking sector in promotion programmes can be a good alternative. As a result of positive experiences promotion

activities are currently enlarged in Tunisia. In May 2006 a similar project for promotion of solar water heaters is supposed to start in the hotel sector.

Selected references

- Agence Nationale de la Mâtrise de l'Energie http://www.anme.nat.tn
- Société Tunisienne d'Electricité et de Gaz http://www.steg.com.tn
- United Nations Environment Programme, Division of Technology, Industry and Economics http://www.uneptie.org/energy/finance

4.5 Barcelona

4.5.1 Background

Spain has set ambitious targets to expand the utilisation of renewable energies in the "Plan de Fomento de Energías Renovables 2000 - 2010 (*PFER*)" and in its update the "Plan de Energías Renovables en España 2005 - 2010 (*PER*)". Until 2010, at least 12 percent of total energy consumption shall be generated from renewable energies. The contribution of solar thermal energy to achieving this target is supposed to be a total installed collector area of 4,900,000 m^2 till 2010. In 2004, the installed collector area amounted to 700,000 m^2.[49] The inner European share was approx. 6 percent.[50] Before 2000, solar thermal energy were almost meaningless in Spain.

The collectors utilised in Spain are relatively simple flat collectors. Production of collectors is still carried out by small, local companies and is little automated. A large part of solar water heaters is imported. However, a stronger national orientation and higher mechanisation could be observed recently. Average costs per installed square meter of collector area of small systems with 2 m^2 amounted to 663 €/m^2 (2005). Larger systems used at apartment buildings or hotels cost on average 579 €/m^2 in 2005.[51]

Besides the promotion programmes from the "Instituto para la Diversificación y Ahorro de la Energía (*IDAE*)" which work with direct grants ordinances on municipal level are of great importance in Spain. The first Construction Ordinance was effectively implemented in Barcelona and represents with no doubt a milestone in urban energy politics.[52]

Barcelona, situated in Catalonia, possesses extremely favourable conditions for the utilisation of solar water heaters with an average of 2,477 hours of sunshine per year and an average annual solar radiation of 1,502 kWh/m^2. Theoretically available solar energy equals more or less the tenfold of the city's energy consumption.[53]

Although Barcelona shows a comparably low level of green house gas emissions, the city council went for an optimising of the energy-mix, as the city sourced almost half of their energy from nuclear power in 1999. At that time the share of renewable energy sources represented only a marginal portion. 4 percent were generated from hydro power and approx. 1 percent from other renewable energy sources.[54] Another reason for a growing use of renewable energies was the strongly increasing energy consumption of Barcelona's population and the resulting increase in CO^2-emissions. The city-owned energy agency forecasts an increase of about 30 percent till 2010 regarding both of these trends.[55]

The Barcelona-Ordinance last but not least is based on a misinformation. Barcelona's city council justified the introduction of the construction obligation for solar water heaters with a

[49] IDAE, Plan de Energías Renovables, 2005.

[50] ESTIF, Solar Thermal Markets in Europe (Trends and Market Statistics 2004), 2005.

[51] IDAE, Plan de Energías Renovables, 2005.

[52] There is a comparable Ordinance in Israel already since 1980. This ordinance is in fact not only valid for municipal level, but nationwide.

[53] Agència d'Energia de Barcelona, The Solar Thermal Ordinance: evaluation and results, 2005.

[54] Rentzing, Grenzenlos Solar, 2005.

[55] Korneffel, Rentzing, Europas Sonnenmetropole, 2005.

supposedly already existing obligation for new buildings from Berlin. Indeed there was an elaborated version of this ordinance in Berlin. However, it was never implemented.[56]

Barcelona tries to improve its environmental performance evaluation not only with the Construction Ordinance. There are several additional attempts in the frame of the "Plan Energético de Barcelona", among these for example projects in the area of photovoltaic, biogas, biodiesel as well as energy efficiency.

4.5.2 Ordinance-outline

Programme generals: The Barcelona-Ordinance (Ordenanza Solar Térmica de Barcelona) was approved by Barcelona's city council in July 1999, came into force in August 2000 and aims at 90,000 m^2 newly installed collector area by 2010. The Barcelona-Ordinance forms part of the "Plan de Mejora Energética" and falls in the responsibility of the urban "Agéncia d'Energia de Barcelona" and the city council. In contrast to those promotion mechanisms already introduced, no financial resources are provided in connection with the Barcelona-Ordinance. The Ordinance includes only an obligation to install solar water heaters and is thus not an economic promotion mechanism. In fact the Ordinance can be assigned to police law.

