SOLAR COOKING COMPENDIUM

Challenges and Achievements of the Solar Cooker Field Test in South Africa

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Abstract

In a pilot program, a comparative field test of solar stoves was conducted in South Africa, comprising two stages: user acceptance of these stoves was studied, as well as the conditions required for commercial introduction into the market. The potential contribution these stoves can make towards a solution of the problems posed by the procurement of household energy for low-income user groups (local shortage, cost, environmental and safety aspects) was also assessed in depth.

In a first step, seven solar stove models of all types (box-, concentrator-, and collector cookers) were selected for an 18 month acceptance test on the basis of prior technical test results and adaptation to local conditions (cooking profiles).

Intensive monitoring showed that families used the solar stoves as frequently as wood, and more frequently than other cooking options (gas, kerosene, etc.). The usage levels of solar stoves in schools and similar institutions were erratic and greatly dependent on non-technical parameters.

In a second step, the potential for market introduction of four short-listed and further adapted stove models was studied. This involved local production and assembly, the organization of information campaigns, the assessment of prospective prices and test marketing. Conjoint analysis showed that, on potential clients' priority list, price is number one, followed by pot content, thermal performance and esthetics. Average payback time for the retail price is two years.

Preparatory work to compile a business case for the Central Energy Fund (CEF (Pty.) Ltd.) included research on the fuel and appliance use and preferences of LSM groups 2-5 (identified previously as the main potential target group by the solar cooker field test). The business case rests on the achievement of the "triple bottom line": commercial viability, environmental sustainability and progressive social development. It shows clearly that the "triple bottom line" is achievable with the support of a co-ordinating and facilitating institutional champion and opportunities exist to promote a combination of fuel-efficient and alternative fuel source cooking appliances

It can be expected that there is a market opportunity for high-quality, low price solar stoves, mass-produced and distributed by successful local companies.

Foreword

The Solar Cooking Compendium (SCC) is about the viability of solar stoves as a solution to the scarcity of household energy. Viability is measured in commercial terms. It means manufacturing and marketing of solar stoves without subsidies. In the future, this will be the criterion for judging projects promoting solar cooking.

The SCC is based on the experience gained in implementing the Solar Cooker Field Test (SCFT) in South Africa from 1996 to 2003. It consisted of Phase 1 – Global market situation of solar stoves and social acceptance test (1996 - 1998) and Phase 2 – Estimate the market potential in South Africa, manufacture of solar stoves, and test marketing (1999 - 2003). The SCFT, a pilot program, was performed under a bilateral Technical Cooperation Agreement between the Governments of the Federal Republic of Germany and the Republic of South Africa (RSA). Executing agencies were the Department of Minerals and Energy (DME) and the Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ).

What were the reasons for implementing the pilot program in South Africa? The answer is as simple as the related challenge was difficult to meet: The will and commitment of both Governments to significantly contribute to solving the shortage of household energy, and more specifically the fuelwood problem, by coming up with a market oriented solution in South Africa; once and for all it had to be shown that solar stoves are not only a niche solution. Ideally such a solution is expected to be suitable in principle for replication in other countries where similar fuelwood problems prevail. Moreover, the SCFT is in line with the energy policy heralded in the White Paper on Renewable Energy (RE) compiled by the DME in 2002 to bring renewable energy into the mainstream energy economy of South Africa.
It also responds to improving the extent of basic energy needs satisfaction addressed by the Bundesministerium für Wirtschaftliche Zusammerarbeit und Entwicklung (BMZ). Finally, it contributes to achieving the goals of the Agenda 21.

Household energy shortage is an issue in many regions of the world with an estimated two billion people being affected. In the past two to three decades, fuelwood scarcity became a major constraint for people in rural and semi-urban regions, notably on the African continent. The problem involves social, economic, technical, health, and environmental aspects.

In turn, an array of solutions has been offered and discussed time and again by politicians and specialists alike. Some follow conventional patterns; others focus on new technologies, in particular tapping renewable energies. One option is solar cooking.

The magnitude and complexity of this global challenge call for an integrated, multi-disciplinary approach, addressing the associated issues from various angles and putting equal emphasis on all-important features. In doing so, the underlying basic rationale is clear: In countries with high solar irradiation of 500Watt per m^2 (this is 50% of the usual maximum irradiation) the use of solar stoves as an additional cooking option can contribute to alleviating energy shortages. The vision for the future is the availability of low cost solar stoves of high quality so that they will be affordable for everyone on the African continent.

In the past, measures to introduce solar stoves were often effected by enthusiasts favoring a technology driven approach. These activities did not result in the sustainable use of solar stoves because they neglected their social acceptance by the target group, notably low income people living in rural and semi-urban areas, and underestimated the mechanisms of the market. The successful marketing of solar stoves, covering the whole chain from the demand oriented design and production to their appropriate use in households, is a complex endeavor. It involves many players with various tasks and responsibilities.

The challenges, accomplishments, and lessons learnt in implementing the SCFT in South Africa have been channeled into the SCC. It provides a comprehensive account of this pilot program, starting from the project idea all the way to the final assessment of the achievements. Thus, the SCC illustrates

- Why have solar stoves been selected as a means to fight energy scarcity of households?
- What have been the key activities of the pilot program?
- How have they been planned, implemented, monitored, and evaluated?
- Which were the lessons learnt for shaping future programs or projects?

To keep it as a user-friendly manual-type document the SCC has been edited in five volumes. It has been edited in five volumes:

Main Report	Challenges and achievements of the Solar Cooker Field Test in South Africa
Volume 1	Scarcity of household energy and the rationale of solar cooking
Volume 2	Social acceptance of solar stoves in South Africa
Volume 3	Making the case for commercializing solar cookers in South Africa. Justification for the development of a commercially viable renewable energy cooking technology industry.
Volume 4	The solar cooking toolkit. Conclusions from the South African Field Test for future solar cooking projects.

The concept, the various features of implementation, and the accomplishments of the pilot program have already been shared with policymakers and professionals in many fields throughout the last three years, e.g. at the international conferences in Varese, Italy (1999), Kimberley, South Africa (2000), and Adelaide, Australia (2001) as well as the International Workshop on Solar Cooking in Johannesburg, South Africa (2001) as well successfully participating in the World Summit on Sustainable Development (WSSD) during 2002. These events also generated valuable feedback for advancing the SCC. It was also presented to the German Ministry of Development Co-operation (BMZ) in November 2003 with the result that solar cooker programmes have been included in their standard set of development instruments and further proposals have been invited for projects of this nature.

The SCC compendium was updated at the end of 2003 to reflect the development of an expanded approach to the concept of commercialising solar cookers. The expanded approach entailed the broadening of the initial narrow focus on solar cookers, to that of a complete renewable cooking industry (including solar cookers, improved wood and coal stoves). The Energy Development Corporation (EDC), a division of CEF(pty)ltd. of South Africa expressed potential interest to become the champion of a renewable cooking industry provided that the potential commercial viability could be confirmed, calculated and quantified. After successfully demonstrating the "business case", for the development of a renewable energy cooking industry, the project has been incorporated into the structures of the EDC.

The Solar Cooker Field Test has received the attention and appreciation of South African and German politicians alike. They visited solar cooking demonstrations and tasted dishes cooked with the sun. The most prominent of them are:

- Ms Phumzile Mlambo-Ngcuka
  Minister of Minerals and Energy, South Africa

- Ms Susan Shabangu
  Deputy Minister of Minerals and Energy, South Africa

- Mr Johannes Rau
  President of the Federal Republic of Germany

- Ms Heidemarie Wieczorek-Zeul
  Federal Minister for Economic Cooperation and Development, Germany

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Abbreviations

BMZ	Bundesministerium für Wirtschaftliche Zusammenarbeit und Entwicklung
CEF	Central Energy Fund
DEM	Deutsche Mark
DME	Department of Minerals and Energy
ECSCR	European Committee for Solar Cooking Research
FAO	Food and Agricultural Organization
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit
HDPE	high-density polyethylene
LSM	Living Standards Measurement
LST	Lightweight Structures Technology
NGO	Nongovernmental Organization
R/A	Renewable/Alternative
RE	Renewable Energy
RSA	Republic of South Africa
SADC	Southern African Development Community
SCC	Solar Cooking Compendium
SCFT	Solar Cooker Field Test
USD	United States Dollar
ZAR	South African Rand

Equivalent of 100 ZAR

	1997	1998	1999	2000	2001	2002	2003
DEM	37.65	32.14	30.02	30.63	25.72	10.10 (Euro)	11.72 (Euro)
USD	21.17	18.07	16.36	14.42	11.62	9.51	13.22

✍ Average annual figures published by the South African Reserve Bank

Overview

Scarcity of household energy and the rationale of solar cooking

1 Two million people depend on biomass worldwide to provide energy for basic energy requirements. In developing countries, fuelwood, charcoal, agricultural residues, and dung are of particular significance. In Africa, they account for 60%, in the SADC region for nearly 80%. Regarding fuelwood for cooking, heating, and other household purposes most of it is consumed by the rural and semi-urban poor. Where biomass resources are scarce, unsustainable fuelwood use contributes to negative environmental, social, and economic effects. Since securing fuelwood is primarily women's work it is they who suffer most from the increasing shortages. Often, they cannot manage alone, but need help from their children who then are kept from attending school. Another option to satisfy the growing household energy demand is renewable energy. Solar thermal energy offers an environmental friendly emission free cooking option. Apart from increasing access to biomass or other supply options, solar stoves probably have the highest potential for contributing to the alleviation of household energy scarcity.

> Solar cooking an environmental friendly emission free
> mobile household energy solution

2 Solar cooking is known for more than 200 years. In the late 18th and early 19th century French and British scientists explored the use of solar box stoves. A parabolic solar stove was shown at the 1878 World Fair in Paris. In the 1950s and 1960s, many solar stove models were tried and disseminated, without addressing such key issues as social acceptance and sustainability. But soon, in the 1980s, and in particular the 1990s, new developments took place. The user (and not an arbitrarily selected stove) was placed at center stage.

3 Nowadays, probably around 250 different solar stove models must have been developed and / or used worldwide. Only a few are industrial prototypes, while most of them are handcrafted solar stoves produced in small batches. Basically, each model fits into one of three categories: box stove, concentrator stove, and collector stove. The most widely distributed models are the Indian box stove and the Chinese concentrator stove. The thermal output of solar stoves varies. The more powerful models can boil water in just a few minutes; the weakest ones never reach boiling temperature. The most important reason to use solar stoves is to save fuel.

4 Roughly 900,000 solar stoves have been disseminated worldwide so far, thereof 95% in Asia. Practically no model is of modern design. Only of late, better solar stoves in terms of performance, handling, durability, appeal, and (sometimes) price are appearing in the market. One of the remaining problems is the reluctance of established businesses to become involved in solar stove manufacturing and marketing. This fact suggests the need of government intervention to provide incentives. To make solar stoves lose their present market niche image there is only one reasonable choice, i.e. adopt commercial procedures in production and marketing with serving the mass market as the objective. Solar stoves represent a sizeable global market potential: 10 billion USD for first equipment and 1 billion USD per year for replacement in a saturated market.

5 The comparative field test in South Africa looked at different solar stove models used in real-life situations as well as manufacturing and marketing environments to identify favorable conditions for the use, manufacture, and marketing. Therefore, the pilot program was split into two distinct parts: Phase 1 established a data base on the use of solar stoves (social acceptance), while Phase 2 pioneered their manufacture and tested their marketing.

