CHANGES IN ENERGY USE PATTERNS IN THE BUSHBUCKRIDGE LOWVELD OF THE LIMPOPO PROVINCE, SOUTH AFRICA: ELEVEN YEARS ON

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ABSTRACT

This research reports on the energy transition that has taken place in the Bushbuckridge district between 1991 and 2002. It is a follow up to a similar study that was done in 1991 investigating a number of aspects of energy use. It uses the 1991 study as a baseline and aims to explore how the passage of time, growth of the local population and changes in incomes and the availability of fuels have affected the patterns of fuel use in the region in the past eleven years. A structured interview approach was used for most aspects of the study. The interview schedule included sections on types, amounts and reasons for use and non-use of 13 different energy sources as well as data on income levels, household size and other economic parameters.

Analysis of the consumption patterns of the different fuel types revealed that between the two survey periods, households in the sample settlements went through some pronounced changes in patterns of fuel use, particularly those that had acquired electricity. The introduction of electricity in the region had certainly played a major role in spurring the energy transition. Fuels that were previously used for lighting, powering entertainment appliances and refrigeration had been displaced by electricity. In terms of cooking and other thermal application, however, the vast majority of households in all the sample settlements continued using fuelwood and complemented it to a lesser extent with paraffin and electricity.

In both surveys, the use or non-use of available fuels in the region was influenced by several factors. Common reasons for non-use of certain fuel types included expense, lack of appliances, the risk involved in using such fuels and the preference for other fuels. Reasons for use were mainly related to the low cost of the fuel and the fuel's ability to meet particular end uses.

Although incomes in the region had increased between 1991 and 2002, they were still below the poverty line. Activities from which households obtained their income remained the same. Old age pension, migrant wages and the informal sector remained the largest contributors of income to most households. Other indicators of relative wealth and poverty, like ownership of vehicles, bicycles and beds remained the same.

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CHAPTER ONE

INTRODUCTION

1.1 FORMS OF ENERGY

Energy is a fundamental and strategic tool to even attain the minimum quality of life (Ramachandra *et al.* 2000). It provides services to meet many basic human needs, such as cooking, warmth, light, and motive power (e.g. transport) (Postnote 2002). Its critical input in social and economic development has been recognised universally: business, industry, commerce and communication are highly dependent on access to energy services (Kaygusuz 2003). There is a direct relationship between the absence of adequate energy services and many poverty indicators such as infant mortality, illiteracy, life expectancy and total fertility rates (IEA 2000). Inadequate access to energy also exacerbates rapid urbanisation in developing countries, by driving people to seek better living conditions (Postnote 2002). Because of its importance to human needs satisfaction, it is, therefore important that the energy system is properly governed and for this, a good understanding of the energy system is necessary.

In the last two centuries, the energy constraints progressively loosened with the possibility of drawing from various concentrated sources, and today various forms of energy are used to meet global demand (Kaygusuz 2003). These can be considered into two categories: primary and secondary (Baird 1993). Primary energy is the energy from natural resources, such as wood, coal, oil, natural gas, natural uranium, wind, hydropower and sunlight (EEA 2003). Secondary energy is the more useable form to which primary energy may be converted, such as electricity and petrol. Primary energy can be classified further as renewable and non-renewable (Baird 1993). Renewable energy is any energy resource that is naturally regenerated over a short time scale and is derived from the sun (such as thermal and photo electric) or from other natural movements in the environment (such as geothermal and tidal energy) (EEA 2003). These harness energy directly from solar radiation, wind, water flow or solar energy gathered and stored by plants and animals that eat them. Non-renewable energy is any energy form that is derived from a source that is not replaceable or is replaced only very slowly by natural processes (Edwards-Jones and Howells 2001). These generally come out of the earth as liquids, gases and solids.

1.1.1 Renewable energy forms

Biomass, hydroelectric, wind, solar and geothermal energy are the common forms of renewable energy (Baird 1993). Other less popular forms are tidal and wave power.