Promotion details: The Ordinance requires that all new buildings with a daily average energy consumption for hot water supply exceeding 292 MJ (approx. 2000 litres) generate at least 60 percent of the required energy is sourced from solar water heaters. Buildings subject to fundamental renovations and replacements are covered by the Ordinance as well. Furthermore, the Ordinance regulates that heating of swimming-pools must be realised with a 100 percent of solar energy.

Installation obligation: The installation obligation covers all residential buildings, hospitals, gymnasiums and commercial buildings, which exceed the limit mentioned above. In case of residential buildings this is usually the case for buildings with more than 16 to 17 units of 4 persons each.

Procedure: The implementation of the Ordinance is based on the requirement placed on constructors to prove already when applying for construction permits or environmental projects how energetic demands of the Barcelona-Ordinance are supposed to be met. The constructor is obliged to actually use and maintain the system, as well as, if applicable, to repair it. This is supposed to assure that the systems are actually used.

Campaigns/ Information strategies: The development of the norm and its dissemination was influenced strongly by the "Mesa Solar de Barcelona". Several stakeholders and associations (architects, energy associations, municipal representatives, associations of renewable energies) were involved in its design. Between the norm's approval and its coming into force a period of one year was chosen for a moratorium deliberately; on the one hand to counteract existing scepticism and refusal by certain stakeholders regarding the integration and maintenance of solar water heaters as such and due to the expectation of rising prices of construction projects and . On the other hand a guidebook was developed during this year to explain the Ordinance and an information campaign was realised that involved the participants of the Mesa Solar de Barcelona.

Quality assurance: The norm demands compliance with quality standards regarding installation and system specifications. Collectors must be certified by licensed institutions. The "Reglamento Nacional de Instalaciones Térmicas en los Edificios (*RITE*)" claims

[56] Poganatz, Betr.: Solaranlagen-Verordnung, 2003.

moreover that installers must be recorded in the respective register and must possess a certificate on the vocational training to a qualified installer.

Results of the Ordinance: Presently, resulting from the Barcelona-Ordinance about 40 percent of all new constructed buildings posses a solar water heater.[57]The installed collector area could be increased from 1,650 m^2 to 24,531 m^2 in the period from January 1st 2000 to April 2004 (from 1.1 m^2/1,000 inhabitants to 16.39 m^2/1,000 inhabitants installed collector area). A survey by the energy agency in Barcelona shows that as of March 2004 approx. 65 percent of the systems were used in the residential sector. Another 11 and 12 percent respectively were installed at hotels and gymnasiums.[58] The Barcelona-model has several imitators in Spain (Madrid, Seville, et al.), thereof 39 in Catalonia and another 16 elsewhere in Spain. High demand by local authorities provoked *IDAE* to provide a Model-Ordinance for local authorities based on the Barcelona-Ordinance. After the first four years, a revision of the Barcelona-Ordinance was decided in 2005. Core modifications include an expansion of the obligation to all new buildings, a certification of system installation and the obligation for the installer to offer the customer an at least biennial maintenance and guarantee contract. Additionally, the norm was extended with regard to an improved architectural integration of solar water heaters and now allows installation at storefronts, however, only on the condition that the cityscape is not influenced negatively. This step was taken above all to close loopholes, which emerged because the installation of solar water heaters was denied on some buildings due to urban, technical specifications.

4.5.3 Criteria-based assessment

Case Study Barcelona (Construction Ordinance)

Transaction costs for applicants	+	• clear and unmistakable regulation • but: imposition of additional costs on constructor through obligatory installation including consulting and planning services
Transaction costs for promotion provider	+	• in the course of a required permission for construction project, independent from the Ordinance, an adequate integration of the solar water heater can be checked well • utilisation of existing infrastructure of the authorities responsible for construction permissions • relatively low bureaucratic effort
Market orientation	o	• despite establishing the „Mesa Solar de Barcelona“ and bilateral dialogues with several stakeholders and associations (architects, energy associations, municipal representatives, associations of renewable energies) the involvement especially of the private sector was insufficient • problems due to character of a norm/ obligation to install and the resulting higher construction costs
Adjustment to country-specific conditions	-	• due to an unincisive awareness for renewable energies and environmental questions information about utilisation of solar water heaters should have been more emphasised

[57] REN 21, Global Status Report, 2005.

