Oil, Wood Fuel and the Sun – What are the Household Energy Options of Chad?

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Abstract: Oil in Chad is not used to cover national household energy demand, even if current production exceeds this demand by several thousand. Households cannot compete with prices paid on the world energy market and are driven to overexploit wood resources. Renewable energies leading to electricity cannot replace biomass for cooking purposes, but solar cookers – especially of the Papillon type – open a way out of this dilemma and have attractive climate policy advantages. Carbon compensation funds may be used to facilitate the transition.

Keywords: Oil, wood fuel, charcoal, household energy, renewable energy, poverty, Poverty Reduction Strategy, poverty line, sustainability, energy ladder, forest cover, Carbon offset funds, solar cookers, Chad.

Oil for export: In july 2003 oil began being pumped through the pipeline from the Doba basin in Chad to the oil terminal Kribi in Cameroon. The oil fields of this basin in Chad (Bolobo, Kome and Miandoum) yield about 225 000 barrels[1] per day, 82 125 000 barrels per year. The oil reserves of the Doba basin are estimated at 900 million Barrel. Additional oil fields are being explored. Their production is bound for export. In the smaller Sedigi oil field, which is going to supply the national market, Production has not yet started (July 2004).

However, energy supply to the Chadian population is not based on oil or gas, but on wood fuel (wood & charcoal) in the first place, as may be seen from table 1. This situation still prevails.

Table 1: Energy consumption in Chad in 1995 in thousand tons oil equivalent (ktoe), according to SAR/HEP, World Bank 1998, shortened.

Fuel wood	Agricultural residues	charcoal*	petroleum products*	electricity*	Total
843	12	57	72	8	992

* as final energy

Thus internal energy consumption in Chad amounted to 992 ktoe in 1995. If we consider the transformation losses during production of charcoal, petroleum products and electricity, the

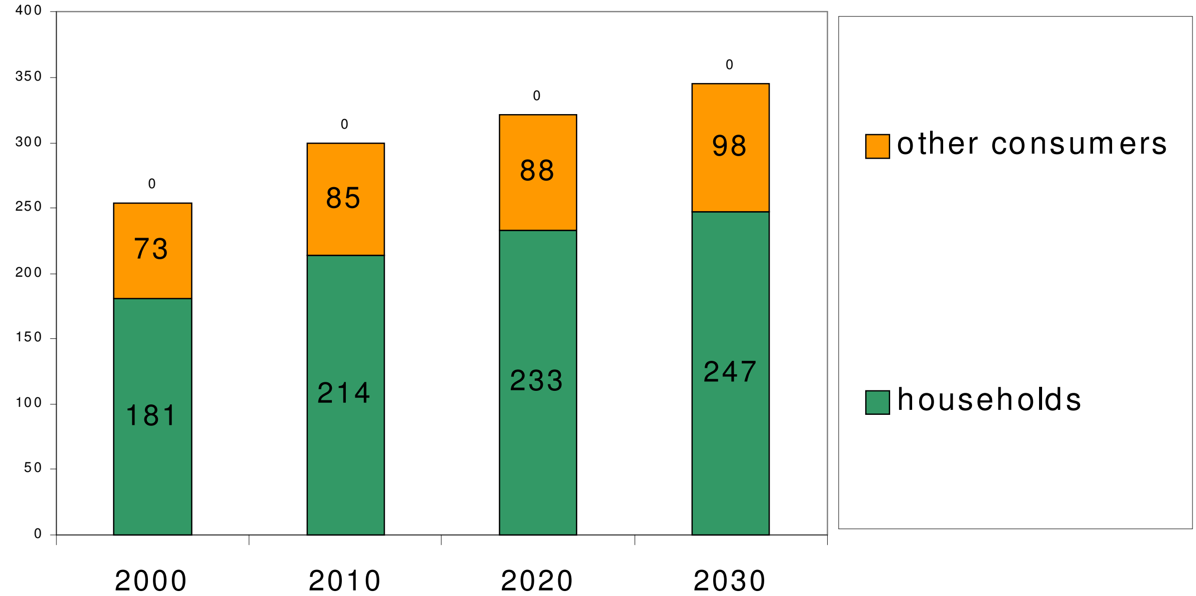
[1] a barrel corresponds to 159 litres

consumption of primary energy in Chad in 1995 must have been something near 1350 ktoe. This corresponds to 8491 barrels of oil. Oil production in the Doba basin thus exceeds national primary energy consumption of Chad in 1995 by a factor of 9672.

