Here Comes the Sun

Options for Using Solar Cookers in Developing Countries

HERA – Household Energy Programme

commissioned by

Federal Ministry for Economic Cooperation and Development

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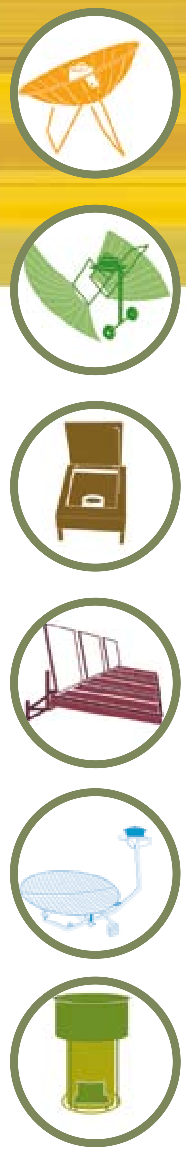

Preface

Energy is the key to the future. Without energy, it is barely conceivable that economic and social development will occur, and energy is an essential prerequisite if the fight against poverty is to be successful. The advances in the quality of life that people living in the developed nations have experienced since the beginning of industrialisation in particular have been accompanied by huge rises in the consumption of energy. There is no doubt, therefore, that especially in developing countries many more people need reliable and long-term access to energy. That said, this growth must not be to the detriment of the climate, which as we are experiencing is currently undergoing change. Alongside further harnessing of renewable forms of energy, then, more efficient energy use is also essential.

Around the world today about 2.5 billion people cook with biomass, mostly firewood. The energy sources familiar to us, such as gas or electricity, are usually unaffordable for those people, if they are available at all. For this reason at least it would appear obvious to make use of solar energy to meet basic, everyday needs, above all in the hot countries of the South. This approach has been pursued in numerous projects, in some cases meeting with a good response. Within the framework of German development cooperation, a pilot project trialling the commercial dissemination of solar cookers was implemented in South Africa between 1996 and 2004, from which important insights into the use of this technology were obtained.

Solar cooking is successful where the ten basic rules quoted in this brochure are observed. The fundamental prerequisite is that it must be accepted by the users. It goes without saying, too, that it must be a financially attractive option. One clear finding from the trial was therefore also that solar energy is not universally utilisable as an alternative for cooking. However, in regions or social systems where solar cookers reach their limits, it is usually possible to use other alternative technologies. A new generation of wood-saving stoves, known as Rocket Stoves, is pointing the way down a highly promising route using just a fraction of the firewood previously required. In suitable cases, consideration should also be given to an energy mix so that sufficient energy is provided with the lowest possible impact on the environment and the climate.

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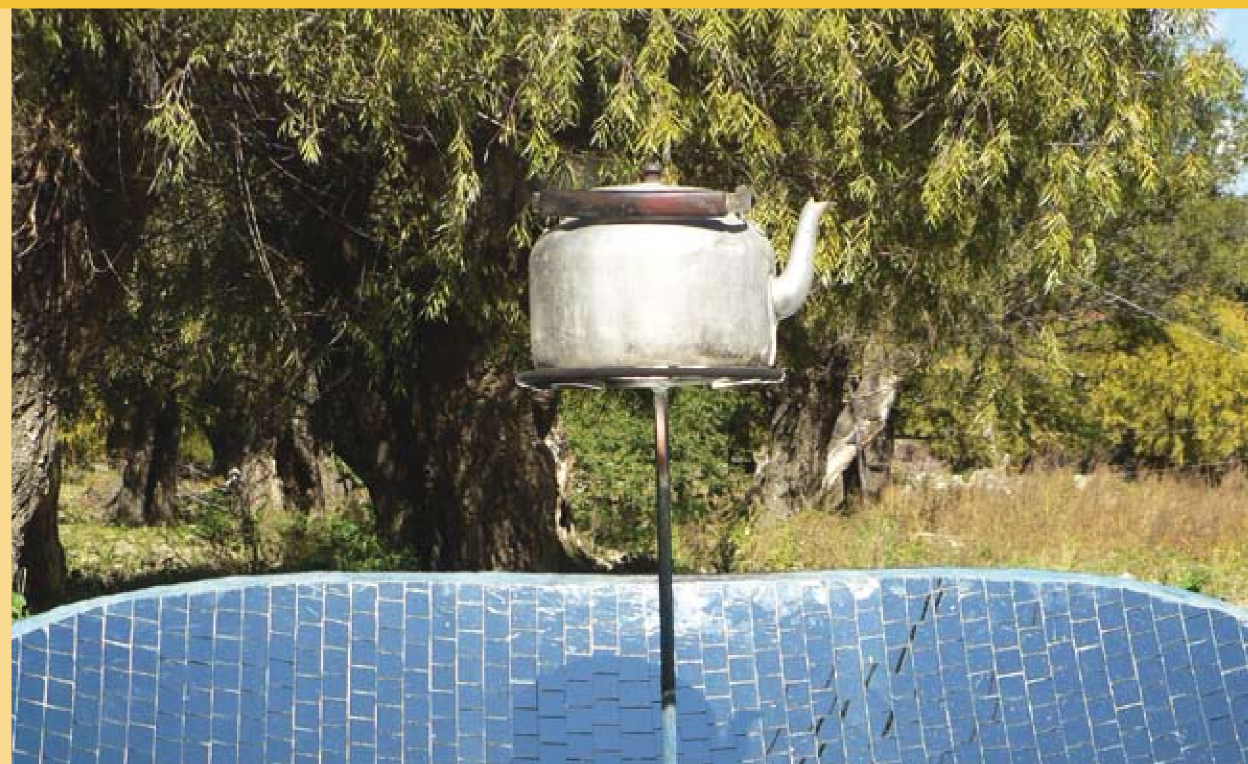

Introduction: Light and shade – two sides of solar cookers

Around the world some two billion people struggle to find enough firewood, which they need primarily for cooking and heating. The problem is further exacerbated by the fact that in many developing countries cooking is traditionally carried out over three-stone fires. However, these can only make use of about 10 to 15 % of the energy produced. Collecting firewood is usually the responsibility of women and children, who often spend several hours each day on this task, having to cope with loads weighing as much as 45 kg. If cooking is performed indoors, fumes and soot frequently cause respiratory diseases; among small children these are among the most common causes of death. In most cases, economic circumstances do not allow the use of other energy sources such as gas or electricity. All in all, it is the poorer sections of the population who suffer most severely from the shortage of wood.•

Solar cookers have repeatedly been seen as a solution to the firewood problem. It is indeed a fact that almost all developing countries are relatively close to the equator, so levels of solar irradiance are high virtually all year round. It is only the rainy season that restricts the use of solar cookers. "Cooking with the sun" also allows the use of a free, effectively inexhaustible source of energy, relieves the workload on women, and reduces the harmful effects on health arising from cooking. Moreover, fewer trees are chopped down, thus stopping deforestation and the advance of desertification, while at the same time guarding against global warming. These are the arguments of the proponents. It has to be said, though, that decades of efforts have not helped solar cookers to achieve a breakthrough. So far it is only on the treeless plateaus of Tibet that solar cookers have truly become established; roughly half of the million or so solar cookers in the world are used in China. According to the experience gathered to date from developing countries, the picture is as follows:

- Solar cookers have only been able to take a firm hold where there are virtually no alternative fuels available – i.e. in Tibet and on the Altiplano in South America – and where they also fit in with customary cooking methods.

- Sophisticated and energy-efficient solar cookers, especially parabolic cookers, have proved to be too expensive, and furthermore it has so far not been possible to set up independent local production in Africa because in most cases important parts still have to be imported from Germany. The simple and inexpensive but less efficient box cookers are usually incapable of competing with traditional stoves.

- The commercial dissemination of solar cookers in India and South Africa has not been successful. Trials in Africa where cookers were sold through a loan system have also had little success.