Social acceptance of solar stoves in South Africa

6 Prior to the social acceptance test, there were two basically different test methods available, both focusing exclusively on technical aspects of solar stoves. The international test effected by the ECSCR in 1994 comprised 25 different solar stove models from 10 countries. Six key technical performance criteria, like heat-up and cool-down times or tracking frequencies and several other features such as pot access and capacity or handling were applied. Out of this range of solar stoves seven models were selected for the social acceptance test in South Africa.

7 The baseline study in the dry northwestern region of South Africa scanned five potential test areas by interviewing 200 of a potential 6,800 households and a series of institutions like old age homes, hospitals, schools, kindergartens, and small businesses. The five areas represented a mix of fuel use patterns and were representative of rural, semi-urban, and urban settlements. Based on criteria like cooking profiles (weather conditions, fuel availability and prices, household size, availability of an appropriate sunny space, cooking techniques and timings) as well as socio-economic characteristics, three test areas were selected.

8 Solar stoves were tested by 66 families and 14 institutions during a one-year placement period. 30 families without solar stoves acted as control households. Monitoring personnel was selected and trained before being deployed in the field. Three solar stove models were placed with institutions, four with families. Every family had one solar stove model for a period of two months before changing to another one. During the social acceptance test solar stoves relied exclusively on local cooking profiles.

9 Intensive monitoring showed that the families used the solar stoves at least once on 38% of all days, prepared 35% of all cooked meals on the solar stoves, and were satisfied with the results of 93% of their solar cooking attempts. Solar stoves along with wood were the most used cooking appliances followed by stoves fueled with gas, paraffin, and electricity. These results indicate acceptance of solar stoves by the family test users. "Acceptance" of solar stoves being defined as "solar stoves are used as much or more than other main cooking options in the household". Solar stoves were used for cooking and baking as add-on appliances, not appliances that replace others. During the solar stove placement period, the 60 participating test user families saved almost 60 tons of wood, more than 2 tons of gas, and over 2,000 liters of paraffin. However, solar stoves were differently used by the selected institutions, due to non-technical parameters.

Appeal is not only the result of technical design

10 Of the 66 solar stoves sold to families at the end of the social acceptance test, 44 units were found more than two years later. Mostly minor repairs had been performed on 21 of these solar stoves. Six households were using their stoves during the visits. High-capacity and efficient solar stoves are used more than low-capacity solar stoves. Their use is dependent on a certain minimum pot capacity which should be in the order of one to two liters per person. To establish commercial viability of solar stoves, high-quality products with appeal need to be available to potential customers.

11 The social acceptance data provide an array of messages. Solar energy is a promising option capable of being one of the leading energy sources for cooking. The high use rate of solar stoves, at par with wood and above other fuels, indicates acceptance of solar cooking by households. Each solar stove model has its own supporters. An obvious single choice does not emerge. All test stoves needed technical improvements and have undergone adaptations. Considerable fuel and time saved by the use of solar stoves generate reasonable payback periods (about two years) of the initial expenses associated with their acquisition. Finally, four of the seven solar stoves tested were retained for exploring manufacturing and marketing opportunities.

A business case for renewable and alternative energy cooking technology

12. The Solco Project has been doing research and piloting the introduction of renewable energy/alternative energy (R/A) cooking technology since 1996. The research initially focused on user acceptance and produced encouraging results. Since 2001, the research has accelerated and has focused on both the demand-side and the supply-side possibilities. This research was expanded to form the basis of a business case for the introduction of R/A energy cooking technology. The business case requires the conceptual understanding of the key elements of the demand-side profile, the supply-side profile and the policy environment and regulatory framework. Analysis showed that, within each of these areas, there were key factors likely to influence the success or

the failure of efforts to implement the business case in practice, and that there were interconnections between these factors.

13. Issues of supply and demand also link directly to the issue of policy environment and the regulatory framework. On the regulatory side, the South African government, despite a policy commitment to renewable energy, has tended to favour electricity and paraffin, both of which enjoy direct support in the form of subsidies. However, the government believes that renewable sources of energy can, in many cases, provide the least cost energy services, particularly when social and environmental costs are included. It is willing to provide focused support for the development, demonstration and application of renewable energy. What is needed is a champion for R/A energy applications to push the government in this regard. The Central Energy Fund (CEF) has now agreed to provide an institutional framework for a unit to do just that, acting as an enabler in the development of such applications.

Demand analysis

14. The research on the demand-side was conducted in two phases: the first was a desk study to analyse the potential target market in detail, and the second was primary research aimed at quantifying the real opportunity.

15. The desk study on the target market focused on LSMs 3-5. These comprise relatively poor people, but with sufficient income at least to be able to purchase an R/A household energy cooker, and more likely to be able to physically access such products than those even less affluent in LSMs 1 and 2. According to the desk study of existing secondary databases, members of LSMs 3-5:

- Number about 17.2 million, or just over 39% of the South African population;
- Are largely black and speak a range of home languages. Between 60% and 80% understand English. Most have some high school education and are functionally literate;
- Account for 22% of purchases of large household appliances;
- Average earnings of around R 1 803 per household (relatively low);
- Are found in all nine provinces, with the highest concentration in Gauteng, and with the biggest concentration living in rural areas and metropolitan areas;
- Have relatively few amenities in the home, and do not seem to prioritise electric cooking appliances even when electricity is available. They are more likely to own a television than to own an electric stove, even if they use electricity for lighting purposes, and
- Buy their appliances primarily from chain stores offering HP.

16. The desk study provided a picture of a promising potential market. The primary research was aimed at determining whether there was a genuine latent demand for R/A energy cooking appliances and, if so, how great a latent demand. A number of studies were done. The biggest and most critical, from which the most important conclusions

concerning potential demand were drawn, was "The Renewable Energy Survey".[1] This involved qualitative and quantitative interviews, product demonstrations and feedback, and in-house observations. Findings included the following:

- Consumers use more than one household energy technology for cooking. They aspire to electricity but often cannot afford to use it for cooking;
- The 10% who use gas are generally unhappy with it for safety reasons. Almost half those in LSMs 3-5 use paraffin which is also seen has being a safety and health hazard but is used because it is relatively inexpensive and safer choices are not available;
- More affluent households in the target group also use coal, and less affluent households use wood, and
- There is a high awareness of solar energy as an option, and a strong willingness to consider it because there is no fuel costs and it is safe.

17. The study concluded that a) there is an opportunity for more fuel efficient wood and coal burning stoves to replace current less efficient wood and coal stoves, at the expense of paraffin and gas; and b) any approach to developing the use of R/A energy appliances for cooking should be inclusive so that consumers can use appliances that complement one another. Even if positive about solar energy, consumers will continue to use more than one energy source, given the limited availability of sunshine.

18. The study indicated that R/A household energy is commercially viable in the primary target group. However, its successful development requires that supply-side issues be addressed. Currently people are not using R/A energy cooking appliances because they are not widely available or familiar.

Supply analysis: meeting the demand in a commercially viable way

19. The key premise underpinning the business case is that unless the latent demand for R/A cooking appliances is met through successful mass production and delivery, it will never be practically realised. This requires commercialisation.

20. While there are significant players, both in terms of energy supply and in terms of manufacture and supply of cooking appliances, in the ***non-renewable*** energy field, the R/A cooking appliance industry lags far behind. There are a limited number of products in the form of energy efficient coal stoves, solar cookers and "hotbag" or "hotbox" type products that cook through retaining heat. Most of these are produced by "enthusiasts", not as commercial ventures. They currently occupy a niche market, rather than a mass market. On the supply-side, if there is to be successful penetration of the primary target group by R/A energy cooking appliances, diversity needs to be strengthened, both in terms of products available and the way in which they are distributed. The problems with supply of R/A energy cooking appliances impact on distribution because there are

[1] All the surveys are available in Volume 4 of the SCC.

not enough suppliers, those that exist do not necessarily have an entrepreneurial drive, or commercial experience, and most do not benefit from economies of scale. These factors impact on quantity and continuity of supply and hence on distribution.

21. There are four main distribution channels that could be used by R/A household energy cooking technology product suppliers: direct response marketing ("outbound" as in direct mail or "inbound" as in advertising), retail distribution, personal selling and institutional channels. Each of the four has advantages and disadvantages. Within the context of establishing a new market and industry, it is useful to see many of the disadvantages as challenges or opportunities.

22. Formal retail distribution is the most pervasive route for marketing in the primary target market. Chain groups have obvious advantages here (location, economies of scale, mass advertising, high visibility, customer trust and loyalty, HP options, and regional supply networks). Independent retailers have advantages such as familiarity with local communities, personal selling and service, support for local promotions and in-store demonstrations. Personal selling is an ideal route to the market in this field. Here the advantages include dedication of the salesperson, the ability to go out to the customer, his/her familiarity with the customers and institutions in the area, and the personalised attention. While there are disadvantages, such as problems of co-ordination with multiple distributors, post-sale services and demand-side financing (HP), there are innovative ways to overcome these (see Volume 4, Appendix 7: Stakeholder Profiles: EMS). Institutional channels (municipalities, refugee organisations, non-governmental organisations etc) are able to move relatively large quantities through a single channel at a time. They also have the advantage of critical mass visibility and experience-sharing in one location. In using this route, it is important that the products are not seen as "specifically for the poor" which would undermine their desirability, and that the institutional approach does not undermine the parallel development of commercial channels by distorting prices through subsidies.

23. In distribution, as in all the supply-side challenges, the enabler will need to assist existing suppliers to develop commercial know-how, but also to facilitate the entry to the industry of many more diversified players. The enabler will also have to prioritise achievement of scale, even to the extent of facilitating the development of wholesalers who are able to do on behalf of suppliers collectively what they may not be capable of doing independently.

Facilitating options within the environment

24. There are a number of enabling and supporting mechanisms that could facilitate the development of a healthy R/A energy cooking appliance industry in South Africa. They include:

- Supply-side financing options such as national, bilateral and multilateral funding institutions, promoters of SMEs, corporate foundations and funds specifically available for renewable energy business initiatives;
- The potential supply-side financing option of setting up of a Clean Development Mechanism (CDM) project to exploit the sale of Certified Emissions Reduction credits. Finance generated in this way could be used to support the development of an R/A cooking appliance industry, and
- An existing network of organisations explicitly concerned with alternative energy issues and loosely grouped under “Local Agenda 21”. The aim of these organisations is to develop communities and cities in a sustainable way. They include NGOs and Section 21 companies, municipalities and government line departments.

Project experience with manufacturing and marketing of solar stoves in South Africa

25. At the beginning of the Phase 2 of the SCFT in 1998 no reliable information existed on the adaptation of solar stoves to user preference as well as existing production and marketing conditions. Thus, technical development was the necessary prerequisite for user acceptance of solar stoves in the market. In principle, local production has many advantages over partly or completely imported solar stoves. After successful technology transfer, the know-how is locally available and controlled; there is less transport, less import duties and more jobs. However, if the main goal is to bring solar stoves on the market, then they should be manufactured wherever the conditions are best.

> High quality, low-cost solar stoves are only available through mass production

26. There are several messages that can be derived from the experience of exploring manufacturing options and improving the quality of solar stoves in South Africa. It would be a decisive advantage to find powerful private partners who are well introduced in the production and marketing of household appliances. To reach low ex-factory prices likely to be accepted in the market, efficient use of mass production processes combined with low cost materials is required. Moreover, there should be competition among manufacturers as an incentive to arrive at lower ex-factory prices. Cost optimization still has a long way to go. Compromise solutions must be found in terms of technical parameters such as efficiency, handling, and durability, as well as market related parameters such as transportability, appeal, and price.

