Feasibility Analysis & Operational Design for Local Manufacturing of Solar Water Heating Equipment

by

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Submitted in partial fulfilment of the requirements for

the degree of

BACHELORS OF INDUSTRIAL ENGINEERING

in the

FACULTY OF ENGINEERING, BUILT ENVIRONMENT AND INFORMATION

TECHNOLOGY

UNIVERSITY OF PRETORIA

OCTOBER 2010

Executive Summary

South Africa is currently experiencing a shortfall in electricity generation capacity. To fund the construction of new generation capacity, the price of electricity supplied to municipalities by Eskom will have to increase by between 24.8% and 25.9% per annum for the next three years (Creamer, 2010). This exponential increase in electrical prices will have a detrimental effect on South Africa's economy.

Solar water heaters are seen as one of the most cost effective renewable energy options available in South Africa. In view of the expected high growth in the market for solar heating equipment, an apparent lucrative opportunity exists to increase the domestic capability for the design and manufacturing of solar water heating systems or components.

In the technical analysis the different solar water heating systems were investigated as well as low-cost water heating systems. Of the low-cost water heating systems the Household Water Mixer were considered the best with an annual saving of R2149.85.

An indirect system with flat plate collectors was considered the best solar water heating system currently available on the market. The payback model revealed that this system has a payback period of 3 years. There is a lucrative opportunity to enter the solar water heating market, but it appears to be as a distributor and installer of these systems rather than the manufacturing of these systems.

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Chapter 1

Introduction

1.1. Problem Background

South Africa is currently experiencing a shortfall in electricity generation capacity. If the shortage can not be met by new generation capacity, Eskom will be forced to implement countrywide load shedding which will harm the economic growth of South Africa. The only solutions to create new electricity supply capacity are either by installing coal power stations or to expand renewable energy capacity. Renewable energy is defined as energy that is gained from natural resources, like water, wind and sunlight.

The White Paper on renewable energy of the South African Department of Energy stated that around 10 000 GWh will have to be supplied in future from renewable energy sources. To fund the construction of new generation capacity, the price of electricity supplied to municipalities by Eskom will have to increase by between 24.8% and 25.9% per annum for the next three years. These power tariff increases have been approved by the National Energy Regulator of South Africa (Nersa) (Creamer, 2010). This exponential increase in electrical prices will have a detrimental effect on South Africa's economy.

Eskom has commenced with the construction of new coal generation plants at Lephalale. However this will increase the release of CO_2 enormously which is environmentally unfriendly. Overseas financial sources are thus reluctant to provide finances to Eskom.

Renewable energy is mainly segmented into different categories such as hydro-electricity (water), bio-mass, wind energy (wind) and solar energy (sunlight). South Africa, however, does not have much water resources to expand hydro-electricity. A solution for this may be the Lesotho Highlands Water Project. A total of 80% of the water generated by this project is provided to South Africa, especially Gauteng, and the other 20% are used by Lesotho for hydro-electricity. Capacity for new bio-mass generation is also limited. The construction of these two as well as wind energy is also very capital intensive which limits South Africa to expand these possibilities. Therefore, it is necessary to expand the construction of solar energy capacity in South Africa. (Conningarth, 2004)

For commercial, industrial and residential buildings water heating comprises a substantial percentage of energy consumption per annum. On average the number of days of sunlight in South Africa is quite high and therefore it makes sense to concentrate on the use of solar energy for water heating. See Figure 1 for an example of a Solar Water Heating system and its components.

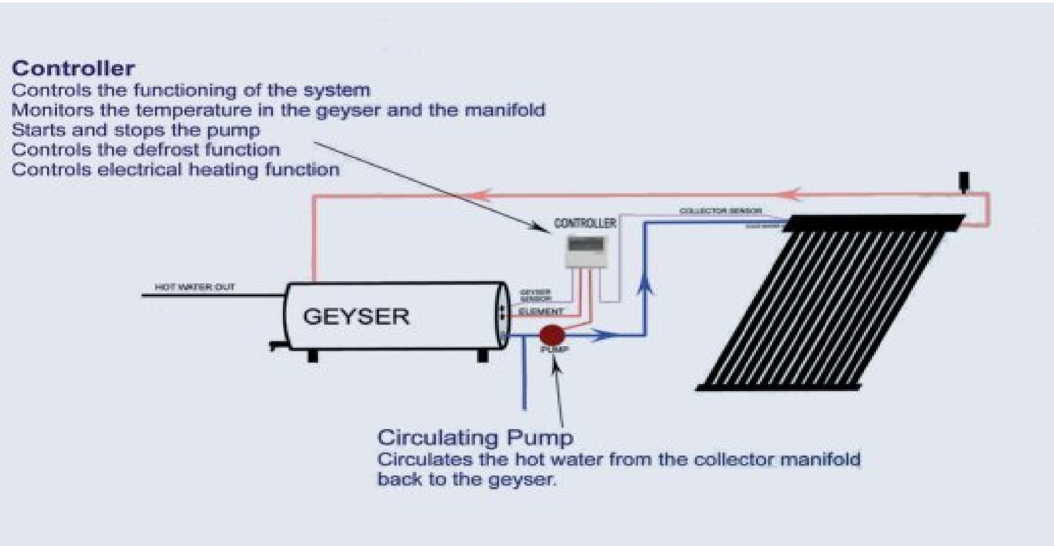

Figure 1: Example of a Solar Water Heating System and its components (Webpage: Crownair gallery solar geysers, 2010)

Fin24 (Williams, 2010) stated that the Government of South Africa has embarked on a new industrial action plan to expand the market for solar geysers. It is envisaged to increase the installation of such geysers from 35 000 to 250 000 per annum over the next three years. At present around 20 000 units are manufactured locally each year and it is planned that this capacity should increase to 200 000 units per annum. The SA Department of Energy hopes that one million solar geysers will be installed by the year 2014 and plans to introduce a new subsidy scheme for solar geysers in the second half of the 2010/11 financial year.

