



UNITED NATIONS ENVIRONMENT PROGRAMME

GUIDELINES FOR **POLICY** AND **FRAMEWORK** **CONDITIONS**



European
Solar
Thermal
Industry
Federation

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ACKNOWLEDGEMENTS

This publication is the result of a joint effort from the following contributors: The European Solar Thermal Industry Federation (ESTIF), the United Nations Environment Program (UNEP) through its Division of Technology, Industry and Economics (DTIE) and the Global Environment Fund (GEF).

This publication is part of the “Global Solar Water Heating Market Transformation and Strengthening Initiative” (Global Solar Water Heating: GSWH project). The GSWH project is a joint initiative of the United Nations Environment Programme (UNEP) and the United Nations Development Programme (UNDP) and is funded by the Global Environmental Facility (GEF) with co-financing from the International Copper Association (ICA). The objective of the GSWH project is to develop, strengthen and accelerate the growth of the solar water heating (SWH) sector.

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EXECUTIVE SUMMARY

Solar thermal is a mature and well established technology in many regions around the world. Taking into account its potential, often the market uptake lags behind. There are different reasons, different barriers that hinder the development of the technology. Adequate policies and framework conditions can enhance market growth.

This publication tries to provide “Guidelines for policy and framework conditions” related to solar heating and cooling, in particular solar water heating. It aims at providing a quick overview of the main issues to be considered for setting the right framework for the promotion of the solar thermal technology. Therefore, it outlines key recommendations and guidelines for the implementation of a programme for the promotion of solar water heating.

It targets policy makers at different levels of governance, local and regional authorities, urban planners, energy agencies, experts, stakeholders, interested citizens and consumers.

These “Guidelines for Policy and Framework Conditions” were developed as part of the GSWH project, a joint initiative of the United Nations Environment Programme (UNEP) and the United Nations Development Programme (UNDP) and is funded by the Global Environmental Facility (GEF) with co-financing from the International Copper Association (ICA). The objective of the GSWH project is to develop, strengthen and accelerate the growth of the solar water heating (SWH) sector.

GSWH consists of two components as follows:

- **Component 1** - Global Knowledge Management (KM) and Networking: Effective initiation and co-ordination of the country specific support needs and improved access of national experts to state of the art information, technical backstopping, training and international experiences and lessons learnt.
- **Component 2** - UNDP Country Programmes: Work in the country programmes revolves around addressing the most common barriers to solar water heating development: policy and regulations, finance, business skills, information, and technology.

ESTIF, as one of the project's regional partner, is committed to the development of knowledge products and services. And for that, ESTIF has been entrusted with the task of elaborating three practical handbooks to include recommendations and best practices in the following areas which have been identified as key for strengthening the solar water heating market:

- Policy and regulatory framework
- Awareness raising campaigns
- Standardization and quality

In order to provide guidance on setting framework conditions, the publication first provides a general overview of the technology and its main benefits. Then, it outlines a methodology to understand its potential, and describes the main barriers to its development. The publication also defines the importance of policies and framework conditions, and analyses the main tools to set those conditions, i.e. communication, non-financial and financial incentives.

The main recommendations stemming from the analysis carried out in this publication are the following:

- Solar thermal is a technology with multiple applications
- Public authorities need to understand of benefits and advantages of solar thermal
- Impact in the market depends on good comprehension of solar thermal potential
- With tailored solutions the various market barriers can be overcome
- Framework conditions can be improved by action of public or private actors
- Awareness raising is a stepstone for public and political support
- Flanking measures are essential but need to be implemented in a coordinated way
- Financial incentives can be effective in the market and provide a quick return on public investment

First, it is important to improve the knowledge of the technology, both with the public and the administrative staff responsible for designing and implementing a solar water heating promotion programme.

Then, it is vital to understand the benefits this technology can bring, as those benefits are key for publicly promoting the need for a solar water heating promotion programme. The benefits must then be adapted to what can be concretely achievable in a particular geographic, social and economic region. It is, therefore, important for policy makers to understand and assess the potential of the technology in a specific country, region or location.

Then, it is crucial to analyse what are the barriers hampering the development and local deployment of the technology, to take full advantage of the identified benefits.

Once groundwork is done, policy-makers trying to design and implement a solar water heating promotion programme will be faced with the issue of how to select and devise actions to set the framework conditions for the development of solar thermal.

It is essential here to consider three main pillars which should be the backbone of each solar water heating promotion programme: awareness raising, non-financial measures, and finally, proper incentives for the deployment of the technology.

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SECTION 1

INTRODUCTION

& GOALS

1.1 STARTING POINT

Solar thermal is a mature and well established technology in many geographical regions around the world, it has been providing cheap and reliable thermal energy for decades in countries such as Cyprus or Israel. However, deployment varies widely across countries and continents, and in many cases solar thermal faces strong barriers to deployment.

Considering the technology potential, and its economic, societal and environmental benefits, policy-makers should focus their attention towards the promotion of the solar thermal technology by setting the right framework conditions and policies to enable such deployment. In brief, policy makers should design and promote specific programmes to encourage solar water heating deployment.

To implement the right solar water heating promotion programme, policy makers at different governance levels must carry out a thorough analysis of the sector. The essential steps are tackled in this publication.

The content of this publication is based on the experience acquired by the ESTIF extended team (secretariat staff and experts) in its role of industry association representing the solar thermal industry at European level.

In particular three major projects/initiatives can be mentioned because of their relevance:

- As an accredited representative body of the solar thermal industry, ESTIF is consulted directly by legislators (European and national) to provide input concerning incentive schemes for solar thermal (financial and non-financial) and also input for the legislative framework for the promotion of solar heating and energy savings in buildings
- ESTIF has been involved in several projects financed by the European Commission, with the objective to study and promote one or more concepts relevant for these guidelines. In particular, the Intelligent Energy Europe projects KEY4Res-H (how to remove barriers to the development of the market for renewable heat in Europe), ProSTO (promotion of solar obligations at local level) and FROnT (Fair Renewable Heating and Cooling Options and Trade).

- ESTIF is also involved in relevant experts groups at global level such as the working group elaborating the International Energy Agency Solar Heating and Cooling Roadmap

This guide is meant to be accessible to a “beginner” and do not take for granted basic knowledge relating to solar thermal, communication, policy and standardisation. This is why some basic concepts are repeated and defined in different contexts, e.g. the different type of solar thermal systems. An effort is made to define the concepts used and to avoid jargon.

For all the publications an extensive use is made of the web based knowledge management tool www.solarthermalworld.org; examples and case analysis can be found concerning all the relevant topics using the right hand side menu “Filer” and then the group “Key Pillars”.

In the preparation of this publication there was also the concern to provide diverse references and literature related to the topics addressed during the guide.

1.2 STRUCTURE OF THE REPORT

The structure is progressive and the subject is approached from the initial assessment to the implementation phase.

The guide begins with an overview of the different systems and applications, and a reminder of the benefits of solar water heating.

The characterisation of the technology is done in **Section 2: Solar heating and cooling systems**, covering different types of solar thermal systems and collectors, as well as different applications.

The benefits are addressed in **Section 3: Benefits for your country or region**, including a description of benefits and advantages and information regarding the assessment of “market readiness”.

The next part of the guide deals with the characterisation of the market, the potential, barriers and framework conditions.

It starts in **Section 4: Potential of solar water heating and market development** describes and analyses different types of potential, relevant to characterise the technology. It also addresses the methodology for assessment of the market development and framework conditions.

Market barriers are tackled in **section 5**, with an analysis of both economic and non-economic barriers.

The final part of the Guide looks into the role that policies can have in changing framework conditions, using support measures, both financial and non-financial.

Taking that into account, **Section 6** is an introduction, addressing the **Importance of policies and definition of framework conditions**.

The analysis of support measures starts with **Section 7**, focusing on the relevance of **Awareness raising** and the importance of communication.

More flanking measures are described in **Section 8: Non-financial measures**, including solar thermal obligations, quality, standards and certification and research & development.

Naturally more detail is put into the analysis of **Financial Incentives**, in **Section 9**. It includes an insight of solar thermal specificities and the main forms of financial incentives. This section includes an overview of the benefits and key success factors for financial incentives.

During this guide we provide key recommendations after each section, including suggested references and literature. These are compiled in **Section 10: Conclusions - key recommendations** and **Section 11: References**.

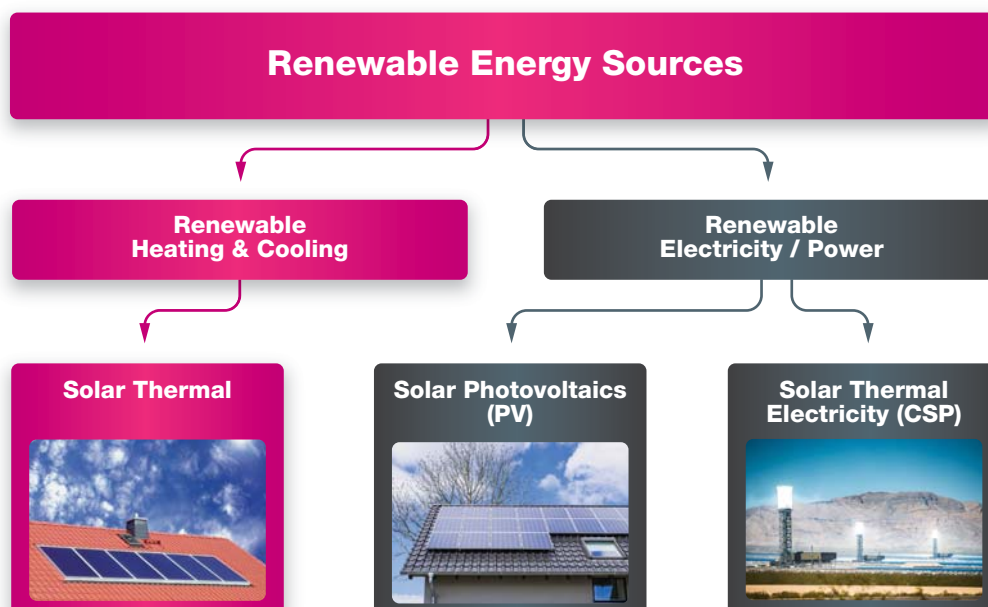
SECTION 2

SOLAR HEATING AND COOLING SYSTEMS

2.1 SOLAR THERMAL ENERGY

The concept of solar heat goes beyond providing just hot water. To be in a position to devise, design and implement the right framework and policy measures for solar thermal technology, it is important to have a basic understanding of the technology and its applications.

As mentioned before, solar thermal produces heat and, as such, it must be clearly distinguished from two other renewable energy sources using the sun directly – Photovoltaic and Concentrated solar – both producing electricity.



In terms of heat generation solar covers a wide range of applications and temperatures, using the technology in different ways.

2.2 TYPES OF SOLAR THERMAL SYSTEMS AND COLLECTORS

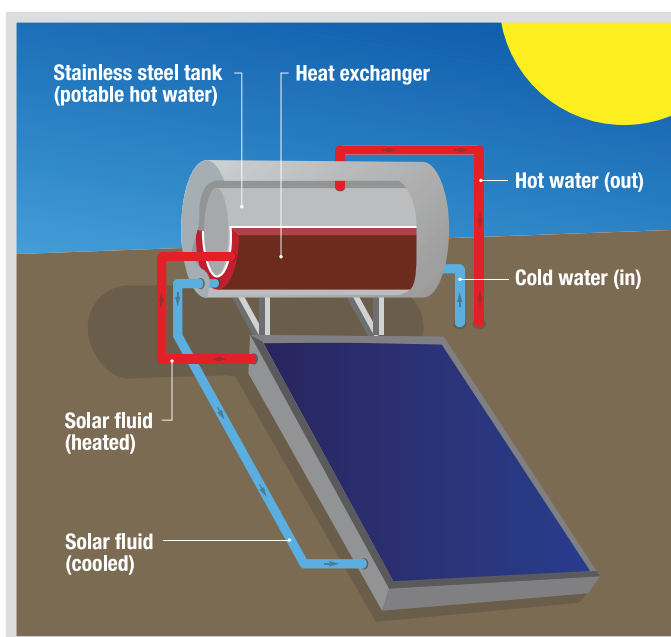
The different types of solar systems and collectors described below are in place in different markets and geographic regions, they have specific advantages, which will in turn influence what kind of policy and framework conditions are required to encourage their market development.

Glazed water collectors are common in most countries, with both China and India mainly installing evacuated tube collectors (ETC), while other key markets rely mostly on flat plate collectors (FPC). The majority of systems in the United States use unglazed water collectors for pool heating. Thermosiphon systems represent nearly three-quarters of all solar thermal systems installed; the rest are forced circulation systems (mainly found in North America and Central and Northern Europe). [REN21 2015]



Figure 1: Example of three different installations. From left to right, forced circulation with evacuated tubes, forced circulation with flat plate collector and thermosiphon with flat plate collectors.
Photo: J.Seco / ESTIF

2.2.1 THERMOSIPHON SYSTEMS



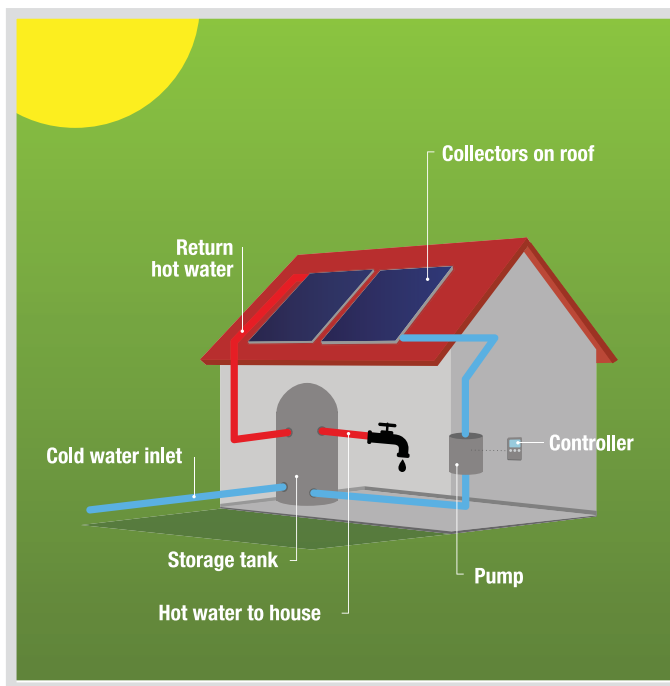
Systems based on a method of passive heat exchange using on natural convection, which circulates liquid without the necessity of a mechanical pump.

This technology is extremely simple in terms of design, manufacturing and installation; this explains probably why it is by far the most commonly sold system worldwide.

It uses a thermodynamic principle: warm water, being lighter, flows up to the storage

tank placed above the collector. Therefore it is absolutely necessary, that the storage tank is mounted at a higher place than the collector. These systems are common in warmer climates, since there the storage tank can be installed on the roof. Installation of these systems is even easier in flat roofs, rather common in warmer climates.

2.2.2 FORCED (PUMPED) CIRCULATION



Those systems use one or more pumps to circulate water and/or heating fluid in the system. Sensors and a controller are used to activate the pump. In these systems, the hot water store is located inside the building. This is a solution common in colder climates, where mostly pitched roofs are used to be better protected against rain and snow and the storage is installed in the basement, protected against important heat losses (and even freezing) in winter. Widely used in European markets, these systems offer a variety of options in terms of application. They provide both hot water and

space heating and are also known as combi systems. The collective and district heating systems are exclusively forced circulation systems. In general pumped circulation achieves better control, performance and efficiency.

