

Partners for Africa

Successful Trends of Fuel Switching in Sudan

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Abstract:

The high dependence on biomass fuels for household energy in Sudan, not only contributes to environmental degradation and desertification, but equally causes serious health problems to women and children below five years.

ITDG-Sudan initiated the first work of its kind in Sudan, by monitoring household indoor air pollution levels during 24 hours, using participatory research methods. A sample of thirty voluntary poor households from a semi-urban residential area (Wau Nour, Kassala) participated in the research. Firewood, purchased from the market, was the dominant cooking fuel, taking a considerable share of the daily household expenditure. Cooking with biomass takes place on traditional inefficient three stone stoves.

The monitoring of indoor air pollution revealed high levels of particulate matter and carbon monoxide. During the research phase, and using a revolving fund system, the project enabled 167 households to switch to cooking with LPG. The level of indoor air pollution reduced by more than 80%. A scaling up strategy was developed based on the Women Development Associations (WDAs) and incorporating project partners and stakeholders. The scaling up phase of the project started in May 2004 and since then great achievements have been realized - presented in the paper. Lessons drawn from this best practice are concluded at the end of the paper.

1. Introduction:

Biomass energy (firewood, charcoal, and residues) composes more than 80% of primary energy consumption in Sudan - Table (1). Over many years, it has become evident that high dependence on biomass energy is a major factor, among others, contributing to forest cover depletion, environmental degradation and desertification. Combined with the successive drought cycles that have stricken the Sudano-Sahelian countries since the early 1970s, and from that time on, Sudan has suffered some lasting imprints and



Woman gathering woodfuel –
Kassala State
(photo: Nigel Bruce / ITDG)

disastrous effects of the drought and the encroachment of the desert. The desert and semi-desert represent 51.5% of the total area, and if the low rainfall Savannah zone is added, the figure jumps to more than 80.6%. This indicates that the problem of desertification and desert encroachment is of a very serious magnitude in the Sudan. The total area affected by desertification amounts to around 1.3million square kilometres (50.5% of the total area of the country).

Energy Source	1980		1999	
	TOE	%	TOE	%
1. Crude petroleum	1038.6	14.59	392.2	3.63
2. Petroleum products	108.5	1.52	1273.8	11.78
Subtotal	1147.1	16.11	1666.0	15.41
3. Wood	5412.5	76.02	7696.6	71.20
4. Agri. Residues	497.1	6.98	1343.7	12.43
Subtotal2	5909.6	83.0	940.4	83.63
5. Electricity	63.6	0.89	104.2	0.96
Total	7120.3	100.0	10810.5	100.0

Source: National Energy Assessment, 1999

The household sector consumes more than 70% of the total biomass energy consumption in Sudan - Table (2). The consumption pattern shows that charcoal is mainly used by urban households, while firewood and agricultural residues are the dominant household fuels in rural and poor urban areas. Charcoal is presently hauled over more than 1000 Km to supply major consumption urban centres (Khartoum and Gezira States).

Sector	Charcoal		Firewood		Residues		Total	
	1000 tons	1000 TOE	1000 Tons	1000 TOE	1000 Tons	1000 TOE	1000 TOE	%
Household	2023.0	1456.6	8264.0	3553.5	2928.0	732.0	5742.1	72.2
Services	248.6	179.0	2487.6	1069.7	-	-	1248.6	15.7
Industry	1.7	1.2	842.6	362.3	2446.9	611.7	975.2	12.2
Total	2273.2	1637.0	11594.3	4985.5	5374.9	1343.7	7966.0	100

Source: National Energy Assessment, 1999, Ministry Energy and Mines

Charcoal and firewood are usually burnt on traditional inefficient stoves, traditional metal stoves and three-stone stoves respectively - Table (3). Efficiency measures have shown that the metal stove is about 15% efficient while the three-stone stove is only 10% or even less. Endeavors to introduce improved stoves during the 1980s and early 1990s were not successful.

