The State of Solar Water Heating Research in South Africa

A review



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Contents

Introduction

South Africa is facing electricity shortages and rolling blackouts, with Eskom unable to supply sufficient electricity to meet the country's current demand. In light of this, the integration of renewable energy technologies into the mainstream energy economy has become pivotal in reducing strain on the electricity grid. The South African government has set a target of 10 000 GWh electricity to be produced from renewable energy technologies by 2013 (1). It was estimated by the Department of Energy that 23% of this target can be met through the implementation of solar water heaters (4). Water heating accounts for approximately 40% of domestic energy costs (4) and the installation of solar water heaters can therefore not only substantially reduce electricity bills but also offers great potential for job creation in the country.

The Eskom Solar Water Heating (SWH) rebate programme was initiated in 2008 as part of a five year plan by the Department of Energy (DoE) to install 1 million SWHs by 2014 (2). Subsidy levels under this programme were doubled from January 2011 in order to accelerate the South African SWH industry (3). The programme has resulted in 180 000 claims for SWH installation and the roll out of more than 38 000 high pressure and 84 000 low pressure solar water heaters by the end of 2011. The SWH market significantly expanded from 20 suppliers in 1997 to 400 in 2011. This rapid stimulation of the SWH market led to Eskom's decision to reduce rebates from the end of April 2011 (4). However, by the end of September 2014 less than halve (417 000) of the DoE's anticipated 1 million SWHs were installed (5). Furthermore, the disruption of the rebate programme has placed pressure on SWH manufacturers and created uncertainty in the industry.

Effective from 1 February 2015, the DoE has taken over responsibility for the national solar water heater programme. The DoE has announced that a cap of 5,000 will be placed on subsidies during the transitional phase. Once this cap has been reached, no more subsidies will be offered under this programme. Future plans involve the introduction of a new rebate scheme where subsidies will be offered while taking into consideration local content. A sliding scale corresponding with local content will apply, where products with a higher verified local content will draw higher rebates. The DoE further announced that under the social SWH programme, “only those products that have met the SABS verification requirements will be eligible for receiving subsidies” (6).

Considering the potential significance that SWH can play in the South African renewable energy mix, it is crucial that steps be put in place to once again drive this industry. It is therefore important to evaluate current research in the field as well as identify future research focal areas and gaps.

The objective of this review is to provide an overview of current SWH research being carried out at South African Universities, Universities of Technology and other research institutions, to identify common themes and priorities in this research, to identify possible gaps that are not being covered by current SWH research, to compile a profile of the SWH researchers actively working in the field and to make recommendations on future SWH research focal areas for South Africa.

The following sections include identified SWH researchers in South Africa with their current research focal areas.

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Current Solar Water Heating Research Themes

SWH Application

- Domestic
- Agriculture/horticulture

SWH Systems and Components

- Integrated collector storage (ICS or batch heater) systems
    - Collector types
        - Tube type
    - Thermal performance improvements
        - Glazing systems
        - Optimising design parameters

- Convection heat storage unit (CHS or thermosyphon) systems
    - Collector types
        - Flat plate (harp)
        - Flat plate (serpentine)
        - Evacuated tube (direct-flow)
    - Thermal performance improvements
        - Storage tank design
        - Collectors - glazing systems

- Indirect (two-phase) thermosyphon systems
    - Collector types
        - Flat plate (harp)
        - Flat plate (serpentine)
        - Flat plate with heat pipes
        - Tube-in-sheet
        - V-trough
    - Heat exchanger configurations and types
        - Plate-type
    - Working fluids
        - Water
    - Thermal performance improvements
        - Storage tank design
        - Collectors – glazing systems
        - Optimising design parameters

Auxiliary Energy Sources

- PV panel to power pumps

Other

- Techno-economic evaluation
- Lifecycle assessment
- Theoretical modelling (simulation) studies
- SWH performance testing/evaluation
- Thermal performance efficiency
- Heat removal efficiency
- Energy efficiency

Single SWH component studies

- Collectors
- Glazing

Overview of Current Solar Water Heating Research

- Domestic solar syphon design developments especially for rural areas;
- Optimising collector plate geometry for a specific solar syphon system design:

  Solar energy is absorbed and converted into thermal energy to heat water, usually by flat plate collectors. The flat plate collectors consists of absorbent surface to solar irradiance, containing pipes attached to it to circulate water, insulated from the bottom and with glass cover from the top to reduce the heat loss by conduction and convection. It is agreed that the performance in terms of the amount of heat acquired by these panels depends primarily on the surface area that is exposed to solar irradiance. The geometry of the panels (such as vertical, horizontal, square) is expected to affect the amount of heat acquired because of the number and length of the tubes attached to the absorbent plate. Furthermore, the geometry also affects heat loss due to prevailing atmospheric conditions. It is intended to test specially manufactured flat plate collectors (provided by local manufacturer at cost) with the proviso that all three will have identical surface area and different orientation. The system will consist of the flat plate collector and a receiving cylinder for the hot water to be collected. The motion of the water will be due to the thermo syphon effect. Thermocouples attached to salient position on the plates will monitor surface temperatures to enable the evaluation of heat loss. Conditions such as incident daily solar radiation will also be monitored;
- Development of tracking technologies for solar water heating;
- SWH applications in aquaponics:

  The use of solar thermal energy is implemented to maintain ideal conditions for aquaculture and hydroponics in a modular compact system;
- A prototype desalination system using solar energy and heat pipe technology:

The project is studying the results that were obtained while monitoring the thermal performance of a solar water desalination system. The system consists of a solar collector equipped with evacuated heat pipes which supply the heat from the sun to a circulating fluid in a collective manifold. Data was obtained indoors by the use of a solar simulator during experiments conducted in the Department of Mechanical Engineering at Cape Peninsula University of Technology (CPUT). A solar simulator consisting of an array of halogen flood lights was used to heat the evacuated heat pipes which in turn transferred the heat to the circulating fluid feeding a heat exchanger in the system's geyser. The irradiance from the solar simulator that could be controlled by means of variable transformers controlling the voltage to the halogen lamps was measured over the surface of the evacuated heat pipe collector. The procedure allowed for exposure of the collector to the solar simulator for seven hours daily and thereafter normal cooling of the system. Preliminary results so far have shown that it is possible to use modern domestic water heating systems to produce steam which when condensed becomes potable water.

Recommendations on Future Solar Water Heating Research Focal Areas in South Africa

- Solar water heating for process industry applications.

Recommendations on Potential Gaps Not Covered by Current Solar Water Heating Research

- Solar water heating applications in HVAC (heating, ventilation and air conditioning) systems.

