Solar Thermal Application in Egypt, Jordan, Lebanon, Palestinian Territories, Syria and Tunisia: Technical Aspects, Framework Conditions and Private Sector Needs

Cairo 23rd - 25th March, 2009
Workshop report

Since the 1st of January 2011
giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

On behalf of

gtz Partner for the Future Worldwide

Federal Ministry for Economic Cooperation and Development

Acknowledgements

The present paper overviews the outcomes of the workshop “Solar Thermal Application in Egypt, Jordan, Lebanon, Palestinian Territories, Syria and Tunisia - Technical Aspects, Framework Conditions and Private Sector Needs”, which was conducted at the end of March 2009 in Cairo. The workshop could be seen as a good example for regional cooperation between three bilateral or regional programmes / organizations supported by German Development Cooperation (RECREE, Private Sector Development Programme Egypt and Promotion of Innovation and Technology for SME in Near East).

I would like to thank my colleagues Dr. Natalija El-Hage (PSDP Egypt) and Dr. Kilian Bälz (RECREEE) for their continuous support and good cooperation within the last months.

In preparation of the workshop country studies for Syria, Jordan and Egypt have been carried out that analyze more deeply the situation of the solar water heaters industry in the respective countries. The findings of these studies are incorporated into this paper. So graphs are taken from the results of the country studies if not cited otherwise.

I would like to thank in particular Mrs. Eng. Samar Jaber (formerly from National Energy Research Center in Jordan), Eng. Housam al-Sha’al from PLANET in Syria and Mr. Moataz Soliman from Alexandria University in Egypt for their contributions as well as my colleague Mr. Manfred Siebert from the Private Sector Development Programme in Egypt. In addition I thank Mrs. Emanuela Menichetti and Mrs. Myriem Touhami from UNEP or respectively Observatoire Méditerranéen de l’Energie for their authorization to publish the contribution about the Tunisia based on a presentation held at the European Solar Thermal Energy Conference 2007. Furthermore Mr. Basel Yaseen from Palestinian Energy & Environmental Research Center who contributed the section about the situation in the Palestinian Territories. Mr. Nader Hajj Shehadeh from the Lebanese Center for Energy Conservation I would like to thank as well for his valuable and dedicated contribution about the Lebanese market.

Last but not least I would like to thank Mrs. Khawla Konyna for compiling the different contributions into one paper.

Alexandra Hilbig
Project Coordinator

Table of Contents

Introduction

The international trend is increasing towards replacing the fossil fuel as a primary source for energy with alternative energy sources that are more environment-friendly and sustainable (renewable). Besides the increasing environmental requirements for sustainable development and climate protection, the compelling issue is the rising energy costs which impacts the production costs in industry and increases the burden on governments to satisfy the national demand of energy. Solar thermal has been proposed as a solution to lower the dependency on fossil fuel sources due to significant solar potential in the southern Mediterranean region, knowing that the available solar power ranges between 2000 and 3200 KWh per m^2 and year. The first straight forward application which reduces the consumption of the traditional energy (electricity, oil, LPG) is the use of Solar Water Heaters (SWH). Using solar energy for heating water became a wide-spread technology and is applied in many countries around the world, but still has a big potential for expansion. At the other hand, the reliance of customers in SWH technology in the Mediterranean region waned of cause of the short shelf life of installed systems due to poor quality of the material as well as the provided services (installation and maintenance). Programmes that promote the application of this technology in the region therefore have to tackle the quality issue under the given legal and economic circumstances, aiming at the definition of minimum quality or performance standards of system components as well as related services for installation and maintenance. This could contribute to stabilize the existing jobs in this sector and create new ones in the future. Stimulated by well targeted awareness campaigns and client oriented credit schemes to ease the purchase of this technology, the sales and installation rates could be significantly increased in the future, having a positive effect on the reduction of green house gas emissions and lower the constantly growing energy demand.

The aim of the jointly conducted workshop was to compile and compare the state of the art of the use of SWH technology in six countries of the region (Egypt, Jordan, Lebanon, the Palestinian Territories, Syria and Tunisia). This document summarizes the results of the workshop and gives a good overview about the current market situation of this promising technology. It is a flash light on the market of this specific Renewable Energy Technology and far from being a comprehensive study covering all aspects of the subject. Details about the current and potential market share of the SWH technology are not available for all countries and could be subject of further investigations.

Executive Summary

- This paper summarizes the results of comparing the situation of the Solar Water Heaters industry in six countries.
- Although the potential for solar thermal applications in various fields is huge (e.g. for heating water in residential buildings but also for industrial processes) the expansion of this technology is limited in the region due to political, social and economic barriers. The use of the Solar Water Heater (SWH) technology varies very much in these countries, mainly depending on the prices for energy the end user has to pay. The higher the price for energy (electricity, gas), the higher the market share of SWH is and can reach more than 50% of the marketable potential of this technology (Palestinian Territories, 2008). The major characteristics of SWH in these countries are:
- SWH systems are available in these markets
- SWH are not affordable compared to the consumer's purchasing powers
- SWH systems prices are not competitive (except for those imported from China)
- lack of incentives for consumers to install SWH systems (except for Tunisia which serves as a successful example)
- no incentives for suppliers (except for Tunisia)

	Egypt	Jordan	Lebanon	Palestinian Territories	Syria	Tunisia
Availability of SWH systems in the market	Y	Y	Y	Y	Y	Y
Affordability (consumer purchasing power)	N	N	N	N	N	N
Competitiveness in prices	N	N	N	N	Y	N
Incentives for consumers	N	N	N	N	N	Y
Incentives for suppliers	N	N	N	N	N	Y

Various impediments for the full adoption of the SWH systems exist though the potential is high. We can sum up the barriers in the different countries in the following:

a. Political / Policy Barriers

Studies reported that the quality control infrastructure is inadequate in all countries. Another area for development on the political level is the law enforcement for installing SWH. The details stated in the studies are given in the following table:

	Egypt	Jordan	Lebanon	Palestinian Territories	Syria	Tunisia
Quality control regulations, rules & infrastructure (standards, testing & certification)	✗	✗	✗	✗	✗	✔
R&D Programs/Fund		✗	✗		✗	
Governmental policies and/or initiatives in RE			✗	✗	✔	✔
Trade movements, import/export regulations			✗	✗	✗	✔
Law enforcement (to install SWH)		✗	✗		✗	✔

✗: missing/problematic ✔:existing/non-problematic

	Egypt	Jordan	Lebanon	Palestinian Territories	Syria	Tunisia
High subsidies for conventional energy	✗	✗	✗		✗	✗
Buying power of consumers		✗	✗	✗	✗	✗
Initial cost for SWH	✗	✗	✗	✗	✗	✗
Collaboration in R&D to enhance Performance/ Cost ratio	✗		✗		✗	
Import prices of SWHs	✗	✗	✗	✗	✗	✗
Effective guarantee offered by suppliers			✗		✗	✔

✗: missing/problematic ✔:existing/non-problematic

b. Economical Barriers

The common primary impediment at this level is the high initial cost for SWH (especially when imported) which gets critical with provision of subsidies for conventional energy and absence of financing schemes.

c. Financial Barriers

There exist no proper financing schemes, which is mainly due to the low level of awareness of the banking sector on RE.

	Egypt	Jordan	Lebanon	Palestinian Territories	Syria	Tunisia
Incentives for consumers	✗		✗		✗	✔
Awareness of local banking sector on RE		✗	✗	✗	✗	✔
Proper financing schemes		✗	✗	✗	✗	
Lower interest rates for loans			✗	✗	✗	✔

✗: missing/problematic ✔:existing/non-problematic

d. Social Barriers

At this level, there are two barriers. The first barrier shared in all countries is the consumer's attitude and/or awareness; it is mostly exaggerated by the SWH notoriety. The second barrier is architectural and would require innovation on the design level.

	Egypt	Jordan	Lebanon	Palestinian Territories	Syria	Tunisia
Roof area	✗	✗	✗		✗	
Notoriety of SWH	✗	✗	✗		✗	✔
Consumer attitude/ awareness	✗	✗	✗	✗	✗	✔

✗: missing/problematic ✔:existing/non-problematic

Recommendations from the country studies covered most of the above mentioned barriers in order of priority for each country. Not surprisingly, they involve the government as the key player (policy maker and legislator). Each country has its own priorities in realization of a comprehensive framework which deals with all the issues (quality standards for products and materials, testing labs, certification of installers, awareness for stakeholders, financing mechanism with guarantees, capacity building, creating a fund, incentives for producers, proper policies & laws of RE enforcement).

With the Tunisian case a very interesting example was presented. In Tunisia it was successfully proven to develop the SWH market within a very short period of three years through the concentrated and comprehensive efforts of the PROSOL project.

