Renewable Energy Technology (RET) Working Group
Global Network on Energy for Sustainable Development (GNESD)

RET 2

Renewable energy technologies for poverty alleviation

South Africa: biodiesel and solar water heaters

EUGENE VISAGIE

GISELA PRASAD

ENERGY RESEARCH CENTRE
University of Cape Town, South Africa

October 2006

Executive summary

South Africa, like other transitional countries, faces the dual challenge of pursuing economic growth and environmental protection. Sustainable energy systems, based on renewable energy (RE) resources, offer the possibility of doing both. The implementation of RE technologies faces a major challenge because South Africa has large coal deposits and its electricity generated from coal is among the cheapest in the world. Currently less than 1% of the 200 000 GWh of electricity generated in the country originates from renewable sources (DME, 2003a). The Government's White Paper on Renewable Energy Policy (2003) supports the establishment of RE technologies, targeting the provision of 10 000 GWh of electricity from renewable resources by 2013. This has the potential to create 35 000 jobs, adding R5 billion to the GDP and R687 million to the incomes of low-income households (DME, 2004). Solar water heating and biodiesel have the greatest potential to contribute to meeting the target. RE is to be utilised for both power generation and non-electric technologies such as solar water heating and biofuels. By late 2005 the DME completed a Renewable Energy Target Monitoring Framework to ensure that progress towards the 2013 target is effectively monitored (DME, 2005a).

In this report, two RE technologies – solar water heaters (SWHs) and biodiesel – have been identified where renewable energy could make a significant contribution towards poverty alleviation in terms of improving the general welfare of households as well as developing productive activities to generate employment. The country has high levels of solar radiation and an established manufacturing infrastructure for SWHs. They can contribute to a reduction in greenhouse gas (GHG) emissions, and their manufacture and installation can contribute to job creation and skills development. However, the high upfront capital cost of SWHs is one of the key barriers to the development of a market in South Africa. Biodiesel has the potential to contribute to job creation, economic development in disadvantaged rural communities, energy security in the light of rising oil prices, and reducing greenhouse gas emissions. Some of the key challenges to the development of a biodiesel market are food security and limited water resources.

South Africa has average daily solar radiation of between 4.5 and 6.5 kWh per square metre. This resource is relatively predictable and well distributed throughout the country (with some regional variations). Providing hot water using SWH technologies has the benefit of offering quality local government infrastructure services, saving households money over the long term, and mitigating GHG emissions associated with fossil fuel usage. SWHs are also the least expensive means of heating water for domestic use on a life-cycle cost basis (Austin & Morris, 2005).

A national programme focused on the delivery of residential SWHs could potentially reduce the overall national energy demand by 4.5% or 9 000 GWh/annum, and do this at the critical peak times of the day (Austin & Morris, 2005). The high level of solar radiation enables the SWH technology to be the least-cost means of meeting the national target for increased use of RE, and could provide around 25% of the 2013 target – with almost twice the estimated installed collector area of domestic SWHs as at 2002 (DME, 2002b).

The City of Cape Town has published a Draft Energy Strategy which aims to install SWHs in 10% of households by 2010. Solar water heating is generally a matured industry in South Africa. There is a significant body of knowledge in both industry and academia to support the modelling and development of the industry, as well as to support the current activities aimed at the industry's regulation.

Biodiesel processing technology is relatively uncomplicated and can be profitable on small or large scales. The fuel can be blended with petroleum diesel. In rural areas cooperatives can be set up with surrounding producers and customers, and it can be produced as energy fuel in the remotest areas. Opportunities for job creation are high, in both the agricultural and production sectors. New cooperatives centered around the biodiesel production units could become development hubs for other agricultural activities, such as cattle feed lots. The selection of an appropriate crop or mix of crops for the producing feedstock oil is a critical factor in developing a sustainable production system. Government support for biofuels is gaining momentum and plans are being proposed and developed to promote planting, harvesting and processing crops such as maize, sugar cane, soy beans, cassava and oil seeds from trees and sorghum into bioethanol and biodiesel feedstock for use in the liquid fuels industry. To this end the government has established a joint implementation committee (JIC) for the biodiesel industry, comprising a range of interested parties such as the South

African Petroleum Industry Association, farmers, oil companies and unions. A biodiesel standard has been completed with the assistance of the South African Bureau of Standards, and the JIC is developing a pricing model for the local biodiesel industry.

The initial assessment identifies problems which RE technologies generally face and the specific problems of SWH and biodiesel development and dissemination. There are also problems relating more generally to the economy, the supply industry and development issues such as security of supply, unemployment, poverty or black economic empowerment.

The methodology of the multi-country RET study describes a problem as a situation that is considered negative and if the situation is addressed it could lead to positive development; objectives outline the desired and feasible situation at which the application of policy is aiming. The methodology starts by analysing a situation and identifying problems that could affect the development of renewable energy technologies. The objectives identify the desired outcome and the policy outline indicates the way to address the problem.

The seven most important problems are identified in the table below.

Problems, objectives and policy outlines for SWH

Problem	*Objective*	*Policy outline*
1. High upfront capital cost and the absence of affordable financing schemes discourage the installation of SWH.	SWH companies and other players offer attractive financing schemes and many households and the commercial sector are installing SWH.	Facilitating attractive financing schemes. Expanding markets for SWH.
2. Many people don't know about or have a negative perception of SWH.	Information, education and quality assurance have convinced people of the benefits of SWH.	Supporting information and education programmes. Encouraging research on evaluating the benefits and limitations of SWH. Implementing quality assurance and standards.
3. Electricity peak load demand will be greater than generation capacity by the year 2007.	SWHs reduce peak load.	Reducing peak electricity demand by expanding SWH market. City by-laws making SWH installations in new houses mandatory.
4. South Africa has one of the highest GHG emission rates because electricity is generated from coal-fired power stations.	Solar water heaters replace electric geysers and water heating on stoves reducing GHG emissions.	Facilitating the replacement of electric geysers by SWH and supporting the installation of new SWH. Reducing GHG emissions for water heating.
5. High unemployment rates limit socio-economic development.	Employment is created in manufacturing, installing and servicing SWH.	Encouraging and supporting manufacturing SWH for employment generation. Training in SWH manufacturing, installation and maintenance.
6. The poor live in shacks and houses with insufficient service provision. Even if they have an electricity connection they cannot afford to use it for water heating.	SWH are installed in all housing projects for the poor, employment is created.	Subsidising capital expenditure on SWH for the poor. Improving quality of life by facilitating SWH for people in social housing.

Problem	*Objective*	*Policy outline*
7. Black economic empowerment is still lacking in the country.	A high percentage of SWH companies are owned and managed by black entrepreneurs.	Facilitating the training of black entrepreneurs in the SWH sector Supporting access to finances for black entrepreneurs Procurement from BEE.

A detailed analysis of the problems is given in a problem identification matrix. The problems are defined separately from the problem manifestations and the causes.

The table below analyses the situation for biodiesel and identifies problems (although it is not an exhaustive list) that could affect the development, social acceptance and market take up of renewable energy technologies. The objectives identify the desired outcome and the policies outline the way to address the problems.

Problems, objectives and policy outlines for biodiesel

Problems	*Objective*	*Policy outline*
1. There is little awareness about the benefits and opportunities of biodiesel. Implementing a biodiesel programme is complex because many ministries and stakeholders must work together to make it succeed.	All concerned ministries and stakeholders cooperate to support the implementation of biodiesel. People are generally aware of the benefits of biodiesel and support it by buying cars using biodiesel.	Raise awareness about the benefits of biodiesel. Facilitating the cooperation between ministries and stakeholders to implement biodiesel.
2. Developing and introducing new technologies and products and getting them accepted is a long and capital-intensive process. Technical capacity and finance are insufficiently available to develop biodiesel and make it economically competitive with petroleum diesel.	Capital investments have been made. Expertise in growing, processing, distributing and marketing biodiesel is developed. The technology has matured and is adapted to small-, medium-, and industrial-scale production. Biodiesel is competing with petroleum diesel in the market without being supported by incentives.	Attracting capital investment for biodiesel development. Providing agricultural extension services to farmers growing oil cops. Supporting oil plant research. Transferring technologies and research results.
3. Global political developments threaten the continuous supply of oil and, in the long term, reserves of fossil oil and gas will be exhausted.	Sustainable production of biodiesel has been achieved and has become competitive with petroleum diesel, which is gradually being replaced. Greater security of supply has been achieved.	Facilitating the production of biodiesel in SA. Increasing security of supply. Supporting the gradual replacement of petroleum diesel.

Problems	*Objective*	*Policy outline*
4. Very high unemployment rates undermine the government's policies aiming at greater equality, poverty reduction and development of disadvantaged rural areas.	Biodiesel plants have been built in central locations as well as in rural areas and the extracted and processed oil and the residue of protein cake are fuelling and feeding secondary developments. Many jobs are created. The biodiesel plants in rural areas have become development hubs, black economic empowerment is achieved.	Training farmers and other rural people to grow and process oil plants. Encouraging the establishment of feedlots for cattle raising. Promoting black economic empowerment.
5. South Africa has one of the highest per capita GHG emission rates worldwide.	Petroleum diesel is gradually and sustainably replaced by biodiesel and consequently GHG emissions are reduced.	Reducing GHG emissions by replacing petroleum diesel with biodiesel. Complying with future obligations of the Kyoto Protocol.

Stakeholders have been consulted and a stakeholders' problem identification recommendation matrix is presented for both SWH and biodiesel.

Strategic lines of action have been identified derived from the report's problem identification matrix and from the stakeholders' problem identification and recommendation matrix. Finally, instruments and actions have been outlined to operationalise the strategic lines.

Contents

1. Background

As a developing economy**,** South Africa faces the dual challenge of pursuing economic growth and environmental protection. In order to promote economic development and environmental protection it is imperative for the country to consider new paradigms for energy production and consumption, thus incorporating the exploitation of its renewable energy resources. The establishment of sustainable energy systems, based on the use of renewable energy (RE) resources, has become a general pursuit of the global community.