The SA Department of Trade and Industry (DTI) will also publish amended building regulations that solar heating will become compulsory for new and renovated buildings as from March 2011. It is also planned that the DTI will introduce legislation which will make it compulsory for the installation of solar geysers when old geysers have to be replaced.

Presently 40% of all solar geysers are imported. With around 13 million houses in South Africa together with a large industrial need for solar heating the potential market for local manufacturing of solar geysers is therefore substantial. At present the total sales in South Africa is estimated at around R220 million per year.

The installation of solar geysers is also cost effective due to the fact that the future savings in electricity cost are more than the capital outlay for the installation of these geysers. These savings are however not enough to encourage residential users to install these geysers and the Department of Energy is planning a new financial model to overcome this problem.

There is also potential for the exporting of solar geysers especially to the rest of Africa. For instance, countries such as Australia and Israel have already established a highly successful international competitive manufacturing industry. (Williams, 2010)

1.2. Problem Statement

In view of the expected high growth market for solar heating equipment, an apparent lucrative opportunity exists to increase the domestic capability for the design and manufacturing of solar water heating systems or components. This potential needs to be evaluated in order to identify the specific opportunities currently available in the market, considering several factors such as:

- Latest technology developments in the field
- Alternative systems and technology available internationally and locally
- Current user affordability, level and sustainability of subsidies and financing model and options
- Current local design, manufacturing and installation capability, expertise and limitations
- Potential for local market supply development in terms of expanded local system design and integration and/or component manufacturing and assembly

1.3. Project Aim

The aim of the project was to evaluate the potential for local manufacturing of solar water heating systems or components, to identify an apparent gap in the market for local manufacturing or assembly and to design the operations to exploit such a business opportunity.

The specific objectives of the project are the following:

- Determine future market potential and affordability factors.
- Evaluate latest technology and benefits of alternatives systems, e.g. direct versus indirect systems, materials used, etc.

- Establish current product offerings and installation capability and approaches in South Africa and internationally.
- Identify gaps or potential in the local market for the design, manufacturing and supply of solar water heating systems.

1.4. Project Scope

The project scope was limited to solar water heating systems and excluded other forms of solar power systems such as photovoltaic systems to generate electricity. The project focused on solar water heating systems that use flat plate collectors and excluded systems with evacuated tubes. Low cost alternative water heating systems which include the Household Water Mixer was investigated.

1.5. Deliverables and Project Approach

The project was executed in the following main phases:

Phase 1: Literature Study

The latest technology in solar water heating systems were analysed through a thorough literature survey. This includes all technical aspects of alternative solar water heating system design, components or subsystems, materials used, etc.

Phase 2: Market Survey

This phase involved an analysis of demand aspects; that is an evaluation of the future market potential and user affordability.

Supply factors were surveyed; that is the current product and service offerings in the local and international markets, pricing, affiliation and competitiveness.

Phase 3: Payback Model

The objective of this Payback Model was to indicate the cost effectiveness of a Solar Water Heating System and the payback period for such a system.

Chapter 2

Literature Review

A literature review is of utmost importance when any project is undertaken. Analysing and evaluating a wide range of sources including past academic and professional journals, books and web based resources will help develop an understanding of the subject area (Rowley & Slack, 2004). If the relevant literature and subject area are understood, identifying improvement and generating new theories or methods will become easier. (Webster & Watson, 2002) states that, '*An effective review creates a firm foundation for advancing knowledge. It facilitates theory development, closes areas where a plethora of research exists, and uncovers areas where research is needed.*'

2.1. Introduction

This literature review includes a technical analysis of the latest in Solar Water Heating systems. This analysis of the latest technology include all the aspects of Alternative Solar Water Heating system design, Direct versus Indirect systems, components or subsystems (including preheating systems), materials used, etc. Low Cost Alternative Water Heating systems was investigated, including the Household Water Mixer and the Speedheat Water Heater.

2.2. Technical Analysis

2.2.1 Direct versus Indirect Solar Water Heating Systems

Direct systems usually consist of one or more solar panels or evacuated tubes. Water is pumped into the solar panels where it is directly heated by the sun and then pumped into a geyser where it is stored. These systems tend to be quite effective but they have a shorter life span than indirect systems. The reasons for this are that the chemicals in the water erode the pipes, panels and the geyser over time and thus the parts needs to be replaced fairly often. In colder weather and in areas affected by frost, the water inside the panels and pipes can freeze, resulting in cold water and damage to the system (Webpage: Choosing a solar geyser, 2010).

Indirect systems use the same panels as direct systems. The difference is in the geyser as it contains copper pipes acting as a heating coil or heat exchanger. In the Indirect systems water is separated from the water inside the tank by the copper pipes. An anti-freeze fluid circulates through the solar panels (Webpage: Choosing a solar geyser, 2010). The fluid flows through the collector and then through the copper pipes inside the storage tank. The useable water in the storage tank is then indirectly heated. A closed loop keeps the heat transfer fluid apart from the useable water (Webpage: Direct vs Indirect Systems, 2010). Only a small volume of the water will come in contact with the copper pipes and thus is not so effective. The presence of the pipes will also allow for less room for water meaning that a 300 litre tank will not have space to store 300 litres of water. The Indirect systems do have a longer life span than the direct systems as the anti-freeze fluid being used is non-corrosive and it also retains heat longer (Webpage: Choosing a solar geyser, 2010). See Figure 2 for an example of a direct and indirect system.