From this experience we can learn the key success factors that need to go hand in hand are:

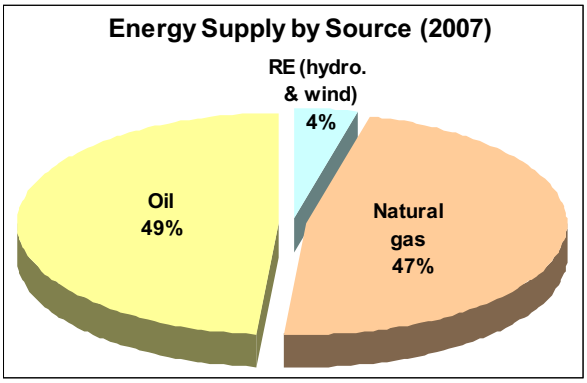
- Capacity building for stakeholders (financiers, consumers, technicians, policy makers)
- Awareness raising campaigns (consumers and banks)
- Communication & Information exchange
- Policies pro leveling the playing field for SWHs to compete (exemption from VAT, lower import tariffs,…).
- Quality infrastructure: standards, testing labs, & certification (for products & installers).
- Financial and fiscal incentives covering:
  - A loan mechanism for domestic customers to purchase SWHs (with securities for banks and suppliers).
  - A capital cost subsidy.
  - Discounted interest rates on the loans
- Monitoring measures & Evaluation by third parties.

Although Tunisia serves as a positive example for having positive framework conditions experience has shown that the implementation of quality standards play an important role in supporting the dissemination of this technology in the long run.
In general the use of solar water heating systems in other than the residential sector, i.e. in the service sector (tourism) or public health sector (hospitals) needs to be supported further in order to reach a more noticable impact on electricity consumption in the countries.

Egypt

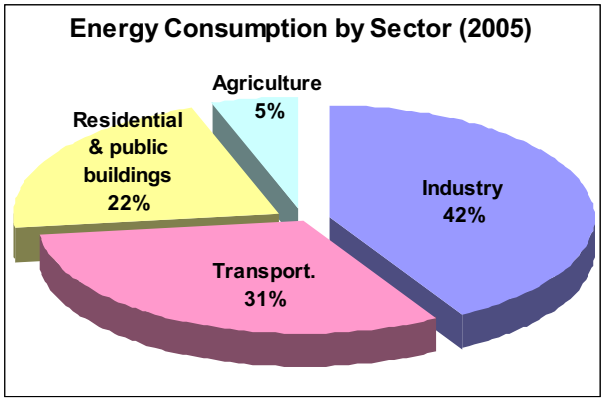
Energy resources

With a total domestic primary energy supply of approx. 70 Mtoe (2007), Egypt is the largest energy absorber in the southern and eastern Mediterranean region, mainly provided by fossil fuels (34 Mtoe oil, 33 Mtoe natural gas), but also 2.8 Mtoe by renewable energy sources (hydro and wind). Natural gas is mainly used to run the thermal power plants; crude oil is refined to petroleum products to satisfy the demand for liquid fuels.



In 2005, Egypt produced 108.5 TWh of electric power, 76% was generated from natural gas, 14% from renewable (mostly hydropower), and 10% from heavy petroleum products. Based on the energy mix in 2005 energy supply, renewable energy has provided approximately 5% of the Egyptian final energy consumption.

Industry is the most important final energy consuming sector in Egypt. Egyptian projections expect high growth of industrial energy consumption following rapid expansion of industrial production. The energy used in transportation is growing very fast in recent years, driven by the doubling of annual new car registration numbers since 2003. Another important part of energy is consumed in residential and public buildings. The demand in this sector is constantly growing.Energy productivity in Egyptian industry is below international average. Final energy consumption per unit of output (i.e. specific energy



consumption) in the most important industries is 10 to 50% higher in Egypt compared to the international average. It is estimated that industry could have produced with 20% less energy input in 2005. But also in other sectors, e.g. buildings, street lighting or transportation, a more rational use of energy could contribute to moderate the growing demand for energy in Egypt.

According to the solar atlas issued in 1991, Egypt is endowed with high intensity of direct solar radiation ranging between 2000-3200 kWh/m2/year from north to south. Despite the excellent conditions, Egypt is still considered as a pre-matured market for solar thermal applications either for power generation or heating processes. However, RE has got more political attention recently, and a strategic decision has been taken by the government having the target to supply 20% of the electricity in 2020 from renewable energy sources.

SWH Status Quo

The history of solar energy utilization in Egypt can be traced back as far as 1916 when a water pump driven by a concentrated solar power station was put into operation. In the 70s and 80s, governmental initiatives resulted in the installation of some hundreds of solar water heaters in rural areas, but without any sustainable effect on the development of the SWH market. Nowadays, it is estimated that 1500-2000 units are sold in Egypt annually, being far from the technically feasible potential and targets set in neighbouring countries. Only the energy used for producing hot water in residential areas with electric water heaters accounts for approximately 6000 GWh (representing 6% of the

electricity consumption) and 2500 MW of grid peak load (the capacity of 2-3 standard thermal power plants). If the need for hot water in residential areas would be satisfied by 100% by solar energy, 4.5 Million tons of CO2 equivalent GHG emissions could be saved each year in Egypt (resulting from direct and indirect fuel consumption).

Solar Water Heater Manufacturers and Suppliers

Nine companies are active in this business area in Egypt: Four companies are manufacturing & installing, and five companies are importing & installing SWH systems. 56% of raw materials or system components are imported, 33% are partially imported and only 11% are completely locally produced.

Materials	Local	Imported
Glass	Tempered	High transmission
Absorber Plate	Copper sheet and tubes Stainless Steel	Copper tubes soldered copper plate absorber
Coating	Locally available paints	selective coatings
Frame	Anodized Aluminum	
Insulation	Locally available materials Foam and Polyurethane	
Tank	Galvanized Steel with Magnesium anode or Stainless Steel	
Piping	Polypropylene	

Except for the high efficiency selective coatings, all the materials needed for the fabrication of solar water heaters are locally available in Egypt, namely: glass, polymers (glazing, piping, insulation), copper, aluminum, painting materials, electrochemical deposition processes (black chrome and black nickel), storage tanks (stainless steel, galvanized steel, polymers).

Collector's Technology

The following types are commonly installed:

1- Thermosyphone "active and passive" systems
2- Thermosyphone indirect systems
3- Vacuum tube systems

Product Specifications	Capacity	Prices
Thermosyphone with Galvanized steel tank (Local)	180 Liter	4,000
Thermosyphone with Stainless steel tank (Local)	750 Liter	14,000

Barriers for SWH Market Development

Political / Policy

- No enforcement for applying standard tests neither for the materials nor the systems.
- Low performance to implement existing regulations (e.g. decree number 401 of 1987 issued by the Ministry of Housing or the new building code of 2008) which should promote the use of SWHs in the residential areas.

Economical

- Relatively high investment costs for solar thermal application compared to prices of conventional heating equipment (electric or gas heaters)
- Subsidized prices for conventional energy (electricity, gas).
- The lack of collaboration between the universities and research centers and the companies prevents improving the performance/ cost ratio of the solar water heaters.

Financial

- No incentives neither for the consumers nor the manufactures.

Social

- The high population density led to high buildings preventing the use of solar water heater in many areas.
- Some companies produced low performance and low durability SWHs which caused the bad reputation of this technology in Egypt.
- Customers are not aware of the advantages and the proper use of SWH. Some customers run their solar water heaters dry for many months (stagnation condition)

Recommendations

The optimal configuration for promoting SWH systems which is sought is:
Minimum cost + Maximum performance + Demonstrated durability

This would be accomplished via:

- Experiences from successful stories in other countries could be useful.
- Creating the governmental commitment to solar energy via:
  - Raising the awareness of the general public of the benefits associated with the use of SWH systems.
  - Stimulating the market by providing an easy finance scheme for the end-user.
  - Providing governmental financial support to the manufacturers of the systems.
  - Adopting demonstration sites.
- Increase spending on R&D of solar technologies in order to adopt local available materials to improve the performance/cost ratio and also to simplify the design of the system.
- Preparation of specifications and quality standards for: Collector, Storage tanks, and Installation.
- Legislations:
  - Decision to make use of solar energy a legal obligation for New Cities, Resorts, Vilas, Hotels…etc.
  - Listing of approved solar collectors and storage tanks manufactures
  - Listing of the approved installers
- Supervising the market of solar energy in order to ensure both the quality of the materials used and the performance of the solar water heaters.
- Establishment of a manufacture's association in Egypt to promote the use of SWH systems.

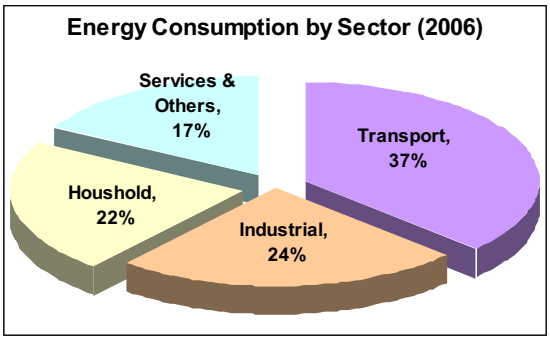
Summary

Although the history of the use of solar energy in Egypt dates back to the year 1916, the number of companies active in SWH systems production/ installation is relatively small. The **main barrier** for the sector development is the **absence of government commitment** to stimulate and promote the usage. This prevails in **missing a legal framework** including: **quality standards** for raw material and end-product, **testing and certification**, **accreditation** of installers and manufacturers. In addition, there is **no incentive** for suppliers, or **financial scheme** to support the consumer. The recommendations revolve around the government role to create the market by **awareness-raising** of the consumer, **capacity building** of the manufacturers and installers, and enforcement of the adoption of the SWH systems.