South Africa's abundance of cheap coal poses a major challenge to the successful implementation of RE technologies (the country's electricity generated from coal is amongst the cheapest in the world and 40% of petrol and diesel is manufactured from coal and gas). Two niches – solar water heaters (SWHs) and biodiesel – have been identified where renewable energy could make a significant contribution towards poverty alleviation in terms of improving the general welfare of households as well as developing productive activities to generate employment. The country has high levels of solar radiation and an established manufacturing infrastructure for SWHs. They can contribute to a reduction in greenhouse gas emissions and SWH manufacture and installation will contribute to job creation and skills development. However, the high upfront capital cost of SWHs is one of the key barriers to the development of a SWH market in South Africa. Biodiesel has the potential to contribute to job creation, economic development in disadvantaged rural communities, energy security in the light of rising oil prices, and reducing greenhouse gas emissions. Some of the key challenges to the development of a biodiesel market are food security and limited water resources.

The first Renewable Energy Technology (RETS 1) report diagnosed the renewable energy sector in South Africa and identified potential niches (SWHs, biodiesel and biomass) where renewable energy could make a significant contribution to sustainable development and poverty alleviation. This report (RETS 2) proposes to take a step further by focusing not only on policy outlines and objectives but also indicating which instruments and strategies are best suited to reach these objectives.

2. Rationale and motivation

The country's fast-dwindling peak electricity generation capacity is expected to run out by 2007 and, given the time needed to build new or refurbish mothballed power stations, the harnessing of abundant renewable resources has become more urgent. Another challenge facing the government is providing energy to remote rural areas where grid electricity is unlikely to reach in the foreseeable future. This, coupled with global concerns around carbon dioxide emissions and rising oil prices, has triggered renewed interest in developing RE technologies. Production of RE can provide economic development and employment opportunities, especially in rural areas, which otherwise have limited opportunities for economic growth. RE can thus help reduce poverty in rural areas and reduce pressures for urban migration (Kaufman, 2000).

In late 2003, the Department of Minerals and Energy (DME) published the White Paper on Renewable Energy Policy, targeting the provision of 10 000 GWh of electricity from renewable resources by 2013. This has the potential to create 35 000 jobs, adding R5 billion to the GDP and R687 million to the incomes of low-income households (DME, 2004). SWH and biodiesel have the greatest potential to contribute to meeting the 10 000 GWh target). Currently less than 1% of the 200 000 GWh of electricity generated in the country originates from renewable sources (DME, 2003a). The target is stated as 'an additional 10 000 GWh of renewable energy contribution to final energy consumption, to be produced mainly from biomass, solar, and small-scale hydro'. The renewable energy is to be utilised for both power generation and non-electric technologies such as solar water heating and biofuels. By late 2005 the DME completed a Renewable Energy Target Monitoring Framework to ensure that progress towards the 2013 RE target is effectively monitored (DME, 2005a).

Since the completion of the RETS 1 report, the country has witnessed rapid developments in the RE sector. In 2005 the Department of Minerals and Energy established its Finance and Subsidy office for RE (REFSO). The government approved R4 million to support RE projects for 2005, with more

funding secured for 2006-2007. The REFSO mandate includes the management of RE subsidies, and providing advice to developers and other stakeholders on RE finance and subsidies (including size of awards, eligibility, procedural requirements etc), as well as opportunities for accessing finance from other sources (DME, 2005b).

The National Energy Bill has been published for public comment. It will form the central legislation regulating the energy sector in South Africa, and lead to dramatic changes and consolidate the energy legislative landscape. If enacted, this legislation will give legislative effect to the White Paper on Energy (1998) and the White Paper on Renewable Energy.

In February 2006 the government announced its Accelerated and Shared Growth Initiative of South Africa (ASGISA), whose ultimate objective is to halve unemployment and poverty by 2014. The biofuels sector has been identified for special priority attention. Biofuels development is labour intensive, a rapidly growing sector world wide, suited to the South African circumstances, and open to opportunities for Broad Based Black Economic Empowerment (BBBEE) and small business development (Mlambo-Ngcuka, 2006).

Voluntary schemes such as the Clean Development Mechanism (CDM) and Renewable Energy Certificates have the potential to provide increased support for an expanded role of RE in the future.

The Department of Environmental Affairs and Tourism, tasked with developing a National Strategy for Sustainable Development for South Africa, has made the development of RE a high priority.

3. Selected niches and justification

3.1 Solar water heaters

The provision of hot water using SWH technologies has the benefit of providing quality local government infrastructure services, saving households money over the long term and mitigating GHG emissions associated with fossil fuel usage. SWHs are also the least expensive means of heating water for domestic use on a life-cycle cost basis because solar energy is free (Austin & Morris, 2005). South Africa experiences high levels of solar radiation, with average daily solar radiation of between 4.5 and 6.5 kWh per square metre. This resource is relatively predictable and well distributed throughout the country with some regional variations. The levels of radiation available for SWH are dependent on:

- geographical location within South Africa;
- the azimuth angle of the collector in relation to True North;
- the angle of tilt from the horizontal;
- local climate and atmospheric conditions.

Table 1 reflects the available solar radiation at optimal angles of tilt for twelve different locations in South Africa (Austin & Morris, 2005)

Table 1: Available solar radiation at optimal angles of tilt for 12 locations in South Africa

Location	*Optimal tilt angle (Degree from horizontal)*	*Worst month at this tilt angle*	*Average daily insolation in worst month ($Wh/m^2/day$*	*Average daily insolation over the year at this tilt angle ($Wh/m^2/day$*
Alexander Bay	30	June	5634	6713
Bloemfontein	30	June	6058	6656
Cape Town	35	June	4193	6029
Durban	35	September	4759	5075
Grootfontein	35	June	5984	6669
Nelspruit	30	November	4840	5598
Port Elizabeth	35	June	4782	5767
Pretoria	30	January	5652	6029
Roodepoort	30	January	5896	6133
Upington	30	June	6105	6914
Average			5390	6158

A national programme focused on the delivery of residential SWHs could potentially reduce the overall national energy demand by 4.5% or 9 000 GWh/annum, and do this at the critical peak times of the day (Austin & Morris, 2005). The high level of solar radiation enables the SWH technology to be the least-cost means of meeting the national target for increased use of RE, and could provide around 25% of the total target of 10 000 GWh by 2013. This is almost twice the estimated installed collector area of domestic SWHs as at 2002 (DME, 2002b).

The City of Cape Town has published a Draft Energy Strategy which aims for a 10% installation of SWHs in all households by 2010. It has prepared draft legislation requiring SWHs and insulation in all new middle-to-high-income households by 2005. Furthermore, it proposes that all low-income formal housing have ceilings – new housing by 2005, retrofit of existing houses by 2007 – houses are built to be energy efficient.

Solar water heating is generally a matured industry in South Africa. There is a significant body of knowledge in both industry and academia to support the modeling and development of the industry, as well as to support the current activities aimed at the industry's regulation (Austin & Morris, 2005). In 2003 an industry association, SolaSure, was established to represent the interest of all stakeholders in the delivery of services in the SWH industry. SolarSure has initiated task groups to deal with the following:

- quality control and testing;
- standards and testing facilities/procedures;
- marketing and membership;
- interaction with Eskom;
- research and development;
- interaction with international bodies.

The Central Energy Fund (CEF) is currently assisting Solarsure in executing these tasks (Hamid,. 2006).

It is further envisaged to establish an ombudsman system to protect the interests of end-users and to uphold the name of the industry.

Currently there are some initiatives underway to develop the skills base of the industry. These include in-house training by individual companies and national programmes offered by the Energy Sector Education and Training Authority (ESETA), in terms of the Skills Development Act.

SWHs are the least expensive means of heating water for domestic use (on a life cycle cost basis), yet the technology take-up has been slow. The market provides three niches for the dissemination of SWH: the middle-to-high-income group, the recipients of RDP houses for the poor, and the commercial and institutional sectors such as in offices, hospitals, hotels and prisons. Solar water heating has considerable potential to leverage electricity savings, increase employment opportunities, improve electricity demand side management, and reduce greenhouse gas emissions. A wide range of solar water heating products are available, but the industry is faced with limitations in terms of standardisation, awareness, affordability and financing, which prevents widespread technology adaptation.

3.2 Biodiesel

Biodiesel processing technology is relatively uncomplicated and it can be profitable on small or large scales. The fuel can be blended with petroleum diesel. In rural areas cooperatives can be set up with surrounding producers and customers and it can be produced as energy fuel in remote rural areas. Opportunities for job creation are high, in both the agricultural and production sectors. New cooperatives centered around the biodiesel production units could become development hubs for other agricultural activities as cattle feed lots.

The selection of an appropriate crop or mix of crops for the production of feedstock oil is a critical factor in developing a sustainable production system. Key considerations are yield per unit area, climate, soil type, availability of water, fertiliser, other resources and whether the oil-bearing part is used as human or animal feed (Wilson *et al,* 2005). Suitable feedstocks are maize, sunflower, soya, peanut and cotton seed. In recent years the tree *Jatropha curcas* has received considerable attention because it gives higher oil yield per hectare than peanuts, sunflower, soya, maize or cotton (Wilson et al, 2006). *Jatropha* grows on marginal land and its rainfall requirements are 300 mm or more per annum. Soy is regarded as the most appropriate oil crop since not only can the oil be used but the residue oil cake is also a desirable by-product either for animal feed or for human consumption, alleviating protein deficiency.

Biodiesel is produced by a process of transesterification, involving the addition of methanol, resulting in biodiesel and the by-product glycerine. In the initial phases production is limited and biodiesel will only be blended with petroleum diesel ranging from 2% to 10% biodiesel and 98% to 90% petroleum diesel. No engine modification is required at such low percentages of biodiesel.

The rising price of international crude oil, the global drive to limit greenhouse gases to curb global warming, technological advances that are lowering the cost of biofuels production and the enormous potential for local job-creation has made the development of biodiesel an urgent and necessary undertaking. The government's aim is that biofuels should account for about 40% of South Africa's RE, to achieve the target of 10 000 GWh of RE by 2013 (*Engineering News*, 2005). South Africa aims to supply 2%, that is 160 million litres, of the eight billion litres of its annual diesel consumption *(Engineering News*, July 2006).

Government support for biofuels is gaining momentum and plans are being proposed and developed to promote the planting, harvesting and processing of crops such as maize, sugar cane, soy beans, cassava and oil seeds from trees and sorghum into bioethanol and biodiesel feedstock for use in the liquid fuels industry. To this end the government has established a joint implementation committee (JIC) for the biodiesel industry. The JIC comprises a range of interested parties such as the South African Petroleum Industry Association, farmers, oil companies and unions. A biodiesel standard has been completed with the assistance of the South African Bureau of Standards, and the JIC is currently developing a pricing model for the local biodiesel industry.