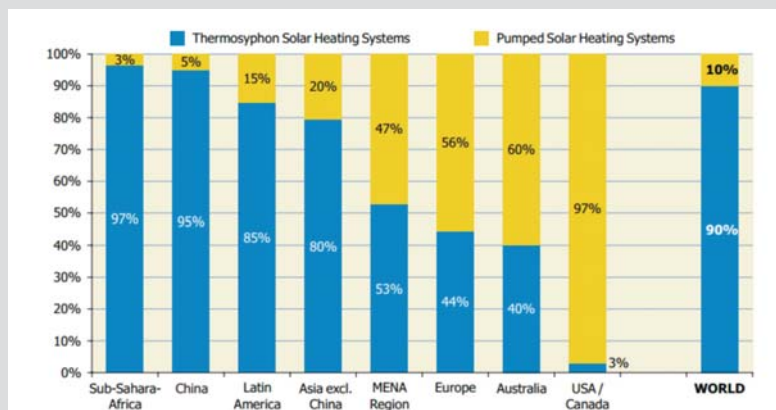


Figure 2: Distribution by type of system for the newly installed glazed water collector capacity in 2013
[IEA-SHC 2015]

Which framework conditions and policy measures for which technology?

Type	Application	Strengths	Weaknesses
Thermosiphon	Individual hot water	<ul style="list-style-type: none"> • Extreme ease of use • No or limited installation • Easy manufacturing • Low cost and payback time 	<ul style="list-style-type: none"> • Warmer climates (above 0°C) • Used only for hot water • Limited scalability • Quality and performance • Aesthetic
Pumped circulation	Individual hot water	<ul style="list-style-type: none"> • Ease of use • Simple installation • Adapted to all climates • Scalability • Medium term payback time 	<ul style="list-style-type: none"> • Necessity of qualified installer • Requires roof and storage surfaces
	Combi-system (space and water heating)	<ul style="list-style-type: none"> • Higher solar use • Adapted to all climates • Scalability 	<ul style="list-style-type: none"> • Necessity of qualified installer • Investment costs • Requires roof and storage surfaces
	Collective housing	<ul style="list-style-type: none"> • Economies of scale • Scalability • Solar heat value 	<ul style="list-style-type: none"> • Necessity of qualified system design • Necessity of qualified installer • High investment costs

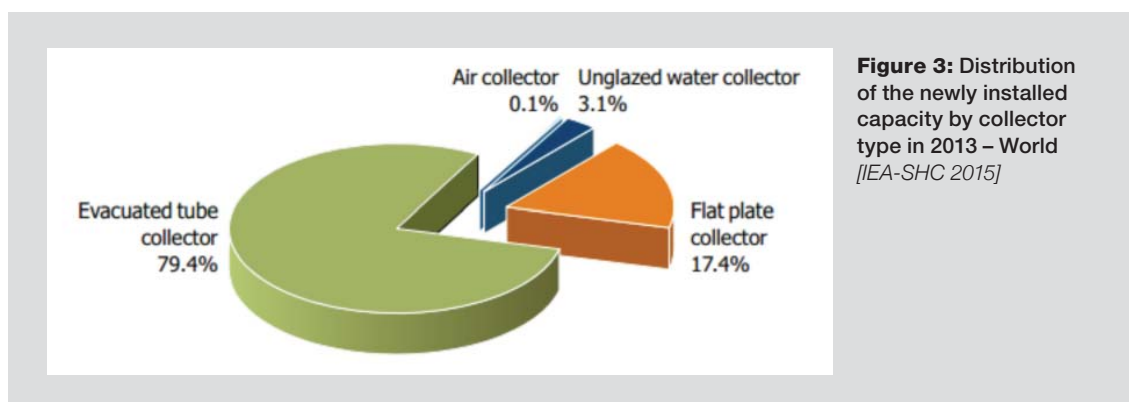
2.2.3 FLAT PLATE, EVACUATED TUBES AND UNGLAZED COLLECTORS

Vacuum tube collectors collectors can use heat pipes or direct flow. Direct flow evacuated tube collectors (ETC) are more common in China, for instance. In Europe it is common to use ETC with heat pipes. Evacuated heat pipe tubes consist of multiple evacuated glass tubes, each containing an absorber plate fused to a heat pipe.

Flat plate collectors consist of a dark flat-plate absorber of solar energy, a transparent cover that allows solar energy to pass through but reduces heat losses, a heat-transfer fluid (air, antifreeze or water) to remove heat from the absorber, and a heat insulating backing.

Unglazed collectors, which are the simplest and least expensive of all collectors, are used almost universally for heating outdoor pools and spas.

These three types of collector account for 99% of the market. Besides the technicalities and comparison of efficiency, it is interesting to note that they have a very strong regional base. The Chinese market uses only exclusively vacuum tubes; flat plates dominate the European market and in the US solar heat is associated with swimming pools.



There are two additional types of collectors, which are not relevant for this publication.

Solar air collectors heat air directly, almost always for space heating. They are also used for pre-heating make-up air in commercial and industrial HVAC systems.

Solar concentrators (parabolic trough or dishes), provide high-concentration and require direct radiation. This type of collector is generally used for high or very high temperature applications. A trough-shaped parabolic reflector is used to concentrate sunlight on an insulated tube or heat pipe, placed at the focal point and containing a medium which collects the heat. Because of its type of application, this family of collectors is not of relevance for this publication.

2.3 DIFFERENT APPLICATIONS

2.3.1 SOLAR HEAT IN BUILDINGS

The core application of solar heat is the production of domestic hot water. In countries with colder climates, space heating in dwellings is also a common application.

The whole range of buildings is covered: Individual, collective, and even buildings supplied by district heating, as solar thermal can be one of the renewable heating sources supplying such networks.

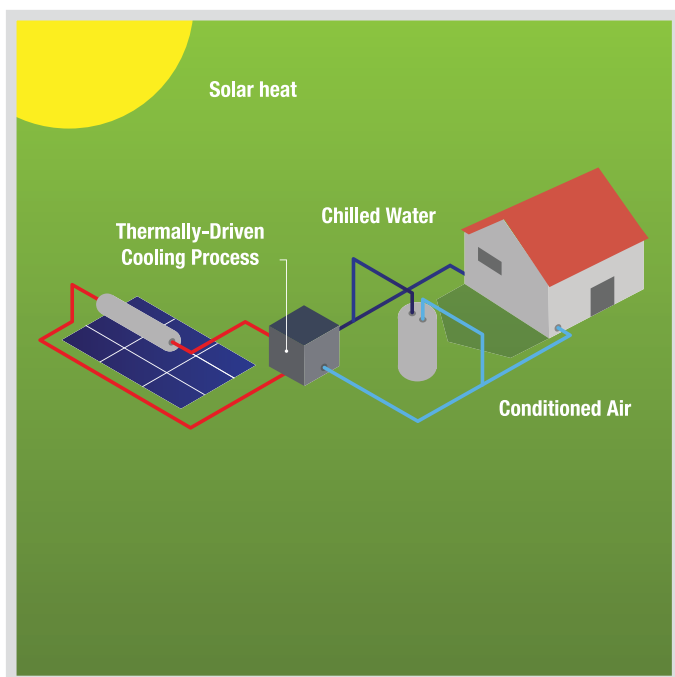
The IEA Solar Heating and Cooling programme makes further distinctions between types of applications:

- Single family houses
- Multiple family houses
- Public sector (hospitals, schools, homes for elderly..)
- Tourism sector (hotels, accommodations)
- District heating
- Pool heating

It should also be pointed out that the use of solar for pool heating remains important, especially in its traditional markets such as the United States.

2.3.2 SOLAR COOLING AND AIR CONDITIONING

Worldwide, the energy consumption required for cold and air conditioning is rapidly increasing. The incumbent technology, namely electrically driven compressor chillers have their maximum energy consumption in summer, adding power consumption to peak-load periods. On the other hand, solar cooling uses thermally driven “adsorbers” and absorbers and no electricity. Nevertheless, electricity may be required to run cooling towers, used for heat rejection. This emerging technology has a great potential because the peak period of solar heat production coincides with peak time use. Solar heating and cooling production can be combined in one system.



The demand for cooling may be driven by different aspects, comfort and refrigeration being the most common uses. In fact, the cooling demand is growing worldwide, even in colder climates, as comfort demand rises.

This results in an increase in air conditioning mainly for tertiary buildings but also for residential applications. Refrigeration is increasing as well with a wider variety of use, mainly within the food industry.

Air conditioning is the main process used for comfort cooling. It involves changing air properties,

such as lowering temperature and humidity levels. Refrigeration implies bringing temperature to low levels, even below freezing point. Cooling is basically achieved by retrieving heat from a fluid or gas and transferring it to the environment, which is usually called heat rejection. This transfer can be done mechanically or chemically.

One of the technologies used for cooling purposes are thermally driven chillers. These use thermal energy to cool down gases or fluids. This thermal energy can be provided by different technologies, including solar thermal energy.

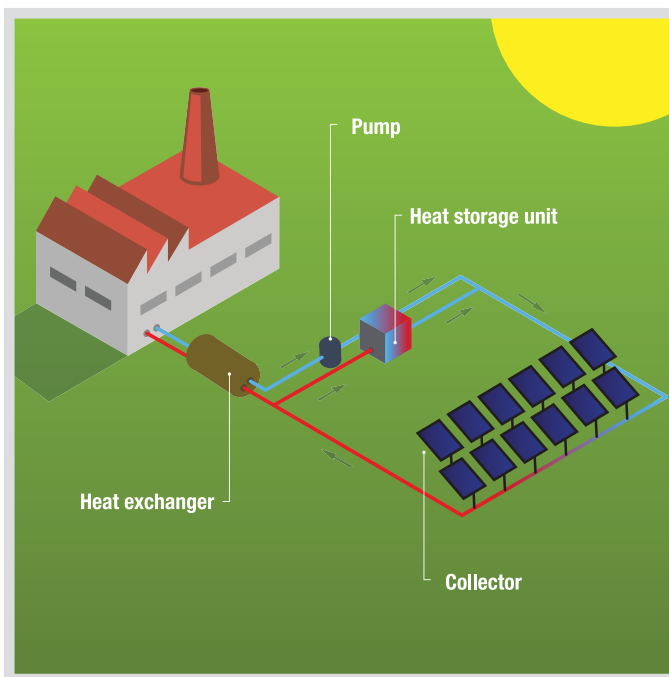
Solar cooling is suitable for residential, commercial, institutional and industrial use. The solar cooling supply is equal to the demand: when the sun is at its hottest solar irradiation is high, the maximum energy is available and the demand is also high.

A typical solar cooling system also provides space heating and hot water, besides cooling. One of the main requirements of such systems is to have an effective heat rejection system. This means that applications requiring both heating and cooling are rather well suited for this technology (for instance, dairy farms, hotels or residential houses with heated swimming pool).

2.3.3 SOLAR HEAT USED IN INDUSTRIAL PROCESSES

A wide range of industrial processes (steam, agro food processing, drying) as well as the treatment of water (desalination) can be achieved by using solar thermal. This applications is usually referred to as solar heat for industrial processes (SHIP).

When considering industrial needs for heat, usually the first image that comes to mind is that of metallurgy. While some industrial processes require very high temperatures, most of the energy needed for industrial processes requires low or medium-temperature heat.



Industrial processes can use low temperature for washing or dyeing textiles. The dairy sector uses heat for washing and pasteurization. Other industries, such as mining, can use it for leaching. Therefore, the use of low temperature heat in industrial processes can be widely diverse. The biggest potential is seen in the food and beverage industry but also in the metal and mining sector.

Solar thermal systems are well suited for generating low temperature heat up to 150°C. This can already be supplied by commercially available solar

thermal collectors. Most solar applications for industrial processes are on a relatively small scale and still largely of an experimental nature. There is potentially a wide range of solar thermal applications. There are already well known applications of solar thermal heat in breweries, mining, agriculture (crop drying) or textile sector. In 2015 about 150 large-scale SHIP systems are documented worldwide ranging from 0.35 MW_{th} to 27.5 MW_{th} (39 300 m²).

2.4 DIFFERENT TEMPERATURES

Solar heat can be produced over a wide range of temperatures. However, the highest are required for electricity production (CSP) and do not come within the scope of this manual.

LOW TEMPERATURE APPLICATIONS



Figure 4: Domestic hot water system in old house, Italy

Applications that require thermal (heat) energy and operate at less than 90°C are grouped under this category. For low temperature applications the standard products are based on flat plate, evacuated tube and unglazed collectors. Domestic applications fall under this category but also some industrial processes requiring hot water at temperatures below 90°C, such as washing or dying.

MEDIUM TEMPERATURE APPLICATIONS

Applications that require thermal (heat) energy and operate in a temperature range from 90°C to 150°C are grouped under this category. The standard products that can be used are evacuated tube collectors and concentrating solar collectors.

These applications are used in processes requiring steam. This includes a wide range of possible uses of solar heat for industrial processes but also in hotels or social amenities using solar cookers.



Figure 5: Solar Bowl on the roof of the Auroville Solar Kitchen
Source: solarcooking.wikia.com

HIGH TEMPERATURE APPLICATIONS

Applications that require thermal (heat) energy and operate in a temperature range from 150°C to 300°C. To reach such high temperatures, the standard option are solar concentrating collectors.

The applications are steam generation up to 350°C and pressure up to 25 bar in Industries for process heat applications including Cooling using Vapour Absorption Refrigeration (VAR) systems and air conditioning systems. These are also used for electricity production, which is out of the scope of solar heat and hence this publication.

KEY RECOMMENDATION

Solar thermal is a technology with multiple applications

Solar thermal has multiple applications, from small scale in buildings to large industrial applications. It can supply domestic hot water at lower temperatures or it can generate steam for complex processes. It can be used everywhere in the world, though the adequacy of some types of applications or systems depends on the location and use.

FURTHER READINGS AND REFERENCES

- RHCTP 2013a
http://www.rhc-platform.org/fileadmin/Publications/Solar_Thermal_SRP_single_page.pdf
- ESTIF/UNEP 2015c
http://www.estif.org/publications/solar_thermal_factsheets/
- IEA 2012
https://www.iea.org/publications/freepublications/publication/Solar_Heating_Cooling_Roadmap_2012_WEB.pdf
- IEA SHC 2015
<http://www.iea-shc.org/data/sites/1/publications/Solar-Heat-Worldwide-2015.pdf>
- ESTIF/UNEP 2014
http://www.estif.org/fileadmin/estif/content/publications/downloads/unep_report_final_v04_lowres.pdf

SECTION 3

BENEFITS FOR YOUR COUNTRY OR REGION

An important step in promoting better framework conditions for the development of solar thermal is a thorough understanding of the reasons why this technology deserves to be promoted and supported. This step is less trivial than one might think – a good understanding of the solar thermal benefits will lay the groundwork for a long-term strong commitment from countries and communities. This is the first, and, probably, the most important recommendation for a successful policy.

3.1 TYPOLOGY OF BENEFITS/ADVANTAGES

We will here deliberately mix benefits and advantages. Solar thermal shares with other renewable energy sources the fact that it is a CO₂ free source of energy. Besides it has the invaluable advantage of relying on an unlimited, free resource, the Sun.

Compared with other forms of renewable energy, solar heating's contribution in meeting global energy demand is, besides the traditional renewable energies like biomass and hydropower, second only to wind power, and makes a much larger contribution than photovoltaic. This fact is still underestimated in energy policies.