Table (3): Woodstoves commonly used in cooking, Kassala

	Frequency	Percent
three stone fire	96	96.0
traditional mud stove	4	4.0

Indoor air pollution resulting from burning biomass fuels has become a worldwide concern. Inefficient burning of biomass fuels, particularly firewood and residues, in traditional inefficient stoves results in liberation of heavy smoke containing large amounts of toxic pollutants such as carbon monoxide, oxides of nitrogen, sulfur dioxide, aldehydes, dioxin, polycyclic aromatic hydrocarbons and respirable particulate matter. The resulting human exposures, mainly women and children, exceed recommended Environmental Protection Agency (EPA) levels by factors of 10, 20 or even more, depending on specific situations (early work conducted by ITDG in Kenya).

It is also widely reported (WHO) and became evident that prolonged exposure to biomass fuel smoke is a significant cause of health problems such as:

- Acute respiratory infections (ARI) in children
- Chronic obstructive lung diseases (such as asthma and chronic bronchitis,
- Lung cancer (where coal is used), and
- Pregnancy-related problems

The high dependence on biomass fuels for household energy in Sudan not only contributes to environmental degradation and desertification, but equally causes health problems to women and children under five years.

ITDG-Sudan initiated the first work of its kind in Sudan, by monitoring household indoor air pollution levels during 24 hours, using participatory research methods. A sample of thirty voluntary poor households from a semi-urban residential area (Wau Nour) of Kassala participated in the research. Firewood was the dominant cooking fuel for the research sample, while charcoal was often used for the preparation of hot drinks (coffee and tea). Both firewood and charcoal were purchased from the market, taking a considerable share of the daily household expenditure - Table (4). Cooking with biomass takes place on traditional inefficient stoves.



Monitoring for smoke – the monitors are housed in metal boxes for safety (photo: ITDG)

The monitoring was conducted both during the dry and wet seasons. Carbon monoxide levels both in the kitchen and in the women's breathing zone were measured. During the same period, particulate matter concentration in the kitchen was recorded.

The results of the first monitoring cycle, pre-intervention, indicated the presence of high levels of indoor air pollution (carbon monoxide and particulate matter). The second phase of the project involved; women's awareness, participatory selection of smoke reduction interventions, and implementation in order to test their effectiveness during the second monitoring cycle (post-intervention).

The third phase of the project mainly concentrated on the dissemination and scaling up of the findings and results achieved during the previous phases.

2. Research approach and methodology

A participatory method involving 30 households from the Internally Displaced Peoples (IDPs) of Wau Nour was chosen as the best approach to address the problem of indoor air pollution resulting from burning biomass fuels. ITDG-Kassala was already assisting the IDP women of Wau Nour through two projects mainly involving income-generating activities and training on food processing. In order to work effectively with the community, activities were organized through formation of a Community Development Committee (CDC) and a Women Development Association (WDA) as a branch of CDC aimed at addressing particular gender issues. The WDA received considerable training on subjects including management, accounting, revolving fund, advocacy etc.

The smoke project found it very easy to start with Wau Nour WDA as the project could be considered as an extension and continuation of previous ITDG interventions. After a first awareness session on household energy matters and particularly the health hazards of smoke, the WDA accepted participation in the research phase of the project.

The WDA committee registered about 60 women volunteers willing to participate in the research. The project randomly selected a representative sample of 30 households taking into consideration the variation of cooking habits between the different ethnic groups. The sample received particular training on research methodology, process, their role, and expected outcomes of the research.

Another facet of the project put great emphasis on involving partners and stakeholders at the early stages of the project. Selected partners and stakeholders are the Ministry of Health – Kassala State, Faculty of Medicine – University of Kassala, Sudanese Society for Environment Protection, Department of Development – Kassala State, Akendon, ACCORD. However the principal partner is the Ministry of health, and the Media.

The project launched its activities by organizing a workshop on the health hazards of smoke and an explanation of its participatory research approach to addressing the issue, expected outputs, and potential future prospects of the project for the poor households

sector. The Ministry of Health, Kassala State, inaugurated the workshop attended by all partners and stakeholders. In addition the Minister assigned the Department of Public Health to be the direct counterpart for the project, the latter to assign personnel to be involved in project activities.

Depending on the results of the first monitoring cycle (pre-intervention) the women were informed on possible alternative household energy options. Also the women's perception on types of smoke reduction interventions were determined through a group discussion approach.

