A desk top study to investigate the global best practice for Solar Water Heating manufacturers

Final Report

Palmer Development Consulting

and

Synopsis

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ABSTRACT

The study was commissioned by the Central Energy Fund to inform the South African public/private sector of global best practice for available SWH technologies, warranty periods, pricing, and standards. Project outputs include a database of international manufacturers as well as a report.

Internationally, the use of SWH is driven by sustainability issues, security of supply as well as government incentives in a number of formats. Interest in SWH within South Africa is fuelled by the target set for renewable energy in the White Paper as well as electricity generation capacity problems and, to a lesser degree, to encourage sustainable energy consumption.

A questionnaire-based survey was addressed to manufacturers world-wide, requesting offers for the export of SWH into South Africa. Proposed systems were similar in size but differed strongly in price. Thus, countries were classified into a low price ("Group A") and a high-price ("Group B") category. Replies were more enthusiastic from Group A companies than from Group B companies.

Imported SWH ex-factory prices were compared with South African prices, which were found to be slightly higher than the imported ones. Reasons for this difference are discussed.

A data base with questionnaire results is reproduced in the Annex.

System types adapted to the South African market are presented including models for situations without piped water supply.

International experience indicates a mix of demand and supply stimulation is required to develop the market. Supply side measures and potential collateral effects are discussed. On the demand side, the study recommends a “virtual feed-in law” approach encouraging the replacement of electricity for water heating by SWH in analogy to the German Renewable Energy Sources Act (guaranteed purchase of renewable electricity for 20 years). Adapted measures for off-grid households are discussed.

ABBREVIATIONS

PDC	Palmer Development Consulting
CEF	Central Energy Fund
SESSA	Sustainable Energy Society of Southern Africa
SWH	Solar Water Heating
SWHs	Solar Water Heaters
REEA	Renewable Energy Electricity Act
GWh	Giga Watt hours
RSA	Republic of South Africa
ISWH	Integrated Solar Water Heaters
EEG	German Renewable Energy Sources Act

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1. Introduction

Palmer Development Consulting (PDC), in partnership with Synopsis (a French based renewable energy research organisation) was appointed by the Central Energy Fund (CEF) to complete a project entitled *"A desk top study to investigate the global best practice for SWH manufacturers"*. The team's proposal to CEF was supported by SESSA (Sustainable Energy Society of Southern Africa). The global best practice study is envisaged to positively contribute to the growing South African solar water heater market, a key component in Government's strategy to reach the renewable energy target of 10 000 GWh (0.8 Mtoe) renewable energy contribution to final energy consumption by 2013.

2. Background

2.1 The international SWH environment

Holm (2005:17) concludes that the use of SWH globally is driven by the need for socially, economically and environmentally sustainable development in the industrialised and developing worlds. More recently, an added incentive is security of supply, not only in terms of overcoming dependence on fossil fuels but also dependence on fuels imported from unstable regions. Europe (ESTIF, 2003) specifically notes the threat of major disruptions of supply and sudden price increases and views solar thermal energy as a reliable alternative.

The world's largest market for solar hot water collectors is in China and with more than 1000 manufacturers. China is also the world's largest manufacturer of SWH equipment with a production capacity of over 16 million square meters per year (ABCSE, 2005:11). China's national goal is 65 million square meters installed SWH by 2005 (which was almost met in 2004) and 230 million square meters by 2015.

Beyond China, at least 18 countries provide capital grants, rebates, or investment tax credits for solar hot water/heating investments, including India, Australia, Austria, Belgium, some Canadian provinces, Cyprus, Finland, France, Germany, Greece, Hungary, Japan, the Netherlands, New Zealand, Portugal, Spain, Sweden, the United Kingdom, many U.S. states, and the U.S. federal government. Capital grants are typically 20–50 % of system costs. Israel still appears to be the only country with a national-level policy mandating solar hot water in new construction. Since 1980, most buildings in Israel have been required to have solar hot water collectors and Holm (2005:20) notes that this has lead to a market penetration of more than 80% for SWH.

At the local level, a number of major cities around the world have enacted ordinances requiring solar hot water in new buildings or providing incentives or subsidies for solar hot water investment. Examples are Barcelona (Spain), Oxford (UK), and Portland, Oregon (USA). Barcelona in particular has enacted one of the most far-reaching of such policies. Starting in 2000, the Barcelona Solar Thermal Ordinance has represented a major milestone in urban energy policy. The ordinance requires all new buildings above a specific size category (292 MJ/day hot water energy consumption) to provide at least 60 percent of their domestic hot water energy demand from solar thermal collectors (Pujol, 2004). Based on the success of Barcelona, other Spanish cities followed with similar ordinances, for example Sevilla and Pamplona (2002) and Sabdel and Madrid in 2003 (Pujol, 2004). Currently, the "Codigo Técnico de la Edificacion" of 17th March 2006 makes the installation of solar thermal equipment compulsory for all new buildings in order to cover 30 - 70% of the hot water needs.

In terms of international market development from 1999 to 2003, Weis *et al* (2005:14) note that the market for flat plate and evacuated tubes grew significantly during this period. The most dynamic markets for flat-plate and evacuated tube collectors are in China, Australia, New Zealand and Europe. The average annual growth rate between 1999 and 2003 was 27% in China, 23% in Australia and New Zealand and 11% in Europe. Furthermore, based on calculations by Weis *et al* (2005:22), energy savings achieved through SWH in 2003 equalled 37 billion barrels of oil in 2005.

In conclusion, SWH is driven internationally by a combination of consumer demand for hot water and limited alternative supply options (China, India) as well as environmental and security of supply concerns in Europe and the U.S. Holm (2005:20) concludes that good solar conditions on their own do not necessarily lead to large scale market development or low prices. Supportive policies by national governments play a leading role in establishing and ensuring a sustainable SWH market; such policies should include a mix of national policy directives, mandatory regulations as well as incentive schemes.

The project team recommend a "nodal" approach to the study, since on the regional level, several specialised SWH nodes have emerged (such as China, Europe with an upmarket node in the North and a low-price node in Israel, Turkey and Greece), parts of the US, and Australia. The five broad manufacturing nodes, based on geographical and typical market criteria are:

1. Australia
2. Europe (including both high-tech and low-tech approaches)
3. China
4. India
5. United States

CEF requested the inclusion of Mauritius due to large market penetration of SWHs in the island group. A short overview of conditions in each node will be presented.

2.1.1 Australia

Policy environment

The introduction of the Renewable Energy (Electricity) Act (REEA) is considered to be one of the most positive policy developments (ESTIF, 2003:242). The Act sets a target of 2% renewable energy by 2012 to be included in the Australian grid, accounting for 9500 GWh of renewable energy. The initiative will also benefit the solar thermal industry.

A second positive development is the subsidy scheme called the "Certified Programme" for solar thermal where subsidies are provided in relation to the performance of the solar system as well as the introduction of Renewable Energy Certificates.

Industry overview

SWHs were developed during the 1940's to supplement water heating in remote regions where energy costs were expensive or conventional sources unavailable. During the 1960's, a number of manufacturers were established in Western Australia but high costs and lack of awareness hampered market growth. Rapid expansion of the industry occurred between 1980 – 1985, stimulated by improved industrial processes as well as oil price shocks. Aggressive expansion of natural gas reticulation damaged the industry from 1980 onwards a number of SWH companies left the market which left consumers un-serviced and dissatisfied. By mid 1980's, only 6 manufacturers remained and they shifted their focus to the export market to maintain sales volumes. Currently, the market is stable with a number of well-established role-players.

Domestic solar water heater design within Australia has focussed on closed loop thermosiphon systems utilizing flat plate collectors. The majority of the installed systems (99%) are in the domestic market.

Standards

The Australian standard applicable to solar domestic hot water systems is AS 2712. Independent testing is carried out at the University of NSW in Sydney. Under the new REEA scheme, no subsidies can be claimed for collectors that have not passed testing.

Lessons for South Africa

- The SWH industry maximised the marketing opportunity afforded by staging the Olympic Games and SWH were successfully integrated and demonstrated at the Sydney Olympic Athlete's Village. South Africa can learn much from this experience in our own planning for the 2010 Soccer World Cup as well as other events;

- The stimulus of a number of policy mechanisms is required to achieve sustainable market growth;

- Local manufacturing companies should be assisted to increase exports as this boosts turn-over and sales volumes.

2.1.2 Europe

Under the European umbrella, a number of experiences from different countries can be examined. In the interest of brevity, Europe is divided into two broad categories: high cots, high-tech and lower cost, high- to medium tech. Only 3 examples per category will be presented. It should be noted form the outset that SWH policies and measures and to a lesser degree, technologies are rapidly changing in Europe and therefore, some degree of caution should be exercised as information may be quickly outdated.

High cost, high tech: Germany, Austria, France

Austria and Germany are regarded as the leading countries in terms of SWH in Europe. In Austria, and estimated 150 000 households are equipped with SWH systems and most systems combine hot water provision with space heating. The annual turnover of the industry is estimated at 120 million euro per annum and the market has grown by 117% in 2001 (ESTIF, 2003). Factors promoting the use of SWH in Austria are:

- High environmental awareness
- High energy costs
- Financial incentives to install a solar system
- Technical product improvement
- Image campaign to raise the image of SWH
- Comfort

Germany also promoted the fact that SWH are mature technologies and that SWH are extremely modern products. In France, an interesting situation occurred where the market in France itself declined steadily from 1987 to 1999, but the market in previous French territories and overseas areas increased during the same period. Important push factors for growth in France were to reduce heating costs as well as environmental considerations. In terms of overseas territories, it was noted that SWH was less important than electricity generation but still promoted.

In Austria, the market is supplied by about 35 SWH manufacturers, supplying 60 different types of SWH. Standards are in place, notably EN 12975 (1-2), EN 12976 (1-2) and EN 12977 (1-3). There is no obligation for collectors to be tested but the stiff market competition ensures that all collectors are tested and comply with standards. In Germany, a strong solar market declined during the 1980's but then improved from 1990's onward and eventually experienced an increase of 30% in demand during the period 1995 – 2001. The German case employed a combination of very forceful marketing programmes ("Solar-na-klar in 1999 and a follow-up programme in 2000) with government subsidies, combined with a strong drive from Industry to become organised and to activate the market. Subsidies for SWH increased from 102 million euro in 1999 to 400 million euros in 2001. An estimated $52m^2$ of solar collectors are installed per 1000 inhabitants. SWH systems are supplied to both the domestic market, as well as for district heating and industrial processes. In Germany, 20 – 30 manufacturers supply the market. Standards are in place but as in Austria, testing is voluantary but since the subsidy is based on kWh yield per collector, most systems are tested and approved. In France, the Helios 2006 or Plan Soleil was launched in 1999 which aimed to install 50000 domestic systems by 2006. In France, SWH systems must adhere to 7 different standards and installed by members of the installers network in order to qualify for the ADEME administered subsidies of between 30% and 100%.