4. Initial assessment of selected niches

4.1 Characterisation of selected RE niches

4.1.1 Needs and energy requirements

Biodiesel
South Africa has become increasingly aware of the opportunities for a viable biofuel industry as a result of rising oil prices, the need to diversify energy supply and to reduce of GHG and the job creation potential. South Africa required about 6 to 7 billion litres of diesel annually in 2003 and it has the potential to produce 1.4 billion litres from oil crops without impacting negatively on food security (DST 2003).

Oil crops to produce biodiesel can be grown in most provinces. The number of people who could benefit from the implementation of a biodiesel programme is difficult to estimate, but planting and harvesting oil crops as well as the processing of biodiesel could energise rural communities in terms of job creation and economic development. Biodiesel could be produced at the industrial-scale and also at a small-scale decentralised production benefiting poor rural communities.

Industrial scale biodiesel
Sasol Oil is considering taking up the production of biodiesel at a centralised location and providing to the oil market. Recognising the importance to its long-term sustainability, Sasol is intending to build a 400 000 t/y soybean-to-diesel plant. The USA already produces biodiesel from soy on a commercial scale. This production is subsidised and such agricultural subsidies may pose a problem when countries such as South Africa market biodiesel internationally.

Small-scale production of biodiesel
The objective is to encourage the small-scale production of biodiesel for decentralised consumption. Small towns and remote rural areas can be energised, leading to local development.

Solar water heaters
The installed capacity of SWH was about 500 000 m^2 in 2003 including both unglazed (pool heating/agriculture) and glazed type (water heating) and the annual sales for SWH were estimated to be 15 000 m^2 in 2003 (Agama 2003).

SWHs can be fitted to most buildings and are suitable in all parts of the country. Different groups of people will benefit from expanding the SWH industry, which has the potential of adding R1383 million to the GDP and R176 million to the income of low-income households (Table 1). It is estimated that manufacturing, installing and servicing SWHs will create 5909 jobs, but since SWHs will in some cases replace electric water heaters some jobs may be lost in the latter industry. The industry employs at present about 300 people (Agama, 2003). SWHs would improve the hygiene and health of the poor if they having running hot water and spend less for it.

In addition to new jobs, if all RDP houses are fitted with SWHs 6.5 million people will enjoy the comfort of running hot water and will be spending less for it. In this scenario government would have to subsidise the SWH. The high-income households are principally targeted for the installation of SWH because they are most likely to afford them and no subsidy would be necessary. In the commercial and institutional sectors, offices, hotels, banks, hospitals, hostels (education) and prisons would derive long-term financial benefits.

4.1.2 Technologies

Biodiesel
Biodiesel is a clean burning renewable fuel of which the raw materials can be produced from agricultural crops or from 'energy crops' that are grown specifically for the purpose of producing biomass for conversion into an energy carrier, or by the conversion of waste vegetable oils and animal fats (Wilson et al, 2005). The production of biodiesel is a matured technology which does not require major or time-consuming studies prior to introduction. The manufacturing process is simple

compared to petroleum refining and is based on a chemical reaction called transesterification, in which a triglyceride molecule from vegetable or animal fat reacts with methoxide to produce glycerin and alcohol esters from the fatty acid chains.

As the infrastructure for large-scale biofuel plants is not yet in place, small-scale biodiesel plants have been started in Stellenbosch and Pietermaritzburg using waste cooking oils. Farmers affected by high input costs, cheap grain imports and rising debts have started to rethink traditional crops and farming systems and expect to become profitable by growing and producing biofuels for themselves. A farmer in the North West Province, assisted by an engineer who designed a cost-effective processing plant, produces 80 000 litres of biodiesel annually as well as oil-seed cake for his cattle. Producing biodiesel on his farm saves him R2 per litre compared to buying diesel at the pump. He can also supply other farmers in the area with cheaper diesel and oil-seed cake for cattle feed (*Engineering News* 2006).

A feasibility study by Mitsui & Co of Japan in 2005 stated that a biodiesel plant producing annually 100 000 tons of biodiesel from *Jatropha curcas* would cost R262 million (US$40 million), including the acquisition of farmland for cultivating the oil crop. The study indicated that the internal rate of return of 4.4% is much lower than the long-term interest of 11.5% in South Africa. The project was found not to be attractive to investors unless it would benefit from carbon credits.

Solar water heaters

Solar water heating is a matured industry in South Africa, but its promotion is hampered by the low cost of coal-based electricity generation and the lack of regulations in national and local building codes. There is, nevertheless, a significant body of knowledge in both industry and academia to support the modeling and verification process as well as to support the current activities aimed at the industry's regulation (Austin & Morris, 2005).

Most SWHs in South Africa are characterised by a solar collector panel and an insulated storage tank. SWH systems vary significantly and the various system designs can be classified as passive or active, and direct or indirect. Passive systems use the thermosyphon principle to heat and circulate the water, whilst the active systems have pumps to circulate the water through the system. Both systems have electrical elements as backups. A direct system heats the water by circulating it directly through the collector. This is not appropriate in cold climates because of the risk of pipes bursting. The indirect system can circulate an antifreeze fluid in the collector which in turn heats the water in the storage tank. Glazed collectors can increase the temperature of the fluid passing through by 30 to 40 degrees centigrade and is more suitable for domestic use. Unglazed collectors can elevate the temperature by 10 to 20 degrees centigrade and are suitable for swimming pools (Borchers, 2002).

Typical SWH configurations are:

- An integral system in which the collector and storage elements are combined.
- The close-coupled SWH system is configured with a collector and storage tank mounted together as a close-coupled unit on the roof.
- In a separate collector storage system the collector is placed on the roof whilst the tank is mounted under the roof.

The integral system is cheaper, but the integral system has the disadvantage that hot water cannot be easily stored for use in the morning or evening and are thus not popular. The price of a 200 litre SWH ranges from R6000 to R9000, excluding installation costs (Solardome SA, 2006).

4.1.3 Renewable resources

The country has a technically feasible RE production potential of approximately 87 000 GWh, corresponding to about 49% of the electricity consumption in 2001 (DME, 2004). Less than 1% of the total electricity used in South Africa originates from renewable sources. RE accounts for approximately 9% of the total energy consumption, generated mostly from fuelwood rather than from modern RE technologies.

Biodiesel

The level of biodiesel activity in South Africa is limited and not yet well coordinated. In 2003 the Centre for Scientific and Industrial Research (CSIR) conducted research into the role of biodiesel in South Africa. The aim was to investigate the potential production of biodiesel feedstock oils without affecting food production, and the availability of edible oils in South Africa. The status of the main oil-bearing crops is as follows (DST, 2003):

- Sunflowers: From 1991 – 2000 average area planted was 544 000 ha. Almost entire crop of 700 000 ton was used as cooking oil.
- Soybeans: Average only 114 000 ha planted per year and the crop tends to have a low yield. The crop is used for oil and the seed milled for use in animal feed, soy milk and for human proteins and margarine.
- Groundnuts: Approximately 100 000 ha are planted annually. The harvest is used for edible nuts and groundnut oil.
- Cotton: The cotton bolls are separated into seed and fibre. Cotton seed contains 18% oil which is mostly used as salad oil and in catering. South African production of cotton lint is less than 50% of the national requirement, thus 38 000 tons of lint is imported annually.

The report concluded that at least 600 000 ha of maize (South Africa produces a large surplus) could be switched to oil crops to increase plant protein production and to provide feedstock for biodiesel production. There is a real potential to produce 1.4 billion litres of biodiesel per annum from these four crops without threatening food production.

Waste vegetable oil is another feedstock which does not require any agricultural land.

The tree *Jatropha curcas* is an oil seed bearing tree which is growing well in Zambia and Zimbabwe where it is also used as a hedging and erosion control plant. It can grow on marginal land at rainfall levels as low as 300 mm per annum. Currently seedlings are being raised in the North West Province for large-scale plantations. The seeds are toxic to humans and animals and have therefore have limited use.

Solar water heating

The high levels of solar radiation enables the SWH technology to be the least-cost means of meeting the national target for increased use of RE, and could provide around 25% of the total target of 10 000 GWh by 2013. This is almost twice the estimated installed collector area of domestic SWHs as of 2002 (DME, 2002b). Table 2 gives estimations of the solar water heating potential from several recent studies. The differences in estimates can be attributed to different assumptions regarding financial and economic costs of harvesting the resource using different conversion technologies and different assumptions about the price that the energy can be sold for.

Table 2: Solar water heating potential (TWh electricity output)
Source: Banks & Schaffler (2006)

Draft Renewable Energy White Paper (ref. in EDRC 2003)	*Renewable Energy White Paper (DME 2004)*	*Economic Modelling Paper (DME 2004a)*	*Renewable Energy Market Transformation Study (World Bank 2004)*	*Upper limits used*
0.5	6 (Urban residential only)	4.9 (domestic only) 2.0 (commercial)	43 in 2021	55 by 2050 Not limited by supply

4.1.4 Assessment of capacities

The SWH technology is relatively well established whilst biodiesel is relatively new and it is not well known. The capacity assessment of the two cases is given below. See also Tables A5, A6 and A7 in the Appendix.

4.1.5 Capacity assessment: Biodiesel

There are no fuel crops grown for biodiesel production, but oil crops such as maize, soya and sunflower are grown for human and animal consumption. There would be some capacity to grow most of the crops but the amount grown would have to be scaled up. There is currently hardly any biodiesel produced or blended commercially, and considerable new capacity would have to be built.

1. Legislative authorities, elected officials and government macroeconomic and development planners

There are just a few pioneering farmers who have grown oil plants for biodiesel in the past and biodiesel is known to some in the agricultural sector but it is not so well known in other sectors and by elected officials. Its potential role in creating jobs and uplifting disadvantaged areas is not yet fully appreciated. Since biodiesel cannot yet compete with petroleum diesel, initial incentives – such as tax relief, subsidies, credits and fuel mandates – would be necessary to get the industry started. When the production cost of biodiesel comes down and the price of fossil oil continues to rise, biodiesel incentives may be reduced.

