



Demand for Woodfuel and Liquefied Petroleum Gas (LPG)

A Case Study of Khartoum in 2009

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Disclaimer

The material in this report does not necessarily represent the views of any of the organisations involved in the preparation and hosting of the workshop. It must be noted that some time has passed between the workshop and the dissemination of this report, during which some important changes have taken place, not least of which is the independence of South Sudan, a fact which greatly affects the national energy context. Critically, following the independence, the rate of deforestation in the Republic of Sudan has risen from 0.7% per year to 2.2% per year, making many of the discussions within this document all the more relevant. Whilst not directly affecting the production of LPG, which is largely derived from oil supplies north of the border with South Sudan, the wider context of the economics of the energy sector, and the economy as a whole, have changed. These changes are not reflected in this document. This being said, it is strongly asserted that this document still represents a useful contribution to the energy sector, particularly given its contribution to charting the breadth of perspectives on LPG in the Republic of Sudan.

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1. Introduction

1.1 Background

There has long been concern about the rate of deforestation in northern Sudan. According to a Post-Conflict Environmental Assessment conducted by the United Nations Environment Programme (UNEP), complete deforestation had affected over 70% of north, east and central Sudan by 2006 (UNEP, 2007). Although the rate of removal of the remaining forest cover has slowed, the pressure on forest resources is still high, especially around urban areas. This is attributed to energy needs and to agricultural clearance. In terms of the former, the extraction of woodfuel in northern and central Sudan is unsustainable (definitions of woodfuel and fuelwood can be found in the respective section). Rising demand for fuelwood for brick-making is a particular concern, while the demand for charcoal in northern cities is negatively affecting forest cover in central, southern and western Sudan (*ibid*).

As deforestation has accelerated, so too has the price of woodfuel on which taxes have also risen. This has encouraged many consumers to seek alternative and cheaper forms of energy. Liquid petroleum gas (LPG) is one of the most widely substituted alternatives to woodfuel. Until recently, LPG was entirely imported into Sudan, but since the country has become an oil supplier it is now also a producer of LPG.

This is the second of a series of studies commissioned by UNEP, the United Nations Development Programme (UNDP) and the Department for International Development (DFID), on behalf of the Environmental Technology Task Force (ENTEC), to explore the potential for scaling up the use of LPG and its availability within Sudan. ENTEC is managed by a committee of UN agencies, members of Darfuri civil society, NGOs and donors. It was borne out of the environmental analysis undertaken concurrently by the D-JAM and by Tearfund in Darfur in 2006. ENTEC's central concern is to introduce and scale-up alternative construction and energy technologies in Darfur to reduce the current rate of deforestation and projected deforestation in the future when IDPs eventually return and reconstruction begins. The first ENTEC study, Destitution, Distortion and Deforestation was completed by UNEP in 2008. (UNEP, 2008, www.unep.org/sudan) This work on LPG extends the work of ENTEC to the national level.

This particular study explores demand for LPG within Khartoum.

As Sudan's largest (and growing) urban conurbation, it is assumed that trends and patterns in energy consumption in Khartoum are likely to be similar to other urban areas in northern Sudan, such as El Obeid and Port Sudan. Because Khartoum is particularly well-served as Sudan's capital, however, it may be ahead of other urban areas in terms of the extent to which LPG has been substituted for woodfuel.

The specific aims of this case study of Khartoum are:

- (1) to explore the extent to which households and small enterprises in the Khartoum area are using woodfuel versus LPG (or other energy sources) to meet their energy needs, how this is changing, and the factors influencing their choices;
- (2) to begin to provide an overview of the woodfuel trade in the Khartoum area (e.g. how the trade is organized, the main sources of supply, the main consumers, prices, taxes etc), trading trends, and the potential displacement effects of greater use of LPG; and
- (3) to provide an initial assessment of the retail trade in LPG in the Khartoum area (e.g. how the retail distribution of LPG is organized, the main consumers, prices, taxes etc.), recent trends and contributory factors.

Subsequent studies will explore the supply of LPG in Sudan and the potential for scale-up, and the experience of projects that have attempted to introduce LPG as an alternative source of energy for domestic cooking. The findings from all of this work will be drawn together into a synthesis report with recommendations for action – at both the policy and programming levels – in early 2011.

1.2 Methodology

A team of four carried out this study in Khartoum. The approach drew upon the methodology used for a study in Darfur in 2008 which explored the demand for woodfuel during the conflict years and the implications for Darfur's forest cover (UNEP, 2008), through the lens of trade. The methodology was adapted for the Khartoum case study through the following steps:

- (1) identification of the main energy consumers in Khartoum;
- (2) identification of other key stakeholders in the woodfuel and LPG trade in Khartoum, including wholesalers and retailers, government departments that determine policy and also monitor and tax the use of both energy sources, international and national non-governmental organizations (NGOs) and research associations that have been promoting the use of LPG;
- (3) semi-structured interviews and focus group discussions with the main energy consumers; meetings and discussions with other key stakeholders (e.g. government officers, local and international NGOs);
- (4) collection of secondary data where possible;
- (5) preliminary analysis by the study team during the field work in Khartoum, supplemented by findings from subsequent fieldwork; and
- (6) final analysis.