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Current Solar Water Heating Research Themes

SWH Application

- Domestic
- Commercial and Industrial
- Medical
- Potable water

SWH Systems and Components

- Integrated collector storage (ICS or Batch heater) systems
    - Collector types
        - Compound parabolic
        - Trough
    - Thermal performance improvements
        - Vessel design
        - Selective coatings
        - Reflector configurations
        - Optimising design parameters

Auxiliary Energy Sources

- PV panel to power pumps

Other

- Techno-economic evaluation
- Economic viability
- Social impact assessment
- Environmental impact assessment
- Theoretical modelling (simulation) studies
- SWH performance testing/evaluation

Single SWH Component Studies

- Collectors

Overview of Current Solar Water Heating Research

- Have just embarked on research into the SWH area as an off-shoot of a project that was recently completed for a German-based competition (Phoenix Contact New Automation Awards). An automated solar oven power generator, a device that operates off-grid and which can be used to boil water, cook food and powers a battery was developed. The device is fully automated and contains features such as an engine that runs entirely on heat, a safety buzzer and several solar panels. Whilst not directly in the area of traditional hot-water solar heating, it was felt that the research could have outcomes related to this.

Recommendations on Future Solar Water Heating Research Focal Areas in South Africa

- Secondary applications – medical, potable water.

Recommendations on Potential Gaps Not Covered by Current Solar Water Heating Research

- None

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Current Solar Water Heating Research Themes

SWH Application

- Agriculture/horticulture

SWH Systems and Components

- Draindown systems
  - Collector types
    - Flat plate (harp)
  - Pump types
    - AC pump
  - Thermal performance improvements
    - Storage tank design
    - Collectors – cover material, glazing systems, absorber plates
    - Methods of insulation
    - Optimising design parameters
    - Extending heat transfer area

Overview of Current Solar Water Heating Research

- The development and characterisation of a cost-effective, renewable energy greenhouse for production of crops in atypical climatic conditions;
- The application of a flat plate solar collector as the primary source of energy for heating purposes.

Recommendations on Future Solar Water Heating Research Focal Areas in South Africa

- The application of parabolic solar heaters as the primary source of energy for heating purposes.

Recommendations on Potential Gaps Not Covered by Current Solar Water Heating Research

- The application of parabolic solar heaters as the primary source of energy for heating purposes.

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Current Solar Water Heating Research Themes

SWH Application

- Domestic
- Commercial and Industrial

SWH Systems and Components

- Integrated collector storage (ICS or Batch heater) systems
  - Collector types
    - Tube type
  - Thermal performance improvements
    - Vessel design
    - Methods of insulation
    - Phase change materials
    - Extending heat transfer area

- Drainback systems
  - Thermal performance improvements
    - Storage tank design
    - Collectors
    - Extending heat transfer area

Other

- SWH performance testing/evaluation

Overview of Current Solar Water Heating Research

- Up to now, MUT has conducted intensive research in low cost solar water heating systems;
- The main research focus has been on two systems namely the copper-tube and evacuated-tube systems;
- Testing at the STARlab at MUT showed that the evacuated-tube systems are far more efficient than the copper-tube systems with higher costs for the evacuated-tube systems.

Recommendations on Future Solar Water Heating Research Focal Areas in South Africa

- Development of a low-cost solar tile is new to South Africa. With technology advancing so quickly, the bulky solar panels are becoming slowly outdated and solar tiles are now taking over the market. Research is now aimed at developing a low-cost solar tile integrated with capillary tubing to capture heat and transfer it to water in the tubes for hot water use in households.

Recommendations on Potential Gaps Not Covered by Current Solar Water Heating Research

- Potential gaps lie in the local design and manufacturing of evacuated-tube systems and solar panels.

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Current Solar Water Heating Research Themes

SWH Application

- Domestic
- Commercial and Industrial

SWH Systems and Components

- Integrated collector storage (ICS or Batch heater) systems
    - Collector types
        - Tank type
    - Thermal performance improvements
        - Vessel design
        - Glazing systems
        - Selective coatings
        - Methods of insulation
        - Optimising design parameters
        - Extended low-cost storage tanks

- Convection heat storage unit (CHS or Thermosyphon) systems
    - Collector types
        - Flat plate (Harp)
    - Thermal performance improvements
        - Storage tank design
        - Collectors – cover material, glazing systems, selective coatings

        - Methods of insulation
        - Optimising design parameters
        - Extending heat transfer area

- Indirect (two-phase) Thermosyphon systems
    - Collector types
        - Flat plate (Harp)
        - Flat plate with heat pipe
        - Evacuated tube (Direct-flow)
    - Heat exchanger configurations and types
        - Internal
        - All area – submerged tanks
    - Working fluid
        - Water
    - Thermal performance improvements
        - Storage tank design
        - Collectors – glazing systems, selective coatings
        - Heat exchangers
        - Optimising design parameters

- Pressurized antifreeze or pressurized glycol systems
    - Collector types
        - Flat plate (Harp)
        - Flat plate with heat pipe
    - Pump types
        - AC pump
        - DC pump (powered by PV module)
    - Heat exchanger configurations and types
        - Internal
        - Plate-type
        - Tube-in-shell type
    - Thermal performance improvements

        - Storage tank design
        - Collectors – cover material, glazing systems, selective coatings
        - Heat transfer fluid
        - Heat exchangers
        - Methods of insulation

- Drainback systems
    - Collector types
        - Flat plate (Harp)
    - Pump types
        - AC pump
        - DC pump (powered by PV module)
    - Heat exchanger configurations and types
        - Storage tanks with integrated exchangers
    - Thermal performance improvements
        - Storage tank design
        - Collectors – cover material, glazing systems, selective coatings
        - Methods of insulation
        - Optimising design parameters

- Draindown systems
    - Collector types
        - Flat plate (Harp)
    - Pump types
        - AC pump
        - DC pump (powered by PV module)
    - Thermal performance improvements
        - Storage tank design
        - Collectors – cover material

- Flooded open-loop systems
    - Pump types

        - AC pump
        - DC pump (powered by PV module)
    - Thermal performance improvements
        - Storage tank design
        - Collectors

- Recirculation systems
    - Pump types
        - AC pump
        - DC pump (powered by PV module)
    - Thermal performance improvements
        - Storage tank design
        - Collectors – glazing systems, selective coatings
        - Methods of insulation
        - Optimising design parameters

Auxiliary Energy Sources

- Electrical heating element
- PV panel to power pumps

Other

- Techno-economic evaluation
- Economic viability
- Social impact assessment
- Environmental impact assessment
- Lifecycle assessment
- Theoretical modelling (simulation) studies
- SWH performance testing/evaluation
- Thermal performance efficiency
- Heat removal efficiency

- Energy efficiency

Single SWH Component Studies

- Collectors
- Insulation
- Storage tanks
- Heat exchangers
- Pumps
- Solar selective coatings

Overview of Current Solar Water Heating Research

- Monitoring of 100 SWH systems country-wide: a project supported by DoE and GIZ;
- Evaluation of the SWH systems performance in ESKOM EEDSM Programmes;
- Developing of SWH performance evaluation tools for ESKOM EEDSM Programmes (developing of guidelines and models for quantifying and savings reporting for SWH in South Africa);
- Testing of SWH systems and components;
- Developing of modular/extended storage low-cost SWH systems suitable for residential and commercial usages;
- Trainings in SWH basics and installations;
- Using solar energy for passive space heating;
- Developing low-cost integral SWH system.