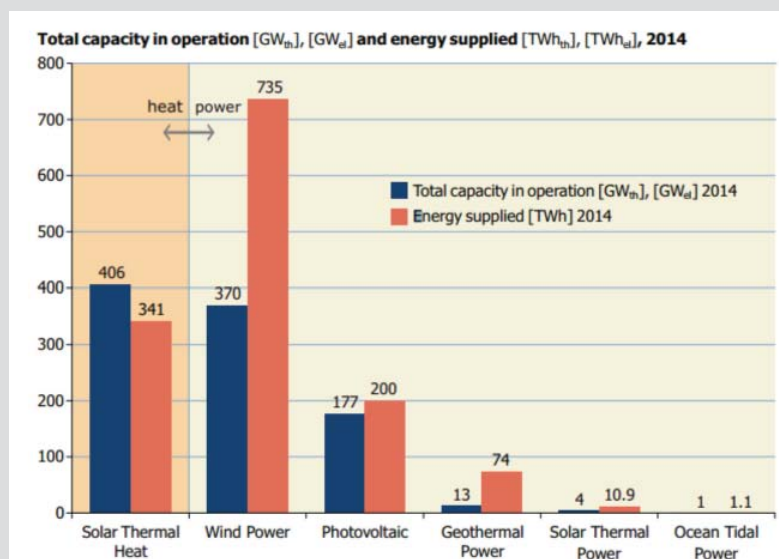


Figure 6: Global capacity in operation [GW_{th}], [GW_e] 2014 and annual energy yields [TWh_{th}], [TWh_e] [IEA-SHC 2015]

The benefits of solar thermal are usually classified as follows:

ENVIRONMENTAL BENEFITS

Solar is the renewable energy source “par excellence”. Without solar energy our planet would not survive at all. And we need to use it further in order to ensure that it can survive. Solar energy is available everywhere, it cannot become scarce and the conversion of solar energy to heat does not produce any kind of emissions.

The environmental impact is very limited (almost irrelevant compared to other products), taking into account that the manufacture and production of solar thermal systems does not involve dealing with hazardous or toxic substances and the systems are easy to recycle.

In the particular context of the international efforts for the reduction of CO₂ emissions solar thermal can be considered, at global level, as part of the solution.

ECONOMIC BENEFITS

• Macroeconomic

Solar thermal, as other renewable energy sources, contributes to the reduction of fossil fuels consumption, in countries or regions that cannot rely on domestic production; the costs and volatility of imported fossil fuels can represent a real economic issue. While, on the other hand, the solar thermal value chain is to a large extent national or local. Even in countries that do not have a manufacturing industry, the local economy will benefit from the market development of solar thermal. Moreover, because of the low technical complexity of manufacturing solar thermal systems such as thermosiphon systems, it can be seen as encouraging the creation of local manufacturing facilities.

• Microeconomic

One or many households using solar thermal will benefit from a long-term cheap energy and will no longer depend on fluctuating energy prices.

SOCIAL BENEFITS

Because of its decentralised nature and its simplicity, solar thermal is a renewable energy which individual citizens can grasp. Solar thermal allows a bottom up approach to energy and environmental issues, empowering consumers as they become aware and in control of their consumption and production of energy.

OTHER BENEFITS

In the context of market strengthening and promotion of renewable energy sources, solar heat has distinctive advantages. When looking into the benefits in comparison with other renewable energy sources, we can identify additional benefits for the use of solar thermal.

• Heat and cold represent the largest portion of energy demand

Solar thermal is a heating and cooling technology. Heating and Cooling accounts for a significant part of the final energy demand alongside electricity production and transport. Solar hot water can, for example, help resolve the issues of peak load electricity for domestic hot water in certain geographies.

- **Managing electricity demand with SWH**

In 2007 the Namibian government launched a programme to reduce its peak electricity demand by almost 20 MW. A set of measures were introduced aimed at imposing SWH in all new public buildings, on existing public buildings without water heaters and in existing public buildings with electric geysers.

The Namibian Renewable Energy Programme (NAMREP) that includes awareness raising, promotion and training of skilled workers accompanied this law¹.

- **Deployable technology**

Solar thermal thermosiphon systems are cheap and easy to use, and are accessible to the majority of end consumers in developing countries. It is an affordable renewable energy source. Solar thermal is a mature, market-ready technology in all its core applications for individual and collective hot water and space heating production. It can be considered for immediate use based on available solutions in the market. Though, research & development should be supported, as an important flanking measure, supporting the additional development of the technology and of solar thermal based solutions.

- **Fast impact in the market**

A support scheme addressing solar thermal products can very quickly provide results in the market. Most systems are small scale and decentralised. When a support mechanism motivates consumers to opt for solar thermal solutions, the impact in the market can be rather immediate.

These benefits and advantages need to be adapted to local conditions and climate. Identifying the most relevant benefits and advantages according to your own situation is extremely useful.

¹ Source www.solarthermalworld.org/node/494

KEY RECOMMENDATION

Public authorities need to understand of benefits and advantages of solar thermal

The understanding by public authorities of benefits and advantages of solar thermal is necessary first step in order to motivate them into developing solutions for the deployment of solar thermal!

FURTHER READINGS AND REFERENCES

- RHCTP 2013
http://www.rhc-platform.org/fileadmin/Publications/Solar_Thermal_SRP_single_page.pdf
- IEA 2012
https://www.iea.org/publications/freepublications/publication/Solar_Heating_Cooling_Roadmap_2012_WEB.pdf
- UNEP/ESTIF 2015
http://www.estif.org/publications/solar_thermal_guides/
- UNEP 2014
<http://www.in.undp.org/content/dam/india/docs/EnE/solar-water-heating-techscope-market-readiness-assessment.pdf>
- FROnT
<http://www.front-rhc.eu/>
- ECOFYS 2014
https://ec.europa.eu/energy/sites/ener/files/documents/ECOFYS_2014_Subsidies_and_costs_of_EU_energy_11_Nov.pdf

SECTION 4

POTENTIAL OF SOLAR

WATER HEATING

AND MARKET

DEVELOPMENT

The potential and conditions necessary for the development of the solar water heating market can vary considerably, the obstacles to overcome, the advantages and benefits on which one should build will determine not only the content of the “action plan” but also the priorities.

4.1 THE POTENTIAL OF SOLAR THERMAL

Five types of potentials can be identified.

- **Theoretical potential:** The highest level of potential is the theoretical potential. This potential only takes into account restrictions with respect to natural and climatic parameters.
- **Geographical potential:** Most renewable energy sources have geographical restrictions, e.g. land use, land cover, reducing the theoretical potential. The geographical potential is the theoretical potential limited by the resources at geographical locations that are suitable. For the solar thermal, it is the solar irradiation.
- **Technical potential** is the total amount of energy (final or primary) that can be produced taking into account the primary resources, the socio-geographical constraints and the technical losses in the conversion process.
- **Economic potential** is the technical potential at cost levels considered competitive.
- **Market potential** is the volume that solar thermal can reach taking into account the demand for energy, the competing technologies, the costs and subsidies of renewable energy sources, and the barriers. As opportunities are also included, the market potential may in theory be larger than the economic potential, but usually the market potential is lower because of all kind of barriers.

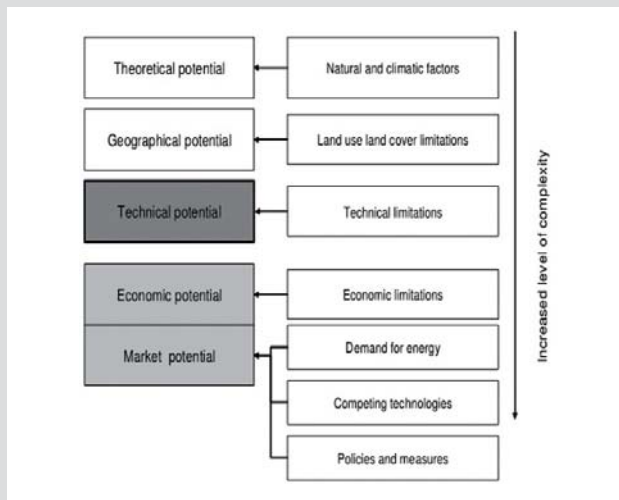


Figure 7: Source “Global Potential of renewable energy sources: a literature assessment” [ECOFYS 2008]

In this section we shall address the potential in two groups. A **first group** can be combined, in order to assess the potential of one technology based on **theoretical, geographical and technical factors**. These combine climatic factors, with specificities related to the location (solar resource, type of demand, context) and the technical capabilities of the technology, current and future.

The second group addresses the **economic and market** potential, which relate to the technology and energy costs, the investment, the competitive alternatives, barriers and enabling factors.

4.1.1 THEORETICAL, GEOGRAPHICAL AND TECHNICAL POTENTIAL

4.1.1.1 SOLAR RESOURCE

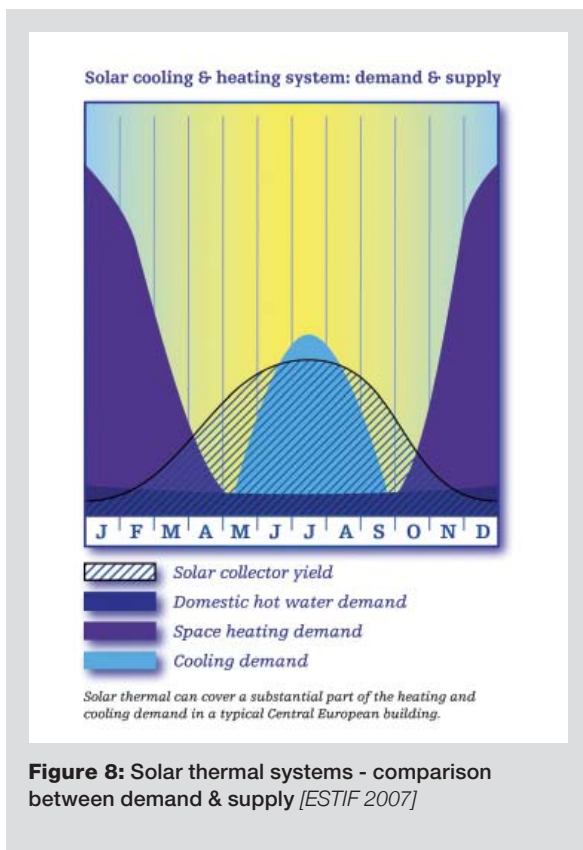
One major non-market related factor affecting greatly the potential of solar thermal must be mentioned: the solar resource.

There is an obvious limitation to the capacity of solar thermal at night and in winter. However, this limitation does not affect the potential of solar thermal as much as one might think. Solar thermal systems include energy storage to provide heat during night time or in the early morning.

In temperate and cold climates solar thermal is combined with an auxiliary heat generator, which is active when solar thermal cannot provide heat. Even when it cannot satisfy the total heat demand solar thermal brings several benefits:

- Free solar energy covers a significant part of the heat demand;
- The auxiliary (fossil fuel) heat generator can be used at its highest level of efficiency thanks to pre heated water and switched off in summer when it would work at a sub optimum load profile;

- When integrated in the building design and combined with highly energy efficient building envelope, solar thermal can cover the whole heat demand even in northern and temperate climates.



Adapting the use of solar heating and cooling to the demand is essential to have a proper assessment of its potential. The solar collector yield needs to be adapted and dimensioned according to the demand profile (how much heat or cold is required and when) and according to the solar yield. Systems too large would produce too much energy during the Summer and would not be so attractive in terms of investment costs and energy costs. Systems too small would fail to make the best of the potential of this technology.

Both demand and solar radiation are dependent on the geographical location. While domestic hot water is required everywhere, even if with different demand profiles, the need for space heating is typical of climates with cold winters. This means that the demand for heating is higher in countries where the solar resource is likely to be lower.

Still, it needs to be taken into account that countries such as Austria, Germany, Denmark and Poland have dynamic markets and include solar thermal in their national energy mix. It is very important to challenge the vision of solar thermal as a solution limited to warm climates held by the population but also by decision makers.

The geographical location will also affect the type of system that can be used. For instance, it must be taken into account that there is the risk of water freezing in colder climates. In such cases, the water in the collector must be protected against freezing.

This is usually achieved in one of two ways: The water in the collector loop is either treated with anti-freeze (glycol) or, the water is drained out of the collector and pipes when it gets too cold. The former requires that the water in the collector is separated from the drinking water with a heat exchanger. The latter is the so called “drain back” principle, which is popular mostly in the USA and in parts of Europe. [ESTIF/UNEP 2014]

On the other hand, warmer climates, needing mostly domestic hot water, are also likely to receive more solar radiation. And in these cases, simpler and cheaper systems can cover the needs of the population.

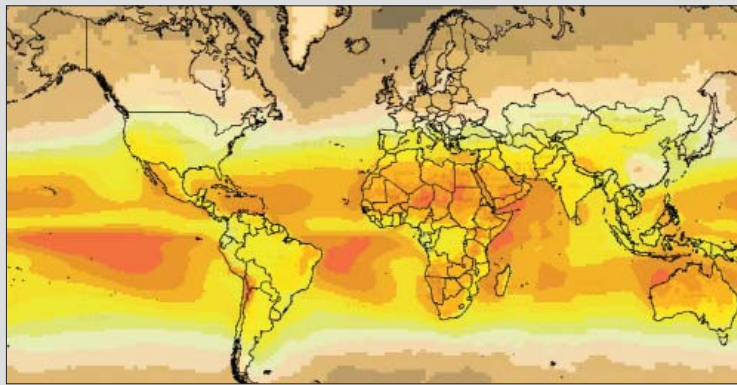


Figure 9: Global Horizontal Irradiation Source: Clean Energy Solutions Center
cleanenergysolutions.org

A thermosiphon system usually ranges from 1 to 4 m² (0.7 to 2.8 kW_{th}) while a solar combi-system, providing both domestic hot water and space heating can range from 8 to 20m² (5.6 to 14 kW_{th}). The first are the most common systems in the world, the later are more developed systems, in terms of design and operation.

In a simple way, we can say that in warmer climates there is the potential for a larger number of smaller solar thermal systems, namely thermosiphon systems for the supply of domestic hot water, while in colder climates there is the tendency for a smaller number of systems but these have larger sizes in average.

4.1.1.2 POTENTIAL STUDIES & SCENARIOS

The technical potential of solar thermal technology is based on projections but around different scenarios, where several assumptions on technological development, demand evolution and some enabling factors are taken into account. The European Solar Thermal Technology Platform (ESTTP) has performed, over the years, analysis of the technical potential of solar thermal in Europe. One example of analysis of technical potential can be found in the ESTTP publication 'Solar Heating and Cooling for a Sustainable Energy Future in Europe' [ESTTP 2008], where, based on purely technical perspective, solar thermal is estimated as being able to cover up to 50% of the heating demand in Europe on the medium to long term.