- Almost all commercial approaches are no longer aimed at the poor or at rural areas but at the numerically much smaller middle class in towns and cities. Although these people are able to afford solar cookers, they do not have to rely on them and therefore often use them only sporadically.

- A possible alternative to solar cookers is a new generation of improved stoves designed according to the principle of the Rocket Stove. Such stoves have an L-shaped, insulated combustion chamber in which the wood burns at a high temperature, producing very little smoke. Like solar cookers, they achieve wood savings of about 60 to 80 %. The cost of such a stove is only a fraction of the price of a parabolic solar cooker, and people barely have to change their cooking habits. These stoves are in widespread use in rural areas of Malawi and Uganda, for example, among families with low incomes too. Further projects aimed at introducing and disseminating this technology are currently in progress in Latin America and in southern and eastern Africa, and are being prepared for western Africa.

The following chapters describe which conditions have to be met for solar cookers to be accepted and put to use. Ten basic rules set out how the dissemination and use of solar cookers can be achieved. Alternatives such as the Rocket Stove are also described.

The most important types of solar cooker

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Parabolic cookers concentrate the solar radiation directly onto the pot. With ratings of up to 1200 W, as a rule they are considerably more powerful than solar box cookers and reach temperatures of up to 250 °C. That said, parabolic cookers are more difficult to build, and even if they are produced locally it is often necessary to import certain parts. This makes them notably more expensive than box cookers. They also have to be adjusted to track the position of the sun about every 25 to 30 minutes, and they are much more sensitive to wind, which makes everyday use more difficult. A further limitation arises from the fact that the users of these cookers are easily dazzled by the sun reflecting in the parabolic dish. On most models of parabolic cooker there is also the risk of the reflector becoming dirty when food boils over. If the reflector is dented or scratched in the course of cleaning, the effectiveness of the cooker is considerably diminished. Another design similar to parabolic cookers is the **butterfly** or **Papillon cooker**, which is widespread in Tibet and West Africa. Compared with parabolic cookers these have the advantage that the cook is better able to handle the pot, the risk of dazzling is lower, and the reflector does not become dirty if the food boils over. The Papillon cooker, developed in Burkina Faso, can be folded up and stored in the house, which reduces the risk of theft. In Tibet the reflector wings of the butterfly cookers are made of cast iron or cement, lowering costs by an appreciable margin.

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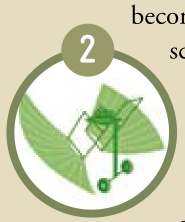

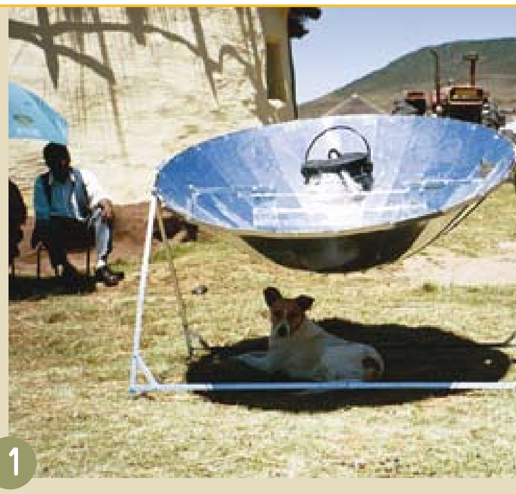

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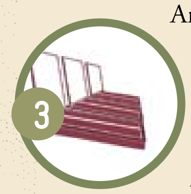
Another type of solar cooker is the **flat-plate collector cooker**, in particular the **Schwarzer cooker**, named after its developer. This is suitable for use by institutions and individual households. This design uses collectors to heat a medium, for example steam, to transfer heat to where it is needed for cooking. These cookers can be enlarged as required, allowing their output to be matched to the needs of institutions. Their transportability is limited, but they have the advantage that they do not need to be adjusted to track the sun. As the cooking point is separate from the collector, it is also possible to cook in the shade or indoors. The inclusion of a thermal storage unit enables such cookers to be used after sunset, too. To date, around 250 to 300 Schwarzer cookers have been built in India and Africa, often by businesses.



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In **solar box cookers** (or solar ovens) the pot is placed inside a closed container, the interior of which is heated by solar radiation. Box cookers are simple to build, often using locally available materials. This makes it easier to produce them in developing countries and reduces procurement costs. Box cookers do not have to be realigned with the position of the sun as often as parabolic cookers, making them easier to use in everyday life. Although box cookers do not achieve the peak performance values of parabolic cookers, they are better able to compensate for fluctuations in solar irradiance. The maximum temperature reached by a box cooker is roughly 180 °C.

As well as the solar cookers described above, which are primarily intended for families and small traders, a technically more sophisticated model has also been developed for large-scale catering, suitable for preparing as many as several tens of thousands of meals. In the **Scheffler cooker** (named after its developer) solar energy is fed from reflectors or collectors via a system of pipes carrying hot steam to the stove, which is usually situated in a separate building. An electrical device enables the reflectors to track the course of the sun automatically; manual re-adjustment is required only every few days. So far several hundred such cookers have been built, mainly in India. They are very powerful and can also be fitted with a thermal storage unit that allows cooking to continue into the evening and even the night. The largest solar cooker in the world is a Scheffler cooker with 106 parabolic reflectors, which supplies energy to a canteen kitchen in Tirupati in India. The drawback of these cookers is the high initial cost. When a large solar bakery in Burkina Faso was equipped with 16 Scheffler reflectors, for example, the cost amounted to about EUR 50,000. To this must be added the considerable amount of space these systems require, especially as a kitchen often has to be built as well. The Scheffler cooker is therefore not suitable for individual households.

Savings

Measurements of fuel consumption at a refugee camp in Namibia revealed savings of approximately 40 % when the cookers were used optimally. Normally, though, solar cookers in households can be put to optimum use for only about eight to nine months of the year. As well as the rainy season, there are also periods of strong winds, and in the Sahel zone there is the particular problem of the dust storms caused by the harmattan desert wind, which hinder use of the cookers or make it completely impossible to operate them. Viewed over the year as a whole, therefore, the savings amount to roughly 30 to 40 %.

"Butterflies" on the roof of the world – in Tibet, solar cooking is a fact of life

More solar cookers are to be found in China than in any other country in the world. Over 600,000 cookers are in use – mostly in rural areas – and each cooker saves about 600 to 1000 kg of firewood a year. Solar cookers play a particularly major role in saving energy in the Tibet Autonomous Region.

It is the largest highland area on earth, lying at an average altitude of 4500 m above sea level. Because of the rain shadow effect of the Himalayan mountain range, the climate is dry with wide fluctuations in temperature across the year. The treeless steppes of the highlands often merge into desert, while the lower-lying regions of the bounding ranges are wooded. In these areas wood was originally one of the most important energy sources, but it is increasingly being replaced by bushes, roots and dung. Whereas in the towns and cities it is mainly coal that is used for cooking and heating, in the highlands dung has always been the most common fuel. Despite the sparse population of the Tibetan uplands, this has had a detrimental impact on soil fertility. The majority of the people are nomads or semi-nomads, whose livelihood is livestock farming.

Solar irradiance on the Tibetan plateau is very high in global comparison, and reaches its maximum during the colder time of the year on account of the clarity of the atmosphere. The conditions for utilising solar cookers in Tibet are therefore excellent, especially as the cookers can be used for **nine or ten months of the year**. The possibilities offered by solar cookers fit in with the dietary habits of the Tibetan population, as hot water is needed for every meal. For breakfast, a barley porridge, the water is boiled the day before on the solar cooker and kept hot in thermos flasks. In the course of the day water is boiled on the solar cooker **10 to 15 times to make tea**, and solar-heated water from thermos flasks is used again for the evening soup. This means that solar cookers can provide virtually all of the energy required for cooking.

