Cooking with Renewable Energies – What Can African Households Afford?

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Summary :
Traditional biomass consumption has increased its share in total energy consumption in Africa, at the expense of fossil and renewable energies, and contrary to policy intentions of national and international bodies. The use of electric energy for cooking – either produced form fossil or renewable sources – is not an economically sound option under conditions of poverty. Solar cookers, for instance the Papillon (butterfly) use solar heat energy directly, without passing through electricity. Thus they tackle the problem of overexploitation of wood resources in a more direct way. Moreover, they are carbon-neutral and a means to reduce the emission of greenhouse gases.

Keywords: Household energy**,** solar cookers**,** Papillon, wood fuel, biomass, charcoal**,** electricity, gas, poverty reduction, climate protection, Chad, energy ladder, emissions, energy prices, modernization.

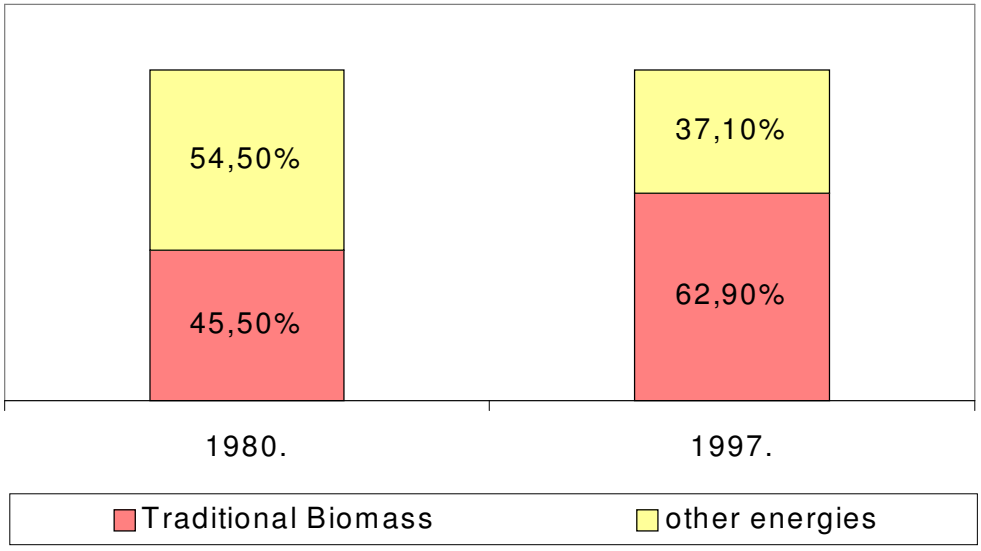
Introduction. Discussing the accessibility – in economic terms – of renewable energies for cooking purposes to households in Africa I should like to start with the following thesis:

1. Energy demand in Africa south of the Sahara is mainly covered by biomass in the form of wood. The biggest share of this demand is that of households for cooking needs.
2. Part of this demand is covered by non-sustainable production, especially around cities & towns.
3. The organizations dealing with energy, climate poverty reduction & development issues strongly recommend modernization of energy supplies in Africa: see the International Energy Agency [IEA 2002] and the German Consultative Council to the German Government "Global Environment" [WBGU 2003]; and that renewable energies should play an important role in this process
4. A part of the wood fuels consumed can be substituted by potent solar cookers, for instance Papillon cookers for families or Scheffler-type cookers for institutions. [Hafner et al., 2002].
5. In publications of the above named organizations there is no mention of solar cookers.

6. Traditional biomass consumption in Africa should be decreasing according to development programmes and rhetoric, but in reality it is on the increase as shown in diagram 1. The Food and Agriculture Organization of the UN FAO [2004 (a), p. 63] calls this „reverse substitution with wood fuel" and mentions price increases of commercial fuels like kerosene and gas as the underlying cause.

The purpose of this paper is to find out which forms of renewable energies could cover the demand of cooking energy in Africa.

Diagram 1: Share of traditional Biomassconsumption as share of total energy consumption in Africa South of the Sahara, according to UNDP 2001; p.235.



Energy losses when using wood fuels.

Consumption of woody biomass is connected with considerable loss of energy; in the case of a three-stone-fire often only 5-15 % of the energy are imparted to the content of the pot [Kammen 1995]. Energy-saving cook-stoves can increase the yield to 10-30 %. In the case of charcoal, the biggest losses occur during production. In Chad, the efficiency of charcoaling on a weight basis is 13 % [The World Bank 1998]. Because of the higher energy density of charcoal, this corresponds to an energy content of 26 % of the wood used for charcoal making. The biggest part of wood carbon is lost. This is important because consumption of charcoal is increasing rapidly due to the preference of city dwellers given to charcoal and the rapid pace of urbanization. Reasons are less indoor air pollution during cooking, easier handling and a more favourable relation of transported energy to transport energy (diesel).