Jordan

Energy situation

Jordan imports oil for all of its needs (around 100,000 barrels per day), therefore it has been vulnerable to energy supply fluctuations (eg. conflict in Iraq). This motivated Jordan to seek alternative sources of supply, and resulted in sharply raising the retail prices of petroleum products charged to consumers.

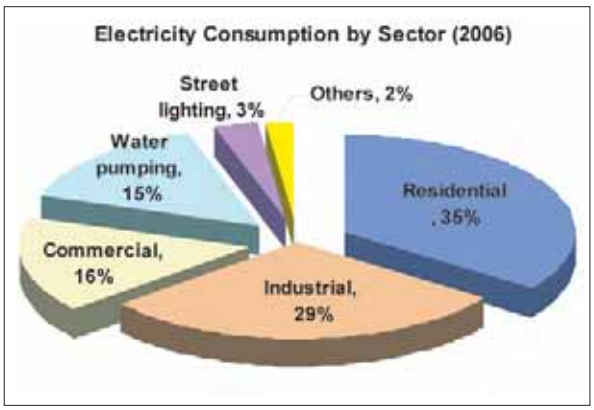


Jordan has modest reserves of natural gas, 6.5 billion m^3. The current output of around 0.85 million m^3 per day from the Risha field is used to fuel one nearby power plant, which generates about 10% of Jordan's electricity.

In August 2003, Jordan began receiving natural gas from Egypt. In May 2001, a 30-year agreement had been concluded with Egypt for gas sales to begin at a rate of 2.8 million cubic-meters beginning in 2003.

The total primary energy supply in 2005 was 7.187 M TOE.

The highest electrical energy consuming sector in Jordan is the residential sector (35%), followed by the industrial sector (29%).



The need for energy efficiency measures and utilizing renewable energy resources has emerged due to the rapid population growth and increase in various economic activities.

Although renewable energy is considered the largest domestic energy source together with oil shale, the contribution of such resources in the national energy mix is still minor. Renewable Energy provides approximately 1% of the total current primary energy demand in Jordan.

SWH Status Quo

The SWH industry in Jordan is well developed. Solar water heaters are used for heating of domestic water.

The Available Industry Infrastructure

Casting Facilities, Metal Fabrication Works, Glass and Plastic Industry, etc.

The Jordanian market has a good industry infrastructure. The local industrial sectors can establish and supply parts of high quality collector productions in the future.

These industrial sectors iclude companies for the development, production, and installation of high quality collectors and solar thermal systems such as:

- Metal industry for the production of absorber plate/fins and hot water storages, pipes and fittings and heat exchanger
- Coating Industry / Electrochemistry for coating of absorber plates
- Industry producing isolation materials
- Plastic industries.

Solar Water Heater Manufacturers and Suppliers in Jordan

There are several Solar Systems manufacturing companies established in Jordan. Only three are big companies with Solar Systems (Flat Plate Collectors) manufactured according to the highest standards and under supervision of the Royal Scientific Society (RSS). The number of small-scale SWHS producers has increased to reach 5 producers in 2007. Also there are some small shops that manufacture and install solar water heating systems.

Collector's Technology

While the main collector's technology used in Jordan are flat plate collectors, vacuum tubes technology were introduced recently, which produce a higher energy than flat plate collectors for the same effective absorber area. The specific cost (cost/m^2) for vacuum tubes is considerably higher than flat plate collectors. The increase in cost is not compensated if only low working temperature (T<60) is required (e.g. with domestic solar water heaters), despite higher efficiency and resulting possibility of reduced array area. Vacuum tubes collectors are not technically evaluated yet.

The selected solar collectors for domestic SWHs (single glazed flat plate collectors) are locally manufactured. These collectors were improved by Royal Scientific Society (RSS). The specifications for solar collectors used in Jordan are:

Model	RSS – Fitted Fin
Volume	3.6 L
Operating Pressure	6 bar
Maximum allowable pressure	10 bar
Insulation	Rock wool
Thickness of Insulation	5 cm
Length	1.75 m
Width	0.75 m
Thickness	11 cm
Area	1.3125 m^2
Storage Capacity	37.5 liter/m^2

A study conducted by NERC in 2009 showed that SWH Systems demonstrate a significant energy saving (as shown in the table below).

		Life Cycle Saving	PBP
SWH replacing	Electrical Heater (90% efficiency)	3,687 USD	1.78 Year
	Diesel Heater (55% efficiency)	2,564 USD	2.4 Year
	LPG Heater (65% efficiency)	2,449 USD	2.5 Year
	Kerosene Heater (60% efficiency)	2,440 USD	2.5 Year

There are few applications for collective solar water systems in Jordan (industries, hotels, hospitals). The total theoretical market potential for large/collective solar water heating in Jordan for non residential applications is around 100,000 m^2 of solar collector area.

Barriers for SWH Market Development

Political / Policy

- Absence of regulations, rules and energy provisions to *control the quality and the effectiveness* of the locally manufactured, imported or used equipment.
- Lack of R&D programs and low government expenditures in R&D.
- Lack of national standards, testing and certification schemes.
- Absence of compulsory testing regulations for collectors.

Economical

- The main barrier to the development of the market is weak buying power of the consumers. Solar water heaters are generally characterized by its high initial cost and low operating cost. In addition, most Solar water heaters require an auxiliary energy source.
- Low level of consumer awareness leading to low market demand.
- High cost of high specification materials/ component such as double-glazing, selective coating material, sheet metal, pipes. This results in hindering the development of designs and quality.
- Local solar water heating manufacturers are small. They do not have the technology and know-how to manufacture solar systems and components required for the large/collective installations.
- The possibility of importing large/collective solar collectors and components from Europe is difficult, because the price level at Europe is not compatible with the local conventional energy prices and labor cost.

Financial

- Low level of awareness of local banking sector on solar energy.
- Lack of proper financing schemes.

Social

- Consumer resistance towards change in behaviors and attitudes because harnessing

renewable energy has in general been more expensive per unit of energy than that obtained from conventional energy sources.

• Widespread skepticism about performance and reliability of SWH's due to past technology failures or weak products performances.

• Recently, most of the buildings are multi-floor constructed on small floor area which is usually used for many purposes. Therefore, there is no enough space for installing solar water heating systems for all residence.

Recommendations

• Revision and Modification of National Building Codes

• Enact an Energy Efficiency Law: Jordan has no energy efficiency law whether for industrial sector or buildings sector so far. There is a renewable energy promotion law under preparation

• Setting up the minimum technical standards for energy efficiency for imported and locally manufactured solar water heater.

• Create intelligent and substantial financing mechanism to promote the application of solar water heating systems and compact fluorescent lamps in residential buildings.

• Continue to raise awareness and provide sufficient information for promoting solar energy to the concerned target groups: public costumers, contractors, and building designers.

• Develop a national marketing plan, including media campaigns and information dissemination.

• Hold design of solar system training courses for building designers, contractors, and suppliers.

• Creating a local financing mechanism for the SWHs which provide long-term financing, i.e. 18 to 24 months, with monthly installments that are collected by the installer.

• On the micro level, large / collective solar water heaters can become attractive in financial terms with the warranty of solar results financing mechanism they can become a positive cash flow investment.

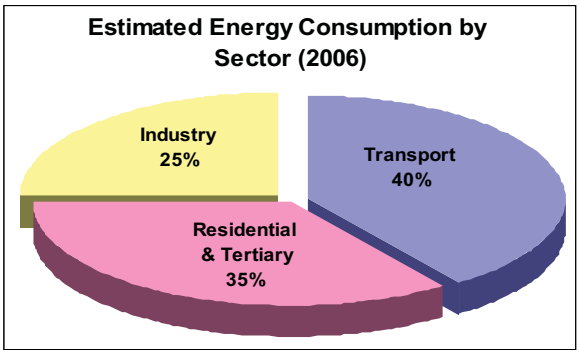
Summary

Jordan is qualified for entering a new phase of local manufacturing of renewable energy systems. The main barriers to the development of the market are the energy prices and the **weak buying power** of the consumers. These add up to the **low quality** of some of the locally produced systems which caused the consumer to have a **bad image** about the SWH. The first priority is to establish a proper **financing scheme** that makes SWHs a positive cash flow project in order to overcome the financial barrier at the consumers' level. In parallel, **quality standards** have to be defined and adopted for produced and imported systems. The **legal framework for conformity** needs to be established, to make use of the testing center available at RSS. The second priority area is **capacity building** in solar energy for all stakeholders: policy makers, standardization authority, testing facilities, producers, consultants, installers, etc.

Lebanon

Energy situation

With no declared petroleum resources in Lebanon, the country is basically considered an energy importer country. Lebanon imported around



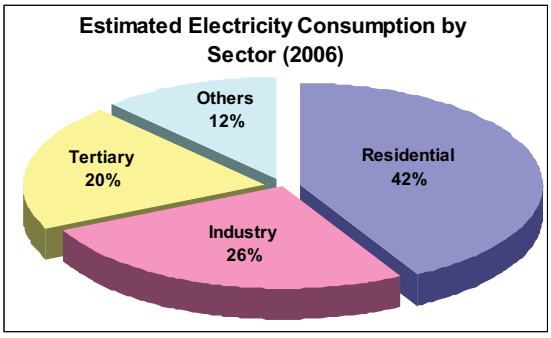
Reference: PlanBleu 2008

$2,200 million worth of fuel in year 2006 to satisfy the country's energy demand.