3. Outputs of the research activity (Monitoring)

The preliminary results of the first monitoring cycle revealed that firewood is the dominant purchased cooking fuel for the 30 sample households. Charcoal came second, but mainly used for preparing hot drinks. Depending on the household size, the average monthly expenditure on firewood purchase range between SD 980 and SD10 200, Table (4). All households used the three stone stove for cooking. Kisra (a sort of pancake) is the staple food for the households; this is cooked on a hot metal plate over the three stone stove.

Table (4) Monthly Household Expenditure on Cooking Fuel (SD*), Wau Nour, Kassala										
Sample No.	1	2	3	4	5	6	7	8	9	10
Firewood	2,800	2,800	1,960	2,800	2,800	1,960	980	980	4,200	3,920
Charcoal	2,100	1,400	1,400	1,400	2,800	2,800	2,000	2,000	1,400	560
Total	4,900	4,200	3,360	3,200	5,600	4,760	2,980	2,980	5,600	4,480
Sample No.	11	12	13	14	15	16	17	18	19	20
Firewood	980	2,100	980	1,960	2,800	0.00	480	1,400	1,680	1,400
Charcoal	1,400	2,800	2,800	1,400	1,400	0.000	2,100	700	1,400	1,400
Total	2,380	4,900	3,780	3,360	4,200	0.00	2,580	2,100	3,080	2,800
Sample No.	21	22	23	24	25	26	27	28	29	30
Firewood	700	2,100	1,680	1,400	10,200	1,960	1,800	2,800	980	2,600
Charcoal	700	700	700	2,100	2,800	1,400	4,200	2,800	2,800	2,800
Total	1,400	2,800	2,380	3,500	13,000	3,360	6,000	5,600	3,780	8,400

Note: US \$ equal 250 SD

The monitoring of indoor air pollution, measured by drawing air at a known rate through filter paper, revealed high levels of particulate matter and carbon monoxide. As well as weighing the filter a good visual indicator was the heavy deposit of soot on the filter paper; these black filters were shown to the women.

A participatory group discussion with the households revealed their high awareness about the health risks of smoke and possible interventions to reduce or eliminate smoke. Table (5) summarizes the households' perception of smoke reduction interventions.

A demonstration of potential smoke reduction interventions (LPG burner, Kerosene wick stove, improved charcoal stove, improved wood stove, and LPG Kisra plate) was organized for the women (see Annex I, regarding thermal efficiency of the systems). The demonstration was accompanied by an awareness session presented by the Civil Defense on safety use and precautions as regards the use of LPG. One very important directive is that a kitchen build of thatch material has to be plastered with mud. Practical demonstrations of actions to take in case of an accident with LPG convinced the women that LPG use is not as dangerous as they believed. As regards households' priorities and preferences of smoke reduction interventions, switching to LPG was the first choice, followed by charcoal - Table (6).

Table (5): Wau Nour - Households' perception of smoke reduction		
Smoke reduction mean	Advantages	Disadvantages
LPG	No smoke. Clean Rapid	Explosion if cylinder left open. Explosion if gas is opened before lighting the match. No LPG refilling shop in Wau Nour. LPG cylinder and gas burner are very expensive. Most kitchens are build of thatch material.
Kerosene (Wick Stove)	No smoke if kerosene is used. Available at nearest shop. Diesel oil could be used instead of kerosene.	Soot deposit on pots, but only when Diesel is used. Not for use out side the kitchen (air may blow off the fire causing fire hazard). Bad smell and smoke when Diesel is used instead of kerosene.
Electrical Heater	No smoke	No electricity in the area
Charcoal	No smoke. Available at nearest shop.	
Chimney, Hood, More windows	Out withdrawal of smoke.	Might cost a lot of money to buy and install.

Kitchen redesign (Hut or Rakuba)	Some women said: the hut is much better than Rakuba while others support the later design.	
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Table (6): Households' priorities as regards smoke reduction interventions

	LPG	E. Heater	Charcoal improved stove	Kerosene (wickstove)
1st Choice	15	1	3	0
2nd choice	0	0	16	0

However, the women raised the issue of accessibility to both the LPG cylinder and the burner as the major constraint. Depending on cylinder and burner sizes, and including the Kisra plate, the cost ranges between SD 9200 and SD17 900 - Table (7). This cost constraint was the main reason for 16 women opting for charcoal as a cheap option. However, improved charcoal stoves are not available in the market.