Attractive financial incentives are available in Austria:

- 10% - 50% subsidies
- financial support for building integration and installing SWH systems in new building
- Tax deductions
- National as well as regional (federal state level subsidies)

European policies form the basis for Austrian policies and are considered to be well aligned with EU directives. The following overarching policies can be identified:

- Security of energy supply
- Economic efficiency of energy supply
- Environmental conservation
- Social acceptability

In Austria, role-players include the national as well as federal government, the Austrian Solar Industry Association as well as additional research and development funding administered through a variety of government programmes. In Germany the formation of the Council for Sustainable Development further encouraged market growth as did policies aiming to reduce CO^2 levels by 25% through a renewable energy feed-in law. In France, industry are also well organised and especially focussed on training installers of SWH through "Qualisol Chart" – only systems installed by members (around 2500 members) of the organisation can qualify for the subsidy. Also, like in Germany and Austria, the policy was supported by a broad, well planned marketing campaign and strategy. Important role-players in France are:

- ADEME (French Agency for the environment and energy management)
- EdF (French electricity utility)
- 2 testing facilities.

French policies are also closely aligned with European Union policies, most notably the 6^{th} Framework Programme of EU.

In general, the Austrian SWH market is characterised by high standards, and it is technically very advanced. In Germany, an interesting combination of strong marketing, aggressive subsidies as well as strong organisation of the industry resulted in impressive market growth.

Important lessons for South Africa from these countries include:

- The important contribution of an organised SWH industry to market growth and the fact that the industry organised themselves;
- High levels of subsidy
- Very strong and aggressive marketing strategies with progressive, modern connotation of the technology

- Voluantary testing but only SWH systems which passed the standard tests qualify for subsidies.

Lower cost, high- to medium tech: Israel, Greece and Turkey
Greece has long been considered the most successful country with the highest number of installed SWH systems. The market took off more than 30 years ago when the price of electricity (the main fuel used for water heating) rose sharply. A strong advertising campaign was launched to promote the use of SWH and low interest rates were offered as well as loans to facilitate the purchase of systems. The Greek Solar Industry Association was founded in 1978 and an estimated 300 manufacturers were active in the market from the 1970's onward. During the 1990's, standards were formulated and the Solar Systems Laboratory of Demokritos and the Centre for renewable Energy Sources (CRES) was established.

In Israel, SWH also took off during the 1950's, pushed by high population growth, good solar radiation and an increase in energy consumption and Israel's dependence on imported sources of fossil fuels. Turkey's market growth started against the backdrop of the oil crises in the 1970's when hotels and summer houses started to install SWH. Mostly flatplate collectors were installed and a large number of manufacturers came on to the market. The market has declined since 1990 and currently there are an estimated 12 medium sized manufacturers as well as a large number of small, backyard type manufacturers in the market.

The market in Greece is mostly in the domestic segment as well as hotels, athletic centres, space heating applications, district heating systems and greenhouses and the most common system is the thermosiphon system (more than 95% of systems sold). An estimated 264 m^2 collectors per 1000 inhabitants are installed. Currently, the market is considered to be saturated and therefore there is a strong focus on export – 40% of all collector production is exported, compared to only 5% in 1991. No subsidies are available, except on large communal systems which can be subsidised up to 50%. Strong competition in the market keeps prices relatively low but lobbying is planned to remove unfair VAT of 18% as opposed to VAT on electricity at 5%. In general, consumers are considered to be extremely well informed about SWH and an estimated 25% of all houses in Greece sport SWH. To increase this rate, Greece is lobbying for progressive policies that would make SWH compulsory in all buildings as well as lowering of the VAT rate on SWH to make it more competitive with electricity. Interestingly, the majority of sales take place through exhibitions. Annually 10 large building material exhibitions take place as well as a number of smaller local exhibitions where most sales are made.

There are currently 10 manufacturers active in Israel selling thermosiphon, open loop systems with electrical back-up. The average size of the systems is 150 litres and more than 80% of houses have SWH installed, or 580m^2 collectors installed per 1000 inhabitants. There are no financial incentives in place although large demonstration projects can qualify for a 30% grant. The market is considered to be saturated and the only potential for growth is considered to be in the air conditioning sector.

The Turkish market has basically 2 types of SWH, one of lower quality than the other and since price dictates consumer decision-making, the lower quality systems are unfortunately the mostly bought. An estimated 10% of the production is exported, the balance consumed in Turkey itself. Approximately 95m^2 collectors are installed per 1000 inhabitants. Applications are mostly to supply hot water (both open and closed loop systems) as well as space heating applications. Four national standards are in place and four testing facilities exist in the country.

In Greece, an estimated 3000 people are employed in the industry and manufacturing range from backyard manufacturers to highly industrialised ones. Most systems adhere to the ISO 9000 quality assurance standard and CEN standards. In Israel, the industry employs around 4550 people. Systems adhere to 6 standards instituted by the Standards Institution of Israel and must have a Mark of Conformity before the system can be sold. Five testing institutes are operational in the country. Despite the existence of standards, standards are not well enforced (ESTIF, 2003).

Push factors for the development of the SWH market in Greece were:

- Price increases in electricity, the main energy form used for water heating;
- Building styles (houses with flat roofs) made it easy to install SWH and allowed the use of the cheaper thermosiphon type systems;
- Favourable climatic conditions;
- State support during start-up phase.

Israel's market was pushed by a regulation promulgated in 1980 that made it mandatory to install SWH in all domestic buildings higher that 27 metres. This regulation is still in place and new installations via new buildings account for approximately 15% of the market of SWH – 85% of sales are to replace old systems or system components. This is considered to be indicative of the high level of acceptance by the public of the technology. In Turkey, the available solar radiation, as well as the image of environmentally friendly consumers is pushing the market. Turkey has no specific incentives in place and no policies to promote the use of renewable energy.

Lessons to be learned for South Africa can be summarised as follows:

- If regulations are not enforced, it does not help to have them
- Directives (as in the case of Israel) serves well to establish the market both technologically as well for consumer acceptance
- Incentives don't have to be forever, they can be phased out once market saturation has been reached.

2.1.3 China

Policy environment

Runqing *et al* (2003:7) notes that renewable energy policies are closely co-ordinated in China at three levels, namely the national level at Central Government where general direction and guidelines are set, secondly at a regional level where specific goals and objectives are articulated and finally at a local, practical level where incentives and managerial guidelines are formulated. Renewable energy policy objectives include expanding energy supply to an additional 6 million people and increasing annual production capacity of SWH to 11 million m^2.

In terms of general renewable energy, the Chinese government is currently in the process of drafting a new Renewable Energy Law (REL) which is to be put into effect sometime in 2006. In terms of the REL, power grid operators have to purchase resources from registered renewable energy producers. The law also offers financial incentives, such as a national fund to foster renewable energy development, and discounted lending and tax preferences for renewable energy projects. China's new law sets the stage for the widespread development of renewables, particularly for commercial scale renewable generating facilities. The grid's buying price for renewables will be set by the National Development and Reform Commission (NDRC), a regulatory department of the State Council. NDRC will adjust the buying price from time to time as necessary. The cost of purchasing this power will be spread across all customers on the grid.

NDRC will also implement a national renewable energy plan, including specific renewable energy targets that will act as the framework for implementation of the law. Provincial planning agencies will then develop their more specific implementation plans. The law includes other details related to the purchase and use of solar photovoltaics (PV) and solar water heating as well as renewable energy fuels.

No direct Government subsidies exist, although Milton (2004:59) states that Government has offered generous financial incentives for SWH manufacturers (Milton and Kaufman, 2005:18). Milton (2004) further notes that the government has been pursuing aggressive public awareness campaigns and has established a nationwide network of technical service centers. Government has also implemented stringent quality control standards for SWH.

IT Power China (http://ukchinarenewables.com) describes the main opportunities for SWH in China as SWH integrated into buildings, SWH for space heating and for large scale district heating. China considers its SWH market as fully commercialized and therefore recommends that policy be focused on issues such as establishing market rules and mechanisms of market operation and encouragement of technology improvement.

Market role-players
Chinese Renewable Energy Industries Association (CREIA

With the aim of addressing the environmental problems caused by China’s energy structure, which primarily relies on coal, CREIA was set up in 2000 with support from the United Nations Development Programme, the Global Environment Facility and the State Economic and Trade Commission. It has since been working as a link between national and international project developers and investors, a bridge between regulatory authorities and the industry, and as a network drawing together new and renewable energy experts in research & development, production and sales. CREIA has over 100 corporate members covering all sectors of renewable energy.

The Department of Resource Conservation and Utilization (DORCU) provides low-interest loans to support industrial development of renewable.

Industry overview

Runqing *et al* (2003:2) describes the SWH market as being dominated by about 10 super large companies, 500 large to medium companies and about 3000 small companies. China is regarded as the world's biggest producer and consumer of SWH systems. Milton and Kaufman (2005:18) state that production reached 8 million m^2 – an increase of 66% over 1999 production levels. Less than 1% of production was being exported. The majority of domestic SWH systems use vacuum tube collectors (Milton and Kaufman, 2005:18) although flat-plate collectors, the predominant technology until the mid-1990's still represent a substantial portion of solar water heating equipment being manufactured. Flat plate collectors cost around $1.45 per litre of capacity while vacuum tube collectors are estimated at $2 - $3 per litre of capacity (Milton and Kaufman, 2005:18). Some integral systems with a combined collector and storage tank are also manufactured but are not very popular (Milton and Kaufman, 2005:18). The SWH market in China is driven by internal demand, especially form areas which are lacking in natural gas and electricity infrastructure. Traditionally, natural gas and electricity have been supplied at low prices but as a result of an increasing reliance on market mechanisms and aggressive measures to improve air quality, the cost of electricity and natural gas have increased (Milton 2004:59). Runqing *et al* (2003:18) further states that price hikes in conventional energy made SWH competitive and coupled with increased household income stimulated the local demand for SWH. Lastly, China is increasingly focussed on sustainable development as guided by Agenda 21 and SWH therefore makes good environmental sense.

Standards

Prior to 2000, the Chinese SWH market was considered to be littered with low-quality SWHs. A working group consisting of representatives of the China National Institute of Standardization, Beijing Solar Energy Research Institute, and the Professional Committee of the Exploitation of Solar Energy of Chinese Society for Energy Sources of the Countryside was established by a UNDP/GEF project and the first solar water heater orientation workshop was held 14-15 September 2000 in Beijing.

The National Standard Bureau has issued 5 different standards for SWH between1994 and1999 and a national test centre and certification institution was established Runqing *et al* (2003:21).

Lessons for South Africa

A number of interesting lessons for South Africa can be drawn from the Chinese experience:

- China made substantial Research and Development funding available since the early 80's to promote the growth of the SWH industry;
- The SWH industry was supported to supply in local demand (mainly from low-income households) but also to become a powerful export industry;

- Despite great strides in improvement of quality and after-sales service, China reports problems in this area and recommends increased efforts to ensure high quality products.

2.1.4 India

Policy environment

High availability of solar radiation and increased energy demand from all sectors stimulated SWH development in India. Capital subsidies, interest rate subsidies as well as tax benefits were used to stimulate the market and overcome the barrier of high upfront costs of solar water heaters.

The renewable energy policy of the Ministry of Non-Conventional Energy Sources (MNES) sets a target of installing an additional 5 million m^2 of collector area by 2012.

Market role-players

The Department of Non-Conventional Energy Sources (DNES) started a number of activities focussed on renewable energy in general and SWH in particular in 1982. They focussed solar thermal programme to overcome three main barriers, namely:

- Lack of awareness,
- Unreliable systems;
- High initial costs.

Capital subsidies were offered in conjunction with a demonstration programme. In 1992, DNES was upgraded to the Ministry of Non-Conventional Energy Sources (MNES) and the solar thermal programme continued as it was conceptualised under DNES.