[58] Agència d'Energia de Barcelona, La Ordenanza Solar Térmica de Barcelona, 2005.

Credibility and reliability	+	• in principle a very credible tool, but: loopholes, constructors could partly elude themselves of the construction obligation, because the Ordinance text provided for construction limits, which partly could be used intentionally
Sustainability	+	• high initial limit value of 292 MJ and therewith a conscious limitation of affected buildings to confront resistances • perpetuation of the norm and step-by-step reduction of the limit value/ expansion of the norm on other buildings can guarantee a high degree of sustainability
Efficiency/Cost-benefit ratio	+	• high probability of target achievement • increase of installed collector area from 1,650 m^2 to 24,531 m^2 between January 1st 2000 and March 2004 (equalling 1.1 m^2 to 16.39 m^2/1.000 inhabitants) • prevention of 3,451 tons of CO^2-emissions per year (status: 01/2005)

4.5.4 Lessons Learned

In general, the Barcelona-Ordinance represents a success story. As the first construction obligation of this kind in Europe it is a precursor for a variety of other Ordinances in Spain and is classified as one of the most prominent examples for success allowing to draw recommendations for further programmes.

The example of Barcelona shows that information and active participation of citizens as well as stakeholders, who are affected by the norm, are of crucial importance for success. Important in this context is to communicate ecological and economical benefits associated with the installation of an appropriate system. This is the only way to create a positive prevailing mood as a pre-condition for the actual implementation of the norm.

Choosing an ordinance as a promotion mechanism allows for a comparably fast and nice–to-plan expansion of installed collector area which can quasi be forced due to the Ordinance's binding character. However, in no way, should the arduousness of a norm as such be supported, because this would lead to significant additional costs for stakeholders (mainly constructors). After all, a norm forces the integration of a solar water heater architecturally and energetically causing an increase in planning costs. However, it should be kept in mind that all constructors are concerned in the same way which does therefore not result in any distortion of competition. Rather should constructors transfer costs directly to the real estate's tenants and buyers respectively. Nevertheless, the example of Barcelona shows that by all means it can come to resistances.

Another important point is to consider diverging interests of constructor/seller and buyer, since the installation of solar water heaters appears purely in form of additional costs to the constructor, because he will not use the system by himself. Due to partly insufficient information of citizens in Barcelona, customers didn't see the added value of the systems either and thus had no interest in installation or utilisation of such a system. This underlines the crucial importance of comprehensive information for all affected groups. A problem similar to the one in the seller-customer-relation arises in the tenant-landlord-relation, since the norm finally causes costs only for the landlord and leads to energy cost savings from which only the tenant would benefit.

The example of Barcelona shows moreover the importance of reliable and efficiently operating systems, not only at start-up, but in the long-run. This is crucial for a successful, broad introduction of solar water heaters. Is that not the case, systems may well be installed

in order to comply with the norm, but might not be used to actually generate energy. The initial idea to use the sun for energy supply would end up in a complete farce.

The Barcelona approach to subordinate first only a certain share of buildings seems advisable in order to avoid massive resistance.[59] In addition, this allows the solar collector industry to grow without any short-term overheating. Increasing competition and decreasing prices, like in Barcelona, can thus come along with sustainable growth, increased awareness for renewable energies and energy efficiency as well as with a possible widening of a norm's scope.

Last but not least, the experience in Barcelona shows that an installation obligation can abet solar water heaters without burdening public budgets. However, and this is crucial, attention should be paid to not impose such a norm selectively on a single technology, but to embed such an initiative in the overall energetic context, as it was the case in Barcelona.

Selected references

- Asociación de Productores de Energías Renovables (APPA) http://www.appa.es
- Asociación Española de Empresas de Energía Solar y Alternativas (ASENSA) http://www.asensa.org
- Agència d'Energia de Barcelona http://www.barcelonaenergia.com
- Instituto para la Diversificación y Ahorro de Energía (IDAE) http://www.idae.es

[59] Exactly that happened in Barcelona, where a comparably high upper limit of 292 MJ was chosen, which explicitly only obliged only a part of buildings for the installation of solar water heaters.

5 Conclusions

5.1 Summary of the results

The analysis of the case studies for Germany, Greece, France, Tunisia and Barcelona presented in this paper shows, that promotion mechanisms whether financial incentive mechanisms or police law-based measures can contribute significantly to introduce solar water heaters into the market and/or to increase their market penetration.