The dissemination of solar cookers in China began about 25 years ago. Today there are some 70,000 solar cookers in use in Tibet, most of them concentrator cookers of the butterfly type. Essentially two different models are built:

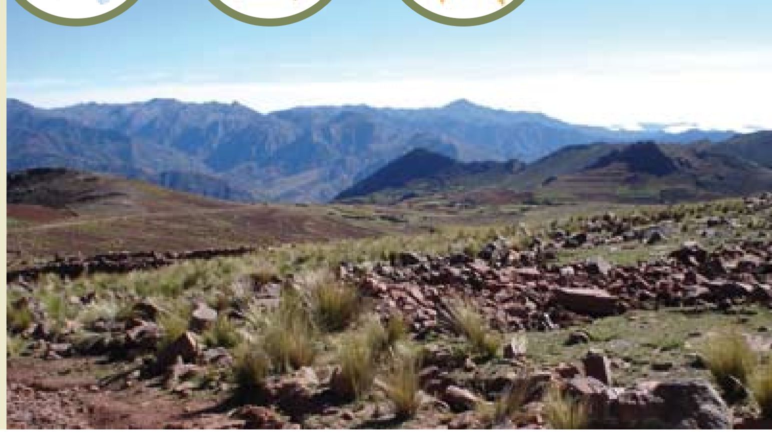
- Cookers with a shell made of cast iron, which are relatively expensive which only be the more well-to-do families can afford. Moreover, the reflective metal foil used to line the shells has to be replaced every two to three years;
- A lower-cost model in which the reflector is made of concrete lined with small mirrors stuck to the surface. Individual mirrors can be replaced if damaged. Production is carried out both on an industrial scale and in family or craftsmen's workshops. Initially subsidised, the cookers were sold at prices of between EUR 15 and 45. In the meantime, however, subsidies have been limited to low-income families. The cookers are now also produced in a local factory.

Solar cookers are very popular in Tibet, not only in the towns and cities but also in rural areas. The reason for this is plain: the dung saved because it is not used for cooking can be used either for heating or as fertilizer, or it can be sold. In this case, therefore, the use of solar cookers also results in the generation of income. In contrast with India, though, only family cookers have been disseminated in Tibet; large-scale cookers for institutions are unknown here.

In recent times the cooker technology from China has been exported to Afghanistan, where there are similar problems with obtaining sufficient firewood. As part of a project supported by the German Federal Ministry for Economic Cooperation and Development (BMZ), 50 families in rural areas received butterfly-type cookers for trial purposes. After a few weeks the experience gained with the cookers was to be documented, and the families were able to choose whether to buy the cookers or hand them back. The trial showed that in particular women from less prosperous families were more likely to be willing to make the switch to solar cookers. In addition, a Chinese trainer taught small-scale entrepreneurs how to build the cooker model with concrete shells; the entrepreneurs kept the cooker they built during the course as a prototype for subsequent production. As the project is in the start-up phase and there is no large-scale production capacity as yet, so far only isolated cooking demonstrations have been carried out. Nevertheless, there are already signs of strong demand. For example, the Renewable Energy Department at the Ministry of Energy and Water, where the project is based, is receiving about 10 to 15 purchase queries per day, based entirely on word of mouth. Two producers have also been found who will begin manufacturing the cookers after completion of training.

Solar cookers on the South American Altiplano – a promising beginning

The Altiplano is a plateau at an altitude of around 3700 m in the Andean regions of Argentina, Bolivia and Peru. Its climate is very dry, permitting the growth of only sparse vegetation. The basis for the livelihood of the exclusively Indian population is provided by animal husbandry (llamas and sheep) and arable farming (Andean potatoes, maize, beans, peas, carrots and other vegetables).



In Argentina the Altiplano is one of the poorest regions in the country. The only fuel available for cooking and heating is the wood from quenua trees and tola bushes, and because of the sparseness of the vegetation there is a shortage of fuel everywhere.

Demand for fuel, however, is great: for example, the children of the local indigenous population are usually taught in boarding schools, of which there is at least one in each community. The kitchens at these schools and kindergartens require on average about 88 tonnes of tola bushes per year for cooking, which is effectively equivalent to clear felling of an area of one hectare. To this must be added the consumption of about nine tonnes of quenua wood, which means cutting down 88 of these trees – in the meantime a rare species. In some places overexploitation of the wood resources has already led to severe soil erosion. On top of that, during the 1990s the Argentinean part of the region was afflicted by a drought lasting several years, exacerbating the situation yet further.

The inhabitants of the Altiplano too suffer from the shortage of wood: every day, men, women and children spend two to three hours gathering and transporting firewood, often carrying loads of up to 30 kg for several kilometres. Switching to gas or oil fuel would be difficult, as both would have to be delivered along a 200 km-long track, causing the price to rise.

The natural and climatic conditions, though, are virtually ideal for exploiting solar energy. Almost everywhere on the Altiplano the levels of solar irradiance are very high, and like Tibet, this region is one of the top places on earth in this respect. Moreover, preliminary investigations also indicated that the socio-cultural conditions too were highly favourable for the use of solar cookers because they could be used without difficulty to prepare all of the dishes commonly eaten in the area.

In the context of a project supported by BMZ investigating the use of solar energy, communal solar kitchens were set up in the schools and kindergartens in collaboration with an NGO and a local cooperative, beginning in 1998. The cookers used were of the Scheffler type (see also section on types of solar cooker). Adjustment and maintenance work is taken care of by specially trained villagers. The performance of the reflectors is sufficient to operate a hotplate with a maximum output of 3 kW, which allows the use of one large pot or two smaller ones with a total capacity of up to 80 l. These are enough to prepare the midday meal – usually stew and soup – for 30 to 40 people. The cookers also incorporate a thermal storage unit, making it possible to continue using them for a short time after sunset too. The kitchens were also equipped with smaller parabolic cookers with an output of 700 W, which bring about 10 l of water to the boil within 90 to 120 minutes.

Locally manufactured parabolic and box cookers were also made available for families (see also section on types of solar cooker). Although parabolic cookers are more powerful, box cookers prove easier to handle and are less susceptible to disturbance from the strong winds often encountered on the Altiplano. Apart from the reflector plates and the parts belonging to the electrical tracking devices, all of the cookers can be produced locally by a cooperative once relevant training is completed.

Practical testing of the solar cookers produced impressive results. For example, the schools require around 30 % less fuelwood, and for five families the savings from using a box cooker amounted to almost 40 %. The combined use of parabolic and box cookers proved particularly effective. In such cases the parabolic cooker is used for quickly heating up or parboiling the food, which is then placed in the box cooker to continue cooking. Some families saved almost 90 % of their firewood using this method.

No detailed investigation has been conducted as yet, but the level of acceptance of the solar cookers among the population appears to be high. For example, it was originally planned to equip only two schools with large-scale cookers. Once these were in place, however, numerous other schools expressed interest, and so far a further two schools have been equipped with cookers. The family cookers are also highly popular. One indication of the great demand is that by July 2004 private users had bought 70 cookers, which cost almost as much as two months' income despite being made locally by a cooperative. The oldest cookers have now been in service for six years and work faultlessly. Further dissemination via the project is planned.

At the end of 2004 the solar cooker experienced an additional, unexpected boom. An economic crisis caused the price of gas to rise sharply. As the local population no longer wanted to go back to burning the ever sparser tola bushes, the parabolic cooker presented itself as an alternative option and sales figures at the cooperative shot up from 20 to 30 cookers per year to 30 per month.