In 1987, the Indian Renewable Energy Development Agency (IREDA) was created to finance renewable energy projects. Capital subsidies were continued for SWHs as well as “interest rate subsidies” whereby Government provides the difference between the market interest rate and the interest rate charged to the consumer. During 1992/93 capital subsidies were phased out but interest rate subsidies are still in place. Other initiatives such as tax benefits are also being provided.

Industry overview

SWH is considered the most commercialised renewable energy technology in India with two distinct markets, the domestic and commercial/industrial market. The latter segment accounts for more than 80% of installed systems in India (ESTIF, 2003:265). The technical potential of SWH is estimated at around 140 million m^2 of collector area.

Penetration levels of SWH differ between the North and South of the country with higher levels in the South and subsequently a well established SWH market. Focus seems to be shifting from commercial/industrial applications with increasing demand from the domestic market, attributable to increasing electricity prices (ESTIF, 2003:266).

Production of SWH focus mostly on single, glazed, flat plate collectors and the domestic market is dominated by thermosiphon systems. Manufacturing of absorbers is mostly automated whereas the manufacturing of collectors is mainly manual.

Despite SWH being a well matured technology, the following barriers are still considered problematic:

- SWH are not readily available, especially at the retail level;
- High upfront costs still poses a problem;
- Absence of micro-credit networks makes credit availability difficult for peri-urban and rural users;
- Despite 2 decades of promotion, awareness levels remains low;
- After-sales and maintenance remains problematic in some cases.

Standards

An estimated 60 SWH manufacturers produce SWH according to the standard set by the Indian Bureau of Standards. Standards for flat plate collectors (IS 12933:1992) have been developed by the Indian Bureau of Standards. To qualify for the low interest loans from IREDA or commercial banks, BIS approved systems have to be used. The Solar Energy Centre near Delhi, as well as 6 regional test centres can test equipment.

Lessons for South Africa

South Africa should note the following lessons form the Indian experience:

- The Indian government has set very specific targets for SWH. This is better than a blanket target for renewable energy;
- The importance of consumer awareness raising was realised early on and yet, despite 2 decades of activities, the awareness remains low. This illustrates the difficulty of the task and South Africa should learn form the double-pronged approach of the Indian government where awareness raising was prioritised as well as linked to subsidies and schemes to overcome the barrier of high initial cost.
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2.1.5 United States

Policy environment

The US Department of Energy manages the Solar Energy Technologies Program which also published a Multi-Year Programme (2007 – 2011). The solar water heating component is administered by Golden Field Office, Golden, Colorado. The Golden Field Office (GO) administers the Solar Rating and Certification Corporation grant for the

Solar Thermal Subprogram. This grant enables the solar industry to develop voluntary standards on the performance and reliability of solar water heaters.

In general, renewable energy was boosted by an announcement from President George W Bush in his 2006 budget speech where the overall budget for renewable energy in the 2007 fiscal year was announced as $1.17 billion. It is estimated that spending on solar energy research, both by government scientists and by outside scientists and academics, would be 78.5 % higher than it was in the 2006 budget (Janofsky, 2006)

From the Multi-Year Programme (2007 and 2011) it can be concluded that the US has realized it has to position itself in terms of international competitors: "In the solar water-heating area, the volume of production of foreign suppliers is much larger than that in the United States. Internationally competitors are already supplying some US markets; if those markets were to expand significantly, exports to the US of highly competitive technology would expand rapidly to meet the demand (US Dept. of Energy:2006:23)".

Alternate financing is available for solar hot water systems. Among the alternative financing mechanisms are Energy Savings Performance Contracting (ESPC) and utility programs including:

- DOE's Federal Energy Management Program (FEMP) has established an Indefinite Quantity Contract (IQC) under which any Federal agency can issue Delivery Orders for parabolic trough solar water heating systems in an ESPC arrangement. The Federal Energy Management Program (FEMP) offers both Regional and Technology-Specific Super ESPCs. FEMP's Regional Super ESPCs allow agencies in a particular U.S. region to place delivery orders with preselected energy service companies. The entire United States, the District of Columbia, and all U.S. territories are covered by the six Regional Super ESPCs. Technology-Specific Super ESPCs allow any facility to access financing for several advanced energy technologies. The first Technology-Specific Super ESPC, for solar thermal concentrating systems to implement low-cost hot water projects, was awarded to Industrial Solar Technology Corporation.

- Several utilities offer rebates, leases, or other solar water heating programs. A complete listing of incentives is provided in the Database of State Incentives for Renewable Energy.

Solar Energy Industries Association

The Solar Energy Industries Association (SEIA) is the national trade association of solar manufacturers, distributors, and contractors, with chapters in many states. SEIA lists solar manufacturers and companies that sell solar systems and products.

Solar Rating and Certification Corporation

The solar energy industry grew after 1974, following the oil embargo. The need for a single national program where manufacturers could test their equipment soon became evident. In an unprecedented move, the trade association for the solar energy industry and a national consortium of state energy offices and regulatory bodies joined together to lay the groundwork for such a program which lead to the founding of the Solar Rating and Certification Corporation.

In 1980 the Solar Rating and Certification Corporation (SRCC) was incorporated as a non-profit organization whose primary purpose is the development and implementation of certification programs and national rating standards for solar energy equipment.

The corporation is an independent third-party certification entity. It is unique in that it is the only national certification program established solely for solar energy products. It is also the only national certification organization whose programs are the direct result of combined efforts of state organizations involved in the administration of standards and an industry association.

The Solar Rating and Certification Corporation currently administers a certification, rating, and labeling program for solar collectors and a similar program for complete solar water and swimming pool heating systems. SRCC's certification program operating guidelines, test methods and minimum standards, and rating methodologies require the performance of nationally accepted equipment tests on solar equipment by independent laboratories which are accredited by SRCC. The test results and product data are evaluated by SRCC to determine the product's compliance with the minimum standards for certification and to calculate the performance ratings. The combined programs of the Solar Rating and Certification Corporation (SRCC) provide one-time certification, national recognition, product credibility, and standardized comparisons of solar energy products. The SRCC programs serve three primary constituencies: the solar energy industry, solar consumers, and state and federal regulatory bodies. All three constituencies benefit from the SRCC programs by obtaining a national state-of-the-art rating system, a mechanism to develop consumer confidence, and rational and defensible criteria for tax credit qualification and other solar incentive programs.

Department of Energy (DOE)

DOE sponsors numerous research and development activities under the Solar Energy Technologies Program to improve existing solar-heating technologies, explore new applications, and develop new technologies. The National Renewable Energy Laboratory (NREL) and Sandia National Laboratories (SNL), several universities, and numerous industry partners work collaboratively on research pertaining to solar-heating technologies.

Industry Overview

The size of the US SWH industry is illustrated by Nelson (2004), indicating the installed glazed flat plate and evacuated tube water collectors equalled 37, 856 m^2, compared to Europe with 1,168,308 m^2.

The US SWH market was stimulated during the 1970's by high oil prices, oil embargoes and a 40% Federal Tax Rebate instituted in 1979 by Jimmy Carter. The tax rebate lasted until 1986 and is commonly referred to as the "Tax Credit Era". A plethora of manufacturers, installers and contractors entered the market, often with disastrous effects due to low quality and selling bad designs at very high prices to take advantage of the tax credit schemes. Common problems included freezing, component failure and bad installations. The end of the Tax Credit Era coincided with a significant drop in oil and gas prices, virtually killing the SWH industry – an estimated 95% of solar dealers went out of business.

The period between 1986 and 2003 saw a number of technical advancements but it is still estimated that more systems from the tax credit era are being removed than new systems installed.

Standards

The combined programs of the Solar Rating and Certification Corporation (SRCC) provide one-time certification, national recognition, product credibility, and standardized comparisons of solar energy products. The SRCC programs serve three primary constituencies: the solar energy industry, solar consumers, and state and federal regulatory bodies. All three constituencies benefit from the SRCC programs by obtaining a national state-of-the-art rating system, a mechanism to develop consumer confidence, and rational and defensible criteria for tax credit qualification and other solar incentive programs.

Lessons for South Africa

In many ways, the US solar water heating industry shows similarities with the industry in South Africa:

- An early industry boom, then decline;
- Small number of companies involved, yet large potential;
- Local manufacture overshadowed by imported products.

2.1.6 Mauritius and Reunion

Policy environment

The need for energy remains a major source of economic vulnerability for many islands, due to their remoteness, isolation and heavy dependence on imported petroleum products, especially for local transport and electricity generated by thermal plants. And the cycles of high petroleum prices versus low commodity prices have impacted negatively on their terms of trade and on the momentum of their economies during the last 35 years. Moreover, many are dependent on biomass as their main source of household energy, which has a negative impact on ecosystems.

Mauritius has no known oil, natural gas or coal reserves, and therefore depends on imported petroleum products to meet most of its energy requirements. Local and renewable energy sources are biomass, hydro, solar and wind energy. Government policy is to encourage a greater use of sources other than oil for the generation of electricity, through the optimisation of the use of local and renewable energy sources.

Most of Reunion's electricity is produced by coal (mostly imported from South Africa) in the town of La Port and in the capital, St Dennis, augmented by hydropower from waterfalls and bagasse from the sugar industry. Reunion anticipates reaching its maximum peak power generation capacity in 2007 and expensive coal imports prohibits the building of another coal fired power station, hence the interest in promoting SWHs.

Jones (2003:4) reports that the French government subsidises the purchase of SWH on Reunion because Reunion is officially part of France and the electricity rate is set at the rate paid in France. The problem arises that it costs the French utility EdF twice as much to generate electricity locally. France introduced the SWH programme 10 years ago and only products carrying the CSTB (French Bureau of Building Standards) mark qualify for the subsidy. Public prices on the various systems are set and the subsidy is linked to the volume of hot water installed. The producer receives the subsidy and the saving is passed on the consumer. Government plans to introduce additional incentives through the off-setting of personal income tax against the purchase of SWHs.

Market role-players

The Ministry of Public Utilities (MPU) is responsible for the design and implementation of energy policy. It is responsible for the power sector (as well as the water and waste water sectors) and oversees the power utility, the Central Electricity Board (CEB). The CEB, which is also a generator and supplier of electricity, currently acts as the electricity regulator. Under the CEB Act, the CEB is statutorily responsible for the control and development of electricity supply in Mauritius. As such, CEB is empowered to "carry out development schemes with the objective of promoting, co-ordinating and improving the generation, transmission, distribution and sale of electricity throughout Mauritius as required". The Electricity Act of 1939 (amended 1991), Electricity Regulations of 1939 and Central Electricity Board Act (1964) comprised the legislative framework for the Electricity sector and CEB operations.

The Ministry of Commerce and Cooperatives (MIC) has the responsibility of the petroleum sector, with the State Trading Corporation (STC), which is responsible for the import of all petroleum products falling under its aegis. Gasoline, diesel, and kerosene are distributed by Shell, Esso, Caltex and Total, via filling stations. The Petroleum Act of 1970 (amended 1991) and the Consumer Protection Act (Price and Supplies) of 1998 under which, inter-alia, petroleum products prices are regulated, are implemented/enforced by the MIC.

Environmental regulations include the new Environment Protection Act of 2002. The object of these regulations is to provide for an institutional and legislative framework for the management and protection of the environment. This legislation is generally based on European Standards and revisions are made as and when necessary.