2. Government energy authority, regulation and non-energy ministries

The DME has set the policy and regulatory framework for the development and implementation of RE as outlined in the White Paper on Energy (1998) and the White Paper on Renewable Energy (2003). At the request of the Cabinet, the Department of Science and Technology (DST) undertook a national technology audit of the transport fuel sector and recommended that commercial-scale production of biodiesel should be supported. The report highlights the benefits to black, previously disadvantaged farmers. To this end the DST established the Biodiesel Joint Implementation Committee (B-JIC) to coordinate further studies to enable the introduction of biodiesel to South Africa. The B-JIC has done extensive work in terms of creating an enabling environment for the biodiesel industry and have focused on the following critical areas (Wilson *et al*, 2005):

- feed stock supply;
- organised agriculture;
- acceptability by the motor industry;
- biodiesel fuel standards;
- financing arrangements.

As pointed out before, the government's aim is that biofuels should account for about 40% of South Africa's RE, to achieve the target of 10 000 GWh of RE by 2013, and biofuels were earmarked as a priority project under ASGISA.

The Department of Transport is currently developing a National Vehicles Emission Strategy, a National Strategy for Sustainable Transport, and intends to implement the Taxi Recapitalisation Programme in the 2006/2007 financial year. This involves replacing the estimated 120 000 petrol-powered taxis with larger diesel-powered midi-bus taxis expected to use 600 000 kl of diesel per annum (CSIR 2001).

The Finance Ministry has recently announced a fuel levy rebate of 30% on biodiesel. This is an encouraging sign for industry because it would make biodiesel manufacture more competitive with petroleum diesel.

The Ministry of Agriculture has set up a *Jatropha* Task Team under the auspices of the Kwa-Zulu Natal Department of Agriculture and Environmental Affairs to investigate the feasibility and impact of introducing the alien *Jatropha curcas* as a crop species. Further, the Water Research Commission has launched a three-year study into the water and resource-related impacts of large-scale planting of *Jatropha curcas*. Two sites in Kwa-Zulu Natal have been identified and transpiration (sap-flow), climate and site water balance measurements are being conducted at each of these sites (Bio-Fuel, 2005).

The National Department of Environmental Affairs and Tourism (DEAT) through its National Strategy on Cleaner Production and Sustainable Consumption encourages certain industries such as the catering and hospitality trade, vegetable oil refineries and food manufacturers to support an emerging biodiesel industry by ensuring that used vegetable oil is recycled for biofuel production.

3. Market coordination agency
There is a need to identify potential market coordination agencies. The recently established South Africa Energy Management Association (website: www.sema.uct.ac.za) includes industry members, energy experts and public sector organisations. With government support such organisations could bridge the gap between policy goals and implementation by providing training, and assistance with technology development and implementation (EDRC 2003).

4. Energy supply industry
Sasol, the world's biggest producer of fuel from coal, is considering a soybean-to-diesel plant (Bridge, 2004). If approved, the plant would produce 91 million litres of biodiesel per annum. At present local farmers produce only 136 500 tons of soy beans and the company might have to import the shortfall until such a time that South African farmers switch to growing more soy.

5. Entrepreneurs and productive industry
Potential large producers like Sasol, which has declared an intention of starting biodiesel manufacture, have the in-house capacity to start a biodiesel industry. Any capacity they do not have they can hire or subcontract. Sasol would build capacity for its own production units but small rural producers need assistance and support from government.

6. Energy equipment and end-use equipment manufacturers and energy equipment O&M services
Some of the equipment will be imported, at least initially. The country has a well-developed mining and manufacturing industry, and if demand is sufficient all equipment could be manufactured in the country. O&M services can be trained locally and will contribute to employment creation.

7. Credit institutions
Credit is essential for manufacturers and farmers. Commercial farmers can obtain credit through the appropriate farming-related institutions. Large companies have well established relations with credit institutions and biodiesel would just be another product for which they would seek credit. The small-scale and community producers need assistance and possibly government support to access credit institutions. Credit institutions need to become familiar with oil crops as an economically viable crop.

8. Local government
The energy policies and strategies of the City of Cape Town support the introduction and development of cleaner transport fuels. City of Durban has developed an Environmental Management Policy encouraging contractors to adopt biodiesel under certain conditions and in certain environments like wetlands, estuaries or at sea. Other cities such as Tshwane and Ekurhuleni have also embarked on sustainable energy strategy development and implementation, and biofuels are considered in these.

9. Civil society / NGOs
Few NGOs specifically promote the use of biodiesel in South Africa, but there are a few with interests in alternative energy, climate change and or sustainable development. South Africa is a member of the International Energy Agency Bioenergy which has the objective of removing non-technical barriers that impede the use of liquid biofuels in the transport sector. Users need to be better informed about the advantages and disadvantages of modern diesel engines. The Africa Eco Foundation is planning to establish a Biodiesel for Community Development programme using *Jatropha* as the oil source, as part of a land claims and resettlement initiative (www.jatropha.org/south-africa/index.htm). The SouthSouthNorth Project is an international network of research organisations and consultants which manages biodiesel projects in Brazil but as yet none in South Africa. The International Institute for Energy Conservation (IIEC-Africa; www.iiec.org) promotes sustainable transport and is based in Johannesburg.

10. Users
Diesel vehicles are not yet common in South Africa, with 99% of light passenger motor vehicles (less than 12 persons) petrol-powered (see Table 3). A study on attitudes towards diesel and petrol-powered vehicles (CSIR 2001) found that petrol vehicles were preferred and gave the following reasons for their preference: the respondents said that they don't know diesel, they are used to petrol, petrol is readily available, petrol cars are faster, they start first time and start better when it is cold,

petrol engines are quieter, have good performance and are more powerful. The respondents gave the following reasons for preferring diesel vehicles: they are more economical, they last longer and are more fuel efficient; diesel vehicles are better for farm and poor roads, their maintenance costs are cheaper and they are easier to maintain/service (CSIR 2001, p 52).

Table 3: Motor vehicle propulsion
Source: CSIR (2001)

Vehicle type	*Petrol/diesel-powered*
Light passenger motor vehicle (less than 12 persons)	99% petrol; 1% diesel
Light load vehicle (GVM 3 500 kg or less)	85% petrol; 15% diesel
Motor cycle	100% petrol
Minibus	85% petrol; 15% diesel
Special vehicle	90% diesel; 10% petrol
Heavy passenger motor vehicle (12 or more persons)	100% diesel
Heavy load vehicle (GVM>3 500 kg, not equipped to draw)	100% diesel
Heavy load vehicle (GVM>3 500 kg, equipped to draw)	100% diesel

11. Energy specialists and consultant firms
The country does not have many experts and consultancy firms specialising in biodiesel. However, pockets of expertise are to be found, mainly in academic institutions.

12. Academia and research organisations
There are no specific courses on biodiesel. Oil crops are well known and are grown in the country as vegetable oils for human consumption and their cultivation is taught in the agricultural faculties. Research and teaching in RE resources, technologies, markets and policies has to be strengthened as a matter of priority at universities and technical training institutions. There are some research projects on biodiesel at universities.

In April 2006 the government granted the University of Stellenbosch R3 million per annum for a period of five years for the establishment of a Postgraduate Programme in Renewable and Sustainable Energy. The programme consists of three components: a masters and doctoral programme, an associated research programme, and linkages to off-campus market transformation and enterprise development initiatives. The overall aim of the initiative is to develop and enhance national capacity in renewable and sustainable energy in support of accelerated and shared economic growth within the bounds of environmental sustainability. The specific objectives are threefold: to build human resource capacity; to deepen knowledge; and to stimulate innovation and enterprise in the field of renewable and sustainable energy (DST, 2006).

13. Media
Media play an important role in shaping public opinion and attitudes. Media should be made aware of the advantages and disadvantages of diesel engines and explain these to the public. Recently a number of articles on biodiesel were published in newspapers and magazines.

4.1.6 Capacity assessment: Solar water heaters

SWH technology is known and a limited number of SWH companies exist. SWH is under-utilised in South Africa and is currently supplying less than 1% of the energy required for heating water (www.solarengineering.co.za/Update). The installed capacity of SWHs is estimated at 242 MW, compared to 39 000 MW for grid electricity.

Capacity building and skills development are critical for the successful roll-out of SWH programmes. Parallel initiatives to develop the skills base in SWH are underway, i.e. in-house training and accreditation schemes for individual companies and national programmes administered by the Energy Sector Education and Training Authority (ESETA), a stakeholder body composed of employees, employers and government departments.

1. Government macroeconomic and development planners
The macroeconomic impact: according to the CaBEERE 2004 report, SWH for commercial buildings and high-income households would create 5909 jobs; the dynamic financial costs would be R0.27 per kWh as compared to the dynamic socioeconomic cost of R0.23 per kWh. They would contribute 2341 GWh to the targeted 10 000 GWh from RE.

2. Government energy authority or ministry
The DME with sponsorship from Danida/DANCED has been running a large capacity-building programme (CaBEERE) focusing on RE and energy efficiency. The White Paper on Renewable Energy Policy has included the contribution of non-electric technologies such as solar water heating as part of achieving its 10 000 GWh target.

3. Energy regulatory bodies
No particular regulation is required for SWH. Developing standards for the industry has been going on for at least 15 years. EDRC recommended standards revisions (EU-compatible) as early as 1990-91. A weak commercial market, and poor SABS performance in this area, led to stagnation in effective national standards implementation.

4. Market coordination agency
In 2003 Sustainable Energy Society for Southern Africa (SESSA) formed an association, SolarSure, to act in the interest of all stakeholders in the delivery of excellent services in the SWH sector. SolarSure has initiated task groups on: standards and testing facilities/procedures; quality control and training; marketing and membership; Eskom interaction; and research and development.

5. Non-energy governmental authorities and ministries
The DST (Department of Science and Technology) and the DTI (Department of Trade and Industry) are generally supportive of RE programmes. The DST supports technology transfer and innovation and also capacity building in these areas. It is also supporting energy technologies that are targeting the poor and have the potential to alleviate poverty. The Central Energy Fund (CEF) will initiate the Solar Water Heating 500 Project in 2006 which aims to transform the market for SWH in South Africa by tackling barriers like standardisation, consumer awareness, affordability and financing, which ultimately prevents widespread technology adaptation. The project will install and incentivise 500 SWHs from the low-income households to higher income households. Building on favourable conditions prevailing at the end of the project, a second phase of the market transformation will be initiated. This phase will enable commercial installation of further 9 000 SWHs over a five-year period, with the ultimate goal being to further bridge affordability gaps and make the benefits of SWHs available to low-income households (CEF, 2005).