Around 96% of the energy supply comes from imported oil, with only 4% through hydropower and other small renewable energy applications.

Lebanon is located on the eastern edge of the Mediterranean with an average of 300 sunny days per year and with very good solar insulation that reaches 2000 kWh/m^2 per year. These good conditions along with the development of the manufacturing market, the simplicity of use, the comfort level enhancement due to scheduled blackouts, and the visible savings, have promoted the solar water heating market in Lebanon.

Energy production in Lebanon is monopolized by the major electricity utility Electricite du Liban (EDL) which produces around 11,000 GWh annually with



Reference: PlanBleu 2008

an average of 40% of technical and non-technical losses.

Lebanon still witnesses **rationalization**, with an average rate of 6 hours a day. For this purpose, stand-alone generators are highly spread all over the country to meet the demand.

The electricity tariffs structure in Lebanon has not changed since 1994, despite of the tremendous increase in fuel prices.

It is estimated that the residential sector is consuming 42% of the electricity in the country.

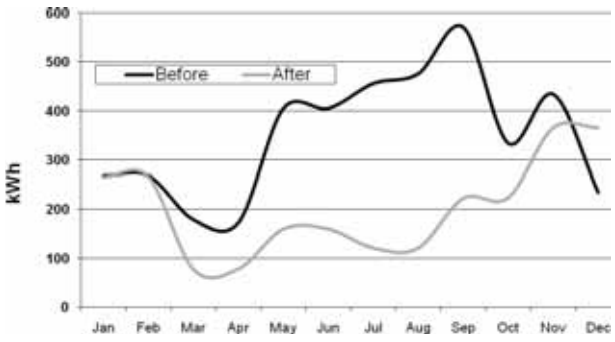
In the same aspect, **Lebanese Center for Energy Conservation** (LCEC) is preparing to launch a major initiative on the development of the "Solar Water Heating Market in Lebanon". This initiative will target five major aspects: the policy level, the financing mechanisms, information and awareness raising, the technical and business development, and the lessons learnt for the future.

SWH Status Quo

The LCEC has conducted SWH study on a solar water heater (evacuated tube type) installed at a residential building in the south of Lebanon.

The results indicate that the system contributed 3049 kWh/yr to the heating load offsetting 98.6 % of electricity needed to heat water. Total annual savings were calculated to be $195. When the analysis is done regarding the real cost of electricity incurred by the national electricity company (EDL), the actual savings are $610/yr providing for a payback period of 2 years. Average monthly tank temperatures varied from 42 ºC in winter up to 80 ºC in summer.

The following graph shows the SWH contribution in water heating for one full year:



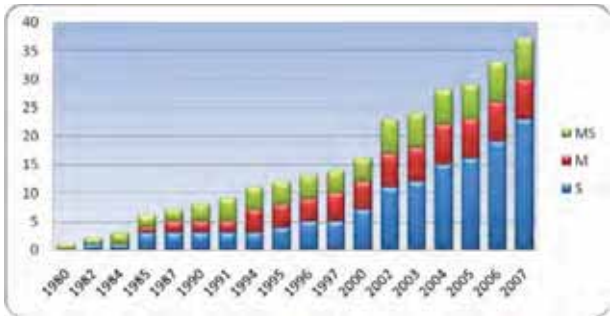
Reference: Assessment of Energy & Financial Performance of a Solar Water System in a Single Family Dwelling: Case Study from Marjeyoun – South Lebanon

On the other hand, another financial performance assessment was done to a collective water preheating system installed in a hospital in Lebanon. The hospital's energy consumption for water heating was analyzed and the savings could lead to a payback period of 5.7 years.

The Lebanese Center for Energy Conservation (LCEC) has started a solar thermal promotion approach in the year 2006. Since then the center could achieve remarkable results in terms of capacity building and technical support, marketing and promotion, in addition to installing around 2,310m^2 of solar collectors all over Lebanon leading to annual saving of around 2,031 MWh. These numbers are expected to reach 10,734m^2 and 120,322 MWh by the end of 2010 with the help of CEDRO (another UNDP project).

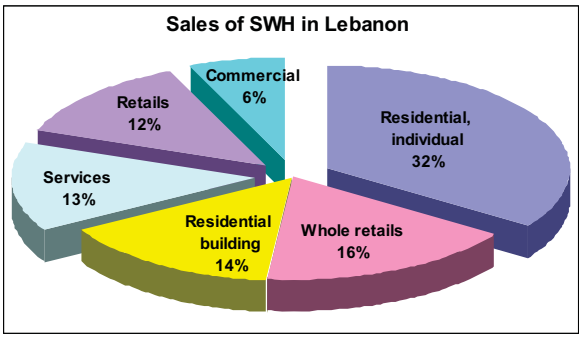
The market has been studied as well in 2 phases, and the results clearly show that the market has been developing in an impressive manner, the business development is shown in the following figure (S: Supplier, M: Manufacturer):

Solar Thermal Companies in Business



Reference: Solar Thermal Market in Lebanon – LCEC 2009

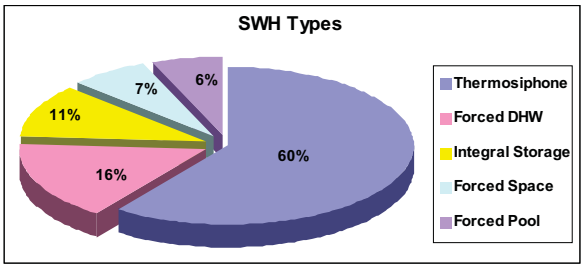
The major sectors using solar thermal are the commercial and residential sectors, with few applications in the industrial sector. The graph shows the sales manner of the solar thermal dealers in Lebanon.



Reference: Solar Thermal Market in Lebanon – LCEC 2009

Collector's Technology

Panels are from the two types: flat plate and evacuated tube. Systems are both open and closed systems.



Reference: Solar Thermal Market in Lebanon – LCEC 2009

Barriers for SWH Market Development

Political / Policy

- No clear policies and regulations regarding the solar thermal applications.
- The tax is 5%, and there are no revenues or grants for individual applications.
- No framework for controling the quality and protecting the market from unqualified material. The products available in the market undergo no testings or standardizations.

Economical

- The system cost in Lebanon is still considered high and not affordable for Lebanese citizens.

Financial

- Lack of financing schemes which would compensate for the economic barrier.

Social

- Lack of space in the buildings' roofs in the cities. This is caused by the installation of water tanks, TV recievers etc. on the roofs.

Recommendations

- Awareness raising among costumers is required.
- Quality control is highly recommended to prevent market breakdown due to low performance applications.

performance applications.

• Capacity Building and offering the SWH dealers more technical knowledge is a must.

• Help & support for local manufacturers should be offered.

• Applying installers certifications is highly recommended to ensure proper installation.

• After-sales-maintenance should be part of the contract.

• R&D should be employed involving engineers and academics.

• A financing mechanism is required.

• Governmental support is vital to promote solar thermal applications. The forecast scenarios with and without the government support have huge differences.

Summary

Lebanon is an energy importer country. Fortunately, it enjoys an average of 300 sunny days per year which is an opportunity for the applications of solar energy. The main barrier is **missing governmental support** for such applications which prevails in the absence of **quality standards**, regulation of **testing and certification** of products and installers, support to the manufacturers, and the grounds for a proper **financing mechanism**. Another area of intervention is the **capacity building** (transfer of know-how) and **awareness-raising** for consumers.

Comparison of international Domestic Solar Hot Water prices

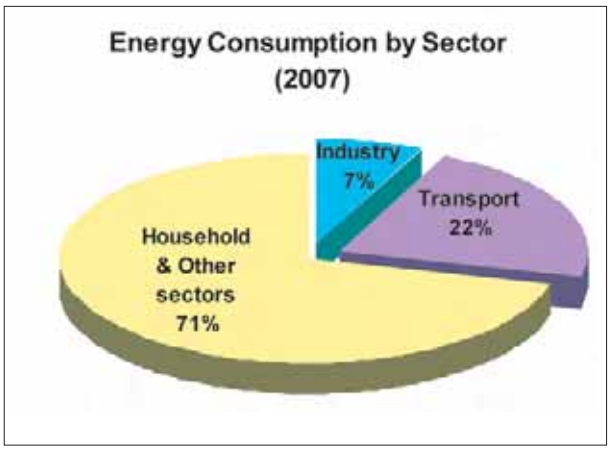
Country	Typical System	GDP / capita	Cost (USD)	Cost/ liter	Cost/ m^2	Cost: GDP
Japan	200 liters – 4m^2	$35,300	$2,990	$15	$748	8.47%
Italy	200 liters – 4m^2	$31,000	$2,000	$10.3	$515	6.45%
Lebanon	200 liters – 4m^2	$11,100	$1,800	$9	$450	16.22%
Tunisia	200 liters – 3 m^2	$8,000	$1,600	$8	$533	20.00%
Spain	200 liters – 2m^2	$34,100	$1,470	$7.4	$735	4.31%
Greece	150 liters – 2.4m^2	$32,800	$1,040	$6.9	$434	3.17%

Reference: Solar Thermal Market in Lebanon – LCEC 2009

Palestinian Territories

Energy situation

Due to the *absence of fossil fuel resources*, Palestinian Territories have to import 100% of its needs of petroleum products from Israeli market and about 92% of electrical energy from the Israeli Electric Corporation.