Detailed economic data on public finance and banking, the national accounts, the balance of payments, the CPI, trade, labour, as well as detailed demographic data is published by the Central Statistical Office. Data is collected for each energy source and fuel type. Data on imports, petroleum products, and coal are available on a quarterly basis at the Statistical Unit of the MPU. Data on the re-export of aviation fuel, diesel and fuel oil is also collected.

Energy data is analysed by the MPU and compiled according to the recommendations of the United Nations manual, series F No 29 on Energy Statistics. Economic sectors are classified according to the International Standard Industrial Classification (ISIC). Historical data since 1980 is available.

Industry overview

Being in the tropics, the country has a very good solar regime. Although solar water heating is considered economically attractive by the government, a number of factors have hampered its large-scale adoption by the public. Easy access to the electricity grid and reliable power supply combined with the relatively high prices of solar water heaters has restrained purchasing. Low interest loan facilities were made available at the Development Bank of Mauritius for the purchase of solar water heaters. They cost approximately US$ 800-1000 each.

In Reunion, SWH are subsidised by the French government. The solar water heating industry is considered mature and a number of brands, such as Solahart, Giordano, Solar Edwards, Eurostar, Solar Reunion and BP Solar are available in the market. From available information, indications are that at last two local companies are manufacturing solar water heaters. Jones (2003:4) reports the annual market size on the island as 8000 systems.

Standards

In Reunion, only products carrying the CSTB (French Bureau of Building Standards) mark qualify for the subsidy.

Lessons for South Africa

The islands of Mauritius and Reunion present interesting lessons for South Africa:

- Factors such as peak capacity running out, environmental concerns associated with coal-generated electricity and population growth all prompted the government to support SWH through installer subsidies in Reunion and end-user loans in Mauritius;

- The subsidy scheme was linked to products of high quality, adhering to international standards.

2.1.7 The South African SWH environment

Important policy documents governing and influencing the development of the SWH market in South Africa are the following:

- White Paper on Energy Policy for Republic of South Africa (1998);

- White Paper on Renewable Energy (2003);

- Regulatory Policy on Energy Efficiency and Demand-side Management for South African Electricity Industry (2004)

The Energy White Paper (1998) makes only passing reference to SWH under general renewable energy. The Renewable Energy White Paper (2003) sets the target of 10 000 GWh (0.8 Mtoe) renewable energy contribution to final energy consumption by 2013 to be produced mainly from biomass, wind, solar and small-scale hydro. The Renewable Energy White Paper (2003:36) lists the replacement of electric geysers by solar water heaters as measure required for households but specifically notes that "the main constraint on implementing a national solar water heating programme relates to cost, which is a function of the current small market and lack of economies of scale. This lack of demand in itself is due to low public awareness of the technology or its economic benefits (Renewable Energy White Paper (2003:50)". The White Paper does not elaborate on specific measures to ensure the replacement of electric geysers, neither does it expand on potential measures to make SWH more affordable.

The Regulatory Policy on Energy Efficiency and Demand-side Management for South African Electricity Industry (2004) outlines energy savings targets to be achieved through demand-side management measures. What should be noted from the document is that SWH are not considered as part of the demand-side management strategy to achieve energy efficiency – not for residential or industrial use. The only related measures listed as potential programmes eligible for energy efficiency and demand-side management (EEDSM) funding are:

- Hot water system efficiency
- Hot water conservation
- Hot water load control

The annual reduction in energy consumed in the electricity sector due to energy efficiency programmes is targeted to be 292 GWh annual energy displaced. The portion expected from hot-water related programmes is illustrated below:

Table 1: Hot water related eligible EEDSM measures. Source, NER, 2004:35.

Programme	**MW/a**	**GWh/a**
Integral CFL's	25.20	91.97
Hotwater system efficiency	2.93	10.13
Low flow showerheads	2.38	10.13
Hotwater conservation	2.38	8.22
Cooking Awareness	0.47	1.63
Total	32.32	115.39

Holm (2005:21) estimates that SWH can reduce peak electricity demand by as much as 18% and the Renewable Energy White Paper (2003:36) quotes Fecher *et al* (2003) who estimate that by replacing 60% of the current electricity being used for water heating purposes with SWHs, potential savings for urban residential households can be 5 900 GWh. This will make a significant contribution to energy efficiency and defer the construction of a coal fired power station. It is therefore, not clear why the Regulatory Policy on Energy Efficiency and Demand-side Management for South African Electricity Industry (2004) ignores the potential contribution of SWH.

Eskom operates a Demand Side Management (DSM) Programme which aims to encourage consumers to modify patterns of electricity usage, including the timing and level of electricity demand. It is further interesting to note that despite the potential contribution of SWH decreased electricity use, SWH is not part of Eskom's DSM programme.

Apart from the illustrated potential energy savings of SWH, Austin (2003) investigated the longer term impacts on employment resulting from developing renewable energy technologies in South Africa. Austin (2003:40) calculated that 120 000 new and direct jobs could be created by the SWH industry should appropriate targets be set. SWHs therefore, hold the potential to reduce energy demand as well as create employment.

Policies that may affect the SWH industry in future, but of which the nature and scope of the impact is hard to determine now, include:

- Draft Policy Paper: A framework for considering market-based instruments to support environmental fiscal reform in South Africa (National Treasury, 2006);

- The restructuring of the electricity supply and distribution industry and the operationalisation of the Regional Electricity Distributors (RED's).

Despite the paucity of comprehensive solar water heating policy directives, a number of interesting national as well as local initiatives are underway for example:

- The City of Cape Town is in the process of developing the first Solar Water Heating by-law in South Africa;

- eThekwini municipality implemented a SWH pilot project in two low-income areas where 100 SWHs were subsidised by 50%;

- Drafting of national standards for the installation, maintenance, repair and replacement of domestic solar water heating systems (SANS 10106) is at an advanced stage;

In summary, despite the existence of a number of policy documents, there is no comprehensive, clear policy regarding solar water heating in South Africa. Existing policy provide a tenuous framework for solar water heating activities, but a comprehensive policy and strategy is lacking, especially strategy linked to resources available for implementation. The situation is well summarised by Milton (2004:38) who states *"The fiscal context in which SWH must operate often encourages – explicitly or not – the use of unsustainable fossil-fuel technologies for heating water, and a vacuum of pro-SWH policy prolongs the public's unfortunate association with mediocre equipment"*.

3. Project description

3.1 Project aim and outputs

The main aim of this research is to inform the South African public/private sector of global best practice for available SWH technologies, warranty periods, pricing, and standards. The main outputs of the project are:

- A database containing information on various SWH systems:
  - Price for SWH system in Euro's
  - Manufacturer's details.
  - Warranty offered.
  - Standards/Marks achieved.
- A report, based on sectored nodes (Australia, China, India, Europe-high tech, Europe – low tech, USA, small islands) detailing the current global technology market environment dealing with policy, standards, approaches and the technology best practice recommendations relating to South Africa's current market.

3.2 Project methodology

The research was conducted through a desk-top analysis of technical and market data. Data collection was through a structured questionnaire, e-mailed to a contact database of SWH manufacturers whose contact details were obtained from the web, trade publications, personal contacts and existing reports. The questionnaire is enclosed as Appendix 1.

Contact details for a total of 712 potential SWH manufacturers were collected from 29 countries. Contact was established mainly through e-mail. In total, 377 e-mails were sent out and of the 377, 31 e-mails bounced while 37 responses were received, of which 12 contained no information, just comments. Questionnaires were faxed successfully to an additional 76 companies, of which 7 responded. Four companies requested additional information on CEF, the project and the SWH market in South Africa and 1 company requested a meeting to discuss the project.

Some difficulties encountered were:

- Incorrect contact details, e-mail non functional, unknown recipients and non-functioning fax numbers;
- Some websites only listed postal addresses for companies; and
- A number of websites requires paid membership before company contact details could be accessed.

The database contains two information sources:

1. Manufacturer replies to the structured questionnaire (Appendix 1)

2. Published information

The results of a comparative evaluation of the manufacturer replies to the questionnaires are presented in section 4, below.

4. Project results

4.1 Sample and reply rate

For the sake of this analysis, these countries were tentatively subdivided in two price segments: "low price" (Group A), and "high price" (Group B).

The main data per country are shown in Table 2. The complete reply count is reproduced in Appendix 2.

Table 2: Reply count for Group A (top) and Group B (bottom)

N°	Country	Contacts	Quests arrived	Returns	Offers	Return rate	Offers/company
1	India	170	104	4	18	0,038	4,5
2	China	63	19	5	28	0,263	5,6
3	Greece	19	18	2	34	0,111	17
4	Turkey	14	12	1	2	0,083	2
5	Mauritius	3	1	0	0	0,000	
6	Cyprus	2	2	0	0	0,000	
7	Israel	5	4	2	16	0,500	8
8	Mexico	3	2	0	0	0,000	
9	Malaysia	1	1	1	2	1,000	2
10	Brazil	2	1	0	0	0,000	
11	Cuba	1	1	0	0	0,000	
	Total	**283**	**165**	**15**	**100**	**0,091**	**6,7**

N°	Country	Contacts	Quests arrived	Returns	Offers	Return rate	Offers/company
1	Germany	16	27	1	1	0,037	1
2	Switzerland	12	20	0	0	0,000	
3	Austria	13	21	1	1	0,048	1
4	US	311	126	1	3	0,008	3
5	Canada	2	2	0	0	0,000	
6	Australia	35	24	1	0	0,042	0
7	New Zeeland	2	4	0	0	0,000	
8	Belgium	13	11	0	0	0,000	
9	France	3	3	1	0	0,333	0
10	Netherlands	1	1	1	1	1,000	1
11	Italy	4	4	0	0	0,000	
12	Spain	5	4	0	0	0,000	
13	Portugal	1	1	0	0	0,000	
14	UK	3	3	0	0	0,000	
15	Sweden	2	2	1	1	0,500	1
16	Reunion	4	2	0	0	0,000	
17	Guadeloupe	1	1	0	0	0,000	
18	Caledonia	1	1	0	0	0,000	
	Total	**429**	**257**	**7**	**7**	**0,027**	**1,0**

The overall reply rate was 5.2 %. In Group A countries, manufacturers replied more than 3 times as much per questionnaire sent out, compared to Group B countries. 107 systems were offered for export into South Africa, all but 7 of them from Group A countries. Also, in general, the Group A reaction was more positive, prices were communicated directly, whereas Group B countries often did not reply but sent comments.

4.2 Systems proposed

All proposed systems were split systems, either with collector and tank as separately installable elements, or with collector and tank mounted onto a common support ("mono-blocs"). No integrated solar water heaters (where collector and tank are the same element, ISWH) were proposed.

Flat plate collector mono-blocs on a roof in Greece

Integrated Solar Water Heater

Group A manufacturers proposed direct (without heat exchanger) and indirect (with heat-exchanger) systems, with gravity flow and pumped. Group B manufacturers proposed mostly indirect pumped systems. Vacuum tubes are dominant in China (see photograph below); in other countries, mostly flat plate collectors were proposed.

The average system dimensions proposed are shown in the Table below; they were of the same order for Groups A and B: collector surfaces 3.8 m² for the sunnier Group A against 4.1 m² for B, with tanks slightly larger for Group B: 258 against 225 litres.

The system dimension distributions for all systems are shown in the histograms below.