Tab. 1: Fuel prices in the capital N'Djamena, Chad [according to Laura, 2001, modified]

Fuel	Unit	weight (kg)	Price per unit	Price per kg in FCFA and (Euro)
Fuel wood	loose	1,33	100	75* (0,11)
Charcoal	Sack	40	3000**	75** (0,11)
Charcoal	Plastic sack	1,10	100	91 (0,14)
Petroleum	loose	1,00	400	400 (0,06)
Gas***	bottle	6,00	4000	667 (1,02)

* in the areas of supply wood is much cheaper. In Sarh 1 kg wood costs only 20 FCFA (~ 0,03 Euro).
** today (June 2004) the sack charcoal is 6000 FCFA; the price per kg has thus gone up to 150 FCFA (0,22 Euro).
*** Gas prices are subsidized.

It is noteworthy that the price per kg for wood and charcoal is the same, despite the higher energy content of charcoal. This is due – at least in part – to the lower transport cost of charcoal compared to wood and explains increasing the popularity of charcoal.

Cooking with energy-saving stoves for wood, charcoal and dung:

World-wide there are hundreds of models of fuel-saving cook-stoves for wood or charcoal, mobile or transportable, made of ceramics, masonry or metal. It is difficult to generalize. Acceptance varies from country to country, and efficiency and emissions vary and should be established for every model.

Massing [2001] writes about his experience with fuel-saving stoves in Chad: „Cooking with fuel wood needs considerable experience and care. Wood or dung have to be completely dry. If the fuel is moist, there are heat losses due to evaporation and higher temperatures are not reached. The quantity of fuel added is critical. If the amount is not sufficient, the temperature in the stove decreases quickly. Cooking with dung produces inevitably much smoke, and for this reason, the place has to be carefully chosen. Otherwise *tolerant neighbours* are needed". But housewives and small children remain exposed to smoke, especially if the cooking is done in a separate, poorly ventilated building.

Massing explains, that at the end of training courses for craftsmen/women a part of ceramic stoves produced presented quality defects, they were either too thick or too thin, deformed or were not in line with the form intended by the trainer.

This implies a basic problem of fuel-saving stoves: the lack of standardization. Moreover, fuel efficiency does not parallel emission reduction. Studies on the amelioration of indoor air pollution by the use of stoves are rare; such an amelioration is difficult to imagine, as long as there is no evacuation of combustion products to the outside.. Fuel-saving cook-stoves thus remain within the logic of traditional biomass consumption with the accompanying health risks. A study published in the WHO Bulletin [N. Bruce, R. Perez-Padilla und R. Albalak 2000] estimates the number of additional deaths from Indoor Air Pollution (IAP) to be 2 million/year, mainly women and children under 5 years. Moreover 4 % of the global burden of disease are attributed to IAP. WHO has presented a new study on the subject in 2004 [Desai MA, Mehta S, Smith KR]. The Scientific Consultative Council to the German Government [WBGU 2003, p. 67] formulates "biomass stoves produce illness". If traditional biomass consumption could be replaced by a form of energy without emissions, much could be gained. On the other hand, it is improbable that we can do without fuel-saving stoves. But this option is not at all sufficient, due to the population increase and rapid urbanization.

Modernization of energy supply as a goal.

The declared objective of energy policy and development organizations like the International Energy Agency [IEA 2002] is to facilitate access to "modern" forms of energy in developing countries. This objective has not been attained in Africa up to now.

An energy form is considered as modern, if it is high up on the energy ladder; the latter is a symbolic representation of energy efficiency and cleanliness [Burning issues, update November 11, 2002]. Solar energy – using as photovoltaic and solar thermal appliances – is at the top, above electricity generated from fossil fuel. High is also gas. At the bottom end is the use of dung for fuel and traditional biomass consumption.

The Proposal of the German WBGU concerning supply of cooking energy in the form of gas:

The Scientific Consultative Council to the German Government [WBGU 2003] pleads for supply of bottled gas to households, first from fossil sources, but in the

medium run of gas obtained through anaerobic digestion or gasification of organic material. However, it is doubtful, whether such a programme can be realized on a large enough scale. First, in the dryer areas necessary conditions are not fulfilled: water for anaerobic digestion, animal husbandry in stables, sufficient vegetable biomass, installation for digestion, gasification and liquefaction under pressure, a marketing system and acceptability to the population, which seem to be reluctant to use gas for fear of explosions. It is not clear neither whether gas from biogenic sources can be provided at acceptable prices. Transport of gas bottles is also problematic. With little exaggeration we might say that gas is something for people who already have a car for transport.