Fieldwork was carried out in the three adjacent cities of Omdurman, Bahri and Khartoum in July 2009. As shorthand, the term 'Khartoum' will be used throughout this report to refer to all three cities unless a distinction is made. See Annex 1 for a list of the stakeholders interviewed.

There were a number of constraints to the fieldwork for this study. Urban fieldwork is usually more challenging to organise than rural fieldwork because of the many demands on the time of urban dwellers and the heterogeneity of urban communities. This was our experience in Khartoum which meant that it was not possible to interview all the stakeholders we had identified as some were unavailable. Limited time for the whole team to work together also set a practical constraint to the scope of the fieldwork. This mainly affected our ability to meet the second aim of this study – providing an overview of the woodfuel trade and the potential displacement of greater use of LPG. However, UNEP is planning a larger study on the woodfuel trade in Sudan in the next couple of years, which may help to address this gap.

1.3 Report Structure

This report is organized according to the study team's analysis of the main consumers of woodfuel and LPG in Khartoum. Section 2 provides a description of these consumers, and of some overall trends in energy consumption in Khartoum. Section 3 explores the domestic use of woodfuel and LPG by households; section 4 by bakeries; section 5 by brick kilns, and section 6 by restaurants and tea-makers.

Section 7 presents the findings on the main trends and factors affecting the woodfuel trade in Khartoum. Section 8 provides a preliminary analysis of policy issues that influence the use of LPG which emerged during fieldwork for this case study (noting that many of these are being explored further in a separate study for this project). Section 9 summarises the main conclusions that can be drawn from this case study of demand for fuelwood and LPG in Khartoum and identifies issues that require further investigation by subsequent studies.

2. An overview of the use and availability of LPG in Khartoum

2.1. Khartoum's main energy consumers and their use of LPG

The Ministry of Energy estimates that biomass currently meets about 65% of Sudan's energy needs, much of which is for domestic use (Hood's 2010 figures from the Second National Energy Assessment of the Ministry of Energy and Mining in 2001 show that biomass accounts for a higher proportion - 78% - of Sudan's energy consumption). Firewood is the main biomass contributor. Within central Khartoum and the oldest parts of the three cities, LPG has replaced firewood as the major source of energy. However, Khartoum still consumes around 10% of Sudan's biomass energy (Hood, 2010). According to the 2001 Second National Energy Assessment, Khartoum now has the lowest per capita consumption of firewood in the country, but the highest per capita consumption of charcoal (*ibid*).

Domestic households are the main consumers of LPG in Khartoum, followed by bakeries, restaurants and factories (especially the food industry, for example Coca Cola and the ceramic industry). Aman Gas, for example, estimates that two-thirds of the LPG they distribute is to domestic households, mostly within Khartoum. Iran Gas estimates that they sell twice as much LPG to domestic households as to bakeries, their second major client. The other main energy consumers in Khartoum – the brick kilns and road-side tea-makers – are not using LPG, despite periodic attempts to encourage them to do so. The reasons why these have not worked or have not been sustained are explained below, mostly to do with technical obstacles or availability.

Energy use in Khartoum is not typical of the rest of the country, specifically the extent to which LPG has replaced the use of fuelwood. According to two gas distributors – Nile Petroleum and Iran Gas – 60 to 65% of their total LPG sales are now in the Khartoum area. Hood's figures (2010) from the Ministry of Energy and Mining indicate that 70% of Sudan's total LPG consumption was in Khartoum in 2002. Increasing and widespread use of LPG is now reported in other urban areas in central Sudan, including Gezira.

The surge in demand for LPG in Khartoum occurred between 2000-2001 and 2006-2007 as Sudan's oil production increased and with the inauguration of the Khartoum (Aljaily) refinery. In 2001, the government introduced a 50% price subsidy to LPG for domestic use and exempted domestic LPG appliances from import duties. At the same time, firewood prices were rising thus accelerating the substitution. According to Nile Petroleum, 60,000mt of LPG was consumed annually by Sudan in 2000; by 2006 this had increased more than threefold to 220,000mt, much of which was consumed in Khartoum. The gas distribution companies report that demand has since stabilised as VAT on LPG has been reintroduced, and is now growing at a rate of around 10% per annum (Data provided by Aman Gas).

This significant shift to LPG since the beginning of the decade is corroborated by firewood and charcoal traders in Khartoum, whose market share of the energy trade has been steadily declining, elaborated in section 7.

