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Energy Access: where are we going in Africa?

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Abstract

Access to modern energy services has been on the development agenda for several decades, focusing on electrification and other clean fuels such as LPG. Nevertheless, access to electricity and modern fuels remains low in Sub Saharan Africa. Traditional biomass, particularly woodfuel, remains a predominantly rural fuel, although charcoal use is high in many urban centres. One major problem with burning biomass in open fires is the smoke, which seriously affects health. Poverty is the largest barrier to the use of modern fuels and appliances. The availability and cost of biomass compared to other alternatives influences fuel choice, and is a barrier to the uptake of other modern fuels in many rural communities. This has been demonstrated in South Africa, where despite access to electricity and a portion of Free Basic Electricity, households in rural communities continue to use large quantities of biomass to meet their energy needs. This paper examines the continued use of woodfuel in rural areas, looking at changes in energy use in two Mpumalanga communities since electrification. It looks at alternatives to traditional woodfuel use for these communities in terms of energy cost and access to modern fuels, and explores the opportunities for and costs of modernizing woodfuel use.

1 Introduction

The use of traditional biomass by households received prominent attention after the FAO (Food and Agricultural Organisation) released a study in 1981 which predicted that a "fuelwood crisis" was developing. The study estimated that in 1980 around 2 billion people were dependent on fuelwood or other forms of biomass for their household energy needs, half of which could not meet their energy needs without overharvesting and that by 2000, based on an extrapolation of trends in population and deforestation, 2.7 billion people would be dependent on traditional fuels of which 2.4 billion would be in a situation of "acute scarcity or deficit" (Arnold, 2003).

The overharvesting and fuelwood crisis predicted by the FAO has not come to pass, although the current estimates are that 2.7 billion people are without clean cooking fuels (WEO, 2011). In many countries, particularly those that do not use charcoal, woodfuel use has resulted in only localized overharvesting. Generally much of the deforestation which has occurred can be attributed to land clearing for agriculture.

Many countries in Africa continue to have large fuelwood resources and woodfuel remains an important and dominant source of energy, fuelwood trade and productive use of fuelwood is also often an important source of income for the poorest of the poor in Africa. However health and other impacts of fuelwood use have kept access to modern fuels high on the development agenda. One of the major problems of burning biomass in open fires is the smoke which seriously affects health. It is estimated that by 2030 more people will die from breathing in smoke in the kitchen than from HIV/AIDS and tuberculosis combined (IEA 2010). These estimates are based on continued use of traditional biomass for cooking (the IEA (2011) estimate that 2.8 billion households will still be using traditional biomass in 2030) and many households will continue to lack access to alternative clean energy sources, for instance it is estimated that at least 1.2 billion households will still not have access to electricity in 2030. The growth of traditional biomass in Sub-Saharan Africa is likely to be higher than in most other regions or countries (IEA, 2006).

Poverty in Africa is the largest barrier to the use of modern fuels and appliances. The availability and cost of biomass compared to alternative fuels and appliances influences both fuel choice and the quantity used, and is a barrier to the uptake of other modern fuels in many rural communities. This has been demonstrated in South Africa, where despite access to electricity, and a portion of Free Basic Electricity in addition to social grants, households in rural communities continue to use large quantities of biomass to meet their energy needs.

Where households have access to electricity, it is often used in small quantities for lighting and other non-thermal uses. Thermal energy for cooking, water heating and space heating by households continues to be dominated by woodfuel. The International Energy Agency (IEA) (IEA, 2010) estimates that 80% of the SSA population (or around 653 million people) compared to 2.5% of North African population (around 4 million people) use traditional biomass, and that 85% of traditional biomass is used by househlds for cooking.

Energy poverty is a term often used to describe a lack of access to modern energy services and clean cooking fuels, Reddy (UNDP, 2000) describes energy poverty as *"the absence of sufficient choice in accessing adequate, affordable, reliable, high quality, sage and environmentally benign energy services to support economic and human development".* These types of definitions of energy poverty are driving the access debate, which for many years has focused on replacing traditional biomass with alternative modern, clean fuels. A challenge for Africa is: given the low electrification rates and the difficulties and costs of electrifying rural areas and the low accessibility and high cost of clean fuels, and given the widespread poverty and widespread access to and continued use of woodfuel, does modernizing woodfuel use present an attractive alternative to other modern fuels in the short to medium term.

