WHY ARE SOLAR COOKERS STILL UNPOPULAR AMONG DEVELOPMENT EXPERTS?

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ABSTRACT

The household energy problem in countries of the south remains critical. Solar cookers can contribute to a solution; however, their potential is seldom realized by the academic and political world. By contrast, bio-energy as a replacement for fossil fuels is increasingly popular in Europe. With regard to tropical developing countries, this European enthusiasm implies unrealistic views about the renewability of woody biomass in drylands under conditions of climate change and increasing population pressure. Another reason of error is a too narrow concept of modernization of energy supplies, neglecting affordable cooking energies and focusing nearly exclusively on electricity.

Cheap solar cooking appliances with a low thermal output are useful in extreme situations like refugee camps to allow survival of large numbers of individuals or mini-groups. Under normal circumstances families need appliances which can cope with the volume of staple food needed, that is the number of people times about 1 litre/person/day.

Keywords: Image of solar cooking, Adaptation of cooker power to family size, modernization of energy supply, limits to renewability of biomass, thermal output capacity of solar cookers, family size cookers.

1. INTRODUCTION

Solar cooking promoters still are engaged in an uphill struggle in several western/northern countries. Political and media support is often lacking, even in settings where “Renewable Energies” for the countries of the South are on the agenda. This became quite clear in the context of the “Renewables” conference in Bonn, Germany, in 2004, where solar cooking was only marginally noticeable. Thereafter, some journalists explained their reluctance to write or publish about solar cooking by referring explicitly to the “Renewables” conference in Bonn. The purpose of this paper is to look into the underlying causes and the conceptions or misconceptions of the actors involved.

2. BACKGROUND: THE IMAGE OF SOLAR COOKING IN THE PUBLIC:

Some months ago, I took part in a conference of German NGOs on renewable energy promotion in countries of the south. One of the speakers began by showing pictures on the destruction of forests and the painful gathering of fuel wood by women and children. Then he went on to talk about electricity from renewable sources, implying a switch from fuel wood to electricity as energy for cooking. On one of the slides shown I read the slogan: “Reforestation instead of solar cookers”.

The Scientific Advisory Panel “Global Environment” to the German Government did not even mention solar cookers in its 283-page report published in 2004 on “Effective Poverty Reduction through Environmental Policy” (WBGU 2004). Attempts to launch a discussion on the subject with members of the panel failed. The panel favours the use of bottled gas for cooking in poor countries, in the short run from fossil sources, and in the long run from biogenic sources.

In 2004, the former German minister for economic cooperation, Jürgen Trittin, expressed the opinion that African countries could only escape underdevelopment if they overcome their dependency on oil, thus denying their far greater dependency on wood energy and very low fossil fuel consumption. In the discussion he argued, that solar cookers are not accepted by the general population. On the same occasion an academic speaker asserted that Africans cling to smoke from wood burning inside houses, because it keeps insects out. He ignored the serious health consequences of Indoor Air Pollution (IAP) from solid fuel smoke in terms of premature deaths – mainly of women and children under five years of age, and the fact that in several countries cooking is done outside the house because of smoke from wood burning.

The state-owned German development agency GTZ embarked on a solar cooker programme in South Africa some ten years ago, together with the South African Department of Minerals and Energy (DME), to decide "once and for ever", whether solar cookers can do more than fill a niche, and published a "Solar Cooker Compendium" (GTZ 2004). The document states: "The Solar Cooking Compendium (SCC) is about the viability of solar stoves as a solution to the scarcity of household energy. Viability is measured in commercial terms. It means manufacturing and marketing of solar stoves without subsidies. In the future, this will be the criterion for judging projects promoting solar cooking". Contrary to the intention, there are no clear-cut conclusions drawn from the GTZ / South African Experience.

3. MATCHING SOCIETY AND TECHNIQUE

3.1 Family size and required cooker capacity:

Solar cookers should match capacity requirements which in turn depend on the number of people for whom food is to be prepared. Family size distribution in Burkina Faso – grouped by sex of the household chief – is as follows:

TABLE 1: FAMILY SIZE IN BURKINA FASO ACCORDING TO INSD 1998

	men	women	total
urban		4.2	5.6
rural	8.5	3.5	8.2
total	7.9	3.8	7.6

The Papillon was specifically designed to provide more heat for higher quantities of food and / or shorter cooking times, as desired by women in Burkina Faso, who had been working with the SK-14. The following calculations give us an idea of the respective power of the Papillon, the SK-14 and the SK-12.

