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Proposals for a Global Solar Cooker Programme

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Summary

A global Solar Cooker Programme can be realised successfully if we find a way to overcome its crucial barrier, the poverty of the victims of the firewood crisis. The paper highlights the encouraging progress in development, use, local production and evaluation of solar cookers, focussing on reflector cookers of type SK (SK12, SK14, SK98). The high potential of solar cookers for reducing CO_2-emission will be pointed out. It makes possible a way of financing a global programme by Joint Implementation/Clean Development Mechanism to comply with the obligation for CO_2-reduction and to fight the firewood crisis, a crisis that causes immense misery today and is developing to a global catastrophe if we disregard the possibilities to help.

People faced with the firewood crisis lose their source of energy that was free or very cheap. Usually they cannot afford the switch to other sources of energy even though the solar cookers are produced in these countries in simple workshops and distributed without a license-fee, so that they pay off within a few months. Thus it is not a matter of product marketing in the usual sense, but a matter of effective help for people who are forced by their poverty to destroy their own natural resources by burning trees, bushes, harvest remainders and dried manure and who cannot find a way out of their misery without external help. *A small fraction of the financial means necessary for CO_2-reduction that would have to be invested in the industrialised countries would suffice to overcome a global crisis.*

Fig. 1:
"The solar cooker appeared sinister to the women at first. They learned quickly however to appreciate the advantages of the non-polluting cooker." [16].

1. Development of Solar Cookers to a high technical standard and their international evaluation as basis for a global dissemination programme

In the past few years solar cookers have been developed to a high technical standard and they have gained world-wide acceptance. The encouraging development regarding technology, use and evaluation of solar cookers was accomplished by co-operation between users, promoting institutions and developers. International Solar Cooker Tests were performed to determine the technical characteristics of different cookers and their ability to meet the requirements, to prove the acceptance and to find out deficiencies. They brought about the turning-point in evaluating solar cooking: *It has now been shown that a global solar cooker programme can be realised successfully under one condition: if the price of the cookers is affordable.*

The results of the International Solar Cooker Tests [4,5,6,9] in Southern Spain (beginning 1993) and South Africa (beginning 1996) and experience gained by solar cooker programmes of foreign aid groups [7,8,10, 12,13,16,18,20] show that people in developing countries faced with the firewood crisis can be helped effectively with solar cookers. Suitable cookers are accepted well if the users have a chance to become acquainted with the new technology. The following comments are mainly derived from experiences with SK-type cookers. This kind of cooker was developed during the past 15 years by the author and his family and in co-operation with many friends from all over the world.

No royalties are charged for the cooker design. The foreign aid group 'EG Solar' at the State Vocational School in Altötting, Bavaria, is co-ordinating the world-wide dissemination of the SK-cookers (address see below; 5.). The progress of recent years in the development and dissemination of these cookers has helped to overcome the well-known disadvantages which had given reflector cookers a negative image in earlier times [12]. We had to work on the following problems which contributed to the non-acceptance: lack of stability and comfort, dangerous position of the pot, high tracking frequency, irritation by glare, low power, cooker not usable in short sunny periods, short lifetime of the reflector, small pot, restricted usefulness, rapid heat loss of the pot without sun with necessity to cook just before mealtime, high price in relation to the power, transport and storage difficulties. But all these problems have now been solved. These cookers in combination with insulating containers (e.g. hay-baskets, see fig. 2) meet now the essential requirements for family and institutional use.

Fig. 2: Combination of the cooker with "hay boxes" is strongly recommended to finish cooking by unattended simmering, to separate mealtime and cooking time, to liberate the cooker for the next pot for doubling the capacity of the cooker and to save fuel even in times with lack of sunshine. Placed in a "hay-basket", with good insulation, e.g. by a straw cushion under the pot and covered by blankets of cotton and wool (perhaps with reflecting plastic foil between the blankets), the pot stays at high temperature for several hours due to its high thermal capacity of the content. So it is ensured that all the components of the meal are finished timely.

2. Experiences with know-how-transfer, production, dissemination and use of reflector cookers

In the last years there has been progress in the following areas of solar cooker development:

Technical and practical characteristics: Capacity, safety and stability, comfortable use, durable reflecting surfaces; insulating containers made from locally available material.

Production: SK-type cookers can be produced in small workshops with devices for cutting, punching (or drilling) and bending; there are also designs for welded and for bamboo structure. Two instructed persons can produce several cookers a day. The thin reflector sheets (anodised, hard, high reflecting aluminium sheet, 0.5 mm thick) are supplied by EG-Solar. They are cut and punched by JAGUS, a social institution for jobless young people in the district of Altoetting, Bavaria. Till now 6000 sets of reflector sheets have been supplied.
Cost of SK-material (strip steel version): approx. 60 Euro, Cost of local production incl. material and pot: approx. 100 Euro. The insulating baskets are produced conventionally. Approximately 6000 SK-type solar cookers (SK10 to SK14) have been installed in more than 60 countries with the assistance of

development aid groups. Small workshops around the world have been established. As part of phase 2 of the field test in South Africa production at a larger scale is being tested by GTZ and DME [9].