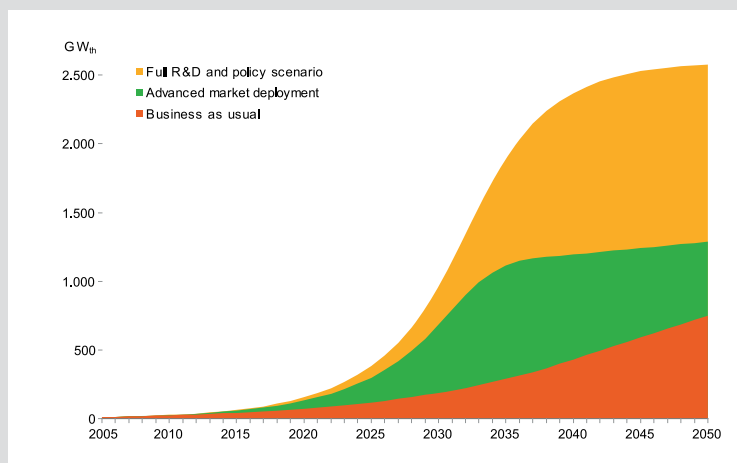


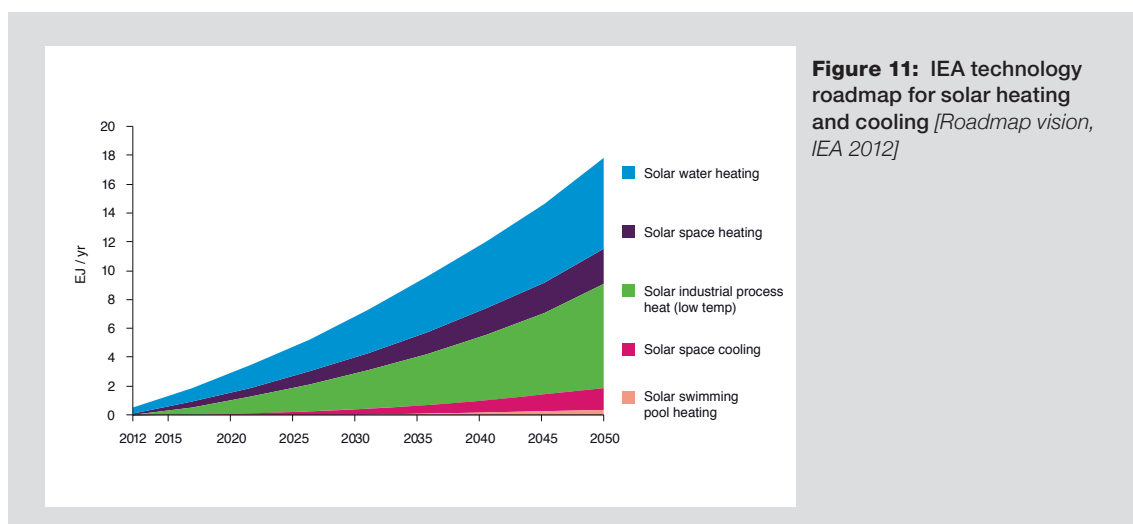
Figure 10: Medium to long term solar thermal potential, based on three scenarios
[ESTTP 2008]

This technical potential takes into account several pre-conditions and scenarios. For instance, the ESTTP considered three scenarios:

- **Business as usual** - based on a moderate growth rate.
- **Advanced market deployment** – it considers that the development will be positively influenced by strong support policies. In the particular case in analysis, it generates a relatively high growth rate in the first period, but after a certain period of time “the achievable potential with current technologies begins to become saturated and therefore the growth in capacity starts to stagnate at a relatively low level”.
- **Full R&D and policy**: this scenario assumes both an advanced deployment of available technologies and strong private and public R&D investments. The R&D investment will lead to additional technological progress, which will allow solar thermal systems to be applied in a broader range of solutions, allowing it to cover a substantially higher share of the total demand for heating and cooling.

The approach, exemplified above, was also used in other potential studies including solar thermal, namely a potential study commissioned by ESTIF [ESTIF 2009] and by the RHC-Platform in the Strategic Research and Innovation Agenda for Renewable Heating & Cooling [RHC-P 2013].

Another reference document to take into account is the Technology Roadmap on Solar Heating and Cooling, launched by the International Energy Agency in 2012. In this document, scenarios related to solar heating and cooling are combined with broader scenarios developed by IEA for the energy sector. This roadmap “outlines a pathway for solar energy to supply almost one sixth of the world’s total energy use for both heating and cooling by 2050”.



This scenario was built on the basis of one of the reference scenarios developed by IEA, the ETP 2012 2DS scenario. This scenario describes how the energy economy may be transformed by 2050 to achieve the global goal of reducing annual CO₂ emissions to half that of 2009 levels.

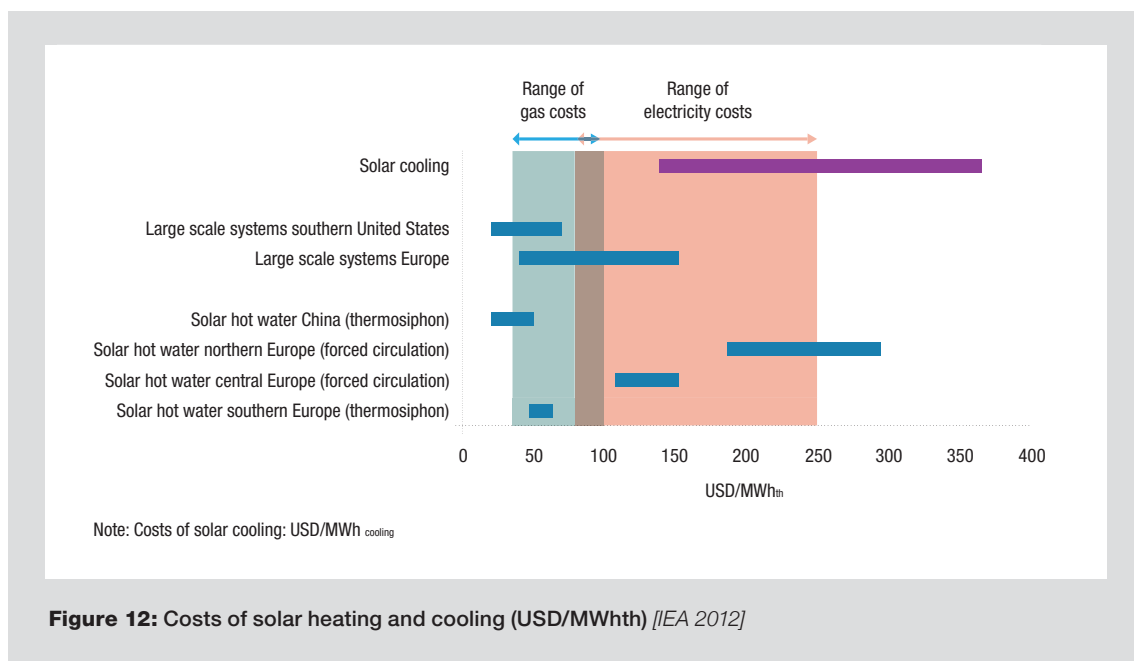
The Roadmap vision details what is the pathway for several applications, namely solar water heating, solar space heating, solar space cooling, solar swimming pool heating and solar industrial process heat (for low temperature requirements). The later is the segment with the biggest increase foreseen, with the potential to become the main market segment for solar thermal applications.

4.1.2 ECONOMIC AND MARKET POTENTIAL

Economic factors and market conditions (demand, competition and barriers) need to be understood to grasp the potential of a given technology in a given market. Other factors can also be relevant. For instance, with regard to solar thermal technology, consumers value the fact that it is an environmentally friendly and reliable technology. Nevertheless, the economic factors are quite relevant, in particular when a technology goes into mass market or is, at least, broadly deployed in the market, going beyond one or few particular market segments.

Therefore the economic and market potential is very dependent on the cost of the energy. On one side it is important to take into account the initial investment required and the cost of the energy supplied in comparison with other alternatives in the market, be it fossil based or other renewable technologies.

The following table provides such a comparison of costs, taking into account the type of application and location and providing also reference cost ranges for gas and electricity.



The energy costs of a solar thermal system are very dependent on the investment cost. In practical terms, and because the operation and maintenance costs are low, the investment on the equipment must be compared with the savings in energy over the years. Still, it implies that the funds required for the investment have to be available (even if different financing options are considered) and also that the return on the investment will be better the lower this initial investment is.

The investment depends obviously of the location (country), the type and size of the system. Though it is clear that the development of the market has a positive effect on the cost of the systems, pushing the price down.

An assessment done in Europe, estimates a learning curve of 23% for solar thermal collectors, i.e., the cost of the collectors went down by 23% at each doubling of the total installed collector capacity.

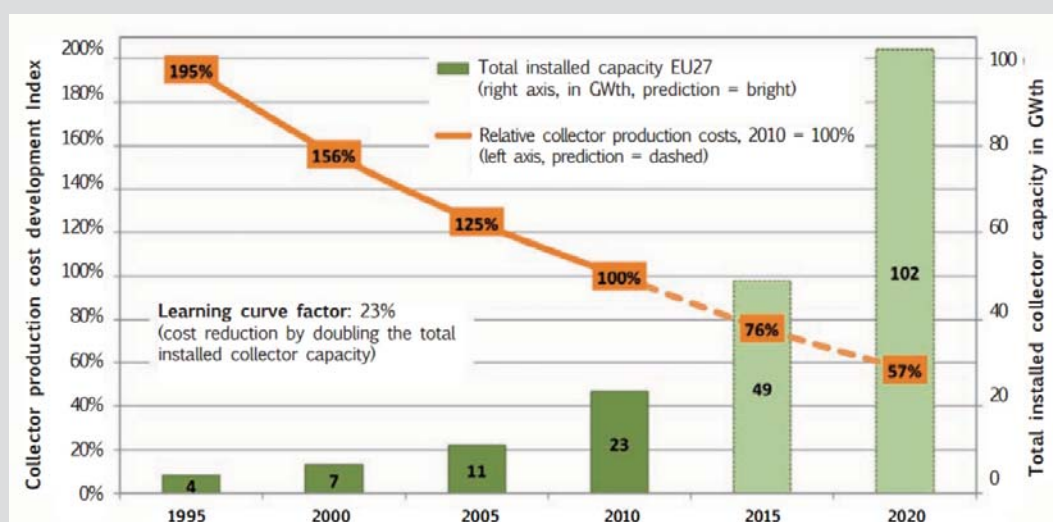


Figure 13: Learning curve for solar thermal collectors in Europe, from 1995 to 2010 and estimation up to 2020 [RHCTP 2013a]

To calculate solar heat costs, the installed solar thermal system price is more relevant than the collector production costs. Dependent on the size of the system, costs for the collector area represent typically between 20% and 40% of the whole system. However, today's system prices cannot be compared with prices in the past, since in the meantime both the quality and the solar fraction of systems have improved significantly by an increased efficiency and larger collector areas. On the other hand, in recent years prices have rather stagnated, since lower components prices were often offset by increased distribution and installation costs. In some countries, the installation costs of small domestic hot water systems may reach 50% of the investment. [RHCTP 2013a].

The economic potential is commonly expressed by several indicators, such as cost benefit analysis (CBA, sometimes also called Benefit Cost Analysis, BCA), payback period and internal rate of return (IRR).

COST BENEFIT ANALYSIS

The Cost-Benefit Analysis (CBA) takes into consideration the known or expected costs of the project, comparing them with all known or expected benefits, in monetary terms. In order to take into account the impact of time, future costs and benefits should not be taken into consideration, as the net present value of all costs and the net present value of all benefits should be compared.

So, apart from the actual investment costs, the main influencing factors are the cost of money (interest rate on a loan or interest not received on alternative investments); the inflation rate and the expected price development of conventional fuels.

Any of the factors can have an important impact on the analysis and a sensitivity analysis may help to understand how each factor may influence the cost-benefit analysis. It may also be difficult to determine all cost and benefit components and complement the analysis with both relative and absolute values.

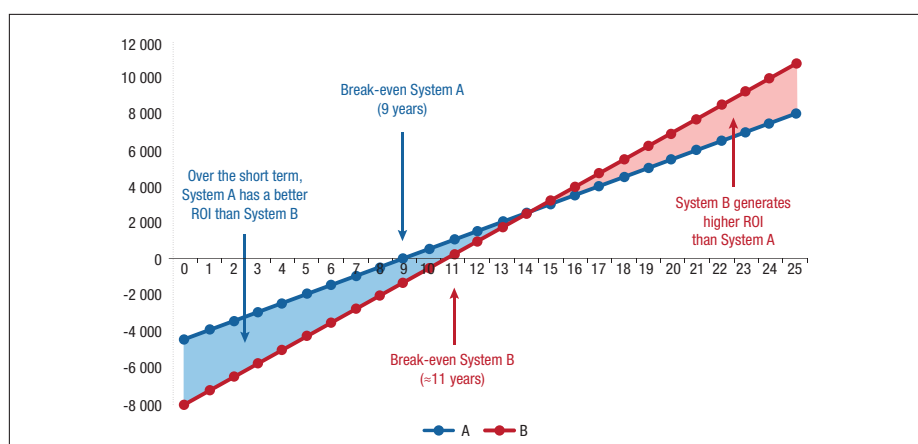
PAYBACK ANALYSIS

Using the payback period as a reference is common in investments. Payback period is, in a simplified way, the time it takes for the cumulated running costs saved by the solar thermal system to equal the additional initial investment. This analysis is complemented with other arguments, such as the preference to remain financially flexible (not to lock capital in fixed assets for long periods).

The focus on payback times is important but should be assessed together with other aspects, such as return-on-investment. An isolated analysis of the payback period may be misleading, as it can result in decisions in favour of cheaper and often less performing or less durable solar thermal systems, which, over the lifetime of the system, save less conventional energy and generates lower net benefits. *[ESTIF/UNEP 2014]*

EXAMPLE

Payback period vs. return-on-investment [ESTIF/UNEP 2014]



The following diagram shows the initial investment and cumulated net benefit of two different systems, A and B. A costs 4 500 currency units and breaks-even after 12 years. B costs 8 000 currency units and breaks-even only after 14 years. However, B has a higher rate of return, and after 16 years, the cumulated net benefit of B is higher. After 20 years it is already 900 units and at 25 years the ROI is 2000 currency units higher than that of system A.

	System A	System B
Initial investment	4500	8 000
Annual net benefit	500	750
Expected life time	20-25 years	20-25 years

Exemplary economic analysis of two different solar thermal systems A and B
[ESTIF/UNEP 2014]

INTERNAL RATE OF RETURN ANALYSIS

The Internal Rate of Return (IRR) is also commonly used in particular by commercial investors and financial institutions, as one of the key indicators when assessing the financial viability of a project. When all other criteria are fulfilled, an investment is considered attractive when the IRR is higher than the cost of capital. However, like the pay-back time, the IRR does not give any information about the total net benefit for the investor. A lower IRR but higher initial investment may actually yield a higher net benefit over the lifetime of the system than another project with a higher IRR but a lower initial investment. Likewise the IRR should not be used to compare e.g. different heating system with assumed different lifetimes: A system with a lower IRR but longer lifetime may actually return more money than the investment with a higher IRR but shorter lifetime.
[ESTIF/UNEP 2014]

FURTHER READINGS AND REFERENCES

- RHCTP 2013a, Levelized costs of heat
http://www.rhc-platform.org/fileadmin/Publications/Solar_Thermal_SRP_single_page.pdf
- IEA 2012, Economics today
https://www.iea.org/publications/freepublications/publication/Solar_Heating_Cooling_Roadmap_2012_WEB.pdf
- UNEP 2014a: SWH techscope market readiness assessment
http://www.estif.org/publications/solar_thermal_guides/
- ESTIF/UNEP 2014
http://www.estif.org/fileadmin/estif/content/publications/downloads/unep_report_final_v04_lowres.pdf
- FRONT, Levelized Costs of Heating and Cooling
<http://www.front-rhc.eu/>

4.2 METHODOLOGY FOR ASSESSMENT OF THE MARKET DEVELOPMENT AND FRAMEWORK CONDITIONS

4.2.1 MARKET VOLUME

MARKET VOLUME AND INSTALLED CAPACITY

The actual solar thermal market and its development should first be in terms of absolute volume. The different units, which can be used, will serve different purposes and target group.