For the predominant majority of households the prospect of reducing their monthly electricity or gas bill is the crucial motivation for the purchase of a solar water heater. Ecological considerations as well as climatic conditions play only a minor role. Germany for example, with a moderate solar radiation in comparison to other European countries, is one of the frontrunners in terms of solar water heaters.

Clear political framework conditions seem to have a much higher influence on the success of a promotion mechanism. Therefore, promotion programmes should make binding, reliable and middle- to long-term statements regarding the accessible promotion elements. Frequently modifying promotion conditions may in contrast cause uncertainty and is therefore harmful. On the other hand, a declining promotion is beneficial, since it encourages a sustainable development. In the ideal case, promotion results in a self-supporting market, like in Greece.

Moreover, it is essential to avoid bad experiences with solar water heaters because of qualitative deficiencies of product or installation in order to prevent a possible negative backlash on demand for solar water heaters. Abandonment of quality assuring measures is extremely hazardous especially during market launch and potentially associated with long-lasting negative effects. Linking the promotion to quality standards seems a reasonable step, especially in countries characterised by weaknesses in terms of know-how in the solar water heater sector.

Furthermore, the analysis carried out previously shows that the promotion programme needs to be easy to access and understand in order to ensure demand for the promotion and thus the programme's success. Complex mechanisms for promotion may discourage basically interested people. In this context it should be mentioned, that in addition to the design of a promotion programme its dissemination in the public is of great importance.

In this regard it is reasonable to involve players from the private sector both in design and intermediation of the promotion. This is especially true since lacking acceptance of solar thermal applications due to neglected information work and awareness building for the public may results a great barrier for the distribution of solar water heaters. Appropriate campaigns should promote particularly the economical and ecological added value of solar water heaters in order to overcome a population's partly existing scepticism.

Naturally, no general or even binding conclusions regarding the ideal design of a promotion mechanism can be drawn here. Rather, any promotion programme – as a combination of promotion instrument and accompanying measures – needs to be adjusted carefully to the respective country-specific conditions. What is working well in a certain country might failure in another just due to slight differences in country-specific conditions.

5.2 Recommendations for the design of promotion mechanisms

The following table provides an overview of favourable framework conditions and recommendations for different promotion mechanisms. The aspects are phrased positively as success factors. Barriers are not listed explicitly, since they result in most cases from the opposite of the presented success factors.

	Direct grants	Tax deduction ability	Low interest loans	Police law
Transaction costs for promotion receiver	Design promotion programmes straightforward and unambiguously			
Transaction costs for promotion provider	Use already existing infrastructure	Use existing tax authority structure	Intermediate via private banking sector or further private players	Use existing construction permit authorities
Market orientation	Utilise architects, craftsmen, etc. as multipliers		Involve house banks or similar for payment of funds	
Adjustment to country-specific conditions	Efficient banking system for cost-efficient transfer of promotion amount	Fiscal system and morality essential Avoid social injustice (poor vs. rich)	Existence and accessibility to capital market for households required	
Credibility and reliability	Align middle, better long-term (avoid dependence on annual fund release) Provide for continuity of promotion rates	Align middle, better long-term Provide for continuity of amortisation rates	Promotion conditions should be defined over complete loan period	Align long-term
Sustainability	Schedule from the beginning a phase-out-mechanism and make it transparent			Step-by-step expansion of affected buildings seems reasonable
Efficiency/cost-benefit ratio	Adjust promotion carefully, because demand reacts sensitive and an escalating increases in demand should be avoided in favour of market development	Consider during design of promotion programme, that mechanism reacts less sensitive (psychological effect due to "delayed promotion")	Especially if credits are paid via the electricity or energy bill of a household, low interest loans may represent a very efficient mechanism	"Cheap" mechanism for promotion provider, since no distribution of appropriations required
Campaigns/ information strategies	Of particular importance, if • little know-how on solar water heaters in the country on side of user as well as on side of further players (architects, craftsmen, etc) • low awareness of renewable energies Emphasise economic saving possibilities in information campaigns.			
Quality assurance	Especially necessary for prevention of negative experiences; especially if only little know-how on solar water heaters exists in the country (systems and installation)			

5.3 Implications for Mexico

As already mentioned in the previous section, generally binding statements on an ideal design of a promotion programme are not feasible. Against the background of international experiences, this section will outline those promotion mechanisms that seem feasible for the specific context of Mexico.