1 hour of operation of the Papillon (power 1kW_{th}) gives 1 kWh (3.6 MJ).
1 hour of operation of the SK-14 (power 0.6 kW_{th}) gives 0.6 kW_{th} (2.1 MJ).
1 hour of operation of the SK-12 (power 0.45 kWh_{th}) gives 0.45 kWh (1,62 MJ)

To calculate the heat flow rate, that is the amount of heat per unit time necessary to bring 1 litre of water from 20 °C to 100°C, we use the formula:
Q_H = (mc?T) / t ;
where Q_H is the heat flow rate, m the mass (1000 g), c is the specific heat, that is the amount of heat per time unit which is needed to raise the temperature of 1g of water by 1°C (1 calorie), ? T is the temperature difference (80°C) and t is the time needed to bring water to the required temperature, measured in hours.

Inserting values gives us:
Q_H = (1000 x 1 x 80 °C)/1 hour = 80 000 calories;
As 1 calorie equals 4.184 Joule, the result is 334720 Joule or 0.334720 MJ.
Dividing the power output capacity of the cookers by the necessary heat flow rate Q_H gives us the respective merits of the cookers:

TABLE 2: POWER CHARACTERISTICS OF SOME SOLAR COOKERS

	kW_{th}	heat output MJ/h	Amount of food (ltrs/h)	number of people that can be served per h
SK-12	0.45	1.62	4.84	4 - 5
SK-14	0.6	2.1	6.27	6
Papillon	1	3,6	10.75	10 - 11

In practice, heat output may be less than assumed here due to dust in the air or clouds; heat loss from the pot surface by thermal radiation and / or convection (wind), or evaporation. The energy obtained and the number of people that can be supplied with food can of course be increased by longer cooking times.

On the other hand, if cooking is done once per day, larger (double) volumes are prepared (and the leftovers kept for the next day). In the countryside this is tradition; in towns it is increasingly done to save fuel. The capacitiy of pots and cookers should be large enough to cope with such a situation.

If we compare the last columns of tables 1 and 2, it becomes clear that the Papillon, and, to a lesser degree, the SK-14 could have the potential for large scale dissemination among families. Consequently, these two cookers types, but not the SK-12, are produced and marketed in Burkina Faso. However, these cookers were not included in the GTZ field trial in South Africa. The choice made by GTZ includes the SK-12 and three other even less performing cooker types. This may be adequate for South Africa, where households seem to be much smaller [Census 2001, household size, fig. 1.18] than elsewhere in Africa. The GTZ experience is therefore of little relevance to Burkina Faso and probably to many other countries in Sub-Saharan Africa.

3.2 The modernization trap:

In a brochure published by German NGOs on "Renewable Energies as a Way to Development and Climate Protection" we read: "The challenge is to supply the energy-poor with modern energy". However, the question to ask is, which forms of energy are modern and which ones are not? Modernization in energy matters is usually conceptualized in terms of an upward movement along the so called energy ladder, which is a symbolic representation of the efficiency and cleanliness of forms of energy. On the top is electricity, especially if stemming from renewable sources like solar panels, wind or hydrogen. Solar cookers are usually not mentioned.

Contrary to the traditional way, modern forms of energy have to be bought, not just collected, and in situations of increasing poverty there may be a return from modern to traditional fuels in case of price increases and / or suspension of subsidies. The FAO (2004) calls this phenomenon "reverse substitution with wood fuel". According to UNDESA country profile , 91,7 % of the population in Burkina Faso used traditional forms of energy in 2005.

Electricity cannot replace fuel wood and charcoal for cooking, as the International Energy Agency (IEA) states: "There is a widespread misconception that electricity substitutes for biomass. Poor families use electricity selectively - mostly for lighting and communications. They often continue to cook and heat with wood or dung, or with fossil-based fuels like LPG and kerosene" (IEA 2002).

With regard to cooking energy, the only modernization option open to many poor African households in this situation is to switch from fuel wood to charcoal, which is less bulky, easier to transport and to store and emits less smoke, which is of course an advantage under health aspects.