Table (7) Prices (SD) of the different LPG appliances and combinations

	LPG cylinder size (Kg) – NPC		
	2.0	4.0	12.5
Cylinder	3,500	5,000	10,000
LPG Cookers:			
One burner	1,200	1,200	1,200
One burner	2,000	2,000	2,000
Two burners	2,700	2,700	2,700
Three burners	3,400	3,400	3,400
Kisra plate	4,500	4,500	4,500
1ST Option: Cylinder + Burner + Kisra Sag			
One burner	9,200	10,700	15,700
One burner	10,000	11,500	15,500
Two burners	10,700	12,200	17,200
Three burners	11,400	12,900	17,900
2ND Option: Cylinder + Burner			
One burner	4,700	6,200	11,200
One burner	5,500	7,000	12,000
Two burners	6,200	7,700	12,700
Three burners	6,900	8,400	13,400

Since LPG costs much less than biomass, based on energy saving and conservation calculations, it was shown that the household could repay the cost of LPG appliances in a maximum period of six months - Table (8). Accordingly, the idea of using the revolving fund was presented to the women. The WDA already have experience with the revolving fund used for funding income-generating activities. The WDA is a registered charity organization, has an account with the Credit and Social Development Bank and is registered for receiving formal credits. On their acceptance of the idea, the project provided seed capital which was later repaid by the households through lease installments. The amount of the monthly installment agreed upon by the women was SD 1000.

In the end, all 30 households in the project opted for LPG as the best smoke reduction intervention because of the following reasons:

1. It is locally produced and abundantly available
2. It is a clean burning fuel, no soot deposits on pots, walls and cloths.
3. The Government encourages its widespread use as an alternative to biomass fuels. Incentives set by the Government are in terms of LPG subsidy of 50%, and exemption of LPG appliances from import taxes.
4. Short cooking time compared to biomass fuels.

Table (8) Payback periods (months) for the different LPG appliances combination options			
Option	LPG cylinder Size (Kg)		
	2.0	4.0	12.5
1ST Option:			
One burner	3.0	3.6	5.3
One burner	3.4	3.9	5.6
Two burners	3.6	4.1	5.8
Three burners	3.9	4.4	6.1
2ND Option:			
One burner	1.6	2.1	3.8
One burner	1.9	2.4	4.1
Two burners	2.1	2.6	4.3
Three burners	2.3	2.8	4.5

Using the above approach, the 30 households sample were equipped with LPG for cooking (Cylinder, gas burner, and Kisra plate). The second monitoring was conducted to measure and confirm the effectiveness of switching to LPG on smoke reduction or elimination.

Table (9) shows a comparison between the levels of particulate matter and carbon monoxide as measured before and after switching to LPG; note that these are preliminary results.

24-hour means:	Pre-intervention (n=30)	Post-intervention (n=30)
	Round 1 (wet season)	Round 3 (wet season)
Respirable PM $\mu\text{g}/\text{m}^3$	980	160
CO kitchen (ppm)	12.9	3.1
CO woman (ppm)	6.3	1.9

It is clear from Table (9) that switching to LPG produced more than 80% reduction in both levels of particulate matter and carbon monoxide. It is thought likely that the remaining level of indoor air pollution results from using a traditional kerosene wick lamp or candles - Table (10).