Gas (LPG[2]) plays a very limited role up to now, despite subsidies. It is being imported from Cameroon, but there are plans not the flare the gas from Sedigi, but to produce LPG instead [World Bank Group 2004].

Wood energy: The major part of energy consumption occurs in households; they use mainly wood and charcoal and, in a broader sense, biomass. The household energy demand is covered to 97 % by wood and charcoal (FAO 2004 c, 2). According to the International Energy Agency [IAEA 2002, 44] biomass consumption will increase – at least in absolute numbers – as can be seen in the following diagram.

Diagram 1: Projected biomass consumption in Africa (IEA 2000, 44), in million tons oil equivalent (Mtoe)



The country report “Chad” of the „Forest Outlook Study for Africa“ [FAO 2004 c, 2] mentions a yearly loss of 0.6 % out of 23 million ha of wood surfaces. For 2020 a minus of 8.85 % – compared to the present situation – is anticipated.

Energy supply and poverty. According to the Central Intelligence Agency CIA [The World Factbook – Chad] 80 % of the Chadian population live below the poverty line of one US $ (about 700 FCFA[3]). As this internationally accepted poverty line is not very useful in the

[2] Liquid petroleum gas

[3] F stands for Franc and CFA for Communauté Financière d’Afrique

Chadian context, two additional poverty lines have been defined in Chad, one food-related – based on minimal energy needs – (194 FCFA, ~ 0,39 US $) and one overall poverty line (253 FCFA, (~ 0,51 US $).

Table 2: Percentage of population living under the food-related and the overall poverty line 1995-96, [according to Rep. of Chad, Poverty Reduction Strategy Paper 2003]

	rural	N'Djamena	other towns	total
Food-related poverty in %	46,2	33,8	38,0	41,6
Overall poverty in %	48,6	35,0	39,3	43,4

It is clear that the population can seldom afford to buy commercial fuel. Prices are determined by the world market. Government and World Bank want to use a part of the proceeds from the oil project to fight poverty; but energy supply for cooking purposes is going to depend on the already overexploited wood resources, if ecologically and economically sound alternatives are not considered.

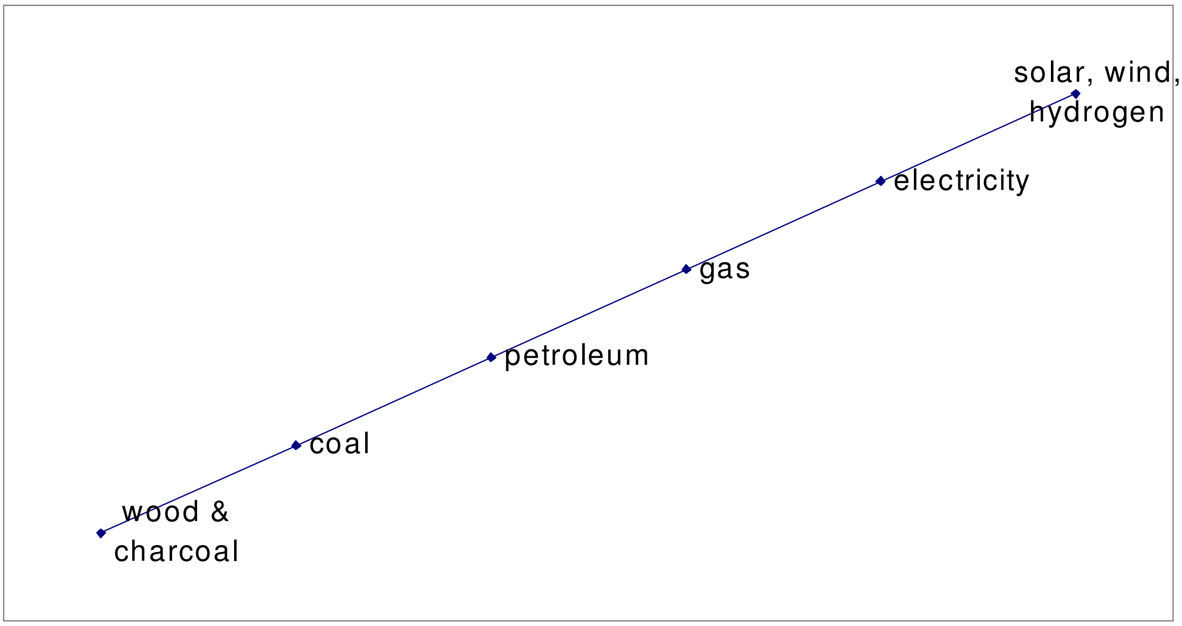
Thee American Energy Information Administration [EIA, 2003] states in its "Chad and Cameroon Country Analysis Brief": "In June 1998, the World Bank approved a $ 5.3 million loan for the establishment of a Household Energy Project . The project is designed to provide affordable and sustainable supply of energy to Chadian households. Wood is the primary source of total energy in Chad, and the project hopes to establish a sustainable wood fuel and charcoal supply in nearly 100 villages located near N'Djamena".