Biomass energy refers to the solid carbonaceous materials derived from plants and animals (Bari *et al.* 1998, Kaygusuz and Turker 2002). These include fuelwood and residues of agriculture, animal wastes and wastes from processing operations. Biomass can be used for energy production through direct combustion, as is the case in many developing countries, or can be used in bioenergy technologies to produce an array of energy related products including electricity, liquid, solid and gaseous fuels (Larson 1993). The latter form of use is popular in developed countries. For example, bioenergy ranks second (to hydropower) in renewable U.S primary energy production and accounts for three percent of the primary energy production in the United States (Hall and Serase 1998). Many different types of biomass can be grown for express purpose of energy production or can be obtained from the naturally occurring woody vegetation (Heller *et al*. 1995). Crops that have been grown for energy production include: sugar cane, corn, sugar beets, grains, elephant grass and many others (Baird 1993). These generally have very high yield of dry material per unit of land (dry tonnes per hectare). Biomass, if used in a sustainable manner, results in no net increase in atmospheric CO_2 (Yamamoto *et al*. 1991). This is based on the assumption that all the CO_2 given off by the use of biomass fuels was recently taken off from the atmosphere by photosynthesis. However, biomass use in most developing countries is leading to deforestation both for either domestic small scale or large scale for industrial purposes (Hall and Serase 1998). Use of biomass for heating and cooking in developing countries is also the major cause of indoor pollution and health hazards, particularly to women, small children and elderly (Bruce 2002).

Hydroelectric energy is generated by power plants that convert the kinetic energy contained in falling water into electricity (Montanari 2003). Falling water can be channelled through a turbine that converts the water's energy into mechanical power. This in turn rotates the turbines to generate hydroelectric energy. This is currently the world's largest renewable source of electricity (Baird 1993). The most oblivious impact of hydroelectric dams is the flooding of vast areas of land, much of it forestry or used for agriculture. Decaying vegetation by damming, may give off quantities of green house gases (Swirbul 2001). Damming a river can also alter the amount and quantity of water in the river down stream as well as preventing fish from migrating up stream to spawn (Johnson *et al*. 2000).

Geothermal energy is the energy recovered from the heat of the earth's core (Lund 2003). It can be extracted from four different types of geologic formation: hydrothermal, geo pressurised, hot dry rock and magma (Baird 1993, Gorecki *et al*. 2003). Each of these different reservoirs of geothermal energy can be potentially used for heating or generating electricity. Different extraction and processing techniques are required for the different sources of geothermal heat. Geothermal energy is safe relative to the other fuels but uncontrolled venting can cause release of unwanted gasses like sulphur dioxide (Baird 1993).

Solar technologies use the sun's energy and light to provide heat, light, hot water, electricity and even cooling for homes, businesses and industry (Kaygusuz 2002). Different techniques are used for this purpose. Concentrating solar power technologies use reflective materials such as mirrors to concentrate the sun's energy (Ekechukwa and Ugwuoke 2003). This concentrated heat energy is then converted into electricity. On the other hand, solar hot water heaters use the sun to heat either water or a heat transfer fluid in collectors (Cardinale *et al*. 2003).

Tides can cause huge quantities of water to rush back and forth as they ebb and flow (Howes and Fainberg 1991). This movement of water is the one that is used to drive generators that produce electricity (Bahaj and Myers 2003). To tap this energy, a dam or barrage is built across the mouth of the river or across an inlet and water turbines are installed in the barrage wall (Baird 1993). As the water rushes in and out it drives the turbines that in turn generate electricity. The barrage has some environmental effect in that it may lessen the flushing action of an estuary reducing the water quality.

The other form of renewable energy is wave energy. This type of energy can be found where winds are strongest, usually across oceans (White 1989). The devices used to capture this energy float on the surface of the ocean and use the up and down movement of the water to generate electricity (Falnes and Lorseth 1991). At the present this technology is expensive and because most places have other energy options, there has been little development of this technology (White 1989).