The Regional Programme Gas (PRG) of the European Union for the Sahel countries, which had been launched in the framework of the "Inter-State Committee for the Fight against Desertification in the Sahel" (CILSS[1]), had only very moderate success. This is not a reason for optimism with regard to gas. Only the urban better-off segments of the population took advantage of this programme [Minvielle 1999]. In Burkina Faso [INSD 1998, p. 122 ff] no more than 9,7 % of the urban population use gas, in spite of subsidies, and nationwide only 2,7 %.

Comparison of prices of wood fuels and electricity from the grid.

From the viewpoint of modernization it is logical to request that electricity – especially from renewable sources – be made accessible to the population in developing countries. But for cooking, thermal energy is needed; therefore we have to ask ourselves, whether is makes sense to incur large expenses and energy losses to convert the radiant energy of the sun into electricity and then to heat, or whether this energy could not be used directly for cooking. This presupposes powerful solar cookers.

The solar cooker types used in the project promoted by GTZ in connection with the South African Department of Minerals and Energy (DME) in South Africa are not powerful enough for large families. The SK 14 cooker was even replaced by the weaker SK 12, [GTZ 2004]. The three other cooker types are even smaller. The most powerful of family size cookers, the Papillon, is not included. Despite high investment costs, sales are not satisfactory

[1] Comité Inter-État de Lutte Contre La Sécheresse au Sahel

The intention of GTZ was this: “Once and for all it had to be shown that solar stoves are not only a niche solution”. However the strategy chosen is not appropriate to attain this objective. The aim of marketing large numbers at a relatively low price must not overpower thermal output and quality considerations.

The Papillon like other solar cookers, but unlike photovoltaic panels, can be produced in countries of the south. Let us look at the subject of household energy from an economic point of view: One kg of wood with an energy content of 3,8 kWh (~ 13,68 MJ) [Samir Amous, without year] costs about 150 FCFA[2] (~ 0,22 Euro) in the Chadian capital N’Djamena. The price of the kWh wood energy is thus 39,5 FCFA (~ 0,06 Euro), see comment ** in table 1. One kWh electric energy however is 170 FCFA [The World Bank 1998, Annexe 2.3], corresponding to 0.26 Euro. In Germany the price of electricity from the grid was 018 Euro in 2003 [Stromtip 2003].

Let us assume a Chadian family wood decide to cook with electricity from the grid in N’Djamena and consider only the amount of energy consumed for this purpose, and let us further assume, that the specific energy consumption for cooking, frying and baking is the same as in Germany, namely 410 kW h for a 2-person-household and 590 kWh for household of 4 persons [Hertener Stadtwerke GmbH], on average 500 kWh/capita. Then 85280 FCFA (130 Euro corresponding to 159 USD) would be spent on cooking energy alone. But the „Gross National Income“ (GNI) of 210 USD per head [The World Bank Group 2002] is only 210 USD per head. The Scientific Advisory Council of the German Government *Global Environment* however urges, that no more than 10 % of the income of poor families should be needed to cover the basic energy needs [WBGU 2003].

The internationally used poverty line marks an income of 1 USD (~770 FCFA); using this standard, 80% of the Chadian population live below the line. The country has defined two further poverty lines, one food-related – which takes only the cost of a minimal caloric consumption[3] into account (173 FCFA/Tag , ~ 0,25 USD) – and on overall poverty line (218 FCFA/Tag, ~ 0,31 USD). With regard to both, more than 40 % of the Chadian population are living below those lines. If they used electricity for cooking, their income would be eaten up by the expense. Such a situation often leads to illegal grid connections. The International Energy Agency IEA [2002, S. 21] states: “Poverty drives people to steal electricity and boosts the number of unauthorised grid connections. The expected rise in urban population will exacerbate the problem.”