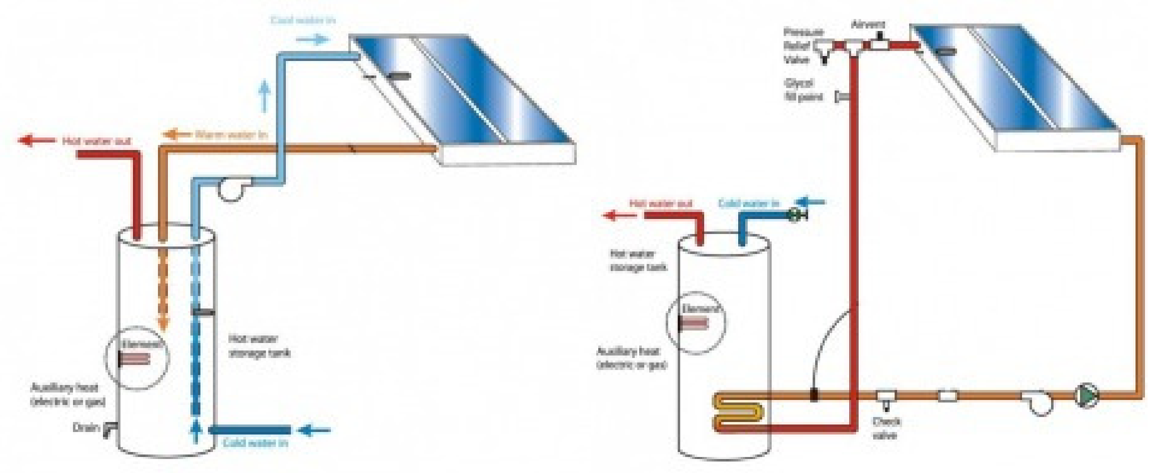

Figure 2: Example of a Direct System (left) and an Indirect System (on the right). Source: (Solar Heating, 2010)

Both the direct and indirect systems geysers are fitted with electricity backup heater elements which can heat the water in the tank if it is not sufficiently heated by the solar energy. The systems are also equipped with a controller which offers constant temperature monitoring, it controls the pump, the functioning of the system, the defrost function and the electrical heating function (Webpage: Solar Geysers, 2010).

Both indirect and direct systems can be installed as a split system (pumped or thermosyphon circulation methods) or as a close coupled system (thermosyphon circulation). The closed coupled system is where the solar water heater is installed outside on the roof and usually above the solar panels (Website: AAA Solar, 2010). The system mostly used in domestic solar water heating is the two component split system. It consists of a flat bed collecter with a direct or indirect system for the heating of the water in a seperately installed vertical or horizontal storage tank (Nieuwoudt & Mathews, 2004) This system is also the most pleasing as the aesthetic value of the house is not compromised, as the geyser is mostly installed under the roof (Webpage: Solar Heating, 2010).

In South Africa both flat plate collecter panels and evacuated tubes are used in solar water heating systems. Evacuated tubes heat up faster and reach higher temperatures than flat plate panels, but they are more fragile (hail damage etc.) and do not last as long as flat plate panels. Also the water only needs to be heated to 40 degrees Celsius, so the higher temperatures that can be reached are unnessecary. Even though the flat plate collectors take longer to heat the water, they are more durable and will last longer (Website: Solartech, 2010). Flat plate panels dominates the local market for solar water heating systems. South Africa has thus followed the example of the European Unions where 85.94% of the installed systems are flat plate systems and only 8.56% are evacuated tube systems. In China it is the exact opposite with only 4.65% using flat plate systems (Han, Mol, & Lu, 2009). This can be seen in the Figure 3.

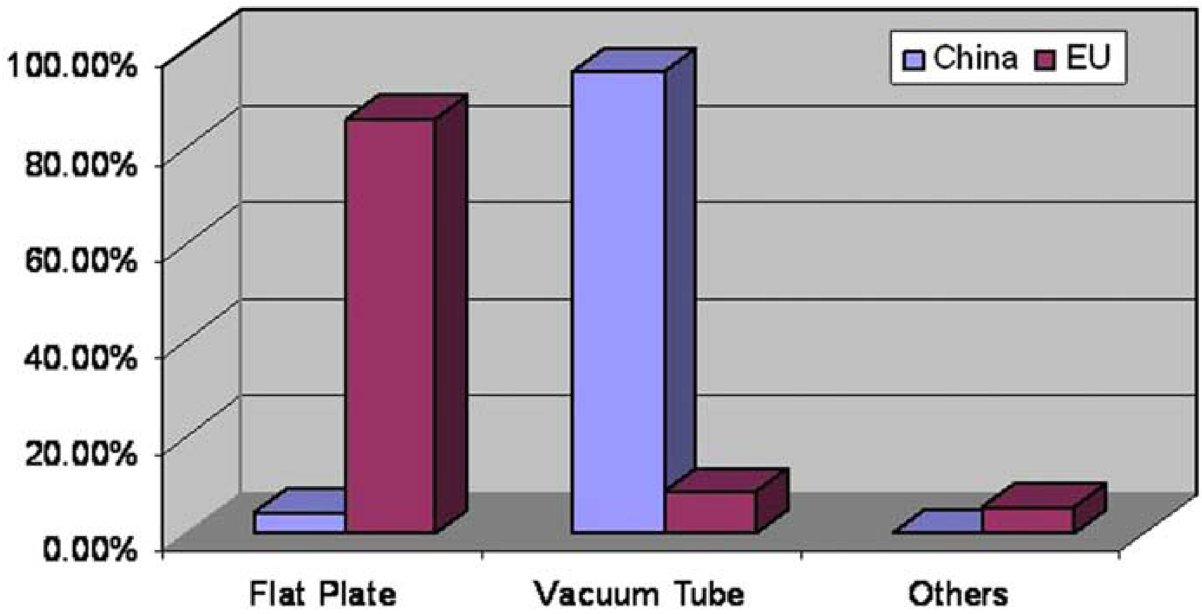

Figure 3: Market share of Solar Water Heating systems in China and the European Unions (Source: Han, Mol, & Lu, 2009).

2.2.2 Solar Water Heating Components

The Solar Water Heating systems that are installed by most companies in South Africa come in 100, 200 and 300 litre systems. The size of the systems will affect the number of solar panels that the system has. The systems geyser cylinders are made up of the following components:

- Cylinder made of stainless steel made for high pressure/temperature. Working pressure of up to 400kPa.
- Insulation with high density polyurethane.
- External casing from stainless steel.
- 2-4kW for the backup element, depending on the size of the tank.
- Anodes fitted for corrosion protection.