2.2 Availability of LPG

Agip and TOTAL were the main suppliers of LPG in the 1970s. When oil was discovered in Sudan, new companies entered the market from the 1990s onwards, including Nile Petroleum (in which the government is the majority shareholder, taking over from TOTAL), Abarsi, Aman Gas, Iran Gas, Bee Petroleum, GapCo (which took over Agip's business) and Sudagas. Abarsi and Aman Gas are now two of the main suppliers in Sudan.

In the past ten years, as supplies of LPG increased and as demand increased rapidly in Khartoum (and in some other urban areas), the distribution network expanded. According to the Secretary General of the Gas Agents Union, the total number of LPG agents in Khartoum rose from 250 in 2000 to 1,300 in 2009. LPG agents report declining profit margins which indicates it has also become a more competitive market. The gas companies provide incentives to commercial enterprises to switch to LPG, usually by freely installing a tank (ranging in size from 0.5 to 2mt for bakeries, and 20 to 40mt for industrial enterprises (e.g. a 40mt tank was installed for Coca Cola) which in turn ties the enterprise into buying LPG from that company. (See also section 7).

Reliability of supply is a critical determinant of whether industry will switch to LPG and this has improved considerably in the past ten years. However, the distribution network is still heavily concentrated in urban areas in central Sudan and is much less extensive and reliable in most rural areas and in less accessible towns.

Aljaily refinery on the outskirts of Khartoum is the main source of LPG supply. Several years ago, two electricity generating stations were constructed beside Aljaily using LPG as their main source of energy. This happened at a time when there was excess supply of LPG, but it was a highly contested decision as it meant that much less LPG would be available for other energy consumers to substitute for fuelwood.

Although supply of LPG within Khartoum has become increasingly reliable in the past decade, aided by the fact that any one retailer of LPG is now likely to be an agent for a number of different gas companies, future shortages are anticipated by many stakeholders interviewed for this study (Apparently there was surplus production of LPG in Sudan from 2001 to 2005 when some was exported, but as demand has risen exports have stopped, LPG is only imported when Aljaily refinery closes for renovation). As demand for LPG continues to rise, domestic supply is not keeping pace, and the government is stepping in to prioritize certain energy consumers. There are plans to expand the capacity of Aljaily from producing 100mt of LPG per day to 200 mt, but some interviewees expect this will take around two to three years to achieve. Meanwhile demand continues to rise implying that imports would be needed in the short to medium term, an unpopular political choice (reported by Abarsi and Aman and by Sayga flour company). As a result, as explained in section 8, certain consumers of LPG have been prioritized over others.

3. Fuelwood and LPG use by domestic households

A high percentage of households in Khartoum are using LPG for cooking. The gas companies estimate 60-70% while the Administrative Officer in one locality in Omdurman assessed the percentage to be as high as 75% (in Gedaref and Sennar a well-informed interviewee estimated that around 80% of households have converted to LPG, supply is reliable and there is good road transportation). Take-up is greatest amongst better-off households where it is up to 100% in some areas. See Box 1. However, there are still a few types of cooking for which households prefer to use charcoal – such as cooking *asida* (millet porridge) for which a pot with a rounded bottom is used, frying meat and making tea and coffee; older women also express their preference for using charcoal and firewood to cook outside in the traditional way.

Elsewhere, particularly in Khartoum's vast unplanned peripheral areas, take-up of LPG depends upon proximity to the road (and therefore supply of LPG) and level of income. Nevertheless, some interviewees estimated that as many as 50% of households were using LPG for cooking in Soba AlAradi, some 25 km from Khartoum. Those who do not use LPG are usually poorer households.

Box 1. A case study of Abrouf, Omdurman

Better-off households began to substitute LPG for fuelwood for cooking approximately 20 years ago when women started to go out to work. Eight years ago, an estimated 65-70% of households were using LPG; by 2009 it was over 90%. They still use charcoal for ironing, grilling meat and boiling water, but only relatively small quantities – around 5 mulwa per week (1 mulwa of charcoal is 1.8kg). Wood is now only used for *dukhan* (a cosmetic use by women of aromatic firewood, *tulleh* and *shaf*) and for cooking *asida* during Ramadan.

Source: Sudan Environmental Conservation Society (SECS) branch, Abrouf

On cost grounds there is a clear economic case for replacing fuelwood with LPG for cooking in Khartoum, confirmed by many interviewees. See Table 1. But it is still out of reach for poorer households. The reasons are to do with the upfront costs of purchasing an LPG stove and cylinder(s). A new full cylinder of 12.5 kg costs about SDG 114-120. The regulator costs around SDG 15-20 and the stove costs SDG 40-50. Thus, the total outlay is SDG 170 or more. Better off households will usually have LPG cylinders from several companies to ensure reliability of supply in case one company is unable to deliver.