27. The social acceptance test permitted two preliminary conclusions, which influenced the later test marketing. To serve a diverse market and to meet different user requirements, more than one solar stove model must be offered. Users opt for larger, more efficient models once they have experienced all possible options. In eight locations, 25 retailers were visited between October 1999 and January 2000. Most of them did not know solar

stoves. Therefore, cooking presentations were the prerequisite to discussions on including solar stoves into their range of products. 20 retailers could be convinced to sell solar stoves, most of them operating small shops. Large supermarket chains were not yet ready to include such stoves in their sales program.

28. Awareness creation campaigns were conducted to inform the target groups on solar stoves. They doubted whether meals could be cooked by using such stoves. The advantage of saving recurring cost was not understood and thus not considered a benefit. Not only target groups were unaware of solar stoves and reluctant to use them, but also manufacturers, retailers, and representatives of government institutions. Between May 1998 and April 2000, 220 cooking demonstrations each attracting about 250 participants were conducted. Thus, roughly 60,000 people were reached. For public relations and advertising activities, radio, TV, newspapers, a solar stove hotline, and the SCFT website were the major media.

29. Between January 1999 and March 2000, about 1,000 solar stoves of various models have been sold. 90% were marketed in South Africa, the balance in neighbouring countries. During the test marketing period of October 2000 to March 2002, 350 solar stoves were sold by 15 retailers, the SCFT office, and the SunStove organization. Given the test market target of 700 solar stoves, the achievement rate pushed 50%.

30. Successful solar stoves are the result of small gradual improvements over many years. This equally goes for their design, manufacture, and marketing. There are no magic solutions. What is needed is hard work by dedicated people supported by the Government (e.g. Central Energy Fund to provide incentives, soft loans, micro financing and 'green' financing), striving to reach the common goal of effectively contributing to solve household energy problems in rural and semi-urban areas of South Africa.

Successful solar stoves are the result of small gradual improvements
in design, production and marketing over many years

Latest developments

31. Until 2002, the solar cooker project invested substantially in product development, but largely in isolation from the market and other market players. Products were tested in the market place with large subsidies, based on the estimated price of the products if mass production would be achieved. The most important problem faced by the project was that the products (notably the izola and T16 solar cookers) were not owned by a specific owner, except for the project itself. The project was therefore, thrust in the undesirable role of being the "owner" of the available products. The original idea was that the market would take over from the project at some stage, but this did not

materialise as no owners for the products could be found. As an important first step, the project set out to find alternative products with owners and moved away from playing an ownership role in the execution of the programme. The project role therefore, changed into one of facilitation and support as opposed to direct involvement in aspects such as sales, distribution, after-sales service and warehousing. Closely linked to the move to find products with owners was also to focus on the affordability of the products. Previous research established that price is a critical factor and that consumers are very price sensitive. The new products therefore, also had to be cheaper than the previous range.

32. The second important change was to broaden the product range on offer and supplement the solar cookers. A bundle of renewable cooking options was developed, which together made an irresistible offer on savings – you can reduce energy consumption for cooking by 80% while with solar cookers alone the maximum savings that can be achieved are in the order of 30%. Furthermore, the value proposition of savings to consumers was confirmed.

33. During the previous phases of the solar cooker programme, a large amount of research was conducted but failed to clarify if there was a case for establishing a renewable energy cooking industry. There was an urgent need to develop a business case for the establishment of a renewable energy cooking industry and at the same time bring private sector players and companies into the market place and provide them with assistance to sell their products. Products could now be sold in the market without subsidies. There were definite constraints in terms of offering products within the expectation range of consumers – product still had to be affordable. Parallel to the development of the business case, the project mobilised local as well as international players to stimulate interest.

34. The end result of this phase (1 year after take over) was that during a presentation to BMZ, a convincing enough case could be presented that the concept of solar cookers in the development context has been included and approved as a standard instrument for development co-operation and further proposals are awaited for such initiatives. A further breakthrough was achieved when CEF (pty) ltd. bought into the project on the basis of the business case. A division entitled the Energy Development Corporation (EDC) was created within CEF (pty) ltd. to deal specifically with renewable energy projects. Because of CEF's involvement, serious private sector players can eneter into a partnership with EDC. EDC has a mandate to invest in suitable renewable energy ventures and while investment in products yielding a commercial rate of return, there is the option to invest in products achieving the triple bottom line or utility rates of investment. Within 3 months of integration, two business were financed through EDC which opted for an equity stake in the ventures. The institutionalisation of the solco project within CEF (pty) ltd. was mutually beneficial to CEF and the programme – they are looking for investment opportunities and the programme aims to grow the industry.

35. The business case consisted of looking in detail at supply and demand side issues. Activities included a major marketing survey yielding the information that clearly demonstrated there is a market for the products, the projects can be sold and both these

are well beyond expectations. The latent potential demand estimated by the investigation was estimated at 300 000 households growing steadily over a 5 year period and 100 000 households thereafter per year. It was therefore established that nothing on the demand side prevents a significant industry and the primary and secondary opportunities in terms of the established LSM groupings were also established. It was however, in terms of the supply side (product, price and promotion) that the most question marks existed.

36. Once the project had convincingly demonstrated the potential to be taken over by a commercially orientated parastatal, the focus also fell on selling the business case to both the public and the private sector to leverage more support from the public sector and to involve more and more powerful players in the private sector. The project also attempts to level out an uneven playing field, since competing products all receive a subsidy or some form of support and the inherent draw-backs of renewable energy products (requires the sun to shine, total upfront costs, etc.) make them hard to compete with other products in anyway. The project endeavours to raise the platform from which the renewable energy products can compete through market intelligence and programme support and eventually overcome the advantages of other energy carriers and appliances.

37. Currently, a dozen products are being supported or sponsored, harnessing a lot of energy and commitment from the private sector players involved. This is important as the market research concluded that the market needed choice and not the "perfect mousetrap" or one perfect product. There is still the trade-off between price and performance and the objective is to attract as wide a range of products in terms of affordability and price as possible.

38. The project activities are proceeding at a satisfactory pace, the market as well as market players are being grown and supported and the project now has 3 main private sector players seriously dedicating their business to introducing the various technologies. Information dissemination campaigns are underway to make research outcomes known to the private sector in the form of advertising in appropriate journals and magazines. On the other hand there is a series of formal presentations to key public sector role players focussing on the role the public sector can play in terms of generic advertising, using solar cookers in public works programmes as well as by employees involved in outdoor activities such as alien invasive clearing and water conservation programmes.

39. At present there is still an emphasis on the development of a distribution chain. Local production at this stage remains a challenge and it is very difficult to mobilise local investment in a relatively unknown product. The routes to market (varied and numerous) have the ability to actually create more jobs than local production and the project will proceed to test and build the market with an imported product.

40. The final 3-year phase of the solar cooker project has been jointly financed by GTZ and UNDP.

1 Scarcity of household energy and the rationale of solar cooking

1.1 Household energy needs and fuelwood

Access to energy can determine our future in many different ways. On the large scale, this goes for the supply of imported oil and other mega energy carriers of strategic importance, particularly for those who have access to energy. In a less visible way, it also applies to those who lack sufficient access to the most basic energy services like cooking, heating, lighting, communication, and entertainment. According to recent FAO statistics, more than two billion people depend on biomass worldwide to provide energy for basic human needs while another two billion have very low access to modern energy such as electricity and thus still depend partially on traditional sources.

In developing countries the role of biomass, notably fuelwood, charcoal, agricultural residues, and dung is of particular significance. It amounts to approximately 33% of the total energy consumption. In Africa it rises to some 60% and can be as high as 90% in some countries. This fact is an indicator for the low rate of urbanization in Africa, where the majority of the population still lives in rural areas and will continue to do so for the foreseeable future. For most of these people there will be no economically viable and ecologically acceptable alternative to the use of biomass as fuel even in the decades to come (**Figure 1**).

Figure 1
Typical area in rural South Africa where people collect fuelwood

Source: SCFT

Available biomass resources are being significantly reduced primarily by agricultural expansion, infrastructure development, unsustainable use of already scarce resources, exploitation for commercial purposes (timber), cutting for charcoal production in semi-urban areas, periodic droughts and in some countries civil strife, e.g. huge refugee camps. The major responsibility for unsustainable wood use lies not with the poor who use it for household fuel (this accounts for 10-20% of the total loss of wooded areas), but with commercial logging and slash burning for agricultural production, which accounts for as much as 75-80%. It has been estimated that in sub-Saharan Africa some 130 million people live in areas where the fuelwood consumption is higher than the regenerative capacity of wooded areas.

In the SADC region biomass amounts to nearly 80% of the total energy demand. About two thirds of it is used for household and institutional purposes, i.e. cooking, baking, heating in households and public institutions such as schools, prisons and military barracks. A substantial amount (20-30%) goes into small businesses such as brick firing, fish smoking, processing of agricultural products, beer brewing and restaurants, fencing and the building sector. Regarding fuelwood for cooking, heating and other household purposes, most of it is consumed in rural and semi-urban areas by the poorer sections of the society. A large part of the fuelwood is collected free of charge, mostly by women and children. At the same time there is an ongoing process of fuelwood becoming a commercial commodity, especially in rural towns and semi-urban areas.

Where biomass resources are scarce, unsustainable fuelwood use, though not the main reason for the scarcity, contributes to the negative effects at the environmental, social and economic level and compounds an already difficult living situation. When biomass is burnt carbon dioxide is set free. This fact adds to climate warming because the trees are no longer available as carbon dioxide sinks. Where fuel has to be bought, biomass-using families often are spending a substantial amount of their total income on fuelwood. Since the provision of fuelwood is primarily women's work, it is they who suffer most from the increasing shortages. Women are spending more time walking longer distances and carrying heavier loads, which affects their health. Often they cannot manage alone, but need the help of their children, who then are kept from attending school.

Fuelwood will remain the main energy carrier for African households for many years to come. Because of the increasing demographic pressure the total consumption will still rise. For the continent as a whole this has been estimated at 1.7% annually, for southern Africa at 1.4%. The reason for the lower increase in southern Africa is mainly due to South Africa actually expecting to reduce its consumption by approximately 3% annually, because of a very low population growth (0.6%). Since the rate of deforestation is going up, other options to satisfy the growing household energy demand have to be considered such as substitution with energy derived from fossil fuel or natural gas, renewable bio-energy carriers or other renewable energies. Solar thermal energy offers opportunities for cooking (**Figure 2**).

Figure 2
People collecting fuelwood in rural South Africa

Source: SCFT

Apart from biomass, solar stoves probably have the highest potential for making a significant impact as far as energy for cooking, baking, and food processing is concerned. This applies to households as well as to small, home-based food processing businesses and street restaurants. With varying degrees southern African countries are in a favorable to excellent position to make use of solar energy. Climatic conditions, cooking traditions, the level of technical expertise and production capacities, marketing structures and access to credit facilities all favor the introduction of solar stoves in this region.

1.2 Origin and history of modern solar cooking

In 1774, over 200 years ago, Horace-Benedict de Saussure (1740-1799) invented and built an insulated box with multiple glazing. He called it a “helio-thermometer” and used it to study the greenhouse effect on his mountaineering expeditions; he pointed out distillation and cooking as potential applications of the device which was in fact the first box-type solar stove.

In 1837, the British astronomer John Herschel used a solar box stove to cook meat and vegetables during an expedition to the Cape of Good Hope. The stove was made out of mahogany, painted black, buried into sand for better insulation and covered by a double glazing to reduce heat losses.