- **Square meters** are usually the reference unit for the industry. Surface sales can also be combined with the sales of storage tanks to work out the number of systems brought to the market. This very rough value does not indicate the final use/application. It is very important to understand the market structure: dedicated water heaters (thermosiphon, forced circulation), combi-systems, collective housing, other domestic applications, and process heat. The right strategy can only be developed with a detailed view of the market.
- The **collector yield** (in Watt thermal - W_{th}) is important in terms of energy policy and energy mix. This is necessary to understand the contribution of solar thermal in macroeconomic terms

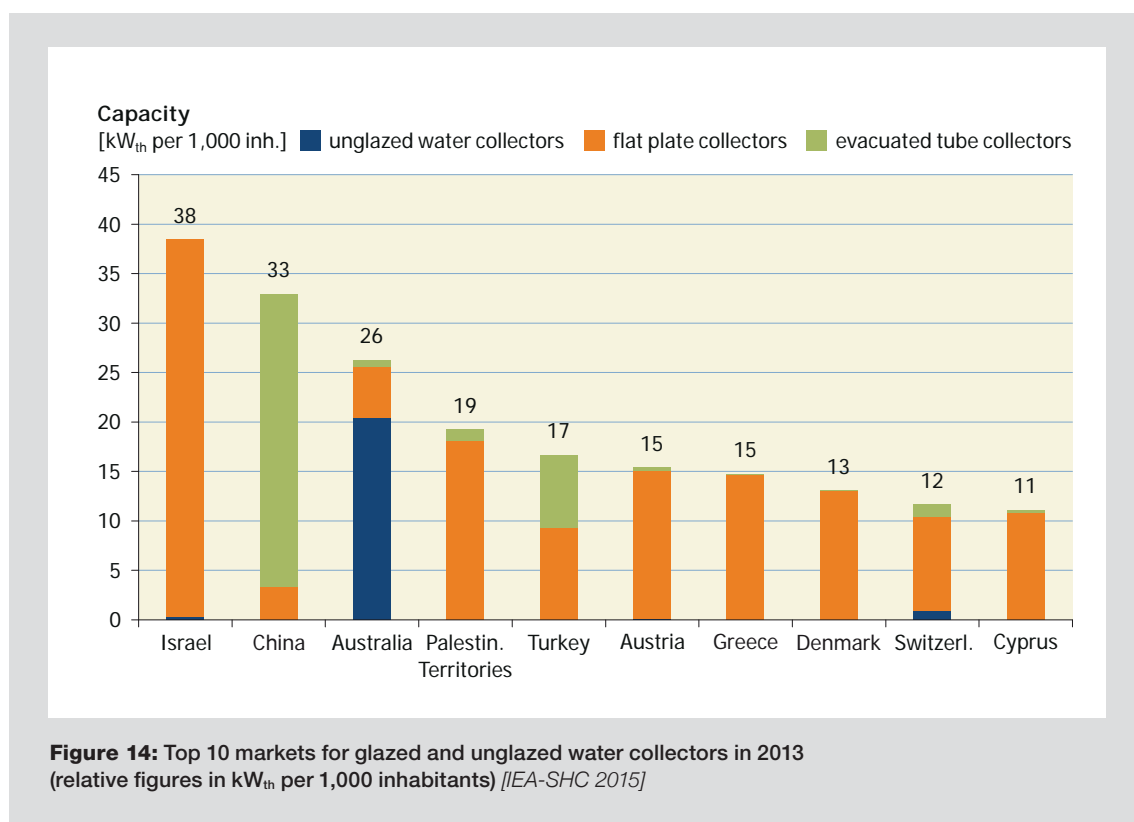
- Million tons oil equivalent (MToe) and CO₂ emission savings are necessary to understand the contribution from solar thermal as a renewable energy source and within the framework of policies against global warming.

The International energy agency offers a tool with agreed conversion factors in the field of energy [IEA-UC]. Besides, the International Energy Agency Solar Heating and Cooling Programme also provides information on the specific conversion factors which can be used regarding solar thermal [IEA-SHC 2011].

VOLUME AND INSTALLED CAPACITY PER CAPITA

The total volume gives a partial indication of the level of development in a market. The volume per inhabitant (capita) gives a very strong indication of the actual level of acceptance of solar thermal penetration. Italy, with an installed capacity of nearly 2.6 million square meters, is the 4th largest market in Europe (second in terms of newly installed capacity) but is below the European average per capita.

The graph below shows the newly installed collector capacity per capita, in 2013. Even if China, Turkey and Brazil are the largest markets, respectively with 45 000 MW_{th}, 1 350 MW_{th} and 965 MW_{th} installed in 2013, these countries do not reach the per capita level of Israel (38 kW_{th} installed per 1000 inhabitants), even if the Israeli market is only the 8th in sales (300 MW_{th}).



4.2.2 MARKET POTENTIAL

The market potential is resulting from the interaction of the economic potential with the given framework conditions. As opportunities are included as well as barriers, the market potential may in theory be larger than the economic potential, but usually the market potential is lower because of all kind of barriers. As explained at 4.1 there is a simple formula from which the market potential can be deduced. This formula can also serve as a basis to understand what actions and initiatives are required to realise this potential and strengthen the market for solar thermal.

$$\text{Market Potential} = \frac{\text{Economic potential}}{\text{Framework conditions}}$$

IEA Solar Heating and Cooling Technology Roadmap envisages a market potential growth for solar thermal systems up to 2050 to produce 16.5 EJ (4 583 TWh_{th}; 394 Mtoe) solar heating annually, more than 16% of total final energy use for low temperature heat. Solar collectors for hot water and space heating in buildings could reach an installed capacity of nearly 3 500 GW_{th} by 2050. Solar hot water and space heating would account for 14% of space and water heating energy use in buildings by that time. In this vision, solar hot water and space heating in buildings will increase by on average 7.1% annually between 2010 and 2050. By 2050, solar hot water accounts for 25% of water heating energy use. The greatest potential for solar heat in buildings will thus consist of solar domestic hot water heating, where the potential by 2050 is about 2.5 times higher than solar space heating potential [IEA, 2012].

4.2.3 MARKET TYPOLOGIES

The typologies of the market affect how their potential is perceived and how they should be addressed. We may distinguish between three main typologies: Mass market, emerging markets, “Niche” markets.

In its solar thermal action plan, ESTIF has set an objective of 1 square meter (0.7 kW_{th}) of solar collector per inhabitant in Europe by 2020. This can definitely be considered as a mass-market level. However, in 2013 no country had reached this level worldwide. The country with the largest installed capacity per capita is Cyprus, with 0.42 kW_{th} per capita (0.6 m²), only 60% of the symbolic target set by ESTIF.

To assess the maturity of a market, it seems more reasonable to consider a combination of the total volume and the volume per capita. Mass, emerging and niche markets will obviously present very different framework conditions. In a mass market, a market strengthening initiative will hardly be required, except if it appears to tackle a negative trend in the market. The framework conditions are obviously in place; however, if stagnation or decrease is observed some corrective measures should be implemented.

CHINA

Market development initiatives in a mass market

Despite the fact that the largest market worldwide is still growing the Chinese government is still active in promoting solar thermal technology. The Solar thermal Roadmaps 2015, 2020, 2030 propose corrective measures to address the decreasing market in large urban areas and to increase the share of solar thermal applications in space heating and collective housing.



In urban areas thermosiphon systems on the roofs are more and more perceived as an issue in aesthetic terms and the Chinese authorities are promoting forced circulation systems, which offer more building integration. In general the Chinese authorities wish to orientate the market towards higher end solutions.

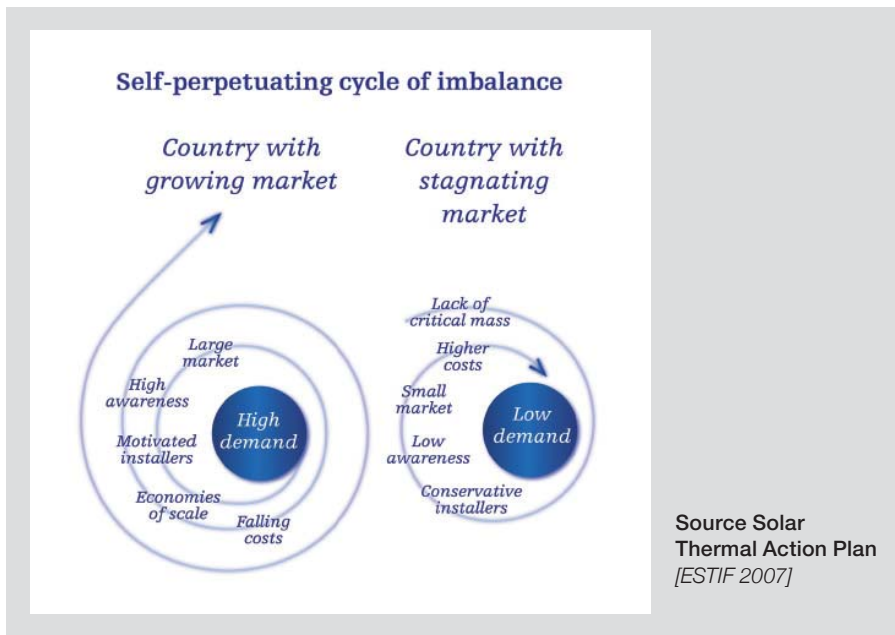
Source: "Chinese solar thermal development and perspectives" by Hu Runqing, Energy Research Institute, China IEA Solar Heating & Cooling Roadmap Workshop, April 2011

The **"emerging" market** still has a low volume of sales and installed capacity but the market trend is positive. The basic framework conditions are there but the market must be monitored and the conditions for a sustainable growth must be implemented.

A **"niche" market** is a market where solar thermal technology is limited to a very small community of interested users and where there is no increase in sales volume. The framework conditions must be built up from scratch.

It is important to correctly assess the situation of the market before designing a solar water heating strengthening programme, as different kind of markets (emerging, niche, mass markets) require different kind of support, and different policy framework, underlying different development.

In general, the growth in a market has positive effects in terms of market conditions as is illustrated in the graph below:



TYPES OF SYSTEMS ON THE MARKET

Different application and solar thermal technology require different framework conditions.

- A market dominated by thermosiphon or unglazed collector systems will require less investment and efforts in the qualification and training of installers. On the contrary, if the market strengthening initiative aims at developing forced circulation and collective systems, it will be necessary to develop a specific strategy to influence the market orientation.
- In a market where combi or collective systems are required, it will be essential to overcome the complexity and focus on the information to be provided to end users, the question of the initial investment costs will also need to be addressed.
- The solar thermal solution promoted must be adapted to the local conditions, climate and heat demand

ECONOMIC DEVELOPMENT AND HEATING MARKET

In certain cases, competition in the heating market will in itself be a major obstacle. Countries that have a domestic production of fossil fuels, or where classical utilities dominate the market, tend to be very challenging for solar thermal. The level of economic development and the capacity for individuals to afford solar thermal systems are of course crucial elements.

4.3 SOLAR WATER HEATING TECHSCOPE MARKET READINESS ASSESSMENT

The Global Solar Water Heating (GSWH) Market Transformation and Strengthening Initiative published a report presenting a replicable and public methodology to evaluate the solar water heating (SWH) policy, finance and investment, business, and quality control infrastructure across countries: the SWH TechScope market Readiness Assessment methodology.

This report is intended to be used in conjunction with the SWH TechScope Market Readiness **Analysis Tool** (Excel-based), which can be used to benchmark and evaluate different SWH markets.

The *SWH TechScope Market Readiness Assessment methodology* uses a system of weighted indicators to develop a score for national SWH enabling environments. The indicator system development was supported by a network of international SWH and renewable energy experts. The scoring system consists of four interrelated parameters. These four parameters are composed of 18 indicators that reflect different elements of the enabling environment for SWH in a given country. Each of the indicators is scored based on a scale of 0 to 5. These indicators are then weighted to develop an overall score for the country – again based on a scale of 0 to 5.

The SWH TechScope Market Readiness **Analysis Tool**, allows users to evaluate the Solar Water Heating (SWH) market of any country by entering relevant data and calculating a TechScope score for the respective country.

Also, the SWH TechScope Analysis Tool integrates an optional module to quantify the GHG emissions reductions associated with increased development of SWH systems.

Users of this guide may refer to the Solar Water Heating TechScope Market Readiness Assessment Report for additional information on solar thermal competitiveness in the following countries: Albania, Chile, India, Lebanon or Mexico. Expert users and public authorities may refer to this publication to assess their own market using the proposed methodology.

Both, the SWH TechScope Market Readiness Assessment report and the SWH TechScope Analysis Tool can be downloaded in the following link.

KEY RECOMMENDATION

Impact in the market depends on good comprehension of solar thermal potential

A good analysis of the solar thermal potential will help to understand how to better influence the market and promote the deployment of the technology, besides providing a basis to realise the aptitude of a growing solar thermal market to benefit the local economy, replacing energy imports with jobs!

FURTHER READINGS AND REFERENCES

- IEA SHC 2015
<http://www.iea-shc.org/data/sites/1/publications/Solar-Heat-Worldwide-2015.pdf>
- RHCTP 2013a
http://www.rhc-platform.org/fileadmin/Publications/Solar_Thermal_SRP_single_page.pdf
- UNEP 2014a
<http://www.in.undp.org/content/dam/india/docs/EnE/solar-water-heating-techscope-market-readiness-assessment.pdf>
- ESTIF/UNEP 2014
http://www.estif.org/fileadmin/estif/content/publications/downloads/unep_report_final_v04_lowres.pdf

SECTION 5

MARKET

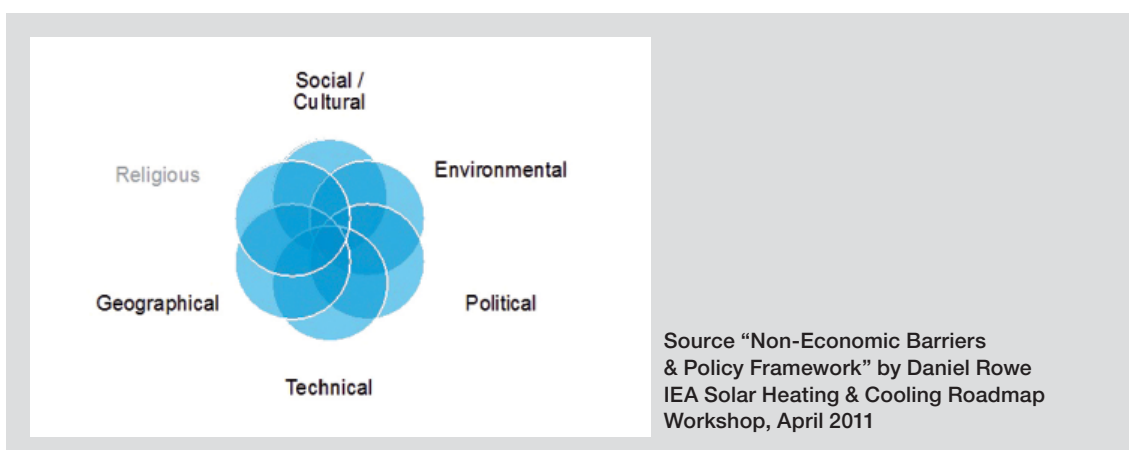
BARRIERS

Despite its obvious benefits and advantages, the solar thermal technology is far from being a standard solution in every country and geography. The mere existence of a programme such as the GSWH demonstrates that it is commonly believed that there is a need for active policies and initiatives to develop the use of solar energy.

This section will provide an overview of the main factors potentially impeding its development while indicating the generic solutions to overcome them.

5.1 NON-ECONOMIC BARRIERS

It is, of course, possible to identify non-economic factors which have a very strong influence on the adoption of a product by consumers. Non-economic barriers can be very broad and can vary significantly according to the specific market. Their impact is not to be underestimated, and often economic incentives and policies are not sufficient to overcome them properly. Specific actions are needed to tackle them, once they have been identified. Non-economic barriers can be social and cultural, when they refer to the understanding or use of the technology; geographical, when they are related to supply or servicing bottlenecks; technical, when related to functionality or performance of the technology; political, when related to incentives or market access distortions; environmental, when related to resource supply and waste production. A number of actions are needed to tackle those barriers, ranging from education/information campaigns, to standard and certification measures, to resource and waste management policies, and so on.



Typology of non-economic barriers:

Sphere	Encompassing
Social/Cultural	Understanding/use
Geographical	Supply/servicing
Technical	Functionality/performance
Political	Incentives/market access
Environmental	Resource supply/waste creation
Religious	

How these factors constitute a real barrier in one given market will vary considerably, e.g. accessing the market to supply and install solar thermal products does not constitute a barrier in the United States where on the contrary incentives are inexistent or very low.