Table 1. Comparative cost analysis: charcoal and LPG for domestic cooking for a household of five to six members

Cooking fuel	Cost per day	Cost per month
Charcoal	SDG 2-4	SDG 60-120
LPG		SDG 15

Source: households in Soba AlAradi

The cash flow requirements for refilling the cylinder may also be a problem for poor households – around SDG 15 for a 12.5 kg cylinder. See Table 2. Instead, they purchase small quantities of charcoal each day. SECS estimates that a household of five to six people will pay SDG 2-4 per day for charcoal. There are other disincentives, particularly safety concerns in unplanned shanty town

areas where many houses are made of flammable material such as cardboard and sacks, for example in Haj Yousif. Also, women who are only used to traditional methods of cooking tend to prefer charcoal because the cooking takes longer and therefore the food tastes better.

In contrast, the benefits of using LPG for cooking are perceived to be cleanliness, the speed of cooking which frees up women's time for other activities, and prestige. For these reasons it is a more popular alternative than, for example, solar cooking. Despite safety concerns, interviewees reported that accidents associated with LPG have not been an issue and that safety awareness has risen. But a number did express concern about the age of many cylinders still in use and that this poses a safety risk. The LPG companies are not providing adequate maintenance by replacing old cylinders, neither is Sudan Civil Defence nor the Standards and Meteorology Organisation (charged with regulating the safety of cylinders) intervening.

Table 2. The cost of refilling a 12.5 kg cylinder with LPG

Khartoum - centre	SDG 12-15
Khartoum - peripheral areas	SDG 15-16
Gezira and Sennar	SDG 14-16
Nyala	SDG 35
El Fashir	SDG 30-35 in Fasher

Source: Dr Hood, pers comm

There have been a number of projects and interventions to encourage the substitution of LPG for fuelwood for domestic cooking. One of the earliest was by the Forestry National Corporation (FNC) in the 1990s, which subsidised the sale of cylinders. However, this was relatively short-lived. Again, in 2002, FNC engaged in a programme with Sudagaz to provide LPG cylinders to households – the Gabat-gaz project – but this ran into problems of refilling the cylinders due to the inadequate distribution network (Hood, 2010).

In the early 2000s, the government provided its employees with credit to buy LPG cylinders. A number of NGOs have also launched projects although mostly outside Khartoum. One of the most experienced NGOs in this field is Practical Action which successfully introduced LPG for domestic use in Kassala, principally for health reasons to reduce smoke inhalation, using micro-finance and a participatory approach (Bates, 2007). Practical Action is now promoting the use of LPG in North Darfur. Plan Sudan promoted the use of LPG in Kassala and White Nile, and SECS worked in two villages in Gedaref to increase the use of LPG (but faced problems of unreliable supply). There has not yet been a comparative review of these different experiences to capture the lessons that can be learned.

The impression gained from interviews for this study is that large-scale attempts to provide LPG cylinders on a loan basis have not been very successful in terms of repayment rates, borne out by the experience of the gas companies themselves, some of which have experimented with payment in instalments (e.g. Abarsi and Aman). However, smaller-scale community-oriented projects, like those led by NGOs, have been more successful although they are inevitably more demanding in terms of management to achieve this. These issues deserve follow-up.

4. Bakeries

There are two types of bakeries in Sudan – the ‘traditional’ bakeries that produce traditional Sudanese bread, and the ‘mechanical’ bakeries (in Khartoum located in the centre of the city) that produce conventional loaves of bread. The latter was associated with potassium bromide which has now been banned by the Ministry of Health because of concerns that it may be carcinogenic. This has led to increased demand for traditional bread, also because of the declining consumption of *asida*, in turn associated with increasing urbanisation and less time to cook.

According to Sayga Flour’s records, over 6,000 of the 7,000 bakeries in Sudan are traditional; in Khartoum there are around 500 traditional bakeries, 200 mechanical bakeries and just under 100 that are hybrid (i.e. use both diesel and firewood for energy)¹. The modern bakeries use diesel although some have apparently switched to LPG because it is cheaper. It is amongst the traditional bakeries that the big shift has occurred, from using firewood to stoke the ovens to using LPG burners.

Key informants interviewed for this study estimate that around 70-80% of traditional bakeries in Khartoum are now using LPG. In some areas, for example Sabreen, the switch began in earnest some three years ago. This was encouraged by Khartoum Locality which passed an act in 2005 that the commercial and services sector must convert to LPG from firewood and charcoal, although this does not appear to have been fully implemented.

Once again, there is a strong economic case for using LPG instead of firewood. See Table 3.