In 1860, the French mathematics teacher Augustin Mouchot started experimenting with solar stoves. He worked on his first solar steam engine (1866), wrote in the world's first technical solar energy book (1869) and received a gold medal for an engine producing steam with the help of a solar concentrator at the 1878 World Fair in Paris. The machine, grandparent of today's parabolic stoves, had a reflector diameter of 5 m made out of silver-plated copper which was equipped with a tracking mechanism for following the orientation of the sun and a hydraulic circuit heated by a black cylindrical absorber. In June 1878, the magazine Scientific American published an article describing how someone in Bombay, India had successfully cooked enough meat and vegetables for seven people with a solar stove.

In the 1950s and 1960s, most of the solar stove design variants were tried and disseminated. Many designs seem outdated today, but they were the first fully operational solar stoves and the ancestors of today's models. At this stage, the vision underlying solar stove projects was simple: the questions of acceptance and of sustainability did not enter the picture until it turned out that, in many cases, users used their stove rarely or never, and that the diffusion of solar stoves stopped when budgets ran out. But soon, in the 1980s and particularly the 1990s new developments were to take place. The user (and not an arbitrarily selected stove) was placed at center stage (**Figure 3**).

Figure 3
An enthusiastic solar cooker user with solar cooked dumplings

Source: SCFT

1.3 Solar cooking today

By now, probably more than 200 different solar stove types must have been tested and / or used worldwide. Only a few of them are industrial prototypes, most of them are handcrafted solar stoves produced in small batches. Some proved useless in practice, but some others have undergone competent development efforts. None of them, however, has yet reached the stage of a mass-produced industrial product. Basically, each of the many varieties of solar stoves fits into one of three categories: box stoves, concentrator stove, and collector stove.

The biggest of all known solar stoves, at Mount Abu (India), consists of a field of automatically tracked parabolic concentrators producing steam which is fed directly into enormous cooking vessels, enough for 10,000 meals. The smallest solar stove measures 30 cm in diameter and uses a 500-ml jelly jar as its cooking vessel.

The most widely distributed solar stove models are the Indian box-type stove and the Chinese concentrator – both claiming several hundred thousand units sold, followed by the Franco-American Cookit, distributed internationally, particularly in Kenyan refugee camps. The thermal output of solar stoves varies: while the more powerful models can boil water in just a few minutes, the weakest never reaches boiling temperature. It merely heats the water to about 80°C in two hours' time.

The most important reason to use solar stoves is to save fuel. The more the stove is used, the more fuel is saved. Savings can also be in time and / or money. Furthermore, solar stoves are convenient. There is no smoke nor is there additional heat in the kitchen. Finally, most solar stoves work independently. An experienced solar cook sets the stove up, loads it, and comes to fetch the hot food ready for the hungry family.

There are also reasons not to use solar stoves: Solar cooking does not work every day of the year because clouds and inclement weather are often unpredictable. It needs a safe place, close to the kitchen, where the sun is not blocked by shadow from buildings or trees. Where these conditions are not found, the user has to move the stove, keeping it in the sun and in a safe place. The stove works outside, so food, pot and stove can be stolen or tampered with. It needs some degree of planning: it is not the ideal solution to provide a quick meal to an unexpected evening guest. Finally, while a solar stove pays for itself in savings, it still is expensive, particularly in an environment where *"no food"* is one reason for not cooking (**Figure 4**).

Figure 4
Fuelwood and solar stoves both used for cooking by households in rural South Africa

Source: SCFT

1.4 Global market situation of solar stoves

The number of solar stoves disseminated so far worldwide is an estimated 900,000 units. This figure is cumulative, i.e. stoves are counted whether they are still used or not. The overwhelming majority (90%) of the stoves were disseminated in Asia. Half of them are (Indian) boxes, the other half (Chinese) concentrators. Practically none are modern designs. Around 45,000 solar stoves have been disseminated in Africa, 70% of them in Kenya and South Africa - in both countries with more recent designs than in the Asian cases.

For several years now, better stoves, in terms of performance, handling, durability, looks and (sometimes) price are appearing on the market. The adaptation of these models for local and central production, as well as for all aspects of commercial distribution, is advancing. One of the remaining problems is the reluctance of established private businesses to become involved in solar stove manufacturing and marketing. This fact suggests the need of government interventions as an incentive to facilitate the emergence of an environment conducive for pro-solar stove decisions and actions of private investors and businessmen.

There are two different options for the future of solar stoves. On the one hand, continue the present niche market situation where technical cooperation agencies and NGOs give away solar stoves (or sell them at heavily subsidized prices) and organize their own manufacture and marketing structures. On the other hand, adopt commercial procedures in production and distribution, with serving the mass market as the objective.

Solar stoves represent a sizeable global market potential: 10 billion USD for first purchases and 1 billion USD per year for replacements in a saturated market. This is a major market opportunity, albeit in a hard-to-access low-income environment.

Is it feasible to reach or approach these figures in reality? On an objective level, solar stoves must meet a number of obvious requirements, such as product quality, performance, handling, user support, affordability and value for money. On a subjective level, success needs confidence along the whole product chain, from manufacturer over distributor and retailer to the client or user. Solar stoves must be credible and the risk to produce, to market or to buy a "lemon", to lose money and face must be perceived as acceptable. In any case, it seems very difficult to reach a major presence on the commercial market for household appliances without the partnership of established players in this field.

1.5. Approach to test social acceptance, manufacture and marketing of solar stoves in South Africa

Given the variety of solar stove types, ways of use, storing them, but also the variety of potential applications and marketing, it was felt that a fixed approach (testing one stove type in one user situation, using one method) would produce information only about one particular case. Therefore, it was decided to test different solar stoves in parallel, in different user situations. The aim was to obtain information not only on one particular solar stove but also on solar cooking in general.

In short, a comparative field test looked at different stove models and their use in different situations as well as the different manufacturing and marketing environments, to identify favorable conditions for use, manufacture, and marketing of solar stoves. Therefore, the pilot program was split into two distinct phases: Phase 1 established a data base on the use of solar stoves (social acceptance test), while Phase 2 pioneered their manufacture and tested their marketing (**Figure 5** and **Figure 6**).

Figure 5
The Sunstove, one of seven solar stove models, used in the social acceptance test

Source: SCFT

Figure 6
The SK 1200, one of the four solar stove models retained for test marketing

Source: SCFT

2 Social acceptance of solar stoves in South Africa

2.1 Situation before the social acceptance test

Prior to the social acceptance test, there were two basically different test methods available. Both of the methods focused exclusively on technical aspects of solar stoves. One addressed the determination of efficiency at ambient temperature and loss factor (figures of merit), the other the establishment of solar stove characteristics like heat-up times, maximum temperatures, tracking frequencies, and similar data. Both methods had to be supplemented by additional criteria to put emphasis on social and economic aspects as well.

The international test effected by the European Committee for Solar Cooking Research (ECSCR) in 1994 comprised 25 different solar stove models from 10 countries. Six key technical performance criteria like heat-up and cool-down times or tracking frequencies and several other features such as pot access and capacity or handling were applied. Out of this range of solar stoves, 7 models were selected for the social acceptance test in South Africa.

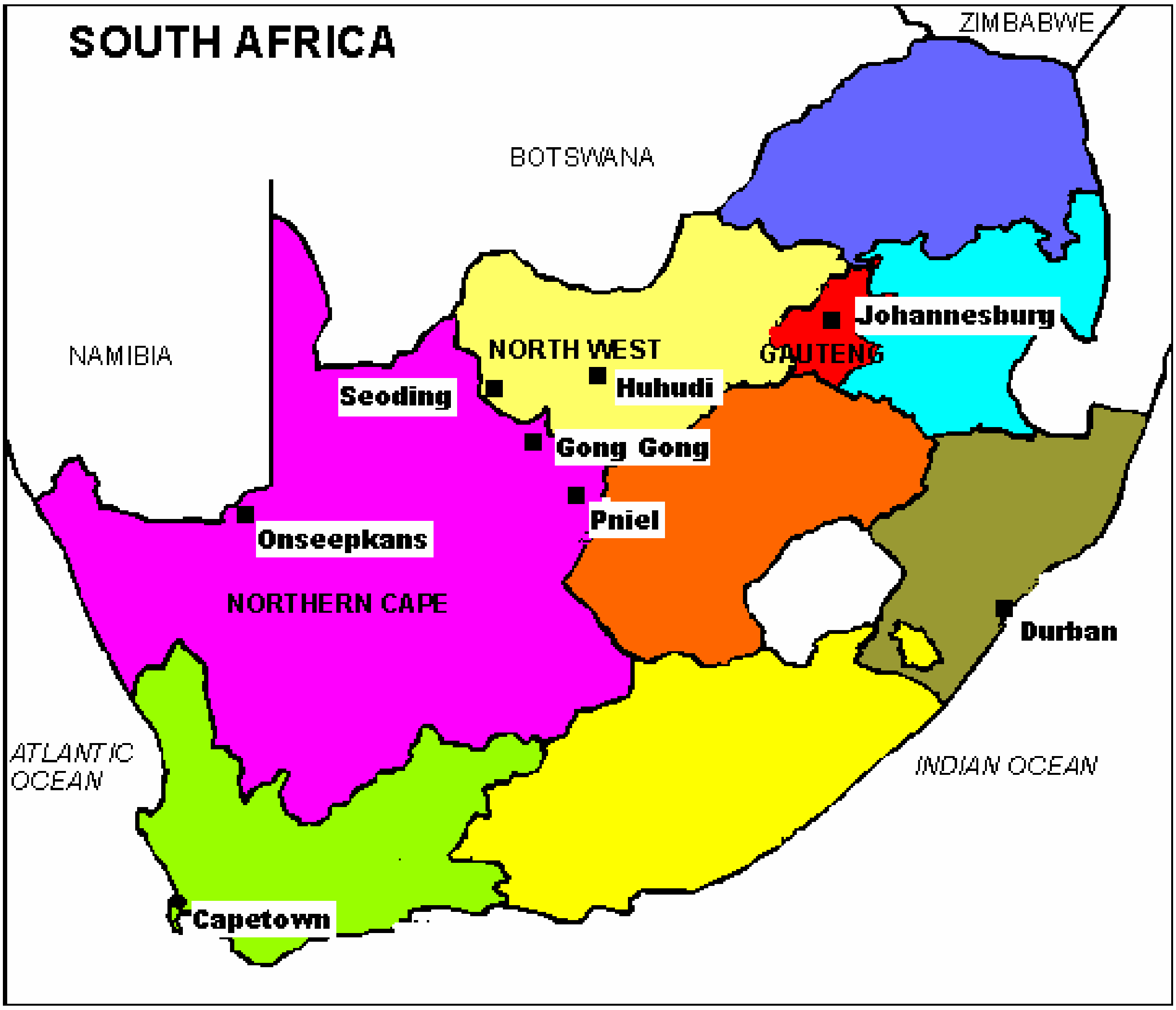
However, prior to the final decision, these technically suitable solar stoves were subject to a cooking test confronting them with a real-life user situation and the African climate. It showed that all selected solar stoves allowed the preparation of all test dishes including the baking of bread. Thus, all solar stove related prerequisites for the social acceptance test were fulfilled.