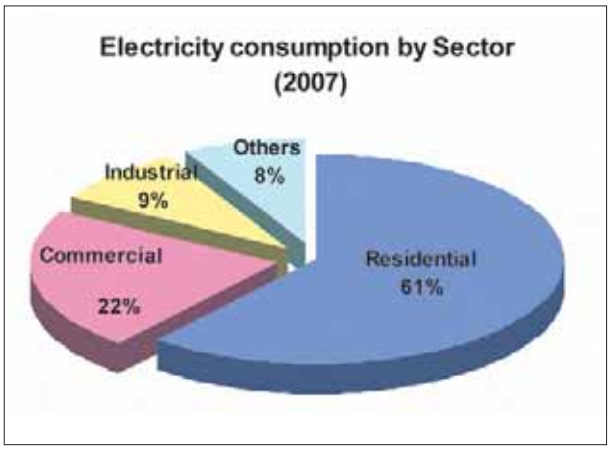


Recent exploration of natural gas in Gaza gives hope and new opportunities for gas industry in the Palestinian Territories. The local demand is estimated to 1.1 billion m^3 per year.
Oil shale is available in substantial quantities (1200 MT), but a project in this area tends to be much more costly than renewable energy sources and *not politically feasible*, at least at the moment.

Local energy resources are:

- Solar energy for photovoltaic and thermal applications (mainly for water heating).
- Biomass (wood and agricultural waste) is traditionally utilized for cooking and heating in rural areas.
- Biogas production is still under investigation and few demonstration projects exist in the Palestinian Territories. Biogas potential is over than 33 million m^3, equivalent to 10M€.
- Potential of wind energy (≈ 600 kwh/m²) seems to be limited to the mountains (elevation of about 1000 m) where the speed surpasses 5 m/s.

The total primary energy supply in 2007 was 1273 ktoe (1.273 Mtoe).



The cost and **consumer prices of electricity** in the Palestinian Territories are the most expensive compared to prices in the region since almost all energy consumed is imported and it is heavily taxed. The price of KWh units is flat (not progressive) to all consumed units. There is no subsidizing policy in the Palestinian Territories, therefore customers are always eligible for changes of prices according to world market and directly affected by Israeli tariffs. The electricity bill is about 10% of the family income. Energy prices are projected to increase by more than 3% per year. The preliminary analysis of solar energy cost used for water heating gives the figure of 0.0177 €/ kWh produced (0.10 €cent/ liter of water).

SWH Status Quo

Industry of SWH in the Palestinian Territories is small and simple, and needs to be developed and structured.
The most commonly used system is family system- thermosyphonic open circuit type. Solar water heaters (SWH) are extensively used in the residential sector; 67.2% of households use solar family systems.
Use of collective systems is very limited in the service (hospitals, hotels, universities) and industry sectors, and has to be introduced in an efficient way.

	Hospitals	Hotels	Universities
Estimated demand of solar panels	8500 m^2	9800 m^2	1000 m^2

The solar heating is competitive with other means of heating (unit price is about 400€). In addition, the system pay-back period is less than 2 years, when compared to that of electric systems.

The existing installed capacity in all sectors is totaled 1,533,000 m² (the highest in the MED region) of which 7100 m² in the service sector. This can produce 962 GWh per year and saves 86 M€ yearly to the national economy.

The market of SWH (13 M€) can be doubled if proper policy with efficient financial scheme is adapted for promotion and encouragement the use of **solar collective systems**, beside improvement and control of the quality. A further potential for SWH is foreseen in the service sector through extending the existing installations to cover more demand (about 60%), and also through new installations in the unequipped centers.

The estimated investment to cover the shortage of solar panels in service, industry and residential sectors is about 33 M€.

Sector	Service	Industry	Residential
Estimated shortage of solar panels	10,000 m²	20,000 m²	10,000 m²

Solar Water Heater Manufacturers and Suppliers

SWH systems are locally manufactured by more than 15 major workshops where the raw material is imported from Israel. The annual production rate is more than 26,000 units. The workshops are capable of fulfilling the local market needs and also export to external markets when provided with the appropriate technical support and advisory as well as financial facilities from the local institutions.

The market for solar thermal energy technologies is limited to water heating and is estimated to 13 M€.

The number of workshops is increasing as the demand is increasing toward using this technology for water heating specially in the residential sector. Many research institutions also are interested in solar technology for wider usage such as space heating and cooling.

Collector's Technology

The most commonly used system is the thermosyphonic open circuit type in which the heated water is used directly by the consumer. The system consists of 2 or 3 flat plate collectors, each measures 1.7 m², a rating of 2750 kcal/ day (iron collector) as a yearly average output, oriented to the south, and tilted by 42°. For climate conditions, three collectors are generally used in hilly areas, while two collectors are utilized in the Jordan Valley, Jenin, Tulkarm and Gaza Strip.

The vacuum tube collectors recently entered the local market. It is considered a new technology and very few systems are installed so far due to the fact that technical specifications are unknown as it is fully imported from China.

Specifications for Flat Plate collector & Hot water Storage Tank:

Collectors	
Number of collectors	2 or 3 collectors per system
Box	0.5 mm galvanized steel 190*190*10 cm
Absorber plate	0.5 mm black steel
Risers	0.5" O.D steel pipes, 7,9 or 13 risers
Headers	1.0" O.D steel pipes
Insulation	3 cm polyurethane or rock wool
Cover	0.4 mm ordinary glass ,2 pieces on each collector
Hot Water Storage Tank	
Size	150 – 200 liters
Shell	4 – 5 mm steel
Insulation	6 cm polyurethane or rock wool
Outside Cylinder	0.4 mm galvanized steel
Electric Heater	2.5 kW (optional)
Pressure	12 bar

Barriers for SWH Market Development

Political / Policy

- No clear, comprehensive and general energy policy (development of RE, energy efficiency) at a national level.
- Absence of governmental initiatives and concern for development of RE.

- Absence of regulations & provisions to control the quality in the market.
- Absence of qualified testing labs & bodies.
- Obstacles on import/export trade movements.
- Heavy tax system and high cost of clean/ efficient technologies.
- Absence of private sector involvement and governmental initiatives for development of the RE market.
- Absence of export's regulations; restrictions and obstacles imposed by Israelis.
- High political risk in implementing solid RE projects.

Economical

- Low income of the family to cover the investment cost of the solar system, especially for the new and efficient technologies.
- High initial investment especially for solar collective systems and new applications.
- Small scale of national projects due to the nature of small country.
- Absence of independent local distributors and importers of the raw materials required for fabrication, and dependence on Israeli sources (not easily accessible).
- Unstructured framework of the solar industry, inefficient industrial processing and inadequate quantity of production to cover the market demand.

Financial

- Lack of proper financing schemes because the mainstream financial institutions are not generally supportive of RE projects.
- High interest rates restricting the use of credit facilities, especially when expected gains cannot be easily visualized.
- High transaction cost, or cost of doing business in general.

Social

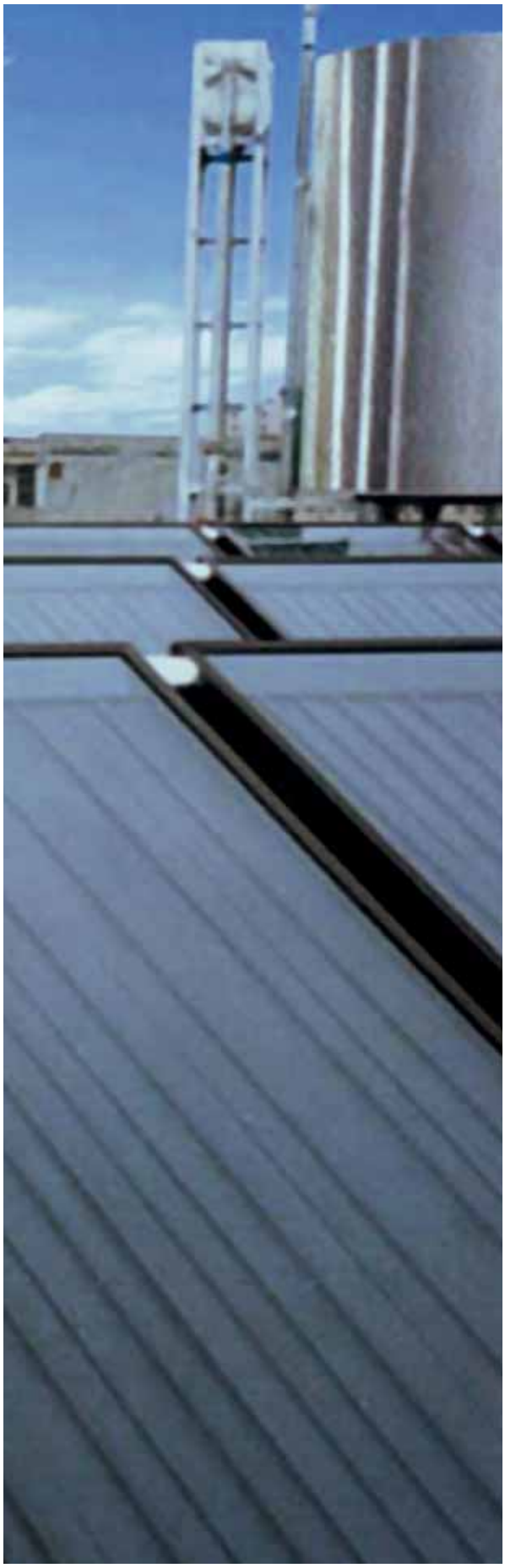
- Low awareness at both end users and suppliers of the new solar applications & efficient technologies, and the selectivity of proper energy system.
- Lack of awareness in the benefits of energy conservation and clean technology.