Solar collector panel components:

- Collector plates manufactured with an aluminium frame and non-reflective, hail resistant glass.
- Semi-selective black chrome finish for best absorption.
- Manifold tubing made out of copper.

Sources: (Webpage: Suntank system specifications, 2010) and (Website: AAA solar, 2010).

2.3 Low-Cost Alternative Water Heating Methods

Figure 4 indicates that water heating makes up approximately 43% of a household's electricity bill. As mentioned above the focus of this study will be on solar water heating and the manufacturing of its components, but alternative water heating methods will be investigated.

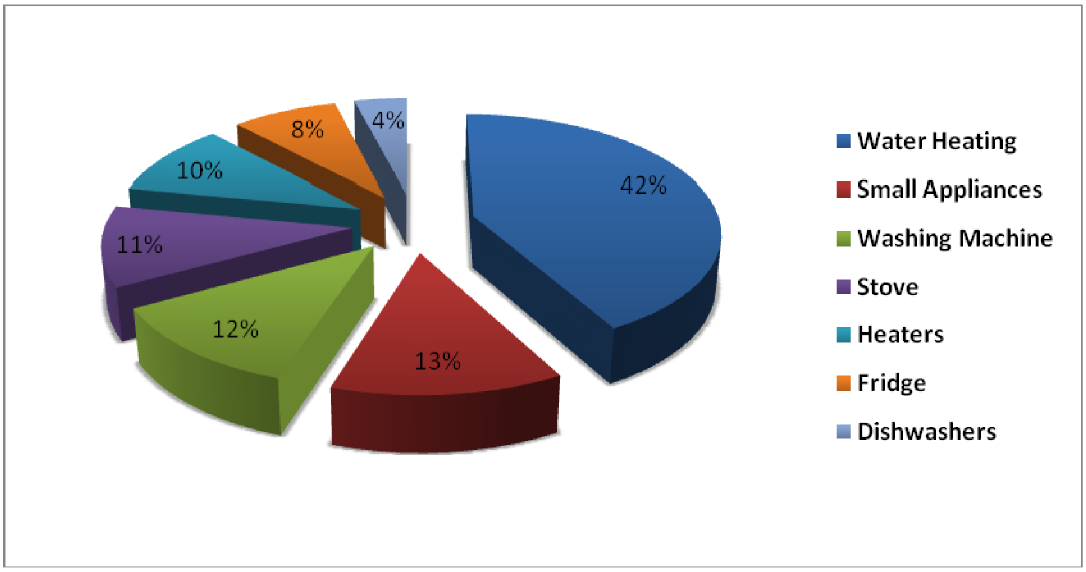

Figure 4: Electricity consumption of appliances in a household (Source: Solar Heating, 2010)

2.3.1 Household Water Mixer

Energy to heat water for household purposes is saved by the introduction of a third pipe supplying lukewarm water to baths, showers, kitchen sink, washing machine and dishwasher. A lot of the initial energy consumption of water heating will be saved as the water can be heated from an initial 15°C to 40°C by the system. The water will then be mixed with hot water supplied by the geyser to 55°C for bathing or showering. The customary hot and cold water will be supplied by the other two pipes respectively.

A mixer will have to be designed which will allow for the use of the lukewarm water and then allow either hot or cold water to be mixed with the lukewarm water if required. The mixer may be designed by making use of several design concepts and valves where three supply sources are coupled. Examples of such valves are: the cylindrical type valve (spool valve) or the spherical type valve.

To heat the cold water to lukewarm water, black PVC pipes (or other pipe options which will be investigated) will be fitted on top off or inside the roof. The cold water is then passed through these pipes to gain the lukewarm water. This system can be connected to a solar water heating system as described above or a regular geyser when hotter water is needed (Source: Eric Brett, 2010).

An example of how the system might look is shown in Figure 5.

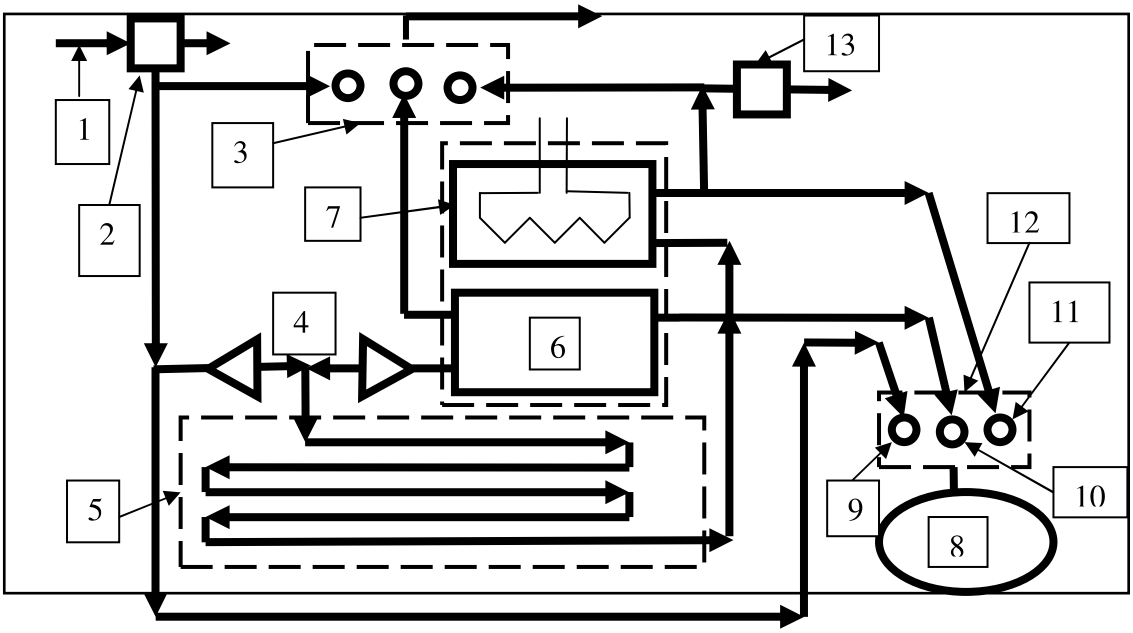

Figure 5: Household water mixer design

1. Water supply

2. Pressure relief valve

3. Kitchen sink

4. Lukewarm water

5. Flexible pipe under roof (or elsewhere)

6. Lukewarm water reservoir tank (optional)

7. Geyser

8. Bath

9. Cold water

10. Lukewarm water

11. Hot water

12. Mixer

13. Pressure relief valve

The following calculations were done to determine the savings when the Household Water Mixer is installed and used:

Assume a household of 4 persons use 200 litre of warm water per day.

The savings calculations are as follows:

• Volume of water	200 litres
• Mass of water	200 kg
• Initial water temperature	15°C
• Water temperature after heating in PVC pipes	40°C
• Joule's coefficient	4 200

Formula (H) = ($m * sh *\Delta\ temp$)

- H = 200*4 200*25
- H = 21 MJ

This equals:

- H = 21000 kWs
- H = 21000/(60*60)
- H = 5.83 kWh

In Pretoria one kWh costs approximately R1.01. The saving per day is thus R5.89. The annual saving is R2149.85.

The total system cost is estimated to be below R3000. This cost will include the piping, mixer valves, couplings and the installation. Your investment will thus be paid back in less than two years (Source: Eric Brett, 2010).

This system may be a solution for water heating in low-income rural areas. The total system cost will be less than the system which will be installed in high-income households. The black PVC pipes will be used in this system as it is the cheapest option. The system will also not need pressure relieve valves because the water source for these households are not from the municipality but usually from a tank situated on a stand next to the house.

In a survey (done by Taylor, 2001) it is shown that people in rural areas use the same amount of hot water in the morning and the evening and less in the afternoon. In the evenings the hot water is mostly used for personal hygiene purposes like bathing or washing (Nieuwoudt & Mathews, 2004). For this system to work in the low-income rural areas, the use of hot water should be limited to the evenings. This is necessary as the system will not be able to be supported by a geyser and the water in the pipes will cool down considerably during the night.

2.3.2 Speedheat Water Heater

The Speedheat Unit is a system that can easily be installed to your bath or sink's taps. The system has a built in element which heats the water as it flows from the pipes. The system will heat the water within 15 seconds of being plugged in to a power source. The Speedheat Instant Hot Water Shower Unit can be easily fitted to your shower and is available in a 3.5kW or 5kW unit.

The website (Speedheat, 2010) lists the following advantages of the Speedheat System:

- Saves electricity and water consumption.
- It is cheaper and easier to install, compared to an electric boiler/geyser.

- The element can be cleaned or replaced if there is a calcium build-up on it.
- It requires a minimum of 60kPa and can thus be used in a low water pressure area.
- It comes with a 1 year warranty.

The following calculations were done to indicate the cost effectiveness of the Speedheat unit:

The calculations were done for the 5 kW Speedheat unit, considering the electrical costs for a family of 6, with each person showering for 5 minutes. The electrical cost of R1.01 per kWh is used.

(R1.01/ 60min) * 5 kW *6 people * 5 minutes = R 2.53 per day = R 921.63 per annum.

The cost of maintaining the heat to an electrical cylinder/geyser:

Standard heat loss formula for a 150 litre geyser = 0.4 watts per litre + 60 watts

= (0.4 * 150) + 60W = 120W

At current cost of R1.01/kWh = 120W * R1.01/kWh = R0.121/Hr

24 hrs * 365 days = 8760 hours per annum

Losses from the geyser only = R0.121 * 8760 = R1059.96 per annum

These calculations exclude the cost of showering and other costs when using a geyser. These calculations are only applicable when the taps are situated some distance from the geyser. The hot water is left to cool in the pipes and needs to be heated every time the hot tap is opened (Website: Speedheat, 2010).

2.4. Comparison of Solar Water Heating Systems

In the technical analysis the difference between indirect and direct systems were investigated. In Gauteng, the Highveld and the Free State only indirect systems should be installed because of the weather conditions. Although there is still companies that install direct systems in Gauteng, these systems has been proven to be not as effective as indirect systems, and the systems tend to fail in extreme cold weather (The Star, 2010). The rest of this paper will focus on indirect systems with flat plate collectors.

Of the two alternative water heating systems that were investigated the Household Water Mixer was considered to be the best. This option should be further investigated, along with which pipes can be used for the water heating. Ways to integrate this system with existing systems or solar water heating systems should be investigated but did not form part of this project.

Chapter 3

Market Analysis

The market analysis will aim to better understand the current market in South Africa for solar water heating systems, determine future market potential and identify future business opportunities with the emphasis on the local manufacturing of such systems.

3.1. Current Market

South Africa experiences some of the highest levels of solar radiation in the world. In Figure 6 the annual solar radiation for South Africa can be seen, which reveals a big potential for solar water heating systems (Department of Minerals and Energy, 2002).