2.2 Baseline study to prepare the social acceptance test

The baseline study in the dry North-Western region of South Africa, i.e. the North West Province and the Northern Cape Province, scanned five potential test areas by interviewing 200 of a potential 6,800 households and a series of institutions like old age homes, hospitals, clinics, schools, kindergartens, and small businesses. The five areas, Huhudi, Seoding, Pniel, Gong Gong, and Onseepkans, represented a mix of fuel use patterns and were representative of rural, semi-urban, and urban settlements (**Figure 7**)

Based on criteria like cooking profiles (weather conditions, fuel availability and prices, household size, availability of an appropriate sunny space, cooking techniques and timings) as well as socio-economic characteristics, three test areas were selected. Onseepkans, representative of small rural villages, where collected wood is the primary source of fuel. Pniel, though also a small rural village, is located 8 km from the nearest town; there is a fuel mix with wood and paraffin used in almost equal proportions. Huhudi, an urban township, has access to electricity, has a high reliance on paraffin for cooking and a comparatively low use of wood.

Figure 7
Location of the areas for the baseline study



Source: SCFT

Schools were found to be the only suitable institutions. Selected schools served at least one meal per day and reported a desire to save on fuel expenses.

2.3 Design and execution of the social acceptance test

Solar stoves were tested by 66 families and 14 institutions in the three selected test areas during a one year placement period. 30 families without solar stoves acted as control households. Monitoring personnel, i.e. three persons for each test area, was selected and trained before being deployed in the field. Their task was to collect and process questionnaires completed by the user households, the control households, and the institutions and to compile additional data.

Six solar stove models were placed with families, three models each for large and small ones. Every family had one solar stove model for a period of two months before changing and using another one. Therefore, by the end of the placement period each family had tried every solar stove twice (during summer and in winter). Moreover, three large solar stove models were placed at institutions. For users and non-users, three different types of questionnaires were completed. In-depth interviews provided additional information. At the end of the placement period, a workshop was conducted in each test area to carry out a preference voting exercise. Finally waiting lists were established for the purchase of used stoves as a useful indicator of user preference.

The solar stoves during the social acceptance test exclusively used local cooking profiles taking into consideration such data as typical housing, monthly family income, number of persons in the household, type of dishes, cooking techniques, cooking times, meal times, existing cooking equipment, cooking area, number of cooking pots, fuels collected or bought, cost of fuel, weather conditions, annual daily insulation, and sufficient space for solar stoves.

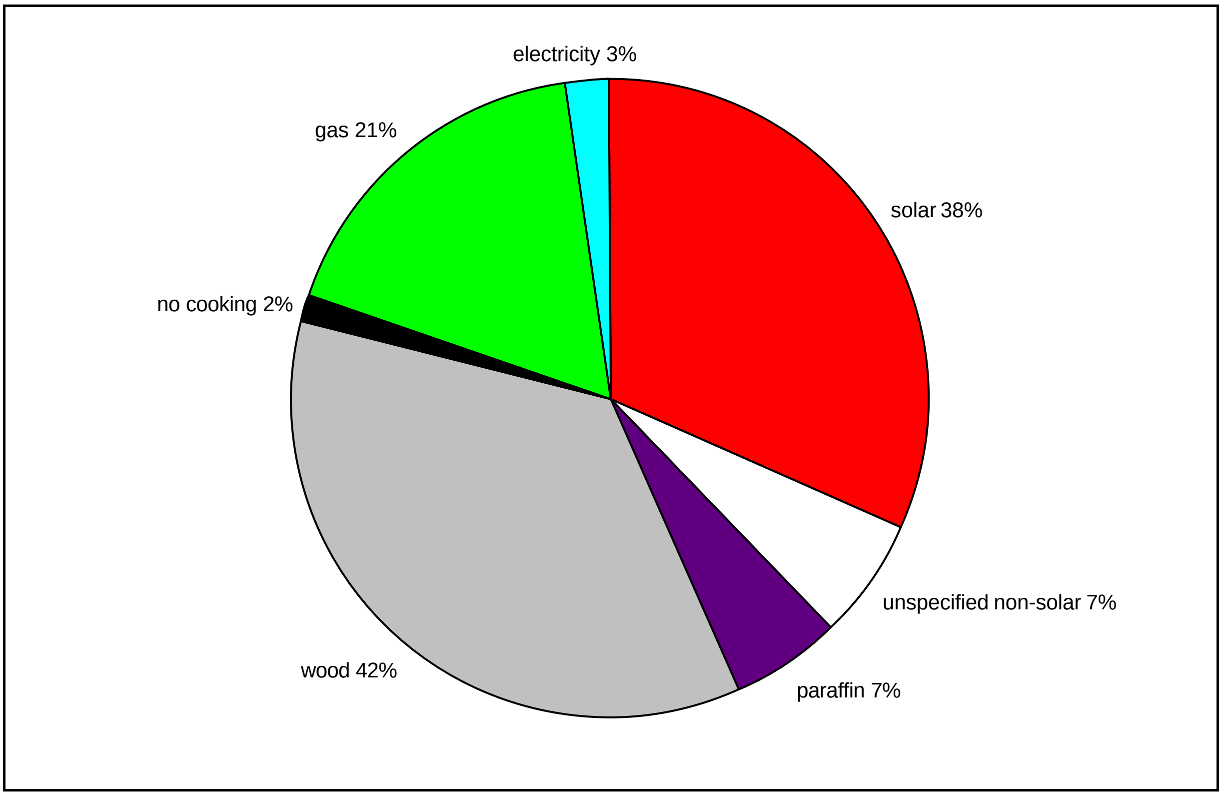
2.4 Results of the social acceptance test at households

Intensive monitoring showed that families used the solar stoves at least once on 38% of all days, prepared 35% of all cooked meals on the solar stove, and were satisfied with the results of 93% of their solar cooking attempts. While it is interesting to know how often solar stoves are used, it is necessary to compare the use of solar stoves with the use of non-solar ways of cooking to put the use figures into perspective (**Figure 8**).

Solar stoves, along with wood (open fires, wood-stoves and coal-stoves fueled with wood combined) were the most used cooking appliances followed by stoves fueled with gas, paraffin and electricity. These results indicate acceptance of solar stoves by family test users, “acceptance” of solar stoves being defined as “solar stoves are used as much or more than other main cooking options in the household”.

The preference of family users for different solar stove models was assessed in three independent ways: By use frequencies of the 6 solar stoves, by the sales of the used test stoves and by user workshop voting results. There were use rate variations but not enormous ones. According to the first criteria, small families prefer the REM5 (over ULOG and Sunstove), large families the SK14 (over SCHWARZER1 and REM15). These priorities have been confirmed by the sales of the used test stoves while the workshop generated a slightly different ranking. Over all three test areas small families mostly used and bought the REM5 but voted for the ULOG as the best solar stove, while large families preferred the SK14 with the REM15 coming first in votes (**Figure 9**).

Figure 8
Frequency of daily use of different cooking appliances in rural and semi-urban areas



Source: SCFT

Figure 9
The SK12, the most efficient solar stove model during the social acceptance test

Source: SCFT

Solar stoves are used for cooking and baking. But they are add-on appliances - not appliances that replace others. Solar stoves, along with wood (open fires, wood stoves and coal stoves fueled with wood combined) were the most used cooking appliances among the test families. They were followed by stoves fueled with gas, paraffin, and electricity. Understandably, electricity use appears to be very low since only one out of three test areas is grid connected. In 7% of the cases non-solar stoves were used, but the fuel type was not specified. On 2% of all days, no cooking took place.

During the solar stove placement period, the participating families enjoyed 38% of overall fuel savings (with 33% of paraffin, 57% of gas and 36% of wood). Considering the fact, that solar stoves are no “stand-alone” option and that many families use more than one fuel type for cooking, these fuel savings are considerable. In absolute terms, the 60 or so test user families have saved almost 60 tons of wood, more than 2 tons of gas, and over 2,000 liters of paraffin. In monetary terms, savings were the highest in Huhudi where fuel is mostly bought, and lowest in Onseepkans where collected wood is an important fuel source. Pniel took an intermediate position.

The solar stoves have been tested in complex social environments characterized by poverty, high levels of migration, low levels of production and lack of institutional support. Impacts on women at the household level include monetary savings, which have enabled them to allocate finances to their spheres of influence, as well as time savings, which provide the opportunity for them to spend more time strengthening their social networks. However, increased engagement in community politics was not identified. Fuel strategies to cope with poverty are not abandoned completely but adapted slightly. Preference among users of solar stoves varies from one household to another. If an elderly person or a child is responsible for cooking maneuverability of the solar stove is of importance. Fuel savings and safety is a key issue at all times, especially for women (**Figure 10**).

Figure 10
Discussing fuel savings while enjoying a solar cooked meal

Source: SCFT

The macro-economic estimate complements the micro-economic assessment and sheds light on likely economic and social impacts once large-scale marketing of solar stoves takes place. Impacts include cumulative savings, reduced air pollution from wood use, and the avoided time used for wood collection. In addition, further effects might be employment generation to a certain extent, slight reduction in air pollution from coal combustion, paraffin poisoning cases, as well as fires and burns from paraffin. Moreover, decreases will occur in the emission of green house gases such as carbon dioxide.

2.5 Results of the social acceptance test at institutions

Since solar stoves were poorly used by the eight initially selected institutions, the social acceptance test was eventually limited to those institutions with reasonable use and interest. Thus, only three of the original institutions remained and another six were added in June 1997. To permit further evaluation, the test period was extended by six months.

Taking into consideration the original institutions where interest was observed together with the new institutions, solar stoves were used on over 50% of all occasions when visited by the monitors or supervisors. Overriding incentives for solar stove use were high motivation of the cooks, management incentives to reduce fuel expenditure and incentives for the cooks to use the solar stoves. The most important reasons for not using the solar stoves were lack of security for the solar stoves, lack of budget control by the cooks and control exerted by outside organizations.

Several interviews generated a series of interesting findings: Most institutions would likely buy a solar stove. Many prefer the SK 14; pot size is an important criterion. Likely prices to be accepted range between ZAR 1,000 and ZAR 1,500. Where decisions are made at the institution, appliances are bought from the cheapest store. They are normally purchased with a 12 to 24-month guarantee. In general the solar stoves are expected to be delivered. The number of people catered for by hot meals varied between 25 and 170.

2.6 Long-term acceptance of solar stoves

Of the 66 solar stoves sold to families at the end of the social acceptance test, 44 units were found more than three years later. Of the solar stoves that could not be located, two units had been passed on to family members outside the test areas and two users were absent at the time of the visit. In some cases families moved away or because of a death in the family the solar stove was divided with other belongings among siblings in other areas. In general, the solar stoves were in good condition. Mostly minor repairs had been performed on 21 solar stoves. 6 households were using their solar stoves during the visits.

The major messages from the ex-post purchase study were: Use rates decreased in winter when the elevation is lowest, limiting the available solar input power. The decrease rate is particularly strong for the two slower solar stove models, the ULOG and the Sunstove. The decrease rates in winter concern mostly Pniel and Huhudi where practically all fuel is bought. In Onseepkans where most of the fuelwood is collected, the drop of the use rate in winter is less dramatic. High capacity and efficient solar stoves are used more than low capacity solar stoves. The use of solar stoves is dependent on a certain minimum per capita pot capacity, which should be in the order of 1 to 2 liters per capita.

To establish commercial viability of solar stoves, high quality products need to be available to potential customers. They have to be convinced of the benefits to purchase solar stoves. This requires a clear understanding of the usefulness of solar stoves to owners, in the short and long-term. One argument is that the cost of the solar stove will be amortized through energy savings over a period of time. A survey in July 2000 revealed that 50% of the families were now using their solar stoves more than in 1997, 5% had a stable use rate, and 45% were using their solar stoves less by now. These figures suggest that long-term acceptance of the solar stoves is proven by the fact that more than half of the households increased the use rates three years after purchasing their solar stoves. This also emphasizes that solar cooking requires a long term learning process, time and effort to master.

