

The South African Solar Thermal Technology Road Map (SA-STTRM)

Direction for South Africa's solar thermal energy future

A discussion document

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CENTRE FOR RENEWABLE &
SUSTAINABLE ENERGY STUDIES



SUSTAINABLE ENERGY SOCIETY
SOUTHERN AFRICA



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About SOLTRAIN

The Austrian Development Agency (ADA) and AEE - INTEC (Institute for Sustainable Technologies from Austria) set up a 3-year solar thermal energy project in cooperation with Southern African educational institutions, renewable energy institutions and companies in South Africa, Mozambique, Namibia and Zimbabwe. SOLTRAIN 2 builds on a previous project, which ran from 2009 – 2012.

The main activities of SOLTRAIN 2 are **focused awareness campaigns** on solar thermal systems to inform all relevant stakeholders and the interested population about the different applications of solar thermal energy and the related impact on security of energy supply, poverty, employment and on the environment.

Another major activity is to implement a sustainable institutional structure and focal points for solar thermal information, training, support for industry and policy as well as for applied research. These **Centres of Competence** will be implemented in institutions of higher education in each country. The Centres of Competence are going to carry out a comprehensive training programme, ranging from practical hands-on training to University level courses.

Furthermore “**Solar Thermal Technology Platforms**” (STTPs) will be implemented into all Centres of Competence in each partner country. These national platforms will be cross-linked to a Southern African Solar Thermal Technology Platform in order to enhance the information exchange and the cooperation between the platforms.

In order to apply the knowledge gained during the training courses, and to increase the public awareness, **40 - 50 solar thermal demonstration systems** of different sizes and applications will be installed at social institutions and small and medium enterprises. The co-sponsored demonstration systems are placed within the Solar Thermal Flagship Districts, and shall be open to visits of Technical Tours by decision makers.

About CRSES

The Centre for Renewable and Sustainable Energy Studies (CRSES) was established in 2006 and is currently partly funded by the Department of Science and Technology (DST) through the Postgraduate Programme in Renewable and Sustainable Energy Studies. The Hub of the Programme is in the Faculty of Engineering at Stellenbosch University in collaboration with other departments and institutes within the University structure, as well as the Sustainability Institute (SI), which is based at Lymedoch outside Stellenbosch.

***Our Vision** is that Stellenbosch University is recognised as the leading, best-known and most productive research and teaching university in the field of renewable energy in Africa facilitated by the Centre for Renewable and Sustainable Energy Studies.*

About SESSA

The Sustainable Energy Society of Southern Africa or SESSA, is dedicated to the use of renewable energy and energy efficiency including all solar-based energies such as photovoltaics, thermal heating and cooling, wind, biomass and hydropower. These principle sources of energy can be used in passive building design and in energy efficiency projects.

The inter-disciplinary nature of SESSA attracts the membership of industry, scientists, researchers, developers and the general public – the only qualification is a keen interest in renewable energy and its utilization to ensure a sustainable energy future.

SESSA was founded in 1974 and is one of 50 National Sections of the International Solar Energy Society (ISES). ISES is regarded as the premier body in solar energy with members in over 100 countries. SESSA is the duly appointed African office of ISES.

Stellenbosch University CRSES in partnership with AEE-INTEC and SESSA hosted a very successful launch of the South African Solar Thermal Technology Platform (SA-STTP) at the Protea Hotel, Breakwater Lodge in Cape Town on Thursday, 27 November 2014. The launch was followed by an interactive workshop to formulate the South African Solar Thermal Technology Roadmap (SA-STTRM).

This workshop was attended by delegates from industry, research institutions and government.

The SA-STTRM is understood to be the implementation plan for the SETRM.

This STTRM documents the progress made in the use of solar thermal technology in South Africa and gives an analysis of the technological, legislative, regulatory and other barriers that need to be overcome to accelerate its deployment. The outcomes of the workshop as well as comments from other interested parties have been incorporated into this roadmap document.

AGENDA

Launch of the South African Solar Thermal Technology platform (SA-STTP) followed by an interactive workshop to formulate the South African Solar Thermal Technology Road Map (SA-STTRM)

27 November 2014, Protea Hotel, Breakwater Lodge, Cape Town

- 09:00 – 09:30 Registration
- 09:30– 09:40 Welcome and Introduction: Prof Wikus van Niekerk (Stellenbosch University)
- 09:40– 10:00 Overview of SOLTRAIN and current status, plus launch of the SA-STTP: Werner Weiss, Managing Director AEE - Institute for Sustainable Technologies (AEE INTEC)
- 10:00 – 10:20 Report back from some SA-STTP workgroup convenors
- Working Group 2: SWH manufacturing: Helmut Hertzog
 - Working Group 3: Solar heat for Industrial Applications: Wally Weber
 - Working Group 5: Solar Thermal Systems for Buildings: Dieter Holm
 - Working Group 6: Training, Education and Awareness: Ryan Dearlove
- 10:20 – 10:50 Background to the SA-STTRM and introduction of the European Solar Heating and Cooling Technology Roadmap: Werner Weiss
- 10:50 – 11:05 Coffee / Tea
- 11:05 – 11:20 Introduction of the SA-STTRM - Karin Kritzinger (Stellenbosch University)
- 11:20 – 12:50 Interactive workshop facilitated by Prof. van Niekerk to unpack and finalise the SA-STTRM:
- Residential Solar Water Heating
 - High Pressure Residential Solar Water Heating
 - Low Pressure Residential Solar Water Heating
 - Multi Family Homes Solar Water Heating
 - Industrial / Commercial Installations for Solar Heating and Cooling
 - Unglazed Swimming Pool Solar Water Heaters
 - Solar Passive Design in Buildings
 - Solar Heat for Space Heating in Buildings
 - Passive solar heating in buildings
- 12:50 – 13:00 Wrap-Up and Way Forward: Prof. Wikus van Niekerk
- 13:00 – 13:30 Light lunch

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Foreword

The current use of fossil fuels for the majority of South Africa's energy needs is economically, socially and environmentally unsustainable. A significant percentage of final energy used in the industrial, commercial and residential sectors is for heat and, with South Africa's unexploited higher than average solar resource, solar thermal energy can play a large part in our path to an independent, low carbon and sustainable energy future.

The South African Solar Thermal Technology Roadmap (SA-STTRM) is based on the Solar Heating and Cooling Technology Roadmap project in Europe, which was developed by the European Technology Platform on Renewable Heating and Cooling. This Roadmap is essentially market oriented to make Solar Heating and Cooling (SHC) more competitive and, thus, develops the full potential of social and environmental benefits inherent to solar thermal technologies. In this roadmap Research & Innovation (R&I) actions are identified to improve significantly the competitiveness of solar heating and cooling technology. It also describes the objectives of the roadmap, to which will be achieved in response to the societal challenges.

Furthermore, the SA-STTRM is furthermore a sector specific roadmap underpinning the Solar Energy Technology Road Maps (SETRM), an initiative of the Department of Energy (DoE) and the Department of Science and Technology (DST) supported by CSIR, SANEDI, the International Energy Agency, Solar Heating and Cooling (IEA SHC) and the GIZ, through the SAGEN programme. The sector-specific roadmaps that feed into the SETRM are coordinated by the CSIR. The process of developing the SA-STTRM is aligned with, and informs, the SETRM sector specific roadmap for solar thermal technologies.

The SA-STTRM sets out a roadmap for the development, support and promotion of solar thermal technologies in South Africa. It excludes technologies such as Concentrated Solar Power (CSP), where electricity is produced with solar thermal energy as well as Solar Photovoltaics (PV).

Finally, it attempts to document the progress made in the use of solar thermal technology in South Africa and presents an analysis of the technological, legislative, regulatory and other barriers that need to be overcome to accelerate the deployment of this technology in South Africa.

Achieving this roadmap's vision will require an effective, long-term and balanced policy effort to allow for optimal technology progress, cost reduction and ramp-up of industrial manufacturing for mass deployment. The South African Government will need to provide long-term targets and stable supporting policies to build confidence for investment in manufacturing capacity and deployment of solar thermal systems.

The huge potential for solar thermal systems in South Africa

South Africa faces an enormous power deficit and nearly 90% of the electricity is generated from coal. In February 2008, the Government of South Africa, their power utility, Eskom and the mines reached an agreement that the mines would cut back an immediate 10% in order to reduce the large amount of load shedding. After about 7 years of low incidence of load shedding, South Africa is yet again experiencing severe power shortages and rolling load shedding started again at the end of 2014.

Such developments of the major power supplier leaves South Africa in a very vulnerable position, hence the country must frantically explore ways of financing power projects to avert economic disruption.



Since about 40 – 50% of the electricity in the residential sector is used for heating water, solar water heaters constitute one of the major cost-effective and rapid options in order to reduce the electricity demand and thus the environmental effects like CO₂ emissions caused by fossil power plants.

South Africa has an excellent solar irradiation with up to 2000 kWh/m² annual radiation, and estimates from the International Energy Agency (IEA) show that solar thermal systems could meet about 70 – 80% of the region's low temperature heating and cooling demand.

This roadmap describes ways to use the huge solar potential with solar thermal systems in order to reduce significantly the electricity demand and thus also the CO₂ emissions of the country. By implementing the roadmap also a significant number of jobs could be created if the government supports local assembling or manufacturing.

An interactive workshop was held on 27 November 2014 at the Breakwater Lodge, Cape Town, where this roadmap was further developed through input from participants. This is a discussion document. Please feel free to distribute widely and send all comments, corrections and additions to karink@sun.ac.za.



Key findings and actions

To be completed

A workshop aimed at stakeholders in the built environment and other interested parties, will be held in February in Gauteng to discuss the roadmaps for Solar Passive Design in Buildings.

An interactive workshop to discuss and further develop the SA-STTRM will be held on 19 March 2015 at Bytes Conference Centre in Midrand. Confirmation of attendance has been received from the office of Austrian Ambassador.



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Abbreviations

CRSES	Centre for Renewable and Sustainable Energy Studies
CSIR	Council of Scientific & Industrial Research
CSP	Concentrated Solar Power
DoE	Department: Energy
DST	Department: Science and Technology
EE	Energy Efficiency
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (German technical cooperation)
GW	Gigawatt
HP	High Pressure
GWh	Gigawatt hour
IEA	International Energy Agency
IEA SHC	International Energy Agency Solar Heating and Cooling
kW	Kilowatt
kWh	Kilowatt hour
LP	Low Pressure
MWh	Megawatt hour
MW	Megawatt
PPPFA	Preferential Procurement Policy Framework Act
PSG	Project Steering Committee
PV	(Solar) Photovoltaic
R&D	Research and Development
RE	Renewable Energy
SAGEN	The South African – German Energy Programme
SANEDI	South African National Energy Development Institute
SAREC	South African Renewable Energy Council
SA-STTP	South African Solar Thermal Technology Platform
SA-STTRM	South African Solar Thermal Technology Roadmap
SETRM	Solar Energy Technology Road Maps
SESSA	Sustainable Energy Society of South Africa
SU	Stellenbosch University
SWH	Solar Water Heater/Heating
WG	Working Group

1. Background

The SA-STTRM is a sector-specific roadmap underpinning and informing the Solar Energy Technology Road Maps (SETRM), an initiative of the Department of Energy (DoE) and the Department of Science and Technology (DST) supported by CSIR and SANEDI. The process to develop the SETRM was started in 2010. In 2012, the International Energy Agency as well as the GIZ, through the SAGEN programme came on board to support the revised SETRM process.¹ On 27 November 2014, the SA-STTRM draft document was discussed at an open stakeholder meeting in Cape Town. The mood of the meeting was constructive and participative.

All comments received have been integrated into this document by CRSES.

The Solar Energy Technology Road Maps (SETRMs)

The Solar Energy Technology Roadmap (SETRM) is a joint initiative of the Department of Energy (DoE) and the Department of Science and Technology (DST) supported by the CSIR and SANEDI. This initiative will be supported by both local and international organisations such as the GIZ and the International Energy Agency (IEA) that the PSC deems relevant.

The purpose of the SETRM is to prepare a guide to the local development of solar energy technologies and their deployment taking into consideration relevant policies and initiatives. The DST has developed a SETRM in 2010 but the scope covered on the DST study was limited to Research and Development of solar technologies.

The IEA describes a roadmap as a strategic plan that outlines the steps a country needs to take to achieve stated outcomes and goals. It clearly outlines links among tasks and priorities for action in the near, medium and long term. Technology-specific roadmaps are intended to support the development of a specific type of technology, e.g. solar PV, CSP, etc. South Africa however, has opted to develop a consolidated roadmap for both solar PV and CSP technologies, which will be based on the IEA methodology.

Various national departments and industry players have specific interests in respect of the development of solar energy technology in South Africa and it has become critical to develop a single document that consolidates these disparate efforts, and that maps out a pathway that all stakeholders can follow. As such, the SETRM also aims to improve coordination in the sector.

¹ http://www.eskom.co.za/AboutElectricity/RenewableEnergy/Documents/H2SA_SETRM_Pogramme.ppt

The SETRM is the investigation of a solar energy technology road map for South Africa, which takes into consideration the draft “Energy, Research, Development and innovation (ERD&I)” strategy drivers that include universal access economic growth, and environmental protection as a framework. The roadmap also highlights key strategic focus areas required, interventions by various role-players and how best South Africa might use its competitive advantage of solar radiation.