[2] F stands for «Franc and CFA for „Communauté Financière d’Afrique“. 1 Euro corresponds to 655 FCFA.
[3] The key used in the document is 2095 Kcal in towns and 2175 Kcal in the countryside

Additional costs of electricity due to the use of photovoltaic current

Electric current in Germany is partly produced from renewable sources, the additional cost of which are paid by all electricity consumers. If electricity is fed into the grid from renewable sources, the producer gets more money than if the current stemmed from conventional sources; this regulation is enforced by law. The exact amount depends on the installed power; with 55 Euro-Cent per kWh on average (against 18 Cent for current consumed). In Chad, where only 1-2 % 0f households are connected to the grid [The World Bank 1998], households which desire to have access to electricity, have mostly to use photovoltaic installations, which are expensive. High import duties and service costs complicate the matter.

A photovoltaic installation with a power capacity of 1 kW would need about 10 sqm of solar panels [Ingenieurbüro Jahrstorfer]. This would cost between 4700-5600 Euro per kW capacity. It should be clear that under these circumstances cooking with electricity in African countries is normally not feasible, even if price increases for fossil fuels may diminish the gap between prices for electricity from renewable and fossil sources.

The Papillon solar cooker

But there is the possibility of direct use of the radiant energy of the sun for cooking, without the detour through electricity, namely solar cookers [Hafner et. al. 2002]. It is difficult to understand why this possibility is hardly ever taken into account. A powerful cooker like the Papillon is much less expensive than a PV-installation. A cooker with the same – not electric, but thermal capacity as the above mentioned PV installation – costs 99000 FCFA in Burkina Faso, roughly 150 Euro. Let us remember that this amount corresponds to the yearly cost for electricity (for cooking only) in Chad. Moreover, electricity is a consumption item, while a solar cooker is an investment available for further use.

Solar cookers open up the chance to bring wood consumption down to sustainable levels, that is to restore the balance between consumption and new growth. Used during four hours, the Papillon would supply 4 kWh. Let us compare this with the wood fuel situation: An average Chadian family of 5,3 persons consumes 5,5 kg of wood as primary energy per day. This corresponds to 24,68 kWh, of which only one tenth – about 2,5 kWh are effectively taken up by the food to be cooked. The comparison shows that the Papillon covers the need for cooking energy of a family. Outside the cooking hours it can be used to Pasteurization (or boiling) of drinking water, warming water for bathing and small scale commercial activities. Four hours of use would mean 1460 kWh per year (275 kWh/head) and contribute considerably to

reaching the desired 500 kWh/head/year [WBGU 2003] until 2030. Combining a solar cooker with a PV-installation would allow to limit the outlay of the latter to the minimum needed for communication and lighting.

Experiences from Burkina Faso:

In Burkina Faso solar cookers became avialable since 1992/93. The experience gained concerns mainly the Bamako type at first, which is largely identical with the SK 14 reflector cooker of EG Solar, Altötting, Germany. Since 2001 the Papillon became available..

In Gaoua, in the South West of the country, a women's organization named APFG had been using and promoting fuel saving cook-stoves for ten years, but their potential was seen as not sufficient. From 1996 solar cookers were promoted with the help of German NGO's like Solar Global, SEWA, BSW Alternative Energie, EG Solar and individuals. In 2002, SEWA and APFG organized a project called "Supply of Household Energy for Cooking" with the financial backing of the German Ministry for Economic Cooperation and Development. In this context, Bamako type and Papillon cookers – 35 of each – were to be made available. Box cookers had been refused by women on an earlier occasion, because stirring of food is not possible. Distinctive climate policy objectives were not defined. The following observations were made:

- In a comparative cooking session in Gaoua the Papillon turned out to be quicker and more effective. Since then, clients in Gaoua only asked for the Papillon, despite its higher price.
- The producer had to shift to the exclusive supply of the Papillon, as far as Gaoua was concerned. Outside the Gaoua area, both cooker types continued to be sold.
- The price of the Papillon could be brought down from 115 000 FCFA (175 Euro) to 99000 FCFA (150 Euro) due to modifications in production. This increased demand. In 2002, about 100 cookers were sold, in 2004 even 200, this time without external assistance.
- With regard to marketing, small credits to members within the APFG as well as selling cookers to people outside the organization – against cash – was important.
- The average fuel expenses of families were reduced from 8500 FCFA to 3750 FCFA (44%) according to an enquiry in June 2003. It is, however, not possible to state what this means in terms of avoided emissions, as the relative share of wood and charcoal before substitution is not known.
- In the meantime, sales in the capital Ouagadougou exceed sales in Gaoua.

In April 2002 the APFG women's organization convened conference on solar cooking, lasting 3 days. The participants could view solar cooking and taste food so cooked. Events of this kind have taken place on several occasion in Gaoua, but this time was outstanding. Not only members of the APFG and other organizations were present, but also political decision makers and representatives of the media. The number of these official participants is 43; the number of people present at cooking demonstrations is far more important, but not precisely known. The local radio station emitted reports and interviews on the subject of solar cooking in five regional languages.