2.7 Lessons learnt

There is an array of messages from the social acceptance test for solar stoves: Solar energy is a promising option capable of being one of the leading energy sources for cooking. The high use rate of solar stoves, at par with wood and above other fuels, indicates acceptance of solar cooking by families / households. Each solar stove model has its own supporters. An obvious, universal, single choice does not emerge. However, clear user preference for certain solar stove models is evident and thus provides a sound basis for the selection of solar stoves to be promoted. All test stoves needed technical improvements and have undergone adaptations. The adapted solar stoves will serve as a basis for local production.

Considerable fuel and time saved by the use of solar stoves generate reasonable payback periods (about two years), except for the most expensive stoves. With price reductions on the horizon, once solar stoves will be mass-produced, payback periods will be reduced even further. The willingness to buy test stoves suggests a viable market for solar stoves, confirmed by an independent ex-post market study. While causing a shift in cooking times and reorganization of household labor, the use of solar stoves does not disrupt social relationships. Solar cooking generates positive macro-economic impacts.

The methodology employed to investigate household use has proven sound. For institutional use, direct observation was the adequate method. The open approach of the social acceptance test where users can express their judgment of a technology in general, and preferences concerning different appliances in particular, has proven valid.

In terms of institutional solar stove use, it can be concluded that the original participating institutions did not maximize the use of the solar stoves available to them. Seven issues were identified which make up the management environment and which influence the potential use of solar stoves in institutions: human resources, financial resources, communication channels and methods, attitudes to work, decision-making structures, wealth of the institution, and institutional support networks (**Figure 11**):

Figure 11
Institutional solar stoves used for training in the Tiger Kloof School near Vryburg

Source: SCFT

Source: SCFT

3. Making the case for a commercially driven process to achieve a social, economic and environmental agenda through renewable and alternative energy cooking technology

3.1 Project rationale and concept

Initially, the solar cooker focused on developing solar cooking technology that was efficient and marketable. Then, as concerns about meeting a range of consumer needs, and developing a market and distributing products arose, it investigated how the social and environmental agendas could be linked to a commercially viable supply-side approach. Now it promotes the concept that the best way to meet the social and environmental agendas is, in fact, through a commercially viable approach. Key elements in this are the contextual policy and regulatory environment, the supply-side profile and the demand-side profile.

While governments and non-governmental organisations (NGOs) are concerned about the "big picture", in terms of societal and environmental imperatives, the consumer's priority is the provision of meals for the family. The energy cost and the environmental savings will only be realised if consumers choose to cook with R/A energy appliances on an ongoing basis. And, they will only do so if they believe that these cookers will be able to provide – at least – an equivalent quality, quantity and diversity of meals as timeously and conveniently as their traditional cooking technologies. If this credibility is to be achieved, then issues of mass accessibility, economies of scale, variety of options all need to be addressed. The best mechanism for addressing these issues is the market. Only a truly commercially-driven approach integrates the different but parallel objectives of society, individuals/families and suppliers efficiently. There needs to be both a "value motive" that drives the demand or market-side of the equation, and a sustainable "profit motive" that drives the supply or industry side.

Despite a policy commitment by the government towards renewable energy, there is a distortion in the regulatory environment towards two dominant energy sources: electricity and paraffin, both of which enjoy direct support in the form of subsidies. This has had a crowd-out effect on other energy forms. The regulatory framework, supports conventional energy sources through subsidization. Potentially, the infrastructure exists to support a R/A energy initiative. The Central Energy Fund (CEF) appears to be an appropriate institutional framework for hosting a unit that could focus on the development of a commercially viable R/A energy household cooking technology sector. The Solco project offers an opportunity to the CEF to look at the AE/RE sector creatively. This opportunity is further enhanced by the demonstrated commitment of several international donor agencies to support initiatives of this kind.

3.2 The vision and mission: conceptual linkages

The vision of the Solco Project is significant and sustainable penetration of renewable and alternative (R/A) household energy technologies, particularly for cooking, in South African households. The envisioned outcome is tangible support in overcoming the varied economic, social, health, environmental and problems facing South Africans, particularly those in lower income groups and in marginalised groupings such as women, children and the elderly. The mission of the Solco Project is to establish a body that will pool and concentrate resources to better enable a commercially viable and sustainable R/A household energy industry and market in this country.

The vision and mission of the Solco Project rely for their achievement on the complex linking of certain key concepts including:

- Commercial viability and sustainability, built on supply and demand;
- Industries and markets as tangible manifestations of supply and demand;
- Value on the basis of quality, real and perceived, price, and perceived risk in having expectations met. The value proposition presents to the consumer the way in which a supplier claims to satisfy the consumer's needs and to do so uniquely (differentiation).
- The profit motive and sustainability. If supply and demand are to be built, then entrepreneurs need to be convinced that an investment in R/A household energy in South Africa is commercially viable. Without an industry, the consumer demands for value, with all the dimensions that implies, are unlikely to be met.
- Sustainability in business. Here the key understanding is that a sustainable society does not deplete its capital, and that capital includes business capital, social capital, human capital and environmental or resource capital. The triple bottom line which measures the performance of companies against economic, social and environmental standards, is a key concept. This is particularly important in a project which has overall societal objectives but it is a concept that needs to be applied flexibly, towards a collective and cumulative effect of the industry on society at large. In the context of this project, which is driven by harnessing the impetus to profit, the economic bottom line is as important as the social and environmental ones.
- The need to use a range of R/A energy sources to complement one another, build on the consumer focus on application outcomes rather than energy source, and acknowledge the need to build consumer confidence in less traditional methods.
- The enabler concept, which seeks to establish a mechanism for pooling resources, which are rendered less effective and more costly by isolation. The enabler in this project would be responsible for popularising the concept of R/A household energy cooking, thus stimulating demand, supporting activities that would lead to economies of scale, and monitoring successes in terms of the triple bottom line.

3.3 Demand analysis

A working hypothesis about a primary target market was developed for the purposes of in-depth consumer research. It was decided to focus on consumers in the Living Standards Measure (LSM) groups 3-5. The choice of a primary target market is based on the need to focus limited time and resources where they are most likely to engender a positive outcome.

According to the desk research on LSMs, the members of the primary target market of LSMs 3-5:

- Number some 17.2 million South Africans, or over 39% of the population, living in 3.6 million households.
- Are largely black. While their home languages cover the spectrum of vernacular languages, between 60% and 80% of them understand English. Most of them are functionally literate. Most have had some high school education.
- Account for 22% of purchases of large household appliances. This makes them a significant market in this field.
- Have an average household size of about five individuals, an important factor in determining stove capacities.
- Have incomes that are relatively low, averaging about R 1 803 per household (corrected by 20% to bring up-to-date).
- Include a relatively high percentage of people who are unemployed (about one third), while of the one third who are employed, only two-thirds work full-time. The remaining one third is not working by choice.
- Are distributed across all nine provinces, with the highest concentration in Gauteng.
- Are in transition between rural and urban areas, and are found fairly equally across rural, village, city/large town and metropolitan areas, with the biggest concentrations in rural areas and metropolitan areas.
- Span the spectrum of different types of housing, with the highest concentrations first in matchbox/RDP type housing, and then in shacks/informal housing, with a significant number still living in traditional dwellings.
- Have relatively few amenities in the home, and do not seem to prioritise electric cooking mechanisms even where electricity is available. Only one third have running water in the home and, of these, only a third have hot water. However, most of them do have electricity (88%) and this is likely to increase. Although they may not choose to use electricity supply to power cooking appliances, because of cost or level of availability, they do have this option. In fact, only 34% of them own an electric stove, and 26% own a primus or coal stove. Ninety percent own a radio, and 69% a TV.

A much higher percentage (49%) own a hi-fi/music centre than own electric stoves. This gives some indication of how they choose to prioritise expenditure.

- Buy their appliances primarily from chain stores at the lower end of the market, offering HP terms.
- Are brand loyal.
- Are positive about life in South Africa in the past five years (more so than other groups) and have positive expectations for the next five years (more so than other groups).

A survey to determine the awareness and understanding of solar energy and solar cooking technology was conducted alongside mass demonstrations of such technology in LSM 3-5 communities. This survey involved 200 random intercept interviews with respondents who displayed interest in the demonstrations. Two smaller surveys were also conducted: one of community leaders and others who could influence the purchase of a particular product, and the other of those who were potential bulk purchasers.

The biggest and most critical survey, from which the most important conclusions concerning potential demand are drawn, is an in-depth study of the primary target market entitled, "The Renewable Energy Study". This study involved a process of quantitative and qualitative interviews, product demonstrations and feedback, and in-household observation that lasted up to a full day with each respondent - the female member of household with primary responsibility for preparing meals. Four hundred and fifty-four respondents were randomly selected according to a structured sample including households in LSMs 2-5 (broken down by LSM so that the differences between them could be analysed; LSM 2 was included for comparison). These households were further segmented by province (interviews were conducted in six provinces), by age of respondent (according to the profile curve for the target market), the presence or absence of electricity in the home, and the type of community. Importantly, samples were selected so that comparisons could be made between the presence or absence of electricity in the home in similar (rural) environments, and across environments (comparing non-electrified rural communities to non-electrified urban informal squatter settlements).

Results of the primary research can be summarised as follows:

- Consumers use more than one household energy technology for cooking. They aspire to electricity, but cannot afford to use it, even if the household is electrified with sufficient capacity to cook. The issue of any fuel cost is paramount.
- In LSMs 3-5, approximately 10% are using gas, but, in general, these consumers are unhappy with gas for safety reasons. A larger percentage, approximately half in LSMs 3-5, are using paraffin, which while not as negatively perceived as gas, is still problematic for health and safety reasons. It is used primarily because it is relatively inexpensive and safer choices are not available.

- In addition to paraffin, the more affluent and electrified households in these LSM groups are also using coal, and the less affluent and non-electrified households are using wood. There is a very real opportunity for solar energy to take its place alongside these latter two fuel sources at the expense of gas and paraffin.

- There is a high awareness of, understanding of, and positive attitude towards solar energy as a household energy source, even though it is not currently being used as such. The strong willingness to consider solar technology (91% of those in the survey sample showed a positive predisposition to solar energy for cooking) rests on the fact that there are not fuel costs and it is safe to use. It is not seen as a "poor person's option". Its dependence on sunshine and its relatively slow cooking speed are, however, seen as negatives.

- There is also an opportunity for more fuel efficient wood and coal burning stoves both to replace current less efficient wood and coal stoves, at the expense of paraffin and gas.

- Any approach to developing renewable household energy should be holistic and incorporate all such technologies. This is because solar can never be the primary household cooking technology in an LSM 3-5 household. Its usage is limited by the availability of sunshine. Consumers will continue to use more than one energy source.

The important point to remember is that the conclusion of the research is that there is strong *latent* demand. Consumers have real needs and are prepared to consider alternatives that provide solutions, including R/A household energy cookers. The issue then becomes converting this latent demand into real demand and this requires that the supply side issues be addressed in a systematic and ongoing way. Without a doubt, it is "supply" and not "demand" that is the single biggest roadblock standing in the way of success.

3.4 Supply analysis: Meeting the demand in a commercially viable way

Besides the dominance of certain individual energy forms, the end-user is also influenced by the utilisation of already existing energy carriers through strong branding such as IP (Industrial Paraffin) or simply familiarity. Subsidised products and the low cost of conventional energy such as coal, IP and also, to some extent, electricity in the targeted income bracket determine the affordability of energy carriers. The fuel cost for one meal portion with electricity is 82 cents as compared to 15 cents for paraffin and 30 cents for coal (SA average).