6. The energy supply industry
The energy supply industry is not involved in SWH. However, it is important for Eskom (and any other electricity suppliers) to judge the role of SWH in reducing average and peak load demands. This can affect their generation investment decisions.

7. Entrepreneurs and productive industry
There is a good number of entrepreneurs in the SWH industry who are trying to increase the market share of SWH. Lack of awareness, high upfront costs and relatively low grid electricity prices are the major obstacles to the expansion of the industry.

8. Energy equipment and end-use equipment manufacturers
The Solar Water Heating Division of SESSA worked out priority areas for their new association called SolaSure. These are generally accepted testing standards, testing equipment and quality assurance for all sections of the industry. Market transformation was to start at the high-to-middle-income sector of the market because that sector is open to innovation and can afford the new technologies.

9. Energy equipment and O&M services
There is a range of companies to supply equipment and provide O&M services. If the market expands it is expected that the companies will grow in number and size and new capacities will have to be built.

10. Credit institutions and financial support

The Development Bank of Southern Africa is supportive of developments in RE and has financed the Lwandle SWH project near Cape Town. Capital and service subsidies for SHS paid by government facilitate private investment in PV concessions but there is no funding support for SWH. Credit institutions in cooperation with SWH companies need to develop affordable financing schemes.

The CDM may offer project opportunities to sell the carbon emission reduction. The buyers in the market are, among others, the World Bank's Prototype Carbon Fund. The DBSA is an intermediary to assist project developers to access these funds from the World Bank. The Kuyasa project in Cape Town has developed a methodology for receiving CDM credits from the installation of SWHs.

11. Local government and NGOs

The City of Cape Town is committed to ensuring that 10% of households have SWH systems by 2010, and has initiated a number of activities to promote the technology. It is currently drafting by-laws to promote the use of SWHs in homes to help meet its target. The City plans to install 22 000 SWHs in the N2 Gateway low-income homes (Atlod, J. 2006) and has started to retrofit 2 400 SWHs at Kuyasa in Khayelitsha. According to Mr Asmal, director of Environmental Planning, the initial retrofitting of SWHs in houses in Cape Town could lead to the establishment of a R1 billion plus industry (Cape Argus, 2006).

Ubushushu Bendalo – meaning 'heat from nature', was founded in August 2004 as a joint initiative by the following civil society organisations: City of Cape Town; Earthlife Africa, Cape Town; AGAMA Energy; Environmental Justice Networking Forum; SouthSouthNorth; and Sustainable Energy Africa. The Ubushushu Bendalo strategy is to harness the expertise, knowledge and capacity in the City of Cape Town to provide a channel for resources to enable effective and efficient implementation of RE and energy efficiency technologies, in particular, solar water heaters. New initiatives include:

- The City of Cape Town has through its ICLEI-funded (Cities for Climate Protection programme) installed 2 300 SWHs (ave. 150 litres) in the Kuyasa low cost housing project.
- SWH initiative for 25 SWH systems for NGOs and Bed & Breakfast outlets.
- The Johannesburg Climate Legacy SWH project at Oude Molen.
- The Driftsands SWH housing project.
- The N2 upgrade project.
- An InWent-funded survey of the existing SWH systems in Cape Town.
- The Kuyasa project for the City of Cape Town's Directorate of Housing.
- Assessment of the social and technical status of the Lwandle SWH systems for the City's Directorate of Housing.
- *New Energies* has become the leading supplier of solar-heated water in South Africa. New Energies provides customers with a retrofitted solar water heater to supply daily hot water needs to its customers at a cheaper price than their current hot water costs. Cost and maintenance of the system is borne by the company. This is made possible through seed funding from E+Co.

A SWH pilot project was initiated in 2002 under the auspices of USAID's Climate Technology Partnership in liaison with the Durban Metro Housing Authority to install 100 SWHs in two low-income townships. The ultimate objective of the project was to help the housing authority determine whether to incorporate SWHs into its housing delivery programme.

12. Users

The potential users of SWH generally lack information about its advantages and drawbacks. Electricity tariffs being low, many users are not convinced that SWHs are an economic investment. It is quite likely that some domestic customers and even some industrial and business customers would be prepared to pay a little more for installing green water heating. Exporting industries would be interested to affix a green label to their products

13. Energy specialists and consultant firms
There are specialist and well established consultancy companies. If there is a massive roll-out more capacity would have to be added to the existing pool.

14. Academia and research organisations
SWH is a specialised topic which is taught as part of renewables. A masters dissertation has recently been written on SWH at the Energy Research Centre, University of Cape Town. As reported above, the University of Stellenbosch is starting a postgraduate programme in Renewable and Sustainable Energy.

15. Media
Media need to be better informed. Professional magazines carry articles on SWH occasionally.

4.2 Assessment and identification of problems (specific to selected niches)

The following general barriers/problems to the implementation of RE have been identified (DME, 2004):

- Many RE technologies remain expensive on account of higher capital costs, compared to conventional energy supplies for bulk energy supply to urban areas or major industries.
- Implementation of RE technologies needs significant initial investment and may need support for relatively long periods before reaching profitability.
- There is a lack of consumer awareness on benefits and opportunities of RE.
- The economic and social system of energy services is based on centralised development around conventional sources of energy, specifically electricity generation, gas supplies, and to some extent liquid fuel production.
- Financial, legal, regulatory and organisational barriers need to be overcome in order to implement RETs and develop markets.
- There is a lack of non-discriminatory open access to key energy infrastructure such as the national electricity grid, certain liquid fuels and gas infrastructure.

Table 4 identifies the specific problems associated with SWHs and biodiesel. These problems are of two kinds; the first are problems relating specifically to SWH and biodiesel such as high upfront capital cost of SWH and the high production cost of biodiesel compared to petroleum diesel. The second type of problems relate to more general issues of the economy, the supply industry or developmental issues.

Table 4: Identification of problems affecting SWHs and biodiesel development and dissemination

Solar water heaters	*Biodiesel*
1. High upfront capital cost and the absence of affordable financing schemes discourage the installation of SWH	1. There is lack of awareness and information on the benefits of biodiesel and consequently many potential stakeholders do not realize the opportunities of biodiesel
2. Many people don't know about or have a negative perception of SWH	2. Considering the price competition with petroleum diesel biodiesel development needs substantial and continued support for attracting capital investment, providing services for farmers, research for improving oil plants
3. Electricity peak load demand will be greater than generation capacity by the year 2007	3. Being a new fuel biodiesel's entry into the market faces legal, regulatory and access problems

4. South Africa has one of the highest GHG emission rates because electricity is generated from coal-fired power stations	4. There is potential conflict with food crops over land and water resources; national food security and the limited water resources have to be carefully assessed before large-scale oil crop plantations are started
5. High unemployment rates limit socio-economic development	5. Natural petroleum resources are finite and will decline in the near to medium-term future. Also global political developments threaten the continuous supply of oil
6. The poor live in shacks and houses with insufficient service provision. Even if they have an electricity connection they cannot afford to use it for water heating	6. Very high unemployment rates undermine the government's policies aiming at greater equality, poverty reduction and development of disadvantaged rural areas
7. Black economic empowerment is still lacking in the country	7. South Africa has one of the highest per capita GHG emission rates

5. Policy outlines

The methodology of the multi-country RET study describes a problem as a situation that is considered negative and if the situation is addressed it could lead to positive development; objectives outline the desired and feasible situation at which the application of policy is aiming. The methodology starts by analysing a situation and identifying problems that could affect the development of renewable energy technologies. The objectives identify the desired outcome and the policy outline indicates the way to address the problem.

5.1 Strategy objectives and policy outlines: solar water heaters

5.1.1 Identification of problems, objectives and policy outlines

The seven most important problems are identified in Table 5.

Table 5: Identification of problems, objectives and policy outlines for SWH

Problem	*Objective*	*Policy outline*
8. High upfront capital cost and the absence of affordable financing schemes discourage the installation of SWH	SWH companies and other players offer attractive financing schemes and many households and the commercial sector are installing SWH	Facilitating attractive financing schemes. Expanding markets for SWH.
9. Many people don't know about or have a negative perception of SWH	Information, education and quality assurance have convinced people of the benefits of SWH	Supporting information and education programmes. Encouraging research on evaluating the benefits and limitations of SWH Implementing quality assurance and standards.
10. Electricity peak load demand will be greater than generation capacity by the year 2007	Installed SWH have reduced peak load	Reducing peak electricity demand by expanding SWH market. City by-laws making SWH installations in new houses mandatory.

Problem	*Objective*	*Policy outline*
11. South Africa has one of the highest GHG emission rates because electricity is generated from coal-fired power stations	Solar water heaters replace electric geysers and water heating on stoves reducing GHG emissions	Facilitating the replacement of electric geysers by SWH and supporting the installation of new SWH. Reducing GHG emissions for water heating
12. High unemployment rates limit socio-economic development	Employment is created in manufacturing, installing and servicing SWH	Encouraging and supporting manufacturing SWH for employment generation. Training in SWH manufacturing, installation and maintenance.
13. The poor live in shacks and houses with insufficient service provision. Even if they have an electricity connection they cannot afford to use it for water heating	SWH are installed in all housing projects for the poor, employment is created	Subsidising capital expenditure on SWH for the poor. Improving quality of life by facilitating SWH for people in social housing.
14. Black economic empowerment is still lacking in the country	A high percentage of SWH companies are owned and managed by black entrepreneurs	Facilitating the training of black entrepreneurs in the SWH sector. Supporting access to finances for black entrepreneurs. Procurement from BEE

5.1.2 Detailed problem identification: SWH

A detailed analysis of the problems is given in the problem identification matrix (Table 6). The problems are defined separately from the problem manifestations and the causes. While Table 4 and Table 5 give a general outline of the problems, Table 6 gives a more detailed analysis. In column 1 of Table 6 the problems are grouped into broad categories such as economic, political/institutional, social and environmental. In the second and third column the detailed problems in the categories are defined and the problem manifestations are outlined. Column 4 identifies the causes of the detailed problems and column 5 the players involved. Column 6 gives the objectives of the detailed problems outlined in column 2.