Experience in Burkina Faso shows, that lower prices – eventually using subsidies from climate protection schemes – can increase sales and use of solar cookers to a considerable extent. Interest has also been aroused in neighbouring countries, and the producer Acomes has received some orders from there.

Avoidance of emissions:

The amount of emissions avoided depends on the fuel used before substitution. If charcoal was used exclusively, the effect is much larger than if wood was consumed. A part of the gases emitted during production of charcoal concerns Methane with a high Global Warming Potential (56, calculated over a time horizon of 20 years) [4]. Most urban households in Burkina Faso as well as in Chad consume fuel wood and charcoal as well, the reduction factor of emissions when using the solar cooker must therefore be between 1 (in the case of wood) and four (in the case of charcoal), abstraction made from the frequency of use.. If the solar cooker is used in one cooking procedure out of two [Viala 1999, observed in Haiti], about 515 kg of carbon corresponding to 1889 kg of CO_2-equivalents can be avoided annually in Chad, if wood was used before, and about 1016 kg of carbon, corresponding to 3723 kg of CO_2-equivalents, if charcoal was substituted by the solar cooker. A detailed account of avoided emissions is given in my paper "Emission reductions and possible CO2-bonuses obtainable by the use of solar cookers in Chadian families". This compare very well with emission reductions obtained using photovoltaic cells in Germany, where an installation of 1kWp capacity leads to an avoidance of only 700 kg CO_2 [Mann Elektrotechnik 2004]. This is due to the fact that solar panels in Europe substitute in part electricity from Gas and nuclear power plants, which are less polluting in greenhouse gas terms.

These calculations show, that is not worthwhile to think of photovoltaic electricity for cooking in Africa; a Papillon cooker is much more useful in this respect. Larger dissemination

[4] Quelle: http://www.ghg.unfccc/int/gwp.html, abgerufen am 21.12.2004

of these cookers would limit the overuse of scarce wood resources, restore the quality of sustainable energy supply to wood and preserve trees as a carbon sink.

The official policy of promotion of renewable energies in development cooperation however is different, as could be seen in the Bonn conference on "Renewables". In a brochure on this occasion we read: „The central challenge is to deliver modern energy to the energy-poor. This means not only to supply electricity as far as possible, but also that it should come from renewable sources. For such an energy system the consumers should not pay more than 10 % of their household income, according to the opinion of the WBGU." [Köpke, Kneissl and Kerkow 2004]. Such a statement is unrealistic and contradictory, as long as solar cookers – as happens in this brochure – are systematically undervalued. Pictures showing the difficulty of fuel wood fetching in barren landscape – used to make publicity for photovoltaic electricity – are misleading the reader.

We can only speculate about the reasons for excluding solar cookers from the discussion of renewable energies. But the impressions is, that solutions which seem interesting to countries of the industrialized north, are transferred without much thought to the countries of the south, which are still dependent on biomass. Electricity however, cannot replace biomass[5] [IEA 2002]. Solar cookers on the other hand, could replace at least a part of biomass, the unsustainable overexploitation of wood resources.

A fresh look at household energy.

Slowly a more realistic view becomes apparent. In a Internet publication by Germanwatch [Denkhaus 2004] we read: The use of renewable energies in the countries of the south does not yet substitute fossil fuels, but is geared at satisfying the demand for new energy services. There is not yet an appreciable contribution to climate protection. But in future, in as far as otherwise energy supply would have to rely on a fossil basis, renewable energies will contribute to climate protection". The author Denkhaus mentions solar cookers, but despite this he thinks more of renewable energies with electricity as the final form. He does not realize that powerful solar cookers can contribute to climate protection now, and he is obliged to put climate protection back into a most uncertain future, a sort of climate-political "thereafter", which depends moreover on the removal of poverty, which in itself is most uncertain. A development programme of this kind is exposed to the danger that any gains in the fight against poverty might be sucked up [Krämer 2003] by increasing prices of electric

[5] „There is a widespread misconception that electricity substitutes for biomass. Poor families use electricity selectively – mostly for lighting and communication devices. They often continue to cook with wood or dung, or with fossil-based fuels like LPG or kerosene".