The developed industry for conventional cooking appliances is characterised by:

- A good distribution network
- An infrastructure for servicing and support
- Economies of scale
- Availability of end-user finance
- And a broad range of products.

Where the existing suppliers have a competitive advantage, the opposite situation exists for suppliers of R/A appliances. At present there is no product supply, familiar to the consumer, and characterised by depth and continuity of supply in the R/A energy cooking technology industry. The lack of entrepreneurial drive to supply in this area corresponds with lack of business advice specifically for the sector of R/A energy technology. As a result, the lack of a branded product or a branded distribution network has never been thought through from a commercial perspective. The appliances have always been distributed as “clean technologies” with the aim of reducing CO_2 emission and air pollution. But, as the demand analysis has shown, the users’ priority is cooking in an efficient manner. Other features of a cooking appliance are not considered priorities. The brands *Sunstove* or *Vesto* are sold because they are seen by customers as fuel efficient and time-saving. Their ability to deliver “clean energy” is not a priority for the buyer.

The focus of supply in a commercially viable approach must be on meeting consumer demands and not just on pushing an environmentally superior technology. A multi-pronged approach is needed to meet this challenge:

- Involvement of financial institutions in investing on the supply side or providing finance on the demand side;
- The establishment of distribution networks and support infrastructure;
- The development of a product range of R/A cooking appliances;
- Promotion and awareness; and
- Building the market to create economies of scale.

R/A energy cooking technology currently occupies a niche in the market. But even within this niche the players and producers have difficulties because the playing field is not level. Investors, enablers and supporters of R/A energy cooking technology have to be careful not to distort the market and impede the proliferation of a variety of products. The interest in one supplier can easily undermine the efforts of other suppliers. Subsidies or investment offered to one product may well amount to manipulation of the market and disregard the commercial principles, which we consider to be of utmost importance in promoting R/A energy cooking technology on a mass basis.

3.5 Routes to the market

The purpose of this section of the business case was to identify all the potential routes to market in South Africa, to describe them, discuss their relative strengths and weaknesses, and highlight key issues.

- There is, currently, a paucity of suppliers of R/A household energy cooking technology products. This is reflected both in the quantity and diversity of suppliers. The paucity of suppliers means a paucity of choice for different distribution channels to be able to differentiate themselves competitively.

- With a few exceptions, the existing suppliers are characterised by a relatively low entrepreneurial drive. Often, the motivation driving the supplier is more one of altruism or technological curiosity than commercial opportunity. In certain instances, the move into R/A household cooking technology products has, in part, been out of the ”comfort zone” of previous business experience: for example, moving from reacting to large contract tenders in the public sector to proactive selling to retailers and direct to consumers. This lack of commercial sophistication has implications for the development of commercial relationships with distribution channels.

- Generally speaking, none of the existing suppliers currently benefits from economies of scale. They are small, and often marginal, businesses (yet, conversely, most of them are formal businesses and not localised micro enterprises physically operating within the target customer communities). This has ramifications in terms of quantity and continuity of supply, and the relative influence suppliers will have with regard to their channels of distribution.

- From the perspective of the enabler, there is a need to engage with existing suppliers to help them reduce the time, costs and risks or improve the economies of scale associated with their businesses. This can be done by improving their understanding of market-suitable products and removing roadblocks to their successful introduction. In particular, facilitating introduction to appropriate distribution channels is essential.

- But, the scope and vision of the enabler must be far broader than the existing sources of supply. It is essential that the enabler facilitate the entry to the industry of many more, diversified, suppliers. Furthermore, the enabler must prioritise achievement of scale, even to the extent of encouraging and facilitating the development of consolidators/ wholesalers who are able to do on behalf of suppliers collectively what they may not be capable of doing independently.

There are four main distribution channel options (with a number of choices within each of these options). These are:

- Direct response marketing;
- Retail distribution;
- Personal selling; and
- Institutional channels.

Each of the four has advantages and disadvantages as illustrated below:

Box 1: Swot analysis of routes to market

Direct Response Marketing – Outbound (e.g. mailing lists) and Inbound (e.g. advertising in media)	
Strengths	**Weaknesses**
✍ No intermediary, no middleman – direct telephone or post or e-mail – gets to remote areas fairly cheaply. ✍ Flexibility. ✍ TV (inbound) gets to most of the target group.	✍ Customer cannot see or experience actual product. ✍ No physical presence – creates fears around follow-up. ✍ Not all in target group is easy to access through telephones etc. They move around. ✍ Not that many target specific data bases (outbound). ✍ Radio (inbound) is not appropriate for visualising products. TV is expensive to use. ✍ Aliteracy (inbound) is high.
Opportunities	**Threats**
✍ Possibility of establishing a professional call-in service. ✍ Market entry into areas without appropriate local retail distribution.	✍ Actual cost of distribution is high. ✍ Danger of delivery, set-up, maintenance problems without support.
Retail Distribution – Chain groups	
Strengths	**Weaknesses**
✍ Economies of scale. ✍ Preferential positions in shopping areas – highly visible. ✍ Aggressive advertising – highly visible. ✍ HP finance. ✍ Sell large volumes. ✍ Have a regional distribution network.	✍ Main interest in merchandise with national, large volume potential. ✍ Conservative about products. ✍ Want supplier to take the risks – but this can be worthwhile as a marketing investment.
Opportunities	**Threats**
✍ Possible to develop win-win situations if suppliers are careful. ✍ If they buy-in, they will increase visibility and harness customer loyalty. ✍ Potential to sell an idea if supplier can prove there is a demand. ✍ If commercial viability proven, will want to get on bandwagon.	✍ Can dominate small suppliers. ✍ Can “steal” ideas. ✍ Hidden costs. ✍ Suppliers must be able to gear up to big volumes quickly – can be difficult for small suppliers.
Retail distribution – independent retailers	
Strengths	**Weaknesses**
✍ Less of a power imbalance compared with chains. ✍ In closer touch with needs of local communities. ✍ Higher degree of personal selling than chains.	✍ Can’t compete with chains on advertising, visibility generally. ✍ Difficult for suppliers to identify and access them. ✍ Difficult for suppliers to manage large numbers of independent relationships.
Opportunities	**Threats**
✍ May be more willing to list and support R/A products than big chains – suppliers can use “difference” as a selling point. ✍ May be willing to do local promotions, in-store demonstrations.	✍ Greater business risk for suppliers – avoid putting too many eggs in one basket.
Personal selling (one on one)	
Strengths	**Weaknesses**
✍ Good option for new products and technologies – based on demonstration. ✍ Familiar route to target group. ✍ Salesperson likely to know community well.	✍ Supplier has to co-ordinate many salespeople – train, supply, collect money etc. ✍ Unlikely to offer finance, post-sale service, usage support etc.

✍ Salesperson has a direct stake and is dedicated to the product and can be committed to the customer. ✍ Salesperson can be proactive – go to the customer.	
Opportunities	**Threats**
✍ Big opportunities for innovative solutions to challenges, particularly for companies with existing distribution networks in the target group. (See EMS in the business profiles.)	✍ Logistical breakdowns may impact negatively on customer perception of the product.
Institutional channels (e.g. government agencies and NGOs)	
Strengths	**Weaknesses**
✍ Ability to move relatively large volumes of cookers through a single channel at one time – economies of scale for suppliers. ✍ Concentration in one area (e.g. a housing project) can achieve a visible critical mass of consumers using the same technology – increases acceptance.	✍ Institutions tend to have social or environmental agendas rather than commercial agendas.
Opportunities	**Threats**
✍ For the enabler to ensure that decision-making by institutions around R/A household energy technology is informed from the perspective of consumer demand.	✍ Institutions may not have an understanding of consumers that will ensure follow-up, concern for individual needs etc and hence sustained usage. ✍ If products are seen as being "for the poor", it could have a negative affect and lead to consumer resistance. ✍ Providing products below perceived market value can undermine the parallel development of commercial channels – distorting the market.

There are a number of enabling mechanisms that could support the development of a healthy R/A energy cooking appliance industry. The existence of such mechanisms will allow the enabler to draw on support for the work it does in terms of bona fide supply side finance support, creating environmental visibility, leveraging useful public private partnerships, generally mentoring the growth of a new industry and mobilising support in the environment. The finance institutions that might support supply side stakeholders in the R/A energy cooking appliance industry can be grouped according to their mission and interests as follows:

- ✍ National, bilateral and multilateral institutions
- ✍ Promoters of SMEs
- ✍ Corporate Foundations
- ✍ Funds for Renewable Energy

Another option would be to use the clean development mechanism (CDM) route. During 2003, the Climate Protection Programme of GTZ commissioned a study on the potential for attracting finance through the Clean Development Mechanism (CDM). Using an internationally accepted theoretical model, it was concluded that the use of solar cookers will reduce emissions of greenhouse gases in most cases. The exception is when wood (or other biomass) is being 100% sustainably cropped (or is considered as renewable). The study based its findings on 244 meal portions per person per year cooked on a solar cooker, five people per solar cooker, and 1.21 MJ per meal portion, with solar energy replacing a range of commonly used fuels. On this basis there would be reduction in the relevant six Kyoto Protocol greenhouse gases at between 0.25 and 1.27 tonnes CO_2 equivalent per year.

The study used a projection of 250 000 solar cookers sold exponentially in the South African market over five years. This figure is deduced from the demand analysis described in the business case. Transaction costs, levies and taxes need to be taken into account. The study concludes, however, that there could be an undiscounted "carbon" income of between US$ 2.21 million and US$ 47.8 million (undiscounted, before tax) per annum (based on a CER Certificate market price of between US$ 3.5 and US$ 18, the fuel being replaced) for a solar cooker industry in South Africa over a period of 16 years. The once-off and ongoing (taxes and levies) transaction costs are broadly between US$ 72 000 and US$ 355 000 for small scale and complex "regular" CDM project activities respectively. The consultants involved in the study believe that they have been conservative in their assessments.

3.6 The Way forward

The most important conclusion to be drawn from the business case is that R/A household energy cooking technology is, unquestionably, commercially viable in the South African market. There is a demonstrable "value motive" for consumers and consequent latent demand upon which a market can be established and an industry built. The roadblocks that stand in the way of success are primarily on the supply (or industry), side, and these have been discussed in some detail. Given the willingness of entrepreneurs and others to invest resources and time, the roadblocks can be addressed and removed. The fundamental issue going forward is, therefore, ensuring that this investment happens. Investments will only be made, especially in "green fields" or speculative start-up projects and industries, if they satisfy the "profit motive" by offering the potential of a reasonable return relative to the risk.

The way forward involves four key tasks:

- Quantifying the size and potential of the opportunity
- Quantifying the societal benefits
- "Marketing" the conclusions of this project.

4. Project experience with local manufacture and test-marketing of solar stoves

4.1 Manufacture of solar stoves

At the beginning of Phase 2 of the SCFT in 1998, no reliable comparative information existed on the adaptation of the solar stoves, not only to user preference, but also to available production and commercial dissemination / marketing conditions. Thus, a high level of technical development was the necessary prerequisite for user acceptance of solar stoves in the market.

A tender procedure was designed and a list of potential manufacturers compiled. A shortlist of large and small companies was drafted, some producing solar energy appliances, some other devices such as satellite dishes or household appliances such as ironing boards. All short-listed candidates and their facilities were visited to assess their production capacities.