Recommendations on Future Solar Water Heating Research Focal Areas in South Africa

- Improving the quality of local SWH systems and components;
- Encouraging regular testing of SWH systems and components against local and international standards for all SWH systems produced in South Africa;
- Developing approved evaluation tools and guidelines for proper Measurement and Variation (M&V) and monitoring of solar water heating programmes;

- Developing M&V guidelines for M&V of SWH rollouts including the quality of installations and related Maintenance and Operation (O&M);
- Developing of "exceeded" hot water storage capacity tanks;
- Developing a market for components of SWH allowing clients to choose and assemble a SWH system on their choice.

Recommendations on Potential Gaps Not Covered by Current Solar Water Heating Research

- Absence of scientific database for testing of SWH systems and components against local and international standards;
- Absence of a large-volume storage tanks at reasonable price;
- Absence of a low-cost reliable SWH system;
- Low level of academia/industry R&D partnerships;
- Sustainable training of installers and maintainers of SWH system (especially in the low-cost areas subject of SWH rollout initiatives).

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Current Solar Water Heating Research Themes

SWH Application

- Domestic

SWH Systems and Components

- Convection heat storage unit (CHS or Thermosyphon) systems
  - Collector types
    - Flat plate (harp)
    - Flat plate (serpentine)
  - Thermal performance improvements
    - Absorber plates
    - Optimising design parameters

- Indirect (two-phase) thermosyphon systems
  - Collector types
    - Flat plate (harp)
    - Flat plate (serpentine)
  - Heat exchanger configurations and types
    - Wraparound
  - Working fluids
    - Water
  - Thermal performance improvements
    - Absorber plates

        - Optimising design parameters

- Pressurized antifreeze or pressurized glycol systems
    - Collector types
        - Flat plate (harp)
        - Flat plate (serpentine)
    - Pump types
        - AC pump
    - Heat exchanger configurations and types
        - Wraparound
    - Thermal performance improvements
        - Absorber plates
        - Optimising design parameters

- Flooded open-loop systems
    - Collector types
        - Flat plate (harp)
        - Flat plate (serpentine)
    - Pump types
        - AC pump
    - Thermal performance improvements
        - Absorber plates
        - Optimising design parameters

- Recirculation systems
    - Collector types
        - Flat plate (harp)
        - Flat plate (serpentine)
    - Pump types
        - AC pump
    - Thermal performance improvements
        - Absorber plates

Other

- Lifecycle assessment
- SWH performance testing/evaluation
- Thermal performance efficiency
- Heat removal efficiency

Single SWH component studies

- Collectors
- Absorbers

Overview of Current Solar Water Heating Research

- Comparative study of performance and efficiency of a tube and fin type domestic solar water heat collector.

Recommendations on Future Solar Water Heating Research Focal Areas in South Africa

- Component testing and SABS specification.

Recommendations on Potential Gaps Not Covered by Current Solar Water Heating Research

- None

Solar Water Heating Colleagues

- None

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Current Solar Water Heating Research Themes

SWH Application

- Domestic
- Commercial and Industrial

Other

- Performance testing

Overview of Current Solar Water Heating Research

- The construction of an outdoor test bench for the long term performance testing of domestic solar water heaters (M Eng student);
- The monitoring and simulation of a large scale SWH / Heat Pump combined system for the provision of hot water for a hospital (M Eng Student);
- The focus is on the performance of existing systems. SWH is a sufficiently mature technology and therefore the key to success in not in improving the technology but in the implementation.

Recommendations on Future Solar Water Heating Research Focal Areas in South Africa

- How successful is the implementation of SWHs in SA? Make a survey of installed systems to determine whether they still function properly.

Recommendations on Potential Gaps Not Covered by Current Solar Water Heating Research

- None

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Current Solar Water Heating Research Themes

SWH Application

- Domestic

Other

- Techno-economic evaluation
- Economic viability
- Social impact assessment
- Theoretical modelling (simulation) studies
- Energy efficiency

Overview of Current Solar Water Heating Research

- Demand side management of SWH in South Africa;
- Potential SWH demand reduction modelling (both demand-side management and modelling work is generally not possible to share because commissioned by electricity provider or DoE);
- Policy and effectiveness.

Recommendations on Future Solar Water Heating Research Focal Areas in South Africa

- Implementation and roll-out;
- Assessment of its contribution to reducing emissions, or reducing electricity demand.

Recommendations on Potential Gaps Not Covered by Current Solar Water Heating Research

- None

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Current Solar Water Heating Research Themes

SWH Systems and Components

- SWH controller testing and optimisation

Overview of Current Solar Water Heating Research

- Solar geyser controller testing and optimisation to optimise energy efficiency.

Recommendations on Future Solar Water Heating Research Focal Areas in South Africa

- Solar water desalination.

Recommendations on Potential Gaps Not Covered by Current Solar Water Heating Research

- Intelligent solar geyser controllers.

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Current Solar Water Heating Research Themes

SWH Application

- Domestic
- Commercial and Industrial
- Agriculture/Horticulture
- Swimming pools

SWH Systems and Components

- Indirect Thermosyphon systems
    - Heat exchanger configurations and types
        - Internal, External, Wraparound, Plate-type, Coiled tube type, Tube-in-shell type
    - Working fluid
        - CFC or HCFC refrigerants
        - Environmentally friendly refrigerants
    - Thermal performance improvements
        - Heat transfer fluid
        - Heat exchangers
        - Optimising design parameters
        - Extending heat transfer area

- Pressurized antifreeze or pressurized glycol systems
    - Heat exchanger configurations and types

        - Internal, External, Wraparound, Plate-type, Coiled tube type, Tube-in-shell type
    - Thermal performance improvements
        - Heat transfer fluid
        - Heat exchangers
        - Optimising design parameters
        - Extending heat transfer area

- Drainback systems
    - Heat exchanger configurations and types
        - External, Plate-type, Coiled tube type, Tube-in-shell type
    - Working fluid
        - Water
        - Refrigerants/phase-change liquids
    - Thermal performance improvements
        - Collectors
        - Heat transfer fluid
        - Heat exchangers
        - Optimising design parameters
        - Extending heat transfer area

Other

- Techno-economic evaluation
- Lifecycle assessment
- Energy efficiency

Single SWH Component Studies

- Heat exchangers
- Heat transfer fluid

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Current Solar Water Heating Research Themes