The SETRM covers the following (1) Analysis of the status of solar energy technologies (globally); (2) South African strengths in solar energy technologies; (3) Analysis of linkages with South African energy and climate change policies/strategies, and the current energy crisis; (4) Direction for energy research capability; (5) An assessment of the country’s competitiveness in solar energy technologies; (6) A clearly articulated and peer reviewed prioritization process, core technologies to be developed over the next 10 years (split into a short, medium and longer term) with clearly measurable objectives for each, should then be selected, and the associated roadmaps developed. The attendant resource requirements to be estimated, and (7) a SWOT analysis and associated mitigation measures.

Statement of Purpose

The South African Solar Energy Technology Road Map (SETRM) is being developed to provide a comprehensive, aligned, achievable and time-bound strategic plan that will help guide: policy and regulatory development, industrial strategy and related investment, education and skills programme development, innovation, research and development; and the overall diffusion of solar technologies in the country, as well as, given the country's significant regional impact, in the broader Southern Africa region.

The objectives of the SETRM are:

To develop a clear, comprehensive, and prioritized implementation plan (i.e. roadmap) for the development and diffusion of concentrated solar power; solar photovoltaic technology (ies); solar heating and cooling technologies; related R & D in South Africa toward reduced energy use, carbon emissions reduction; distributed electricity generation, expanded independent power production and electricity supply to the national grid, and the reduction of reliance on carbon fuels.

Process

The development process of the South African SETRM involves four key phases: Planning and Preparation; Visioning; Roadmap Development; and Roadmap Review and Validation. The Planning and Preparation phase of the SETRM process involves the undertaking of researching and aggregating available reports on the sector, attending stakeholder fora, engaging with sector stakeholders, and undertaking research on relevant policies, industry incentives, public and private stakeholders and sector earmarked finance.

The Visioning phase of SETRM process involves bringing key stakeholders together, along with the researchers, consultants and development partners that have been developing various independent solar sector related strategic plans and/or programmes that focus on South and Southern Africa.

The intent in convening the gathering is to enlighten everyone to the collective work being undertaken, illicit support for the various projects, and to explore points of mutual interest toward alignment and mutually beneficial exploitation of the various platforms that have been or are under development in the country.

The Roadmap Development phase of the SETRM process involves compiling and drafting a document that reflects the work that has been done in the country to date in the relevant solar fields and through a consultative process developing an aggregate set of goals, timelines, responsible actors, requisite inputs and catalysts and agreed on metrics to review progress and measure and evaluate the rate and degree of success achieved through the implementation of the SETRM process - within each of the three sub-sectors.

The Roadmap Review phase of the SETRM process is the final stage of the process and involves stakeholder review and assessment of the written plan of action and affords stakeholders the opportunity to point out any inconsistencies, changes, and/or corrections to be made to the SETRM report - toward the improvement of the document and toward increasing the likelihood that a maximum number of stakeholders will find the document relevant, useful in their planning, and worthy of being their default strategy to develop within their respective spheres of influence.

http://www.energy.gov.za/files/SETRM/setrm_overview.html

The South African Solar Thermal Technology Roadmap (SA-STTRM) is a project within the South African Solar Thermal Technology Platform (SA-STTP), which forms part of the SOLTRAIN 2 project. The other SOLTRAIN partners in Southern Africa, Namibia, Zimbabwe and Mozambique, are developing similar STTRMs and all four roadmaps will be incorporated into one document by the end of the project.

The SA-STTP supports the switch from fossil fuels to sustainable solar energy sources for applications such as water heating, (solar) cooling, process heat and low temperature steam.

The SA-STTP brings together all interested parties from academia, government, financial institutions, end-users and industry to;

- Share information on technical, practical and financial aspects of solar thermal energy
- Identify knowledge gaps and opportunities
- Mobilise institutions or individuals to do the required research
- Disseminate the results and keep record of the roll-out of solar thermal energy systems in the country

Furthermore, the SA-STTP links with a Southern African STTP as well as the STTP in Europe.

The SA STRM outlines the path to arrive at the **Vision of the SA-STTP**, namely;

To have $\frac{1}{2}$ m² of net solar thermal collector area for every member of the population by 2030 in South Africa. (Circa 30 10⁶ m² by 2030)².

This relates to an installed capacity of 21 GW_{th} and annual electricity savings of 34 000 GWh, avoiding 23 Million tons of CO₂ every year.

The estimated population in South Africa for 2030 is between 54 and 68 million^{3 4 5}

From this, the target for solar thermal installations by 2030, according to the vision of the SA-STTP, is 30 million m² (if the population is taken at 60 million for 2030)

The estimated solar thermal installations at the end of 2014 is at least 2 277 835 m², made of by the following⁶;

- Low Pressure Residential Solar Water Heating (1 m² per unit): 200 000 m²
- High Pressure Residential Solar Water Heating (4 m² per unit): 1 200 000 m²
- Multi Family Homes Solar Water Heating (10m² per unit): 10 635 m²
- Industrial / Commercial installations for Solar Heating and Cooling (180 m² per installation): 3 444m
- Unglazed Swimming Pool Solar Water Heaters: (200 m² per unit): 867 000 m²
- Solar Heat for Space Heating/Cooling in Buildings: (323 m² per unit): 1 292 m²

² In comparison: Countries like Cyprus and Israel had already about 0.6 m² of solar thermal collector area for every member of the population installed in the year 2012. Source: IEA – Solar Heat Worldwide report, Edition 2014.

³ <http://www.timeslive.co.za/local/2011/01/25/south-africa-s-population-to-shrink-after-2030>

⁴ http://www.issafrica.org/uploads/AF7_15Oct2013V2.pdf

⁵ http://www.ifs.du.edu/ifs/frm_CountryProfile.aspx?Country=ZA

⁶ <http://www.iea-shc.org/data/sites/1/publications/Solar-Heat-Worldwide-2014.pdf>

- Solar Passive Design in Buildings: No available statistics

Existing legislation, regulations and government targets for South Africa

Targets

Department of Energy: 1 Million Solar Water Heaters by 2014⁷

The White Paper on Renewable Energy (2003): 10 000GWh of energy to be produced from renewable energy sources by 2013⁸

The South African Government's National Development Plan 2030 has a target of 3 000 000 solar water heaters by 2030⁹

The 2011 Green Economy Accord signed by Government and business reiterates the 2014 target of 1 000 000 solar water heaters, secures the support of the insurance industry for replaced units, and commits to promote the marketing of solar water heaters¹⁰.

Regulation and legislation

SANS 10400-XA Energy Efficiency in New Buildings: A minimum of 50% of the annual average heating requirement for hot water must be provided by means other than electric resistance heating or fossil fuels¹¹

The Preferential Procurement Policy Framework Act (PPPFA) regulations, which came into effect on the 7 December 2011, empower the Department of Trade and Industry to designate industries, sectors and sub-sectors for local production at a specified level of local content. Solar Water Heater Components have a 70% minimum threshold for local content¹².

Rebates

Eskom: Residential solar water heater programme for high pressure solar water heaters¹³

Department of Energy contract programme for low-pressure solar water heaters (not in place as yet)

Programmes

City of Cape Town Solar Water Heater Programme¹⁴

eThekweni: Shisa Solar¹⁵

Johannesburg: City Power Solar Water Heating Programme¹⁶

Nelson Mandela Bay and Ekurhuleni Solar Water Heater Pilot Programmes (currently on hold)

⁷ http://www.energy.gov.za/files/swh_frame.html

⁸ http://www.energy.gov.za/files/renewables_frame.html

⁹ <http://www.gov.za/issues/national-development-plan/>

¹⁰ <http://www.gov.za/documents/download.php?f=159756>

¹¹ <https://www.sabs.co.za/Sectors-and-Services/Services/Energy/index.asp>

¹² http://www.dti.gov.za/industrial_development/ip.jsp

¹³ http://www.eskom.co.za/IDM/EskomSolarWaterHeatingProgramme/Pages/Solar_Water_Heating_Programme.aspx

¹⁴ http://saveelectricity.org.za/pages/water_heaters.php

¹⁵ <http://www.shisasolar.org.za>

¹⁶ http://www.joburg.org.za/index.php?option=com_content&view=article&id=8304:08102012-launch-of-solar-water-heating-programme-by-city-power&catid=217:press-releases-2013&Itemid=114

2. The technology roadmap

For the purposes of this roadmap, the solar thermal applications in South Africa are divided into sub divisions, namely;

- Residential Solar Water Heating
 - High Pressure Residential Solar Water Heating
 - Low Pressure Residential Solar Water Heating
- Industrial / Commercial / Multi-Family Housing Installations for Solar Heating and Cooling
- Unglazed Swimming Pool Solar Water Heaters
- Solar Passive Design in Buildings
 - Solar Heat for Space Heating in Buildings
 - Passive solar heating in buildings

A roadmap for each of these sections is developed below and these roadmaps are then combined in Section 3.

The following priority research themes as identified in a SOLTRAIN stakeholders workshop held on 7 October 2014 at the SESSA/SAREC offices in Parkwood, Johannesburg and for which SANEDI gave major input, are included in the SA-STTRM. This priority list is understood to be open-ended.¹⁷

High Priority

1. Research national policies of 10 international ST champions (Cyprus, Austria, Israel ..) & their applicability to SA
2. Update C van Horen *Externality Cost Study of Electricity Generation in RSA* which was written in the previous century
3. Independent research on peak demand impact of Eskom SWH Rebate Scheme
4. Independent study on lessons learned from Eskom SWH rebate scheme, including energy saved
5. Optimisation study on enlarged SWH energy storage cost vs peak demand cost saving
6. Development of a transparent, interactive model to create long-term stable government Solar Thermal policies
7. Government and SESSA awareness campaigns to focus on EE rather than rebates. Research end user perceptions, preferences
8. Research Solar Thermal Market potential in South and Sothern Africa (see EU study)
9. Quantify historical cost of policy uncertainty in RSA
10. Research efficacy import duties vs local content legislation in RSA

Medium Priority

11. Study on nameplate standing losses vs reality standing losses of all storage HW systems
12. Social upliftment cost/benefits of SWH
13. Job creation through maintenance on Eskom rebate installations

¹⁷ <http://www.blackdotenergy.co.za/events-seminars/>

14. Finding a cost-effective test procedure reflecting realistic frost risk in South Africa, including climate change
15. Research perceived stigma/status attached to LP/HP SWH
16. Research Solar Cooling technologies suitable for RSA

Low Priority

17. Find a low-cost SWH that is suitable for both the high and low-income market, which can be completely manufactured in SA with materials and components from SA.

PROVISIONAL NOT FOR PUBLICATION

Roadmap 1: High Pressure Residential Solar Water Heating

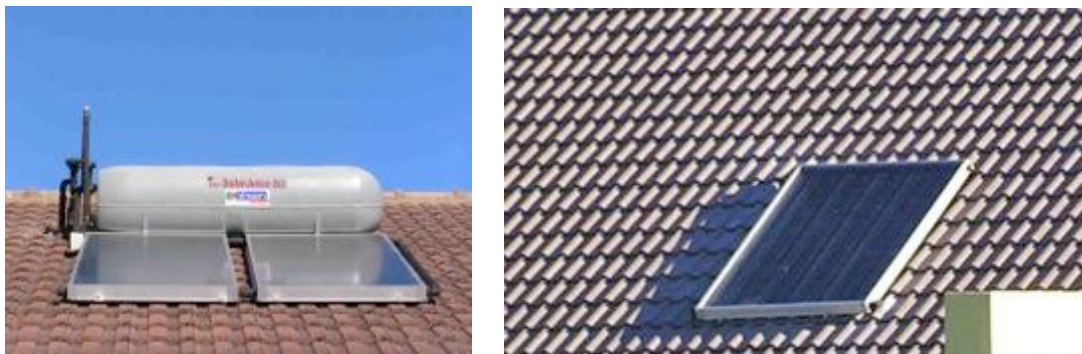


Figure 1: Typical high pressure solar water heaters with flat plate collectors

High-pressure (HP) solar water heaters are the typical technology used by middle to upper income families in residential homes. They consist of a high-pressure water tank, or geyser, and a solar collector. Units included under this definition are the typical HP systems as were defined by the Eskom SWH programme as well other as HP tank and collector combinations for household use.

The solar collector can be flat plate or evacuated tubes, and the transfer of heat to the geyser can be direct or indirect, and circulated by thermosyphon or pumped. The geyser can be installed above the collector outside, or split and installed inside the roof space.

Water is traditionally heated by electric resistance elements in South Africa and the energy to heat hot water typically requires up to 50% of monthly residential electricity spend. South Africa is blessed with abundant sunshine, and switching to a solar water heater can typically save more than 70% of the electricity spend for hot water over a year¹⁸.

A rebate, based on the potential electricity saving that generally amounts to about one third of the capital cost of the installation, has been available through Eskom since 2008 to the end of 2014.

An amendment to the National Building Regulations and Building Standards (SANS10400 Part XA: Energy usage in Buildings) to introduce requirements for energy usage in buildings came into effect on 9 November 2011. This includes the requirement to install a SWH or heat pump in all new buildings for 50% of the water heated¹⁹.