Living conditions on the Bolivian Altiplano are just as difficult as they are in the Argentinean part. In this case, though, almost 40 % of the country's population live there, the majority of them below the poverty line. Wood and gas are the main sources of energy for household use. The introduction of solar cookers began here in the year 2000, under the leadership of the French NGO, Bolivia Inti. Most of the cookers disseminated here have been box cookers, which can be produced locally at low cost. The cookers were presented at public cooking demonstrations, after which interested craftsmen were given training in how to make them. The success of the project was shown by an evaluation conducted in 2005, which looked at a total of 170 families with and without solar cookers. More than 90 % of the families were still using their cookers after three to five years, and during the dry season almost two thirds used their cookers at least once a day. This indicates that solar cooking has become part of their everyday life. As the families have to buy their fuel, it was also possible to demonstrate a direct monetary benefit of solar cooking. Using a solar cooker saved 35 to 40 % of the families' expenditure on wood or gas, for example, depending on the time of year. A direct connection was established between the use of a solar cooker and saving money; in other words, the more solar cooking the family did, the more money they saved. In the meantime the project is being supported by the Bolivian NGO CEDESOL, which has adopted an integrated approach offering solar cookers together with energy-saving stoves for households and institutions. It reports that about 3000 cookers are supposed to have been disseminated so far.

Since October 2005 this approach has received further assistance through the PROAGRO programme, supported by BMZ and the Directorate-General for International Cooperation of the Dutch Government (DGIS). The programme provides support in the form of subsidies to producers in the first two years of their manufacturing improved stoves and solar cookers. CEDESOL was also placed under contract, enabling the project to call upon its many years of experience. Even within the first year over 300 families were furnished with improved stoves and/or solar cookers; a total of over 5000 is targeted for the end of the first project phase.

All in all, projects aimed at disseminating solar cookers have so far been implemented in several South American countries. Despite the promising beginnings, however, across the continent as a whole apparently only a few thousand cookers have been disseminated so far. Whether solar cookers will become as important for the supply of energy on the Altiplano as they are in Tibet remains to be seen in the future.

Despite wood shortages and a loan system – so far solar cookers have not caught on in Burkina Faso

Burkina Faso is one of the countries of the Sahel, and in contrast with South Africa or India it has no natural resources such as coal or gas reserves from which to generate energy. The north of the country in particular is sparsely vegetated. Nevertheless, the population relies almost exclusively on firewood for its energy supplies; just 3 % of households are able to fall back on paraffin (kerosene) or gas. Not only that, with an average available per capita income of less than US $1 per day, the country is one of the poorest on the continent of Africa. Whereas in rural areas, where perhaps 80 % of the population live, the wood for household use is gathered by hand, urban dwellers have to buy their firewood at great expense. Solar energy, however, is available in abundance in Burkina Faso. The sun shines for 250 to 300 days of the year, and the very high level of solar irradiance hardly fluctuates at all throughout the year. It has to be said, though, that the desert wind, the harmattan, blows for several months each year; even in sunny weather this severely compromises the use of solar cookers because of dust and sand.

Attempts to disseminate solar cookers in Burkina Faso date back to the 1990s. Local women's organisations often had an important role to play here. Over the past ten years the NGO APEES has disseminated about 500 solar cookers and solar dryers, with support from the German-Burkinabè NGO "Solar Energy for West Africa" (SEWA). The organisation worked closely with local craftsmen.

Beginning in 1997, **solar cookers** of a type called **CooKit** were disseminated in rural areas with the aid of a Dutch NGO, KoZon. These simple and cheap cookers were manufactured by a local company and sold for the equivalent of US $ 2.50. This price is subsidised by KoZon. Although the CooKit is somewhat too small for an extended family in Burkina Faso and produces only little power, the cooker is said to have sold well; a figure of 300 cookers is given for 2003. Moreover, acceptance seems to extend beyond the conventional target group of women. KoZon reports that young men are also using the cookers to an increasing extent when they live apart from their families. Nonetheless, a survey revealed that more than half of the families used their cookers on fewer than three days a week. Furthermore, during the six-day field investigation, none of the families the team came across were observed cooking with the CooKit. The NGO ACCEDES is said to disseminate about 25 to 50 solar cookers in the city of Bobo Dioulassa every year, although nothing is known about its dissemination strategy or the type of cooker involved.

SEWA sells the **Papillon cooker** (among others) through a **loan system**, which has been successfully employed since 1999. The instalments are linked to the cost of firewood, and the cookers are supposed to be paid off within 18 to 21 months. In 2002 and 2003 approximately 300 solar cookers are said to have been sold. In the city of Gaoua the Burkinabe NGO APFG disseminated 70 Papillon cookers with support from SEWA. The funds for building these were provided by BMZ, although APFG plainly has major problems collecting the monthly instalments of about EUR 7.50 to 15.00.

The German NGO EG-Solar, too, reports of a successful **hire or loan system**. The number of cookers sold is said to be below 100. In this case the families pay a hire charge of EUR 0.23 for their cooker, although only on days when the sun is shining, i. e. when they are actually saving firewood. This charge is set below the cost of firewood, which is put at roughly EUR 0.30 per day.

By and large the loan systems described here can only be used by the urban middle class. The objective in the long term is to use solar cookers as a means of stopping environmental destruction, as they are simply too expensive for use as a poverty reduction instrument. Nevertheless, in contrast with most countries in Africa it has proved possible to establish several production facilities for solar cookers in Burkina Faso with support from international NGOs. A family enterprise called ISOMET in the capital, Ouagadougou, produces and sells about 50 cookers per year, although the company focuses more on technologies for the utilization of biomass. About 200 to 300 Papillon cookers per year are manufactured and sold by the ACOMES workshop. Some of these have been passed on to the NGO SEWA.

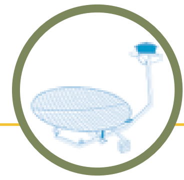
In Burkina Faso there are also some examples of solar cookers being used in the commercial sector. One such case is a **large bakery** on the outskirts of Ougadougou which was equipped with **16 Scheffler reflectors** (conversion costs: EUR 50,000) with support from the Solar-Institut Jülich on the initiative of the Luxembourgian NGO “Chrétiens pour le Sahel”. The reflectors have a total surface area of 80 m² and heat a stone oven, which has a gravel bed for storing the heat. This allows baking to be carried out early the following morning, when the temperature is still about 250 °C. The bakery has a capacity of roughly 1500 loaves per day, and the system is said to save approximately 300 l of diesel per month. As the system only entered service at the end of 2003, there are no reports of practical experience yet. However, numerous thefts of the much sought-after reflector material made construction more difficult.

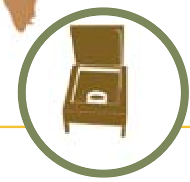
Within the framework of a pilot project supported by SEWA, solar cookers are also used in the **production of karite butter**, a raw material for the cosmetics industry among other uses. The butter is extracted from karite nuts by heating them. The advantage of using a solar cooker is that the nuts are heated slowly and gently, giving the karite butter obtained in this way considerably improved quality. So far this is done by only one family.

Two **parabolic cookers** were used in a **restaurant** in the city of Gaoua. The technology aroused avid interest among customers, and raised hopes that solar cookers would become popular through this route. In the course of time, however, it became necessary to use larger pots, for which simple parabolic cookers were no longer adequate. The purchase of a Scheffler cooker would have solved the problem, but this was beyond the financial means of the restaurant.

All in all, despite numerous efforts to boost their dissemination, solar cookers play only a minor role in Burkina Faso, whether due to cooking traditions or psychological barriers among the rural population, who consider cooking with solar energy to be impossible. It is apparent that above all the technically advanced and powerful models of cooker are out of the question for the great majority of the population on account of their high price. So far not even a loan system, which is aimed at middle-class people with regular incomes, has been able to change this situation.

Solar cookers in India – success limited to temple kitchens?





In India, 58 % of the population use biomass as an energy source, accounting for almost half (41 %) of total energy supplies in the country. The rural population is particularly heavily dependent on biomass. In rural areas biomass meets as much as 97 % of energy needs, and only 3 % of households use paraffin (kerosene) or gas. In some provinces, dung and crop residues are often used as fuels. In other regions wood is the main source of energy; 80 % is consumed by households. The fact that in certain states chopping down trees is a punishable offence aggravates the situation further. The shortage of energy is considered one of the primary causes of the difficult living conditions in rural areas. However, the conditions for exploiting solar energy in India are excellent. The subcontinent extends from a latitude of about 10° north to 30° north, with the consequence that there is a high level of solar irradiance with up to 300 days of sunshine per year.