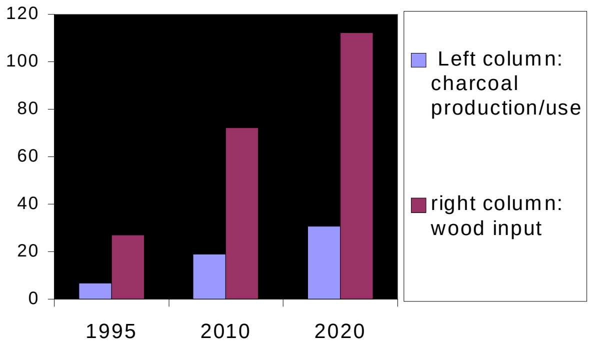

Fig 1: Anticipated increase in charcoal production in mill. tons oil equivalent (Mtoe) in Africa, according to S. Lambert d'Apote, IEA 1998, p. 163.

But there is a problem. Charcoaling needs process heat, and a considerable part of wood energy is thus consumed. The government of Burkina Faso reckons that 5 kg of wood leads to 1 kg of charcoal, corresponding to the energy content of 2 kg of wood. Often freshly felled trees (green wood with a high moisture content) are used. This adds up to energy losses of 60 % or more. The shift from fuel wood to charcoal is especially noticeable in cities and towns. This fact – together with the rapid urbanization process – means that the per capita impact on wood resources is bigger in case of city dwellers than in case of the rural population, and is still increasing and expected to further increase, as can be seen from fig 1.
This leads us to the next problem; unrealistic views held by NGO's, development politicians and academics about the sustainability of biomass energy in countries of the south.

3.3 Misleading views about biomass.

Biomass is perceived by many NGOs of northern countries as an always renewable and thus potentially inexhaustible form of energy. But renewability (regenerability) of woody biomass depends on the maintenance of the resource base and on the conditions of soil and climate, and has to be defined in a geographical context (Krämer 2003). An example is Burkina Faso, see fig. 2. Removal of the vegetation cover may produce a shift of those conditions from relatively high to low productivity and from robustness to vulnerability and even to deforestation and degradation.

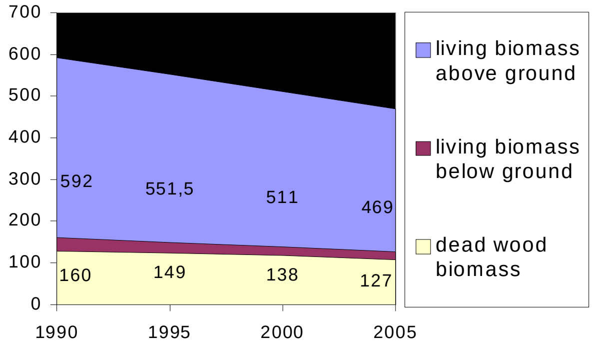

Fig. 2: Decline of forest biomass in Burkina Faso, in mill. tons, data based on FRA 2005, FAO)

We have to distinguish between modern fuel use and traditional biomass consumption. In the former case – for instance in heating systems using wood pellets – the escaping gases from wood burning are collected and burnt. But in traditional charcoal-producing kilns those energy-containing and climate-damaging gases are emitted into the atmosphere. This implies much wasting of energy and, hence, more wood consumption.

In industrialized countries like Germany wood is being promoted as a substitute for oil. In fact, Germany now has a lot of forests. However, a few hundred years ago, most of these forests had been largely depleted, and early industrialization might have come to a standstill due to lack of wood fuel, if coal had not become available. Later, coal was replaced by mineral oil and gas.

Countries of the north and west do not depend on wood fuel resources, at least up to now, and there is little or no overexploitation. From the renewability of wood fuel resources in northern and western countries it is often falsely inferred, that biomass is inexhaustible in the south. This is not true. For instance total living biomass available in forests in Ghana declined by over 25 % in 15 years (1990-2005), namely from 1328 mill. metric tons oven-dry weight to 993 mill. tons (FRA 2005, FAO, country report Ghana). Clearly, the extent of woody biomass consumption in Ghana is not sustainable.

Another indicator of overexploitation of wood resources it the decline of carbon stocked in forest biomass, for instance in Nigeria, carbon content of forests declined even by nearly 35 % between 1990 and 2005 (FRA 2005). In Burkina Faso, losses during the same period amounted to 88 Mill. Tons (20 %) in 15 years.

In Burkina Faso, charcoal supply for the capital Ouagadougou is a big problem. The gap between anticipated demand and secure supply of wood for charcoal production that can be made available by sustainable forest management in the project area can be grasped from Figure 4.