The SCFT office received seven written tender bids. All of these bidders were visited. All but two were small in size, ranging from a one-man show to some 150 employees. Most bidders were enthusiastic about the solar stoves. However, none of them was willing to take up more than production of solar stoves on job order by, and delivery to, the SCFT office. As a result of this procedure, and after one-by-one negotiations, the following bidders were appointed:

A two-carpenter partnership producing high-quality design furniture, with basic woodworking equipment adapted for ULOG and a metal working shop equipped with a variety of machines for SK14 and REM5. Both retained manufacturers had the necessary qualification, facilities and most of the equipment needed for the production of the respective stove models.

To find or select a suitable manufacturer for a given solar stove model, or to adapt a stove to given conditions, a method called “production profiles” was developed by the SCFT-team and applied. The aim of this method is the identification of problems before they occur. These profiles were established for each of the test stoves:

- SK14 has few component materials, but needs some import and qualification. It has been re-placed in the test period by the redesigned version SK1200 that was developed for the production of complete kits, local pre-assembly and final assembly by the user.
- Sunstove shows a mix of manufacturing modes: industrial blow-molded casing and workshop-type assembly, all of this in South Africa.
- REM5 had the highest production requirements of all models tested: many components, particularly imports, complicated and unforgiving assembly procedures. This model was redesigned in two versions: a fiber reinforced polyester model T16/LST produced in South Africa by Lightweight Structures Technologies (LST), and a kit sheet metal version T16/LC, to be manufactured in Germany with local final assembly.

- ULOG is well adapted for small-scale production: few component materials, easy local procurement and no high qualifications needed.

Production activities should not start before test marketing provides a clear unconditioned go-ahead signal. On the other hand, regular, full-scale marketing cannot commence before quality stoves are actually available. Thus, good chances for success require to start production of solar stoves in existing workshops with existing machinery operated by already present and qualified staff instead of establishing a new factory and hiring new staff, to start solar stove marketing with imported or partly locally assembled units, and to start production carefully "as specified".

4.2 Initial marketing and awareness creation activities during the field test

A first step investigating marketing of solar stoves was when Markinor, a leading South African market research institute, carried out a market survey for the SCFT office in four locations (Kuruman, Kimberley, Upington, Springbok) in the Northern Cape Province in September/October 1997. While cooking demonstrations with the SK14, the Sunstove, the REM5, and the ULOG were conducted, 100 persons in each location were interviewed. These interviews generated an array of findings. Most persons interviewed were willing to buy a solar stove in 24 monthly installments. The preferred solar stove was the ULOG followed by the REM5. Based on these results, Markinor presumed a large potential market for solar stoves. The income structure, the household appliances owned, and the related consumption patterns of the interviewed persons suggest that solar stoves are within their reach.

After the social acceptance test (May 1996 to August 1997) all solar stoves, which had been used for more than a year by families in three locations (Onseepkans and Pniel in the Northern Cape Province and Huhudi in the North West Province) were sold to these families with the exception of the big institutional stoves. Collectively about 60 solar stoves were sold, however, at sales prices calculated on the material cost less a substantial discount (second hand solar stoves).

When awareness creation commenced in South Africa solar stoves were unknown to the majority of the people. Target groups doubted whether meals could be cooked by using solar stoves. For demonstration purposes in about ten locations of the three provinces a sufficient number of solar stoves and a mobile cooking unit were procured, staff were trained, and richly illustrated information material was prepared. Then, between May 1998 and April 2000 SCFT personnel and external demonstration teams carried out approximately 220 cooking demonstrations. Each event attracted some 250 participants. Thus, a total of roughly 60,000 people were reached. Public relations and advertising activities were performed with radio, TV, newspapers, a solar stove hotline, and the SCFT website being the major media. This awareness campaign led to expenses of about 730,000 ZAR. However, the impact, i.e. the change in the attitude of the people and regarding related decisions to buy solar stoves, is not yet transparent for the time being.

4.3 Test marketing

The aim of test marketing is to obtain data from a small part of the overall market permitting reasonable estimates about the suitability of marketing instruments and the likely future sales of solar stoves on the entire South African market. For economic reasons test marketing was restricted to three medium-size towns (Upington, Kimberley, Calvinia) and some locations in the Northern Cape Province serving as supply centers for rural and semi-urban households of the target groups. In the Gauteng Province Randburg and Pretoria were retained. Test marketing was scheduled for a period of about one year. Based on the outcome of the social acceptance test four solar stove models were retained for the test marketing: SK1200 (former SK14), Sunstove, T16 (former REM5), and ULOG.

Initially, consignment acceptance forms were signed with about 20 retailers in the selected locations because the retailers were not prepared to buy the solar stoves from the SCFT office and pay their price right away. Among the retailers were three cooperatives, five small shops for sports and leisure goods, radios and TV sets, furniture, and kitchen appliances, seven small outlets offering products for daily supply, one agent for photovoltaic appliances, one NGO, one women's group, and two monitors (after sales service staff) of the social acceptance test. In addition, the SCFT office and the Sunstove organization was acting as retailers.

Despite intensive efforts, including solar cooking demonstrations, it was not possible to convince any of the nationwide operating supermarket chains to participate in the test marketing. They gave several reasons for their reluctance: The market is not ready for the new innovative product, the volume of solar stoves readily available is too low, their quality, and their appeal does not fulfill the expectations and requirements.

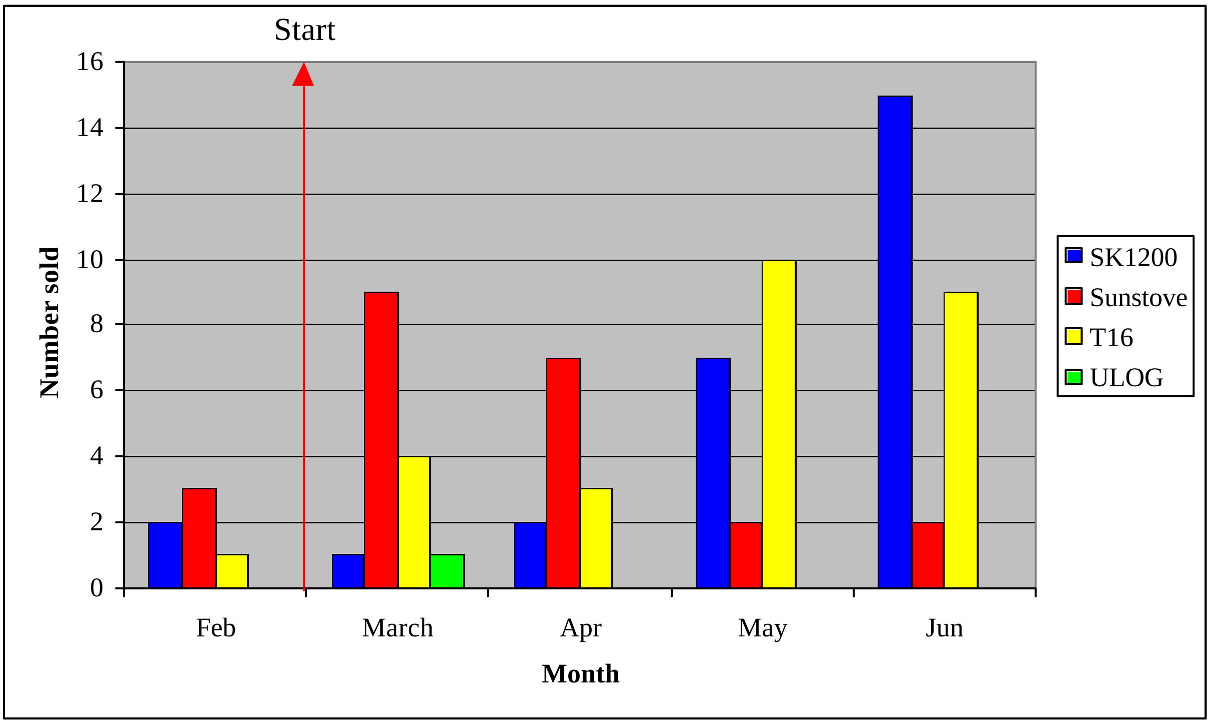
4.4 Results of test marketing

Between January 1999 and March 2002 about 1,000 solar stoves of various models have been sold. 90% were marketed in South Africa, the balance in neighboring countries. During the test marketing period of October 2000 to March 2002, 350 solar stoves were sold in the ten locations of the test area by 15 retailers, the SCFT office, and the Sunstove organization. 95% were sold in only five of the ten locations.

Given the test marketing target of 700 solar stoves the achievement rate pushed 50%. At the beginning of the test marketing the SK1200 and the T16 were sold for a price of 600 ZAR. These sales prices were reduced to 399 ZAR in two successive steps. Since April 2001 they remained constant. The price of the SunStove was cut once from 245 ZAR to 210 ZAR in the first quarter of 2001. The sales of the SK1200 and the T16 commenced with relatively low volumes. They increased modestly with the first price reduction and quite strongly with the second one (from 4 to 50 units); during that time the price sensitivity investigation took place

In the first quarter of 2002 the sales volumes returned to their initial level once the advertising activities stopped. This fact makes it difficult to detect a permanent impact of price reductions as well as advertising on sales volumes. Furthermore, the sales results have to be assessed with caution because the absolute sales figures are small and have to be distributed over 15 retailers.

Figure 12
Solar stove sales during the price elasticity study (March to June 2001)



Source: SCFT

3.5 Lessons learnt regarding production

Solar stoves are an innovative product of high quality using the power of the sun as a natural resource. They are mostly unknown to all future stakeholders like target groups, manufacturers, sales agents, retailers, and political decision-makers. At the start of product development the potential producer is not aware of the difficulties associated with the physical characteristics and technical properties of solar stoves, the material required for their manufacture, and the production process to be followed. Neither potential retailers nor customers are familiar with the proper operation and the benefits of solar stoves.

Awareness creation, i.e. the step to create attention for and interest in solar stoves, is the prime prerequisite to ever generate the desire of a potential customer to own such a product and to actually buy it. The expenses for awareness campaigns are high and often beyond the reach of (small and medium) private businesses.

Thus, the Government of South Africa must share the related cost burden to a significant extent (a renewable energy fund is in planning within the central energy fund to provide for incentives, soft loans, micro financing and 'green' financing). Failing to do so will endanger the successful implementation of its renewable energy policy as far as solar cooking is concerned. In other words, making headway in the use of solar stoves will be a significant contribution to alleviating the household energy constraints in rural and semi-urban South Africa.

It would be a decisive advantage to find powerful private partners who are well introduced in production and marketing of household appliances. If such partners cannot be found, the reasons for this lack of interest must be analyzed, e.g. lack of trust in the product or in its market potential, and acted upon.

Although an astonishing number of solar stoves has been invented and tested worldwide, there are not many stove designs, which could be readily adapted for cost-efficient large-scale production. Low-cost versions should be based on mass-produced components. They could be imported if this reduces costs, particularly for the first small batches for the start of new projects in other countries. Systematic comparison of different solutions, e.g. value analysis for production and conjoint analysis for client preferences, should be used to find optimum cost solutions.

Solar stoves must be optimized carefully. Compromise solutions must be found, in terms of technical parameters such as efficiency, handling, and durability as well as market-related parameters such as transportability, appeal and price. Even minor modifications can have major consequences - and can only be implemented on the basis of solid experience. In the beginning, this means using the input of both developer and manufacturer, with qualified inputs from the marketing side. In doubt, modifications should not be implemented directly; the stoves should stay "as specified".

Technology transfer is a two-way process, where technical know-how in form of plans and specifications meets local experience in form of requirements. The developer knows the physical characteristics, the operating conditions and critical issues. The manufacturer, after the production of initial batches of (as specified) solar stoves, knows about the critical issues in material procurement, tooling, and in the production process.