***Dissemination of solar cookers and know-how*:** World-wide co-operation and workshop installation, solar cooker sponsorships, information, assistance and supply of sample cookers mainly done by development aid groups. EG-Solar has promoted SK-cookers since 1989 and is co-ordinating these activities. JAGUS produces SK-cookers and sets of reflector sheets for dissemination by EG-Solar. So far 2000 cookers and 6000 sets of reflector sheets have been delivered.

Courses for training manufacturing, assembling and maintenance are carried out regularly by EG-Solar. Workshops for production of these cookers have been founded and supported world-wide, in Argentina, Bangladesh, Bolivia, Brazil, Costa Rica, Cameroon, Ecuador, Ethiopia, Germany, Ghana, India, Kenya, Madagascar, Nepal, Nicaragua, Peru, Philippines, South Africa, Tanzania, Uganda, Zimbabwe. Now there are approx. 6000 SK-type cookers distributed. Further workshops are in preparation. Expenses are sponsored by donations.

An example from Zimbabwe: A small SK-workshop was founded by Dr. Eder with assistance of EG-Solar three years ago at the hospital, which she directed for 37 years. Four SK14 cookers are produced a week. The women accompanying the patients and the inhabitants of the area have extreme difficulties in finding fuel wood. The cookers cover almost the total demand for cooking at the hospital near the Kalahari. Promotion and production of SK14-cooker in Kathmandu Valley was described in Solar Cooker Review, March 1999 [20]. Concerning Bangladesh please see the article of L. Bähr.
It is obvious that people who most need solar cookers are often the least able to afford to buy solar cookers. This fact limits actually the dissemination of solar cooking.

3. Features of SK-type solar cookers

The cookers are designed for use in families, and - in a modular way - for institutions e.g. community kitchens. They are applicable for cooking, baking, frying, sterilising water and instruments, preserving fruits and vegetables and other thermal applications, e.g. desorption of adsorbers. The main aim of the development of the last 15 years has been a durable cooker for safe and easy use which can be produced in simple workshops. The proven design allows adaptation to the local demands and to the capabilities of the manufacturer. Characteristics of the SK-type cookers are given in the Appendix of this article and in the literature [4,8,10,12].

4. International Solar Cooker Test Results and Improvements

The Solar Cooker Field Test in South Africa confirmed the high acceptance of the SK-type cooker. The advantageous technical data were appreciated. There had been some recommendations for improvements which were considered in the new models. Instead of a string there is now a friction clutch consisting of a disc mounted at the bearing plate and a simple grip fixed at the stand for comfortable orientation of the reflector. The reflector geometry and all characteristics of the proved concept of SK12 are unchanged. Solar cooker SK98M can be separated into two parts to simplify transport and storage. The base can be used as at stand of a table. The cooker structure can be made from strip aluminium to reduce the weight and to increase the lifetime of the structure.

5. Proposal for financing a Global Solar Cooker programme JI/CDM

5.1 Firewood crisis - the disastrous consequences of the loss of a cheap energy source

"In past years no comprehensive solution of the energy supply crisis was achieved. On the contrary, it seems that the crisis has rendered itself independent and has become a global syndrome of under-development and ecological destabilisation", J. Herkendell writes in his report *"Firewood crisis in the Third World - a repressed ecological and development problem"* (in German) [3]. According to

estimates by the FAO, by 1980 about 1200 million people in the developing countries covered their energy requirements by cutting more wood in their immediate surroundings than could grow again and till the year 2000 an increase is expected to 2400 million people faced with the firewood crisis [15]. They lose their free or very cheap energy source. Most of them can't afford the change to other energy sources . They destroy their natural resources and sink into misery if they don't get help to help themselves [14]. We might even argue that solar cooking is not a question of acceptance any more but of survival in the countries suffering from firewood crisis. To fight the global firewood crisis by using solar cookers, it is necessary to find a new way of raising money for their manufacture and dissemination. In the following paragraphs it will be shown that the saving of CO_2-emission by solar cooking is so high that financing of solar cooker programmes offers an extraordinary good way to keep the promised reduction.