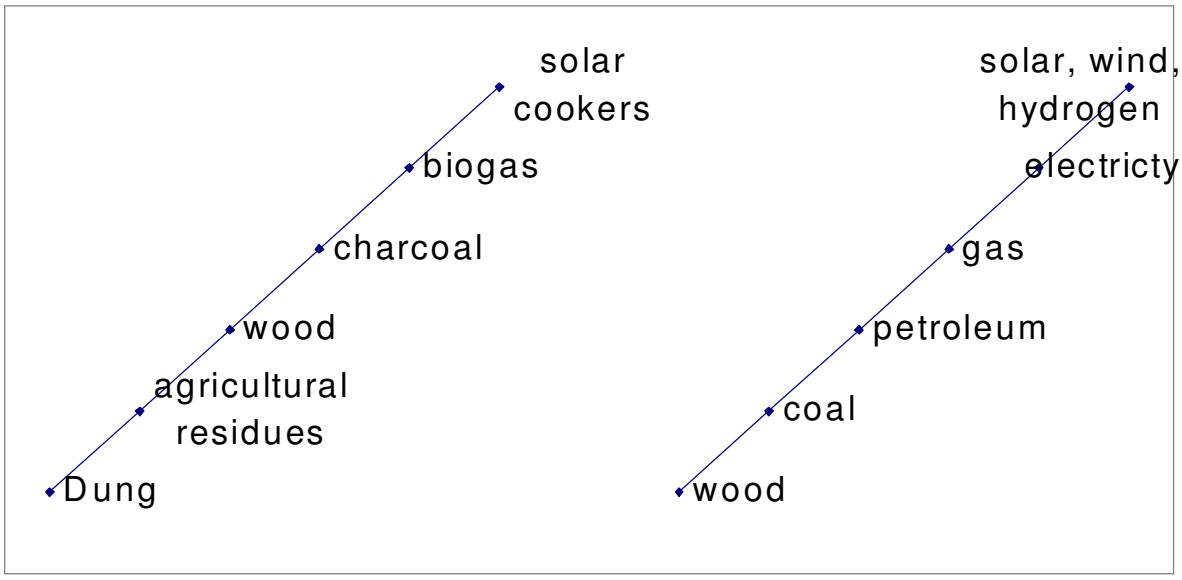
energy. Solar cookers, on the other hand, contribute to reducing poverty, in as far as they reduce the vulnerability of families vis-à-vis price increases of commercial forms of energy.

Denkhaus continues: "A significant ecological problem in certain areas is deforestation. This is even more pressing, if charcoal is used instead of wood. Deforestation not only has negative social and ecological consequences, but is also harmful to climate". It is a pity that Denkhaus does not deduce from these facts that solar cooking should be promoted, but, nevertheless he mentions the Papillon.

Two sub-systems.

Apparently it is difficult for scientific and political institutions and even many NGO's, to conceive the de-centrally usable solar cooker technique as „modern". If one thinks of photovoltaic current, hydrogen technique and fuel cells, this reserve is understandable. But we have to acknowledge, that the potential for mutual substitution of energy forms is limited in practice. Perhaps, we should conceive the energy system not as a uniform bloc, but rather as composed of parallel sub-systems with differing demand structures and criteria of what can be regarded as "modern". This idea may be presented in form of two energy ladders. If this concept were accepted, the protagonists of "modern energies" – in the conventional sense – might perhaps recognize the modernity of solar cookers.

Diagram 2: the household energy ladder and the political economy energy ladder



The Kenyan scientist Stephen Karekezi [1992] writes: „Electricity meets the needs of industry. There are very few opportunities for substitution in either the main demand or the

principal supply sectors. In most cases, linkages between these supply and consumption sub-sectors are limited which constrains opportunities for substitution". Karekezi quotes from a document of the "Energy Sector Review Management Assistance Programme" [ESMAP 1992] of the World Bank about Burundi: „ ... there are very strong associations between specific sources of energy and specific categories of energy demand in Burundi's economy, and weak links among the sources or among the users … While a limited amount of inter-fuel substitution is possible, energy issues in Burundi must really be treated in parallel sub-sectors rather than as an integrated whole".

Energy supply and wood resources:

Let us examine the question how the cooking energy demand in Africa can be satisfied from the quantitative point of view.