The transition from wood to charcoal: An British study [I.S. LTD] on the supply with wood fuel of the capital N'Djamena considers a supply zone of 125 km radius and concludes that a sustainable supply is possible, on the condition, that a massive shift from wood to charcoal does not happen. However, this shift is already under way. Moreover, the drainage area of wood and charcoal is larger than that supposed in the study. Wood is shipped from as far away as Sarh during part of the year, about 600 km up the Chari river. Charcoal causes less smoke than wood, and has about double the energy density compared to wood. For transport over large distances charcoal is preferred.

The Concept of the energy ladder: Expert bodies in energy policy like the International Energy Agency [IEA 2002] and the Scientific Advisory Panel to the German Government "Global Environment" [WBGU 2003] demand to replace "traditional biomass consumption" by modern forms of energy, mainly for health reasons. A study published in the Bulletin of the WHO [N. Bruce, R. Perez-Padilla und R. Albalak 2000] estimates the number of additional deaths due to indoor air pollution (IAP) at 2 million per year, mainly among women and children under five. Four percent of the global burden of disease are attributed to IAP. That is why the WBGU [2003, p. 67] says “biomass stoves cause illness”.

Modern forms of energy are those high up on the energy ladder. The latter is a symbolic representation of the efficiency and cleanliness of forms of energy [Burnings issues].

Diagram 2: The Energy Ladder



But for the majority of the Chadian population, charcoal is the only option with regard to modernization, and this option is unsustainable, because is wastes enormous amounts of wood. The traditional way of charcoaling leads to 13 kg of charcoal per 100 kg of wood [World Bank HEP/SAR 1998]. It is improbable that improved kilns, fuel saving cook-stoves – which are used by 4 % of the population only – and forest management can prevent further forest losses, if we take the growth in demand due population increase and urbanization into account. The massive internal southward migration and the current influx of refugees from Darfur (Sudan) contribute to further destabilization of an already disturbed ecological balance. Fuelwood originates to 99 % from natural forests. Up to the year 2000, only 31000 ha were managed. Reforestation is insufficient; in 1999 only 300 ha were planted. The FAO [Forestry Outlook Study for Africa, FAO c, 17] warns that with this rhythm of reforestation wood supply to the population may not be ensured in future. Pressure on forests and wood resources has led to considerable losses of wood surfaces, not only in Chad. The FAO [b, S.

xii] study states (shortened): 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, particularly exacerbation of the water crisis because of the deterioration of watersheds, with other negative effects such as declining quantity and quality of water supplies and increased siltation of reservoirs and other irrigation facilities …”

Subregion / year	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
Africa total	702,5	649,9	- 0,80

Table 3, Changes in wood surface cover, according to FAO [2004, b].