The City of Cape Town as well as eThekweni Municipality have programmes in place to promote the installations of high-pressure solar water heaters. Nelson Mandela Bay Metropole and Ekurhuleni Municipalities had pilot programmes in place where high-pressure solar water heaters could be paid off via the municipal bill. Both these programmes are on hold at present.

The cost for solar water heaters can be added to a home loan and short-term loans are supported by all the large commercial banks^{20 21 22 23}. The insurance industry (the largest procurer of standard geysers in South Africa) supports the switch to solar and actively supports the SWH industry^{24 25 26 27 28}.

¹⁸ <http://solarthermalworld.org/sites/gstec/files/Solar%20Market%20-%20South%20Africa.pdf>

¹⁹ <http://www.buildingregulations.co.za/free-downloads/>

²⁰ http://www.absa.co.za/Absacoza/Offers/Promotions/Solar?cmpid=PSC_BT13101

²¹ http://www.nedbank.co.za/website/content/homeloans_microsite/greening.asp

²² <http://sustainability.standardbank.com/solar-water-heaters/>

The strong government support, coupled with the financial benefits from installation of a solar water heater, has convinced many entrepreneurs on entering the market, significantly growing the supply side²⁹. However, all these measures have not been able to convince households in South Africa to install solar water heaters, and the demand remains low.

The total residential geyser market in South Africa is estimated at 450 000 units per year. In the light of this, it should be clear from Figure 2 and Figure 3 that the high-pressure solar heater market is performing well below its potential. The average solar collector area per residential solar water heater installation is estimated at 4 m²³⁰.

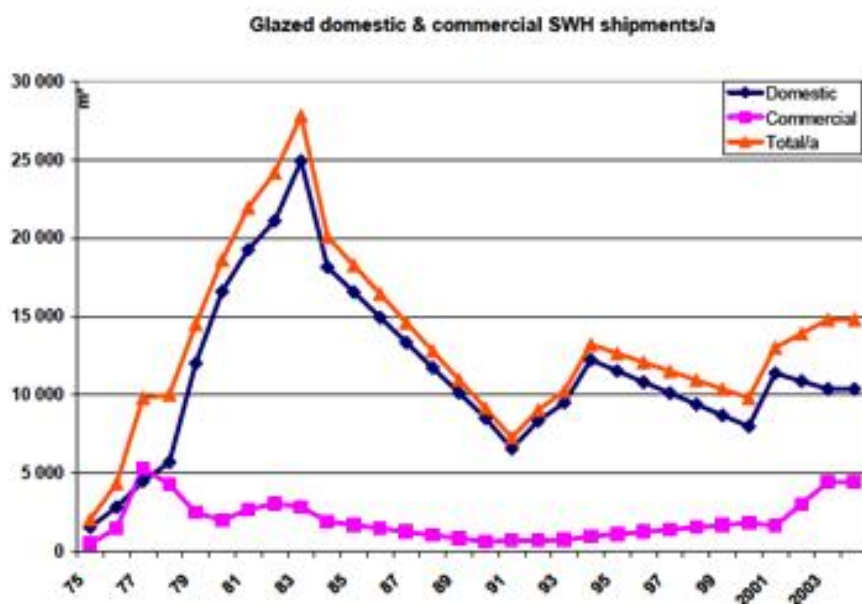


Figure 2: Solar water heater collectors installations in m² per year 1975 - 2005³¹

²³ <https://www.fnb.co.za/home-loans/building-loan.html>

²⁴ <http://sustainability.standardbank.com/solar-water-heaters/>

²⁵ <http://www.nedbankgroup.co.za/sustainEnvironmentFacilitation.asp>

²⁶ <http://www.santam.co.za/about-us/media-centre/sustainability/hot-water-is-going-green-with-santam/>

²⁷ http://www.absa.co.za/Absacoza/Offer/Promotions/Solar?cmpid=PSC_BT13101

²⁸ http://www.thefulcrumgroup.co.za/uploads/files/SAIA_Bulletin_-_May_2014_+114835.pdf

²⁹ <http://green-cape.co.za/assets/Uploads/GreenCape-MIR-Energy-Efficiency.pdf>

³⁰ HOLM, D. 2005. **Market Survey of Solar Water Heating in South Africa**. Energy Development Corporation (EDC) of the Central Energy Fund (CEF). Johannesburg, quoted by <http://solarthermalworld.org/sites/gstec/files/Solar%20Market%20-%20South%20Africa.pdf>

³¹ <http://solarthermalworld.org/sites/gstec/files/Solar%20Market%20-%20South%20Africa.pdf>

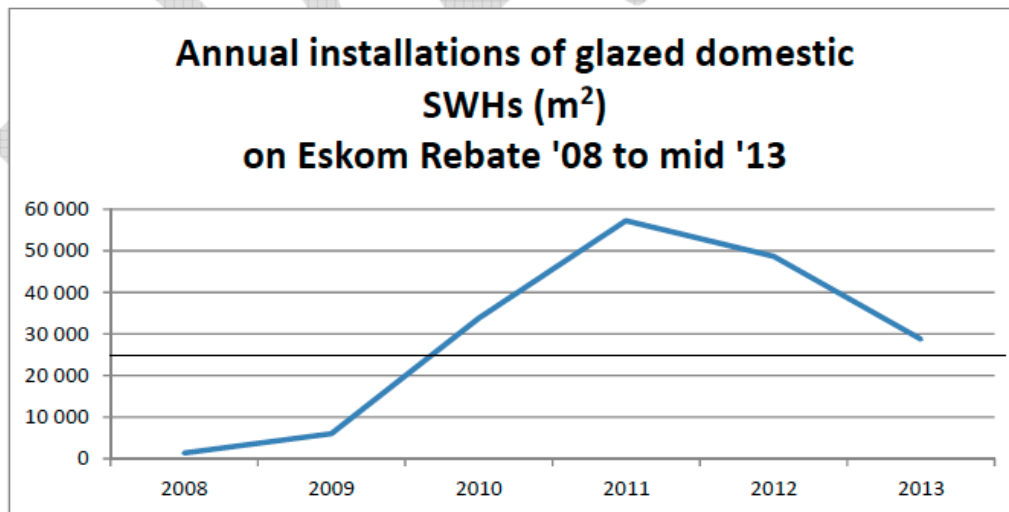


Figure 3: Solar water heater collector installations in m² per year on the Eskom rebate 2008 - 2013³²

Estimated units installed 2014: ~150 000²⁴

Estimated installation area at 4 m² per installation: ~600 000 m²

Estimated total houses with existing geysers in South Africa for 2009 (potential for solar water heaters at 1 geyser per house at 100% penetration) ~4 200 000³³

Target for 2030: ~12 000 000 m² (3 000 000 units)

To grow the installed area to ~12 000 000 m² by 2030, requires a growth rate of 21% per annum on annual installations.

³² <http://green-cape.co.za/assets/Uploads/GreenCape-MIR-Energy-Efficiency.pdf>

³³ http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&ved=0CCMQFjAB&url=http%3A%2F%2Fsessa.org.za.resources.s3.amazonaws.com%2F5WH_DoE_High_Level_%2520Framework_Workshop_5Nov.pdf&ei=2B1rVOz5PMqM7Abtn4GQCQ&usg=AFQjCNHHC6BnDhtYv4aAfyIMKLZSJ4HUg&bvm=bv.76477589,d.ZGU&cad=rja

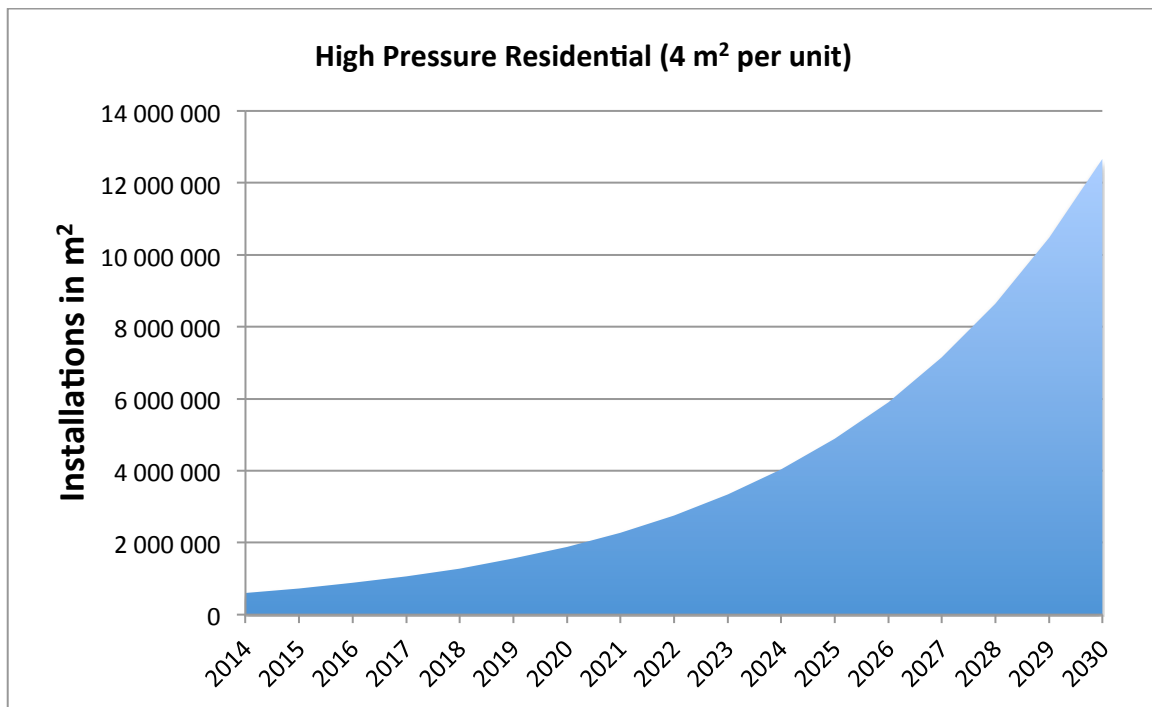


Figure 4: Projected installations for the high pressure system sector based towards the goal to reach 0.5 m² installed collector area per inhabitant by 2030. To reach this, an annual 21% growth rate in installations is necessary

Table 1: Industry and Government roles in support of High Pressure Residential Solar Water Heaters

Awareness and Marketing	
Industry Role	<ul style="list-style-type: none"> Collect and share consumer satisfaction surveys Develop the needs for marketing campaigns Improve the awareness of cost saving of solar Support Government and SESSA awareness campaigns to focus on EE rather than rebates. Research end user perceptions, preferences
Government Role	<ul style="list-style-type: none"> Support industry in awareness and marketing activities Assist and support (financially and through leadership by example) marketing campaigns – Awareness of rebate schemes and other support structures Support and develop installations for demonstration purposes (Compare CSIR campaign of 1970 / 1080 for awareness) Create an awareness of available support for start-up cost (including testing cost) for new entries in the market Develop Government and SESSA awareness campaigns to focus on EE rather than rebates. Research end user perceptions, preferences Demonstration Projects
Research and Development	<ul style="list-style-type: none"> Raise the awareness of research capacity / not just technology, also markets Create awareness of the role of research to assist industry in pricing and improving



	<p>the technology</p> <p>Monitor and feed-back of existing installations</p> <p>Disseminate research results</p>
Institutional Issues	
Industry Role	<p>Insurance sector could take a leading role³⁴</p> <p>Banks need to actively promote loans for SWHs</p> <p>Industry needs to clean up its own act – perception of charlatans. Strong ombudsman function lead by industry (end user does not trust the industry)</p> <p>Create shared back-up pool to cover poor installations</p> <p>Share information on a merged platform</p>
Government Role	<p>Create a clear, transparent, stable and consistent policy environment that is communicated in time with good lead times</p> <p>Continue with the SWH rebate scheme until a sustainable market is established</p> <p>Support the inclusion of component testing^{35 36} Announce changes well in advance</p> <p>Promulgate and enforce regulations for a switch to green hot water at point of geyser failure (to support the insurance industry)</p> <p>Promulgate and enforce regulations for energy efficient water heating at sale of property</p> <p>Support local manufacturing concerns (mainly concerns of the manufacturing industry on the sustainability of the market supported by subsidies)</p> <p>Apply SANS10400 and other relevant legislation consistently at Local Government level</p> <p>Create a link between performance test on components and where the product is installed geographically in an easy to understand outline</p> <p>Share information on a merged platform</p> <p>Support SWH Testing Facilities</p>
Research and Development	<p>Collaborate on a national basis to ensure productive use of resources</p> <p>Define research priorities in consultation with Industry and Government stakeholders</p> <p>Lobby for additional funding to support SWH R&D</p>
Education and Training	
Industry Role	<p>Ensure all installers well trained and certified</p> <p>Ensure proper maintenance</p> <p>Ensure well trained salesperson</p> <p>Industry organisations to develop and enforce accreditation for members (SESSA/PIRB/Builders) and use ombudsman to bring renegades to account</p> <p>Make use of skills development programmes</p>
Government Role	<p>Develop, support and expedite training certification (qcto / saqwa) – hot water installation qualification</p> <p>Develop hands on public education</p> <p>Regulate installer and COC certification</p> <p>Support start-up cost (including testing cost) for new entries in the market</p>

³⁴ http://www.thefulcrumgroup.co.za/uploads/files/SAIA_Bulletin_-_May_2014_+114835.pdf

³⁵ <http://green-cape.co.za/assets/Uploads/energy-efficiency/The-case-for-component-testing-du-plessis-mulcahy.doc>

³⁶ <http://green-cape.co.za/assets/Uploads/energy-efficiency/Component-testing-for-SWH-120912-1.pdf>

Research and Development	Support education and training activities by making expertise and facilities available
Research and Development	
Industry Role	Support initiatives to collect and share installation statistics Develop more efficient and lower cost collectors Reduce manufacturing cost of collectors, tanks and components
Government Role	Take the lead with collection and sharing of installation statistics in IEA SHC format, and incorporate in annual Stats SA reports Fund R&D in this area Enhance regional alignment of manufacturing and installation standards
Research and Development	Conduct appropriate SWH R&D based on the requirements of the STTP

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Roadmap 2: Low Pressure Residential Solar Water Heating



Figure 5: Typical gravity fed / low-pressure solar water heater with evacuated tube collector

Gravity fed solar water heaters, also known as low-pressure solar water heaters, represent the typical technology used for water from solar thermal energy in low cost housing developments in South Africa. The hot water tank is fed via a separate feeder-tank with a ball valve to reduce the high pressure of the water from the municipality, and the hot water flows to the house with the pressure from gravity alone, minus pressure losses of the pipework. These geysers are always installed on the rooftop and most make use of evacuated tubes to collect the solar heat.