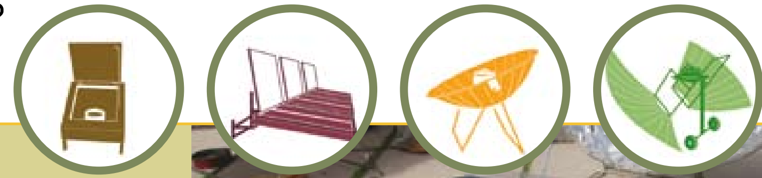
Solar cooking technology is relatively high developed in India. The (at the time) **largest solar cooker in the world** was built in the monastery-like ashram in Taleti in the state of Rajasthan in 1999. 84 parabolic reflectors with a diameter of about four metres and a total surface area of 190 m² heat water, generating an output of 250 kW. The steam can be used to prepare **36,000 hot meals** a day, as well as for sterilising **10,000 litres of drinking water**. A steam storage unit allows the solar energy to be used at night as well, or in cloudy weather. It is only when the sun does not shine for several days in succession that conventional stoves have to be used. The solar cooker substitutes the combustion of 350 litres of diesel per day. The system in Taleti became a model for numerous other large-scale cookers that have been built by an Indian company; of these, the one in Tirupati is even larger than the original, with 106 reflectors.

These systems have not proved to be a breakthrough for solar energy, however, as experience among households has been rather sobering. Ever since the 1960s the government has launched programmes aimed at disseminating **subsidised parabolic cookers, box cookers and solar ovens**. Through these programmes, cookers with manufacturing costs of US$ 60 to 70 were sold for about US$ 30 to 35, and in rural areas even for as little as US$ 15. Many companies also assisted their employees in purchasing a cooker by providing a subsidy of US$ 10. In parallel, an intensive publicity campaign was run in the media and cooking demonstrations were held in villages. The target group was middle-class families with a regular income of up to approximately US$ 200 per month.

Up to 2003 a total of about 530,000 cookers were reportedly sold, the majority of these in towns and cities. Investigations revealed, however, that after a while some of the families used the cookers only sporadically, and around 30% did not use them at all any more. Occasionally the box cookers were also used for other purposes, for example for insect-proof safekeeping of documents or as a box for keeping food warm.

Evidently the programmes have had barely any impact in rural regions, even though it is precisely here that people suffer from energy shortages. For example, a 1996 study on rural energy consumption in six states revealed that, despite all the publicity campaigns and subsidies, of 51,000 households surveyed only 70 possessed a solar cooker. Proof that the people in these rural areas were definitely open to new technologies was shown by the fact that as many as 6,200 families possessed an energy-saving pressure cooker (in other words almost one hundred times more than those owning a solar cooker). Besides that, in the year 2000 the figure of 487,000 solar cookers that had been disseminated could be contrasted with **three million biogas plants and about 29 million improved stoves** which save about 40% of the firewood or charcoal that would otherwise be used.

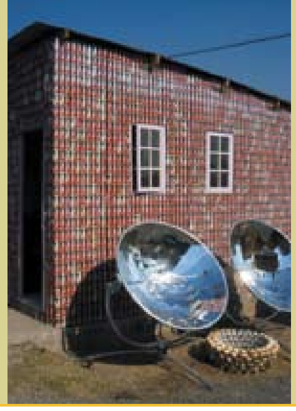
Solar cookers in South Africa – a product without a market?



In many respects South Africa offers good conditions for the use of solar cookers. Thanks to its location at about 30° south of the equator, for example, solar irradiance is roughly comparable with that in Tibet or on the Altiplano. Furthermore, the country has only scarce wood resources at its disposal; less than 10% of the land area is forested. Since the end of apartheid the economic situation has been better than it is in most other countries on the continent; annual per capita income amounts to about US$ 2,600, although there are wide differences within the population. Well-developed infrastructure favours the local production of solar cookers. Apart from wood, above all gas and paraffin (kerosene) are used as the main sources of energy for cooking, as well as electricity in urban areas.

Several attempts have been made to disseminate solar cookers on a commercial basis in South Africa. At the end of the 1990s a medium-sized enterprise from Germany introduced a **box cooker onto the market** that had been specially developed for South Africa. Technically this cooker worked well, but it failed due to a lack of interest on the part of the South African partner and a shortage of resources on its own part. In contrast, for many years now the international non-profit organisation Sunstove has been promoting an inexpensive, if less powerful solar cooker, the **Sunstove**, of which over 10,000 units have been sold to date. Unfortunately there has been no systematic study of the rate of utilisation of the Sunstove.

In order to obtain an answer at long last to the question behind the **factors determining the success of commercial dissemination**, the (up to then) most comprehensive field trial for solar cookers was launched in 1996 on behalf of BMZ. Potential trial regions were investigated in advance, and 200 households were questioned about their cooking habits. A pre-selection of solar cookers was conducted in parallel. Altogether **seven different models** were used in the trial, which included all cooker types with the exception of the Scheffler cooker that is not well suited for use in normal households. All of the meals typically eaten in the trial areas could be prepared with the chosen models. Monthly expenditure on fuel ranged between EUR 4.50 and 10.00, depending on the locality. On the basis of the results the project selected **66 families in three** communities, who tested the various models of cooker for a year. Precise details of cooking behaviour and expenditure on fuel were recorded.



In order to find out which model was best suited for introduction onto the market, the families switched to a different type of solar cooker every two months. 30 families without solar cookers served as a control group.

After a year the results of the field trial were encouraging. The solar cookers along with wood-fired stoves were the most frequently used types of cooker, followed by gas and paraffin stoves and electricity. Using the solar cookers enabled the households to reduce their energy costs by an average of almost 40 %. The **high level of acceptance of the solar cookers** was also evident from the fact that at the end of the field trial all of the participating families purchased their cookers and a waiting list had to be created for other interested families. In absolute terms, during the one-year trial all of the families together saved a total of 60 tonnes of wood, 2 tonnes of gas, and over 2,000 litres of paraffin. Another survey of the families conducted in 2000 revealed that most of the cookers were still being used, and indeed most intensively in a village where previously firewood had been the main fuel used for cooking.

The foundations were therefore in place for the next phase of commercial dissemination of solar cookers in Johannesburg and the province of Gauteng, which was carried out in cooperation with a government enterprise, the Energy Development Corporation. The indicator for success was the sales figures, which were supposed to double every six months, starting with 1,000 cookers. That would mean that after two years about 16,000 cookers should have been sold. This was to be achieved by supporting private companies operating all along the supply chain. In the course of the project, however, support was concentrated on the suppliers of wholesalers in order to prevent the companies from becoming dependent on the project. The **interventions** by the project were focused **strictly according to free-market principles**, which ruled out any subsidising of cookers, for example.

The **target group** of the project comprised **families in Johannesburg and Gauteng** with monthly incomes **between EUR 150 and 340**. This group made up 40 % of the population. Another target group was families with an income of over EUR 1,900, who made up less than 5 % of the population. The sale of relatively expensive cookers to higher-earning families was meant to create a **positive image** for **solar cookers** in the public eye. This in turn was intended to encourage the sale of cheaper cookers among poorer families.

The cooker models on offer ranged from simple, inexpensive **box cookers** to the highly developed **Papillon** (butterfly). The output of the cookers ranged from 200 W in the case of the Suncatcher to 1,200 W for the Papillon; as a rule, the parabolic cookers were more powerful than the box cookers. The prices started at about EUR 10 for the Sunstove, rising to approximately EUR 170 for the Papillon.