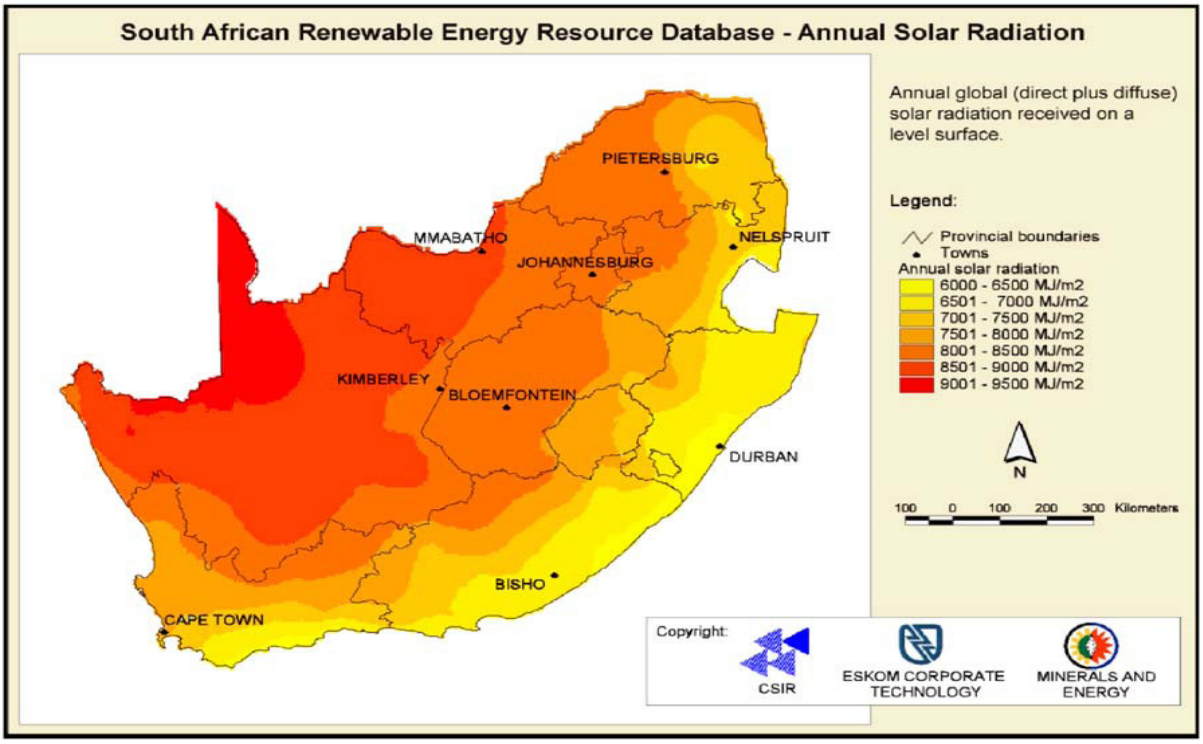

Figure 6: Annual Solar Radiation for South Africa (Department of Minerals and Energy, 2002)

Until the present electricity crises, the market penetration of solar water heating systems was very small. In 2007 it was determined by Statistics South Africa (Stats SA, 2007) that less than 8200 households or 0.07% of the 12,5 million households used solar energy for the heating of water. (See Table 1). This was mostly due to the fact that the payback period for the capital costs of solar water heating systems was too long for the average household. This can be contributed to the fairly low price of electricity supplied by Eskom through municipalities and the inability of suppliers to persuade households to justify the additional initial cost to install solar water heating systems.

Province	Number of households with Solar Geysers installed		Total number of households
Eastern Cape	605	0.04	1 586 745
Free State	475	0.06	802 873
Gauteng	1 092	0.03	3 175 578
KwaZulu-Natal	1 711	0.08	2 234 119
Limpopo	405	0.03	1 215 933
Mpumalanga	1 755	0.19	940 402
North West	594	0.07	911 122
Northern Cape	452	0.17	264 659
Western Cape	1 087	0.08	1 369 181
TOTAL	**8 176**	**0.07**	**12 500 612**

Table 1: Number of households using solar power for water heating purposes (StatsSA, 2007).

Fin24 reports that the rebates of around R5000 paid by Eskom to households for the installation of these systems was also too low to entice households. For example two of these systems costs between R23 000 to more than R35 000 per system. These prices include the system, VAT and an electrician's certificate of compliance (Wasserman, 2010).

These rebates have now been increased. On a 300 litre Solahart system, supplied locally by Selected Energy and manufactured in Australia, Eskom will now pay consumers R12 097, compared to R4 917 before. On a Xstream 300 litre system, supplied by Atlantic Solar Heaters and produced in the Paarl, the rebate has increased from R5 722 to R9 566. The total system with installation costs R24 500, which means it will cost the customer only R15 000, which the company says should be recouped through power savings within three years (Wasserman, 2010). These rebate increases, together with the large power price increases approved by NERSA over the next three years have already caused a large expansion of the market for Solar Water Heating systems.

Fin24 also reported that one of the objectives of the S.A. Government's new Industrial Policy Action Plan (Ipap2) is the expansion of Solar Water Heating systems from 35 000 a year at present to 250 000 per annum over the next three years. Domestic production should also increase from 20 000 at present to 200 000 per year. The Department of Energy plans to have 1 million installed Solar Water Heating systems by 2014. The industry has so far been characterised by small-time manufacturing and importation. 700 companies currently work in this sector of which 200 are in manufacturing and 400 in installation only (Williams, 2010).

3.2. Market Players

The three biggest role players in the solar water heating market currently are Solartech, Solahart, Suntank and Kwiksol. These companies are currently the largest distributors and installers of solar water heating systems in South Africa and Kwiksol is the largest manufacturer of these systems.

Solartech was established in 2006. It currently consists of 40 Solertech franchises countrywide, installing 35000 systems yearly. Unfortunately a lot of these systems are not installed in households but in businesses, mines etc. Solartech does have plans in place to improve the percentage of their systems installed in households. Currently Solartech installs both direct and indirect systems but the sales of the direct systems have decreased because of the problems with these systems. Solahart only installs indirect systems. By 2015 Solartech envisions having 60 franchises countrywide, with each franchise installing 50 geysers per month in households (Solartech, 2010). Solartech, and several other solar water heating companies such as AAAsolar, Solar4Africa and Solareclipse use systems based on geysers manufactured by Kwikot.