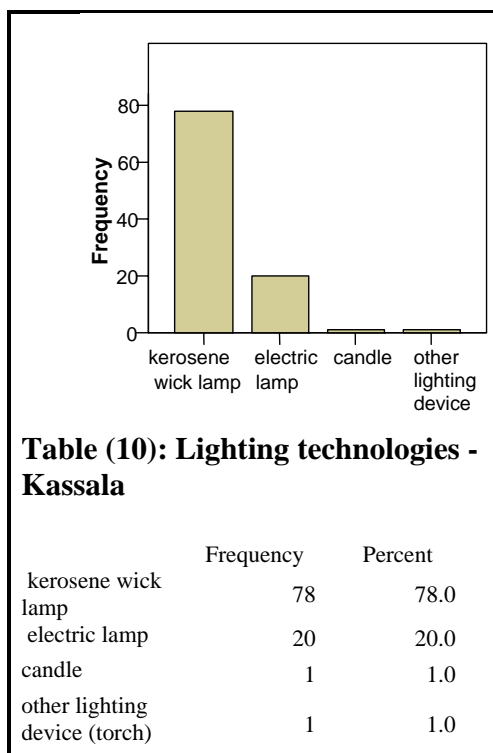


Table (10): Lighting technologies - Kassala

	Frequency	Percent
kerosene wick lamp	78	78.0
electric lamp	20	20.0
candle	1	1.0
other lighting device (torch)	1	1.0

Due to cash-flow problems, some women were not able to refill the cylinder and thereby reverted to firewood use on some occasions. In addition, the non-availability of LPG refilling shops in the area discouraged some women.

Before the end of the second monitoring cycle, the news of LPG benefits and advantages over firewood and the option of accessibility through the revolving fund made a big impact in Wau Nour and the nearby Kadugli IDPs residential areas. Mouth to mouth was the only communication media between the women. The project received claims and requests from an additional 60 households; around 30 from each area. The project decided to overlap the dissemination phase into the research one and using the revolving fund system made advanced payment for the additional 60 women. Equally the women belonging to the IDP camp at EL Gadaref (200 Km from Kassala) presented a

request for the project to be involved in the smoke reduction activity through the revolving fund. The project made the same funding approach to 30 households.

Working with partners proved to be very important during the research phase of this project. Some partners were actively involved in project activities, namely:

1. The Faculty of Medicine, University of Kassala, assigned a teaching assistant to participate in the monitoring activity and awareness sessions
2. The Ministry of Health, Kassala State, assigned a physician to participate in the awareness sessions
3. The Sudanese Society for Environment protection seconded a staff member to work full time for the project, assigned them responsibility for project activities
4. The Civil Defense Department assigned personnel for awareness sessions on safety precautions of LPG use
5. The Forest National Corporation, FNC, assigned personnel for awareness sessions on alternative household energy options
6. ACCORD provided seed funding for LPG appliances for an additional 30 households in Kadugli, Kassala, and expressed their willingness for more funds if the approach, system, and management of the revolving funds proved effective.
7. The Agent of Petroleum Nile Company in Kassala agreed a 50% down payment for LPG cylinders and repayment of the remaining 50% through six equal monthly installments.

Following these successes the project obtained more funds for scaling up its activities in Kassala and Gadaref cities, Eastern Sudan.

4. Strategy for scaling-up smoke reduction activities

4.1. Working Through WDAs

The Women Development Associations, WDAs, of Kassala, and likewise those of Gadaref, are registered civil society organizations. Their objective is mainly women's development in the broader sense. Besides the headquarters in Kassala and Gadaref, the two organizations have eleven branches in different residential areas of Kassala and Gadaref and in the rural towns of the two States. During four years of work with ITDG, the WDAs gained remarkable experience in different aspects of development work. Almost every WDA has a bank account, and the two head offices in Kassala and Gadaref serve as collateral for the branches when a member or group of members wishes to seek access to formal credit. Each branch has its own revolving fund system managed by a committee headed by a president. All WDAs are well trained by ITDG in the management and organization of revolving funds. Many members benefited from revolving fund services, particularly those running income-generating activities. A lot of women have reported the livelihoods of their families greatly improved, because of the revolving fund system. Without the WDAs, they would never have had access to credit.

The smoke project, during its research phase, benefited greatly from the existence of the revolving fund system within Wau Nur, Kadugli and Jebel Marco (Gadaref). Many women in these poor residential areas (originally IDP camps) were able to convert to cooking with LPG instead of firewood. The women really felt the difference between

using the two fuels. The case of Amna, president of WDA-Wau Nour was a good example. She makes Kisra for the market using firewood as fuel. Her monthly expenditure on firewood was SD 6,000. On switching to LPG her monthly fuel expenditure reduced to only SD1,300 (78.3 % reduction). Additional benefits are: no smoke, clean kitchen, short cooking time leading to more time for rest.