The South African government supported the installation of gravity fed solar water heaters with the Division of Revenue Act Allocations (DoRA) from 2009 – 2011, and a rebate from 2011 to December 2012. About 400 000 units (mostly Chinese imports) were installed with these schemes. A Revised Contracting Model has been designed and would have been rolled out in 2014. Due to the sectoral determination from the Department: Trade and Industry, only units deemed to be locally manufactured will be able to qualify for this programme.

Over and above these national initiatives, some local governments also have installed, and are in the process of installing gravity fed solar water units for low-income households. Some examples are Kuyasa, Joe Slovo³⁷ and Lwandle³⁸ in Cape Town, The City of Johannesburg solar water Heating Programme by City Power³⁹, Nelson Mandela Bay Metropole's Zanembula Solar Water heater Pilot Project⁴⁰ and eThekweni's Low Cost Solar Water Heater Programme⁴¹

Low-pressure, gravity-fed solar water heaters can in addition play a role in off grid rural areas, for large and small scale applications, such as residential, game lodges, clinics, mining, staff ablution blocks etc.

Estimated installations 2014: 400 000

³⁷ <http://www.westerncape.gov.za/news/solar-water-heaters-and-partnership-pays-joe-slovo-housing-langa>

³⁸ http://lcs-rnet.org/pdf/lcs_rnet_meetings/2010/ppt_p5_2_3_Thorne_prst.pdf

³⁹ http://www.joburg.org.za/index.php?option=com_content&view=article&id=8304:08102012-launch-of-solar-water-heating-programme-by-city-power&catid=217:press-releases-2013&Itemid=114

⁴⁰ <http://www.nelsonmandelabay.gov.za/Content.aspx?objID=425>

⁴¹ http://www.kznenergy.org.za/download/projects/8_eThekweni_Energy_Office_Project_Briefing_Document_Low_Cost_Solar_Water_Heaters.pdf

Estimated m² of installation area at 1 m² per installation: 400 000 m²

Estimated total houses without geysers in 2009 (potential units at 100% penetration at 1 geyser per house) ~5 300 000⁴²

The South African government has committed to install 600 000 units in the next two years. For the purposes of this roadmap, it is presumed that this commitment of 300 000 units per year will be sustained up to 2030, to produce a total installation number of 5 200 000.

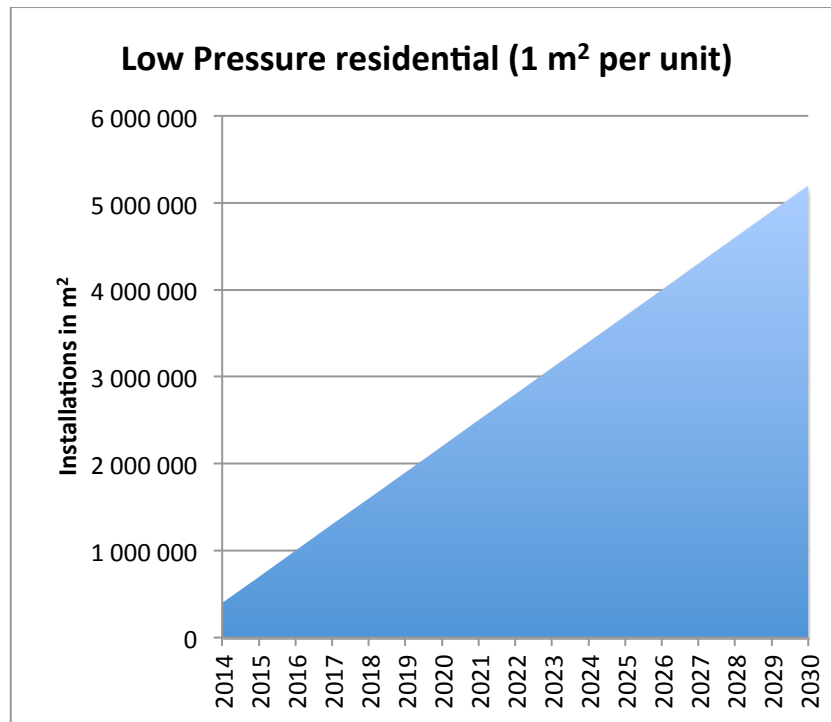


Figure 6: Projected installations for the low pressure system sector based on the goal to reach 0.5 m² installed collector area by inhabitant by 2030.

⁴²http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&ved=0CCMQFjAB&url=http%3A%2F%2Fsessa.org.za.resources.s3.amazonaws.com%2FFSWH_DoE_High_Level_%2520Framework_Workshop_5Nov.pdf&ei=2BIVoz5PMqM7Abtn4GQCQ&usg=AFQjCNHHC6BnDhtYv4aAfyIMKLZSJ4HUG&bvm=bv.76477589,d.ZGU&cad=rja

Table 2: Industry and Government roles in support of Gravity Fed Residential Solar Water heaters

Awareness and Marketing	
Industry Role	<p>Promote low pressure SWHs in low income communities, urban and rural areas</p> <p>Raise the awareness in agricultural and other areas that fall outside of the DoE roll-out programme</p> <p>Raise awareness of life cycle cost of higher quality, more expensive units vs lower cost, lower quality units</p> <p>Create awareness of the positive stories to counteract bad experience/press</p>
Government Role	<p>Promote and subsidise low pressure SWHs in low-income communities</p> <p>Include other communities outside formal settlements in the DoE roll-out programmes</p> <p>Raise awareness of other rebate / subsidy schemes (ie local government schemes) available for low-pressure SWHs</p>
Research and Development	<p>Increase the awareness of the available expertise available to test and develop low-pressure SHW components and systems</p>
Institutional Issues	
Industry Role	<p>Develop manufacturing facilities for low pressure systems, especially collectors</p> <p>Industry needs to clean up its own act – perception of charlatans. Strong ombudsman function lead by industry</p> <p>Ensure good quality systems with strong warranties – ombudsman can play a role</p> <p>Strong industry body to work with financial institutions to come up with a warranty fund (fidelity fund) where % of revenue goes into fund to maintain the installed systems</p>
Government Role	<p>Develop and implement a stable, clear, transparent, stable and consistent policy environment that is communicated in time with good lead times</p> <p>Put measures in place for the roll out of 300 000 units per year on an on-going, sustainable basis</p> <p>Enforce local manufacturing requirements</p> <p>Enforce SA National Building Regulations on all buildings, with penalties for non-compliance</p> <p>Develop clear legal direction on ownership of installed systems, especially concerning maintenance and/or replacement of hail damage etc.</p> <p>Investigate possibility of alternative support schemes (soft loans)</p> <p>Enforce minimum product and installation standards, including warranty</p> <p>Address the current problems with failing, low quality systems installed to date</p> <p>Support the testing of components</p>
Research and Development	<p>Collaborate on a national basis to ensure productive use of resources</p> <p>Define research priorities in consultation with Industry and Government stakeholders</p> <p>Lobby for additional funding to support SWH R&D</p>
Workforce Development (Training and Education)	
Industry Role	<p>Ensure oversight from qualified installers</p> <p>Employ formally trained staff and support the formal training of existing staff</p>
Government Role	<p>Support training and certification of installers</p>
Research and Development	<p>Support training programmes with expertise and facilities</p>
Research and Development	

Industry Role	Develop low cost, low pressure SWHs Research into life cycle cost of higher quality, more expensive units vs lower cost, lower quality units
Government Role	Support the development of low cost, low pressure SWHs that can be locally manufactured Support research into the cost of and impact of past and new subsidy schemes
Research and Development	Conduct appropriate SWH R&D based on the requirements of the STTP

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Roadmap 3: Industrial / Commercial / Multi-Family Residential installations for Solar Heating and Cooling



Figure 7: The world's largest solar thermal installation for industrial application at a copper mine in Chile⁴³



Figure 8: Typical multi family building solar water heater installation, Stellenbosch



⁴³ <http://solarthermalworld.org/content/275-mw-provide-heat-copper-mine-chile>

Figure 9: Installation at student residences, University of Pretoria

In this section of the road map, all solar water heater installations that are of a larger size than for a typical household are combined. These can include installations for multi family homes, flats and dormitories, shopping centres and office blocks as well as industrial installations where solar thermal energy is used for process heat and or cooling.

The large percentage of final energy used in South Africa, coupled with the good solar resource, results in a yet to be exploited potential for larger solar thermal energy systems for industrial and commercial applications. Large SWH installations are also frequently used in multi-family residential units such as apartment blocks, hostels and student residences.

For case studies of large systems installed in South Africa, see <http://www.blackdotenergy.co.za>

Installations for this sector are estimated at 213 installations of ~50 m², giving a total installed area of 10 635 m² for 2014.

If this market is grown at 60% per year on total installed area from this very low base, a total area of 368 935 m² will be installed by 2030.

Estimated installations 2014: 213⁴⁴

Estimated m² of installation area at 50 m² per installation: 10 635 m²

Estimated number of hotels and multi family homes in South Africa ???

Potential for industrial process heat might be determined from boiler statistics, which are at present not available.

If this market is grown with 40% per year on total installations, there will be 48 848 m² of solar collectors installed by 2030.

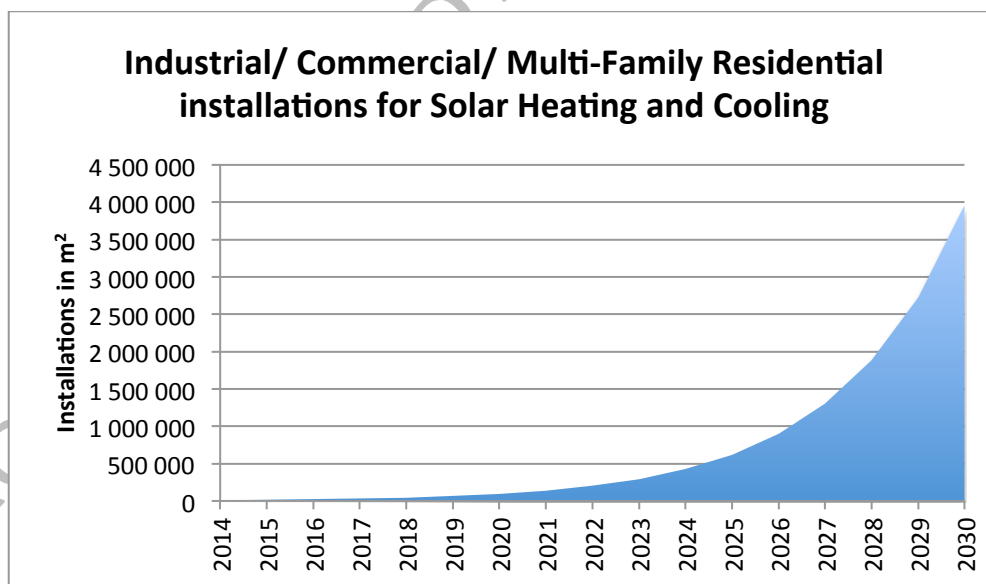


Figure 10: : Projected installations for Industrial / Commercial / Multi-Family Residential installations based on the goal to reach 0.5 m² installed collector area by inhabitant by 2030.