Kwikot is a South African company established in 1903 and are the market leaders in hot water storage systems. In South Africa they are the market leader in the manufacturing of solar water heating systems under the brand name Kwiksol which were established in July 2008. The Kwiksol Solar Water Heating Training Course was established in January 2010 and has already trained over 200 plumbers in the installation of solar water heating systems. (Website: Kwikot, 2010)

3.3. Future Market Potential

The future market of solar water heating systems in South Africa depends on the willingness of primarily high-income households to install these systems. In Table 2 it can be seen how the number of households (with emphasis on the high-income housing) have drastically increased from 2001 to 2009. In South Africa the income categories are divided as:

- Low-Income: A household with income of R0-R30 000 annually
- Medium-Income: A household with income of R30 001-R360 000 annually
- High-Income: A household with a income of more than R360 001 annually

Number of Households by Income Category: Low-, Medium- and High-Income				
	Low Income	**Medium Income**	**High Income**	**Total**
1996	5 413 615	3 824 141	165 114	**9 402 870**
2001	6 034 000	4 981 250	410 719	**11 425 968**
2009	4 003 868	8 172 558	1 274 141	**13 450 567**

Table 2: Number of Households by Income Category (Source: DBSA, 2010)

The majority of low- and medium income households would not form part of the market for solar water heating systems as they do not have the funds for a system that can cost anything from R20 000 upwards. Ever increasing electricity prices and innovative financing might change this situation and drastically increase the potential future market.

In Table 3 the number of new residential buildings that were built in each province is shown. These are high-income households and include flats and townhouse buildings. Although it can be seen that the total number of residential buildings built has decreased in 2010 from 2009, it is still a substantial amount of high-income households that were built.

Residential Building Statistics by Province (High-Income)		
	Jan 09 - July 2009	**Jan 10 - July 2010**
Gauteng	10831	10288
Western Cape	6737	6193
Eastern Cape	3393	3527
Northern Cape	107	189
KwaZulu-Natal	2496	1887
Limpopo	493	777
Free State	2197	929
North West	3208	1752
Mpumulanga	1366	1479
Total	**30828**	**27021**

Table 3: Number of New High-Income Households (Source: StatsSA, 2010)

The increase in number of high-income households and the number of new high-income residential buildings show a significant future market for solar water heating systems. The amended building regulations proposed by The SA Department of Trade and Industry (DTI), states that solar heating will become compulsory for new and renovated buildings as from March 2011, which will enlarge the market for these systems significantly (Williams, 2010).

3.4. Conclusion of Market Analysis

This paper's market analysis revealed that the Solar Water Heating market for South Africa has expanded drastically since 2007. Eskom rebate increases have made solar water heating systems more economically feasible for high-income households. Eskom's Solar Water Heating Programme, as well as the new building regulations proposed by The SA Department of Trade and Industry (DTI), shows a big increase in the market for solar water heating systems. Even without these building regulations it is predicted by economists that by 2015, 70% of new residential buildings will be fitted by a solar water heating system.

Chapter 4

Payback Model

The objective of this Payback Model is to indicate the cost effectiveness of a solar water heating system and the payback period for such a system.

For the payback model the solar water heating system example used was a Kwiksol 200-l p x1 from AAA solar. It is a 200 litre indirect split system with flat plate collectors (Website: AAAsolar, 2010).

4.1 Assumptions and Values used for Calculations

The model was set up for a household of 3 persons with one geyser installed. If more than one geyser is installed in a household, the model can be updated accordingly.

- The AAA Solar system costs R21 989 which includes the installation costs.
- Eskom currently offers a rebate of R6 273 on this system.
- The Discount Rate used is 10% and this is assumed to be the interest rate on loans.
- It is estimated that water heating/geyser makes up 45% of a households electricity bill.
- A solar geyser uses 70% less electricity than a conventional electrical geyser (Solar Water Heating FAQs, 2010).
- The households monthly energy consumption was 1 021kWh, thus the monthly savings in energy consumption with a solar geyser will be 322kWh. The electricity bill for this month was R1 028.
- The assumed new tariff which came into affect on the 01/07/2010 of R1.01 per kWh is used for this model.

- An inflation of 6% was used to determine the future cost of the system.
- The real increase in bulk electricity supply cost (before inflation), is assumed to be 3.7%. The assumption is also made that bulk supply cost is 50% of the retail electricity tariff. It is thus calculated that the retail price of electricity will increase by 25% for the first year and thereafter at 7.96% for the following years (Conningarth, 2010).
- The Electrical savings are calculated as the monthly saving with a solar geyser, times the tariff per kWh, times the inflation cost of electricity.
- The Net Benefit Costs for the year are calculated as the annual electricity savings, minus the cost of the system, plus the rebate paid by Eskom.
- The Net Present Value (NPV) is calculated as R28 959.15 at the discount rate of 10%.
- The Internal Rate of Return (IRR) is calculated as 47.4%.
- The break-even point will be during 2013 which means a payback period of approximately 3 years.

Table 4 indicates the different systems offered by Solartech, the prices of these systems, rebate offered, the Net Present Value and the Internal Rate of Return on these systems. All the systems are manufactured by Kwikot and distributed and installed by SolarTech. All the systems are indirect split systems.

The Payback Model proves the cost effectiveness of solar water heating systems and that the payback period for such a system will be less than 5 years and can be as short as 3 years.

SolarTech System	K150ip	K200ip	K200ipx	K250ip
Size of Geyser (Litres)	150	200	200	250
Number of Collectors	1	1	2	2
Usage (People)	1-3	2-3	2-4	3-5
Cost (incl. installation)	R 18 677	R 19 589	R 22 250	R 28 025
Rebate	R 4 233	R 3 856	R 6 273	R 6 496
NPV	R 30 231.15	R 28 942.15	R 28 689.15	R 23 146.15
IRR	52.70%	47.30%	46.40%	31.90%
Payback Period (months)	37	40	41	52

Table 4: SolarTech Solar Geyser Systems (Source: Solartech, 2010)

Figure 7 indicates the difference between the amount of money that are spent on a conventional geyser and a solar geyser annually. It indicates that the money spent on a conventional geyser compared to a solar geyser will increase over time and with this the future savings will increase.