There have been very few defaulting households, where women have not been able to pay the monthly installments; in general they are all very keen to pay because they know that failure to pay results in other women in the queue waiting being deprived of LPG appliances.

Generally speaking, the present day mode in Sudan is that every woman has great hope and ambition to convert to cooking with LPG, particularly in towns where such a service exists. For this reason the smoke project is highly dependent on the ability of WDAs to scale-up its activities during the dissemination phase. The existing revolving fund system can easily absorb this activity.

The project will act through the two WDAs head offices in Kassala and Gadaref. The first activity is to conduct a needs survey among the members of the branches to determine the scale of demand for LPG appliances.

4.2 Seed Money for the Revolving Funds

The cost for a combination of LPG cylinder, gas cooker and a Kisra plate is around SD 15000, but this can vary, depending on the woman's choice. Normally the revolving fund requires a SD 1000 downpayment from each member. Relying on this system alone can take long time before the members start getting the first batch of appliances. It is hard to convince the LPG companies to give free appliances, or provide substantial seed money, and rely on LPG sales profit to cover such an investment. Our short-term experience with LPG companies has showed that they will accept an advanced of 50% of the cylinder cost and the remaining 50% paid in six monthly installments. The gas cookers and Kisra plates are sold through different enterprises.

Due to above complications, the project will advance a grant to the two central WDAs to enable them to maintain shops for LPG appliances. The WDA branches buy the appliances for its members from the central WDAs through their revolving funds, benefiting from a credit from the Credit and Social Development Bank, CSDB. The Central WDAs provide assurance and serve as the collateral for its branches.

The central WDAs require a certain profit margin, to be discussed with the project, in order to earn some money to cover its administrative expenses. In addition, the central WDAs' shops are accessible to everybody in Kassala and Gadaref who wants to buy

LPG appliances using cash or short term installments. In this way those households not members of the WDAs also benefit from the reduced prices at WDAs' shops.

On the other hand the project will help the central WDAs to work out a business relationship with LPG companies where the cylinders can be paid for through installments rather than paying 50% in advance.

The above arrangements will make things much easier for the Central WDAs and will enable a greater number of members to have access to LPG instead of waiting for a long time until enough installments are collected from members then paid to the companies before obtaining the appliances.

4.3. Awareness and Training



'No smoke – no indoor air pollution' – dissemination at women's handball match (photo: ITDG)

Although the WDAs are already trained in management and organization of revolving funds, additional training is envisaged.

Training and awareness sessions are also needed for the members of the different branches, particularly on the following issues:

- Household energy alternatives
- Smoke health hazards and risks, particularly for women and children
- Hazards, safe and effective use of LPG
- Maintenance of LPG appliances

The project has already developed experience on conducting such training and awareness sessions in cooperation and collaboration with its partners: State Ministry of health; Forest National Corporation (FNC), Environment Conservation Society and the Civil Defense.

The different media will be used to the maximum to advertise for project activities and raise the awareness of the public and particularly women on the dangers of smoke to their health and children.

4.4. The Role of Partners

The project partners will have a major role to play for the success of this scaling-up phase of the project. The State Ministry of Health, FNC, Environment Conservation Society, and the Civil Defense will continue their original role in training and awareness.

The partner NGOs will be encouraged to participate in funding some of the project activities in order to cover all the WDAs' branches in Kassala and Gadaref. ACCORD have already started cooperation with the project and is willing to continue. Its participation is highly appreciated, but the project has to consolidate this cooperation through a signed agreement clearly stating the roles, activities and work-plan.

The private sector and particularly the Nile Petroleum Company will be approached to further cooperate with the project. An important message is that profit resides in LPG sales rather than cylinders. The recent increase in cylinder price (from SD 8000 to 10 000 is hard to justify). The company will be urged to accept selling the cylinders on installments rather than paying 50% in advance and 50% on installments. The Nile Petroleum can play a role in providing the LPG appliances (gas cooker and Kisra plate) at lower prices than presently available in the market, ideally through a package comprising a cylinder, gas burner and Kisra plate. In addition the company, NPC, is being urged to open new refilling shops where the number of households using LPG meet their requirement.