⁴⁴ <http://www.iea-shc.org/data/sites/1/publications/Solar-Heat-Worldwide-2014.pdf>

Table 3: Industry and Government roles in support of large-scale Industrial/Commercial Solar Collectors

Awareness and Marketing	
Industry Role	Develop expertise and products for larger scale SWH applications Promote larger systems to industrial clients
Government Role	Implement rebates or other incentives for large customers as part of a demand side management programme Lead by example Promote the use of SWHs in the industrial and commercial sectors Establish a dedicated subsidy programme for large-scale solar thermal systems. This should include mandatory consulting of experts in the planning phase and also mandatory third party monitoring of the installed systems e.g. by Universities. This way negative examples can be avoided and attractive showcases proving the reliability and financial effectiveness of large SWH systems can be communicated effectively.
Research and Development	Develop and distribute material to promote the application of larger SWH installations Carry out the independent consulting and monitoring programme for the subsidy programme described above.
Institutional Issues	
Industry Role	Insure standard maintenance contracts, and maintenance training Clarify the necessary steps needed to be able to offer solar heat contracting (to overcome amortisation time dilemma). Establish international cooperation with other solar thermal industry associations.
Government Role	Introduce SWH legislation for preheating and industrial/agricultural process heat Certification of components / efficiency curves of collectors / certified collectors Design phase Design to be signed off by a competent person (this is in the EE building regulation) in place Enforcement of EE building regulation
Research and Development	Monitor and publish results of large SWH installations Collaborate on a national basis to promote large-scale SWH R&D Define research priorities in consultation with Industry and Government stakeholders Lobby for additional funding to support large-scale ST R&D Establish international cooperation with research institutions working on large-scale ST systems
Education and Training	
Industry Role	Employ or consult trained engineers and technicians to design, install and maintain larger systems
Government Role	Support training programmes at the tertiary level of engineers and technicians qualified to design and install large SWH systems Support the training of building control officers to evaluate the current and future specificantions NHBRC building contractors
Research and Development	Develop training programmes for engineers and technicians that can design and install large SWH systems

	Support training and education of engineers and technicians with expertise and facilities
Research and Development	
Industry Role	Develop products and components for local manufacture Support the development of in-house and external expertise to design and implement large SWH systems
Government Role	Support the R&D of local components for the industry
Research and Development	Conduct appropriate SWH R&D based on the requirements of the STTP for large-scale SWH systems Develop low-cost monitoring systems to effectively assess the performance of installed large-scale ST systems

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Roadmap 4: Unglazed Swimming Pool Solar Water Heaters



Figure 11: Typical rooftop installation of an unglazed swimming pool heater in South Africa

The market for unglazed swimming pool heaters is showing strong growth in South Africa, without any government support or interventions. These heaters consist of an array of thin plastic tubes, usually installed on a roof or any other suitable flat surface. When the pool pump circulates the water through the filtration systems, the water is also circulated through the collector and heats up at high efficiencies because of the small temperature rise required.

Estimated installations 2014: 4 335⁴⁵

Estimated m² of installation area at 20 m² per installation: 86 700 m²

The number of swimming pools in South Africa is estimated at 800 000⁴⁶

If this market is grown with 35% per year on total installations, there will be 527 630 installations, or 10 522 598 m² of solar collectors installed by 2030, which represents 65% of the current number of swimming pools in South Africa.

⁴⁵ <http://www.iea-shc.org/data/sites/1/publications/Solar-Heat-Worldwide-2014.pdf>

⁴⁶ http://active.cput.ac.za/energy/past_papers/DUE/2008/PPT/DUE%20Conference%20-%20Workshops/Swimming%20Pools/R%20Hill.pdf

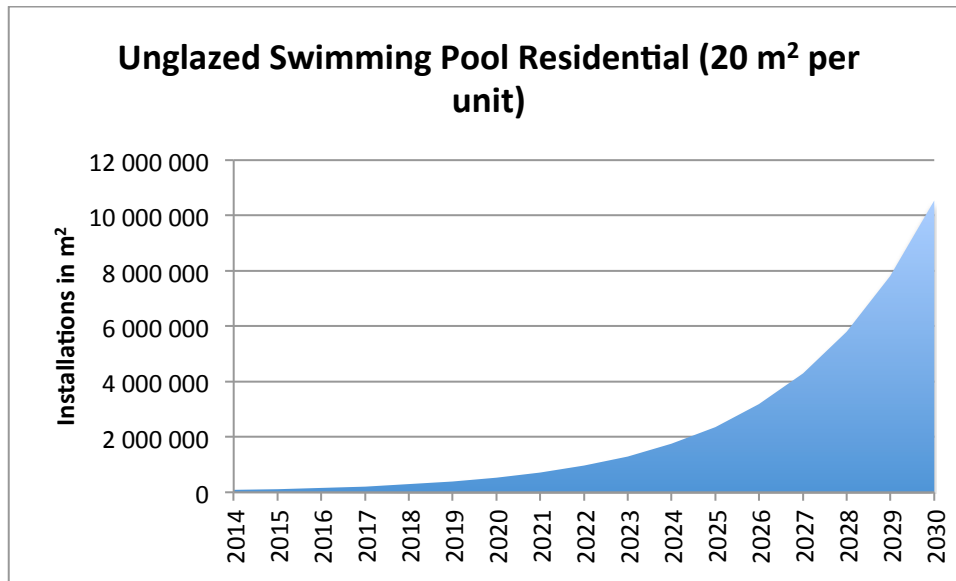


Figure 12: Projected installations for unglazed solar collectors for swimming pool applications based on the goal to reach 0.5 m² installed collector area by inhabitant by 2030.

Table 4: Industry and Government roles in support of Unglazed Swimming Pool Solar Water Heaters

Awareness and Marketing	
Industry Role	Promote unglazed collectors for swimming pools
Government Role	Promote unglazed collectors for swimming pools
Research and Development	Conduct measurements and publish the results to quantify the benefit of unglazed SWHs
Institutional Issues	
Industry Role	Develop suitable unglazed SWH systems for SA conditions
Government Role	Replace non-solar water heaters with solar on all government installations, public swimming pools
Research and Development	Participate in collaborative research and measurement projects, specifically with industry
Workforce Development	
Industry Role	Train installers of unglazed systems
Government Role	Support development of formal training programmes of installers
Research and Development	Support training activities with expertise and facilities
Research and Development	
Industry Role	Support the development of lower cost collectors
Government Role	Support the development of lower cost, locally manufactured collectors
Research and Development	Conduct appropriate SWH R&D based on the requirements of the STTP

Roadmap 5: Passive Solar Thermal (PST) heating /cooling of buildings

Solar passive design is the art and science of using the natural forces of a given climate and a building’s orientation, size, disposition and management of its elements in order to achieve indoor comfort, while using a minimum of imported energies. Energies flow naturally while the building is in a passive mode – hence passive design.

Solar thermal buildings outlast the life cycle of power stations, and can be built faster and more cost-effectively. These buildings constitute solar collectors with built-in energy storage facilities.

Solar passive or solar thermal (PST) design pertains to *inter alia* orientation, window placement, operable windows, thermal mass, insulation and solar chimneys. While ST design can be quite demanding and sophisticated, the building systems are typically simple, demanding minimal maintenance. Solar thermal design also reduces the energy demand of HVAC buildings.

Buildings in the Developing and Developed World consume 40% of the primary energy, while emitting 36% of GHGs (UN University for Advanced Study of Sustainability, 2015. **Sustainable Urban Futures**). The main driver for energy use in buildings is the lack of indoor comfort. Efforts to address this lack of comfort include artificial lighting, artificial heating/cooling, (de)humidification, and fresh air supply. Artificial lighting tends to increase the amount of excess indoor heat generation, as does the increasing use of electric appliances that eject their waste heat into the indoor environment.

In South Africa, heating and cooling accounts for 38.5% of the total final energy consumed in buildings (DAH 2007). In all new buildings, this percentage has to be reduced gradually to near zero by the year 2030: ..."Progressively strengthen the energy efficiency criteria set out in the South African National Standard 204 to achieve a zero carbon building standard by 2030..." (NDP, p. 288, Ch. 8 - Transforming Human Settlements). The assumption is that the existing building stock will be upgraded at a rate of 9% per year (R Milford 2009. **Greenhouse Gas Emission Baseline and Reduction Potential from Buildings in South Africa**. UNEP SBCI, Paris).

The combined annual savings of *new* PST buildings plus upgrading of the *existing* stock has been illustrated in **Figure 13**.

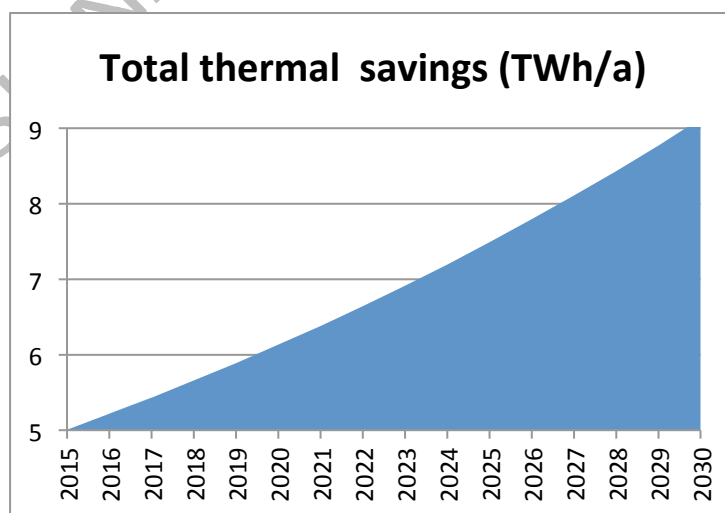


Figure 13: Annual savings through solar thermal heating/cooling of new and retrofit buildings in South Africa in TWh/annum

The above savings can be translated into equivalent SWH collector areas as follows:

Assuming an average global radiation of $1900\text{kWh/m}^2\cdot\text{a}$ in South Africa, this translates to an average energy harvest of $1900\text{kWh/m}^2\cdot\text{a} \times 0,44 = \pm 800\text{kWh/m}^2\cdot\text{a}$. Hence, one TWh is equivalent to $1\,250\,000\text{m}^2$ of SWH. The resultant SWH equivalent area of the annual savings through solar thermal buildings is shown in **Figure 14**.

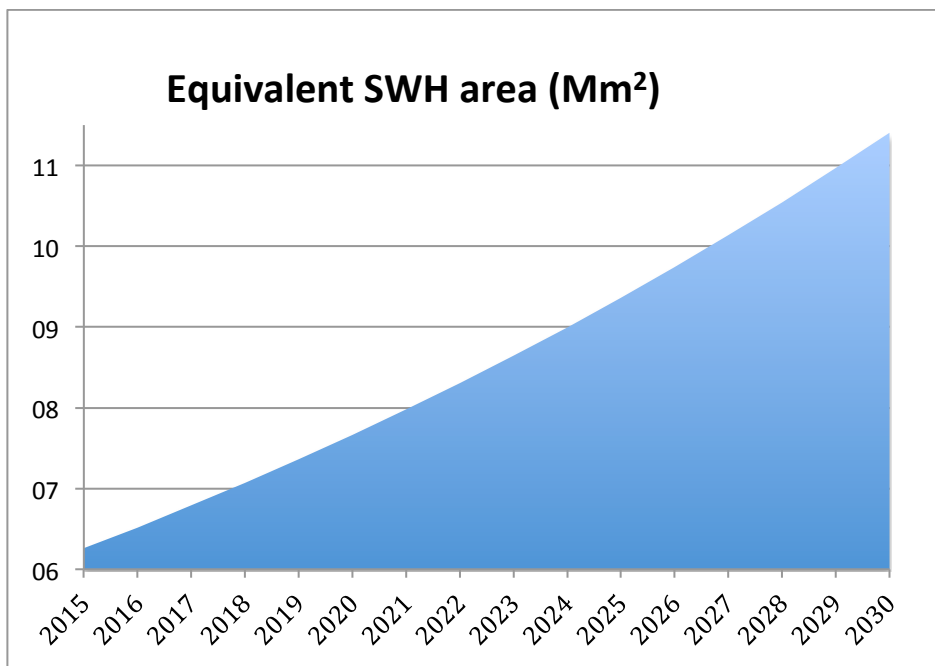


Figure 14: Equivalent SWH area of solar thermal heating/cooling of new and retrofit buildings in South Africa in Million m²

It should be noted that solar thermal buildings include at least one day's integral thermal storage as a result of the prescribed interior thermal mass (SANS10400XA).

The above calculation does not include the energy content of manufacturing, transporting and demolishing building materials and components.