Table 3: Systems proposed

Group	A	B	A/B	B/A
S m²	3,8	4,1	0,93	1,08
V litre	225	258	0,87	1,15

The most widely distributed SWH model type: vacuum tube mono-bloc

4.3 Prices

In the questionnaire survey, manufacturers were requested make to informal offers, i.e. to give ex-factory prices for their systems for orders of 100 and 1000 units, as well as the number of systems fitting into a 20' or 40' container.

Most group A manufacturers provided this information; some added retail prices of their products. On the other hand, group B manufacturers provided little price information. Therefore, published data on thermosiphon systems as well as the corresponding retail prices were included in the data base.

Large, roof-integrated flat plate collector split system in Germany

4.3.1 Prices in Group A and Group B countries

Per m² of collector surface, Group A water heaters only cost 38% of the Group B models, per unit tank volume 43%. For indirect models, per unit tank volume, the Group A models cost half of the Group B models. For indirect pumped systems, Group A models cost two third of Group B models. It can be seen that for the more elaborate designs the price difference decreases.

Table 4: Prices (in Euro) per square meter and per lire

Group	A	B	A/B	B/A
Price	626	1809	0.35	2.89
Price/m²	176	461	0.38	2.62
Price/litre	2.9	6.8	0.43	2.34

However, it must be noted that there are certain differences between the offers:

- aesthetics and building integration are generally at a higher standard in Group B countries where building regulations are more stringent

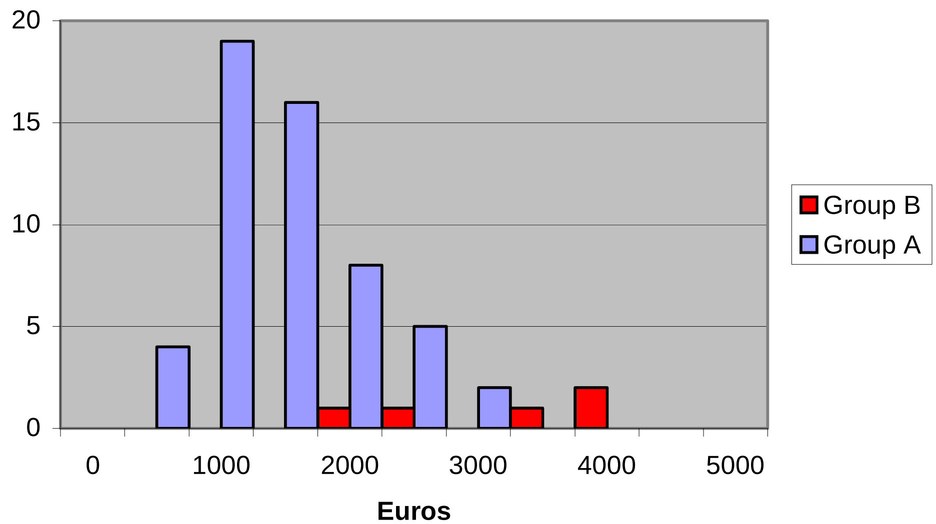
- it is well known that direct models (mostly proposed by Group A countries) have a lower durability than indirect models, due to calcium and particle deposits, corrosion and freezing. These models would therefore only be appropriate in areas of South Africa where freezing is not a problem, making them of limited use.

4.3.2 Retail prices

Retail prices (in Euro) for complete systems are shown in the histogram below.

Group B SWH retail prices are situated between 2000 and 5000€, Group A model retail prices show an asymmetrical distribution around 1500€.

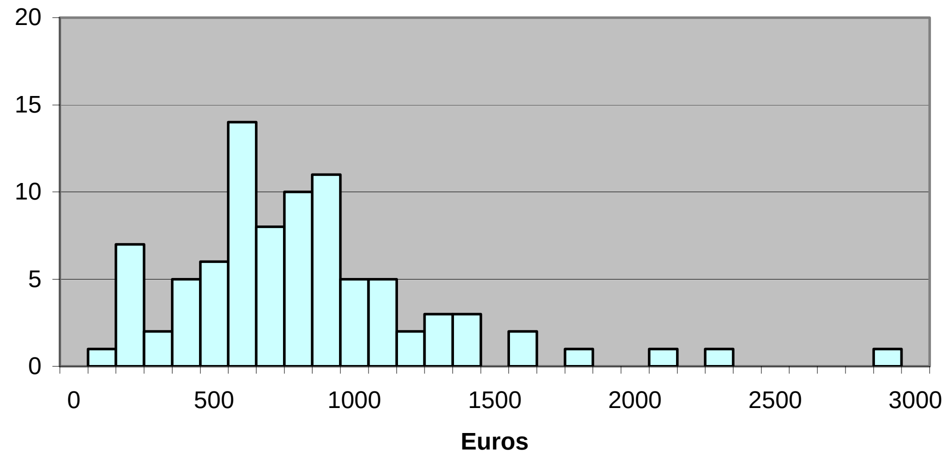
Figure 1: Retail prices Group A and B



4.3.3 Ex-factory prices

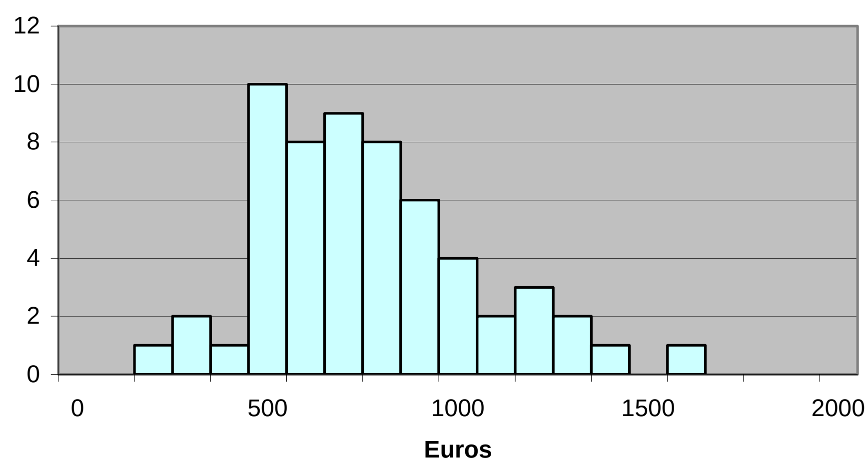
For the scope of this study, it is important to compare ex-factory prices. The distributions of per-unit ex-factory prices for an order of 100 units, as well as for an order of 1000 units are shown below.

Figure 2: Ex-factory price per unit (100)



It should be noted that the samples represented in the histograms are not identical, since not all manufacturers quoted all the different prices.

Figure 3: Ex-factory price per unit (1000)



4.3.4 Size-specific ex-factory prices

The price information presented so far concerned systems of different sizes. Since larger systems tend to be more expensive than smaller ones, it is useful to calculate "specific" prices (i.e. prices per unit of tank volume or per collector aperture unit). The following histograms show the results for 100 unit ex-factory prices: they can be used for the direct comparison of SWHs on the market. The most frequently offered prices were €3.50 per litre (e.g. €700 for a SWH with a 200 litre tank) and €200 per m² (e.g. € 800 for a SWH with 4 m² collector aperture surface).

Figure 4: Ex-factory price per m² collector area (100)

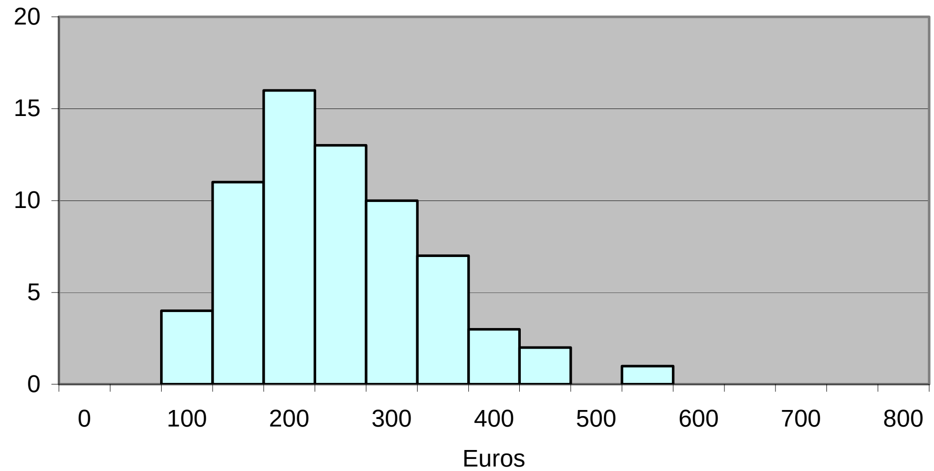


Figure 5: Ex-factory price per litre of tank volume (100)

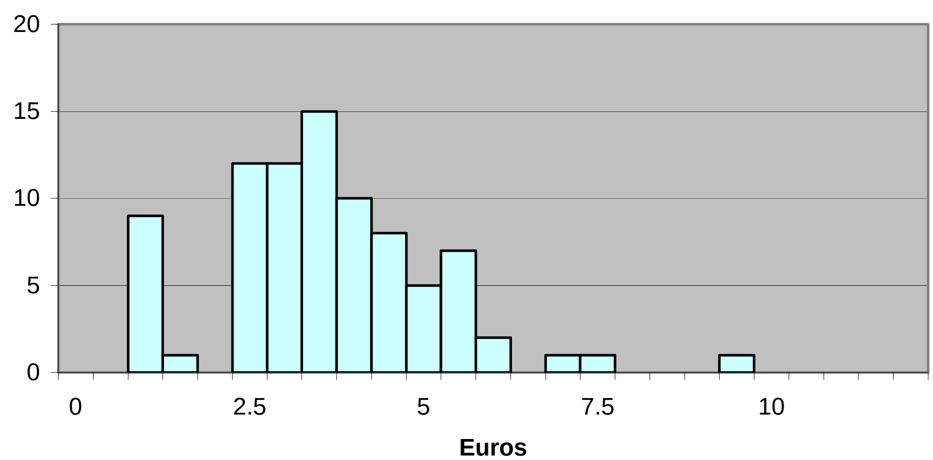
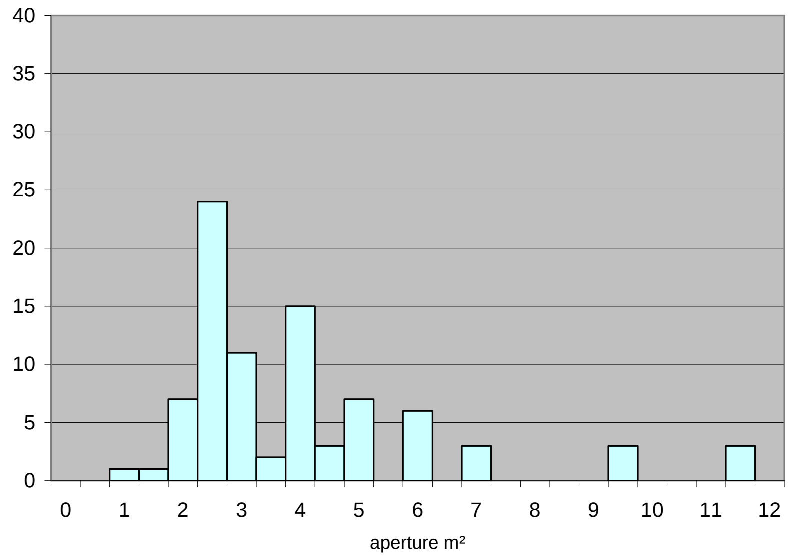


Figure 6: Collector aperture distribution (all systems)



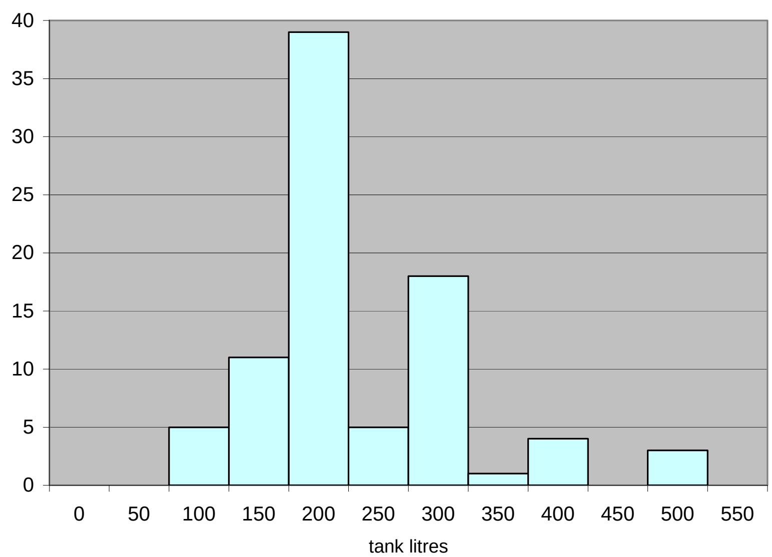


Figure 7: Tank volume distribution (all systems)

4.4.Offered SWH systems, system types and warranty conditions

The available SWH system type options are listed in the Table below.