SWH Application

- Domestic
- Commercial and Industrial

SWH Systems and Components

- Integrated collector storage (ICS or Batch heater) systems
    - Collector types
        - Tank type
    - Thermal performance improvements
        - Methods of insulation

- Convection heat storage unit (CHS or Thermosyphon) systems
    - Collector types
        - Plat plate (harp)
    - Thermal performance improvements
        - Optimising design parameters

- Pressurized antifreeze or pressurized glycol systems
    - Collector types
        - Flat plate (serpentine)
    - Pump types
        - AC pump

    - Heat exchanger configurations and types
        - Coiled tube type
    - Thermal performance improvements
        - Heat transfer fluid
        - Methods of insulation
        - Optimising design parameters
        - Mass flow rate optimisation

- Draindown systems
    - Collector types
        - Flat plate (serpentine)
    - Pump types
        - AC pump
    - Thermal performance improvements
        - Methods of insulation
        - Optimising design parameters

Auxiliary Energy Sources

- Electrical heating element
- PV panel to power pumps

Single SWH Component Studies

- Collectors
- Storage tanks
- Heat exchangers
- Pumps
- Heat transfer fluids

Overview of Current Solar Water Heating Research

- Optimisation of mass flow rates for a forced circulation (active) solar water heating systems (SWHS);
- Design parameters of fluid storage tank for maximum energy storage;
- Design parameters of connecting pipes for energy loss minimisation;
- Selection of pump parameters for the improvement of the pump operating efficiency;
- Comparison of different mass flow rate optimisation techniques used in order to improve the performance and efficiency of solar water heating systems connected to a flat plate solar collector.

Recommendations on Future Solar Water Heating Research Focal Areas in South Africa

- Initial cost implication of using active/passive SWHS;
- Performance and efficiency of locally produced active/passive SWHS in South Africa;
- Social impact of current ergonomic designs of SWHS;
- Integration of locally produced solar thermal and heat pump systems;
- The energy saving capacity of SWHS when considering the South African water usage load profile;
- Research on the optimisation of the following design parameters:
  - Solar collector: The collector heat removal factor, thermal loss coefficient, glazing, optimal number of reflective layers, transmittance absorbance factor and solar tracking, optimal number of collectors, minimisation of shading effects;
  - Heat exchanger: Optimal parameters in order to maximise the rate of energy transfer;
  - Tank: Design for optimal size/volume as well as the tank volume to collector area ratio in order to maximise the performance of SWHS;
  - Connecting pipes: Selection of appropriate pipe insulation in order to reduce thermal losses;
  - Architecture of SWHS: Research on structural requirements of residential houses in order to support different types of SWHS.

Recommendations on Potential Gaps Not Covered by Current Solar Water Heating Research

- Local content implications on the design and performance of locally developed SWHS.

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Current Solar Water Heating Research Themes

SWH Application

- Domestic
- Commercial and Industrial

SWH Systems and Components

- Integrated collector storage systems

Single SWH Component Studies

- Collectors
- Glazing
- Insulation
- Absorbers
- Storage tanks
- Heat exchangers
- Heat transfer fluids

Other

- Techno-economic evaluation
- Economic viability
- Theoretical modelling (simulation) studies
- SWH performance testing/evaluation

- Thermal performance efficiency

Overview of Current Solar Water Heating Research

- Mostly MSc/MEng type next generation and new idea development which includes:
  - Wax storage systems for lower cost, longer storage SWHs;
  - Improved SWH ideas to solve problems with the poor installation track record in SA;
  - Cheaper collectors.

Recommendations on Future Solar Water Heating Research Focal Areas in South Africa

- SWH system research: Address the problem of poor policy, revising SABS standards, solutions on how to install SWH correctly;
- Strict standards for procurement process as to ensure high quality SWHS and their installation on RDP houses;
- SWH solutions that better serve demand, both at point of use and for the national grid;
- Resource quantification and economic analysis for any installation.

Recommendations on Potential Gaps Not Covered by Current Solar Water Heating Research

- None

Solar Water Heating Colleagues:

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Current Solar Water Heating Research Themes

SWH Application

- Domestic
- Commercial and Industrial

Other

- Techno-economic evaluation
- Economic viability
- Social impact assessment
- Environmental impact assessment
- Lifecycle assessment
- Theoretical modelling (simulation) studies
- SWH performance testing/evaluation
- Thermal performance efficiency
- Heat removal efficiency
- Energy efficiency

Overview of Current Solar Water Heating Research

- Solar process heat for industries: feasibility studies, techno-economic evaluations, system design, tender facilitation and inspection;
- Collectors: efficiency curve tests, test stand development and performance tests;
- System testing: performance and techno-economic evaluation.

Recommendations on Future Solar Water Heating Research Focal Areas in South Africa

- Component research and design to improve quality and reduce cost;
- Large scale solar water heating system designs and integration.

Recommendations on Potential Gaps Not Covered by Current Solar Water Heating Research

- None

Solar Water Heating Colleagues

- None

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Current Solar Water Heating Research Themes

SWH Application

- Domestic
- Agriculture/Horticulture

SWH Systems and Components

- Convection heat storage unit (CHS or thermosyphon) systems
  - Collector types
    - Flat plate (Harp)
    - Flat plate (Serpentine)

- Indirect (two-phase) thermosyphon systems
  - Collector types
    - Flat plate (Harp)
    - Flat plate (Serpentine)
  - Working fluids
    - Water
  - Thermal performance improvements
    - Collectors

- Pressurized antifreeze or pressurized glycol systems
  - Collector types
    - Flat plate (Harp)

- Flat plate (Serpentine)

Other

- Theoretical modelling (simulation) studies

Overview of Current Solar Water Heating Research

- Currently no research is being conducted into SWH except a few studies at honours level;
- In the past few years about five students did work for their honours project work in SWH;
- One colleague is working on theoretical modelling on solar water heaters.

Recommendations on Future Solar Water Heating Research Focal Areas in South Africa

- Materials for better performance;
- Means of increasing efficiency;
- Cost cycle analysis;
- Research work on how to reduce production cost;
- Solar radiation versus heating (conversion efficiency).

Recommendations on Potential Gaps Not Covered by Current Solar Water Heating Research

- None

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Current Solar Water Heating Research Themes

SWH Application

- Domestic
- Commercial and Industrial

SWH Systems and Components

- Integrated collector storage (ICS or batch heater) systems
  - Collector types
    - Tank type
    - Compound parabolic
  - Thermal performance improvements
    - Selective coatings
    - Methods of insulation
    - Optimising design parameters

- Convection heat storage unit (CHS or thermosyphon) systems
  - Collector Types
    - Fully flooded
  - Thermal performance improvements
    - Storage tank design
    - Selective coatings

Auxiliary energy source

- Electrical heating element

Surface/selective surface coatings

- Hot mirror coatings

Other

- Economic viability
- Thermal performance efficiency

Overview of Current Solar Water Heating Research:

- Research the impact of using hot mirror coatings as opposed to selective coating for solar thermal application. Specific focus is on solar trough (concentrator) technology, but since selective coatings are used for water heating applications, this research lends itself to a much wider range of technologies.