Table 5: Industry, Research and Government roles in support of Passive Solar Thermal (PST) Design in Buildings

Awareness and Marketing	
Industry Role	Lack of awareness and information is a key barrier: overcome by programs promoting passive solar thermal (PST) efficiency in buildings. Champion the NDP target of Near Zero Energy Buildings incorporating PST by 2030. Demand leadership by example in solar thermal government buildings from all tiers of government Advertise the fact that higher levels of energy efficiency in buildings result in increased economic production for the same amount of energy. Make architects, contractors and vendors aware of possible (potential) funding opportunities for PST design (informed customer) Include orientation, local site environment (model local climatic data, impacts of

	overshadowing and physical obstruction to predict solar gain annually) and natural lighting (climate-based daylight modelling) in all new house/building plan design prior to building.
Government Role	<p>Lead by example in implementing/upgrading passive solar thermal improvements to government buildings from all tiers of government. Implement program for all government buildings to be near zero energy at least two years ahead of the private sector.</p> <p>Prioritise PST buildings as part of the NDP.</p> <p>Monitor and publish ST buildings progress in Stats SA.</p> <p>Provide solar access rights by providing restrictions on vegetation, structures and objects that could impair passage of light or air flow.</p> <p>Feed in tariffs to guarantee prices for developers when implementing PST designs in new building based on future health and environmental benefits.</p>
Research and Development	<p>Develop and implement passive PST building design curricula at tertiary institutions.</p> <p>Develop and support regional and sub-regional centres of excellence of passive PST building design and implementation.</p> <p>Monitor and publish existing buildings' energy performance.</p> <p>Update SANS10400XA annually.</p>
Institutional Issues	
Industry Role	<p>Create multidisciplinary PST building forum.</p> <p>Provide consumers with a home (current and building plan) energy rating using certified energy raters.</p> <p>Report energy rating, estimate of annual energy use and cost, recommended improvements, their costs, potential savings and expected payback time for building improvements (consumer pays for service but cost included in loan)</p>
Government Role	<p>Invoke SANS10400XA rigorously at municipality level and prosecute non-compliance.</p> <p>Implement appliance and building energy rating as a priority.</p> <p>Package of interventions in standard 30m² RDP house: ceiling, roof insulation, window size and partitions (short payback); residential and commercial building codes can require higher efficiency standards in middle – and upper income houses and commercial buildings (regulation rather than subsidy);</p> <p>Local government finance efficiency measures and recoup the outlay by structuring tariffs to include the saved energy costs as repayments.</p> <p>Financial incentives rather than regulation (tax credits) for passive design upgrades</p> <p>Provide consumer loans at lower interest PST improvements.</p>
Research and Development	Study applicability of international ST building success stories and feed back to national building regulations.
Workforce Development	
Industry Role	<p>Obtain feedback from developers and other stakeholders.</p> <p>Promote Green Building Council work.</p> <p>Participate in Eskom Eta Award Competitions.</p> <p>Potential for job creation in passive design and construction.</p> <p>Train more energy raters.</p>
Government Role	<p>Train building inspectors and designers in PST aspects in the national building regulations.</p> <p>Develop courses in ST building design.</p>

	Provide loans in the range of 10 to 20 per cent of incremental capital required for PST improvements or upgrades would likely be enough to tip balance in favour of energy efficiency investments and job creation opportunities in PST.
Research and Development	Develop and promote methodologies to upgrade the existing building stock in South Africa, including finance models.
Research and Development	
Industry Role	Financial institutions and government to create a low-interest fund for PST buildings in South Africa. Move beyond pilot project research, scale up demonstration projects
Government Role	Target new and existing energy intensive government buildings for priority ST interventions. Develop and implement solar access legislation to protect investment in ST facilities. Cooperate regionally on PST developments. Provide standards, incentives and recovery of PST program costs. Use all PST technologies without selecting a winner. Build/create long term foundation for passive solar research in RSA
Research and Development	Increase PST research budget to 4% of total investment of buildings in South Africa.

*Authors of Roadmap 5: Dieter Holm and Contributors: Frank Raymondo (green home owner) Keith (Energy expert), Malcolm Worby (green architect), Jean Simonis (Hydrologist) and energy experts from Specialised Solar Systems

3. Combined roadmap and way forward

Table 6: Total installations of solar collectors in m², 2014 – 2030

	High Pressure Residential systems (4 m ² per unit) [m ²]	Gravity Fed residential systems (1 m ² per unit) [m ²]	Industrial/ Commercial/ Multi-Family Residential installations for Solar Heating and Cooling [m ²]	Unglazed Swimming Pool Collectors (20 m ² per unit) [m ²]	Passive Solar Thermal (PST) heating /cooling of buildings [m ² equivalent]	TOTAL (excluding PST) [m ²]
2014	600 000	400 000	10365	86 700	-	1 099 079
2015	726 000	700 000	15029	117 045	6 300 000	1 560 089
2016	878 460	1 000 000	21792	158 011	6 552 000	2 060 279
2017	1 062 937	1 300 000	31599	213 315	6 814 080	2 609 867
2018	1 286 153	1 600 000	45819	287 975	7 086 643	3 221 964
2019	1 556 245	1 900 000	66437	388 766	7 370 109	3 913 467
2020	1 883 057	2 200 000	96333	524 834	7 664 913	4 706 244
2021	2 278 499	2 500 000	139684	708 525	7 971 510	5 628 729
2022	2 756 984	2 800 000	202541	956 509	8 290 370	6 718 056
2023	3 335 950	3 100 000	293685	1 291 288	8 621 985	8 022 946
2024	4 036 500	3 400 000	425843	1 743 238	8 966 864	9 607 605
2025	4 884 165	3 700 000	617472	2 353 372	9 325 539	11 557 034
2026	5 909 840	4 000 000	895335	3 177 052	9 698 561	13 984 252
2027	7 150 906	4 300 000	1298235	4 289 020	10 086 503	17 040 188
2028	8 652 596	4 600 000	1882441	5 790 177	10 489 963	20 927 242
2029	10 469 641	4 900 000	2729539	7 816 739	10 909 562	25 917 949
2030	12 668 266	5 200 000	3957832	10 552 598	11 345 944	32 380 726

The total installed collector area of ~30 million m² is related to an installed capacity of 21 GW_{th}.

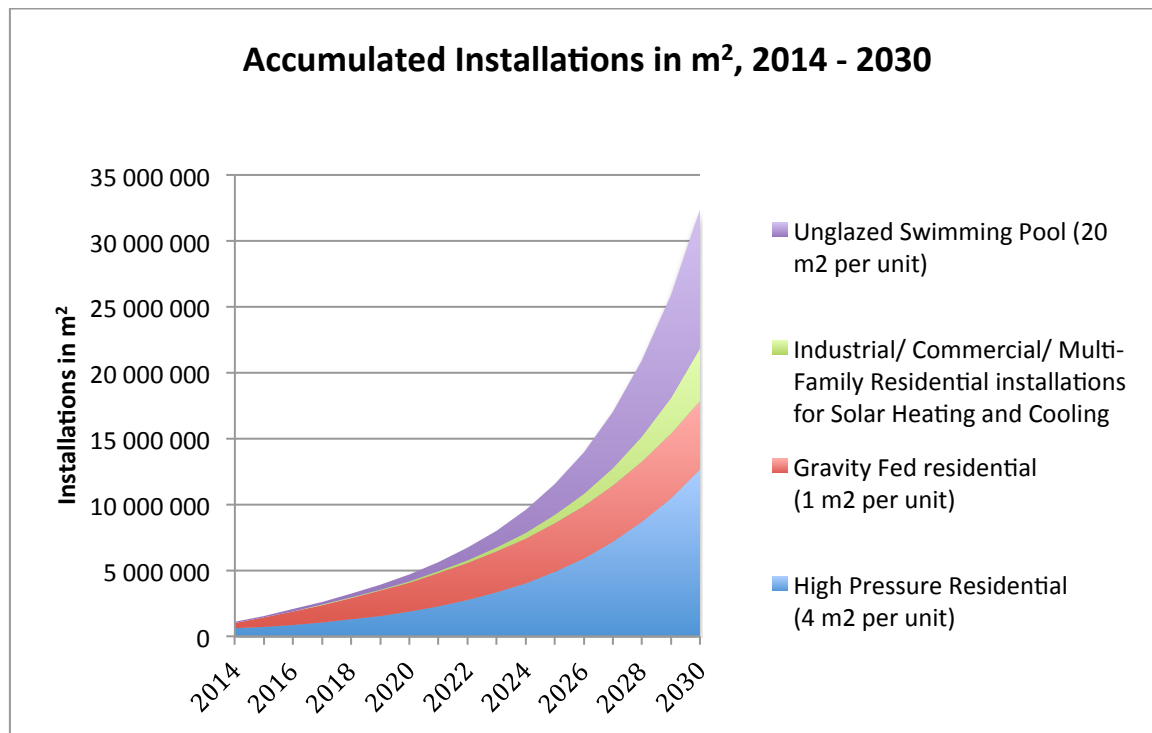


Figure 15: Projected total solar thermal collector installations based on the goal to reach 0.5 m² installed collector area by inhabitant by 2030 Development 2014 – 2030

If the Roadmap goal of installing ½ m² collector area (30 million m²) in the different applications is reached by 2030, South Africa would save annually 34,000 GWh electricity and would avoid 23 million tons of CO₂. The following figure shows how the different applications would contribute to this overall savings.

If the saving from Passive Solar Thermal is included, the saving in electricity as well as the carbon saving is even higher.

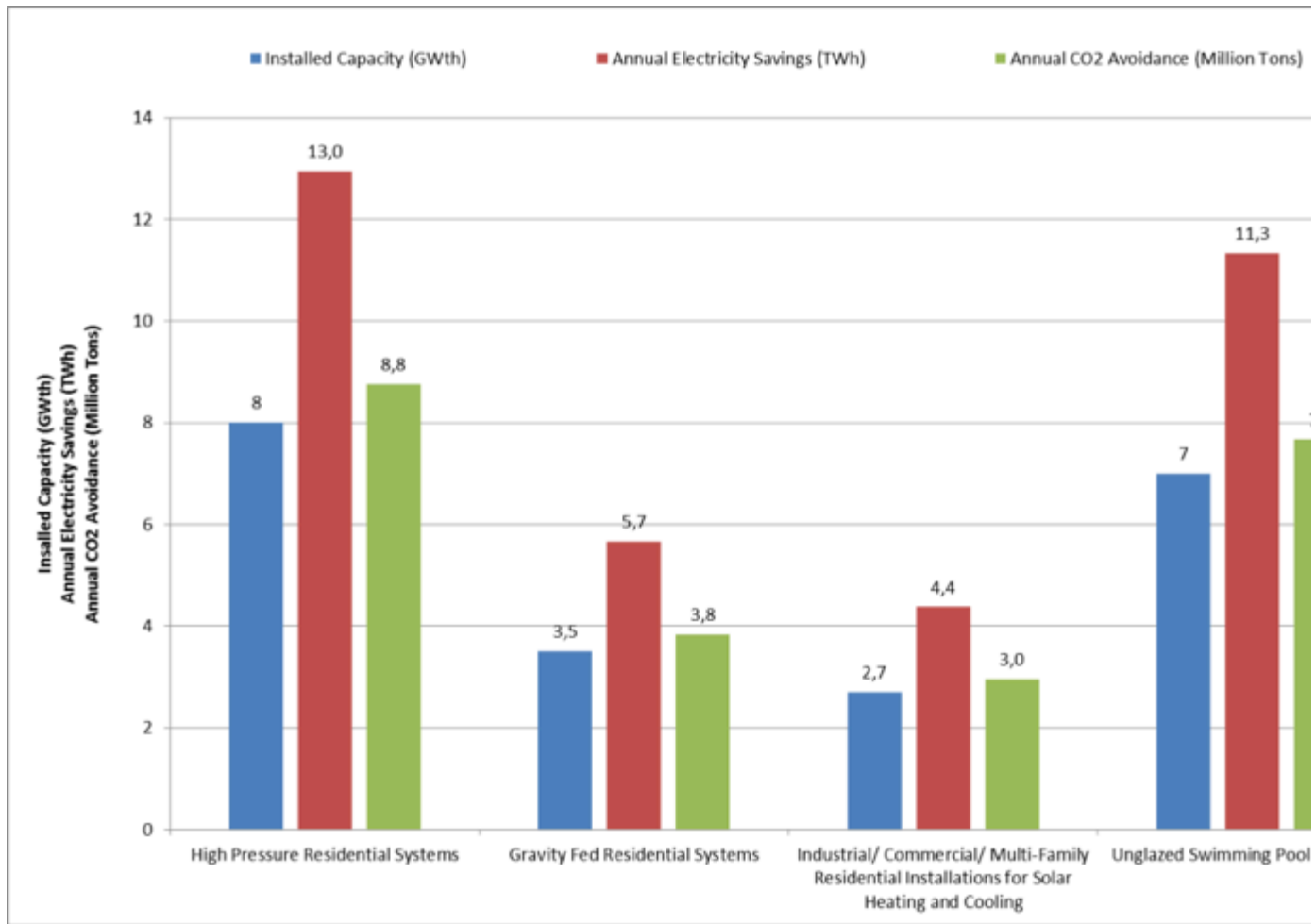


Figure 16: Installed capacity, annual electricity savings as well as avoided CO2 emissions based on the assumption that the Roadmap goals are reached by 2030.