Table 3. Comparative cost analysis: firewood and LPG in bakeries

Cooking fuel	Quantity used per month	Cost per unit	Cost per month
Firewood	150 guntars	SDG 17/ guntar	SDG 2,550
LPG	Max of 2 tankfuls (0.5mt/ tank)	SDG 1/ kg	SDG 1,000

Source: bakers in Sabreen and Marzoug

A number of bakeries have funded the switch to LPG themselves. However, the technology available for baking with LPG is quite basic and there are industrial accidents. Since 2006, Sayga Flour has launched a major ‘green bakeries’ project across the country, assisting traditional bakeries to make the transition to LPG. Sayga subsidises the cost of the USD 1,400 burner (which is imported from Italy, and is regarded as superior and safer than the burners currently available on the market in Sudan) by USD 400. It also loans the instalment costs over five years. In return, the bakery is committed to purchasing its flour from Sayga for that period. As these are substantial costs we can assume that only bakeries with a high turnover are able to participate in the project. Nevertheless, it has been judged a success by Sayga Flour; there was high demand to participate in the project at the outset although this has tailed off as time has passed. Many gas suppliers provide the bakeries with free LPG tanks. This practice is now widespread and has been ongoing since about 2002.

¹ Sayga Flour is the largest flour company in Sudan, currently supplying 70% of the market.

Overall, the encouragement to bakeries to use LPG appears to have worked well in Khartoum, as well as in Medani and Gedaref, where LPG supplies are readily available and firewood is expensive. Elsewhere it has been less successful, either because the supply of LPG is not sufficiently reliable, or because of unreliable electricity supply (on which the Sayga-supported LPG burner depends, although the traditional burner does not), or because firewood is cheap (for example in Sennar and in El Obeid)².

Nevertheless, increasing the use of LPG by bakeries is predicted by the gas companies as one of the greatest potential sources of increasing demand. As more bakeries switch to LPG they anticipate that this could trigger demand for LPG, outstripping current levels of supply.

5. Brick kilns

Although brick-making has been identified as one of the most damaging causes of deforestation in Sudan (UNEP, 2007; UNEP, 2008), and the source of rising demand for firewood, the brick kiln industry in Khartoum appears to be in decline. In El Jereif, a traditional area for brick kilns on the banks of the Nile, the number is said to have dropped by about 30% in the past ten years; in Hillat Kuku it is said to have fallen by 50%³. This is mainly due to increasing use of alternative building materials, especially cement blocks which is being encouraged by government. Nevertheless, in an urban area like Khartoum there are still over 1,000 brick kilns in operation. Hood (2010) estimates that they account for around 35% of the total consumption of fuelwood by the brick-making industry in northern Sudan⁴.

According to those interviewed, almost all brick kilns in Khartoum are currently burning firewood in large quantities. See Table 4. Brick kiln owners in El Jereif, however, told us that four years ago they started to complement firewood with animal dung in the months immediately after the rainy season when it is available. Dung (*gargaf* – the residue of compacted cow dung and urine) is brought from dairy farms in Gezira. It is the preferred form of fuel because it burns better than wood and is cheaper, but is not available throughout the year.

Although the source of firewood has remained constant – in Blue Nile, Southern Kordofan and areas bordering Ethiopia – the price has risen sharply in recent years (see also section 7). The brick kiln owners attribute this to taxation and government restrictions on the firewood trade, corroborated by the traders themselves.

Table 4. Firewood consumption and costs for brick kilns

Amount of firewood used to produce 150,000 bricks	80 guntars
Cost of firewood 10 years ago	SDG 4/ guntar
Cost of firewood in 2009	SDG 16/ guntar

Source: brick-kiln operators in El Jereif

2 A further disincentive identified by some interviewees is when businessmen rent bakeries for short periods of time; the rapid turnover inhibits the take up of LPG technology.

3 Some brick kiln owners reported declining prices for bricks in the last 4 years.

4 The Khartoum locality authorities have made efforts to relocate the brick kilns outside the city, but this has been resisted because of the need for water and close proximity to the Nile.

The rising cost of firewood makes a compelling economic case for the substitution of LPG. According to trials and estimates from SOBMAC (a national NGO – the Sudanese Organisation for Building Materials and Construction) it costs twice as much to fire bricks with firewood at current costs in Khartoum than with LPG, and the firing time is cut by about a third with LPG⁵. However, there are still major technical problems associated with the LPG technology. The study team heard a number of stories from the brick-kiln operators of unsuccessful trials using LPG, funded and implemented by organisations such as the United Nations Industrial Development Organization (UNIDO), SECS, and individual businessmen.

The challenge remains to find appropriate technology that consistently produces bricks of superior quality using LPG. Initial indications are of a successful enterprise in Nyala where LPG is being used to fire 1,000 bricks in about six hours, a high percentage of which are of superior quality. Further research is needed to learn from this case. The brick kiln operators interviewed for this study emphasised that a reliable supply of LPG must be guaranteed before they would be prepared to make the investment necessary to switch to LPG, and this is currently not the case.