Diagram 3: Projected biomass consumption in Africa (IEA 2000, 44), in million tons oil equivalent (Mtoe)

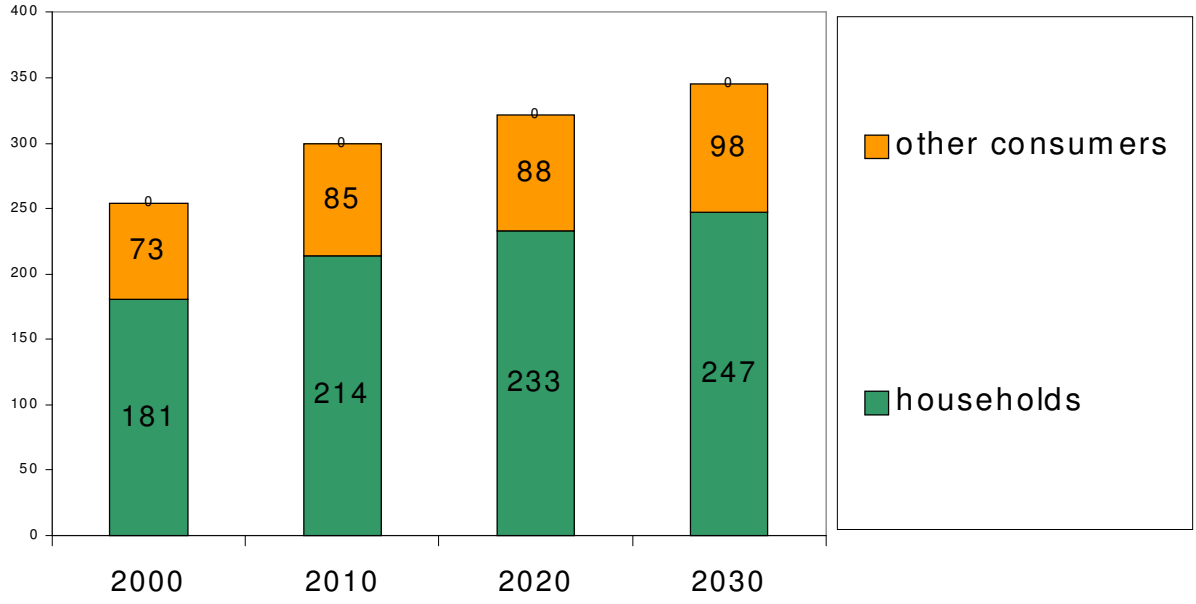


Diagram 3 shows that households play the major part in wood fuel consumption. This statement is further stressed by a FAO document [2004 b, p.8], according to which 91 % of African wood production in 2000 was used as fuel. It is not important, whether the felling of trees was primarily motivated by land needs for agriculture, or to obtain fuel wood. The study states: „Although demand and supply are balanced in the aggregate, there are areas of acute deficit, resulting in extraction far above sustainable supply levels. This is particularly the case close to urban centres". This means, that wood cannot always be regarded as a renewable

energy source. Renewability must not be presumed, but should be proven for a given country or area. Otherwise the concept of renewability makes no sense.

Table 2 shows the prevision of wood fuel needs for greater African regions. In practice, it will be necessary to go into further detail according to countries and other geographically defined units.

Sub-region	year 2000 (in Million m^3)	year 2010 (in Million m^3)	year 2020 (in Million m^3)	increment between 2000 and 2020
North Africa	60,08	67,29	72,22	12,14 (~ 20, %)
East Africa	199,21	233,73	268,87	69,66 (~ 35 %)
Southern Africa	84,32	99,05	115,79	31,47 (~ 37 %)
Central Africa	116,42	137,16	157,83	40,58 (~ 35 %)
West Afrika	175,09	204,29	235,49	59,10 (~ 38 %)
Total	635,12	741,52	850,19	215,07 (~ 34 %)

Tabelle 2: Estimated consumption of wood fuel consumption in Africa, according to FAO (b) 2004, based on Broadhead 2001. The original is an internal document of FAO and was not available**.** Column 5 was calculated by P..Krämer.

Pressure on forests and wood resources has led to considerable losses in forested areas. Table 3 accounts for these losses between 1990 an 2000. It is improbable, that increases of fuel wood consumption of 30-40 % in 20 years – as reported in table 2 – can be compensated by forest management, if we take the losses that have already occurred into account.

Forest surfaces changes per region:

Sub-region Jahr	1990 in Mill. ha.	2000 in Mill. Ha.	Annual change in %
North Africa	77,5	68,1	- 0,94
East Africa	90,8	85,6	- 0,51
Southern Africa	199,4	183,1	- 1,62
Central Africa	250,1	240,7	- 0,93
West Africa	84,7	72,2	- 1,26
Total	702,5	649,9	- 0,80

Tabelle 3, Forest surface changes in Africa, according to FAO (b) 2004, based on Broadhead et al. 2001.