2 Extent of traditional biomass use in Africa

Traditional biomass, particularly woodfuel use remains a predominantly rural fuel, although charcoal use is high in many of the urban centres in Africa such as Maputo and Lusaka. Table 1 shows the estimated percentage of population using

traditional biomass for cooking in Southern, Eastern, Western, Central and Northern Africa. The picture changes dramatically in Southern Africa when Mauritius and South Africa are excluded.

Table 1: Estimated percentage of households using biomass for cooking by region

Source: Adapted from WHO (2010)

	Rural	*Urban*
Southern	81%	27%
Eastern	98%	74%
Western	94%	51%
Central	98%	75%
Northern	8.2%	0.7%
Southern Africa excluding Mauritius and South Africa	97%	48%

Access to modern fuels remains low in many sub-Saharan countries. The Energy development index (EDI) developed by the IEA considers four factors: per capita commercial energy consumption; per capita electricity consumption in the residential sector; share of modern fuels in total residential sector energy use; and the share of population with access to electricity. Each indicator has an index which has as its minimum and maximum values the minimum and maximum values for the developing countries covered by the index. The EDI for several Southern African countries is shown in Figure 1. It is clear that in most countries the use of modern fuels for cooking is extremely low and that it is likely to be many years before the majority of the population has access to electricity.

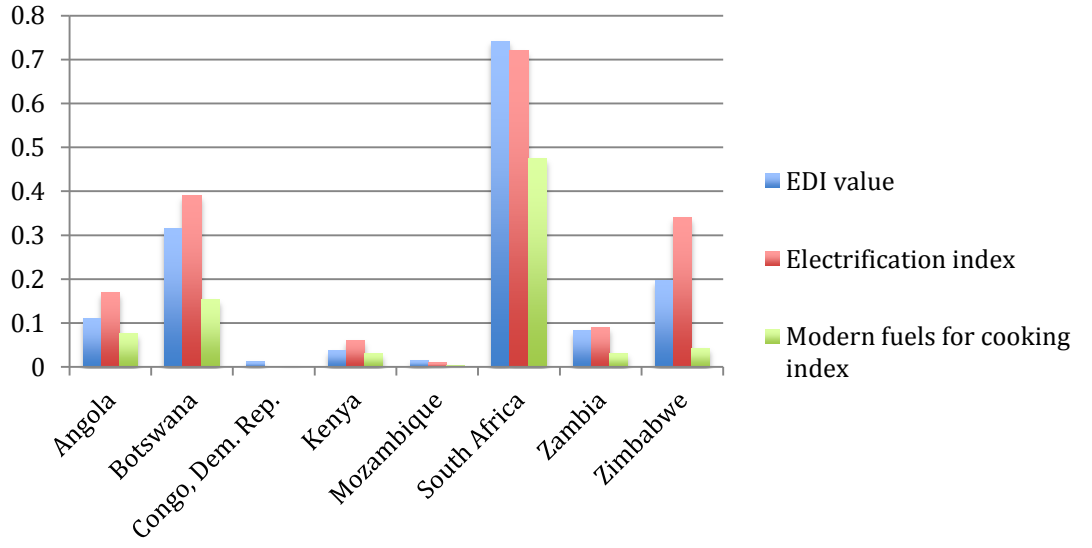

Figure 1: Energy Development Indicators (Source: IEA, 2010)

Poor households which have access to electricity tend not use it for cooking (Figure 2). In all sub-Saharan countries woodfuels are the most common cooking fuels. The only exceptions are Mauritius and South Africa where gas and electricity use is common (Figure 3).