Recommendations

- Development of proper *financing schemes* with involvement of government, private sector (investors, local banks), and international financial institutions proper to local needs and facilities.
- Creation of a *national fund* with participation of the government, private sector and external financial aid for supporting development actions of RE and energy efficiency.
- Development of *governmental policies, regulations, provisions and incentives* to encourage use and investment in solar thermal technologies (duty license reduction and VAT exemption for raw material & equipment to industry, building tax/license reduction to users).
- Imposition of standards, regulations and certifications for improvement the level of market quality.
- Establishment of national testing facilities/ research centers and labs.
- Experience exchange, know-how transfer and upgrading of technical skills especially for the new applications of solar thermal applications.
- Establishment of national unity for solar technologies manufacturers & suppliers.
- Upgrading the local industry of solar thermal technology by modernization of the production machines and industrial processing and fabrication of new efficient designs for solar water heaters appropriate to local climate conditions and requirements.
- Mobilization of installing solar collective systems by government legislative measures to mandate SWH in new housing, hospitals and hotels.
- Application of some kind of guarantee such as GSR.
- Development of bilateral cooperation agreements for development of collaboration projects in the region.
- Dissemination of awareness to both demand side and supply side for the new applications and efficient technologies of solar thermal energy.
- Creating of Mediterranean Solar Network.
- Conducting of Solar Thermal Conferences & Exhibitions.

Summary

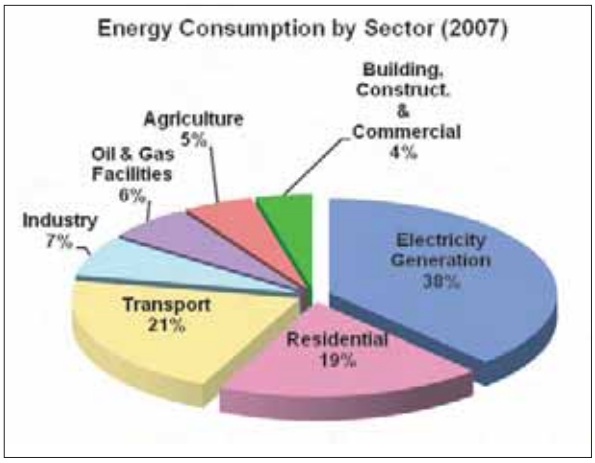
Huge efforts are needed for the development of energy sector in the Palestinian Territories. Scarcity of conventional energy resources and the limited renewable resources have created unrealistic price control and energy shortage in the country. Utilization of geothermal technology could be feasible in the Palestinian Territories as a source of energy for heating and cooling. In addition to the major barrier of **high political risk** in implementing solid RE projects and dependence on Israeli sources (not easily accessible), Palestinian Territories bear the absence of **governmental initiatives** for development of RE, regulations and provisions to **control the quality** in the market. Since SWH requires high initial investment and families have low income, the priority is to establish a proper **financing scheme**. Therefore **awareness-raising** for stakeholders (end-users, suppliers, financial institutions) is highly needed. SWH Industry in the Palestinian Territories is small and simple. Hence it needs to be developed and structured which requires **capacity building** in Solar Energy.



Syria

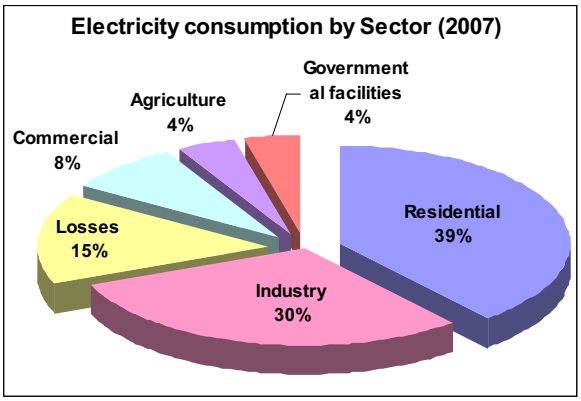
Energy situation

Syria is considered as an oil exporter country. The production of electrical energy mainly relies on the use of thermal power plants (using fossil fuels) and also on hydroelectric energy. During past few years, Syria started to use natural gas in electrical energy generation and in industrial processes.



According to "Syria Country Report, Feb. 2009, Economist Intelligence Unit", the importance of oil has been diminishing in recent years, with oil revenues falling from around 50% of total revenues in 2003 to 24% in 2008 (and a forecast 10% in 2009). The forecasts confirm that the oil production is decreasing.

Syria enjoys excellent solar energy resources; it is located in the world's solar belt. The annual average global solar radiation over Syria ranges from about 1500 kWh/m²/year on the Mediterranean coast to more than 2300 kWh/m²/year in Badia region. While about 90% of the Syrian territory has an average global radiation greater than 1700 kWh/m²/year.



Solar thermal energy can be used in a wide spectrum of applications, such as hot water supply, space heating and air conditioning in buildings, drying agriculture crops, and finally for industrial purposes and electricity generation. However, solar thermal energy is being developed in Syria mainly for the application of solar water heating systems especially in the residential sector.

The total primary energy supply in 2007 was 2.89 M TOE.

SWH Status Quo

Syria has good solar energy resources like other countries in the Middle East and on the Mediterranean coast. The average global horizontal solar radiant flux in Syria is approximately 5 kWh/m²/day or 1.8 MWh/m²/Year. The average daily radiant flux varies from 4.4 kWh/m²/day in the mountainous areas on the west to 5.2 kWh/m2/day in the desert regions in the Badia. The annual sunshine hours also vary between 2,820 and 3,270 hours.

Solar water heating is the most RE common technology in Syria. The total installed capacity of SWH systems in Syria is about 300,000 m² till 2008 concentrated in residential sector, about 100,000 m² of them had been installed last three years when fossil fuels were no longer easily available all the time. Solar applications in commercial and industrial sectors are very limited.

The national strategy is focusing on solar thermal application especially for residential and commercial sectors. Efforts are concentrated to set a national strategy with a target of installing 100,000 m² annually, which will encourage the improvement of the national solar thermal systems industry.

The solar water heaters industry in Syria is at a fairly advanced stage of maturity but the technology is yet to find wider acceptance with the user groups, this kind of industry had been existed in Syria since early eighties of the last century and it is developing gradually till now. Local SWHs are easy to install and they are cost-benefit for the national economy, because of the heavy subsidy of diesel oil and electricity.

Solar Water Heater Manufacturers and Suppliers in Syria

According to the Syrian Ministry of Industry it was estimated in 2007 that there were about 92 private licensed entities for manufacturing SWHs, but investigation showed that only about 25 of them are really do manufacture SWHs. These 25 entities vary between small workshops with an annual production capacity ≈100 DSWHs, and large factories with an annual production capacity about 20,000 m^2.

We can divide the local companies into three major categories:

1. Manufacturing companies using completely local materials: mainly working in flat plate technology.
2. Manufacturing companies using local and imported materials: working in both flat plate and evacuated tubes technologies.
3. Importing companies: mainly working in evacuated tubes technology.

There are no specialized companies for installation of SWHs, the installation is provided by the manufacturers or the importers.

Nowadays, the DSWHs manufacturing is affected by the evacuated tubes systems which are imported from China with lower prices. Some of the national manufacturers started importing this kind of technology next to their products.

Local Prices

SWHs prices have been considered high for a long time in comparison to other technologies used for heating water (investment and running costs). The imported non-pressurized evacuated tubes systems changed the perception; they are now available in the Syrian market with lower prices than the local manufactured flat plate systems.

The average price for a typical solar water heating system consisting of tow collectors -providing the need of a typical family of 3 to 5 persons- is about 50,000 SP (800€). However, the same size of the Chinese non-pressurized evacuated tubes systems is half price and needs fewer accessories.

On average the installation cost of accessories is about 10,000 SP (160€), so the total price of the flat plate system could reach up to 60,000 SP (960€) whereas the Chinese evacuated tube non pressure solar water heating system will costs about 35,000 SP (560€).

Collector's Technology

SWH systems in Syria have two main types: flat plate collectors systems, and evacuated tubes collectors systems.