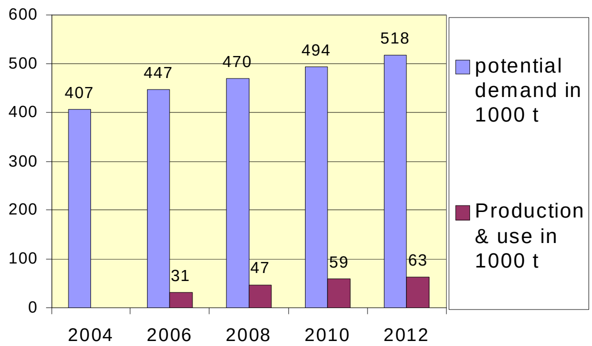

Fig. 3: Potential demand (t) and secure supply(t) of charcoal in tons for Ouagadougou, Burkina Faso, according to S. Coulibaly et al.

With regard to the capital Ouagadougou, I conclude from figures given by Coulibaly (2004), that for a yearly consumption of 530 kg of wood (fuel wood and raw material for charcoal) per head 62 % of the wood is used for charcoal making and 38 % for fuel wood. The same percentages apply to the surfaces needed to grow the raw material, namely wood. Surfaces needed to grow enough wood fuel for 839 800 inhabitants of Ouagadougou (numbers from 2002) amount to 1 432 867 ha.

The difference between the two columns in fig. 3 is in fact filled by “anarchic” felling of trees. Management of forests will drive wood prices up, and there is a danger that the market be split into a legal and an illegal sector, the latter being subject to increased corruption. Startled by the dwindling resources and the difference between potential demand and secure supply, the government proclaimed a temporary suspension of charcoal production in July 2005, to give time for new thought and reorganization.

A frequently held view is that the main cause of deforestation is land reclamation for agriculture, not felling trees for fuel. This is probably correct in a “slash and burn” system, but the argument becomes less relevant if the resulting wood is sold for fuel, as is increasingly the case. Without forest clearings for agriculture, the demand for fuel would be satisfied by felling trees elsewhere, with a different motive, but the same result. Whatever the motive of forest clearings, the resource base of wood production is eroded.

Another doubtful view regarding biomass is the belief that current trends could be reversed by the plantation of trees alone. According to the “Forestry Outlook Study for Africa” (FOSA, FAO 2004) tree plantations account for just over 4 % of forest surfaces in the world and play only a negligible role in Africa. Attempts at large-scale industrial-type reforestation in the Sahel proved to be a costly undertaking, and for this reason it was largely abandoned. Even many tree nurseries have closed down. Gonzalez (2001), in his study on “Desertification and a shift of forest species in the West African Sahel” concluded: “Ultimately, only natural regeneration can cover an extensive surface area, a condition necessary not only to map a comprehensive system of natural resource management, but also to engage positive climate effects”. Realizing that natural regeneration needs protection, the Swiss “newTree” organization launched a project in Burkina Faso aimed at fencing and surveillance of plots of land.

In Burkina Faso the population density is about 48 persons / km^2, assuming a population of 13.228 000 in 2005 (UNDESA 2006). An area comparable with regard to vegetation cover and population density in Senegal was studied by Gonzalez [2001]. He wrote: “The rural population of 45 people km^{-2} exceeded the 1993 carrying capacity, for firewood from shrubs, of 13 people km^{-2} (range 1 to 21 people km^{-2})”.

Food and wood fuel production both need surfaces. A map published by J. Henao and C. Baanante (2006) shows that in a large band of the Sahel comprising most of Burkina Faso the population exceeds the carrying capacity for food production. According to these authors, increases in cereal production in Africa have been obtained primarily through cultivation of additional surfaces, while in Asia increased production was the result mainly of intensification of agriculture. Agricultural exploitation of additional surfaces means forest clearings and deforestation. There is evidence of competing surface needs for food and wood fuel production. The resulting stress upon the environment could be eased by higher agricultural yields on the one hand, and substitution of wood fuel by other forms of energy, including solar cookers.

3.4 Fuel saving stoves:

Some advantage may be obtained by the use of fuel-saving cook stoves for wood or charcoal. However, their usefulness with regard to saving the resource base from depletion is limited in the face of growing population and urbanization, coupled with to a shift to charcoal. Fuel-saving stoves may also be used as back-up energy for solar cookers, but gas is preferable for this purpose, because it allows a quick swift to and fro, if weather conditions change during cooking.
However, the efficiency of fuel-saving cook stoves is not necessarily paralleled by a corresponding reduction of emissions and Indoor Air Pollution (IAP) compared to open fires. There are several hundred fuel-saving stove types, all with different emission characteristics. Therefore, Ballard-Tremeer and Jawurek (1996) state: "Clearly, efficiencies and emissions need to be determined before a stove design is disseminated". This precaution is usually disregarded.