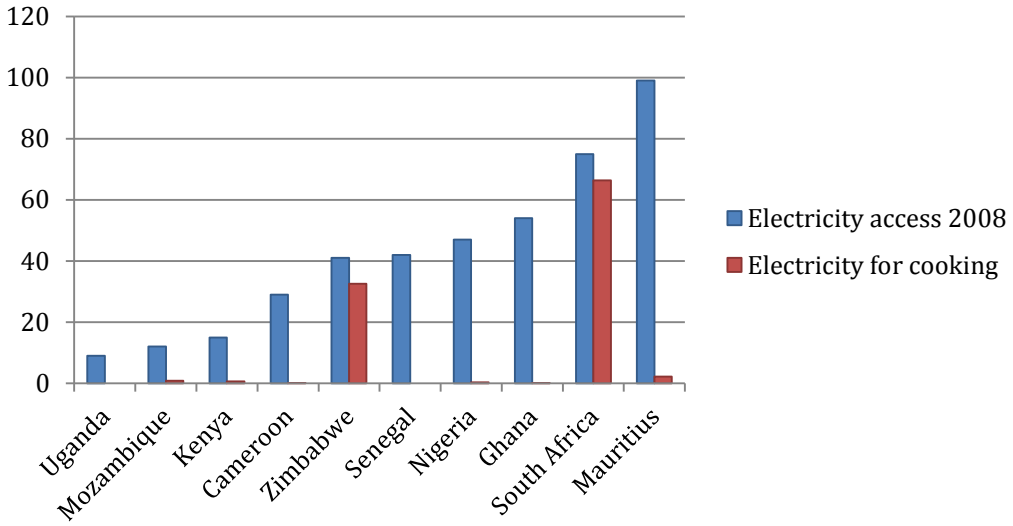

Figure 2: Access to electricity and use of electricity for cooking in sub-Saharan African households (Data source:Banerji et al 2009)

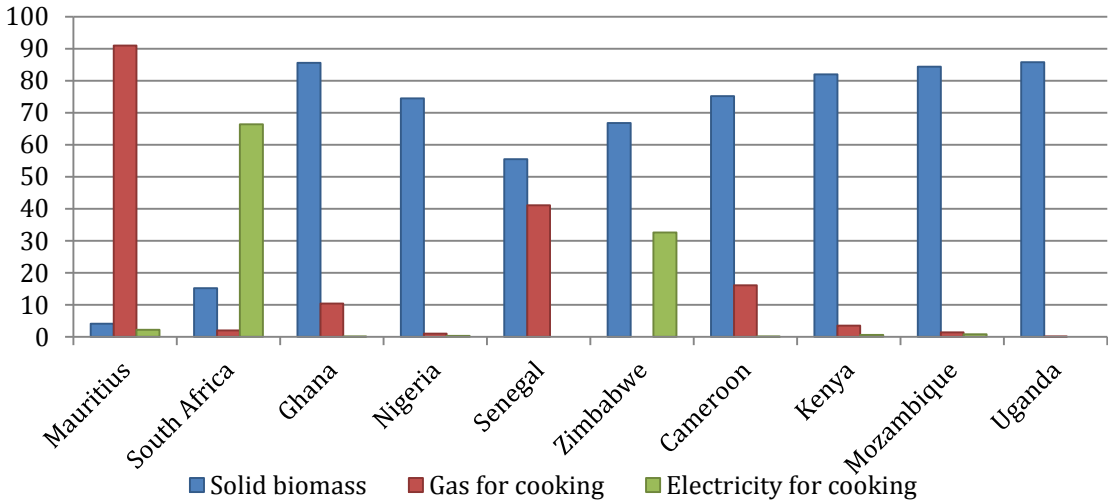

Figure 3: Cooking fuels in sub-Saharan Africa (Data source: UNDP and WHO 2009)

Although the majority of South Africans use electricity for cooking there are rural communities where almost all of the households in these communities depend on woodfuels for cooking. The following section takes a closer look as woodfuel use in South Africa.

3 Extent of traditional woodfuel use in South Africa

According to the 2007 Community Survey conducted by Statistics South Africa (StatsSA) households in several provinces in South Africa continue to use wood as their main fuel for cooking. Wood use is most prominent in the Eastern Cape, KwaZulu- Natal, Limpopo and Mpumalanga, all provinces into which former homelands were integrated. Figure 4 shows the percentage of households in each province using wood as their main fuel for cooking according to the 2007 Community Survey (STATSSA, 2007).