The flat plate SWH systems specs:

- Absorber: mainly produced locally. Some dealers import absorber from Greece and Turkey. The absorber could be made of Cooper Aluminum and Iron.
- Black coating: till now neither of Syrian producers use the selective coating the coating used is thermal black coating.
- Glass: normal glass produced locally. The production of low ironing glass and prismatic glass does not exist.
- Insulation mainly used the glass-wool imported from Turkey and Saudi Arabia. Some producers use Styrofoam (imported) and rock-wool (locally manufactured).
- Pumps: imported mainly from Italy and China
- Control devices mainly imported from Sweden, Italy, France, Korea, and China; some manufacturers assemble some controls.
- Auxiliaries: many local manufacturers produce all needed auxiliaries made of iron, plastic and galvanized steel. In addition, other products are imported from Turkey, Russia, Romania, and Spain.
- Tanks: there are many manufacturers who produce high quality insulated tanks with double jacket or heat exchanger. Few companies import them from Turkey and China.

The Evacuated tubes collectors:

Four years ago this new technology entered the Syrian market and nowadays it has a large potential of the market.

All evacuated tubes products are imported mainly from China. The efficiency is unknown due to

missing testing laboratories infrastructure.

The common model of SWH evacuated tubes system is the non-pressurized system consisting of two glass tubes with evacuated space between them. The inside tubes where the water flows is coated with black paint without thermal mediator.

Some manufacturers are making the hot water tank locally and importing the tubes from China.

Barriers for SWH Market Development

Political / Policy

- Law enforcement to install SWH, although since early 2009 the new law no.3 is giving the legal framework for the use of renewable energies and energy conservation concepts as well as measures including labelling of household devices etc..
- Missing quality assurance rules
- Absence of a certification system for different SWH products
- Lack of favorable import taxes for RE products and components as well as conducive policies to promote RE developments
- The absence of *effective* policies, legislations and regulations

Economical

- Prices of SWH systems are high for households, no incentives
- High subsidies on oil and gas
- Non-effective guarantee for SWH systems offered by suppliers

Financial

- Lack of financing options, no effective bank loan programs

Social

- Lack of consumer trust in the performance of SWH systems Architecture impediments: roof tops of multi-floor buildings are catering to individual households; satellite dishes which occupy most of roof's areas.
- Lack of collateral: No cooperation between public and private sector, no government programs - little help from the utility companies.
- Absence of coordination between the public institutions and the private sector in the field of R&D.

Recommendations

- Establish financial procedures to promote SWHs in Syria, namely:
  - Giving long term loans to purchase SWHs
  - Also giving non interest loans to purchase SWHs
  - Reducing taxes and the charge dues
  - Repaying rate of costs. Selling SWHs by soft installment plan
  - Reduction of import duties
  - Tax credits
- Establish a certification and accreditation system supported by national standards and needed test facilities, as well as a monitoring body.
- A national program including all involved entities working hand in hand to attain Public Private Partnership (PPP).
- Regarding the problem of space needed for the installation of SWHs recently a strict decision has been taken by the Ministry of Environment and Local Administration. It restricts the owned property of the roof and obligates all residents to install one central satellite dish per building. This decision will be implemented gradually and has started in Dummar near Damascus.
- The strategy of energy pricing, as a socioeconomic aspect, should take into consideration the promoting of RE techniques as alternatives, so this strategy could start with transferring the subsidy to these technologies gradually.
- Financial incentives and establishing the subsidization fund with suitable implementation mechanisms supported by control, supervision and observation bodies
- Building capacity and carry out awareness campaigns
- Establishing R&D bodies involving public and private sectors to provide the services according to the governmental national strategies.

Summary

Although Syria is considered an exporter of oil, the forecasts confirm that the oil production is decreasing. Fortunately, Syria enjoys excellent solar energy resources since it is located in the world's solar belt.

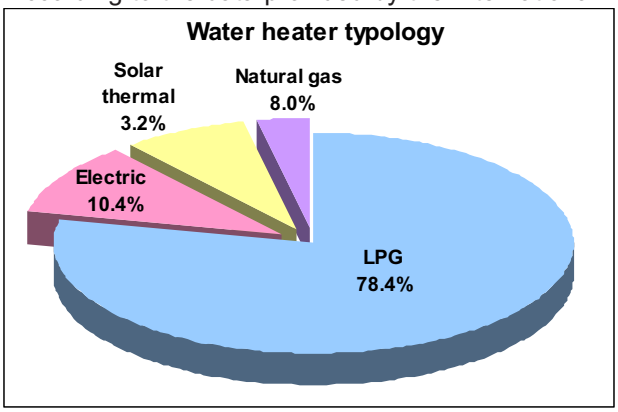
The absence of proper **quality infrastructure** (standards, testing labs, certification, & accreditation) for SWHs is hindering the development of the sector. In addition, there are no effective **governmental policies and initiatives** to regulate the market and coordinate the R&D needed. The second main issue is the absence of **financing schemes** in installing SWHs which would come in hand with the **awareness raising** of the customer's to repair the **bad image** which resulted from suppliers past practices. Of course **capacity building** for the stakeholders (policy maker, suppliers, R&D support institutions, & consumers) is needed.

The Tunisian case: A Good Example

Energy situation

Tunisia has a significant solar potential, with very high irradiation rates. According to the GIS-based data made available by the European Commission's DG Joint Research Centre (JRC, 2007), the country benefits from 1,700 to 2,200 kWh/m^2 per year. The National Agency for Energy Conservation (ANME) estimates that solar thermal panels could satisfy approximately 70-80% of sanitary hot water needs in the residential sector. So far, SWHs cover only 3% of the market in the domestic sector. As one can see, the market is dominated by LPG-fired boilers, which constitute 78% of the existing stock (Missaoui and Amous, 2003). While sun is an abundant source in Tunisia, the country has scant fossil fuel reserves and its net energy balance has been showing negative values since 2001. In particular, LPG (liquified petroleum gas) is entirely imported.

According to the data provided by the International



Energy Agency (IEA, 2007) in 2004 LPG imports reached 364 KTOE (+22% over 2000 and +164% over 1990). Hot water demand is over 30 million m^3 per year, and is projected to increase up to 70 millions m^3 by 2010. This would imply a further growth in LPG imports, if current energy consumption patterns remain the same. This would translate into a higher deficit in the balance of payments, and in an increase of government's expenditures to subsidize the product. Currently, LPG is subsidized in a measure corresponding to 50% of its real price.

Solar thermal has been repeatedly proposed as a solution to lower the country's dependency from imported fossil fuel sources. The first solar thermal energy strategy was developed by the Tunisian government in the 1980s. But only in the period 1997-2001 a real market and technology infrastructure have been developed, thanks to a project financed by the Global Environment Facility (GEF) and the Belgian Cooperation. The support mechanism was based on a 35% capital cost subsidy. At the end of the period, 50,000 m^2 of new solar thermal panels were installed, 8 suppliers (among which 3 manufacturers) and over 130 installers were operating in the market, for a total of 260 new jobs created. Despite these important results, as soon as project funds expired, SWH sales dropped again.

The PROSOL project

The PROSOL project was initiated in 2005 by the Tunisian Minister for Industry, Energy and Small and Medium Enterprises and the National Agency for Energy Conservation (ANME), with the support of the UNEP-MEDREP Finance Initiative. The objective of PROSOL was to revitalize the declining Tunisian SWH market caused by the GEF project ending. The innovative component of PROSOL lies in its ability to **actively involve all the sector stakeholders and particularly the finance sector** which turns it into a key actor for the promotion of clean energy and sustainable development. By identifying **new lending opportunities**, banks have started building dedicated loan portfolios, thus helping to **shift from a cash-based to a credit-based** market.

The main features of the PROSOL financing scheme are:

- A loan mechanism for domestic customers to purchase SWHs, paid back through the electricity bill
- A capital cost subsidy provided by the Tunisian government, up to 100 Dinars (57€) per m^2.

• Discounted interest rates on the loans progressively phased out.

A series of accompanying measures have been developed, which include: supply side promotion, control quality system set up, awareness raising campaign, capacity building program and carbon finance.