Firewood is also used in lime kilns, for which the greatest concentration in northern Sudan is once again Khartoum. However, in total these consume about a third of the amount of firewood consumed by the brick industry in Khartoum (as quoted in Hood, 2010).

6. Restaurants and tea-makers

The increased reliability of LPG supplies in Khartoum has been a critical factor encouraging restaurants to switch from fuelwood for cooking. The owners of the Acropole Hotel in Khartoum recount how they started using LPG many years ago, but always had to have back-up charcoal stoves for the periods when LPG was difficult to obtain. In the past decade this has changed and they can now rely totally on LPG for cooking. Preliminary investigations indicate the use of LPG by restaurants – small and large-scale – is very high. Restaurants usually use large LPG cylinders, of 25 or 50 kg.

In contrast, road-side tea-makers (almost always women, and numerous) are heavy users of charcoal. As with domestic households, there is a strong business case for the tea-makers to switch to LPG as the price of charcoal rises: it has doubled in the past five years. But there are major disincentives to do so. Not only would the installation costs be high, but tea-making is currently an informal and 'non-legal' livelihood activity. Tea-makers therefore face a high risk of having their assets confiscated. The Savings and Development Bank ran an experimental programme to supply tea-makers with LPG in 2003-2004, providing a 3 to 5 kg cylinder, a gas stove, shade, plus the basic ingredients. But this ran into problems with the local authorities; one tea-maker interviewed for this study who had been supplied with all of the above then had it confiscated by the local authorities on the grounds that tea-making equipment was not a formal business and was unlicensed.

The road-side nature of their trade also means that tea-makers have nowhere to store their stoves so they must be portable. The tea-makers interviewed for this study all buy the charcoal they need in the area where they live, and bring it in small quantities – usually three to five bags per day – to their area

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It takes 3 to 5 days to fire a brick kiln of 150,000 bricks using firewood, depending on the strength of the wind, according to brick kiln owners in El Jereif.

of work (one bag of charcoal is usually less than 1 kg, and costs SDG 1). Those interviewed are advocates for using LPG (and indeed some of them use it for their own cooking at home), but only if tea-making is 'legalised' and licences issued to protect them.

7. Firewood and charcoal trade in Khartoum

Overall, the trade in both firewood and charcoal has been declining in Khartoum for at least the past decade. This is immediately evident from figures on the number of traders in some of Khartoum and Omdurman's major markets. In Al Abasia market in Omdurman the number of firewood traders has halved in the past ten years, and the number of charcoal traders has fallen from four to one. In El Thora Shingiti market the number of firewood and charcoal traders has also halved compared with the mid 1980s. Many of the individual traders interviewed for this study, although still in business, reported that the quantities they now trade have fallen by 50% or more in the past five years. The main reasons are to do with declining demand for firewood and charcoal for domestic household consumption and from the bakeries.

7.1 Firewood

The ranking of consumers by a firewood trader in Al Abasia market is illuminating in terms of how demand for firewood has changed. See Box 2. Domestic households are no longer significant customers, and bakers have also dropped down the list. The brick kilns have now become the major source of demand.

Box 2. Changing demand for firewood: an example from Al Abasia market

A firewood trader in Al Abasia market ranked his main consumers of firewood in 2009 compared with 10 years ago as follows:

10 years ago	Now
Bakers	Brick kilns
Factories	Pottery makers
Brick kilns	Bakers
Pottery workers	Factories
Households	Firewood retailers

As already described above, the rise in firewood prices in Khartoum in recent years has been substantial, in some cases doubling in the past five years. Much of this is to do with rising taxes and transport costs, illustrated in Table 5 below.

Table 5. Tax and fee increases in the firewood trade

<i>Item</i>	<i>10 years ago</i>	<i>Now</i>
FNC tender for firewood from Blue Nile	SDG 18-20/m ³ 15 years ago	SDG 70/m ³ , but actually costs SDG 135/m ³ taking account of taxes and transport costs
Licences and fees paid by trader in Al Abasia market	Licence: SDG 100/ yr Tax to local authorities: SDG 250/yr Zakat: SDG 50/yr	Licence: SDG 500/yr Tax to local authorities: SDG 1,000/yr Zakat: SDG 250/yr Garbage disposal: SDG 360/yr TOTAL is more than SDG 2000/yr

Source: Firewood trader, Al Abasia market

The sources of firewood are more or less unchanged over the past ten years Ed Damazin in Blue Nile, Gedaref, Renk in Upper Nile, and Southern Kordofan. However, one trader reported receiving much of his current supply of firewood from the gardens around Khartoum as the land is cleared for farming.

7.2 Charcoal

A charcoal trader in Al Abasia market ranked his main consumers as:

- (1) restaurants;
- (2) tea and coffee shops; and
- (3) roadside tea makers.