Table 6: Detailed problem identification matrix: SWH

1.Elements of the problem: dimension	*2. Problem definition*	*3. Problem manifestation*	*4. Causes*	*5. Players involved*	*6. Objective*
Economic	High initial capital cost	Low rate of SWH dissemination keeping the unit price high	Cost of SWH compares unfavourably with cost of conventional water heaters	Manufacturers , installers, customers	Manufacture of large numbers of SWH has reduced the initial capital cost is and SWH are affordable for customers

1.Elements of the problem: dimension	*2. Problem definition*	*3. Problem manifestation*	*4. Causes*	*5. Players involved*	*6. Objective*
Economic	Absence of financing schemes for SWH	Customers continue to heat water with electricity, gas, coal or wood	Potential customers cannot afford the installation	Banks, insurance companies, customers, installers, manufacturers	SWH are widely used for heating water
Political/ institutional	Many people including planners, developers and architects have a negative perception of SWH	People are not buying SWH because they are not sure that it is a worthwhile investment	Lack of knowledge about SWH and the absence of compulsory standards	Department of Minerals and Energy, Energy Efficiency Agency, South African Bureau of Standards, manufacturers, customers	Information and education have convinced people of the benefits of SWH. Standards are widely accepted by manufactures and installers
Political/ institutional	The peak load capacity will have been reached in 2007 and new generation plants will have to be built	Electric water heaters contribute to the peak load	Households use hot water during the morning and evening peaks	Electricity company, households	Reducing peak electricity demand by expanding SWH market
Socio-economic	There is high unemployment and the SWH industry could create many new jobs	High unemployment leads to social problems	Unemployment deprives people of their dignity and social integration	Unemployed, government, SWH industry	A flourishing SWH industry will create many more jobs
Social	The poor live in shacks with insufficient service provision	SWH cannot be installed	There is no piped water and roof structures cannot carry the weight of the SWH	Ministry of housing, municipality	SWH are installed in all social housing
Environ-mental	Heating water with electricity, gas, coal and firewood contributes to high GHG emissions of the country	High GHG emissions per capita	High emission rates of fuels used	Households, Energy and Environment ministries	SWH are replacing electric, gas , coal, firewood as sources for water heating and GHG emissions are reduced

5.1.3 Stakeholders' problem identification and recommendations: SWH

At a side event of the International Conference on Domestic Use of Energy held in Cape Town in April 2006, representatives of different organisations with an interest in the area of SWH held a workshop to discuss urgent issues and made recommendations for the way forward. The stakeholders represented the DME, the energy regulator, NGOs, the Sustainable Energy Society of Southern Africa, SWH companies and universities. They gave presentations followed by discussions. The programme of the workshop is given in Appendix A and the presentations are available online (at www.ctech.ac.za/conf/due/index.html). The Workshop identified the eight most important problems and gave recommendations on how to address the problems (Cawood & Prasad, 2006) (see Table 7).

Table 7: Stakeholders' problem identification and recommendation matrix: SWH

Problem definition	*Problem manifestation*	*Objective*	*Recommendation*
1. SESSA is not funded and cannot act effectively.	SESSA having the potential to lobby for SWH promotion cannot act effectively because it is not funded.	Establishing SESSA as an independent and sustainable NGO.	Set up an effective and sustainable funding mechanism. The possible options are DME, EDC, NERSA, SANERI, Energy efficiency agency, PG Programme in Sustainable and Renewable Energy.
2. SWHs are not effectively promoted.	The public has insufficient information and the promotion by government and parastatals is almost nonexistent.	The public is well informed about SWHs.	Establish good communication and awareness programme, linked to sticks and carrots funded by: DME, EDC, NERSA, DST, SANERI or Energy Efficiency Agency.
3. There are no courses or workshops on SWH.		Educational material on SWH is widely available.	Develop educational materials funded by: DME, EDC, NERSA, DST, SANERI or Energy Efficiency Agency; SESSA to assist in developing material.
4. The SWH industry is not well coordinated.	SWH industry not coordinated to promote the industry and subsequently uninformed customers.	A well coordinated SWH industry will promote the industry and inform the public.	SWH industry to work in a multi-stakeholder way and in consultation. SESSA to act as umbrella organisation.
5. Standards exist but implement-ation is not mandatory and full-scale test facility not yet available.	Customer confidence is undermined by absence of SABS mark of approval.	Standards are implemented; full-scale testing facilities are available at subsidised rates	Expedite testing of SWHs and the installation of test facility at subsidised price.

Problem definition	*Problem manifestation*	*Objective*	*Recommendation*
6. Financial incentives are not developed.	SWHs are too expensive and many cannot afford the initial capital cost.	To develop financing mechanisms to make the installation of SWHs more attractive.	Local government particularly those with climate change strategies should promote SWH through incentives; financing mechanisms for easier pay back, rates rebates , government subsidised lower interest rates.
7. Transparency of potential benefits.	Benefits of ripple control, DSM and other load shed devices have not been passed on to customers who paid for them. Similarly customers have not been informed of benefits to be expected from SWH.	Benefits to be passed on to customers in transparent programmes.	To be transparent about benefits of SWHs in regard of load control and to work out how benefits are passed on to customers.
8. There is a gap between utility information and SWH performance regarding regulatory support.	There is regulatory support for utility hot water load control but no support for SWH.	Stakeholders in the hot water provision and load control business to work together to provide balanced information on SWH and other systems.	Motivate for regulatory support for SWH to be adjudged with similar basis as that of ripple/radio control systems.

5.1.4 Strategic lines of action: solar water heating

The strategic lines of action are the policies that are expected to lead to the desired objectives. They are derived from the problem identification matrix (Table 6) and from the stakeholders' problem identification and recommendation matrix (Table 7).

Strategic line 1: SWH companies together with banks develop attractive financing schemes together with service contracts targeting different market niches. Particular schemes are developed for institutions such as clinics, hospitals, prisons, schools and boarding houses, adjusting their repayment schemes to the saved electricity expenditure. It is expected that high-to-middle-income groups are the first to take up the offers and monthly electricity expenditure will be much reduced when SWHs are installed.

Strategic line 2: An information and education campaign is developed and carried out. It is funded by government departments and related organisations (DME, DST, EDC, SANERI, NERSA. Information on SWH, their benefits and limitations is widely disseminated in different media. Easily accessible demonstration sites are set up. SESSA is supporting the campaign and the association of SWH companies, Solasure assures quality and dissatisfied customers can complain when they are not satisfied with the installed product.

Strategic line 3: Affordable financing schemes and government assistance is facilitating an active SWH market. As a consequence, more jobs and sustainable employment in manufacturing, installing and servicing SWH is created.

Strategic line 4: House and flat owners are replacing their electric geysers with SWHs and people who heated water on electric stoves have switched to SWH. Institutions have installed SWHs and it

is estimated that about 2300 GWh (DME 2003) of grid electricity is replaced by SWH, thus reducing the peak load.

Strategic line 5: Government is already implementing housing plans to provide basic housing to improve the livelihoods of the poor. In addition to the basic housing grant of about R23 000, an amount to install SWH is added. Part of this amount is to be included as an addition in the housing grant and the other part to be paid by the customer in affordable instalments. The precise proportions and the repayment schedule are to be worked out by government, SWH companies and the customer. SWH are made affordable for the poor and are installed in new RDP houses and retrofitted in old ones.

Strategic line 6: Intensive training conducted by the Energy SETA (Sectoral Education and Training Authority) and other organisations, together with financial incentives for BEE companies, black technicians and entrepreneurs are encouraged to set up SWH companies. After initial support the BEE companies have gained technical and managerial experience and successfully compete in the market without further incentives.

Strategic line 7: Making load control benefits of SWH transparent and motivating for regulatory support for SWH with a similar basis as that of ripple/radio control systems.

Strategic line 8: The measures under strategic lines 1 to 7 are leading to the dissemination of many SWHs, replacing water heating that previously used grid electricity from coal-fired power stations or heating water with coal or wood. GHG emission rates are being reduced.

The major strategic actions are: developing access to attractive and affordable financing. Implementing technical standards, wider information programmes, increasing the capacity of the industry and the expanding market leading to lower prices for SWH.

5.1.5 Instruments and actions: solar water heating

The instruments and actions should indicate how to operationalise the strategic line. This list is not exhaustive and many more actions or subactions could be added.

1. SWH companies represented by an association and commercial banks will work out an agreement for financing SWH – similar to financing the purchase of a car. The savings from electricity bills should be estimated and the repayment rates could be linked to the saved electricity expenditure. The financing scheme should initially target high-to-middle-income households.
2. Government is persuaded to make finance available for an information and education campaign. Interested parties will be invited to bid for the programme.
3. The uptake of SWH by house and flat owners should be monitored as an indication of the effectiveness of the information campaign. The growing market will create more jobs and more training will be required.
4. Local government will prepare and pass bylaws to make the inclusion of SWH mandatory in new housing and gradually retrofit SWH in old houses. The City of Cape Town has already prepared such bylaws. Other municipalities are following suit, and can learn from the experience in Cape Town.
5. Training courses to be set up or expanded by the Energy SETA, technical universities and vocational training centres. The newly trained technicians and entrepreneurs to take advantage of the various existing programmes supporting new entrepreneurs.

5.2 Strategic objectives and policy outlines: Biodiesel

Table 8 identifies the problems associated with biodiesel. These problems are of two kinds; the first are problems relating specifically to biodiesel such as the high production cost of biodiesel compared to petroleum diesel. The second type of problems relate to more general issues of the economy, the supply industry or developmental issues.

5.2.1 Identification of problems, opportunities and policy outlines: biodiesel

The RET methodology starts by analysing a situation and identifying problems that could affect the development, social acceptance and market takeup of renewable energy technologies. The objectives identify the desired outcome and the policies outline the way to address the problems.

Problems, objectives and policy outlines for biodiesel are presented in Table 8. The Table is not intended to be an exhaustive list. It summarises some of the important problems and gives some of the policy outlines in order to reach the strategic objectives.