In actual fact the project was able to increase the number of commercial suppliers of solar cookers to more than 20. However, many companies ceased their activities after the project had cut back the support it provided. In the early stages in particular there were also set-backs as a result of entering into cooperation with partners who proved to be unsuitable. For example, some individuals had too few resources of their own to market solar cookers independently.

During the planning of the project the **caution displayed by the private sector** in the marketing of solar cookers was seen as the **core problem**. Despite advertising in the print media, on radio and television, it proved impossible to overcome this hurdle.

One example was a South African **fast-food chain**, which received financial assistance to use solar cookers in its branches. Cooperation came to an end, however, when the project reduced the support it was providing. Another cooperation arrangement with a **mining company** was supposed to help to popularise solar cookers within the poorer strata of the population. The company purchased several hundred cookers and distributed them among its workers or gave them to schools for demonstration purposes. In parallel, employees underwent training and an accompanying financing model was developed. However, this measure too proved to be unsuccessful in the long term.

Despite all of the efforts, over the course of two years it was possible to sell **only about 1,300 cookers** in total. This was less than a tenth of the target of about 16,000 cookers that the project had set itself. Moreover, some of the solar cookers had been purchased by a private company for charitable purposes. As the South African partner enterprise also saw no possible way of continuing the activities under its own direct control in the light of the obstacles it faced, the project was terminated in 2006.

Solar cookers in refugee camps – not a success story so far

According to the UNHCR, in 2004 there were more than three million refugees in Africa. They frequently have to live temporarily or even for lengthy periods of time in camps, mostly in thinly populated, ecologically sensitive regions. The camps often have only basic infrastructure: although the refugees are provided with accommodation and food, they do not have the fuel needed to cook the food or to keep themselves warm. They search for the necessary firewood in the vicinity of the refugee camps, which often results in conflict with the local inhabitants and causes serious environmental damage. In many cases the problem is not limited to a brief transitional period in a camp, either: tens of thousands of refugees often have to wait many years before they can return home. As the climatic conditions are generally also favourable, using solar cookers appears therefore to be a sensible option.

The first attempts to disseminate solar cookers among refugees in Africa date back to the 1990s, when various NGOs distributed over 2,300 cookers in the Daadab refugee camp and the surrounding area of Kakuma in northern Kenya (near the border to Sudan). Before then, wood and charcoal had been the main fuels. The model of solar cooker used in this scheme was the very inexpensive if rather inefficient **CooKit**. Although it was well received by the families, it proved to be insufficiently robust for the stresses and strains of everyday use. At the end of the 1990s, therefore, **parabolic cookers were introduced**. Trained craftsmen assembled a total of 1,050 solar cookers in the Kakuma and Daadab refugee camps. The type of cooker was called Ilanga, corresponding to parabolic cookers SK10 and SK14. They were distributed to refugee families. Institutions such as schools, churches and hospitals were also given more than 70 cookers. In comparison with the CooKit these cookers reach considerably higher temperatures and can also be used for frying.

Another pilot project was launched in 2003 at a refugee camp in **Osire in Namibia**. The camp was much smaller than the one in Kakuma, with about 12,500 refugees, most of whom came from Angola. Wood was the principal energy source, and for the most part was gathered from the vicinity of the camp. In addition the refugees received paraffin free of charge, not only for lighting but also for cooking purposes, which was to prove extremely counterproductive with regard to the use of solar cookers.

All in all 111 parabolic cookers of the SK9, SK10 and SK14 type were installed by trained refugees. Interest in the new technology was great: after just three cookery demonstrations over 460 families had already had their names put down on waiting lists. So as not to raise expectations too highly and because of the limited number of solar cookers available, the demonstrations were then discontinued and the cookers were given out to selected families, who in return worked in communal gardens or other communal facilities.

The unusual situation in refugee camps makes it easily possible to check the use of solar cookers. This showed that all of the typical meals that had previously been cooked using firewood could also be prepared on the new equipment. Nevertheless, the traditional stoves continued to be used, while the solar cookers served as an additional option. Estimates in Kakuma indicated, however, that roughly 35 % of energy consumption could be saved if the cookers were used as much as possible.

The results of a comprehensive evaluation in Osire were initially encouraging: the families stated that they used the cookers on five or six sunny days each week. They said they liked the taste of the food prepared on a solar cooker, which did not have the ‘flavour’ of paraffin fumes; meat cooked ‘à la solar cooker’ was even considered a delicacy among the refugees. The users also praised the fact that they worked without generating smoke. Some families, moreo-

ver, proved themselves to be highly inventive. They used their solar cooker for **making soap** and thus generated income for themselves; others used them not only for cooking but also for **heating their clothes irons**, in order to save charcoal. Yet others used the parabolic cookers as **reflectors for lighting in the evening**, by positioning a candle at the place where the pot usually goes. Some poorer families sold the paraffin ration that they received from the UNHCR for cooking to wealthier families, while they themselves used their solar cooker. And not least, the work of assembling cookers by trained refugees was an activity that they in their own words rated highly as a meaningful change from the otherwise uneventful daily life in the camp.

A closer investigation of the impacts on fuel consumption revealed, however, that only fewer than ten of 111 surveyed families used their solar cookers regularly, thereby achieving a saving of 40 %. The great majority cooked only occasionally by solar means, and some families gave up using the cookers in the course of the study or even right at the outset, which was made easier by the provision of free paraffin. This applied in particular to the smaller models of cooker, while the more powerful SK14 came off better. Experience was similar in Kenya, where only about 10 % of the families used their solar cookers regularly. When an American aid organisation donated several million dollars in order to buy up firewood at the camp in Daadab, this brought solar cooking activities to an abrupt end.

In Namibia too, acceptance was the crucial problem, and in the end solar cookers were not able to establish themselves in the face of competition from other fuels. On the scale of popularity of fuels, solar cookers took last-but-one place after wood and charcoal; only paraffin was used less. One of the principal reasons why solar energy came off badly was its **dependence on the weather**, which the families cited as being the main problem. However, the **longer cooking times on the smaller solar cookers** were also considered by many to be a handicap, as was the **risk of damage to eyes from dazzling**. If the cookers are handled correctly, though, the latter can be avoided without difficulty, and the technique was also demonstrated to the families. The wind in the region is sometimes very gusty, and frequently blew the cookers over, damaging them. Furthermore, in Daadab and Kakuma **sand and dust** were a problem, as a result of which the soiled cookers lost over a quarter of their power. Cleaning the sensitive parabolic reflectors was a labour-intensive effort requiring relatively large amounts of water, which was in short supply in the camps.

The fact that solar cooking was not seen as an ‘emergency’ option either was shown when disputes with the local population in Osire escalated and shots were fired at refugees gathering wood. This did not, as might have been expected, lead to greater use of the solar cookers; instead, less cooking was carried out with wood and more with paraffin.

These experiences in refugee camps demonstrate that solar cookers certainly could make a contribution to energy supply. The central problem, however, has so far been the acceptance of the technology.

Dissemination strategies for solar cookers have had little success – acceptance is still the problem

According to the experience gained in the various regions and projects, four different dissemination strategies can be identified, which are often used in combination:

- **State-controlled dissemination programmes** at sometimes heavily subsidised prices or free of charge (China)
- **Commercial dissemination of subsidised models** (China, India)
- **Market launch with only indirect subsidising of the cookers** (South Africa) and accompanying offers of loans for buyers (Burkina Faso)
- **Renting and sale at usual market prices,** supported by project activities relating to advertising and awareness-raising (Burkina Faso).