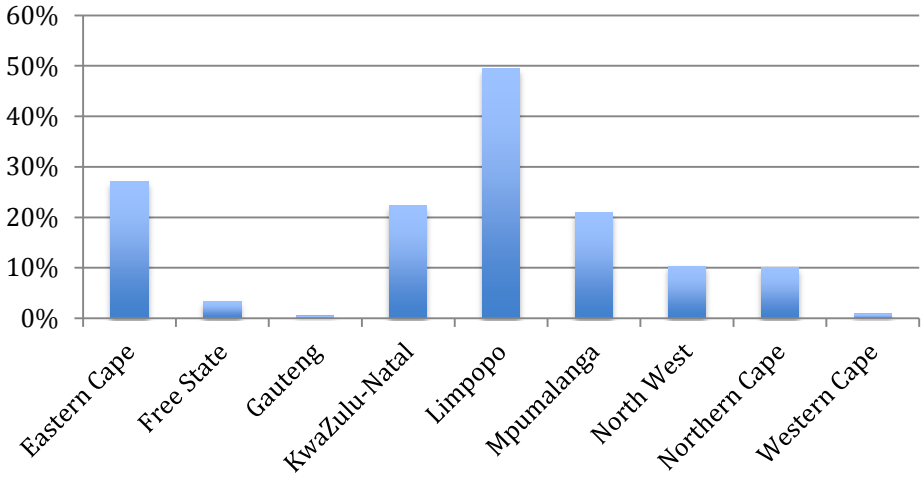

Figure 4: Use of wood for cooking in South Africa's provinces (adapted from StatsSA Community Survey 2007)

Electrification levels and the percentage of households using electricity, paraffin and gas as their primary fuel for cooking is shown in Figure 5. The figures demonstrate that many households which have access to electricity, paraffin or gas continue to use wood as their primary fuel for cooking. The use of wood as the primary fuel for cooking is largely confined to the lower income groups. Over 90 percent of the households that recorded using wood as their primary fuel for cooking, earned less than R76000 per year in 2007 (StatsSA, 2007)

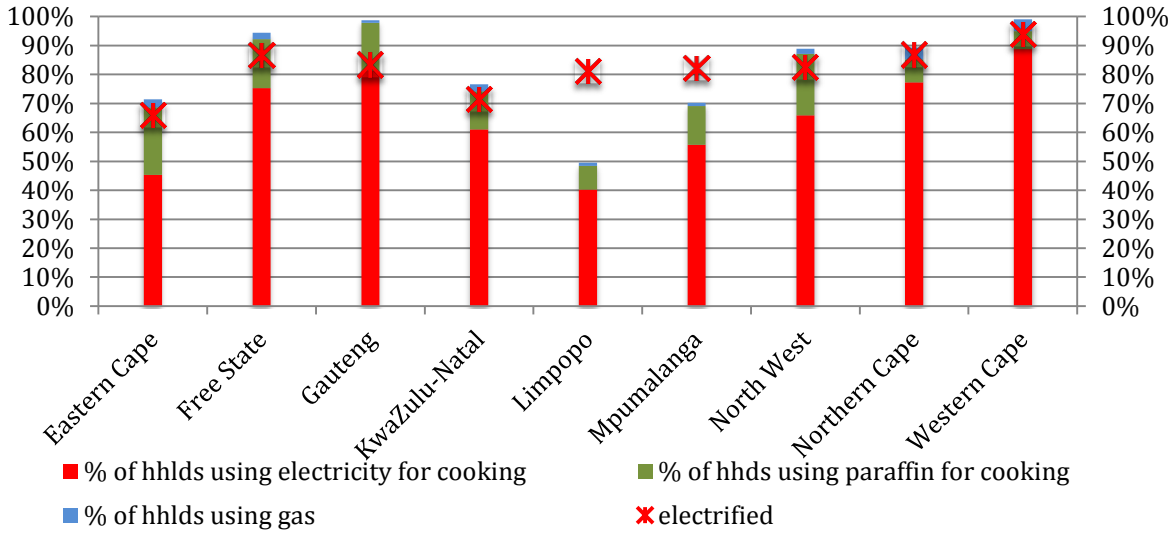

Figure 5: Electrification and the percentage of households using electricity, gas and paraffin for cooking in South Africa's provinces (adapted from StatsSA Community Survey 2007)