5.2 Scenarios

To estimate the potential of solar cookers for reducing CO_2 it is helpful to compare scenarios:
A) Resources provided by the global forest are decreasing with growing speed and its carbon content (approx. 500 kg/ ton of wood) is burnt to CO_2 (about 1.8 tons per ton of wood). This situation is connected with the rural exodus of the people involved and their switching over to using fossil energy.
B) A forest stand that is growing until it reaches an equilibrium on a high level - because there is less wood burnt than is growing again - and in which CO_2 is stored during growth. This strengthened forest naturally absorbs carbon out of the atmosphere with the help of solar energy and, after having achieved the sustainable equilibrium, the increment is burned instead of fossil fuel and so its release of CO_2 is avoided. In this way the aimed sustainable forest economy - enabled by reducing the consumption by use of solar cookers - does not produce CO_2 at all because the same amount of CO_2 that is released by burning of wood is absorbed by new growth. The conversion of fossil sources of energy to CO_2 and its emission is avoided by the use of solar cookers and by reforestation to a sustainable forest stand which is made possible by the global solar cooker programme. The absorption of CO_2 by the growing stock instead of its release during the transition period should also be credited. No time should be lost to reach scenario B), because the time between the first appearance of the shortage symptoms and the disappearance of the forest may be unexpected short [11].

5.3 CO_2-reduction and the cost of saving CO2-emission by SK-type cookers

For a rough estimation of the possible global CO_2-reduction by solar cooking we should consider that a firewood shortage of 1000 million cubic meters (about 450 million metric tons) is forecast for the year 2000 [3]. Solar cookers should prevent above all the increasing non-sustainable consumption and enable the stabilising of a sustainable firewood supply. Consequently, the direct saving potential is more than 450 million tons per year * 1.83 = 820 million tons of CO_2 annually.
For a simple and transparent calculation of the cost for saving one ton of CO_2 we may suppose that scenario B needs a saving of about half of the firewood burnt by one family in regions afflicted by the firewood crisis and that this firewood otherwise would be burnt in a non sustainable manner. If this saving is performed during the lifetime of the cooker (minimum 15 years with maintenance of the reflector), we can divide the cooker cost in its lifetime by the saving of CO_2 of the cooker and get the cost of one saved ton CO_2. If the transition to a sustainable firewood supply will need about 15 years, the saving of CO_2 will lead to a lasting solution of the firewood problem and we can assume that one solar cooker will save half of the emission of CO_2 of a family permanently.

Details of the calculation are explained in [19], cost data refer to the strip steel version. The results are:

- One SK-cooker used by a family can save about 3800 kg CO_2 per year i.e. 57 ton CO_2 in 15 years.
- Cost of the SK-equipment including maintenance of the reflector in this time is about 150 Euro.
- Cost per saved ton of CO_2 is 150 Euro/57 ton = 2.6 Euro. This is a small fraction of the cost industrialised countries face with other methods of reducing CO_2 and even less than most of alternative JI/CDM-projects.

This proves that financing this programme is one of the most cost-efficient world-wide.

5.4 JI/CDM: Co-operation for climate-provision

Joint Implementation (JI) was drawn up as a climate-political instrument at the Framework Convention on Climate Change at Rio de Janeiro in 1992 and worked out at the Conference of Member States of the Framework Convention at Berlin in 1995 and extended by the pilot-phase "Activities Implemented Jointly (AIJ)" [1, 2]. In Kyoto the Clean Development Mechanism (CDM) was defined for co-operation to reduce emission of greenhouse gases between member states (states with obligation of reduction of greenhouse gases) and other states. From 2000 onwards it makes JI/CDM projects possible, which are financially supported by member states that in exchange get credits for their promise to reduce their emission of greenhouse gases. JI/CDM-projects must comply with a number of criteria and only a part of the reduction promise can be met in this way. JI/CDM is exceptionally qualified for a global solar cooker programme mainly financed by industrialised countries, particularly if it is connected with reforestation projects and training programmes for energy saving cooking.

5.5 Solar cooker programmes are most appropriate projects for JI/CDM

- The potential for reduction of CO_2-emission is very high (about 800 million metric tons annually)
- A solar cooker programme can satisfy all criteria for JI/CDM;
- Cost of a solar cooker programme is only a small fraction of the expense for corresponding measures to fulfil the obligation to reduce the CO_2-emission;
- Spending money for solar cookers in exchange for " CO_2-credits" opens a way out of the firewood crisis, because it offers solar cooking to those people who in their poverty destroy their own natural resources and that of future generations;
- Dissemination of solar cookers is essential for the success of reforestation projects, which are preferred JI/CDM projects;
- With the global solar cooker programme many additional positive effects are expected.