Type	Water	strat	use	Electri	Back-up	RSA comp	RSA ncomp
unglazed shower bag	N	N	PM	N	N	low price, leisure	low durability
glazed garden shower	Y	Y	PM	N	N	price potential	
unglazed garden shower	Y	Y	PM	N	N	price potential	
UV transparent water bottle	N	N	PM	N	N	very low income	very low drblty
plastic IPSWH	Y	YY	PM	Y	N	price potential	integration
metal tank IPSWH	Y	Y	PM EV	N	N	price potential	integration
flat plate monobloc	Y	YY	A	N	Y		integration
vac tube monobloc	Y	YY	A	N	Y		integration
flat plate gravity split	Y	YY	A	N	Y		integration
vac tube gravity split	Y	YY	A	N	Y		integration
flat plate pumped split	Y	Y	A	Y	Y	opt: geyser	
vac tube pumped split	Y	Y	A	Y	Y	opt: geyser	
flat plate drain split	Y	Y	A	YY	Y		pump drblty ?
vac tube drain split	Y	Y	A	YY	Y		pump drblty ?
direct monobloc	Y	YY	A	N	Y		integration

Are shown from left to right: the system type, the need of a piped water supply, the build-up of temperature stratification in the tank, the time of the day hot water is available, the need of grid electricity, the possibility to include a back-up heating system, the adaptation or lack of adaptation to the South African situation. Y means yes, YY very much, N no, PM afternoon, EV evening, A all the time.

The grey entries correspond to system types that were not offered by the manufacturers who obviously preferred to stick to "middle-of-the-road" technologies for the little known market of South Africa. In fact, caution is called for: in part of the country, freezing occurs which poses problems for open systems. In other parts of the country, water is scarce which excludes the use of SWH installed at a certain distance to the hot water taps (which wastes water). In most parts, electricity is scarce which poses problems with back-up systems, particularly placed in outdoor tanks (as in mono-blocs).

Also, the RSA market is highly diversified:

- from wealthy customers able to afford large pumped split systems with roof-integrated collectors,

- over middle-class customers potentially interested in mono-bloc systems installed next to the house,

- to low-income customers living in formal (or even informal) settlements, lacking space and investment capacity for all but very basic integrated systems.

Finally, the system types offered by the manufacturers don't contain some recent advances such as:

- low-flow systems

- light weight tanks

- drain-back systems.

Typical warrantee periods are one year for tanks (6 years for collectors) from Israel, two years for India, three years for China, and between 5 and 6 years (up to 10 years in one case) for other countries (see data base in the Annex). <u>It must be noted that only one of the respondent companies has a representation in South Africa, leaving open the question of warrantee application.</u>

4.5 Recommendations

In this complex situation, no simple strategy (such as "100% import" or "100% local production") can be recommended. Also, single indicators: (such as "import if it is cheaper, otherwise produce locally") are not adequate. Comparative acceptance studies would be of great interest for industry as an unbiased model selection basis. Alternatively, manufacturers should be encouraged to maintain a multiple choice of SWH types.

For each SWH system to be put on the market (imported or not), tests according to specific RSA standards should be conducted and published. These tests should be voluntary and cheap or paid by a subsidy.

Development of integrated SWH for the low price market segment should be encouraged.

5. SWH standards

There are two types of standards for SWHs, the first concerning components, the second complete systems. A standard for South Africa has been proposed and should be used as a basis for further efforts.

5.1 Component standards

Component standards exist mainly for collectors, but also for tanks, heat exchangers, and controls, concerning thermal performance under different, well-defined and controlled environmental conditions (indoors or outdoors) as well as durability parameters. The corresponding tests require elaborate experimental set-ups, although simplified versions have been designed.

Results consist of numerous parameters and are not self-explanatory. They are very useful for the precise comparison of different split systems consisting of the respective components. Round robin testing has allowed insuring that collectors tested according to EU standards yield the same results in different climatic conditions.

There are three basic options for RSA:

1. develop and use original standards,

2. adapt standards to the local situation, and use these standards,

3. have components tested abroad.

We recommend option 2, since the RSA has the potential to conduct tests adapted to local conditions at lower cost, in a shorter timeframe without shipping delays and in closer interaction with manufacturers.

In a first step, basic collector performance standards (e.g. based on OG100 or NF EN 12975-2 Installations solaires thermiques et leurs composants - Capteurs solaires - Partie 2 : méthodes d'essai) should be adapted.

A minimum thermal and durability test programme could have the following parts:

- determination of steady state efficiency (input and output temperature, mass flow, ambient temperature, irradiance, wind speed),

- at 6 output temperature points,

- outdoors,

- under clear sky conditions, feeble wind.

Durability test by initial dry weight determination, followed by 6 month of dry and 6 month of wet stagnation, visual inspection (for leaks, thermal degradation, corrosion, glazing and casing integrity) initially once a week, then once a month. After one year, control measurement of weight and efficiency at one point.

5.2 System standards

Standards for complete SWH systems such as OG300 are essential for the RSA where up-market products could find a market as well as very basic concepts, each being proposed for a well-defined user situation.

System standard results usually determine thermal performance under outdoor environmental conditions; they consist of a few self-explanatory parameters allowing the potential client to get a qualitative picture of how a given system would perform in practical use. Quantitative precision is limited, but sufficient for the comparison of different systems under the same climate.

System standards have to reflect a variety of system types. Their results should allow the client to make an informed choice between different models available.

In general, simple systems need more detailed procedures than elaborate systems.

System standards should be specifically directed at the identification of faulty or sub-optimal design characteristics and choices of components and materials.

Different procedures must be designed for systems with and without back-up energy:

- Systems with back-up energy must be tested for excessive heat losses to ambient, for wasteful back-up control strategies (typical example is the back-up heating the whole tank at night - resulting in zero solar heat gain) or long tubing resulting in waste of both energy and water.

- Systems without back-up must be studied for build-up of temperature stratification in the tank and for the stability of this stratification. Swift build-up of stratification allows for hot water use after a short time of irradiance. Rapid loss of stratification (as in the example of horizontal tanks with conductive tank walls or poorly designed cold water inlets leading to mixing of water layers in the tank) means no hot water in the morning.

A special case is up-market SWH in situations without back-up: it can be worthwhile to use generously oversized vacuum-tube collectors for the reason that these collectors, due to high stagnation temperatures, produce useful hot water in low-irradiance conditions -

despite the fact that the cost of the solar kWh is rather high in these conditions and that overheating occurs frequently.

We recommend the definition of RSA-specific system standards, even though individual procedures can be based on existing test procedures such as OG300.

6. SWH system types recommended for the RSA market

For the highly stratified South African market (see Holm, 2005), different models for the different market segments are recommended as follows:

6.1 Up-market segment

The upmarket segment demands the best systems in terms of aesthetics, solar energy harvested, water savings and reliability. The rich can afford to pay for optimum systems, therefore systems are recommended with the following characteristics:

- collectors integrated in or on the roof for aesthetics

- well insulated tanks with stable thermal stratification, placed close to the draw points or hot water loops to save water,

- instant back-up or back-up placed in the top part of the tank, to save back-up energy

- sophisticated pump controls.

This market segment concerns houses as well as apartment buildings; it requires not only quality and durability, but shows little tolerance regarding technical problems (corrosion, calcium deposits, steam venting on overheating, leaks etc.). It should be noted that the design of such systems is no easy task. There is a wealth of long-term experience with these systems (e.g. Solarpraxis, 2004) which should be carefully applied, concerning:

- the basic concept,

- the choice of components.

Planners and installers of these systems have to be highly and specifically qualified.

The price of these systems is driven up by these requirements, as well as high installation costs.

6.2 Mid-market segment

The mid-market segment lacks money to invest in expensive systems therefore recommended systems should represent a compromise. This market segment can be characterised by the availability of piped water with tap(s) either in or close to the house, and enough sunny space close to the house - or on flat roofs of apartment buildings - to install one SWH per household.

Recommended systems are:

- mono-bloc, indirect systems (compulsory in places where minimum temperatures below 5°C occur)

- mono-bloc, direct systems (for places where minimum temperatures below 5°C do not occur).

The following technologies could be suitable to South African conditions:

- Integrated pressure tank SWHs, potentially cheaper than mono-blocs, although they seem to have disappeared from the market

- Integrated super-light pressure-less tank SWH, potentially very cheap, although they also seem to have disappeared from the market

- glazed or unglazed "garden showers", available in group B countries as leisure garden and swimming pool appliances, could be developed specifically for this market segment.

Unfortunately, manufacturers of these technologies did not respond to the survey and more detailed recommendations are therefore not possible.

The feasibility of innovative building integrated large-scale systems, for example, glazed steel-piped or concrete corner or roof integrated units be investigated.

6.3 Low-price market segment

In terms of SWH, this market segment could be characterised by the non-availability of piped water close to the house, and the extreme lack of space in and around the house.

Obviously, none of the SWH types listed above is adapted to this segment. The following designs, mobile and independent of piped water, could be used:

- the "wheel-barrow" SWH, a South African development
- the "shower bag", available as camping item in group B countries.