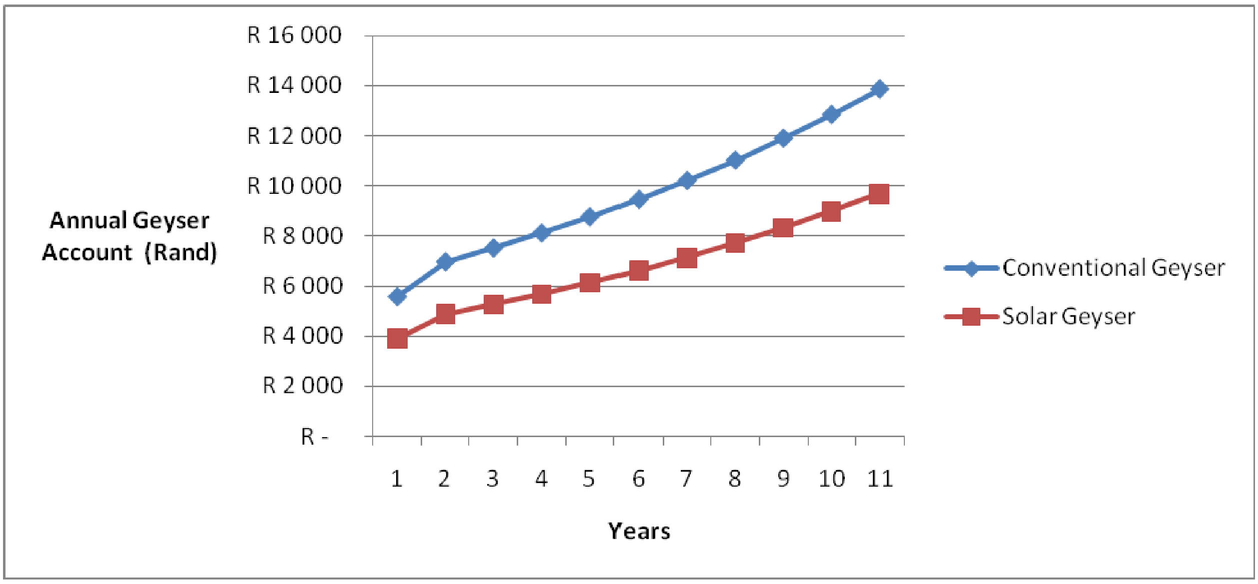

Figure 7: Annual Geyser Account

Chapter 5

Conclusion

This paper has proven that solar water heating systems are currently the most cost effective renewable energy option currently available in South Africa. As water heating makes up approximately 45% of a household's electricity consumption, solar water heating can go a long way in helping to the energy crises currently experienced in South Africa.

The technical analysis revealed that the best system currently is an indirect system with flat plate collectors. Even though a direct system costs less, the rebate offered by Eskom is larger for indirect systems and indirect systems have a longer life span. The House Water Mixer is the best of the low-cost alternative water heating methods investigated and this option needs to be investigated further.

The opinion is formed that it is in each homeowner's best interest to invest in a solar water geyser as the system has a payback period of less than four years and the future savings on such a system will increase over time.

The market for solar water heating systems has grown considerably over the last couple of years and plans are being put in place to expand this market by the Government. In view of the expected high growth in the market there is a lucrative opportunity to enter this market.

With Kwikot dominating the local manufacturing market it limits the entry possibility for a market role player in the manufacturing of these systems. The biggest barrier to entry in the manufacturing market would be the capital needed and the cost of developing such a manufacturing company as the company would have to manufacture systems in mass production if it wanted to compete with Kwikot. A cheaper solution with considerably less barriers to entry would be to establish a distribution and instillation company. The full solar water heating system can be purchased from Kwikot and the Kwiksol Solar Water Heating Training Course trains companies in the installation of these systems.

It is concluded that it is worth while to invest in a solar water distribution company or to establish a distribution company which also handles the installation of these systems. It would also be worth while to further investigate this project as solar water heating systems are the future for water heating and it can greatly contribute to solving the energy crises currently experienced in South Africa.

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Appendices

Appendix A: Payback Model

COST EFFECTIVENESS OF SOLAR WATER HEATERS

Capital Cost		R 21 989
Rebate		R 6 273
Discount Rate/ Interest Rate	10%	

Reduction in Electricity Consumption

Geyser Usage/ Total Electricity	45%
Saving vs Electrical Geyser	70%
Monthly Geyser Consumption (kWh)	459
Monthly saving with Solar Heating	322

Monthly Electricity Account (Incl. VAT)	R 1 028
Assumed New Tariff as from 2010/07/01	R 1.01
Consumption per Month (kWh)	1 021
Average Costs (kWh)	R 1.0066

YEARS		2010	2011	2013	2015	2017	2019	2020
Inflation - Cost	6.00%	1.00	1.06	1.19	1.34	1.50	1.69	1.79
Inflation - Electricity	7.96%	1.00	1.25	1.46	1.70	1.98	2.31	2.49

Real Inflation from 2012 on Eskoms Tariffs	3.7%
Bulk Supply as percentage of Retail Tariff	50%

Capital Cost	R 21 989						
Rebate	R 6 273						
<u>Benefits</u>							
Savings Electricity (Monthly)	R 324.83	R 406.04	R 473.26	R 551.61	R 642.94	R 749.38	R 809.04
Savings Electricity (Annually)	R 3 898	R 4 872	R 5 679	R 6 619	R 7 715	R 8 993	R 9 708
Net Benefits/Costs	R -11 818	R 4 872	R 5 679	R 6 619	R 7 715	R 8 993	R 9 708
Break-even	R -11 818	R -6 946	R 3 994	R 16 745	R 31 606	R 48 928	R 58 637

RESULTS:		
NPV	10%	R 28 959.15
IRR		47.4%

NB: INPUTS ARE HIGHLIGHTED IN YELLOW COLOUR