PROVISIONAL NO



Figure 17: Participants at the STRM workshop on 27 November in Cape Town

Appendix 1: Interested Parties

ABSA	Hisun Solar	South African Insurance Association (SAIA)
Advocate Neville Melville, Consumers Ombudsman	Hollard	South African Institute of Architects (SAIA)
AEE-Intec	Holms and Friends	South African Local Government Association (SALGA)
AGS Solar	ICLEI Africa	SANEA
Blackdot Energy	iLanga Heat	Sanedi
Cape Chamber of Commerce	Ikhwezi Solar	Santam
Central Energy Fund Group of Companies (CEF)	Innovation Group	SESSA
City of Cape Town	Investec	Solac
City Power	Institute of Plumbing South Africa (IOPSA)	Solahart
Cape Peninsula University of Technology	Kayema	Solar Heat Exchangers
City of Cape Town	Kwikot	Solarbeam
Crest Africa	Lion of Africa	Soldardome
Centre for Renewable and Sustainable Energy Studies (CRSES)	Masters Artisans Academy	Solar Juice
CSIR	Master Builders Association	Solar IQ
Department: Energy (DE)	MTech	Solarmax
Department: Science and Technology	National Solar	Solar Primeg
Duratherm	National Business Initiative (NBI)	SOLTRAIN
Department: Trade and Industry (DTI)	Nedbank	Standard Bank
E3	Nelson Mandela Metropolitan University (NMMU)	Stellenbosch University
Enervision	National Regulator for Compulsory Specifications (NRCS)	Suntank
Energy Research Centre (ERC)	North-West University (NWU)	SWH-Mancosa
Eskom	Outsurance	Tasol
eThekweni Energy Office	PowerzOn	Tecron
Euroheat	Plumbing Industry Regulation Board (PIRB)	The Copper Alliance
First National Bank (FNB)	Renaissance Solar	Tshwane University of Technology (TUT)
FOGI	South African Consumer Union (SANCU) Clif Johnston	University of Cape Town (UCT)
Franke	South African Property Owners Association (SAPOA)	University of Johannesburg (UJ)
Frost And Sullivan	South African Bureau of Standards (SABS)	University of Pretoria (UP)
Geyserwise		Urban Earth
Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)		Watersmith
GreenCape		Western Cape Government (WCG)
		WWF
		Xstream Geysers

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Appendix 2: Data from IEA SHC reports “Solar Heat Worldwide 2005 – 2014”

To convert from MW_{th} to m², divide th MW_{th} by 0.7

Table 7: Total capacity in operation by the end of 2012 [MW_{th}]

Country	Water Collectors			Air Collectors		TOTAL [MW _{th}]
	unglazed	FPC	ETC	unglazed	glazed	
Albania		77,8	0,6			78,3
Australia	3.045,0	2.035,6	47,6	196,0	5,0	5.329,2
Austria	391,0	3.002,7	55,7		1,3	3.450,8
Barbados*		92,2				92,2
Belgium	31,5	230,6	38,5			300,7
Brazil	1.620,3	4.163,1				5.783,4
Bulgaria		84,0	1,4			85,5
Canada	544,7	43,0	25,0	244,8	16,9	874,4
Chile***		56,0				56,0
China		12.177,7	168.212,3			180.390,0
Croatia#		84,0				84,0
Cyprus	1,5	605,7	16,2			623,4
Czech Republic	327,6	235,1	61,5			624,2
Denmark	14,4	444,0	6,0	2,3	12,6	479,3
Estonia		2,8	1,8			4,6
Finland	8,2	21,2	4,5			34,0
France (mainland) +	74,0	1.623,3	29,5	3,5	0,8	1.731,1
Germany	409,9	10.095,4	1.282,4		21,5	11.809,2
Greece		2.872,9	12,5			2.885,4
Hungary	9,5	118,1	35,8	1,3	1,0	165,6
India		3.521,7	994,0		14,1	4.529,8
Ireland		129,2	61,2			190,4
Israel	22,3	2.901,5		0,4		2.924,2
Italy	30,6	2.048,6	333,5			2.412,7
Japan		3.064,8	58,3		352,1	3.475,2
Jordan***	4,2	611,4	171,3			786,8
Korea, South		1.179,4				1.179,4
Latvia		2,0	0,8			2,8
Lebanon***		163,8	204,4			368,2
Lithuania		2,3	1,9			4,2
Luxembourg		24,5	3,3			27,9
Macedonia*		17,5	0,5			18,0
Malta		25,2	8,6			33,8
Mexico	582,1	610,6	228,2	0,2	5,6	1.426,7
Morocco***		343,9				343,9
Mozambique		0,2				0,2
Namibia**		14,5	0,9			15,4
Netherlands	293,1	300,2	11,9			605,2
New Zealand*	4,9	100,1	6,8			111,8
Norway	1,4	22,0	1,9		2,1	27,4
Poland		641,6	206,5			848,1
Portugal	1,5	661,9	15,5			678,9
Romania		56,5	21,0			77,5
Russia#		12,3	0,9			13,2
Slovakia		88,1	14,8			102,9
Slovenia		117,3	13,5			130,8
South Africa	606,8	266,7	80,9			954,5
Spain	93,9	1.862,9	117,2			2.074,0

Sweden	91,0	182,0	42,0			315,0
Switzerland	148,1	686,7	51,1	613,3		1.499,2
Taiwan	1,6	927,1	75,3			1.003,9
Thailand		84,3				84,3
Tunisia		415,1	32,3			447,5
Turkey		9.580,2	1.268,4			10.848,5
United Kingdom		376,6	120,2	13,3		510,1
United States	14.311,4	1.853,3	82,1	66,7	14,0	16.327,4
Uruguay**		8,8				8,8
Zimbabwe		13,1	0,6			13,7
TOTAL	22.670	70.983	174.061	1.142	447	269.303

Note: If no data is given: no reliable database for this collector type is available.

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Table 8: New installed capacity in 2012 [MW_{th}/a]

Country	Water Collectors			Air Collectors		TOTAL [MW _{th}]
	unglazed	FPC	ETC	unglazed	glazed	
Albania		14,7	0,1			14,8
Australia	455,0	167,6	21,3	24,5	0,7	669,1
Austria	1,7	140,6	3,9		0,6	146,7
Belgium		35,4	8,1			43,4
Brazil	367,9	438,1				806,0
Bulgaria		5,2	0,4			5,6
Canada	50,1	4,6	5,5	11,1	8,7	79,8
Chile*		15,3				15,3
China		3.500,0	41.230,0			44.730,0
Croatia #		9,6				9,6
Cyprus	0,0	14,5	1,0			15,5
Czech Republic	35,0	25,9	9,1			70,0
Denmark		78,8	0,4			79,1
Estonia		0,6	0,6			1,3
Finland		2,1	0,7			2,8
France mainland +		168,5	6,1	3,2	0,7	178,5
Germany		725,2	79,8			805,0
Greece		169,1	1,1			170,1
Hungary	1,1	24,5	10,5	0,2	0,2	36,4
India		374,5	640,5		5,6	1.020,6
Ireland		13,0	5,7			18,7
Israel	0,8	217,4				218,2
Italy		198,7	32,3			231,0
Japan		111,1	2,2		5,6	118,9
Jordan*		38,2	9,6			47,8
Korea, South		44,6				44,6
Latvia		0,1	0,1			0,2
Lebanon*		30,8	15,4			46,2
Lithuania		0,4	0,8			1,3
Luxembourg		2,3	0,6			2,9
Malta		1,0	0,4			1,4
Mexico	76,7	66,7	66,7			210,0
Morocco*		55,0				55,0
Mozambique			0,1			0,1
Netherlands	19,2	19,6	5,6			44,4
Norway		10,7	0,6		1,4	12,6
Poland		151,2	60,2			211,4
Portugal	0,1	58,5	5,0			63,6
Romania		6,0	4,9			10,9
Russia #		4,3	0,2			4,5
Slovakia		4,6	0,7			5,3
Slovenia		9,5	2,1			11,6
South Africa	34,3	15,5	35,2			85,1
Spain	2,5	147,7	8,8			159,1
Sweden	0,6	5,8	2,1			8,5
Switzerland	8,3	87,9	12,1			108,3
Taiwan	0,0	74,0	8,3			82,3
Thailand		15,9				15,9
Tunisia		52,0	1,5			53,5
Turkey		802,4	334,6			1.137,0
United Kingdom		33,5	8,0	3,5		45,0
United States	530,2	160,8	8,4	10,5	9,8	719,7
Zimbabwe		0,6	0,4			1,0
TOTAL	1.583,4	8.354,1	42.651,7	52,9	33,2	52.675,3

Note: If no data is given: no reliable database for this collector type is available.

Table 9: Newly installed capacity in 2011 [MW_{th}/a]

Country	Water Collectors			Air Collectors		TOTAL [MW _{th}]
	unglazed	FPC	ETC	unglazed	glazed	
Albania		9.0	0.1			9.1
Australia	420.0	240.8	15.6	25.2	0.6	702.2
Austria	4.0	155.1	6.1		0.2	165.4
Belgium		24.9	7.0			31.9
Brazil	358.5	362.3				720.7
Bulgaria		7.0	0.6			7.6
Canada	52.1	5.5	6.7	19.9	5.0	89.2
Chile		7.6				7.6
China		2,016.0	38,304.0			40,320.0
Cyprus	0.1	18.8	1.2			20.0
Czech Republic	45.5	34.4	11.7			91.6
Denmark		43.3	0.4			43.7
Estonia		0.6	0.6			1.3
Finland		2.1	0.7			2.8
France (mainland)		169.5	6.2	0.4	0.1	176.2
Germany		806.4	82.6	0.3		889.3
Greece		161.0				161.0
Hungary	1.1	9.8	4.2	0.2	0.2	15.4
India		707.0				707.0
Ireland		8.8	5.8			14.5
Israel	1.8	259.7				261.4
Italy		237.5	35.5			273.0
Japan		108.7	1.3		7.5	117.5
Jordan		38.2	9.6			47.8
Korea, South		38.3				38.3
Latvia		0.7	0.6			1.3
Lebanon		28.0	14.0			42.0
Lithuania		0.4	0.8			1.3
Luxembourg		2.5	0.7			3.2
Malta		1.6	0.3			2.0
Mexico		66.5	59.5	0.2		126.2
Mozambique			0.1			0.1
Netherlands	19.2	22.0	3.5			44.7
Poland		131.2	46.4			177.6
Portugal	0.2	88.4	0.5	0.1		89.2
Romania		6.0	4.9			10.9
Slovakia		13.5	2.6			16.1
Slovenia		6.3	2.1			8.4
South Africa	33.7	30.0	27.5			91.2
Spain	6.0	174.8	12.1	1.1		193.9
Sweden	15.8	11.0	3.6			30.4
Switzerland	6.3	90.4	6.1	6.3		109.1
Taiwan		70.3	7.7			78.0
Tunisia		45.0	5.6			50.6
Turkey		910.8	353.2	1.1		1,265.1
United Kingdom		51.1	13.2	3.9		68.2
United States	523.5	125.9	8.0	10.9	4.2	672.5
Zimbabwe		0.2	0.2			0.4
TOTAL	1,487.8	7,348.6	39,072.7	69.5	17.9	47,996.5

Table 10: Newly installed capacity in 2010 [MW_{th}/a]

Country	Water Collectors**			Air Collectors**		TOTAL [MW _{th}]
	unglazed	FPC	ETC	unglazed	glazed	
Albania		5.2	0.1			5.3
Australia	476.0	253.6	25.1			754.7
Austria	3.9	187.7	8.3	0.2		200.1
Belgium		21.9	4.9			26.8
Brazil	345.6	331.1				676.7
Bulgaria		5.4	0.5			5.9
Canada	59.3	8.0	8.0	62.7	1.6	139.6
Chile		5.6				5.6
China		2,100.0	32,200.0			34,300.0
Cyprus	0.1	23.1	1.2			24.4
Czech Republic	37.1	51.7	12.4			101.2
Denmark		43.4	0.3			43.6
Estonia		0.1	0.3			0.4
Finland		2.8	1.4			4.2
France		221.9	6.3			228.2
Germany		724.5	80.5			805.0
Greece		148.8	1.1			149.8
Hungary	1.7	10.3	4.4	0.2	0.1	16.7
India		425.9	196.3			622.2
Ireland		12.2	9.2			21.4
Israel		221.2				221.2
Italy		299.3	43.8			343.0
Japan		102.8	3.4		8.3	114.5
Jordan	4.2	55.7	8.9			68.8
Korea, South		48.9				48.9
Latvia		0.1	0.1			0.1
Lithuania		0.0	0.1			0.1
Luxembourg		2.5	0.7			3.2
Malta		1.2	0.8			2.0
Mexico	63.0	66.5	59.5		1.8	190.8
Morocco*		48.5				48.5
Namibia		3.8	0.6			4.4
Netherlands	18.6	32.1	2.8			53.5
Norway	0.1	1.5	0.6			2.2
Poland		77.7	24.5			102.2
Portugal	0.2	130.9	0.2			131.4
Romania		6.0	4.9			10.9
Slovakia		9.0	1.5			10.5
Slovenia		10.5	2.8			13.3
South Africa	35.0	29.6	5.4			70.0
Spain	7.7	220.9	15.1			243.6
Sweden	12.0	9.5	5.0			26.5
Switzerland	8.4	90.3	11.0	5.6		115.3
Taiwan	0.0	81.2	8.3			89.4
Tunisia		50.5	8.8			59.3
Turkey		1,160.6				1,160.6
United Kingdom		52.9	20.7			73.6
United States	656.5	157.8				814.3
Zimbabwe		0.3	0.1			0.4
TOTAL	1,729.3	7,554.7	32,789.4	68.7	11.8	42,154.0

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Table 11: Newly installed capacity in 2009 [MW_{th}/a]