Planning has to be based on longer periods than one year. If we consider a ten-year period instead, the loss is 9.3 % for Central Africa and 8 % for the continent as a whole. The amount of wood fuel corresponding to these forest surface losses has to be substituted with other forms of energy in the ten coming years, just to maintain the current state of the environment; but if we want to gain ground by upgrading and increasing forest surfaces while maintaining a sustainable wood fuel supply and climate protection, substitution will have to go further.

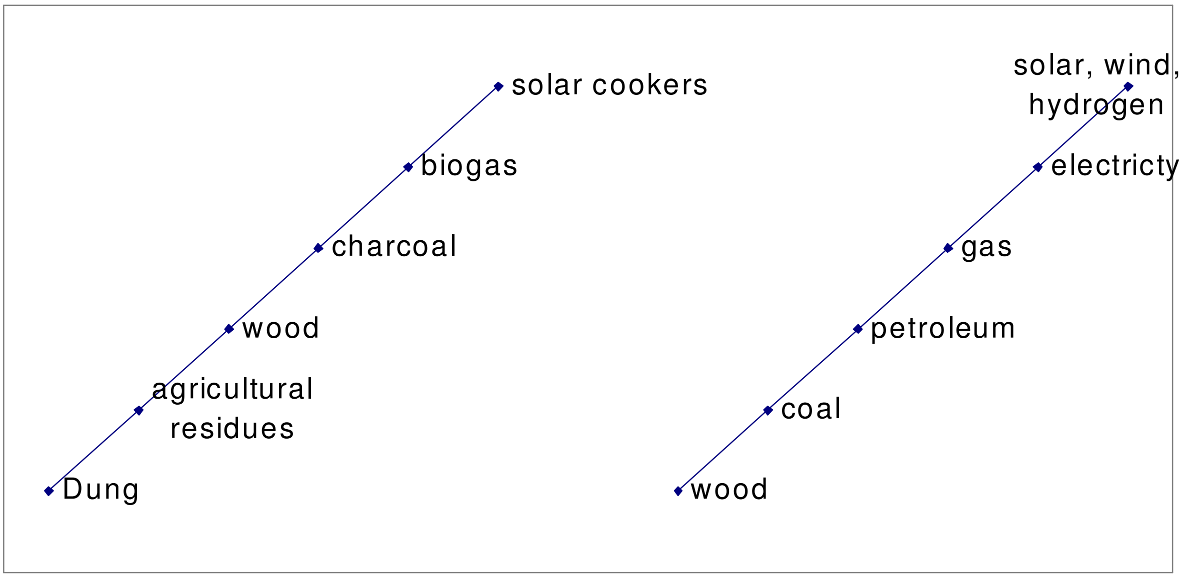
Renewable energies may open up a way out of this dilemma. But we have to realize, that possibilities of inter-fuel substitution are often limited for economic reasons. According to the IEA[4] electricity cannot replace biomass. But most “renewables” lead to electricity as the final form of energy. Therefore we have to elucidate, which forms of renewable or alternative energies can satisfy the demand for cooking energy.

The “energy ladder” in the conventional presentation gives no hint in this respect. If we consider household energies in Africa as a subsystem of the overall energy supply and demand

[4] „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”.

system, the issue becomes clearer. In diagram 2 the graph on the left side shows the modernizing options of households.

Diagram 3: the household energy ladder and the political economy energy ladder



The Kenyan energy expert 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 [1992] quotes a document of the "Energy Sector Review Management Assistance Programme" (ESMAP) of the World Bank on 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". This statement can be generalized to the whole of Africa south of the Sahara.

Electricity for cooking? In Germany, where much of the cooking is done on electric stoves, we have to count with a specific consumption for cooking, frying and baking of 500 kWh/person/year [Hertener Stadtwerke GmbH]. In Germany the price of one kWh varies according to region, supplier and conditions, from 0.16 to 0.18 Euro [Stromtip 2003]. In the Chadian capital N'Djamena however the price of one kWh is 170 FCFA [The World Bank 1998, Annexe 2.3], corresponding to 0.26 Euro. If electricity were used for cooking, the entire per capita income of the population living under the above mentioned poverty lines would be sucked up. Similar situations lead to unlawful connections. The International Energy Agency [IEA 2002, 21] writes in this context: “Poverty drives people to steal electricity and boosts the number of unauthorised grid connections. The expected rise in urban population will exacerbate the problem”.