Table 8: Identification of problems, objectives and policy outlines for biodiesel

Problems	*Objective*	*Policy outline*
6. There is little awareness about the benefits and opportunities of biodiesel. Implementing a biodiesel programme is complex because many ministries and stakeholders must work together to make it succeed.	All concerned ministries and stakeholders cooperate to support the implementation of biodiesel. People are generally aware of the benefits of biodiesel and support it by buying cars using biodiesel.	Raise awareness about the benefits of biodiesel. Facilitating the cooperation between ministries and stakeholders to implement biodiesel.
7. Developing and introducing new technologies and products and getting them accepted is a long and capital-intensive process. Technical capacity and finance are insufficiently available to develop biodiesel and make it economically competitive with petroleum diesel.	Capital investments have been made. Expertise in growing, processing, distributing and marketing biodiesel is developed. The technology has matured and is adapted to small-, medium-, and industrial-scale production. Biodiesel is competing with petroleum diesel in the market without being supported by incentives.	Attracting capital investment for biodiesel development. Providing agricultural extension services to farmers growing oil cops. Supporting oil plant research. Transferring technologies and research results.
8. Global political developments threaten the continuous supply of oil and, in the long term, reserves of fossil oil and gas will be exhausted.	Sustainable production of biodiesel has been achieved and has become competitive with petroleum diesel, which is gradually being replaced. Greater security of supply has been achieved.	Facilitating the production of biodiesel in SA. Increasing security of supply. Supporting the gradual replacement of petroleum diesel.
9. Very high unemployment rates undermine the government's policies aiming at greater equality, poverty reduction and development of disadvantaged rural areas.	Biodiesel plants have been built in central locations as well as in rural areas and the extracted and processed oil and the residue of protein cake are fuelling and feeding secondary developments. Many jobs are created. The biodiesel plants in rural areas have become development hubs, black economic empowerment is achieved.	Training farmers and other rural people to grow and process oil plants. Encouraging the establishment of feedlots for cattle raising. Promoting black economic empowerment.

Problems	*Objective*	*Policy outline*
10. South Africa has one of the highest per capita GHG emission rates worldwide.	Petroleum diesel is gradually and sustainably replaced by biodiesel and consequently GHG emissions are reduced.	Reducing GHG emissions by replacing petroleum diesel with biodiesel. Complying with future obligations of the Kyoto Protocol.

5.2.2 Stakeholders' problem identification and recommendations: biodiesel

The stakeholders' problem identification matrix was gathered from discussions and reports.

Table 9: Stakeholders problem identification and recommendations: biodiesel

Problem definition	*Problem manifestation*	*Objective*	*Recommendation*
1. Lack of awareness of biodiesel.	Diesel consumers are not aware of biodiesel and its benefits on health, and environment.	Diesel consumers, diesel fleet managers and political key figures and organisations are aware of the benefits of biodiesel	Prepare information and education material and implement awareness campaigns.
2. Technical expertise and capacity for all stages of biodiesel production is lacking.	Biodiesel programmes and strategies cannot be advocated and implemented.	Personnel is trained in all aspects of the biodiesel production chain.	Government support for training courses and for facilitating expertise in biodiesel.
3. The security of supply and the price of fossil oil is influenced by factors beyond the control of South Africa.	The price of crude oil varies considerably and the trend is generally rising.	Petroleum diesel is replaced, in stages, with home-grown biodiesel to achieve greater security of supply.	Government assistance is required to facilitate the production, distribution and marketing of biodiesel.
4. The cost of producing biodiesel cannot yet compete with fossil diesel.	Investment in biodiesel production is not forth coming.	To reduce the price of biodiesel at the pump to be competitive with petroleum diesel.	More government support, facilitation and incentives for all stages of biodiesel production.
5. .Petroleum diesel contributes to GHG emissions and particularly to air pollution in cities	GHG emissions from vehicles using petroleum diesel are high and lead to atmospheric pollution, eg, brown haze over Cape Town.	To gradually replace petroleum diesel with biodiesel which is GHG neutral.	To facilitate the gradual replacement of petroleum diesel by biodiesel in vehicles and stationary engines.

5.2.3 Strategic lines of action: biodiesel

Strategic line 1: All concerned ministries and stakeholders cooperate to support the implementation of biodiesel. Interministerial cooperation on new projects is complex and can take a long time. When several ministries are involved and expected to complete interdependent tasks it is not always easy to make progress. The Biodiesel JIC is already addressing this issue. Educational programmes

explaining the environmental and social benefits of biodiesel may be necessary to convince the motor vehicle users to buy biodiesel.

Strategic line 2: Sustainable production of biofuels has been achieved. As petroleum resources decline over the next decades and prices increase, biodiesel will gradually replace petroleum diesel. It must be borne in mind that all petroleum diesel will not be replaced by biodiesel because there is not enough land available for growing the crops. Initially production will be limited and biodiesel will be added to petroleum diesel at a low ratio of 2% to 10% (B2 to B10). This ratio will rise with time. Fuel mandates are used in other countries to achieve biofuel implementation. They stipulate minimum percentages of biofuel for all vehicle fuels. Fuel mandates are easy to implement. Government levies are not reduced and the higher prices to cover the higher cost of biofuels are paid by the consumers at the pump.

Strategic line 3: Oil companies are realising the long-term benefits of biodiesel and have made capital investments in biodiesel production. Government policy is supporting the development. Expertise in growing and processing crops for vehicle fuels is developed and the technology is matured and adapted to small-, medium- and industrial-scale production.

Various oil crops are cultivated in different climatic zones supported by agricultural extension services. Plant breeding programmes have developed varieties that optimise oil content and quality and high-value protein seed cake. Sunflower and cotton are widely produced and the poor quality of sunflower oil cake has been improved to compete with oil cakes from other crops. Agricultural extension services and research institutions work closely with farmers to support the transfer of new plant varieties and their farming systems. The marketing of improved by-products initially facilitated through extension programmes is now competitive. High yields are achieved and oilseeds and their by-products are economic crops which do not require any further subsidy. Oil seeds are grown in many SADC countries, custom barriers have been removed and they are freely traded in a liberalised regional market.

Strategic line 4: Biodiesel plants have been built in rural areas. The oil fuels secondary developments and the protein cake feeds cattle-growing industries and jobs are created in disadvantaged areas. Initially capital assistance is required to set up oil processing plants. Private investment, government investment or foreign aid are possible sources of funding. Incentives for private investment will be necessary. In disadvantaged rural areas all technically qualified people continually migrate to the cities in search for jobs and therefore training will be needed at all levels. Once the plants are established and rural areas become development hubs, job seekers will be attracted to these centres and the migration to the cities will be slowed down. Emergent farmers are successfully growing oil crops and black economic empowerment groups are managing the oil processing facilities. Cattle feedlots are added and initially aided by extension services. More emergent farmers are benefiting by raising and selling cattle. Once the system is in place the market will drive further developments and no further incentives are required.

Strategic line 5: Petroleum diesel is gradually replaced by biodiesel and GHG emissions from petroleum diesel are reduced. The use of fossil oil in engines is gradually phased out and it is used predominantly in manufacturing and other industries.

Using biodiesel is carbon neutral when crops are grown continuously. There is some concern that the cultivation of soya releases NO_x into the atmosphere. Growing plants such as oil crops absorb CO_2. The CO_2 is released back into the atmosphere when the fuel is burned. Petroleum diesel only emits CO_2 without absorbing it. As less and less petroleum diesel is burnt less GHG is emitted. As petroleum resources decline petroleum prices go up and fossil oil is phased out as a motor fuel and it is used predominantly in petroleum-based industries such as plastic, pharmaceuticals and cosmetics. The driving forces are emission reduction regulations such as the Kyoto Protocol, economically viable biofuels and their by-products and declining petroleum resources.

5.2.4 Instruments and actions: biodiesel

The instruments and actions indicate how the strategic lines achieve the specific objectives. This list is an indication of actions only – many more could be added.

1. Government to finalise the biofuel strategy. The Joint Implementation Committee to facilitate biodiesel pilot projects particularly in rural areas where job creation is most urgent and poverty is very high.

2. Government to change voluntary blending of diesel with petroleum diesel to mandatory blending to give assurance to investors and to promote the industry. To start information and education programmes on biodiesel.
3. Government to further investigate instruments to facilitate private investment in biodiesel. Fiscal reform has been suggested. Departments of Agriculture at national and provincial level to support the planting of oil crops. Agriculture research institutions to investigate the suitability of new oil crop varieties for South Africa. Government to make funding available for research into oil crops and seed cake
4. To develop training programmes on growing and processing oil crops for emergent farmers in disadvantaged areas. To promote the development of secondary developments such as production of oil cakes and cattle feed lots.

5.2.5 Conclusion

The cooperation of different ministries to implement biodiesel is essential. Strategies to raise the initial capital for biodiesel production and making the cost of biodiesel competitive with petroleum diesel have to be addressed. Expertise in growing and processing oil resources has to be further supported. Development of biodiesel production in remote rural areas should be given priority because it leads to poverty alleviation by creating jobs, better livelihoods and rural development. Replacing petroleum diesel with biodiesel reduces GHG emissions.

6. Summary of key findings and recommendations

The wider dissemination of SWH and biodiesel faces problems specifically related to the two technologies, but there are also more general national issues regarding the economy, transformation relating to black economic empowerment and the supply industry. In this section the specific and general problems and policy recommendations are summarised.

6.1 Solar water heating

The major problems preventing the general dissemination are given in bold italics, with the policy recommendations and recommendations following below them..

1. High capital cost and the absence of affordable financing schemes prevent the uptake of SWH

It is recommended that attractive financing schemes be facilitated. The policy should address banks, insurance companies, customers, installers and manufacturers.

Local government particularly those with climate change strategies should promote SWH through incentives such as rate rebates, government-subsidised lower interest rates.

2. Lack of information about SWH and negative perception of SWH

It is recommended to support information and education programmes; encouraging research on evaluating the benefits and limitations of SWH; implementing quality assurance.

3. Electricity peak load demand will be greater than generation capacity by the year 2007

It is recommended to expand the SWH market through local-government by-laws making SWH in new houses mandatory.

4. Electricity in South Africa is generated from coal leading to very high GHG emissions

It is recommended to facilitate the replacement of electric geysers by SWH and to support the installation of SWH.

5. High unemployment rates affect socio-economic development

It is recommended to support and encourage the manufacture and installation of SWH to generate employment. This should include facilitating training.

6. The poor can neither afford the installation of SWH nor an electric geyser

It is recommended to subsidise the capital expenditure for SWH for the poor to improve the quality of life.