Estimates of the quantities of fuelwood used by households are very difficult to establish as traditional biomass is typically a non-commercial fuel and consumption is difficult to measure accurately even with small focused surveys. However, assessing the drivers and determinants of fuelwood use are critical to establishing the reasons for the continued use of fuelwood and the viability and appropriateness of alternatives. With this in mind a survey was carried out in two villages in Bushbuckridge, Mpumalanga, an area where fuelwood use remains high (Table 4) despite many of the households having been electrified for over 5 years. It is clear from the table that whilst many households are electrified, wood remains the dominant fuel for cooking, heating water and space heating in this area. The following section describes the villages, the survey method and fuel use patterns.

4 South African case study on woodfuel use, cost and supply

4.1 Description of the two villages, Welverdiend and Athol

Welverdiend and Athol fall under the Bushbuckridge municipality in Mpumalanga. Bushbuckridge is situated in the lowveld in the Savanna biome of South Africa. This biome covers almost a third of the total surface area of South Africa and supports at least 9.2 million people living in the rural areas. The Savanna biome is characterized by rolling grasslands, scattered shrubs and trees. Bushbuckridge encompasses the former Gazankulu and Lebowa homelands, both Athol and Welverdiend were formerly part of Gazankulu. The boundaries of both Athol and Welverdiend, which encompass the communal woodlands, are in strait line rhomboid fashion, there is a fairly dense settlement of houses in the centre. There is a local headman and chief and fuelwood harvesting within the communal woodlands falls under their control.

As of 2009, there were approximately 1500 households within Welverdiend. Athol is a relatively small village with around 550 households. Athol lies around 30 km from Welverdiend along a dirt road, with another village Hluvukani separating the two villages. The nearest town, Acornhoek, is around 40 km away although both villages have several small shops, supplying food, fuel and minor appliances such as paraffin lamps and stoves.

4.2 Data sources

This study draws on three separate surveys in Athol and Welverdiend completed in 1991, 2002 and 2009. In 1991, 56 and 46 households were surveyed in Athol and Welverdiend respectively. In 2002, 49 and 80 households were surveyed in Athol and Welverdiend respectively. In May 2009 a survey of 140 and 137 households was carried out in Athol and Welverdiend respectively. During the

2009 survey households were selected randomly using aerial photographs and a random number generator. The sample size applies to all tables and graphs in the paper.

4.3 Household income

Income levels of rural households are extremely hard to measure. Households are often not aware of income earned through migrant labour, or the total income earned by family members, however they know how much they have available to spend. Although income is a poor measure of affluence, particularly in rural areas where households have access to land on which to grow crops and livestock, nevertheless an income comparison is provided in Table 2. For 2009 both the estimated total household income as well as income available to the household to spend is recorded in the Table (for sample size see section 4.2). What is of particular interest is that in the 2009 study, in both Welverdiend and Athol, a large percentage of the household income is from social grants (mainly child grants) however, total household income does not appear to have increased proportionally and the money available to households to spend on food, fuel, appliances and other household necessities is very low, particularly when you consider that the mean household size in Athol and Welverdiend was 5.2 and 6.3 respectively in 2009.

Table 2: Household income (2009 rands)

Athol		**1991**	**2002**	**2009 Total income**	**2009 available to household**	**% of income from social grants**
	Mean	1668	2072	1803	1332	43%
	Median	1610	1515	1500	1075	33%
	Min	35	149	240	150	0%
	Max	5250	8408	6480	5000	100%
Welverdiend						
	Mean	1433	3010	1911	1399	58%
	Median	1138	2228	1630	1220	59%
	Min	350	446	20	20	0%
	Max	4970	10398	7210	4500	100%