A recent FAO report on African forests gives a prognosis for the next 20 years [FAO b, S. xii]: "The overall impact of such a situation on forests and forestry in the next two decades will be as follows:

- continued loss of forest cover, at roughly the current rates;
- negligible efforts to apply sustainable forest management;
- increasing demand for wood fuel, which in the context of high urban consumption would deplete forest and woodland resources in the vicinity of urban centres;
- a decline in the state of the environment" …

The losses of forest cover in Africa during the decade 1990 t0 2000 were 5.1 % in East Africa, 16.2 % in Southern Africa, and on the continental average 8 %. At least these losses and the resulting wood fuel scarcity have to be made good through substitution with other energies to arrive at sustainable wood energy supply and climate protection. If the fuel deficit in an area is not known, 10 % ob wood consumption may be used instead as a basis for planning for the next 10 years. As the solar cookers will be available in full numbers only at the end of a possible large-scale project, it is advisable to aim at a higher rate a higher rate of substitution, to account for the increase of consumption which can be expected in the meantime.

What happens, if the problem is not resolved?

The handbook of household energy [République du Tchad, Projet d'Énergie Domestique, 2001] says: „The situation carries considerable political and social risks. If the destruction of natural resources is not controlled, the problems of extreme poverty, insufficient nutrition and ill health cannot be attenuated and may even worsen. This will probably lead to a big migration movement, social upset and political instability … We have to understand, that the long lasting overuse of natural resources leads inevitably to the destruction of the resource basis and its regenerative capacity". However the handbook continues to rely only on wood resources. But conditions are bad, as "there are practically no Projects with the aim to ameliorate forest management". Fuel saving cook stoves are rare. (4 % of households use them).

How shall we go on?

The necessary substitution of wood could be realized in principle by gas or oil. In part, this shift is already underway, as in some areas of the oil-rich country Sudan [FAO 2004 (b), p. 41]. In other parts of Sudan – for instance in the war-ridden province of Darfur, the situation

is different. It is probable, that the catastrophic ecological situation in Darfur is a factor in the conflict in Darfur.

Referring to alternatives to wood fuel, the FAO [2004 (b), p. 41] writes : „The extent to which alternative energy sources replace wood fuel will largely depend on purchasing power and whether other commercial fuels are easily available.“ However, shifting to gas would mean an inversion of current trends in most countries, which is improbable, the more so as poverty is not decreasing, but increasing. The FAO [2004 (b), p. 41] warns: „In many countries, efforts to privatize commercial energy have increased costs, often resulting in reverse switching to wood fuel. This has particularly been the case in some urban areas, indirectly resulting in resource depletion".

In this situation solar cookers, especially in the form of the Papillon, are a promising option, the more so, as they are not harmful to climate. The danger of a massive return to wood fuels due to price increases is lessened, even if the economic situation of families deteriorates. Solar cookers contribute to survival chances and poverty reduction, provided the cooker type is powerful enough for a family with several members, and not only for singles or mini-families. Admittedly, Papillon cookers are expensive, but by far not so much as the use of electricity or gas for cooking. According to experience gained in Burkina Faso the price can be brought down by shifting from craftsmanship to small-scale industrial production. Moreover, climate protection funds may be mobilized to allow large-scale dissemination.
If the "household energy ladder" is accepted as a useful concept and as different from the "political economy energy ladder", and if promotional activities have more chances of being financed, we may hope that the trend depicted in diagram 1 is stopped or even reversed. Otherwise the share of traditional biomass will further increase according to projections of the IEA (remember diagram 3). The highest level of modernization attainable by African households would remain the use of charcoal, despite the negative impact on wood resources and climate. It is not possible – or at least not wise – to renounce to the contribution of solar cookers. This answers the question posed at the beginning, which forms of energy can cope with the demand of energy for cooking in Africa. The use of solar cookers is a prerequisite to the sustainable use of wood fuel.

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Résumé:

Contrairement aux intentions de L'Agence Internationale de l'Énergie la consommation traditionnelle de biomasse a augmenté sa part dans la consommation d'énergie en Afrique Noire; au dépens de la somme des énergies fossiles et renouvelables. L'utilisation de l'énergie électrique – produite à partir de sources fossiles et surtout renouvelables – pour la cuisson des aliments n'est pas une option économiquement réalisable dans des conditions de pauvreté. Les cuiseurs solaires comme le Papillon utilisent le rayonnement solaire de manière directe, sans

passer par l'électricité. Il s'attaquent au problème de la surexploitation des ressources ligneuses d'une manière plus directe.