Recommendations on Future Solar Water Heating Research Focal Areas in South Africa:

- Very recently started investigating commercial viability of fully flooded, flat water preheaters for domestic electric boilers. Solar technologies in South Africa will only have an impact if they can become commercially more competitive than at present.

Recommendations on Potential Gaps Not Covered by Current Solar Water Heating Research:

- Current technology solar geysers (boilers) are overpriced in South Africa (costing over R10 000, sometimes including ESKOM rebates), where similar products in China cost less than half the price. At this point, local manufacture may even become competitive.

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Current Solar Water Heating Research Themes

SWH Application

- Domestic
- Commercial and Industrial

Overview of Current Solar Water Heating Research:

- Currently looking at using solar PV to heat water.

Recommendations on Future Solar Water Heating Research Focal Areas in South Africa:

- Investigate the use of solar PV for water heating.

Recommendations on Potential Gaps Not Covered by Current Solar Water Heating Research:

- The use of PV as energy source is not currently covered.

Solar Water Heating Colleagues:

- None

Common SWH Research Themes at South African Research Institutions

The following section includes tables with consolidated SWH research themes from South African research institutions, as well as visual representations of the primary SWH research themes.

Table 1: Common SWH Research Themes at South African Research Institutions

	CPUT		CUT	MUT	TUT	NMMU	NWU	UCT	UJ	UP		US		Univen	Wits	
	Mr. Kanyarusoke	Mr. Kallis	Mr. Aggenbacht	Prof. Malinga	Prof. Dintchev	Mr. Kleyn	Mr. van Niekerk	Ms. De Groot	Mr. Bhamjee	Prof. Meyer	Prof. Xia	Mr. Gauché	Mr. Joubert	Prof. Sankaran	Dr. Ferrer	Prof. Cronje
SWH Application																
Domestic	x	x		x	x	x	x	x		x	x	x	x	x	x	x
Commercial and Industrial		x		x	x		x			x	x	x	x		x	x
Agriculture/Horticulture	x		x							x				x		
Swimming pools										x						
SWH Systems																
Passive direct systems																
Integrated collector storage	x	x		x	x						x	x	x		x	
Convection heat storage unit	x				x	x					x		x	x	x	
Passive indirect systems																
Indirect thermosyphon	x				x	x				x				x		
Active indirect systems																
Pressurized antifreeze or pressurized glycol					x	x				x	x		x	x		
Drainback				x	x					x						
Active direct systems																
Draindown			x		x						x					
Flooded open-loop					x	x										
Recirculation					x	x										

Table 1: Continued

	CPUT		CUT	MUT	TUT	NMMU	NWU	UCT	UJ	UP		US		Univen	Wits	
	Mr. Kanyarusoke	Mr. Kallis	Mr. Aggenbacht	Prof. Malinga	Prof. Dintchev	Mr. Kleyn	Mr. van Niekerk	Ms. De Groot	Mr. Bhamjee	Prof. Meyer	Prof. Xia	Mr. Gauché	Mr. Joubert	Prof. Sankaran	Dr. Ferrer	Prof. Cronje
SWH System Components																
Integrated collector storage systems																
Collector Type																
▪ Tank type					x						x				x	
▪ Tube type	x			x												
▪ Compound parabolic		x													x	
Thermal performance improvements																
▪ Vessel design		x		x	x											
▪ Glazing systems	x				x											
▪ Selective coatings		x			x										x	
▪ Methods of insulation				x	x						x				x	
▪ Reflector configurations		x														
▪ Phase change materials				x												
▪ Optimising design parameters	x	x			x										x	
▪ Extending heat transfer area				x												
Convection heat storage unit systems																
Collector Type																
▪ Flat plate (Harp)	x				x	x					x		x	x		
▪ Flat plate (Serpentine)	x					x								x		
▪ Evacuated tube (Direct-flow)	x												x			
▪ Fully flooded															x	

Table 1: Continued

	CPUT		CUT	MUT	TUT	NMMU	NWU	UCT	UJ	UP		US		Univen	Wits	
	Mr. Kanyarusoke	Mr. Kallis	Mr. Aggenbacht	Prof. Malinga	Prof. Dintchev	Mr. Kleyn	Mr. van Niekerk	Ms. De Groot	Mr. Bhamjee	Prof. Meyer	Prof. Xia	Mr. Gauché	Mr. Joubert	Prof. Sankaran	Dr. Ferrer	Prof. Cronje
SWH System Components																
Thermal performance improvements																
▪ Storage tank design	x				x										x	
▪ Collectors																
○ Cover material					x											
○ Glazing systems	x				x											
○ Absorber plates						x										
○ Selective coatings					x										x	
▪ Optimising design parameters					x	x					x					
▪ Methods of insulation					x											
▪ Extending heat transfer area					x											
Indirect thermosyphon systems																
Collector Type																
▪ Flat plate (Harp)	x				x	x								x		
▪ Flat plate (Serpentine)	x					x								x		
▪ Flat plate with heat pipe	x				x											
▪ Evacuated tube (Direct-flow)					x											
▪ Tube-in-sheet	x															
▪ V-trough	x															
Heat Exchanger Configurations and Types																
▪ Internal					x					x						
▪ External										x						

Table 1: Continued

	CPUT		CUT	MUT	TUT	NMMU	NWU	UCT	UJ	UP		US		Univen	Wits	
	Mr. Kanyarusoke	Mr. Kallis	Mr. Aggenbacht	Prof. Malinga	Prof. Dintchev	Mr. Kleyn	Mr. van Niekerk	Ms. De Groot	Mr. Bhamjee	Prof. Meyer	Prof. Xia	Mr. Gauché	Mr. Joubert	Prof. Sankaran	Dr. Ferrer	Prof. Cronje
▪ Wraparound						x				x						
▪ Plate-type	x									x						
▪ Coiled tube type										x						
▪ Tube-in-shell type										x						
SWH System Components																
Working fluid																
▪ Water	x				x	x								x		
▪ CFC or HCFC refrigerants										x						
▪ Environmentally friendly refrigerants										x						
Thermal performance improvements																
▪ Storage tank design	x				x											
▪ Collectors														x		
○ Glazing systems	x				x											
○ Absorber plates						x										
○ Selective coatings					x											
▪ Heat transfer fluid										x						
▪ Heat exchangers					x					x						
▪ Optimising design parameters	x				x	x				x						
▪ Extending heat transfer area										x						
Pressurized antifreeze or pressurized glycol systems																
Collector Type																
▪ Flat plate (Harp)					x	x							x	x		