At the time of writing, none of these strategies has yet achieved conclusive success. However, this has less to do with the chosen dissemination approach; instead, alongside the **technical problems with certain types of cooker** the reluctance to adopt the technology is blamed above all on the **lack of social acceptance**. In many cases solar cookers cannot be integrated into families’ everyday working and domestic lives without further complication. Moreover they call for changes in behaviour, which it is difficult to persuade people to adopt as long as there are alternatives that are more convenient or closer to users‘ traditions. The example of India shows that cooking is viewed as a private activity that is not something to be done outdoors. Traditional dishes that require deep-frying and shallow-frying cannot, for example, be prepared with box cookers, or at least not all of them. Why, then, should people make the switch? Cooking habits are very much part of the private sphere of the kitchen, and are generally not easy to change. This also applies to the use of a cooking stove, which people are unwilling to change without further ado even if the ‘new one’ works faster and costs less to run (example: families in the South African trial). Not only that: when it comes to using a solar cooker, external factors such as the weather and the time of day also have to be taken into account. If, though – as is the case in South African townships, for example – cooking is often traditionally carried out in the late afternoon or evening, a solar cooker is not a real option. It is admittedly true that there have been isolated approaches aimed at taking account of these difficulties and providing solar cookers in combination with other technologies, such as Rocket Stoves. In such cases the potential savings from improved stoves and solar cookers can complement each other. Whether this integrated approach will become established remains to be seen.

To this must be added the fact that some dissemination strategies **hamper sustainability because of their very approach**: high initial subsidies arouse false expectations among consumers. Once the subsidy is taken away, interest in the technology dissipates as well. Moreover, subsidising solar cookers does not ultimately solve the problem of lack of acceptance. Instead, it would be important to develop financing models that promote the use of the technology rather than its acquisition – in other words encourage solar cooking rather than the purchase of a cooker. Unfortunately, although such models have been considered, as yet none have been tried in practice.

The South African approach was meant to take account of the problem of subsidising: the mechanisms of the market were supposed to be utilised for dissemination of solar cookers from the very beginning. It was hoped to achieve market introduction by promoting companies operating all along a supply chain for solar cookers avoiding direct subsidies. Despite this, the project was unable to achieve success; one of the most significant reasons for that proved to be the trend in the price of the **competing energy source, electricity**. As South Africa has considerable excess capacity in electricity generation, the rise in electricity prices over the entire course of the project lay below the rate of inflation. In the larger towns and cities, for example, even for poorer households the incentive to switch to solar cooking was obviously not sufficiently great, especially as the purchase price of a solar cooker was equivalent to several times the monthly salary. Attempts made by the project to introduce a **loan system for solar cookers** failed because of a **lack of**

interest on the part of the banks. A credit fund financed by the project, on the other hand, was not compatible with the marketing concept. A further problem was plainly also people's great fascination with solar cookers at first glance. At exhibitions and trade fairs the project usually aroused lively interest, and many visitors spontaneously expressed a willingness to buy a cooker. However, the user-friendliness of the cookers, the behavioural changes required making best use of them, and consequently the actual benefits of a solar cooker in everyday life were often misjudged. The 'word-of-mouth advertising', an important factor in mass dissemination, was less effective than hoped for; disappointed customers, on the other hand, can quickly ruin a product's image.

Generally speaking there is still a lack of **systematic training for users** on the day-to-day handling of solar cookers and on looking after and maintaining them. Nor is there training of or access to a professional maintenance service. It is seen from the example of China that the quality of the cookers suffers especially from the **lack of a manufacturer's guarantee**. Apart from the government-sponsored programmes, however, there are also a large number of

mostly foreign-promoted NGOs which support the local production and dissemination of solar cookers in small craft enterprises or family businesses. Follow-up support and user training is usually better organised in these approaches.

In India greater emphasis was placed on commercial **dissemination of subsidised cookers**. Here, too, there are complaints about deficient follow-up support for customers, even though six regional centres for solar cookers were set up which apart from testing cookers also offered assistance with technical problems and conducted training programmes.

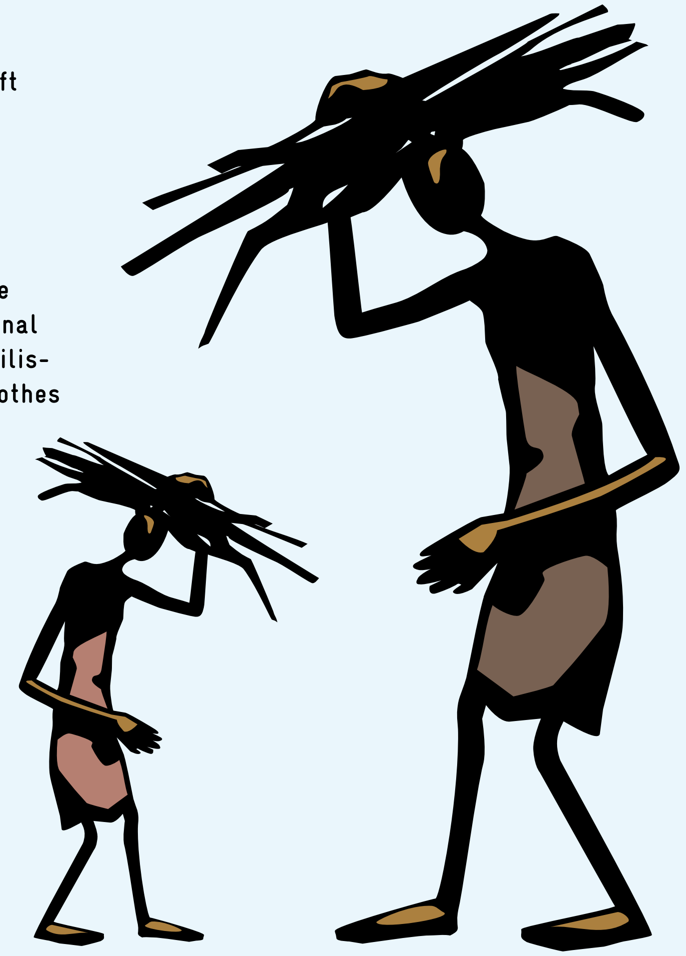
Comprehensive customer aftercare is essential with solar cookers, however. Especially at the beginning people often operate them incorrectly, but this is usually put down to the quality of the device and quickly leads to the technology being rejected. In order to solve this problem it is important for a contact person to be available on the ground.

Incidentally, a common theme of all the strategies described here, apart from the approach in Tibet, is that they are **no longer directed at poor segments of the population but at the middle class**. This is due to the relatively high purchase price of a solar cooker, which largely rules out the commercial dissemination of sophisticated models among poorer members of society. A **fundamental dilemma** becomes apparent here: studies have shown that it is precisely poorer families which make more intensive use of solar cookers, as they are less able to switch to other energy sources than the middle class. Efforts are therefore being made to use climate change funds for solar cookers as well, via the Clean Development Mechanism (CDM) that was developed within the framework of the Kyoto Protocol, and thereby reduce the selling price. Calculations of the CO_2 savings made by solar cookers suggest that a considerable reduction could be made in the price of the Papillon, for example. Solar cooking is carried out in the Indian ashrams to offset the CO_2 emissions that the participants at the Renewables Conference in Bonn in 2004 caused by their flights. However, promotion through the CDM requires a complex monitoring process and incurs high transfer costs within the CDM, which so far has hindered any wide-scale promotion of solar cooker projects. That is why efforts are now being made to simplify this process.

Nevertheless, a pilot project is currently in preparation in the Indonesian region of Banda Aceh which is intended to disseminate 1,000 parabolic cookers on the basis of the CDM. It remains to be seen whether the requirement of intensive use of the cookers for 1,500 hours per year can be achieved, as needed to satisfy the CDM criteria. Finally, there remain concerns that the **sustainable** introduction of solar cookers does not appear to be compatible with long-term subsidies, even if they are based on the Kyoto Protocol.