The key client he has lost are domestic households as so many now use LPG, and many small shops in residential areas now sell charcoal in small quantities which meets the current domestic demand for ironing, grilling meat and making coffee.

Charcoal prices vary according to quality: charcoal from hardwoods is higher (e.g. SDG 45 per sack for charcoal from *Acacia nilotica*), while from miskeet (*prosopis*) – an increasingly common source – it is much lower (SDG 30 per sack). Overall, prices have mostly doubled in the past ten years just as LPG has become cheaper. Like firewood, the charcoal trade has been hit by rising taxes and fees. According to some interviewees, the retail price of charcoal (from miskeet) in Khartoum is seven times

the price paid to producers in Tokar, mainly because of taxes. Charcoal traders report that they can no longer hold significant stocks of charcoal through the rainy season when areas of production become harder to access because of the amount of capital this would require. Indeed, many transporters now choose to sell charcoal directly from their trucks to local shops for cash, rather than to wholesale charcoal traders on a credit basis as they used to.

The main sources of charcoal appear to have changed little in the last five to ten years, coming from Malakal, parts of Kosti, Gedaref and Upper Nile. But there is one important new source of supply since the end of the north-south civil war: Southern Kordofan.

8. A preliminary analysis of relevant policy issues

At the federal level there are a large number of different government departments with an interest in policy issues relating to LPG. Not only is this the domain of the Ministry of Energy, but the State Petroleum Administration, Civil Defence, the Ministry of Finance and the FNC all have an interest in the extent to which LPG replaces fuelwood as a source of energy, pricing levels (see below), and whether imports of LPG are permitted to keep pace with demand. A preliminary review of federal policy relating to LPG in northern Sudan indicates that it has not been consistent and that it has not yet prioritized increasing and stabilising the supply of LPG.

Since decentralisation, state-level policies have also had an impact on the use and take-up of LPG, particularly through fees and taxes. As described in section 7 above, firewood traders in Khartoum attribute a large part of the rise in firewood prices to increasing taxes imposed at the state level. This directly affects the economics in favour of substituting LPG for firewood. Some state governments have taken more draconian measures to reduce the use of firewood. For example, Khartoum State passed an Act to stop the use of charcoal and firewood in the commercial and services sector (as mentioned in section 4), although this does not appear to have been followed through.

In the absence of a clear policy direction on LPG there are cases of contradictory measures being taken at the federal and state levels. For example, at the federal level, taxes were removed from domestic appliances to use LPG but state governments (e.g. the Northern State) have then taken their own initiative in levying taxes on the transport of LPG.

As demand for LPG has started to outstrip supply in northern Sudan (and Khartoum in particular) this has forced one clear policy decision. Government has prioritized certain users of LPG – households, restaurants and bakeries – over others – the use of LPG for vehicles (now banned) and LPG for brick kilns. Despite these measures, many stakeholders in the LPG industry believe that imports will be necessary to keep pace with rising demand, but this may not be a popular option with all government ministries because of the foreign exchange implications.

The basic price structure for LPG is set by the Sudan Petroleum Company (SPC). SPC determines the price at the refinery gate, applying a subsidy of approximately 50%; in July 2009 the price of LPG in Sudan was USD 250/mt compared with the average world price of around USD 530/mt. The transport costs from the refinery to distribution points around Sudan are also supposed to be determined by government. In practice, however, there is some local variation in the price that different LPG distributors charge. Further research is needed to fully understand LPG pricing policy and practice in Sudan.

9. Conclusions

In the past ten years there has been a widespread shift to LPG by domestic households and by bakeries in Khartoum – traditionally two of the main consumers of charcoal and firewood respectively – supported by the economics. The costs of cooking or baking with LPG are half (or less) the monthly costs of cooking or baking with charcoal and firewood. Approximately 70% of households in the main urban areas, and three-quarters of traditional bakeries have made the switch. (In peripheral areas the percentage of households using LPG is lower, but may still be around half). These percentages are higher than in most other towns in Sudan, but indicate the potential for switching from firewood to LPG elsewhere in the country if the LPG distribution network was stronger and transport costs lower. Some LPG distributors predict that bakeries will continue to be a rapidly growing source of demand for LPG in the future. Even if the substantial subsidy on LPG (of around 50%) was lifted by government, it would still be marginally cheaper to use LPG than fuelwood in Khartoum.

The brick kilns in Khartoum are now the major consumers of firewood (although there is some evidence that this is an industry in decline). This is where there appears to be greatest potential for substituting LPG for firewood, dependent on two conditions being fulfilled: first, that the technology for firing bricks using LPG is improved and disseminated; and second, that current supply-side constraints on LPG are lifted to guarantee a reliable supply of LPG to the brick kilns. This is, above all, a policy issue as current policy clearly prioritizes domestic households and bakeries as the prime consumers of LPG.