Figure 8: Filling a portable solar water heater with water. Photograph: Solar Engineering Services

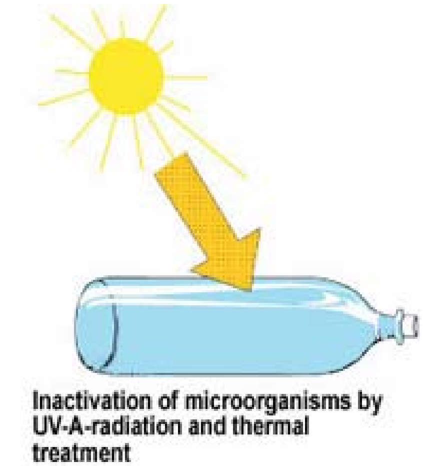
Figure 9: Two portable solar water heaters available in South Africa. Photograph: Solar Engineering Services

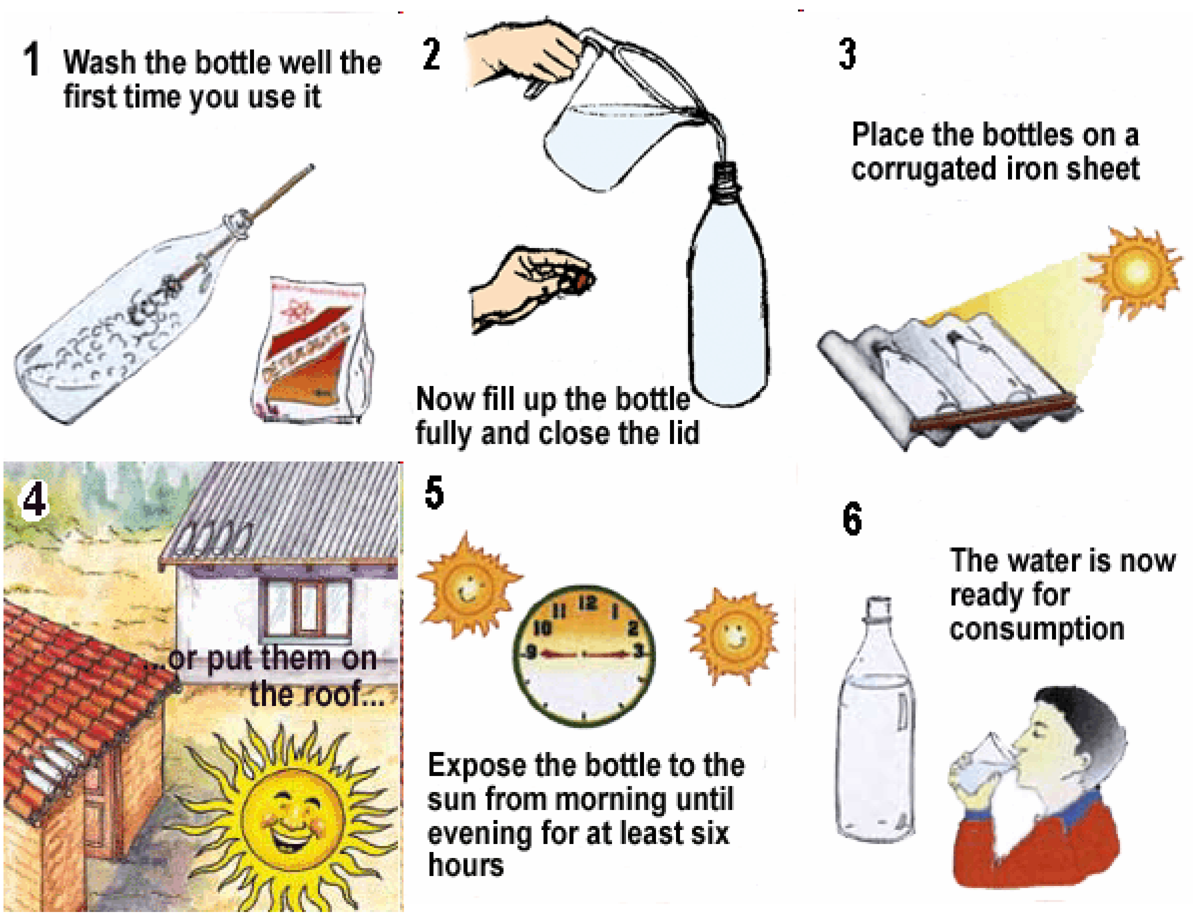
Figure 10: A solar shower or shower bag

Further research into suitable stand-alone systems for this market segment is recommended.

There are even cheaper ways to heat water: at the very low end of the market spectrum, there is the SOLVIS process, a way to heat and sanitise water by solar radiation. All it needs is some plastic bottles, some clear water, sun and some time.

Instructions for sanitising water have been published by the Swiss group EAWAG; they are shown below.





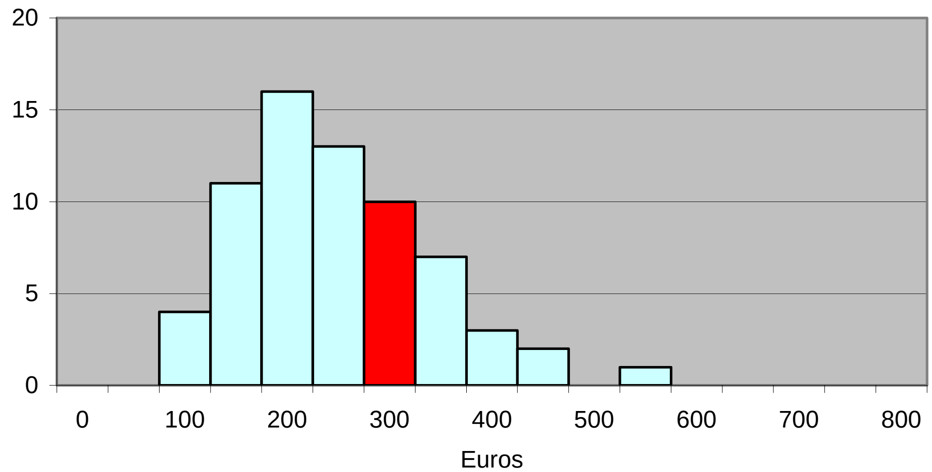
The abovementioned recommendations are supported by findings from an earlier study investigating consumer response to mobile solar water heating in 1999 in Ivory Park, a township in Midrand, Gauteng (Manyaapelo, 1999). The study estimated that 15.5 million people in South Africa live without piped water in their homes. Three mobile SWH devices were tested during the study: a wheel-barrow type solar water heater and 2 solar showers. Manyaapelo (1999:3) reported general acceptance of the devices, although the low volume shower unit was least preferred with households finding the time/volume trade-off unappealing. The study concluded that a financing mechanism to enable low-income households to purchase a SWH should be instituted and that innovative marketing techniques need to be devised to ensure access to the technology. Sowazi et al (2000:3) supports the recommendation of developing financing mechanisms and specifically recommends revolving credit funds, leasing arrangements and credit sales via commercial banks or retailers for the low-income market.

7. Comparison of South African to imported SWH prices

The average per m² retail price, including installation, distribution and VAT, for South African SWH has been found to be ZAR3736 by Holm (2005). Using figures for installation and distribution published in the same study, this corresponds to an ex-factory price (excluding VAT) of ZAR2340, or €277 (at the exchange rate of 24/05/2006).

The following histogram shows a comparison of this price with the 100 unit ex-factory prices proposed by the manufacturers replying to the questionnaire of this study. The entry marked in red corresponds to the average South African price (Holm, 2005) which is 20% higher than the average prices observed in the present study.

Figure 11: Ex-factory price m2 collector area (100)



It should be noted that this comparison must be read with caution, not only due to the variations in the ZAR exchange rate, but also because:

- the transport of the import models is not taken into account
- all but one of the respondent manufacturers don't have a South African legal presence which makes eventual warrantee conflicts more difficult for the client.
- the SWH models compared have different quality standards.

However, the comparison indicates that there is a price reduction potential for SWH produced in South Africa.

8. Salient features of the SWH market

The market for SWH is different from the markets for other similar appliances: each implantation of a SWH needs a necessary part of specific expertise for the choice of system, the best spot for its implantation, security, maximum energy harvest - the contrary of a *one-size-fits-all* commercial attitude. The bigger and more complex the system, the better it has to be conceived to avoid malfunction and costly after-sales service.

Best practice options for SWH professionals include therefore:

- to rely on highly integrated designs (such as ISWH or mono-blocs) with minimum complication for installation (e.g. clip in hot water outlet and cold water inlet)

- to rely, for split systems, on easy to install components such as light-weight tanks, integrated and pre-installed loop components, pre-insulated double collector piping with clip-in fittings. Since these components are normally rather expensive, it would be interesting to encourage local product development and production.

- to offer complete kits with all the necessary components.

In general, and with few exceptions, the SWH sector remains on the low-tech, semi-industrial level. This is adequate for most market segments, in a situation where manufacturers complain about several hundred percent over-capacity. But it will not do to win a price war with producers of vacuum tubes and mono-bloc SWH in China.

In general and with few exceptions, SWH success-stories are based on sales "at home", often guarded by protectionist measures, home being anything from the region, the country, down to the street. It is striking to see that SWH often form "clusters" on neighbouring houses (this minimises the risk to be the only fool in town).

In the short term, radical price reductions can only be expected due to new concepts (such as stable versions of the low pressure ISWH, or SWH integrated building elements). Also, prices for materials are expected to rise.

Courageous transition strategies must be based on market pull, on minimum bias technology choices, on the availability of "enough" capital, on partnership with all concerned players and stakeholders.

The key to capital is credibility and the expectation of rising fuel prices.

9. How to stimulate the South African SWH industry

There is a wealth of unpublished and informal international experiences on SWH industry success and failure stories and on the role of public policy measures concerning this industry. The issue is largely contradictory and the following observations can be considered subjective.

9.1 Supply stimulation

Good practice stimulation of supply:

- helps companies to manufacture quality products at competitive prices,
- encourages fair competition from newcomers
- discourages dumping practices
- creates a R&D framework including affordable standards for product rating
- allows lower VAT rates on external cost avoidance grounds.

The main divide between different supply side policies is the degree of protection of established industry against competition from domestic and international players. This protection can take many forms:

- The concentration of many weak SWH companies into a few strong ones has been tried - successfully - in one of the European Group B countries where the number of collector producers fell from more than 100 to 3 in a few years. Unfortunately, sales took a similar plunge as well.
- The protection of the lay public against "bad" products is a difficult task: as soon as the real problems start, the faulty companies have disappeared, leaving loyal companies bearing the brunt.
- The quality control and information of market players about performance and durability of different products according to standards can be very expensive and has been known to have competitors refrain from export into the respective countries.

It is necessary to steer a balance, in order to avoid these pitfalls without jeopardising quality or price aspects.

9.2 Demand stimulation

Typical measures can be directed at facilitating the acquisition of SWH and / or at lowering the cost of renewable hot water. They can take the following forms:

- compulsory installation of SWH (like in Barcelona)
- meter-based leasing schemes
- tax credits
- direct subsidies
- reward systems for the use of SWH.

9.3 Combined supply-demand stimulation - towards a "virtual feed-in law”

A solid majority of experts believe that the best and the most cost-effective market stimulation schemes are of the structure of the German EEG for the production of renewable electricity:

- utilities have the obligation to admit renewable electricity into the grid,
- the price per kWh has to cover the cost, which is decreasing over the years
- the investment is financed by low-interest credit schemes
- all conditions, such as the basic contract between the state and the individual and prices agreed to are guaranteed for at least10 years.

It is not easy to apply this structure to our case, since SWH cannot feed back hot water into the electricity grid. However, the special situation of RSA allows a direct application of this scheme, for the reason that SWH mainly replace electricity in "geysers". Use of a SWH therefore is equivalent to the production of electricity (one could call this "virtual" electricity feed into the grid).

To illustrate the issue, consider two neighbours (one with a SWH) who take a shower each every day. On rainy days, both will use electricity, on sunny days, the SWH will heat the water and no electricity will be used by the "solar" neighbour. For all practical purposes, this is equivalent to both neighbours being non-solar, and one of them feeding a shower's worth of electricity into the grid, each sunny day.