Although it can be argued that all these barriers can be removed by economic incentives, it is necessary to tackle them through framework conditions and policy that do not focus solely on these economic incentives.

Barriers	Solutions
Understanding/use	Information/education
Supply/servicing	Industrial policy
Functionality/performance	Standard and certification/R&D
Absence of Incentives/ no market access	Building obligations/ free market access to imported products
Resource supply/waste creation	Resource & waste management

5.2 ECONOMIC BARRIERS

Economic barriers relate to prices, costs and competitiveness of solar thermal on the market. This includes the price of the system installation, the price of the heat produced over the life cycle of the system and the comparison with the alternative solutions on the market, in particular with traditional heating devices based on fossil fuels. Economic barriers are thus related to the real and to the perceived price of the solar thermal system, therefore the concepts of pay-back time and initial upfront investment costs are crucial, as their variation directly impacts consumers' choices and preferences. Economic barriers are also related to market distortions such as import tariffs and other taxes on equipment.

- What is the price of a solar system installed?
- What is the price of the heat produced over the life cycle of the system?
- How do those prices compare with fossil fuels or renewable alternative solutions on the market?

In order to fully understand how economic barriers can occur, it is important to distinguish between the initial investment costs (the solar system and its installation) and the cost of each unit of heat it produces over its life cycle. Solar heat will, anyway, pay for itself because the sun is free; but depending on the initial costs, and the costs of other options,

the “payback” will vary considerably. Sensitivity to the “payback” time and the capacity for end consumers to invest must be understood and analysed to understand to which extent they will or not constitute a barrier.

In China, Greece and Israel solar thermal is not only extremely competitive compared with other options but also, in absolute terms, the initial investment costs are low. This probably explains, to a large extent, the success of solar thermal in these countries.

Financial/economic incentives will usually address directly the issue of price by either trying to compensate the difference with other options or create an economic advantage.

Finally, it is important to take into account that the market development of solar thermal in itself is a factor which will contribute to a reduction in prices and improve competitiveness through increased competition in systems and installation costs, economies of scales in manufacturing and other, as explained in section 4 (4.1.2 Economic and market potential).

KEY RECOMMENDATION

Barriers to the deployment of solar thermal solutions in the market can be diverse, varying from country to country but even between regions and cities

The understanding of the barriers and how they hinder the development of the solar thermal market is essential to develop adequate solutions to unleash the potential of the technology.

FURTHER READINGS AND REFERENCES

- Key4RES-H 2007
https://ec.europa.eu/energy/intelligent/projects/sites/iee-projects/files/projects/documents/k4res-h_renewable_heating_and_cooling.pdf
- IEA-RETD 2015
<http://iea-ret.d.org/wp-content/uploads/2015/02/RES-H-NEXT.pdf>
- GSTEC, “Market barriers”
<http://www.solarthermalworld.org/>

SECTION 6

IMPORTANCE OF POLICIES AND DEFINITION OF FRAMEWORK CONDITIONS

6.1 PUBLIC POLICIES

Public policy or government action is generally the principal guide to action taken by government departments with regard to a category of issues. The policy action occurs through legislations, regulations, financing, and communication. Government can act directly or via local authorities, agencies or other public bodies. The government can substitute or complement private initiatives - a marketing campaign, a financial incentive can result from private initiatives – however public bodies have the monopoly of imposing obligations and/or taxes.

Public policies are key in creating the right conditions in which private investors are confident enough to invest in the technology. Besides the specific tools that policies may promote to tackle barriers to deployment, policies must develop long-term visions and commitments, in order to guide market development. In particular, the creation of ‘credible and ambitious targets that provide investors a clear idea of market size and opportunity [...] to generate confidence among industry players’(IEA-RETD, 2015) is a crucial task for policy-makers.

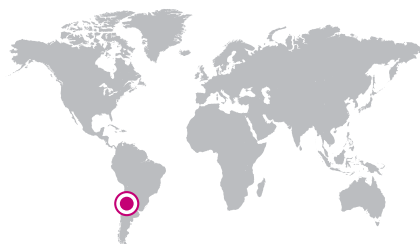
Besides facilitating the development of frameworks to create a sustainable solar water heating market, policy-makers can design and implement specific policies to achieve secondary targets, which will in turn help achieve such frameworks. Policies can be used to enhance the awareness of consumers and sector professionals (installers, architects, etc.), to contribute to the development of financing mechanisms increasing the demand for solar water heating systems, and to improve certification and quality control schemes [UNEP, 2104].

A market-strengthening programme will require the implementation of targeted policy measures contributing to the creation of the right framework conditions for the development of the solar water heater market.

CHILE

Chile: the “Programa Solar”: addressing the 4 pillars

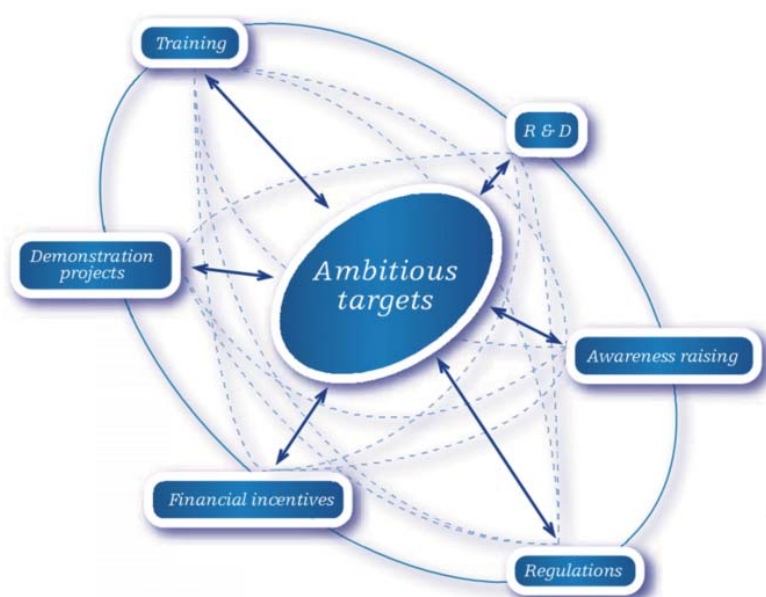
The initiative seeks to promote the integration of solar thermal technologies into the housing sector. The Programa Solar is a project supported by the Chilean national institutions and is based on four main pillars:



- 1 standards, regulations, ordinances and system certification,
- 2 market awareness,
- 3 skill-enabling programmes for engineers and technicians, and
- 4 financial incentives.

A financial incentive developed in this framework is particularly interesting and innovative because it addresses the construction sector in the form of a corporate tax deduction for solar thermal investments. Integration of ST in new buildings is less expensive and increases the value of a building.

Source solarthermalworld.org



Public policies, in order to design an effective strategy promoting the sustainable development of the solar thermal market, it is necessary to take into account a combinations of measures.

These can be divided into:

Measures with a direct and rapid impact on the market:

- Obligations / building regulations
- Financial incentives
- Awareness raising

Measures with an indirect or only longer-term effect on the market:

- Training
- Research & Development (& Demonstration)
- Quality assurance

In some cases, the indirect measures are considered as flanking measures, supporting the implementation of the direct measures.

In alternative, we can also consider that any of the measures referred above can be considered as a flanking measure, as they can be addressed as support to the main measure. For instance, in some cases, the main measure may be based on building regulations, with the other measures becoming flanking measures. In other situations, financial incentives may constitute the primary measure.

Hence, the central piece of the strategy to promote solar thermal, composed of one or more measures should be complemented by other measures that will be considered as flanking measures.

Experience in several countries has shown that the implementation of one measure alone will have no or limited effect. There are financial incentives that were well designed but were not known by the majority of the population. In other cases, the market was not prepared for the impact on demand of a particular incentive, lacking enough qualified installers in the market. In other cases, obligations did not take into account adequate quality assurance measures, promoting indirectly the use of low quality/low cost products. These are just some examples of the need to apply several of the listed measures in combination.

This shall be addressed in more detail in the following sections. In this case, there will be a specific section on awareness raising (section 7), considering its relevance and specificities. Another section will address non-direct measures (section 8). And finally, financial incentives will be detailed in section 9.

6.2 FRAMEWORK CONDITIONS

The concept of framework conditions is broader than that of policies. It covers the hot water market *stricto sensu*, the solar and heating industry development, public acceptance and awareness of solar thermal, the national, local energy mix, the research and testing capacity, the qualification and training and, finally, the regulatory framework.

Both policies and private initiatives can contribute to shape and influence the framework conditions but, as already demonstrated, the influence of the public sector is crucial to be able to put in place a coherent set of measures.

The importance of framework conditions is well reflected on the “SWH techscope market readiness assessment”, addressed in chapter 4.3.

For instance, the business climate in the country is an important element. If there is economic growth and a good investment framework (for instance, low interest rates), there will be a stronger propension for private investment, be it in solar thermal companies, be it in building or other business that may require solar thermal products.

On the other hand, if energy costs are very low, it will affect the competitiveness of solar thermal solutions. But, if those low costs are the result of high public subsidies, then the state may support alternatives that can reduce their “energy subsidies” bill.

Additionally, if the medium to long term market outlook is good, it will provide confidence for companies to invest more in Research & Innovation, or installers to invest in training, new equipment and enlarge their team.

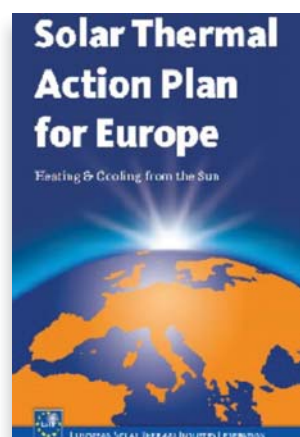
As such, the relevant factors affecting framework conditions are broad and diverse from country to country. A more detailed analysis taking into account the local reality should be considered.

EUROPE

A Solar Thermal Action Plan by ESTIF

In 2007 ESTIF published the “Solar Thermal Action Plan for Europe”, this document aimed at proposing a series of recommendations to reach the ambitious target of 1 square meter of solar collector for every European by 2020. This work contains several studies and projects on solar thermal and, at least, one conclusion in evidence: “The market strengthening of solar thermal in order to be successful requires to address all framework conditions, the incentives especially the financial ones are only one part of the plan and the public authorities can play an even more important role in fields of such as standardisation, quality, training, R&D, information and promotion, where public and private initiative can be combined.”

Solar Thermal Action Plan, ESTIF 2007



KEY RECOMMENDATION

Framework conditions can be improved by action of public or private actors

The action of public or private actors is essential to change framework conditions, developing the conditions in the market for the adequate deployment of solar thermal, addressing different barriers and putting in place enabling factors.

FURTHER READINGS AND REFERENCES

- Key4RES-H 2007
https://ec.europa.eu/energy/intelligent/projects/sites/iee-projects/files/projects/documents/k4res-h_renewable_heating_and_cooling.pdf
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SECTION 7

AWARENESS

RAISING:

THE IMPORTANCE

OF COMMUNICATION

Guidelines and recommendations for the promotion of solar thermal, as well the organisation of campaigns, is the object of a guide also published by ESTIF within the framework of the GSWH programme. In this publication, we will limit ourselves to explaining which role should be played by communication as part of a strategy for market strengthening.

With regard to market strengthening and improvement of market conditions, communication will serve mainly three purposes: Awareness raising; Information and education; Marketing & advertising.

7.1 BASIC AWARENESS

In emerging and niche markets it is often necessary to raise awareness on the existence and availability on the market of solar thermal systems. This basic situation of awareness is well illustrated by the questions: “Solar... what or solar... why?”

Campaigns with this kind of messages are necessary at early stages of market development, although it has been demonstrated in previous sections that the vast majority of markets worldwide are still at phases where basic awareness raising is needed.

The support of government and local authorities for solar thermal has in itself a huge added value in terms of communication. The commitment of public authorities instils consumer confidence and provides stability to the industry.

7.2 INFORMATION AND EDUCATION

A more advanced type of communication consists of targeted information or education campaign.

Information on the technology when interest has been awakened: is there a technical solution adapted to my needs, where can I obtain a quote or buy a system?

When incentives, especially financial, are adopted it is always necessary to promote their existence and inform about the administrative process and requirements.

Campaigns can have educational purposes. Customers can be encouraged to purchase certain products with a quality mark, to request qualified installers or dealers, to monitor the performance of their systems, to testify about their experience.

7.3 MARKETING AND ADVERTISING

We have already stressed the importance of cooperation between public and private sectors for the success of the market strengthening initiatives. In the field of communication, it is crucial that efforts in the public sector are known and complemented by private initiatives. The industry, which will benefit from the market development, should co-finance the communication efforts and acquire visibility for their brands at a later stage, products advertisements will contribute to the promotion of the technology and increase in sales.

LEBANON

Lebanon's advertising campaign on SWH technologies

The solar water heaters (SWH) market faced major challenges in Lebanon. The lack of awareness was, as usual, amongst the most important barriers. The re-introduction of the SWH in Lebanon's water heaters market started with the urge to address the negative reputation that had been risen in the past, due to the lack of experience of installers and poor quality of the SWH's.

An advertisement campaign launched in 2006 by an LCEP-UNDP project and Lebanon's Ministry of Energy and Water fruitfully effected the targeted audience and upturned the interest in the technology.

The campaign was financially supported by GEF and MEW, being the total amount of dollars allocated encompassing 3 Million USD (2.8 million euros).



The outreaching campaign used media outlets such as radios, billboards and even TV commercials with engaging renowned actors.

Video to promote use of solar thermal energy, by LCEC, Lebanese Center for Energy Conservation

The campaign can be evaluated through a survey held in 2012 and published in 2014 where nearly 70% of households considering energy efficiency decided to give primacy to SWH's, instead of efficient lightning (10%) or other types (21%).

Besides the residential users, the campaign also addressed commerce and industry.. The advertising campaign had to be different than the one created for residential users since it requests to tackle large-scale installations, should be based on pilot projects and had to take into account other needs, such as economic information on savings and return on investment.

Source: SWH Case Study Report UPTD

KEY RECOMMENDATION

Awareness raising is a stepstone for public and political support

Awareness raising promotes market growth. It has a pull effect in the market, leading consumers and other market actors to consider solar thermal as an option and demand for it. But it can also have a pull effect, namely promoting political support. Public support can generate political support. Political support can generate public support. Both are important in order to create push and pull effects that can sustain market growth. Market growth generates benefits for the economy (jobs, income, lower imports) but also improves the competitiveness of the technology. This creates a virtuous circle.

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- Key4RES-H 2007
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SECTION 8

NON-FINANCIAL MEASURES

Non-Financial Incentives include all public policies that do not involve a direct financial support for the acquisition of solar thermal systems. These measures should be combined with financial incentives. These non-financial incentives (including awareness raising) are part of the flanking measures.

These incentives can have a more direct and immediate impact in the market, generating a pull effect, as it is the case for solar thermal obligations. In this case, the effect is not only on the short term, as it provides a stable context for the development of the technology in the future, bringing more actors into the market, improving competitiveness, generating investment.

Other measures will provide assurance to the consumer, as it is the case for quality standards and certification. By promoting that the market is replenished of reliable solutions it will serve consumers and promote confidence in the technology and its different solutions, which will have a positive effect in the market in the longer run.

Likewise, research & development will allow for better and more competitive solutions come into the market in the medium to long term.

Such instruments can create an indirect financial advantage for companies involved in the market and this benefit is then passed on to the users.

support the creation of public good, even when providing an indirect financial advantage to the solar thermal market. For instance: an awareness raising campaign financed from public money or a programme to subsidise craftsmen training or R&D, etc.

8.1 SOLAR THERMAL OBLIGATIONS

WHAT IS A SOLAR THERMAL OBLIGATION (STO)?