Country	Water Collectors*			Air Collectors*		TOTAL [MW _{th} /a]
	unglazed	glazed	evacuated tube	unglazed	glazed	
Albania		7.0	0.1			7.1
Australia	434.0	338.1	25.4			797.6
Austria	5.8	243.9	5.4	0.3		255.4
Barbados		4.9				4.9
Belgium		31.9	3.6			35.5
Brazil	284.9	273.8				558.7
Bulgaria		5.6				5.6
Canada	51.1	6.4	0.8	31.7	0.6	90.6
Chile		6.3				6.3
China		1,400.0	28,000.0			29,400.0
Cyprus		37.1	1.4			38.5
Czech Republic		21.0	7.0			28.0
Denmark		36.4	1.8			38.2
Estonia		0.04	0.3			0.3
Finland		2.0	0.8			2.8
France		185.5				185.5
Germany		1,001.0	129.5			1,130.5
Greece		143.2	1.1			144.2
Hungary	2.1	9.8	5.6	0.4	0.14	18.0
India		365.8	19.3			385.0
Ireland		18.5	11.3			29.8
Israel**	2.0	186.5				188.5
Italy	4.9	283.8	47.3			336.0
Japan		97.9	1.2		8.5	107.5
Jordan		21.3	6.4			27.7
Korea, South**		48.1				48.1
Latvia		0.03	0.10			0.1
Lithuania		0.04	0.11			0.1
Luxembourg		2.6	0.7			3.3
Macedonia		2.1			0.0	2.1
Malta		3.1	2.9			6.0
Mexico	52.9	57.4	49.3		3.8	163.3
Namibia		2.8	0.2			3.0
Netherlands	20.2	31.7				51.9
New Zealand**	0.3	17.2				17.6
Norway	0.2	1.2	0.15			1.5
Poland		74.5	26.5			101.0
Portugal	1.1	91.0	9.5			101.5
Romania		7.7	6.3			14.0
Slovak Republic		8.1	1.3			9.5
Slovenia		11.9	3.5			15.4
South Africa	37.8	21.3	2.5			61.6
Spain	7.7	262.5	11.2			281.4
Sweden	17.5	9.2	5.7			32.4
Switzerland***	8.4	94.7	7.2	7.7		118.1
Taiwan		72.9	8.6			81.6
Thailand**		10.3				10.3
Tunisia		49.1	10.4			59.5
Turkey		668.5				668.5
United Kingdom		36.4	26.0			62.4
United States	599.6	111.6	18.7		1.3	731.2
Uruguay**		5.1				5.1
Zimbabwe		0.2	0.10			0.2
TOTAL	1,530.5	6,428.7	28,459.1	40.0	14.2	36,472.5

Table 12: Newly installed capacity in 2008 [MW_{th}/a]

Country	Water Collectors			Air Collectors		TOTAL [MW _{th} /a]
	Unglazed*	Glazed*	evacuated tube*	Unglazed*	Glazed*	
Albania		6.8	0.1			6.9
Australia	420.0	193.9	9.8			623.7
Austria	10.7	240.5	2.9			254.0
Barbados		1.9				1.9
Belgium		57.4	6.3			63.7
Brazil	195.2	274.6				469.8
Bulgaria		2.8				2.8
Canada	62.7	9.2	0.8	23.9	0.8	97.4
Chile		6.3				6.3
China		1,085.0	20,615.0			21,700.0
Cyprus		28.2	0.7			28.9
Czech Republic		18.6	6.0			24.5
Denmark		21.7	1.4			23.1
Estonia		0.4				0.4
Finland	0.2	2.7	0.5			3.4
France		273.0				273.0
Germany		1,330.0	140.0		4.8	1,474.8
Greece		205.5	3.2			208.6
Hungary		6.0	1.8			7.7
India		324.4	16.2			340.7
Ireland		22.2	8.3			30.5
Israel	1.8	194.6				196.4
Italy		252.0	42.0			294.0
Japan		143.9	1.4		9.4	154.7
Jordan		14.0	21.0			35.1
Korea		36.1				36.1
Latvia		1.3				1.3
Lithuania		0.6				0.6
Luxembourg		2.0	0.6			2.5
Macedonia		2.7	0.4			3.1
Malta		4.2				4.2
Mexico	34.8	81.2				115.9
Namibia		2.8	0.1			2.9
Netherlands	19.8	16.4				36.1
New Zealand	0.4	14.3				14.7
Norway	0.1	0.7	0.1			1.0
Poland		62.9	27.9			90.7
Portugal	0.6	55.2	5.0			60.8
Romania		5.6				5.6
Slovak Republic		8.4	1.1			9.5
Slovenia		9.8	1.8			11.6
South Africa	70.2	15.0	12.7			97.8
Spain	22.4	286.3	17.5			326.2
Sweden	20.1	10.2	8.6			38.8
Switzerland*	6.6	72.8	6.2	4.9		90.4
Taiwan	0.2	74.0	8.2			82.4
Thailand		7.0				7.0
Tunisia		52.5	3.5			56.0
Turkey		651.0				651.0
United Kingdom		33.1	23.6			56.7
United States	773.9	134.1	23.7		1.8	933.5
Uruguay		2.9				2.9
Zimbabwe		0.2	0.02			0.3
TOTAL	1,639.5	6,358.6	21,018.0	28.8	16.9	29,061.77

Table 2: Installed capacity in 2007, MW_{th}/a

Country	Water Collectors			Air Collectors		TOTAL [MWh]
	unglazed***	glazed	evacuated tube	unglazed***	glazed***	
Albania		6,50	0,06			6,56
Australia	403,20	142,10	2,10			547,40
Austria	6,06	194,33	2,38			202,78
Barbados		1,91				1,91
Belgium	6,18	25,90	3,50			35,58
Brazil	68,21	332,78	0,25			401,23
Bulgaria		1,75				1,75
Canada	27,92	1,02	1,67	11,94	0,09	42,64
China		770,00	14.028,00			14.798,00
Cyprus		10,50	0,70			11,20
Czech Republic	4,20	13,23	4,27			21,70
Denmark	0,42	16,10	0,28	2,38	2,45	21,63
Estonia		0,25				0,25
Finland		1,47	0,44			1,91
France *	3,71	213,50	8,89			226,10
Germany	21,00	588,00	70,00			679,00
Greece		195,30	2,80			198,10
Hungary		4,20	1,40			5,60
India		175,00			4,90	179,90
Ireland		10,41	3,36			13,77
Israel	0,49	49,70				50,19
Italy	2,56	147,00	24,50			174,06
Japan		116,36	2,84		8,76	127,95
Jordan		5,37	2,52			7,89
Latvia		1,05				1,05
Lithuania		0,49				0,49
Luxembourg		2,10				2,10
Macedonia		1,37	0,14			1,51
Malta		3,85				3,85
Mexico	32,40	75,59				107,99
Namibia		1,97	0,13			2,10
Netherlands	19,41	13,94				33,35
New Zealand	0,42	8,26	3,61			12,29
Norway	0,14	0,50	0,04			0,68
Poland		32,92	14,78			47,70
Portugal	0,43	31,14	3,99			35,56
Romania		0,35				0,35
Slovak Republic		10,89	6,94			17,83
Slovenia		4,56	0,81			5,37
South Africa	47,11	9,80				56,91
Spain	2,10	175,70	7,70			185,50
Sweden	14,30	10,89	6,94			32,13
Switzerland **	7,22	44,12	1,79	1,40		54,53
Taiwan		87,50	6,93			94,43
Thailand		5,60				5,60
Tunisia		27,30	0,70			28,00
Turkey		490,00				490,00
United Kingdom		18,90	18,90			37,80
United States	787,53	90,73	14,36		0,89	893,51
TOTAL	1.455,00	4.172,20	14.247,69	15,72	17,08	19.907,69

Table 13: Installed capacity in 2006, MW_{th}/a

Country	Water Collectors			Air Collectors		TOTAL [MWth]
	unglazed***	glazed	evacuated	unglazed***	glazed***	
Albania		5,57	0,05			5,63
Australia	385,00	109,20	10,50			504,70
Austria	4,85	202,82	2,05			209,72
Barbados		1,91				1,91
Belgium	6,18	21,89	3,06			31,12
Brazil		304,03				304,03
Bulgaria		1,54				1,54
Canada	25,40	0,92	0,50	16,41	0,03	43,26
China		1.260,00	11.340,00			12.600,00
Cyprus		42,00				42,00
Czech Republic	4,20	12,94	2,48			19,62
Denmark	1,12	19,95	0,70		4,90	26,67
Estonia		0,21				0,21
Finland		2,38				2,38
France *	4,20	198,80	7,70			210,70
Germany	21,00	945,00	105,00			1.071,00
Greece		174,30				174,30
Hungary		0,70				0,70
India		350,00				350,00
Ireland		2,87	0,63			3,50
Israel	2,66	155,40				158,06
Italy	2,56	109,06	18,59			130,20
Japan		183,87	0,97	12,21		197,04
Jordan		5,37	2,52			7,89
Lativa		0,84				0,84
Lithuania		0,42				0,42
Luxembourg		1,75				1,75
Macedonia		1,48	0,03			1,51
Malta		3,15				3,15
Mexico	20,32	47,41				67,73
Namibia		1,20				1,20
Netherlands	17,09	10,46				27,55
New Zealand	0,42	6,72	2,35			9,49
Norway		0,49	0,07			0,56
Poland	0,11	24,61	4,38			29,09
Portugal		19,81				19,81
Romania		0,28				0,28
Slovak Republic		5,39	0,56			5,95
Slovenia		4,41	0,42			4,83
South Africa	45,57	9,66				55,23
Spain		113,31	9,19			122,50
Sweden	9,39	13,88	6,10			29,37
Switzerland **	6,27	35,25	1,06	0,70		43,27
Taiwan		79,55	5,99			85,54
Tunisia		24,17	0,33			24,50
Turkey		490,00				490,00
United Kingdom		18,90	18,90			37,80
United States	1.010,99	83,57	3,58		0,39	1.098,52
Total	1.567,33	5.107,43	11.547,67	29,31	5,32	18.257,07

Installed Capacity 2006, MWth

Table 14: Installed capacity in 2004, MW_{th}/a

Installed Capacity in 2004 MWth/yr							
Country	Water collectors			Air Collectors		TOTAL	Water coll glazed+ev.tube
	unglazed	glazed	evacuated tube	unglazed	glazed		
Albania	0,00	6,18	0,00	0,00	0,00	6,18	6,18
Australia	270,90	105,00	0,70	0,00	0,00	376,60	105,70
Austria	6,23	126,00	1,82	0,00	0,00	134,05	127,82
Barbados	0,00	1,91	0,00	0,00	0,00	1,91	1,91
Belgium	0,00	10,29	0,00	0,00	0,00	10,29	10,29
Brazil	0,00	270,12	0,00	0,00	0,00	270,12	270,12
Canada	25,24	0,82	0,14	11,34	0,00	37,53	0,96
China	0,00	1.050,00	8.400,00	0,00	0,00	9.450,00	9.450,00
Cyprus	0,00	21,00	0,00	0,00	0,00	21,00	21,00
Czech Republic	0,00	5,67	0,28	0,00	0,00	5,95	5,95
Denmark	0,00	8,40	0,00	0,00	3,50	11,90	8,40
Estonia	0,00	0,18	0,00	0,00	0,00	0,18	0,18
Finland	0,00	0,98	0,16	0,00	0,00	1,14	1,14
France (incl. Oversea Departments)	4,34	77,50	0,00	0,00	0,00	81,84	77,50
Germany	21,00	472,50	52,50	0,00	0,00	546,00	525,00
Greece	0,00	150,50	0,00	0,00	0,00	150,50	150,50
Hungary	0,21	1,75	0,14	0,00	0,00	2,10	1,89
India	0,00	140,00	0,00	0,00	0,00	140,00	140,00
Ireland	0,00	0,84	0,56	0,00	0,07	1,47	1,40
Israel	0,00	49,00	0,00	0,00	0,00	49,00	49,00
Italy	0,00	40,60	0,00	0,00	0,00	40,60	40,60
Japan	0,00	172,40	3,24	0,00	0,00	175,64	175,64
Lativa	0,00	0,35	0,00	0,00	0,00	0,35	0,35
Lithuania	0,00	0,35	0,00	0,00	0,00	0,35	0,35
Luxembourg	0,00	1,19	0,00	0,00	0,00	1,19	1,19
Macedonia	0,00	1,05	0,00	0,00	0,00	1,05	1,05
Malta	0,00	2,86	0,09	0,00	0,00	2,95	2,95
Mexico	28,86	19,24	0,00	0,00	0,00	48,11	19,24
Namibia	0,00	0,03	0,00	0,00	0,00	0,00	0,03
Netherlands	22,40	18,20	0,00	0,00	0,00	40,60	18,20
New Zealand	0,00	5,57	0,43	0,00	0,00	6,00	6,00
Norway	0,14	1,05	0,00	0,00	0,18	1,37	1,05
Poland	0,46	15,79	1,89	0,00	0,00	18,13	17,68
Portugal	0,00	11,26	0,00	0,00	0,00	11,26	11,26
Slovak Republic	0,00	3,85	0,00	0,00	0,00	3,85	3,85
Slovenia	0,00	1,26	0,21	0,00	0,00	1,47	1,47
South Africa	42,70	9,80	0,01	0,00	0,00	52,51	9,81
Spain	3,15	55,44	4,41	0,00	0,00	63,00	59,85
Sweden	6,07	12,25	1,79	0,00	0,00	20,11	14,04
Switzerland	7,82	20,93	0,88	1,40	0,00	31,03	21,81
Taiwan	0,00	72,26	5,86	0,00	0,00	78,12	78,12
Tunisia	0,00	4,90	0,00	0,00	0,00	4,90	4,90
Turkey	0,00	336,00	0,00	0,00	0,00	336,00	336,00
United Kingdom	0,70	8,40	7,00	0,00	0,00	16,10	15,40
United States	884,96	32,58	0,13	0,00	0,26	917,93	32,71
Total	1.325,18	3.340,06	8.482,24	12,74	4,01	13.164,19	11.822,30