4.4. Monitoring and Evaluation

The project will develop a monitoring system for all its activities and in particular the revolving funds. Regular and periodic meetings with the WDAs and partners will identify bottlenecks requiring immediate action in order to resolve any problem that might hinder the smooth running of the revolving funds. Very important is the payment of installments by the members.

The cost of LPG appliances advanced to the WDA as seed money as well the contribution of ACCORD and Nile Petroleum Company is presented in Annex II. The Nile Petroleum, which supplies the LPG cylinders, made several incentives for the WDA in terms of paying the cost of cylinders. First: 50% paid in advance and the rest in 6 monthly equal installments. Second: all the cost paid in 10 monthly equal installments. Third: all the cost paid in 12 monthly equal installments. The company realized that it can make more profit through LPG sales rather than through cylinders. This made more money available for buying LPG burners and Kisra plates hence more households switching to LPG use.

Tables 1, 2, and 3 in Annex (III) present the percentages of installments repayments by the different WDA branches for batches 1, 2, and 3. After six months evaluation of the revolving fund system revealed that some WDA branches are not repaying their installments regularly. The repayment default is beyond the expected rate of maximum 10 percent. It became clear that some women believe that NGO money need not be repaid back. It is concluded the central WDA and the branches make a case by case evaluation of each defaulting household and if necessary the appliances are taken back.

5. Achievements

During the research phase, the project enabled 167 households in Wau Nour, Kadugli and Marco to switch to cooking with LPG. The scaling up phase of the project started in May 2004 and since then the following achievements are realized:

1. Agreement with central WDA Kassala to replicate the best practice to households in Kassala city through its 11 branches.
2. ACCORD fully involved in project activities by financing 50% of all activities including seed money to WDAs. An agreement is signed between ACCORD and ITDG Kassala.
3. Central WDA Kassala is very active and has selected and initial five of its Kassala branches. Awareness sessions and training have been successfully conducted for the five WDA branches.
4. So far a total of 925 households (161 during the research phase and 764 since the start of scaling up phase) got access to LPG appliances using the revolving fund system, Table (11)
5. Further training for the central WDAs on revolving fund management and accounts has been completed
6. The central WDA is now in direct contact with the supplier of gas burners and Kisra plates in Khartoum, thus improving the supply chain
7. The LPG supplier in Kassala has agreed to supply LPG cylinders through ten monthly installments
8. Wau Nour WDA has been given approval for their LPG refilling shop (there are more than 200 cylinders in the area)
9. Kadugli refilling shop is waiting for the completion of their community development centre
10. Kisra plate development is awaiting final agreement with a workshop in Khartoum. The workshop is keen to have proof of the level demand before investing. Development may incur an increase in price and might limit the size of the market. In the meantime, the supplier of gas burners is producing the same Kisra plate.
11. WDA is taking the promotion and marketing of smoke intervention as a business through the revolving fund system. Having completed a food-processing project, the smoke intervention has become their main business. Project is further supporting WDA on management, planning, accounting, revolving fund calculations etc.
12. Advertising through the media and participation in Kassala TV programmes generated good media coverage for the project and the WDA. Accordingly, women in four other residential areas have submitted a demand to become members of the WDA in order to access LPG through the revolving funds. Word of mouth among the women is working very effectively in Kassala as a good information and advertisement media.
13. Those women not belonging to WDAs are approaching the WDA individually to obtain LPG appliances through short terms installments or cash. The WDA price for cash is much lower than that in the market.

rapidly.

16. Wau Nour and Kadugli WDAs work independently of each other as they can each run sustainably. Although some of the people belonging to them have problems with repayments, the WDAs are working to find sustainable solutions
17. Training on safety measures is going well with our partner, the Civil Defence, and so far no accident has been reported.
18. The project is extending its activities to a new area, New Halfa Locality, within Kassala State.