In this scheme, investment into SWH can be a personal decision, open to all stakeholders, users, utilities, investors, and to the state (see Recommendations).

9.4 "Collateral effects"

Policy measures can have unforeseen effects, such as:

- Subsidies have the tendency to be absorbed by installers or suppliers with the effect that none of the subsidy reaches the user.

- Announcement effects, a classical political tool, can be very effective - a simple announcement of a future subsidy is enough to stop investment dead. This was very aptly illustrated when the capital subsidy for PV systems were announced. The public did not understand that the subsidy was only applicable in the non-grid concession areas and businesses selling PV systems reported a significant drop in sales.

- "Grid lock" effects occur when several agencies have to agree on - and finance - a project

9.5 Summary and Recommendations

In summary, the following observations can be made:

- Internationally, SWH application focus shifts between domestic (Australia) and industrial/commercial (India) while the most successful countries (Austria, Spain) have almost a 50/50 split between domestic and commercial applications;

- In Europe, SWH applications are balanced between hot water and space heating applications. Space heating applications were not evident in large numbers in any other country;

- Most countries have renewable energy policies setting targets, but the more successful countries articulated very detailed targets for SWH (either in number of people to be serviced or m^2 of collectors to be installed);

- A mix of instruments was found to be used in different countries to stimulate the SWH market. These include capital subsidies (mostly to installers or manufacturers), interest rate subsidies, financial incentives to manufacturers, as well as financing/credit schemes for end-users;

- Successful countries (China, Austria, India and Australia) invested in large-scale public awareness programmes together with other incentive schemes;

- Successful countries have on-going research and development (R&D programmes). In countries were the subsidy is calculated based on energy actually produced, there is an active interest for all involved to increase solar energy output, which in turn boosts R&D focussed on the most efficient solution, for example, Germany China.

- Factors that boosted the market for SWH and may also boost it in South Africa are uncertainty in electricity supply and electricity price increases.

The following recommendations are put forward:

1. Ensure stability and credibility of policy measures in order give a solid and credible decision basis to investors and clients

2. Prefer investment schemes over subsidy: this leaves the responsibility with the investor and motivates success

3. Install low-interest loans over about 10 years (this will further boost the responsibility of the investor and puts durability and competitive price in his own best interest)

4. Minimise subsidies - this will minimise collateral effects

5. Base subsidies to cost – do not subsidise hardware, rather subsidise energy produced

6. Tie subsidies to the electricity price - the logic being the "virtual" electricity production by SWH (see above), and that all electricity users should share the cost of transition to renewable electricity

7. Tie subsidies to energy actually produced and not to installed capacity. Subsidies are set and guaranteed at the outset of the programme.

8. Subsidise innovative products, upstart companies

9. Don't overprotect established companies

10. Use standards and labels as means for market development and not as market barriers

11. Invest in specific standards and help industry to obtain labels

12. Have foreign competitors breathing down the neck of domestic companies to keep them alert

13. In cases where foreign competitors have the means to deliver key technologies cheaper than domestic companies (e.g. vacuum tube collectors from China), enter in a joint venture for the adaptation, production and marketing of these products

14. Encourage a strategic reflection on potential key technologies for South Africa. Strategic reflection should include consideration of regional needs and potential markets so that South Africa can position itself as a market leader in the region.

15. Access the market in sub-Saharan Africa and neighbouring islands based on these key technologies.

16. Both local as well as regional demand should be targeted by the SWH industry.

17. When the solar market takes off, the operational companies which are operational at the time will be the fist in line to reap benefits. South Africa should focus on becoming the regional centre of SWH expertise.

BIBLIOGRAPHY

Austin, G. 2003. Employment potential of renewable energy in South Africa. Electricity Supply Industry Africa, Issue 4, 2003; 40 – 43pp.

Australian Business Council for Sustainable Energy. 2005. Renewable Energy In Asia: The China Report. An overview of the energy systems, renewable energy options, initiatives, actors and opportunities in the People's Republic of China. Victoria:Australia.

Department of Minerals and Energy. 1998. White Paper on Energy Policy for Republic of South Africa. DME:Pretoria.

Department of Minerals and Energy. 2003. White Paper on Renewable Energy. DME:Pretoria.

European Solar Thermal Industry Federation (ESTIF). 2003. Sun in Action II – A solar thermal strategy for Europe. Volume 2. EU Altener programme:EU.

Fecher, R; Thorne, S and Wamukonya, N. 2003. Residential solar water heating as a potential Clean Development Mechanism project: a South African case study. As quoted in Department of Minerals and Energy. 2003. White Paper on Renewable Energy. DME:Pretoria.

Holm, D. 2005. Market survey of solar water heaters in South Africa. Final report prepared for EDC, CEF and UNDP. Central Energy Fund:Johannesburg.

Jones, D.T. 2003. Solaire La Reunion. In: Sessa Friend, December 2003, p.4.

Janofsky, M. 2006. Solar energy is gaining powerful friends. New York Times, February 9, 2006.

Manyaapelo, K. 2000. Consumer response to mobile solar water heating in the low-income Sector. IIEC:Johannesburg

Milton, S. 2004. Carbon Finance and Solar Water Heating Technology. Exploring possible synergies through five case studies. The Fletcher School, Tufts University: Massachusetts.

Milton, S and Kaufman, S. 2005. Solar Water Heating as a Climate Protection Strategy: The role for carbon finance. Green Markets International, Inc:Arlington, Massachusetts.

National Electricity Regulator. 2004. Regulatory policy on energy efficiency and demand-side management for South African Electricity Industry. NER:Pretoria.

National Treasury. 2006. Draft Policy Paper. A framework for considering market-based instruments to support environmental fiscal reform in South Africa. National Treasury:Pretoria.

Nelson, L. 2004. Chair, Solar Thermal and Building Products Division, Solar Energy Industries Association. Solar heating, cooling and lighting overview. Paper presented at the Renewable Energy Modeling workshop. 6 December 2004.

Pujol, T. 2004. The Barcelona Solar Thermal Ordinance. Evaluation and Results. Presentation at the 9th Annual Conference of Energie Cites. Martigny, 22 – 23 April 2004.

Runqing, H; Jinli, S and Junfeng, L. 2003. Policy study on the development of the solar water heating industry in China. CRED.

Sowazi, S, Cawood, W and Baloyi, R. 2000. Solar water heating system project for households.

US Department of Energy. Solar Energy Technologies Programme. Multi-Year Technical Plan 2003 – 2007 and beyond. US DoE.

Weis, N; Bergmann, I and Faninger, G. 2005. Solar Water Heating World Wide. Markets and contribution to the energy supply. International Energy Agency Solar Water Heating and Cooling Programme. IEA:Paris.

http://www.eskomdsm.co.za
http://www.solar-rating.org/standards/standards.htm

APPENDIX 1

Structured questionnaire

Manufacturer Questionnaire
Please complete and e-mail before 31 May 2006
to marlett@pdc1.co.za and to synopsis@wanadoo.fr
Or fax to ++27-11-501-3388

Manufacturer Contact Details:

Company Name:	
Name of respondent:	
Country:	
Contact e-mail:	
Website:	
Telephone number:	
Fax number:	

Types of Solar Water Heaters (SWH) manufactured (tick appropriate boxes; please use a copy of the questionnaire for each of the systems manufactured by the organisation):

- ☼ Split system (collector and storage are separately installed elements) ( )
- ☼ Monoblock system (collector and storage are separate elements, installed on the same support) ( )
- ☼ Integrated SWH (storage serves as absorber) ( )
- ☼ Evacuated tube collector ( )
- ☼ Flat plate collector ( )
- ☼ Other (please specify): ____________________

- ☼ Circulation pump ( )
- ☼ Gravity flow ( )
- ☼ Drain-down system ( )

☼ Direct (without heat exchanger) ( )
If direct, please explain freeze and corrosion protection: ____

☼ Indirect (with heat exchanger) ( )

Collector aperture surface:____
Tank volume: ____

Back-up energy device included: yes ( ) no ( )

Type of back-up energy: electricity ( ) gas ( ) other: ___________________

Back-up energy fed into: top of the tank ( ) middle of the tank ( )
bottom of the tank ( )
other: ____

Performance and durability test results:
Standards systems adhere to:____

Test results available at
www.____

or other references:____

Warranty conditions:

____

____

____

____

I would be interested to export the system described under the following conditions:

Price per unit (euro, ex-works, 100 units):_______________________________________
Delivery time 100 units:____
Price per unit (euro, ex-works, 1000 units):____
Delivery time 1000 units:____

Transport and handling:
Approximate shipment cost (euro per container, FOB port): _______________________
Number of units per container: ____

Do you have an agent in South Africa? Yes ( ) No ( )

Company background information:
Numbers of SWH units manufactured per year: __________________________________
Number of years in existence: ____
Structure of commercial dissemination (please describe: ____
____
____
____

Please describe any support mechanisms or incentives in place for your business (for example, tax breaks, state subsidies for manufacturing, other schemes)

____
____
____
____
____
____
____
____

APPENDIX 2

Reply count per country

Appendix 2: Reply count all countries

Country	Group	Contacts	Mails sent	Mails bounced	Faxes	Quests sent	Quests arrived	Returns	Offers	% return	Offers/company
Germany	B	16	14	1	14	28	27	1	1	0,037	1
Switzerland	B	12	11	2	11	22	20	0	0	0,000	
Austria	B	13	12	2	11	23	21	1	1	0,048	1
India	A	170	98	1	7	105	104	4	18	0,038	4,5
US	B	311	125	6	7	132	126	1	3	0,008	3
Canada	B	2	1	0	1	2	2	0	0	0,000	
Australia	B	35	24	2	2	26	24	1	0	0,042	0
New Zeeland	B	2	2	0	2	4	4	0	0	0,000	
China	A	63	23	4	0	23	19	5	28	0,263	5,6
Greece	A	19	17	1	2	19	18	2	34	0,111	17
Turkey	A	14	10	2	4	14	12	1	2	0,083	2
Belgium	B	13	13	2	0	13	11	0	0	0,000	
France	B	3	3	0	0	3	3	1	0	0,333	0
Mauritius	A	3	1	2	2	3	1	0	0	0,000	
Netherlands	B	1	1	0	0	1	1	1	1	1,000	1
Cyprus	A	2	1	0	1	2	2	0	0	0,000	
Israel	A	5	3	1	2	5	4	2	16	0,500	8
Italy	B	4	2	0	2	4	4	0	0	0,000	
Mexico	A	3	0	1	3	3	2	0	0	0,000	
Malaysia	A	1	1	0	0	1	1	1	2	1,000	2
Spain	B	5	4	1	1	5	4	0	0	0,000	
Portugal	B	1	0	0	1	1	1	0	0	0,000	
UK	B	3	3	0	0	3	3	0	0	0,000	
Brazil	A	2	2	1	0	2	1	0	0	0,000	
Cuba	A	1	1	0	0	1	1	0	0	0,000	
Sweden	B	2	2	0	0	2	2	1	1	0,500	1
Reunion	B	4	0	2	4	4	2	0	0	0,000	
Guadeloupe	B	1	1	0	0	1	1	0	0	0,000	
Caledonia	B	1	1	0	0	1	1	0	0	0,000	
Total		**712**	**376**	**31**	**77**	**453**	**422**	**22**	**107**	**0,052**	**4,9**