4.4 Fuel use

In 2009 the majority of households surveyed in both Athol and Welverdiend were electrified. Table 3 shows the percentage of electrified households in the 1991, 2002 and 2009 surveys, and the percentage of households which reported using wood as their main fuel for cooking in each of these years. The number of households in the sample group was far larger in 2009 in both Athol and Welverdiend (see section 4.2), and therefore the high number of electrified households in the Welverdiend sample in 2002 versus 2009 does not necessarily indicate such a dramatic decrease in electrification levels, although the high number of unelectrified households in the 2009 sample in Welverdiend is largely

due to increases in household numbers over the years, as well as an influx of households from Mozambique which were not supplied with electricity connections. What is very clear in Table 3 and Table 4 is that electrified households continue to use wood for cooking, almost without exception. Households frequently use wood in combination with paraffin, electricity or gas. The main reasons for not using wood related to time pressure or weather.

Table 3: Percentage of electrified households in survey

	Electrified households			**Households using wood for cooking and space heating**		
	1991	**2002**	**2009**	**1991**	**2002**	**2009**
Athol	0%	0%	88%	97%	94%	87%
Welverdiend	0%	96%	63%	90%	78%	96%

Table 4 shows the percentage of households using wood, electricity and paraffin as their main fuel for cooking in Welverdiend and Athol in the 2009 survey. Wood is still the dominant source of energy for all thermal uses. Space heating is an outside activity, possibly because the houses in the area were built with tin roofs and without ceilings or a fireplace, making space heating indoors a costly and inefficient activity. However, many households reported not feeling a need to space heat citing the use of blankets as an alternative. Many studies over the years have reported the combined benefit of wood use for cooking and space heating, as an added attraction of wood use, this is seen in Welverdiend and Athol although not to a large extent.

Table 4: Main fuel for cooking, recorded for Welverdiend and Athol in 2009

	Main fuel for Cooking			**Main fuel for Space Heating**		
	Wood	**Electricity**	**Paraffin**	**Wood**	**Electricity**	**Paraffin**
Athol	86%	13%	0%	54%	0	0
Welverdiend	87%	10%	1%	64%	0	0

4.5 Cost and availability of fuel

Households in the area purchase gas, paraffin, electricity, candles and wood. Paraffin, electricity and candles, as well as small appliances are available from village shops which are generally within easy walking distance of households. Appliances such as electric hot plates are available for cash or credit at the pension day markets. Figure 6 shows the monthly electricity consumption of electrified households in both 2002 and 2009, and the kWh of electricity used in 2009 (assuming each household receives 50kWh of free basic electricity). The majority of households in Welverdiend were electrified in 1998, the amount spent by households on electricity appears to have remained largely the same.