6. Lessons learned

A lot of lessons are being learned from this project, summarized as follows:

1. Poor communities' reception or acceptability of new ideas and technologies to alleviate poverty very much depend on addressing their needs and priorities.
2. Participatory approaches and awareness-raising are the best methods to reach, organize, understand the needs and priorities of poor communities, and guarantee their involvement in project activities. It is an approach that leads to sustainability.
3. The revolving fund system is a development of a traditional funding system in Sudan (Sandug). It solves the problem of poor communities accessibility to services, income-generating activities, and is an empowerment tool, particularly for women, which leads to an improvement in their livelihoods. It is an appropriate alternative to the subsidy dilemma.
4. Involving partners and stakeholders at early stages of the project is a key element in project success and sustainability. Partners and stakeholders are easily influenced by best practices and can easily replicate them individually or in partnership with the project.

5. In poor households, smoke from burning firewood is not the sole source of indoor air pollution. Traditional kerosene wick lamps and candles are contributing to indoor air pollution. The project is intending to address the issue.

Annex I:

Thermal efficiencies of some biomass energy conversion systems in comparison with LPG and Kerosene

Type of combustion system	Percent thermal efficiency
Three-stone fire	10 – 15
Improved wood burning stove	20 – 25
Charcoal stove with ceramic liner	30 – 35
Sophisticated charcoal-burning stove	Up to 40
Kerosene pressure stove	53
LPG gas stove	57
Steam engine	10 - 20

Annex (II):

Table (1): Cost of interventions so far provided to WDAs and revolving fund component

Batch No.	Cost of	Cost of	Cost paid	Cost paid	Total	To be paid	No. of
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And date	LPG Appliances (SDD)	LPG Cylinders (SDD)	by ITDG (SDD)	by ACCORD (SDD)	seed Money (SDD)	to Nile Com. (SDD)	Beneficiaries
1. Kassala							
First Sept. 2004	435,100	610,000	595,100	213,050	803,150	241,950	112
Second November 2004	501,900	790,000	701,900	195,500	896,900	395,000	137
Third	1,014,000	1,455,000	1,741,500	0.0	1,741,500	727,500	205
Forth	1,493,500	2,170,000	1,493,500	181,200	1,674,700	1,988,800	250
Total					5,116,200		704
2. Gadaref							
First	270,000	600,000	570,000	0.0	570,000	300,000	60

Beneficiaries during the Research Phase:

Wau Nour 77
Kadugli 54
Gadaref 30

Annex (III):

Table (1): Smoke project, Monitoring of revolving fund, percent repayment of installments by different WDA branches. 1st batch of LPG appliances (Starting Sep. 2004)

WDA Branch	Percent monthly Repayment of installments (%)								
	1 st installment	2	3	4	5	6	7	8	9
El Shaheed	100	100	100	100	77.2	54.6	100.5		
El Sougoon	86.3	91.7	87.2	69.1	11.6	5.9			
EL Turaa	6.7	68.6	100	100	100	100	100		
El Shabi	101.6	106.5	79.8	87.7	79.9	312.6			
El Khatmiya	100	100	100	100	64.7	74.9	46.6		

Table (2): Smoke project, Monitoring of revolving fund, percent repayment of installments by different WDA branches. 2nd batch of LPG appliances (Starting Nov. 2004)

WDA Branch	Percent monthly Repayment of installments (%)								
	1 st installment	2	3	4	5	6	7	8	9
El Shaheed	89.4	86	74.2	52.3	88.8	5.2			
El Sougoon	97.5	41.1	37.3	19.9					
EL Turaa	98.8	65.8	100	100	100				
El Shabi	90.3	72.6	61.2	75.1	1.9				
El Khatmiya	99.9	99.9	100	100	41.4				

Table (3): Smoke project, Monitoring of revolving fund, percent repayment of installments by different WDA branches. 3rd batch of LPG appliances (Starting Jan. 2005)

WDA Branch	Percent monthly Repayment of installments (%)								
	1 st installment	2	3	4	5	6	7	8	9
El Shaheed	75.2	68.5	30.7						
El Sougoon	28.4	23.6							
EL Turaa	77.4	0.78	7.8						
El Shabi	75.8	87.9							
El Khatmiya	78.3	100	100						
Wau Nour	98.3	55.8							
Kadugli	100	100							