Tea-makers are a significant source of demand for charcoal, and another potential market for substitution with LPG. This study indicates there may be an interest and willingness amongst some tea-makers to make the shift, but not in current conditions. It would require formal recognition of tea-making as a trade, and thus some protection of this livelihood source.

Although large quantities of firewood and charcoal are sold in Khartoum, the overall trend in the fuelwood trade in the capital is a declining one. This seems to be influenced as much by the wider policy context as by changing preferences for energy. Retail prices of both firewood and charcoal in Khartoum have doubled in the past five to ten years, mainly because of the range of taxes that are applied at state level between the source of supply and the market place in Khartoum.

This study has identified three issues that require follow-up to feed into the final analysis of the potential for scaling up the use of LPG in Sudan:

- (1) **Analysis of the policy context:** there are a wide range of stakeholders in the Government of National Unity involved in policy-making on LPG (and the choice of energy sources more generally). Government policy is perhaps the most critical factor determining the availability of LPG and therefore the potential for supply to meet rising demand in the future (for example through imports). Mapping the stakeholders and current policy priorities will help to understand the policy context.
- (2) **Capturing lessons on how to promote the uptake of LPG:** there have been a number of projects to increase the use of LPG in the past couple of decades, mostly targeted at energy use by domestic households. These have had a mixed record. A workshop to capture the lessons learned and what has worked is key to inform any future programming on promoting the uptake of LPG, especially amongst poorer households.
- (3) **Developing the technology for brick kilns to use LPG:** although experimentation with LPG in the brick kilns in Khartoum has had limited success, there is an opportunity to learn from the Nyala brick kilns that are using LPG apparently with greater success. This deserves further investigation and follow-up.

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Acronyms, abbreviations and definitions

ENTEC	Environmental Technology Task Force
FNC	Forestry National Corporation
LPG	liquid petroleum gas
Mt	metric tonnes
NGO	non-governmental organisation
SECS	Sudan Environmental Conservation Society
SOBMAC	Sudanese Organisation for Building Materials and Construction
SPC	Sudan Petroleum Company
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNIDO	United Nations Industrial Development Organization
VAT	Value Added Tax

Woodfuel: Woodfuels refer to all types of biofuels originating directly or indirectly from woody biomass, including fuelwood, charcoal and black liquor.

Fuelwood: Fuelwood refers to woodfuel where the original composition of the wood is preserved.

Annex 1 List of stakeholders interviewed

Please note: Where the name was not recorded during the interview, the name is only reported as 'official'.

Official	FNC
Omer Mohamed Kheir	Secretary General, Ministry of Energy
Idris Abdul Halim	Director of Supply, Ministry of Energy
Igbal El Sadig	Head of Renewable Energy Section, Ministry of Energy
Nizar Abul-Hameed	Administrative Officer, South Rural Locality, Omdurman
Mahjoub	Practical Action
Mohammed Hussein Hamid	SOBMAC, also University of Khartoum
Muwahia Shedad	SECS
Official	Institute of Environmental Studies
Yousif Suliman	Acting Manager, Abarsi Gas
Faisal Abdu Salaam	Commercial Manager, Aman Gas
Official	Commercial Manager, Iran Gas
Official	Director of Operations, Bee Gas
Hafiz Fatah El Rahman	Secretary General, Gas Agents Union
Lena Mahjoub	Dal Group – corporate social responsibility
Suzan El Sadig	Customer Services Manager, Sayga flour
Other officials	

Focus group discussions and interviews with current and potential users of LPG

For domestic use

Women from SECS local branch – Abrouf, Omdurman

Members of SECS local branch – Haj Yousif, Hai Al Wuhda, Bahri

Woman from Soba Al Aradi (25 km south of Khartoum), Khartoum

Bakeries

Chairman of the Bakers Union

Bakery owner, Tayef, Khartoum

Bakery owners, Sabreen and Marzoug, Omdurman

Brick kilns

Brick kiln owners in Giraif East, Hillat Kuku and Shambat, Bahri

Restaurants

Acropole Hotel, Khartoum

Tea-makers

Tea-makers in Al Soug Alarabi, Khartoum

Tea-maker in Al Soug Al Shabi, Omdurman

Focus group discussions and interviews with traders

Firewood and charcoal

Firewood and charcoal traders in Abbasiya market, Omdurman

Firewood and charcoal traders in El Thora, Omdurman

Firewood and charcoal traders in Hillat Kukuk, Bahri

Firewood and charcoal traders in Souq Libya, Omdurman

Firewood and charcoal traders in Sabreen, Omdurman

LPG agents

LPG agent, Jabra, Khartoum

LPG agent and charcoal retailer, GharbalHarrat, Omdurman