Electricity from the grid is expensive; it will become still more expensive if it is produced de-centrally from renewable energy sources, particularly photovoltaïcs. A photovoltaic installation of 1 kWp power output would cost (in Germany) 4700-5600 Euro and need approximately 10 m^2 panel surface area [Ingenieurbüro Jahrstorfer]. In Germany electricity from the sun is subsidized and the burden is shared by consumers; there is nothing like that in Chad. Furthermore, cooking needs thermal energy, there is no reason why thermal solar energy should be transformed into electricity and then back into heat. That would be a wasteful detour.

Economic and clima aspects of solar cooking: Nowadays we have potent solar cookers like for instance the Papillon for family use or the Scheffler cooker for institutions [Hafner, Heinzen, Krämer 2002]. A Papillon with the same power – not electric, but thermal – as the above mentioned 1 kWp PV-installation costs about 150 Euro in Burkina Faso. In Chad the price would be higher in the beginning – up to 175 Euro, until production shifts from handicraft to small scale industrial manufacture. Contrary to solar panels, the Papillon and other solar cookers can be produced in the country where they are going to be used, and thus create jobs there. Only the Aluminium reflectors have still to be imported.

Cooking wit the Papillon. Using the Papillon cooker allows yearly carbon dioxide (CO_2) output reductions of 4-5 tons per cooker and per family (the average family size is 5.3 persons), if we assume, that the cooker is used in every second cooking procedure [Krämer, unpublished][5]. The calculation is based on equal amounts of energy from wood and charcoal being substituted by solar cooking.

A PV-installation in Germany with an average output of 1000 kWh – this presupposes a capacity of about 1,1 kWp – the CO_2-reduction is much less, namely 700 kg [Mann Elektrotechnik 2004]. This is due to the fact that the resulting power generation from PV

[5] The base of the calculation is: energy content of 1 kg of wood 4,3 kWh; energy content of 1 kg of charcoal 8.5 kWh; carbon content of wood 50%; equal amounts of energy in form of wood and charcoal are used; wood fuel consumption/day/person 1.04 kg (primary energy); family size 5,3 persons, 1 Papillon per family.

partly replaces electricity produced in gas and nuclear power stations, which are already less dirty than coal or wood..

If climate protection funds can be obtained, Papillon cookers can be sold at much cheaper prices and thus contribute to large-scale dissemination. The idea is to lower the price to 40-50 Euro. If the technique works, acceptance is hindered not so much by cultural barriers, as is often assumed, but by the lack of accessibility in terms of money. Africans have no objection to radios, motorcycles, cars, guns, sewing machines and so on – why should they object to solar cookers? But solar cookers need a back-up energy for days when the sun is not shining. This back-up energy is most probably wood & charcoal. On the other hand, solar cookers help to bring wood consumption down to sustainable levels, and to restore full renewability to wood fuels. They contribute to protection of trees and forest stands and to maintain them as CO_2-sinks. The objectives of the Conferences of the United Nations Convention to Fight Desertification and the Biodiversity Convention are also served by the use of solar cookers.

Training courses in Chad. In march 2004, training courses for craftsmen (and women) for the construction of Papillon cookers were organized in two locations in Chad (Benoye and Sarh) in collaboration with several German NGO's and their Chadian partners. Public demonstrations of solar cooking, which met with great interest, were part of the final ceremonies.

Solar cooking and the fight against poverty: There is a real danger that eventual positive results of poverty reduction efforts are nullified by increasing energy prices, if people are dependent on commercial forms of energy. Solar cookers, however, are not a consumption item like gas or charcoal, but rather an asset, an investment. According to a Word Bank study [Fofack, Monga und Tuluy 2001] in Burkina Faso, the possession of assets is inversely related to the degree of poverty. The use of solar cookers diminishes vulnerability of families vis-à-vis fuel price increases. A Papillon cooker with a capacity of 1 kW, used during four hours, can deliver 4 kWh/day, and 1460 kWh/year. As the average statistical size of a Chadian family is 5.3 persons [Rep. Du Tchad 1999, 9], 275 kWh would thus be made available per person. In this way, the biggest part of the 500 kWh/person considered as the minimal requirement for a decent life by the Scientific Advisory Panel to the German Government "Global Environment" [WBGU 2003, 27] would be covered.