Besides ANME who manages the overall program, key partners include:

• The State electricity utility STEG (Société Tunisienne d'Electricité et du Gaz)

• A commercial bank that provide the best loan condition under a bidding process (Attijari bank)

• Suppliers including local manufacturers and importers

• Installers of SWHs

• Renewable Energy Syndicate

Functioning of the financing mechanism

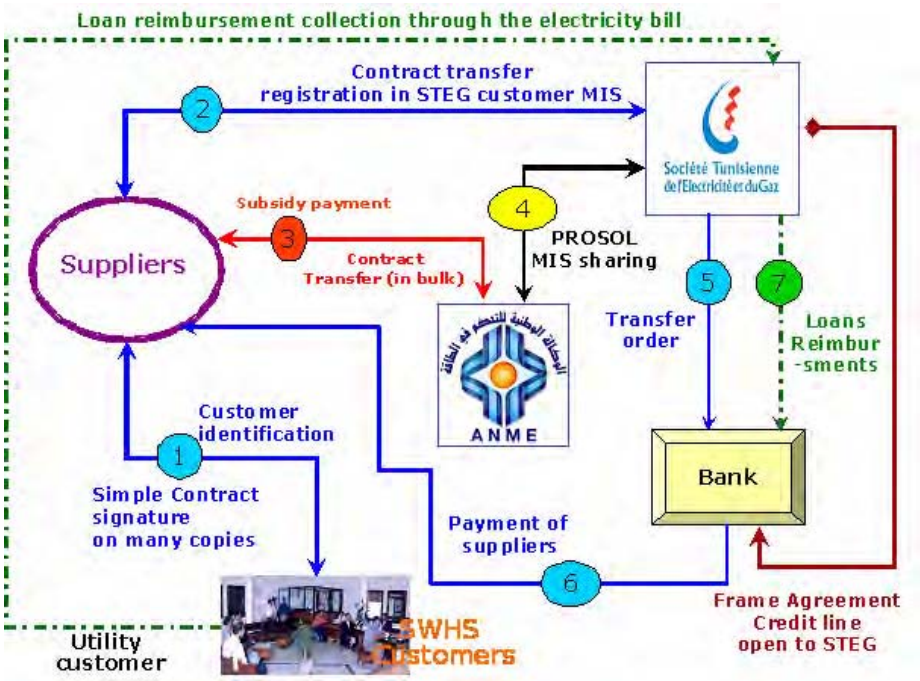
In the PROSOL scheme, *loans for SWHs are effectively driven by suppliers*, who act as indirect lenders of money for their customers. The process begins when a customer decides to purchase a SWH from an eligible supplier. It is worth highlighting that *only suppliers accredited by ANME can operate* within PROSOL. To this end, products must meet a series of *technical requirements and performance standards*, as set in a manual prepared by ANME.

Only customers who have an electricity service contract with the utility are eligible to PROSOL. The customer signs an adhesion form to proposal program and commits himself to pay back the loan and authorize the Utility to cut electricity in case of payment default. The SWH is then installed at the customer's home. The *customer pays only a small part of the SWH cost depending on the loan level he chooses*.

After the installation, the supplier receives:

- The subsidy payment from ANME of 200 Dinars (€114) for a 200-litre system or 400 Dinars (€228) for a 300-litre unit, and
- A payment from the bank of 750 Dinars (€428) for the 200-litre SWH, or 950 Dinars (€542) for the 300-litre system.

The customer repays the loan on over a *five-year* term, *through the electricity bills* issued bi-monthly by STEG. Within this scheme, the bank does not have any direct contact with the customer, who is the final beneficiary of the loan. They deal instead with SWH suppliers. This unusual arrangement *provides a double security*: the customers' loans are warranted by STEG for the bank; and consumers cannot easily default because STEG suspends their electricity supply.



Highlights of main features

The most distinctive aspects of the PROSOL financing scheme are:

- The engagement of banks: they provide the necessary funds to develop the market
- The active involvement of the State utility: provided enough guarantee in recovering the loan payments through its electricity bills to banks to extend the loan terms and lower the interest rates.

In PROSOL, loan duration is five years instead of the usual three-year term. As the financial risk is very low for the bank due to STEG guaranty, the interest rate is much lower than the commercial lending rate for similar loan products in Tunisia (around 7% instead of 14%).

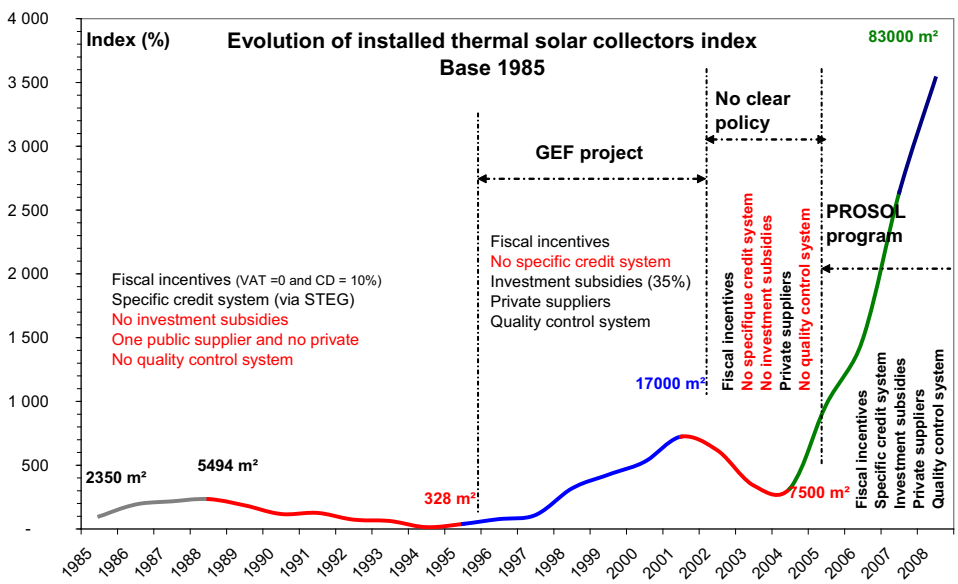
The mechanism is conducted in transparent manner through a special Management Information System (MIS) used by a dedicated team within the ANME. Moreover, PROSOL is regularly evaluated and audited by a third party (KPMG in 2007).

Results and Outlook

Launched in April 2005, the PROSOL project has resulted in an immediate success. In less than one year (April-December 2005), sales reached the record figure of 7,400 solar water heating systems, for a total surface installed of 23,000 m². In 2008, around 30,000 units were installed corresponding to approximately 83,000 m². The total installed capacity within the PROSOL is more 200.000 m² of collectors between 2005 and 2008.

These figures show clearly that the PROSOL mechanism implied a real market transformation of the solar water heaters in Tunisia.

As regards geographical distribution, the majority of solar heating systems are concentrated in the *Northern part of the country and in coastal areas*. In terms of equipments, most installations are represented *by flat plate solar panels* but vacuum tube collectors are slightly gaining market share. As for financial data, the total market for 2005-2008 is estimated to around $80 million. The bank sector has granted loans for more than $60 million. The number of SWH suppliers eligible within PROSOL has rapidly increased, passing from 5 to 9 in few months and stimulating other applications. Today, the number of companies selling SWH is /30/ companies, of which /6/ are producers. As far as installers are concerned, their number has reached more than 700 units, i.e. 6 times the figure achieved at the end of the GEF project. These remarkable results have led the Tunisian government to set very ambitious targets. In fact the annual avoided subsidies of displaced LPG for the Government could be estimated to around $3 million in 2008.



In spite of the considerable strengths of the project, the main future issue is the maintenance. In fact, despite that the supplier provides a guaranty of the SWH for 5 years, if no dedicated measures for maintenance are adopted, installed SWH might not be working anymore because of lack of maintenance. New measures are currently in study to develop a hot water service approach by including maintenance contract within PROSOL mechanism.

Accompanying measures

In order to give visibility to the project, inform customers on the advantages of the mechanism and promote the purchase of SWHs, a **comprehensive communication plan** was developed at national level. The following media were used: TV, radio, posters, brochures. Moreover, a **Training Support Facility** was established to build capacity amongst financiers and expand their confidence degree in renewable energy technologies, with the ultimate goal to increase the number of sustainable energy loan portfolios. Finally, **carbon finance** is another important component of PROSOL. Prosol is currently under validation process as CDM Program of Activity (PoA). The CDM revenues will be used to strengthen the program, mainly for awareness and capacity building.

Long-term Impacts

The PROSOL project is proving to be a real successful example. In only two years, it has driven important changes, namely:

- The setting by law (Law 82/2005 and decree 2234/2005) of a **20% capital cost subsidy** on all new solar water heating installations
- In order to improve technology level and decrease costs, the decree 4/2006 has exempted SWHs from VAT and decreased custom duties. **These measures help create a more level playing field where solar thermal can better compete against conventional energy sources** like natural gas or LPG.
- The **capacity building** and the information exchange stimulated a dynamic attitude of the Tunisian government, which has established a **comprehensive strategy** made of **policy**, **financial and fiscal incentives**, **awareness raising campaigns** (including the “Solar month” campaign), **monitoring measures**, etc.
- Engaging the banks has proven to be a successful strategy, since they leveraged enough financial resources to stimulate the creation of a market for solar thermal.
- The mechanism PROSOL has been entirely developed by local actors; which represents a very positive outcome, since it demonstrates that a **self-sustaining market and policy decision making process** are being built up.

As other UNEP projects, PROSOL was relatively small-scale, but has triggered rapid expansion of the SWH market. This proves that considerable results can be achieved- even with a limited budget- when money is channeled in the proper direction and synergies are exploited. With this respect, an extensive stakeholder consultation process has been carried out and the collaboration with all partners involved has been tied in.

Summary

The success in Tunisia has its ingredients, namely:

- Capacity building for stakeholders (financiers, consumers, technicians, policy makers)
- Awareness raising campaigns (consumers and banks)
- Communication & Information exchange
- Policies pro leveling the playing field for SWHs to compete (exemption from VAT, lower import tariffs,…).
- Quality infrastructure: standards, testing labs, & certification (for products & installers).
- Financial and fiscal incentives covering:
    - Capital cost subsidy to improve the pay back period for the end user
    - Loan mechanism for domestic customers to purchase SWHs to remove the barrier of first investment
    - Security system for banks and suppliers
    - Quality control and an accrediting system of suppliers, installers and SWH models
- Management Information System and monitoring measures & Evaluation.