5.6 Calculations to give a survey about a global programme of solar cookers

- More than 2 billion people are affected by the firewood crisis. If about 9 (from 3 to 15) persons use one solar cooker and 2 hay-baskets, 220 million solar cookers and 440 million hay-baskets are necessary.
- If about 1000 cookers are produced in one workshop per year, then 15 000 workshops need 15 years for 220 million cookers (15 million cookers per year).
- If there are 10 part-time jobs per workshop, then 150 000 part-time jobs are created world-wide.
- Cost of a workshop equipment is approx. 5000 Euro, i.e. 75 million Euro for 15 000 workshops.
- Cost of local production for one SK-cooker: approx. 100 Euro; i.e. approx. 11 Euro per person.
- Cost of production of 150 million cookers per year are 1 500 million Euro per year
- Nominal power of SK is 600 W; 220 million cookers have a nominal power of 132 000 Megawatt.
- If one cooker saves the emission of approx. 4 metric tons CO_2 per year, then 220 million cookers save 880 million metric tons CO_2 per year. This is approx. the annual emission of Germany.

6. Suggestions on main elements of a Global Solar Cooker Programme financed by JI/CDM

The programme needs favourable basic conditions and bilateral or multilateral agreements; it would be helpful supporting a network of innovation institutions for know-how transfer (in which the media and especially television should be invited to participate powerfully); structuring the solar cooker programme in stages carried out in projects; inviting participation of experienced NGOs and other experts for dissemination and continual support; establishing centres for promoting solar cooking and for supplying material to the workshops step by step, inviting the setting up of workshops for manufacture of solar cooker systems and of community kitchens, e.g. at vocational schools and social institutions or by appropriate private enterprises e.g. co-operatives, for training how to assemble and maintain the cookers and hay baskets and to learn how to save fuel by the heat-preserving and simmering technique and by cook-stoves that need less firewood [11] and to learn how to avoid mistakes and risks.

A JI/CDM Solar Cooker Fund should serve for financing the workshops and training facilities, material for the cookers and training-material, enabling to purchase the cooker at very favourable conditions, e.g. in exchange for assistance in reforestation projects or at community kitchens at a low price (e.g. 25 Euro) with favourable rates of interest by micro-credits; regional assistance centres are recommendable e.g. run by NGOs for evaluation and locally support. Procedures of application for participation and the performance of the programme should be dealt with in detail in the media and especially in television and at school. Also the use of other sustainable technologies, *permatechniques*, e.g. food drying and local electrification (see fig. 3) by solar energy, should be encouraged. The programme should be accompanied by evaluations and equipped with an information network, to record and make public the gained experience and the improvements. JI/CDM is a chance for the poorest people in the world, to get help by their free solar resource, (i.e."the sun pays them the bill"). We should take the chance for a programme which can relieve women and children from their pressing burdens and can open ways to a sustainable supply.

7. Indication

Support, documentation, SK-cookers, reflector material sets are available form EG-Solar e.V.
(Development Group Solar Cooker of the State Technical College Altötting),
Neuöttinger Str. 64c, D-84503 Altötting (see heading of the article)
Tel.: 08671 96 99 37; Fax: 08671 96 99 38; e-mail: EG-Solar@t-online.de

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10. Appendix: Characteristics of SK-type solar cookers

A1) Concept SK-solar cookers:

- Parabolic reflector made of thin, hard aluminium sheets with protected, high reflecting surface mounted at a rigid basket structure.
- Reflector with short focal distance for safety reasons, long tracking intervals and high efficiency.
- Removable black pot (with lid), held in upright position in the focal area by a support, which is part of the horizontal axis. Standard is a 12-litres-pot of black enamelled steel with a diameter of 28 cm. Other pot designs with well absorbing surface (cast iron, blackened pottery) are in use, too.
- Easy one step access to the pot. Baking using the pot by inserting a baking tray on a support.
- Tracking is accomplished by moving the whole cooker (azimut) and by turning the reflector around the horizontal axis (elevation), adjustment of the reflector to the sun by use of a shadow indicator.

A2) Technical data:

• reflector diameter / focal distance	140cm / 28cm
• nominal effective power	0,6 kW
• pot capacity	12 litres
• pot diameter (standard)	28 cm
• continous cooking *	boils 48 litres of water in a day
• max. temperature (oil) *	198º C
• min. tracking frequency *	85 min (96°C) / 115 min (80 °C)
• unattended cooking / max. temperature *	74 minutes / 98 °C

(* = data from Second International Solar Cooker Test by ECSCR, Almería (Spain) 1994, [4]. The test was performed with the original 12-litre-pot, half-filled, with lid)

- weight of SK (strip steel support / aluminium support) approx.27 kg / 14 kg

A3) Safety precautions:

- Reflector with focal area instead of focal point;
- focal area inside reflector (i.e. deep focus design) at the stable support of the pot;
- pot remains automatically in the focal area;
- tracking without irritation by glare by using a shadow indicator,
- rigid structure; fixation on the ground is possible;
- no necessity of looking into the reflector;
- inserting and removal of the pot is done after turning the reflector out of the sun.

Fig. 3: Solar cooker SK12 and PV-panel for decentralised energy supply