The idea – widespread between development experts and politicians – that the “Renewables” (without details) can solve the energy and climate problems in Africa, while solar cookers do nothing more than occupy an insignificant niche, is outdated since very potent cooker types are now available. This idea is a misconception with potentially disastrous consequences, because the necessary modernization of the household energy subsystem is stopped on the level of charcoal, leaving overexploitation of wood resources, deforestation and desertification unimpeded. Thus, contrary to the modernization rhetoric, the share of “traditional biomass consumption” in total energy consumption in Africa south of the Sahara has increased between 1980 and 1997 from 45.55 to 62.9 % [UNDP 2001, chapter 18], which means that the share of “modern” forms of energy has decreased. This is probably due not only to poverty of African countries, but also to the bias towards electricity[6] – either from fossil or regenerative sources – in official development aid organizations.

The instable situation in Chad needs not only political and economic, but also ecological and social prevention measures. Solar cookers can contribute significantly to success. Leaving their potential untapped is a dangerous negligence.

What will happen, if the problem remains unsolved? The manual of the Household Energy Project [République du Tchad, Projet d’Énergie Domestique, 2001] states: “The situation carries considerable social and political risks. If the destruction of natural resources continues uncontrolled, problems of extreme poverty, malnutrition and ill health cannot be diminished and may even deteriorate. This will probably lead to big migration movements, social uproar and political instability …We have to understand, that the long-lasting overuse of natural resources necessarily leads to the destruction of the resource basis and its regenerative capacity.

However, the manual deals only with wood fuel production and management on the supply side and fuel-saving cook-stoves on the demand side. It deplores the practical inexistence of forest management projects and the

[6] The call for electrification has apparently political and ideological connotations just as in Lenin’s famous formula: Soviet power + electricity = communism.

poor dissemination of improved stoves – only 4 % of households use them, but, nevertheless, it is stated that the process has to continue and that the manual cannot be considered as definitive.

Due to population increase and urbanization it seems t be improbable that the problem can be solved without the contribution of new energy technologies.

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Zusammenfassung: Die großen Ölvorräte des Tschad werden bisher nicht zur Bedarfsdeckung der Haushalte herangezogen, obwohl die Förderung den Eigenbedarf im Land um ein Vieltausendfaches übersteigt. Das Öl geht in den Export; die Haushalte können aus Gründen der Armut mit den auf dem Weltmarkt gezahlten Preisen nicht konkurrieren und sind überwiegend auf Holz und Holzkohle angewiesen, die bisher billigsten Brennstoffe. Darum werden die Wälder über den Neuzuwachs hinaus in Anspruch genommen. In diese Zusammenhang wird die Rolle erneuerbarer Energien diskutiert. Elektrizität – auch solche aus alternativen Quellen – kann aber Holz nicht ersetzen. Solarkocher – insbesondere in Form des Papillon – bieten einen Ausweg aus diesem Dilemma. Freiwillige Klimaschutzmittel können diese Option wesentlich erleichtern. Die ökologischen, sozialen und politischen Konsequenzen des "Weitermachens wie bisher" werden angesprochen.

Résumé: La production annuelle de pétrole et gaz au Tchad dépasse la demande d'énergie des ménages du pays par plusieurs milliers. Elle va vers l'export; les prix sont ceux du marché mondial, que la population ne peut pas payer. Le bois de chauffe et le charbon sont les seules formes d'énergie accessibles à la majorité des ménages. Ceci conduit à une surexploitation des ressources ligneuses. Les énergie renouvelables (ou soutenables) qui conduisent à l'électricité ne peuvent pas remplacer la biomasse pour la cuisson des aliments. Les réchauds solaires permettent de sortir de ce dilemme. Les fonds de compensation du dioxyde de carbone pourraient être utilisés pour diminuer les prix et arriver à une large diffusion des réchauds solaires.