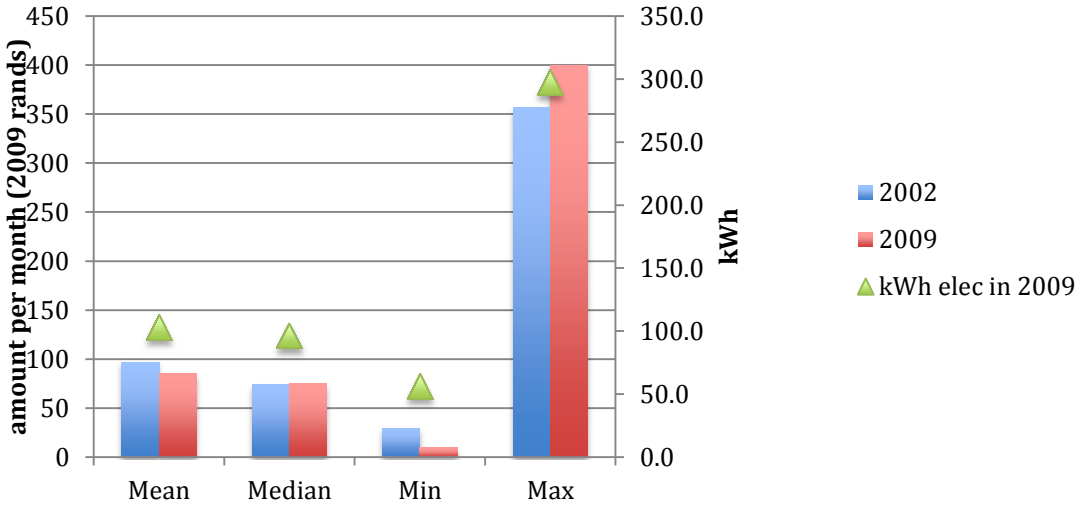

Figure 6: Electricity use in Welverdiend

Over the years the number of households buying fuelwood has been increasing as shown in Table 4. Fuelwood is bought by the bakkie or wheelbarrow load. The cost of fuelwood from a bakkie is relatively cheap at between R250 and R300, however the cost of fuelwood from a wheelbarrow is expensive at R 30 to R 50 for a wheelbarrow. Households which do not buy fuelwood cited the cost of fuelwood as the main reason for collecting wood. The most common reason for purchasing was that households are not able to collect, either because they cannot perform the labour required, or they are afraid of being caught and fined (what happens to the fines or how exactly they are implemented differed by village and was difficult to establish, it also appears that no fines were implemented on weekends). A few households mentioned that they purchased firewood due to the quality and low moisture content of the purchased wood.

In Welverdiend the majority of households (74%) indicated that they were able to collect sufficient wood for the households needs, 36% of households could not access sufficient wood for their needs. This leads to a high percentage of households that either rely only on purchased firewood (15%) or collect and purchase firewood (18%).

Of the households surveyed in Athol, 95% of households indicated that they were always or mostly able to access sufficient fuelwood, only 5% of households indicated that they had difficulty accessing sufficient fuelwood for their needs. This could explain the lower percentage of households purchasing wood in Athol.

Table 5: households purchasing fuelwood

	1991	**2002**	**2009**
Athol	1%	8%	9%
Welverdiend	19%	20%	34%

Collection of wood from the surrounding communal woodlands is still the most common method for obtaining wood. The most common method of carrying firewood back to the homestead is by wheelbarrow, which allows fairly large loads to be carried by a single person. It has over the years become harder to

collect wood, with very little dry wood being available. Although it is in theory "illegal" to cut live bushes to collect wood, the majority of households collect wood in this way. The bushes cut are a fast growing coppicing variety of acacia and grow in thickets fairly close to the village. Collection times recorded during the 1991, 2002 and 2009 surveys are shown in Table 6. In 2009 the average time spent per person per collection trip was 4.6 and 3 hours for Welverdiend and Athol respectively. The opportunity cost of collection is therefore high both in terms of time and energy.

Table 6: Time spent colleing wood 1991 and 2009 (hours/week)

	1991		2009		
Athol	**Winter**	**Summer**	**Nov to Apr**	**Winter**	**Aug to Oct**
Mean	19.4	24.6	11.7	17.4	11.7
Median	12.0	18.0	9.0	16.0	9.0
Welverdiend					
Mean	8.8	13.2	13.0	23.6	16.8
Median	5.0	9.0	6.0	14.0	10.0

Household spending on paraffin and candles is generally low, candles are generally only used by electrified households when there is a power failure and power failures occur infrequently. Paraffin is used by 35% of households for lighting and 5% for cooking, it is also largely an alternative where households are not electrified, or for cooking when it is raining or households are in a hurry.

Despite the low efficiency of wood use, particularly with an open fire, and taking into account that the estimate of the weight of a bakkie load of wood (500kg) could be incorrect, nevertheless wood is very cheap compared to the other commercial alternatives, paraffin and electricity. Paraffin wick stoves with low efficiencies are more expensive than electricity, whilst paraffin primus is comparable (Table 7).

Table 7: Fuel cost of cooking

cost of fuel	**2009 rand cost**	**Cost R/MJ 2009**	**assumed efficiency**	**Cost (R/MJ) cooking**
wood open fire	0.55R/kg	0.03	11%	0.31
wood stove			25%	0.14
paraffin wick	11.5R/l	0.31	40%	0.78
paraffin primus			57%	0.55
electricity	1.61 R/kWh	0.45	74%	0.60
candles (pack of 6)	12 Rand for 6			

4.5.1 Appliance Ownership

Cooking appliance ownership is recorded in Table 8. There are far more households who own an electric hotplate or stove than the number that use electricity as their primary fuel for cooking probably indicating that they occasionally cook with electricity. In Athol a number of households owned a

stove and a hotplate, the percentages recorded in Table 8 are for working appliances only, although there is no indication of how well they were working. An electric hotplate could be purchased in the village for R150 or R200 on credit.