Ten basic rules that promise successful dissemination and use of solar cookers

1. Only sparse quantities of biomass are available as fuel and obtaining it is difficult; the potential users have problems obtaining fuel at least part of the time.
2. The target group does not have easy access to other, reduced-price energy sources.
3. Cookers should never be offered as a sole solution but best of all as a package with other energy-saving household technologies.
4. There must be places within the living area positioned favourably for capturing sunlight, enabling solar cooking to take place.
5. It must be possible to prepare the most important local dishes on the cooker, and solar cooking must not get in the way of local cooking traditions.
6. Cookers with a good price-performance ratio must be available locally, and after-sales service and maintenance must be assured.
7. Thorough follow-up support for users must be guaranteed, and structures to provide this have to be put in place.
8. In some areas the cooker must be protected against theft and should therefore be easy to move to a safe place.
9. Handling (especially tracking the sun) must be easy and the cooker must be stable.
10. When it comes to disseminating solar cookers it must be borne in mind that they can also fulfil important additional functions, depending on the situation – for example sterilising drinking water, preserving jams or fruits, heating clothes irons.



Rocket Stoves instead of solar cookers – a new generation of efficient stoves as a sensible alternative

Despite intensive efforts, to date solar cookers have mostly found a role only in certain niches. There are other technologies that can make a substantial contribution to solving the firewood problem. Among the various **improved cooking stoves**, models have been developed that can certainly compete with solar cookers in terms of their potential for saving energy, and in some cases can even beat them. Looking at utilisation over the period of a whole year, the use of solar cookers is largely limited to days when the sun is shining. Wood consumption throughout the year can therefore be reduced by 30 to 40 % at most, as illustrated by the solar cooker field test in South Africa. Examples of these improved stoves that can be cited here include models developed in China based on the principle of wood gasification, improved stoves in southern Africa that burn both wood and charcoal highly efficiently, or models designed along the lines of the Rocket Stove. The latter are currently being disseminated in several African and Latin American countries and are examined in more detail below.

The Aprovecho Research Center in the USA developed the Rocket Stove principle for improved stoves in 1984. The design has a highly favourable impact on wood consumption and reduces smoke and fumes that are harmful to human health. The name **Rocket Stove** relates to the shape of the stove and the noise it makes in operation, resembling that of a rocket being launched. An L-shaped, well insulated combustion chamber provides for the correct supply of air so that the wood burns at a high temperature and almost smoke-free. The position of the pot on or in the stove allows optimum transfer of heat. Domestic stoves designed according to this principle save about 50 or 60 % of the firewood that would be used on a three-stone fire. Large-scale stoves for institutions such as hospitals, schools and prisons are even more efficient, consuming up to 90 % less wood. One impressive example of this came to light in a trial on a tea plantation in Malawi, in which the traditional maize porridge was cooked for 120 people on a three-stone fire and a Rocket Stove. In the trial a saving of about 80 to 90 % was achieved with the Rocket Stove. A prison canteen was able to reduce its need for wood to about an eighth of its previous consumption by using the new stoves. This technology has given an undreamt-of boost to the dissemination of improved stoves in southern and eastern Africa. The two examples from **Malawi and Uganda** described below are intended to illustrate this.

The SADC Programme for Biomass Energy Conservation in Southern Africa (ProBEC) implemented by GTZ on behalf of BMZ and DGIS has been particularly successful in disseminating Rocket Stoves in Malawi. Rocket Stoves are used both in households and in large institutions, with cooking pot sizes ranging up to 250 litres. So far approximately **3,000 metal Rocket Stoves** have been produced and sold, yielding firewood savings of about 50 to 90 %. The cost per stove varies between **US $ 20 and 300**. At present Rocket Stoves are manufactured for the national market on a commercial basis by four producers who have been trained and certified by ProBEC. Models with a 100 litre-capacity pot or even larger pots are used by the World Food Programme, Mary's Meals, UNICEF, and other institutions for school feeding. That's how, more than 300,000 children are getting a warm meal every day. The tea plantations in Malawi, vitally important for its economy, have likewise begun to cook the meals for their workers on these energy-saving stoves. So far, several Rocket Stoves have been built by the tea industry following training by ProBEC.

For the commercialization of Institutional Rocket Stoves both ProBEC and Aprovecho were awarded the Ashden Award for Sustainable Energy in 2006.

The successes in **Uganda** are similarly impressive. In this country the dissemination of improved stoves is one of the objectives of the Energy Advisory Project (EAP), financed by BMZ and DGIS. A region in the west of the country which suffers particularly badly from a shortage of firewood was selected as the pilot region for introducing the stoves. The project cooperates with a number of NGOs, which train local village stove producers according to the '**train the trainer**' principle. The stoves are built with locally available materials, usually clay. As each family helps to build the stove and 'payment' can also be made in kind, the cost of a stove is low and the technology is therefore also within the means of poor families. The quality of the stoves is ensured by close monitoring carried out by the project or the NGOs.

And the success stories are impressive. In Bushenyi District in western Uganda more than **200,000 stoves for households** were built according to the Rocket principle within the last two years. They use only between half and one third of the previous amount of firewood. The project was then expanded into Rakai District, where a **further 55,000 stoves** were built within six months. As these also generate less smoke and fumes, the strain on women's health is reduced. The project is currently being expanded to cover the entire country.

Results of a Cost-Benefit Analysis showed that in 2006 due to the use of efficient stoves in Ugandan households 220,000 tonnes of wood were saved. The economic benefit amounted to 5.4 Mio. Euros. Every day the families need one hour less for gathering firewood and cooking; furthermore, each stove saves 1.5 tonnes of CO_2 per annum. All in all, over a time period of ten years, every one Euro invested brings in a return of 25 Euros.

TO SUM UP: improved, new-generation stoves are usually the preferred choice of poor families in rural regions of Africa, Latin America and Asia. The favourite type is still a stove that is adapted to the way people are used to living and cooking and at the same time conserves energy 'as a bonus'. It is only under specific geographical conditions, as encountered for example on the high plateaus of Asia and Latin America, that solar cookers have so far been able to take on a significant role in the provision of energy for households.

Further Reading

- A comprehensive study of solar cookers around the world: **Barbara Knudson**: The State of Art of Solar Cooking, available as a download from **www.she-inc.org**
- Experience from the field test in South Africa: GTZ (2004): SOLAR COOKING COMPENDIUM.
- About the field test in South Africa and about solar cookers in general: GTZ (1999): Solar cookers in developing countries. Acceptance and market introduction. Available as a download from **http://www.gtz.de/de/dokumente/de-solarkocher-1999.pdf (German)**
- A guide to planning solar cooker projects: **Michael Grupp (2004)**: THE SOLAR COOKING TOOL KIT – CONCLUSIONS FROM THE SOUTH AFRICAN FIELD TEST FOR FUTURE SOLAR COOKING PROJECTS.
- At **www.solarcooking.org** you will find extensive information about solar cookers along with a directory of all organisations and individuals actively engaged in this field.
- For information about the Rocket Stove technology see **http://www.aprovecho.org**
- For information on widespread stove technologies worldwide see **http://www.bioenergylists.org**

Abbreviations

ACCEDES	Alliance Chrétienne pour la Coopération Economique et pour le Développement Social
ACOMES	Atelier de Construction Metallique et d´Energie Solaire
APEES	Association pour la promotion d'exploitation d'énergie solaire
APFG	Association Professionelle des Femmes de Gaoua
BMZ	German Federal Ministry for Economic Cooperation and Development
CDM	Clean-Development-Mechanism
CEDESOL	Centro de Desarrollo en Energía Solar
DGIS	Directorate-General for International Cooperation
EAP	Energy Advisory Projekt
EG Solar	Entwicklungshilfe Gruppe Solarkocher der Staatlichen Berufsschule Altötting e.V.
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH
ISOMET	Innovation en Solaire et Metallique
NGO	Non governmental organisation
PROAGRO	Programa Desarrollo Agropecuario Sostenible
ProBEC	Programme for Biomass Energy Conservation in Southern Africa
SADC	Southern African Development Community
SEWA	Solar Energy for West Africa
UNHCR	United Nations High Commissioner for Refugees
UNICEF	United Nations International Children's Emergency Fund

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