3.5 Some fallacies of solar cooking promoters:

Small cooking appliances suited for individuals or mini-groups are useful in particular circumstances like refugee situations. But more potent alternatives should also be available. Eating together maintains family ties. Maintenance of these ties is essential in a society largely lacking social security services.The simultaneous use of several small appliances is not a substitute for a really efficient family cooker.

3.6 Obstacles to incorporation of solar cookers into development programmes**:**

Even if powerful family size cookers are used, there are limitations due to variation in cloudiness, dust in the air and so on. Sometimes, conditions for solar cooking may vary from hour to hour. Therefore, promoting a package of a solar and a gas cooking set may be a good idea to allow a quick swift to and fro. Up to now, gas is mainly used by urban households as an additional option alongside with charcoal or fuel wood. In Burkina Faso gas is subsidized by the government to relieve pressure on wood resources; smaller package units are higher subsidized than bigger ones. Subsidies place a heavy strain on the national budget; for this reason, it will not be possible to generalize cooking with gas. The combination of solar cooking with gas is therefore a useful option not only for individual households, but also for the national economy.

3.7 How can family size cookers be made affordable?

Solar cookers have made progress in recent years in Burkina Faso, but despite outside help by NGOs both Papillon and SK-14 cookers are still financially out of reach for most families. The current price of a Papillon cooker is 115 000 FCFA (in French: Franc de la Communauté Financière d'Afrique), that is about 175 Euro. The SK-14 costs 99 000 FCFA, about 151 Euro. About 45,3 % of the population live under the poverty line, which was established at 72 690 FCFA/head (about 111Euro). An average size family of 7,6 people would have an income of 552 500 FCFA; buying a Papillon cooker would eat up more than 20 % of the family income, while only reducing but not eliminating the need for a back-up cooking energy. It is clear that without price reductions (subsidies) it will not be possible to reach large-scale dissemination.

As we have seen, carbon stocks in African forests are declining. This means the difference is being emitted. Solar cookers can contribute to lessen this effect. In this respect, it is highly regrettable, that the Executive Bureau of the Clean Development Mechanism (CDM-EB) decided in its meeting in September 2005: "Combustion of any non-renewable biomass shall be accounted in the same way as combustion of fossil fuels. Emissions reductions due to the displacement of non-renewable biomass shall not be accounted".

Therefore at this moment, we (i.e. the NGO "Solar Energy for West Africa" and our partners in Burkina Faso) cannot go ahead with the validation and registration of our "Simplified Project Design Document for Small Scale Project Activities" (SSC-PDD) for solar cooker promotion in Burkina Faso. A replacement solution will have to be found.

Moreover, poverty reduction strategies papers (PRSP) should incorporate mechanisms to finance solar cookers, which are really investments or family assets – in contrast to commercial fuels, which are consumption items. Otherwise, eventual gains due to poverty reduction efforts may be drained away by price increases of commercial fuels.

4. CONCLUSION

The possibilities of dual land use (agro-forestry) are limited. There is a complex but largely antagonistic relationship between food and wood fuel production; both need soil surfaces. The stress of deforestation and shortened or abandoned fallow periods results in degradation of the land. Minvielle (1999) suspected an upcoming "energy famine" for the Sahel, and envisaged provocatively the need for the supply of energy for the same humanitarian reasons as food aid. Minvielle describes the inconsistencies of EU programs in the Sahel in the energy sector: one example is the promotion of gas to diminish traditional wood consumption, followed by the promotion of traditional wood energy to diminish the gas bill.

The promotion of simple low-price solar cookers may be seen as a form of immediate humanitarian aid as envisaged by Minvielle. But in order to obtain a bigger environmental impact, this form of aid has to be completed by programs promoting more potent solar thermal appliances suitable for large families, institutions and small-scale industrial applications.

There is a need for a holistic approach to development on the policy but also on the project level: protection of land to allow natural regeneration, reforestation and intensification of agriculture should go hand in hand with affordable energy supply, which of course must be aimed at reducing wood fuel consumption, but not necessarily fossil fuel consumption, which is very low.

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