Table 1: Continued

	CPUT		CUT	MUT	TUT	NMMU	NWU	UCT	UJ	UP		US		Univen	Wits	
	Mr. Kanyarusoke	Mr. Kallis	Mr. Aggenbacht	Prof. Malinga	Prof. Dintchev	Mr. Kleyn	Mr. van Niekerk	Ms. De Groot	Mr. Bhamjee	Prof. Meyer	Prof. Xia	Mr. Gauché	Mr. Joubert	Prof. Sankaran	Dr. Ferrer	Prof. Cronje
▪ Flat plate (Serpentine)						x					x		x	x		
▪ Flat plate with heat pipe					x								x			
▪ Evacuated tube (Direct-flow)													x			
▪ Evacuated tube (Heat pipe)													x			
Pump Type																
SWH System Components																
▪ AC pump					x	x					x		x			
▪ DC pump (powered by PV module)					x											
Heat Exchanger Configurations and Types																
▪ Internal					x					x			x			
▪ External										x			x			
▪ Wraparound						x				x						
▪ Plate-type					x					x			x			
▪ Coiled tube type										x	x		x			
▪ Tube-in-shell type					x					x						
Thermal performance improvements																
▪ Storage tank design					x											
▪ Collectors																
○ Absorber plates						x										
○ Cover material					x											
○ Glazing systems					x											
○ Selective coatings					x											

Table 1: Continued

	CPUT		CUT	MUT	TUT	NMMU	NWU	UCT	UJ	UP		US		Univen	Wits	
	Mr. Kanyarusoke	Mr. Kallis	Mr. Aggenbacht	Prof. Malinga	Prof. Dintchev	Mr. Kleyn	Mr. van Niekerk	Ms. De Groot	Mr. Bhamjee	Prof. Meyer	Prof. Xia	Mr. Gauché	Mr. Joubert	Prof. Sankaran	Dr. Ferrer	Prof. Cronje
▪ Heat transfer fluid					x					x	x					
▪ Heat exchangers					x					x						
▪ Methods of insulation											x					
▪ Optimising design parameters						x				x	x					
▪ Extending heat transfer area										x						
▪ Mass flow rate optimisation											x					
Drainback systems																
Collector Type																
▪ Flat plate (Harp)					x											
Heat Exchanger Configurations and Types																
▪ External exchanger										x						
▪ Storage tanks with integrated exchangers					x											

Table 1: Continued

	CPUT		CUT	MUT	TUT	NMMU	NWU	UCT	UJ	UP		US		Univen	Wits	
	Mr. Kanyarusoke	Mr. Kallis	Mr. Aggenbacht	Prof. Malinga	Prof. Dintchev	Mr. Kleyn	Mr. van Niekerk	Ms. De Groot	Mr. Bhamjee	Prof. Meyer	Prof. Xia	Mr. Gauché	Mr. Joubert	Prof. Sankaran	Dr. Ferrer	Prof. Cronje
SWH System Components																
▪ Plate-type										x						
▪ Coiled tube type										x						
▪ Tube-in-shell type										x						
Working fluid																
▪ Water										x						
▪ Refrigerants/phase-change liquids										x						
Thermal performance improvements																
▪ Storage tank design				x	x											
▪ Collectors				x	x					x						
▪ Heat transfer fluid										x						
▪ Heat exchangers										x						
▪ Methods of insulation					x											
▪ Optimising design parameters					x					x						
▪ Extending heat transfer area				x						x						
Draindown																
Collector Type																
▪ Flat plate (Harp)			x		x											
▪ Flat plate (Serpentine)											x					
Pump Type																
▪ AC pump			x		x						x					
▪ DC pump (powered by PV module)					x											

Table 1: Continued

	CPUT		CUT	MUT	TUT	NMMU	NWU	UCT	UJ	UP		US		Univen	Wits	
	Mr. Kanyarusoke	Mr. Kallis	Mr. Aggenbacht	Prof. Malinga	Prof. Dintchev	Mr. Kleyn	Mr. van Niekerk	Ms. De Groot	Mr. Bhamjee	Prof. Meyer	Prof. Xia	Mr. Gauché	Mr. Joubert	Prof. Sankaran	Dr. Ferrer	Prof. Cronje
SWH System Components																
Thermal performance improvements																
▪ Storage tank design			x		x											
▪ Collectors																
○ Cover material			x		x											
○ Glazing systems			x													
○ Absorber plates			x													
▪ Methods of insulation			x								x					
▪ Optimising design parameters			x								x					
▪ Extending heat transfer area			x													
Flooded open-loop																
Collector Type																
▪ Flat plate (Harp)						x										
▪ Flat plate (Serpentine)						x										
Pump Type																
▪ AC pump					x	x										
▪ DC pump (powered by PV module)					x											
Thermal performance improvements																
▪ Storage tank design					x											
▪ Collectors					x											
○ Absorber plates						x										
▪ Optimising design parameters						x										

Table 1: Continued

	CPUT		CUT	MUT	TUT	NMMU	NWU	UCT	UJ	UP		US		Univen	Wits	
	Mr. Kanyarusoke	Mr. Kallis	Mr. Aggenbacht	Prof. Malinga	Prof. Dintchev	Mr. Kleyn	Mr. van Niekerk	Ms. De Groot	Mr. Bhamjee	Prof. Meyer	Prof. Xia	Mr. Gauché	Mr. Joubert	Prof. Sankaran	Dr. Ferrer	Prof. Cronje
SWH System Components																
Recirculation																
Collector Type																
▪ Flat plate (Harp)						x										
▪ Flat plate (Serpentine)						x										
Pump Type																
▪ AC pump					x	x										
▪ DC pump (powered by PV module)					x											
Thermal performance improvements																
▪ Storage tank design					x											
▪ Collectors																
○ Absorber plates						x										
○ Glazing systems					x											
○ Selective coatings					x											
▪ Methods of insulation					x											
▪ Optimising design parameters					x											

Table 1: Continued

	CPUT		CUT	MUT	TUT	NMMU	NWU	UCT	UJ	UP		US		Univen	Wits	
	Mr. Kanyarusoke	Mr. Kallis	Mr. Aggenbacht	Prof. Malinga	Prof. Dintchev	Mr. Kleyn	Mr. van Niekerk	Ms. De Groot	Mr. Bhamjee	Prof. Meyer	Prof. Xia	Mr. Gauché	Mr. Joubert	Prof. Sankaran	Dr. Ferrer	Prof. Cronje
Single SWH Component Studies																
Collectors	x	x			x	x					x	x	x			
Glazing	x											x				
Insulation					x							x				
Absorbers						x						x				
Storage tanks					x						x	x	x			
Heat exchangers					x					x	x	x				
Pumps					x						x					
Heat transfer fluids										x	x	x				
Solar selective coatings					x											
Other SWH Studies																
Techno-economic evaluation	x	x			x			x		x		x	x			
Economic viability		x			x			x				x	x		x	
Social impact assessment		x			x			x					x			
Environmental impact assessment		x			x								x			
Lifecycle assessment	x				x	x				x			x			
Theoretical modelling (simulation) studies	x	x			x			x				x	x			
SWH performance testing/evaluation	x	x		x	x	x	x					x	x			
Thermal performance efficiency	x				x	x						x	x		x	
Heat removal efficiency	x				x	x							x			
Energy efficiency	x				x			x		x			x			