Mexico possesses excellent circumstances for the use solar water heaters due to its climatic conditions. However, until now, solar water heaters are in fact barely used. Main barriers besides a relatively low environmental awareness are still moderate charges for subsidised alternative energy sources electricity and gas, especially in the low consumption sector. Another fundamental barrier to stronger distribution are high up-front investment costs, although the mostly frost-free Mexican climate allows the use of simple, comparatively low priced thermosyphon systems.

The award of direct grants is not recommendable in terms of a sustainable development due to a likely short-term jump up, which could overstrain the barely existing national solar thermal industry. In addition, such a mechanism would require a relatively high administrative effort. Due to a comparatively low fiscal morality it is questionable, if a mechanism of tax deduction ability would work satisfactorily in Mexico. Such a mechanism seems rather little promising. Apart from this, neither direct nor indirect subsidies would help overcome the main barrier of high up-front investment costs.

A good alternative could be offering attractive loans. It would be conceivable that not the state itself would deal in consumer loans, but rather via credit institutions or other financial service providers, who would offer capital in order to overcome high start-up costs. Such financing options could be offered as well directly by producers of solar water heaters. A promotion programme based on low interest loans could be designed in manifold ways.

A rather fundamental question is, whether it seems generally reasonable and politically realistic to provide public financial resources in form of demand-driven subsidies of any type in a country like Mexico.

Of crucial importance in the Mexican context is the involvement of all relevant players (private producers, installers, authorities, municipals, and etc.) from the very beginning of the planning- and design-phase. Furthermore, the compliance with quality standards requires major attention as Mexico has so far only relatively little know-how with regard to production and installation of solar water heaters. Binding quality standards are essential to avoid bad experiences with solar water heaters and thus, long-term negative effects. It will be as important to sensitise Mexico's population for solar water heaters through appropriate campaigns in TV, radio and press and to convince them of the ecological, and above all the economic benefits of solar water heaters. Overcoming the scepticism prevailing in the population seems to be a pre-condition for a successful large-scale dissemination of solar water heaters on household-level in Mexico.

Annex

	Germany	Greece	France	Tunisia	Barcelona
Type of promotion mechanism	Direct grants	Tax deduction ability	Direct grants, followed by tax deduction ability	Low interest loan/ interest subsidy	Police law
Programme name	Programme for Market Stimulation (MAP)	not available	Plan Soleil	PROSOL	Ordenanza Solar Térmica de Barcelona
Players	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), Federal Office for Economy and Export Control (BAFA)	Ministry for Development	Agence de l'Environment et la Maîtrise de l'Energie (ADEME)	Mediterranean Renewable Energy Programme (MEDREP), United Nations Environment Programme (UNEP/DTIE), Agence Nationale de la Mâtrise de l'Energie (ANME), Société Tunisienne d'Electricité et de Gaz (STEG)	Agència d'Energia de Barcelona commissioned by the city council of Barcelona
Promotion duration	One-time grant	One-time deduction ability	One-time grant, singular deduction ability	60 months	For the time being unlimited
Promotion period	Since September 1st 1999	1.1.1995 to 31.12.2002	1.1.2000 to 31.12.2008	Since March 2005	since August 1st 2000
Promotion details	105 €/m² for systems up to 200 m² 60 €/m² for systems larger than 200 m² (since July 1st 2005)	Deduction ability regarding taxable income of 75 percent of investment costs; upper limit 30.000 and 40.000 Greek drachms respectively (promotion of up to 30 percent of the investment costs)	Direct grants, at last flat-rate of 690 € (for systems up to 3 m²), 920 € (3 to 5 m²), 1,150 € (5 to 7 m²) (until December 31st 2004) Reorientation to tax deduction ability of 40 percent of costs excluding installation (since January 1st 2005) since January 1st 2006: Increase to 50 percent of costs	Loans with interest rate of 7 percent Repayment of loan via electricity bill with an interest rate of 0 percent, since April 2006 3 percent Subsidy for the difference between the loan's interest and the interest paid by the household	Construction obligation for solar water heaters on new buildings with a daily energy consumption for hot water supply of more than 292 MJ (at least 60 percent via solar water heater) Heating of swimming-pools with 100 percent solar energy
Promotion subject	Solar water heaters for hot water generation, systems for burning of solid biomass, biogas plants	Solar water heaters for hot water supply	Solar water heaters for hot water supply, combination systems for heating support	Solar waster heaters for hot water supply	Solar water heaters for hot water supply
Promotion coverage	Private individuals (99 percent of systems), freelancers, small and medium-sized enterprises (SME)	Private individuals	Private individuals	Private individuals	Residential buildings, gymnasiums, hospitals, commercial buildings
Application	Via application at BAFA	Presentation of purchase and investment receipts with tax return	Via application at ADEME (direct grants) Presentation of purchase receipts with tax return (tax deduction ability)	Via application form at the installer presenting latest electricity bill Authorisation directly from the installer	Within the construction application it must be documented how energetic requirements will be fulfilled