STO are legal provisions making mandatory the installation of solar thermal systems in buildings. The obligation mainly applies to new buildings and those undergoing major refurbishment. The owner must then install a solar thermal system meeting legal requirements. Most of the existing STOs are connected to national or regional energy laws and implemented through the municipal building codes. A growing number of European

municipalities, regions and countries have adopted solar thermal obligations. Already today, more than 150 million people live in regions covered by a STO.

BENEFITS

A major benefit of solar thermal ordinances is their effectiveness combined with low costs and limited administrative overheads for public authorities. As part of the building permit process, the inspection with regard to the renewable energy requirement is simple and thus does not strain public finances.

The introduction of a solar thermal ordinance prevents market fluctuation caused by inconsistent incentive programmes. It provides a stable planning environment for market actors and investors, encouraging local economic growth and creating new jobs in this sector.

NEED FOR ADDITIONAL FLANKING MEASURES

Solar obligations have a profound effect on the solar thermal market's structure. Therefore, to maximise their benefits, they require flanking measures.

In a market where solar thermal becomes mandatory, promoters and customers will tend to question the solar systems' operation and react more negatively than in a voluntary market.

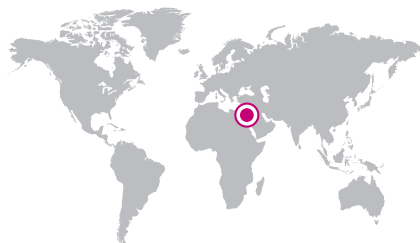
Ends users and the construction sector will often go for the cheapest possible solution, while building owners will try to circumvent the obligation through exemptions. The real impact of any regulation strongly depends on its technical parameters and control procedures.

It is vital, therefore, that the regulations adopted ensure state-of-the-art quality assurance, products, planning, installation and maintenance of the system, guaranteeing the same high level of customer satisfaction as in the current voluntary market. Poor performance of "mandatory" systems would not only undermine public acceptance of the obligation, but also, possibly, of the solar thermal technology in general.

ISRAEL

30 years of experience with solar thermal ordinances

Thirty years ago, Israel was the first country to pass legislation on solar thermal installations. With the second oil crisis at the end of the 1970s, members of parliament examined ways to make their country less dependent on imported energy. The result was a law, which made solar water heaters mandatory in new buildings such as residential housing, hotels, guest houses and old people's homes up to 27 metres high. The legislation entered into force in 1980.



Nowadays over 80% of Israel's households get their domestic hot water from solar rooftop heaters. A typical domestic unit consists of a 150 litre insulated storage tank and a 2 m² collector. These hot water heaters save the country the need to import about 4% of its energy needs, and replace about 9% of the electricity production.

The law has now become redundant. More than 90% of the solar systems are installed on a voluntary basis, i.e. they are installed in existing buildings, or the systems are larger than required by the obligation.

Source: PROSTO project

8.2 QUALITY, STANDARDS AND CERTIFICATION POLICY

The need and methods to ensure quality in the market are so important for solar thermal, that a complete guide is dedicated to this topic in the framework of the GSWH project.

THE NEED FOR STANDARDS

The objective of standardisation and quality assurance is to guarantee product safety and quality, as well as lower prices. At every stage of market development, the capacity of solar thermal systems to deliver the expected level of performance is a key factor. In the early stage of the market, quality issues have had long lasting devastating effects. The existence of standards is the cornerstone of quality assurance.

THE ACTORS OF STANDARDS AND CERTIFICATION

Standardisation and quality for solar thermal should be the result of a joint effort from public authorities (market regulation), the industry, the technical community and, when they are adequately organised, the end users.

- Public authorities have a key role to play in imposing stringent quality requirements and in initiating, facilitating and controlling the standardisation process.
- The industry must provide product and technical expertise. It must understand the benefits
- of ensuring standardised level of quality. Public authorities should guarantee that the standards are neutral and do not favour certain products or companies.
- It is essential to be able to rely on independent testing facilities and certification bodies. If the private initiative is not adequate, then public authorities should actively support the creation of such structures.
- Consumer organisations can bring a useful contribution to the process.

QUALITY INSTALLATION FOR QUALITY PRODUCTS

Solar thermal products usually need to be installed. This operation can be simple to the extent that it might not require the intervention of a specialist, e.g. some thermosiphon systems, but on average it should be undertaken by a professional. To guarantee performance, the quality of the installation is as important as the quality of the system. Minimum requirements in terms of training and qualification of installers should be implemented in parallel with product requirements. Public authorities should regulate in the absence of initiatives from trade and industry.

PERFORMANCE AND QUALITY FOR A SUSTAINABLE MARKET

Performance and quality measures do not constitute flanking or accompanying measures. Framework and regulations should be developed, and relevant bodies involved from the beginning, even if this has to be imposed to the market to some extent.

The market tends to be short-sighted; industry will naturally prefer to avoid costs and regulations. The benefits of high quality regulations and market surveillance will emerge eventually and guarantee a sustainable market. Public authorities should ensure that incentives and promotion endorse quality.

8.3 RESEARCH AND DEVELOPMENT, DEMONSTRATION PROJECTS

Solar thermal is a simple and mature technology; however, research and development are necessary to guarantee that performance will continue to improve and costs to decrease. Research and development can also contribute to adapt the technical features of products to local needs, e.g. improve water tightness in tropical areas, resistance to frost in mountainous regions. Research and development cannot proceed only from public initiative but, through public universities and public research centres, public authorities have a leading role to play.

BUILDING UP CENTRES OF TECHNICAL EXCELLENCE

Applied research, engineering education, development, product innovation, standardisation, testing are closely linked and there are a lot of synergies between those fields. Most of the time, the same persons will be likely to teach, test and lead research projects. A sustainable market will always require relying on a high level engineering community. Public authorities should encourage the creation of multi-disciplinary technical facilities for solar thermal engineering and encourage or even impose on the industry to participate in this effort.

IMPORTANCE OF DEMONSTRATION PROJECTS

For both promotion and technical (experimental) reasons demonstrations projects are extremely useful. Projects implementing technologies that are not market ready, but which have an important potential, will allow testing and improving the solution, gather data, monitor functioning and finally demonstrate the feasibility to the general public and the industry in order to prepare the introduction on the market.

KEY RECOMMENDATION

Flanking measures are essential but need to be implemented in a coordinated way

A mix of flanking measures is necessary to address different matters while creating synergies between actions. Several flanking measures can complement direct financial support schemes, namely via regulatory measures that promote the use of the technology. Some of the flanking measures address the future development of the market, either by creating confidence in the market (by means of quality assurance) or by promoting consistent technological development.

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- ESTIF/UNEP 2015b
http://www.estif.org/publications/solar_thermal_guides/

SECTION 9

FINANCIAL

INCENTIVES

It is important to address the financial incentives, as these are traditionally the most effective means of supporting the deployment of solar thermal products. These can take different forms, such as direct, indirect, tax incentives or low interest loans.

Financial Incentives include any public policy giving a financial advantage to those who install a solar thermal system or that use solar thermal energy.

9.1 SOLAR THERMAL SPECIFICITIES

VALUE AND COSTS

The direct economic value of a solar thermal system for its owner consists of:

- The economic value of the energy it saves
- The independence from conventional energy supply

The costs of a solar thermal system include:

- The investment to buy and install the system
- The costs of maintenance and decommissioning

Life cycle assessments of solar thermal systems have shown very low environmental impacts and thus external costs, almost all of them in connection with the manufacture of the product or its raw materials. But nearly all materials can be recycled.

Over the lifetime of a system, the largest part of the cost (usually well over 90%) occurs at the time of investment, since the maintenance and decommissioning costs are very low. The economic benefit, however, is spread over the lifetime of the system, which is usually over 20 years. Alternatively, in the case of conventional heating and cooling systems, the operational (mainly fuel) and maintenance costs are much higher than the investment costs.

INITIAL INVESTMENT AS A BARRIER

This high share of upfront investment costs is a major barrier for increased use of solar thermal and other renewable as well as energy efficiency measures. For many private individuals, the absolute amount of upfront investment costs is the key barrier. And, future lower heating costs tend to be undervalued against the initial investment costs.

For many commercial decision makers, it is the payback time, which is seen as crucial. Even in the case of high returns on investments (over the lifetime of the system), many companies avoid solar thermal because the payback time is higher than 5-7 years. Furthermore, the calculation of a payback time depends largely on the assumption made for the price of conventional fuels when replaced by solar. In the absence of reliable price forecasts, many investors calculate with stable prices of conventional fuels, which may lead to lower estimations of the future energy costs savings through solar thermal systems.

Even in countries where the solar thermal market has reached a certain market size, the decision to purchase and install a system can still be more complicated than installing a conventional heating system. Only in mass markets has solar thermal become a mainstream technology.

9.2 MAIN FORMS OF FINANCIAL INCENTIVES

This overview is not extensive, and other forms of financial incentives might be developed:

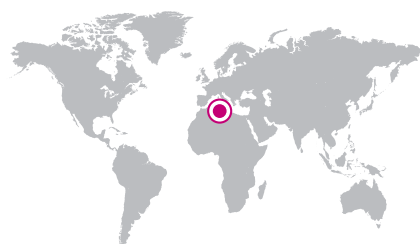
- Direct grants
- Solar heat tariff
- Tax reductions
- Loans at reduced rates
- Green heat or energy efficiency certificates
- Tradeable Certificate Schemes (green heat or energy efficiency certificates)

TUNISIA

Prosol, an effective combination of incentives

The ambitious subsidy programme Prosol started in 2005. This programme intended to promote an alternative to the use of gas. The goal was to promote a sustainable solution, applying more effectively public funds rather than spending continuously and inefficiently on supporting LPG prices locally.

The incentives combine a direct grant of 20 % of the investment costs for a solar water heater with the payment of remaining investment costs done through the electricity bill on a monthly bases over five years. The level of the monthly rates is fixed according to the money the household have spent so far on LPG gas bottles or on electricity for hot water.



The system is very successful and increased the market from 7000 m² in 2005 to 80,000 m² in recent years.

Source: www.solarthermalworld.org/node/266

GRANTS

Grants are a direct support to reduce the initial investment (upfront cost). This is probably the most common form of incentive and it is definitely the case in Europe.

Such a grant scheme always implies an administrative structure for processing the applications as well as a budget to cover the costs. If the budget is limited, the number of acceptable applications must be limited, either on a first-come-first served basis or on other criteria.

SOLAR TARIFF

In 2011, the United Kingdom introduced a system of incentives, which, to our knowledge, is unique. The Renewable Heat incentive is a tariff paid to the end users for each unit of renewable heat they produce. Solar thermal is only one of the technologies covered by this scheme together with geothermal, biomass and heat pumps.

The UK government has established a tariff for each energy source, which is supposed to increase the return on investment. This concept is largely inspired by the feed-in tariff introduced in many European countries for electricity.

For budgetary reasons the introduction has been partially delayed and it is too soon to draw any conclusions on the effect such measures will have on the market.

TAX REDUCTIONS (DIRECT AND INDIRECT TAXES)

The first part of this section looks at reductions in income or corporate tax and the second section looks at VAT reductions.

• DIRECT TAXES

Part, or all, of the investment in a solar thermal system can be made deductible from income tax or corporate tax.

In monetary terms, tax breaks can give the same incentive as direct grants. However, because they work differently, it has been argued that their impact could be lower than direct grants.

Firstly, a reduction in the income or corporate tax leads to a benefit only one or two years later (when the income is declared and the tax returned). But typically a benefit at some point in the future is valued less by people than an immediate payment (which could be accomplished with a grant). The longer the interval between the expenditure (purchase of a solar thermal system) and the incentive (tax reduction or return) the longer the person has to finance the whole investment.

Some positive effects of a tax reduction can outweigh any disadvantage:

The tax reduction removes the need to apply for a grant before purchasing a solar thermal system. This drastically reduces the procedure and the waiting period.

It should be noted that a real tax reduction can have socially unjust implications: As low-income households typically pay no or very low taxes, the absolute tax reduction may be lower than for the medium to higher income earners.

For the government, an income or corporate tax reduction has the advantage that it does not require significant additional administration.

For the solar thermal industry, a tax reduction has the benefit of not being tied to a limited budget: As long as the scheme is applied, there can be no limit on the number of accepted applications. This contributes to creating a more positive framework for the industry to invest in market development, particularly if there is confidence that the tax break will last for several years.

• **INDIRECT TAXES**

In principle, a reduction, or abolition, of the indirect taxes applied on solar thermal products and services needed to install and maintain a solar thermal system can be a very effective financial incentive for private individuals: Like a grant it immediately lowers the overall investment costs to the end consumer. And it does not involve the processing of any grants or additional items in a tax declaration and is thus very simple to apply.

LOANS AT REDUCED RATES

The investment in solar thermal systems can be supported by loans offered at a lower-than market interest rate. So far, such loan schemes alone have not had a significant impact on the development of the solar thermal market in any European country.

Due to the rather small size of the typical solar thermal investments (often in the range of between 1 000 to 5 000 Euro), a loan for a solar thermal system alone does not seem very attractive to many consumers, as the overhead costs for both the bank/government and the end-consumer are quite high. However, they can be an interesting complement to other support measures.

In principle, a privileged loan is an appropriate answer to one of the main barriers to growth for solar thermal, i.e. the high rate of upfront investment cost. The loan allows to spread the investment costs so that the energy cost savings of the solar thermal system can be used to pay off the loan.

Under present conditions, low interest loan programmes could be very useful if targeted at large solar thermal systems purchased by commercial users; such as HVAC systems used in large residential buildings and hotels, solar process heating systems and solar cooling systems. In these cases, the investment volume is higher and so the propensity to take loans increases.

Apart from public loans, some companies offer agreements, in which the solar thermal company builds, owns and operates the (large) solar thermal system and the customer only pays for its usage, just like he would pay for oil or gas. Such offers, where the solar thermal company effectively operates as an Energy Service Company (ESCO) have

become known as “Guaranteed Solar Results” contracts. Their market share is still very limited but with a growing solar thermal market it can be expected that their impact will rise. By providing low interest loans, governments can support the development of viable markets for solar thermal ESCOs.

TRADABLE CERTIFICATE SCHEMES

In a Tradable Certificate Scheme (TCS), those investing in a solar thermal system obtain certificates representing the energy saved through the system. The certificates can then be sold on a certificates market, which is typically driven by a requirement on certain stakeholders (e.g. energy suppliers) to cover a share of their energy trading with certificates.

In the electricity sector, TCS usually awards certificates for each produced and measured unit of energy. As the price of the certificates varies according to supply and demand, the income from certificates is not known in advance. This, critics of TCS have often maintained, would not create the market stability needed for the young and growing RES-electricity sector.

PRIVATE SECTOR INITIATIVES

Regarding financial incentives it can prove extremely useful to encourage initiatives coming from the private sector utilities, system manufacturers or others. In that case the financial burden can be shared or even transferred to the private sector that conducts the initiative as a marketing and profit-making programme.

These initiatives can be triggered or encouraged by public authorities via TCS (see above) or simply support to awareness and marketing.

Private sector initiatives refer to financing tools that are most commonly used from the private sector to the development of renewable energy projects, as for instance traditional bank loans. Those instruments are widespread in the renewables financing market, and are commonly the bulk of the financing of a project, whereas public or alternative financing sources act as a complement of the private financing. Those instruments, however, are very much sensitive to fluctuations according to the risk perception of renewable energy projects in the market, and several barriers have been growing up during the last years, following the economic crisis, when it comes at the effective possibility for renewable energy projects to access private financing.

ESCOs can offer different forms of contracts and agreements, from leasing to on-bill repayment contracts. ESCOs can perform Energy Savings Agreements or Energy Performance contracts, between a recipient and the provider of a renewable energy installation, where investments for that installation are paid for in relation to a contractually agreed level of renewable energy production and/or other criteria, such as bills savings.