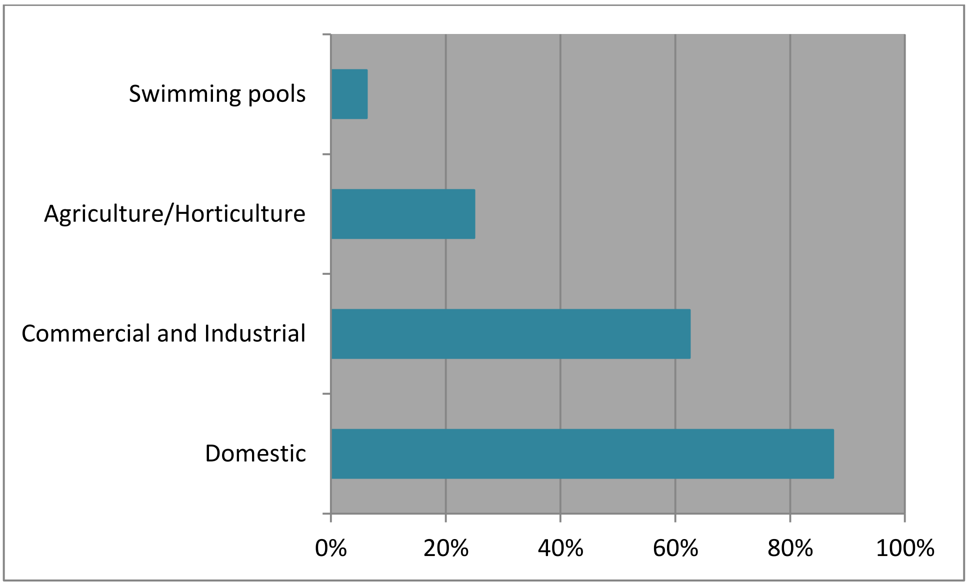

Figure 1: Percentage researchers involved in studies related to different SWH applications.