Table 8: Appliance ownership

Cooking appliances	Paraffin	Gas	Electric hot plate	Microwave	Electric[1] Stove with oven
Athol	1%	1%	40%	14%	33%
Welverdiend	10%	4%	34%	12%	47%

5 Alternatives to traditional biomass and opportunities for modernizing fuelwood use

Alternatives to traditional biomass which are commonly pursued through both country policy, NGO's and other organisations are gas (LPG), electricity, biogas, paraffin or ethanol. The IEA (2011) estimate, in the energy for all scenario, that the cost of supplying clean cooking facilities to households in sub-Saharan Africa by 2030 would be US$22 billion. The clean cooking facilities considered are biogas digesters at an estimated cost of US$924, LPG cylinder and stove at a cost of US$60 and advanced biogas cookstoves at a cost of US$50. In their assessment of cost, they do not consider the cost of fuel to the household, which from the study of households in both Welverdiend and Athol is the major barrier to the use of alternative fuels. The strategy of supplying households with appliances on which to cook with alternative fuels is unlikely to modernize fuel use in rural areas where households are poor and fuelwood is readily accessible. Modernizing fuelwood use (both wood and charcoal) therefore provides a valuable short to medium term alternative, allowing collection times and emissions to be reduced.

Currently cooking and water heating with woodfuel is done at low efficiencies commonly around 10% on an open fire. Improved cookstoves which are based on simple designs, loclly available materials and manufactured by local artisans, offer efficiency improvements of up to 50% and emissions reductions of around 40%. None of the households surveyed in Welverdiend and Athol were using improved cookstoves, whilst there is a cost associated with purchasing the stove, stoves are often manufactured by local artisans at a relatively low cost of around $20.

Electrified households in Welverdiend and Athol using wood for cooking cited the cost of electricity as the main barrier to using electricity for cooking. Critical however to the adoption of improved woodfuel cookstoves is their perceived value, and ease of use. To this end cookstove design has focused recently on including communities during the design phase, as well as testing of efficiencies both in the field and in laboratories at a variety of cooking speeds. Behavioral changes offer additional potential for improvement.

[1] This is the percentage of electrified households that own an electrical stove or hotplate

6 Conclusion

Universal access to electricity, cleaner cooking fuels and stoves is necessary to alleviate poverty, promote social and economic development and improve human health and well being. In sub-Saharan Africa 653 people still rely on traditional use of solid biomass - that is 81 % of the population. Out of these 89% live in rural areas and 46% in urban areas. Extrapolating from global figures 360 000 people in sub-Saharan Africa die prematurely from inhaling smoke from open cooking fires.

Poverty is the major reason why people cannot switch to modern cleaner energy services. Even if people have an electricity connection most of them cannot afford to use electricity for cooking. South Africa is an exception and over 65% of households cook with electricity, but in many rural areas people are too poor to afford cooking with electricity although they have an electricity connection in their home. Households continue to use woodfuel, despite the inconvenience of collection and use, citing the benefits of low cost and fast cooking as the main reason for the continued use.

Whilst gas, ethanol, biogas and electricity present attractive alternatives as modern fuels for cooking, it is likely that, due to the high cost associated with their use, poor households in sub-Saharan Africa will continue to rely on fuelwood (both wood and charcoal) for many years to come. Fuelwood production and trade is also an important source of income for poor households in many countries.

The savings of using improved biomass cookstoves can be significant, improved cookstoves can reduce consumption by 20-50%, and emissions by up to 40%. Improved stoves can also be locally manufactured and designed to suit the cooking methods of the users. Where modern fuels are not readily accessible or affordable, improved fuelwood cookstoves should be considered as a short to medium term alternative. Programmes such as the Global Alliance for Clean Cookstoves, which include the provision of improved biomass cookstoves in their agenda are therefore essential to improving energy access for communities in Africa.

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