Other private sector initiatives may involve innovative financing tools, such as leasing, ethical banks, joint ventures, venture capital funds or green bonds. It may also refer to participated financing tools, such as renewable energy cooperatives or crowdfunding.

UNITED STATES

Utilities promote solar heat

Lakeland Electric in Florida and the California-based renewable energy service company Regenesys Power offer solar heat to consumers on a contracting basis since October 2010.

Both utilities offer homeowners the possibility to purchase the energy a system generates for a monthly fee,

which is comparable to the monthly electricity, costs for a family of four.

The contract runs over 20 years with a fixed, monthly energy fee. In addition to a fixed price plan, the customer receives other benefits, such as no up-front investments costs, additional hot water storage, zero maintenance costs, a reliable supply and the option to purchase the system.



9.3 BENEFITS OF FINANCIAL INCENTIVES

EXTERNAL UTILITY OF PRIVATE INVESTMENT

Private investment creates external utility: society benefits from the reduction of emissions and other external costs linked to the use of oil, gas or electricity for heating or cooling purposes. The financial incentive rewards private investors for these positive externalities.

SECURITY OF ENERGY SUPPLY

By decreasing the dependency on imported energy sources, every solar thermal system reduces the need to take public measures such as strategic energy reserves, investment on infrastructure for transport of energy sources, diplomatic and military costs. By increasing national energy supply, in the long term, a financial incentive for solar thermal can be cheaper than alternative measures.

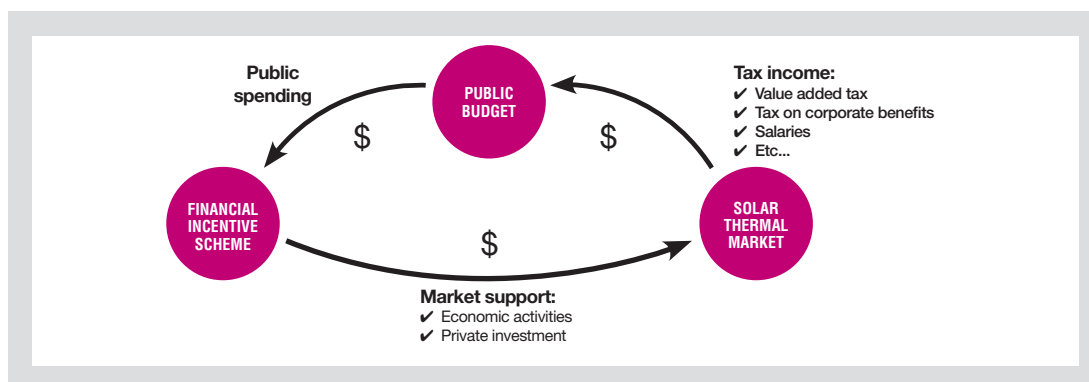
REMOVING THE BARRIER OF UPFRONT INVESTMENT COSTS

For the different reasons mentioned above, private investors can be discouraged by the high rate of upfront investment costs, compared with a conventional heating or cooling system. By reducing this financial and psychological burden, investments in solar thermal are encouraged. Thereby, a number of economically sound investments (with payback time shorter than the lifetime of the system and a substantial benefit in terms of energy saving) are encouraged.

SOLAR THERMAL REPLACES IMPORTED FUELS WITH LOCAL JOBS

Regardless of where the solar thermal hardware has been produced a substantial part of the turnover linked to a system remains local: marketing and distribution, design, installation, training etc.

By stimulating investments, financial incentives create benefits for the local and national economy.



A POSITIVE SIGNAL FROM THE PUBLIC AUTHORITY

The fact that a public authority gives a financial incentive shows a positive signal to citizens, concretely demonstrating public support for this kind of investment. This builds market confidence in both the technology and the installers supported by the FIS.

FINANCIAL INCENTIVE AS A MARKETING TOOL

The existence of financial incentive schemes can be one of several methods for marketing solar thermal products. Their introduction should always be accompanied by a public awareness raising campaign. At the same time, private market actors will communicate with their customers. The level of incentives can be low but their existence still motivates the general public to purchase solar because of the “should not be missed” feeling in a similar manner to a discount campaign.

CREATING ECONOMIES OF SCALE

Since there are very few mass markets for solar thermal, the potential for economies of scale are substantial. This is true not only for manufacturing, which is driven more and more by competition, but also for the subsequent stages of the value chain, e.g. in areas like marketing and distribution, system design, installation, customer care, etc. In some cases, these service costs represent over 50% of the final consumer cost e.g. pumped circulation. This means that, in countries with a low level of market penetration, there is a significant potential for economies of scales and reinforced competition in local and regional servicing. Financial incentives help to create economies of scale at all levels and thus reduce the price of solar energy in the short and long term.

9.4 KEY SUCCESS FACTORS FOR FINANCIAL INCENTIVES

When a financial incentive scheme for solar thermal is developed a certain number of generic key factors will influence its success:

CONTINUITY

This factor is very important. Short term or sporadic support is the single most important factor leading to the failure of a FIS. In some cases, sporadic availability leads to a stop-&-go market dynamic that seriously disrupts the development of healthy market structures. This sometimes outweighs the benefits of the financial incentive scheme.

The most obvious effect of erratic support is that people postpone their purchase until the support is available. In numerous cases, this tends to slow down considerably market development. By discussing, or even announcing, a support scheme in the future, the market actually decreased rather than increased.

Considering that the main objective of the financial incentive is to mitigate the risks and provide more certainty about their return, projects that may last several years, e.g. grid construction for district heating, need to have mechanisms for payment levels adjustments clearly communicated so that investors can more easily assess their risks. Investors will feel more comfortable with their investment decisions if they are provided more information about financial incentives over a long period of time. In other words, long term incentives should be stable so that the decision making process can be captured in formulas, allowing investors and developers to know when and how an incentive may be altered.

Another problem with short term measures is the lack of incentives for the supply side to invest in the development of healthy market structures, e.g. by building up a sales network, by training installers and other professionals etc. On the contrary, such a stop-&-go dynamic encourages the emergence in the market of “gold diggers”, short term companies only aiming at making a quick buck. As these “cowboy” companies install low quality systems with low or non-existent after-sales customer care, the reputation of the whole solar thermal industry can be seriously damaged.

CLEAR TARGET

When targeted at a very specific application or market segments (e.g. only at individual domestic hot water systems, or at large collective combi systems, at swimming pool heating or at solar thermal heat for industrial processes) the incentives can be much more effective. This is especially the case for new and emerging applications.

QUALITY CRITERIA

The support allocation should always be linked to minimum quality requirements to prevent bad quality systems from receiving public money.

MONITORING AND EVALUATION

While not strictly necessary for its smooth operating, it is very important that a scheme is continuously monitored and the results evaluated. It allows governments to fine-tune the scheme operation and prevents major problems in the future. Metering and monitoring services are important elements that when effectively incorporated in a particular financing programme can help the technology gain a better foothold in the market.

Evaluation should be done in close cooperation with market experts. It is important to include the wide variety of different stakeholders, such as Government agencies, trade organizations, industry and consumers and civil society groups. This is an important way to assure that different experiences are embedded in a program and relevant aspects such as equipment quality, control mechanisms and certification of professionals are correctly evaluated.

FINANCIAL RESOURCES

The scheme models are different in terms of how they set incentives, but also where the financial resources come from.

The most typical FIS, a governmental grant scheme, is usually financed through public funds, i.e. through taxes. This means that all taxpayers contribute to the financial incentives granted for solar thermal. It also means that the budget is limited – as approved by parliament – and this creates uncertainty if the required amount has not been assessed properly or if the scheme proves more successful than expected. The negative consequences of stops and uncertainties regarding financial incentives are often more damaging for the markets than the absence of such schemes.

Therefore, it is of utmost importance for any government to plan on a long-term basis in order to have budgets approved, which allow potential market growth. Several experts have suggested the use a grant-like scheme, but to finance it not from public funds but through the sales of conventional fuels. Such a model would have several benefits compared with annual or pluri annual budgeting:

- It reduces dependence on public finances (both in terms of total amount available, and approval procedures)
- It applies the Polluter-Pays-Principle by putting a financial burden on the user of conventional energy.
- It minimises the administrative tasks for the government

Such a funding, outside public budget, is more likely to be stable long term.

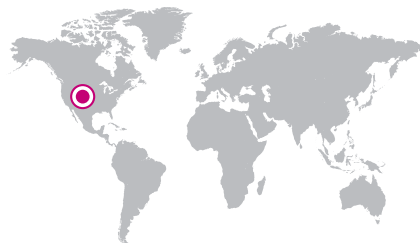
If the financing is not adequate, most likely financing programmes will not help the technology gain foothold within the market. In some cases low financing will exacerbate the investment that the industry might mobilize for the scheme. When this happens, a new planning system will have to be put in place costing money and other resources, further inhibiting industry from displacing finances to other areas of economic activity.

On the other hand, if the level of support is way above the required, two things might happen. The final cost of equipment might be fixed at higher level, compromising the uptake of RES-HC solutions in the general market and, a reduced number of total installations. Moreover, additional finances to fix eventual problems that might come up during the implementation of the scheme might not be available.

UNITED STATES

Financial incentives independent from Public budget

The **California Solar Initiative (CSI)** – Solar thermal Programme is a pure “rate-payer” financed programme. That means that the budget over 8 years of US\$ 250 million for replacing gas heating systems is collected from the gas ratepayers and the US\$ 101 million for replacing electric systems are collected from the electric ratepayers.



The CSI has some more innovative features that are worth mentioning: the tariffs are performance-based and decrease over time.

Source: www.solarthermalworld.org/node/1453

BASIS OF THE FINANCIAL INCENTIVES: COLLECTOR AREA OR ENERGY YIELD

The basis chosen for the allocation and calculation of the amount of incentive given is typically related to the size or capacity of the supported system: Larger systems receive higher incentives than smaller ones. Traditionally the incentive has been based on square meters of collector area, sometimes differentiating according to certain size brackets, applications or technologies. This method is not very refined but extremely simple in terms of implementation and understanding.

Alternatively, it would be possible to base the financial incentive on the expected or real solar energy yield of the system. This would add complexity, and thus costs. Any such calculation of incentives based on the energy production should therefore be carefully weighed against the additional costs of such a procedure.

In order to measure the energy yield of a solar thermal system, two different approaches are available: Actual measuring of the solar energy production and (ex-ante) calculation of the annual energy yield of the solar thermal system. Standards methods and metering are available for this purpose. Methods based on the solar yield can contribute to raise the awareness on systems' quality and performance.

AMOUNT OF INCENTIVE

Experience shows that the absolute amount of a financial incentive given is not the most important factor. The correlation between the amount and the market growth does not seem to be high. There is no “right” amount.

If the overall market framework conditions for solar thermal are good, then the amount can be lower and still present a good enough incentive. On the other hand, the decrease of financial support can have very disruptive effects on the market, if it comes at the wrong time.

SIMPLICITY OF THE APPLICATION AND PAYMENT PROCEDURES

Not surprisingly, simplicity of the application and payment procedure is recommended. The more complicated it is for the consumer to benefit from a FIS, the less incentive the FIS provides to install a solar thermal system. At the same time, governments also benefit from lean procedures as it avoids unnecessary bureaucratic overheads.

In order to avoid misuse of financial incentives, governments should check at least randomly, if the systems, for which financial incentives were claimed, were actually installed.

FLANKING MEASURES

The importance of flanking measures cannot be underestimated – an incentive alone almost never has a significant impact on the uptake of solar thermal. The most successful support policies for solar thermal target the different barriers to growth for solar thermal and provide a package of measures. The upfront investment costs are only one issue, yet an important one. The “potential “flanking measures” are constituted by all the items described in the previous section.

KEY RECOMMENDATION

Financial incentives can be effective in the market and provide a quick return on public investment

To deploy solar thermal at a larger scale, financial incentives are necessary and are an effective mechanism, provided several key success factors are taken into account. Financial incentives can provide fast results in the deployment of the technology and can provide a quick return to the public budget, in the form of direct and indirect taxes or other resulting from the dynamics in the local economies and job creation. Financial incentives require flanking measures to maximize their results.

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SECTION 10

CONCLUSIONS - KEY RECOMMENDATIONS

This publication shows the importance of considering all key elements of a solar water heating strengthening programme, from having a broader and deeper understanding of the technology, its potential and benefits, to carrying out an analysis of barriers and designing, implementing and disseminating tools to overcome such barriers.

Those steps are necessary in order to have a correct perspective on all the different issues at stake when designing and implementing a solar water heating strengthening programme, and thus in order to guarantee a successful outcome from such programme.

Summing up, the key recommendations in order to set the right framework for the promotion of the solar thermal technology by correctly implementing a solar water heating strengthening programme are:

I. Solar thermal is a technology with multiple applications

Solar thermal is a technology with multiple applications, from small scale in buildings to large industrial applications. It can supply domestic hot water at lower temperatures or it can generate steam for complex processes. It can be used everywhere in the world, though the adequacy of some types of applications or systems depends on the location and use.

II. Public authorities need to understand of benefits and advantages of solar thermal

The understanding by public authorities of benefits and advantages of solar thermal is necessary first step in order to motivate them into developing solutions for the deployment of solar thermal!

III. Impact in the market depends on good comprehension of solar thermal potential

A good analysis of the solar thermal potential will help to understand how to better influence the market and promote the deployment of the technology, besides providing a basis to realise the aptitude of a growing solar thermal market to benefit the local economy, replacing energy imports with jobs!

IV. With tailored solutions the various market barriers can be overcome

Barriers to the deployment of solar thermal solutions in the market can be diverse, varying from country to country but even between regions and cities. The understanding of the barriers and how they hinder the development of the solar thermal market is essential to develop adequate solutions to unleash the potential of the technology

V. Framework conditions can be improved by action of public or private actors

The action of public or private actors is essential to change framework conditions, developing the conditions in the market for the adequate deployment of solar thermal, addressing different barriers and putting in place enabling factors.

VI. Awareness raising is a stepstone for public and political support

Awareness raising promotes market growth. It has a pull effect in the market, leading consumers and other market actors to consider solar thermal as an option and demand for it. But it can also have a pull effect, namely promoting political support. Public support can generate political support. Political support can generate public support. Both are important in order to create push and pull effects that can sustain market growth. Market growth generates benefits for the economy (jobs, income, lower imports) but also improves the competitiveness of the technology. This creates a virtuous circle.

VII. Flanking measures are essential but need to be implemented in a coordinated way

A mix of flanking measures is necessary to address different matters while creating synergies between actions. Several flanking measures can complement direct financial support schemes, namely via regulatory measures that promote the use of the technology. Some of the flanking measures address the future development of the market, either by creating confidence in the market (by means of quality assurance) or by promoting consistent technological development.

VIII. Financial incentives can be effective in the market and provide a quick return on public investment

To deploy solar thermal at a larger scale, financial incentives are necessary and are an effective mechanism, provided several key success factors are taken into account. Financial incentives can provide fast results in the deployment of the technology and can provide a quick return to the public budget, in the form of direct and indirect taxes or other resulting from the dynamics in the local economies and job creation. Financial incentives require flanking measures to maximize their results.

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This publication tries to provide “Guidelines for policy and framework conditions” related to solar heating and cooling, in particular solar water heating. It aims at providing a quick overview of the main issues to be considered for setting the right framework for the promotion of the solar thermal technology. Therefore, it outlines key recommendations and guidelines for the implementation of a programme for the promotion of solar water heating.

It targets policy makers at different levels of governance, local and regional authorities, urban planners, energy agencies, experts, stakeholders, interested citizens and consumers

This UNEP Guide was developed as part of the Global Solar Water Heating (GSWH) Market Transformation and Strengthening Initiative.