	Germany	Greece	France	Tunisia	Barcelona
Origin of budget	Income from ecological tax reform	National budget	National budget	Mediterranean Renewable Energy Programme (MEDREP), Italian Ministry of Environment and Territory	not available
Promotion payment	Bank transfer of promotion amount Accumulation with Federal-, Federal States- or Municipal-programmes for solar water heaters not possible	Reduction of tax liability, if applicable income tax refund	Transfer of promotion amount (direct grants) Reduction of tax liability, if applicable income tax refund (tax deduction ability) Accumulation with regional promotion programmes possible	Reduction of the interest rate to be paid for the loan	not available
Campaigns/ information strategy	Communication of the programme via press releases, internet pages Multiplier role of craftsmen, architects, consultants (private campaigns „Solar – na klar!“	Publicity and information campaign of the Greek solar industry association (EBHE) in collaboration with the utility Public Power Corporation (PPC), additional support by the state	Information campaign by ADEME (TV, press, trade fairs, events) Publicity campaigns by producers	Commercials in TV and radio, announcement in print media, leaflets, posters, raffles Cooperation of UNEP/DTIE and ANME	Information campaign by Agéncia d'Energia de Barcelona with participation of stakeholders and associations (guidebook explaining the Ordinance)
Quality assurance	No requirements, however high technical standard of systems and installation	National standards since the end of the 1980's, but not binding At the beginning only little know-how; larger producers opened shops (consulting) including offers to install systems in order to overcome this problem	Qualisol-standard (binding capcity building programme for installers) Quality standards of national verification institute Centre Scientifique et Technique du Bâtiment (CSTB)	Quality checks of the systems by ADEME Training for installers of solar water heaters	Certification of solar water heaters required Installer must be listed in register and prove their qualification
Particularities	Annual funds release leads to strong fluctuation of the promotion demand	not available	Step-by-step implementation of Plan Soleil (first 5 regions, than another 4, finally all 22 regions)	Problem of potential excessive indebtedness of producers in the case STEG withdraws and the system collapses	One year moratorium between approval of the norm and its coming into force
Results of the promotion	124 million € for promotion generated investments of 853 million € (January 1st 2002 to June 30th 2004) CO^2-prevention of 88,873 tons (January 1st 2002 to June 30th 2004)	Increase of collector area from 1.7 million m² (1990) to 2.8 million m² (2004) 25 percent of Greek households possess a solar water heater Annual energy savings of 280 GWh	Increase of total installed collector area by 250,000 m² (till 2005) Increase of newly installed collector area per year from 3,500 m² (1999) up to 100,000 m² (2005) CO^2-prevention of 13,000 tons (2000 to 2005)	Increase of newly installed collector area from April 2005 until December 2005 by 13,675 m² (equals 4,150 households) Forecasted increase of newly installed collector area between April 2005 and March 2006 by 29,000 m² (equals 8,800 households) Forecasted increase of newly installed collector area until 2011 by 220,000 m² since the beginning of the programme in April 2005	Increase of total installed collector area from 1,650 m² (January 1st 2000) up to 24,531 m² (March 2004) Annual energy savings of 19,625 MWh Annual CO^2-prevention of 3,451 tons (January 2005)

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Links for a first orientation

European Renewable Energy Council (EREC)	http://www.erec-renewables.org/
European Solar Thermal Industry Federation (ESTIF)	http://www.estif.org/
Altener-Programme of the European Union	http://europa.eu.int/comm/energy/en/pfs_altener_en.html/
Global Environment Facility (GEF)	http://www.gefweb.org/
United Nations Environment Programme (UNEP)	http://ww.unep.org
United Nations Development Programme (UNDP)	http://www.undp.org/

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