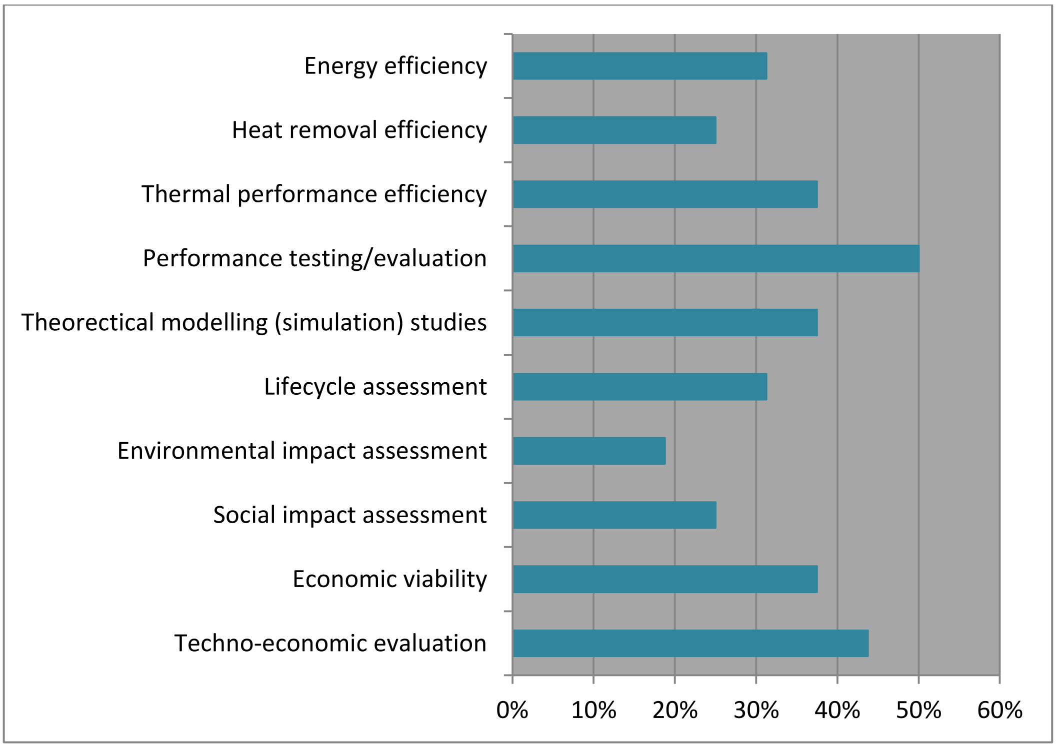

Figure 2: Percentage researchers involved in a variety of SWH studies

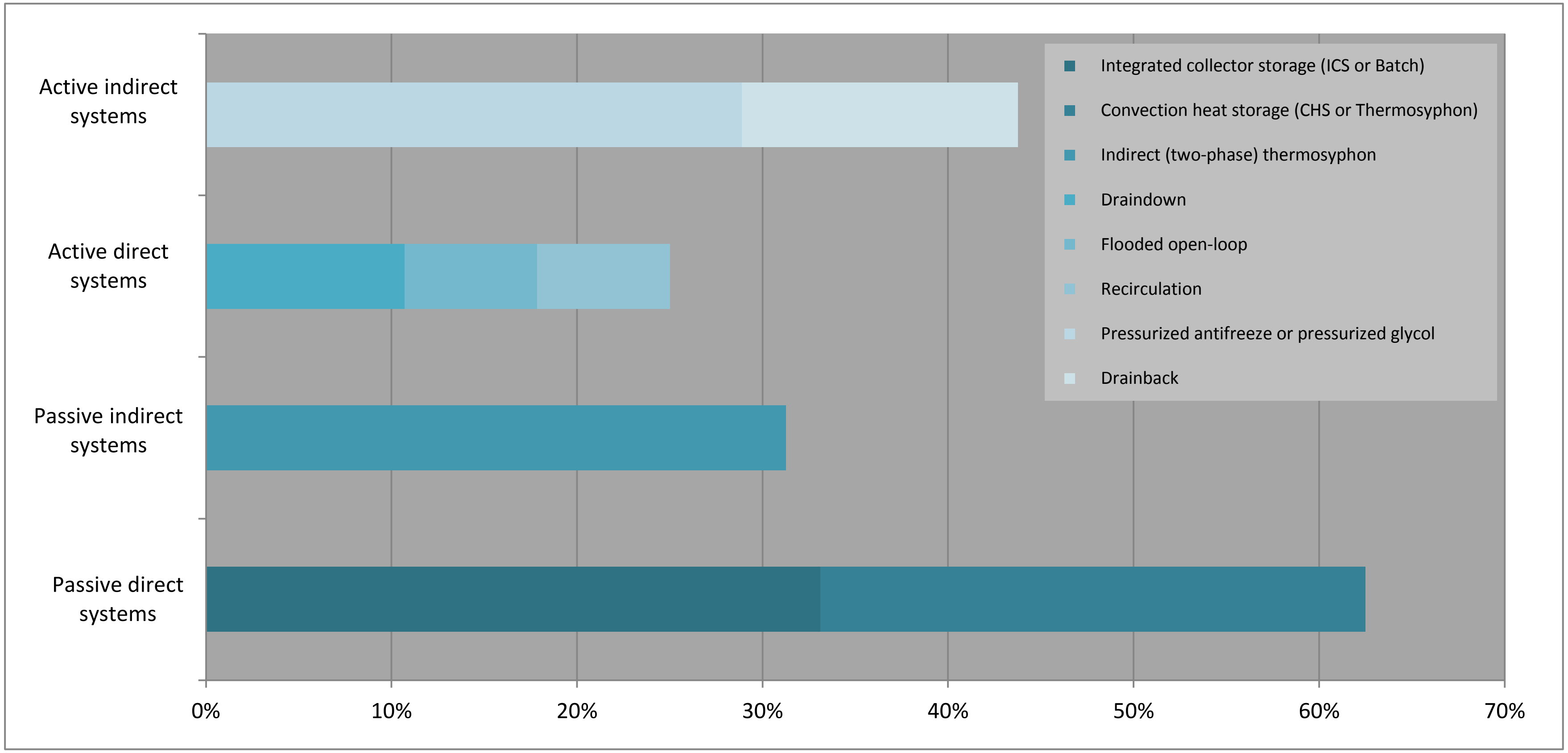

Figure 3: Percentage researchers involved in studies related to different SWH systems.

Summary

Recommendations on Future Solar Water Heating Research Focal Areas in South Africa

- Integration of locally produced solar thermal and heat pump systems;
- Large scale solar water heating system designs and integration;
- Component research and design to improve quality;
- Materials for better performance;
- Research on the optimisation of the following design parameters:
  - Solar collector: The collector heat removal factor, thermal loss coefficient, glazing, optimal number of reflective layers, transmittance absorbance factor and solar tracking, optimal number of collectors, minimisation of shading effects;
  - Heat exchanger: Optimal parameters in order to maximise the rate of energy transfer;
  - Tank: Design for optimal size/volume as well as the tank volume to collector area ratio in order to maximise the performance of SWHS;
  - Connecting pipes: Selection of appropriate pipe insulation in order to reduce thermal losses;
  - Architecture of SWHS: Research on structural requirements of residential houses in order to support different types of SWHS;
- Development of low-cost solar tiles;
- Increasing SWH efficiency;
- Solar radiation versus heating (conversion efficiency);
- Research work on how to reduce production cost. Solar technologies in South Africa will only have an impact if they can become commercially more competitive than at present;
- Cost cycle analysis;
- Application of SWH in the process industry;
- Secondary SWH applications, e.g. medical field, water desalination, potable water production;

- Application of parabolic solar heaters as the primary source of energy for heating purposes;
- Comparative study of performance and efficiency of a tube and fin type domestic solar water heat collector;
- Determine the success of SWH implementation in South Africa. Compile a survey of installed systems to determine whether they still function properly;
- Implementation and roll-out;
- Assessment of SWH contribution to reducing emissions, or reducing electricity demand;
- Initial cost implication of using active/passive SWHS;
- Performance and efficiency of locally produced active/passive SWHS in South Africa;
- Social impact of current ergonomic designs of SWHS;
- The energy saving capacity of SWHS when considering the South African water usage load profile;
- SWH system research: Address the problem of poor policy, revising SABS standards, solutions on how to install SWH correctly;
- Strict standards for procurement process as to ensure high quality SWHS and their installation on RDP houses;
- SWH solutions that better serve demand, both at point of use and for the national grid;
- Resource quantification and economic analysis for any installation;
- Encouraging regular testing of SWH systems and components against local and international standards for all SWH systems produced in South Africa;
- Developing approved evaluation tools and guidelines for proper Measurement and Variation (M&V) and monitoring of solar water heating programmes;
- Developing M&V guidelines for M&V of SWH rollouts including the quality of installations and related Maintenance and Operation (O&M);
- Developing of “exceeded” hot water storage capacity tanks;
- Developing a market for components of SWH allowing clients to choose and assemble a SWH system on their choice;
- Investigate the use of solar PV for water heating.

Recommendations on Potential Gaps Not Covered by Current Solar Water Heating Research

- Potential gaps lie in the local design and manufacturing of evacuated-tube systems and solar panels;
- Local content implications on the design and performance of locally developed SWHS;
- Solar water heating applications in HVAC (heating, ventilation and air conditioning) systems;
- The application of parabolic solar heaters as the primary source of energy for heating purposes;
- The use of PV as energy source is not currently covered;
- Intelligent solar geyser controllers;
- Decreasing manufacturing cost of locally produced SWH systems;
- Absence of scientific database for testing of SWH systems and components against local and international standards;
- Absence of a large-volume storage tanks at reasonable price;
- Absence of a low-cost reliable SWH system;
- Low level of academia/industry R&D partnerships;
- Sustainable training of installers and maintainers of SWH system (especially in the low-cost areas subject of SWH rollout initiatives).

References

1. DME. (2003) *White paper on renewable energy*, Department of Minerals and Energy, Pretoria.
2. DoE. *Solar water heating*. [Online] Available from: http://www.energy.gov.za/files/swh_frame.html. [Accessed 15 June 2015].
3. De Bruyn, C. (2010) Eskom hopes to accelerate SWH roll-out as it doubles rebates. *Engineering News.* [Online] 13 January. Available from: http://www.engineeringnews.co.za/article/eskom-hopes-to-accelerateswh-rollout-as-it-doubles-rebates-2010-01-13. [Accessed: 15 June 2015].
4. Eskom. COP17 fact sheet: Solar Water Heating (SWH) Rebate Programme. [Online] Available from: http://www.eskom.co.za/AboutElectricity/FactsFigures/Pages/Facts_Figures.aspx. [Accessed: 15 June 2015].
5. Pressly, D. (2015) Eskom is bailing out of solar programme. *Fin24.* [Online] 15 January. Available from: http://www.fin24.com/Companies/Industrial/Eskom-is-bailing-out-of-solar-programme-20150115. [Accessed: 16 June 2015].
6. DoE. (2015) *Solar Water Heater Programme update* [Media release] 4 February. Available from: http://www.energy.gov.za/files/media_frame.html. [Accessed: 15 June 2015].