7. There is an urgent need to facilitate black economic empowerment.

It is recommended to facilitate the training and access to financing for black entrepreneurs and increasing procurement from black economic empowerment companies.

6.2 Biodiesel

The major problems facing the biodiesel industry are given in bold italics, with the policy recommendations and recommendations following below them.

1. There is a lack of awareness and knowledge about biodiesel impeding the implementation of biodiesel programmes.

Recommendation: to raise the awareness of the benefits of biodiesel at all levels of government, all stakeholders and the general public.

2. Technical capacity and finance are not sufficiently available to develop a biodiesel industry.

Recommendations:

- government to further (beyond the 30% tax rebate) facilitate investments in the biodiesel industry;
- agricultural extension services be provided to farmers growing oil crops for biodiesel;
- oil plant research be funded and the results be transferred to stakeholders.

3. The security of oil supply from global sources is not guaranteed.

Recommendation: to facilitate the production of biodiesel in South Africa in order to replace petroleum diesel from imported crude oil.

4. High unemployment rates perpetuate inequality and poverty

Recommendations:

- to train rural people in disadvantaged areas to grow and process oil plants;
- to produce high-protein seed cake;
- to encourage the establishment of feedlots for cattle raising;
- to promote black economic empowerment.

5. South Africa has very high per capita GHG emission rates

Recommendation: To gradually replace petroleum diesel by biodiesel to reduce GHG emissions and urban air pollution.

References

Agama 2003. Employment potential of renewable energy in South Africa. Agama Energy, Cape Town.

Asmal, O. *Cape Argus*, March 1, 2006. Cape Town.

Atlod, J. 2006. Western Cape Local Government. Personal communication.

Austin, G. & Morris, G. 2005. The status of solar water heating for domestic hot water supply in the low-income sector in South Africa. Agama energy. Stellenbosch.

Banks, D. & Scaffler, J. 2006. The potential contribution of renewable energy in South Africa. Draft Update Report. Johannesburg.

Bio-Fuel. 2005. Investigations on Track into Impact of 'Bio-Diesel' Tree. The Water Wheel, September-October 2005.

Borchers, M. & Engel, W. 2002. Solar water heaters – the forward? ESI Africa 1 2002.

Bridge, S. 2004. Sasol ponders a soya biodiesel plant. *Business Report* 12 March, 2004. http://www.business report.co.za/index.php?fArticleId=3772168.

CaBEERE 2004 (Capacity Building in Energy Efficiency and Renewable Energy). Economic and financial calculations and modeling for the renewable energy strategy formulation. DME, Pretoria.

Cawood, W. 2006. Domestic solar water heaters – Introduction. Workshop on Solar Water Heaters. International Conference on the Domestic Use of Energy. Cape Town 4-6 April 2006 (www.ctech.ac.za/conf/due/ 2006due_solar.htm).

Cawood, W. and Prasad, G. 2006. Recommendations: Solar water heating. (www.ctech.ac.za/conf/due/ due_conf_archive.html

CEF (Central Energy Fund). 2005. Solar Water Heating 500 Project. Call for proposals: Terms of reference for supplier selection.

CSIR 2001. Study which assessed the petrol-diesel price differential.

CSIR, 2002. South African Renewable Energy Resource Database – Annual Solar Radiation. www.csir.co.za/plsql/ ptl0002.

DFA (Department of Foreign Affairs), 2004. State of the Nation address by the President of South Africa, Thabo Mbeki, to the joint sitting of the Houses of Parliament, Cape Town, 21 May 2004. www.dfa.gov.za/docs/speeches/2004/mbek0521.htm

DME 1998 (Department of Minerals and Energy). White Paper on the Energy Policy of the Republic of South Africa. Department of Minerals and Energy, Pretoria.

DME, 2002a White Paper on the Promotion of Renewable Energy and Clean Energy Development. Part One. Pretoria, Republic of South Africa.

DME 2002b. Capacity building in Energy Efficiency and Renewable Energy: Baseline Study – Solar

Energy in South Africa. Report No. – 2.3.4-13

DME 2002c. Capacity building in Energy Efficiency and Renewable Energy: Baseline study – Hydropower in South Africa. Report No. COWI P54126/EE/RE/70

DME 2003a. White paper on the Renewable Energy Policy of the Republic of South Africa. Department of Minerals and Energy, Pretoria.

DME 2003b. Green Power: Business opportunities in South Africa for renewable energy independent power producers 2003. DME brochure. page 3.

DME 2004. Capacity building in Energy Efficiency and Renewable Energy. Report no. 2. 3. 4. – 19. Economic and Financial Calculations and Modelling for the Renewable Energy Strategy Formulation. Department of Minerals and Energy, Pretoria.

DME 2005a. Capacity building in Energy Efficiency and Renewable Energy: Renewable Energy Monitoring of Targets. Report No. – 2.3.4 – D. Department of Minerals and Energy, Pretoria.

DME 2005b. Renewable Energy Finance and Subsidy Office (REFSO). CaBEERE Newsletter, September 2005. Department of Minerals and Energy, Pretoria.

DST 2003 (Department of Science and Technology). Investigation into the role of biodiesel in South Africa. Prepared by CSIR Transportek. Pretoria.

DST, 2006. www.dst.gov.za

EDRC 2003. Policies and measures for renewable energy and energy efficiency in South Africa. Energy and Development Research Center, University of Cape Town.

Engineering News 2004. Weekly Feature, 03 August 2004. www.engineeringnews.co.za/eng/news/ Features/

Engineering News 2005. Weekly Feature, 03 August 2005. Biodiesel blueprint. www.engineeringnews.co.za/ eng/news/ Features/

Engineering News 2006. Weekly Feature, February 2006. South Africa sows crops-to-energy seeds. www.engineeringnews.co.za/eng/news/ Features/

Engineering News 2006. News Today, 10 July 2006. South Africa sows crops-to-energy seeds. www.engineeringnews.co.za/eng/news/today/?show=78440

ERC 2004 (Energy Research Centre). Energy for sustainable development: South African profile. Energy Research Centre, University of Cape Town, South Africa.

ERC, 2004. Solar electrification by the concession approach in the rural Eastern Cape (South Africa): Phase 1.Baseline Survey. Energy Research Centre, University of Cape Town.

Hamid, N. 2006. Central Energy Fund. Personal communication.

Kaufman, S. 2000. Rural electrification with solar energy as a climate protection strategy. Renewable Energy Policy Project (REPP), Washington, DC.

Kotze, IA. 1997. Renewable energy activities in South Africa – PV and Rural electrification. In: Proceedings of the Third OAU/STRC Inter-African Symposium on New, renewable and Solar Energies, 22-24 October 1997, Pretoria, South Africa, Department of Minerals and Energy, pp 10-16, Pretoria..

Kotze, IA. 1998. Photovoltaics and rural electrification in South Africa – Problems and prospects. In: Proceedings of the ISES Utility Initiative for Africa: Initial Inplementation Conference, 26-27 March 1998, Midrand, SouthAfrica.

Mlambo-Ngcuka, P. 2004. Budget vote speech by the Minister of Minerals and Energy, June 2004, Parliament, Cape Town.

Mlambo-Ngcuka, P. 2006. *Background document*: A catalyst for Accelerated and Shared Growth-South Africa (ASGISA). Media Briefing by Deputy President Mlambo-Ngcuka, 6 February 2006.

Nadal, G. 2004. Renewable energy theme GNESD. Methodological issues, 29 December 2004. Written communication to network members.

National Treasury, 2003. www.finance.gov.za

NER (National Electricity Regulator), 2001. Electricity Supply Statistics for South Africa 2001. Pretoria, Republic of South Africa.

NER (National Electricity Regulator), 2002. Lighting up South Africa 2002. Pretoria, Republic of South Africa.

NRS (National Rationalised Specification). 2003. Quality of service standard for non-grid electricity customers (NRS 070). Standards South Africa, Pretoria.

Sasol. 2006. *Sasol and CEF to conduct joint feasibility study into biodiesel manufacture in South Africa*. www.sasol.com/sasol_internet/frontend.

Science in Africa. 2005. Biodiesel – will an alien tree deliver? www.scienceinAfrica.co.za/2005/biodiesel).

Shabangu, S. 2003. Former Deputy Minister of Minerals and Energy. Foreword, White Paper on RE Policy of the Republic of South Africa. Pretoria.

Solardome SA, 2006. A manufacturer's perspective on solar water heating. www.ctech.ac.za/conf/due/2006due_solar.htm

Wilson,S.C., Matthews, M., Austin, G. & von Blottnitz, H. 2005. Review of the Status of Biodiesel Related Activities in South Africa. Report for the City of Cape Town, South Africa. Pp 76.

Winkler, H. 2005. Renewable energy policy in South Africa: policy options for renewable electricity. Energy Policy 33, p. 27-38. Cape Town.

Appendix: Programme of the SWH workshop

DUE 2006: Solar Water Heater Workshop
8.30 am to 12.45 pm, Wednesday 5 April 2006
Cape Peninsula University of Technology, Cape Town

Chairperson: Will Cawood

Time	*Topic*	*Presenter*	*Organisation*
8.30-8.40	Welcome and introduction	Will Cawood	Solar Engineering Services
8.40-8.55	DME policy and support through CEF and REFSO	Terence Govender	Renewable Energy, Department of Minerals and Energy
8.55-9.10	SWH initiatives in the city of Cape Town	Leila Mahomed	Sustainable Energy Africa (SEA)
9.10-9.25	Education and promotion of SWH	Will Cawood	Solar Engineering Services
9.25 -9.40	SWH specifications and UNDP/GEF solar 500 project	Carmen Armstrong	Energy Development Corporation
9.40-9.55	SWH implementation, Demand Side Management and their impact on the potential energy crisis	Jon Adams	Sustainable Energy Society of Southern Africa
9.55-10.10	Pre-heating of water	Ernst Uken	Cape Peninsula University of Technology
10.10-10.25	Regulatory support consideration for solar water heating	Yaw Afrane-Okese	National Energy Regulator
10.25-10.35	Discussion		
10.35-11.05	*REFRESHMENTS*		
11.05-11.20	The suppliers' perspective and costing	Ryan Dearlove	Solardome
11.20-12.45	Conclusions/Recommendations Will Cawood and Gisela Prasad		
12.45-13.45	*LUNCH*		