1.1.2 Non renewable energy forms

Primary examples of non-renewable energy forms are fossil and nuclear energy forms. Fossil energy comes in three major forms: coal, oil and natural gas (Baird 1993). These are derivatives of prehistoric plants and animals that lived millions of years ago and decomposed slowly into organic material (Kaygusuz 2002). Different types of fossil fuels were formed depending on what combination of animal and plant debris was present, how long the material was buried and what condition of temperature and pressure existed during decomposition (Howes and Fainberg 1991). Oil and natural gas are thought to have originated from the remains of microscopic marine organisms that decomposed at the bottom of the seas and oceans (Baird 1993). These were transformed at high temperature and pressure into crude oil and gas. They then squeezed out of the marine shales in which they were deposited, and made their way into porous sedimentary rocks such as sandstones and limestone. Coal on the other hand was formed from the plant material that accumulated millions of years ago (Kaygusuz 2002). Over years the organic material was compacted under the weight of the underlying sediments and was transformed into coal (Baird 1993).

Today, crude oil is extracted from oil fields and refined into many different products including: paraffin, gasoline, lubricants, paints and many other products (Rejowsky and Pinto 2003). These products are used for a number of tasks including: space heating and cooking in residential and commercial buildings and to generate electricity (Griffin *et al*. 1992). They are also used to provide energy for over 95% of the world's transportation (Cuff and Young 1986). Coal is mined and burned directly in stoves for cooking, space heating and water heating (Murray *et al*. 2003). It's also used to provide steam to generate electricity and power other industrial machines. Natural gas is used for coking, heating and fuelling other types of home appliances (Howes and Fainberg 1991). Combustion of fossil fuels results in oxidant gases containing carbon dioxide (CO_2), carbon monoxide (CO), sulphur dioxide (SO_2), nitrous oxides (NO_x) and particles (IPCC 2001). CO_2 and CO are green house gases associated with global warming while SO_2 contributes to acid rain (Baird 1993).

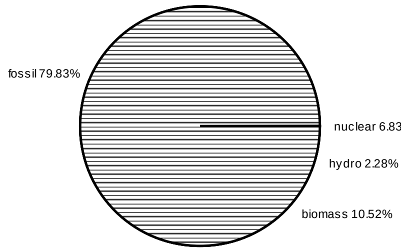
Nuclear energy is a source of energy that is not a fossil fuel, but is also found under ground. Uranium or Plutonium is mined and taken to nuclear power plants where its tiny atoms are split apart (Kodochigov *et al.* 2003). This can occur very quickly as in an atomic bomb, or in a more controlled manner allowing the energy to be captured for useful purposes (Baird 1993). The nuclear material is used in reactors to boil water to produce steam that is directly fed through a turbine to generate electricity (Salameh 2003). The effects of nuclear reactors can be divided into those occurring from an accident and those occurring during normal operations (Baird 1993). Accidents usually release huge amounts of radiation exposure to the land and water around the accident site and could become unfit for human habitation for thousands of years. Effects occurring during normal operations include low levels of radiation during operation and disposal of wastes. Several studies have claimed to discover high levels of cancer such as leukaemia and birth defects in those living near nuclear plants (Cuff and Young1986).

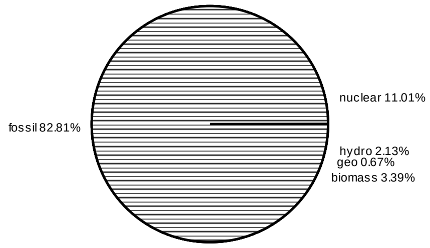
1.2 GLOBAL BREAK DOWN OF THE VARIOUS ENERGY FORMS

Estimates of total global distribution of the various energy forms are given in Fig. 1 (IEA 2001, IEA 2002). Fossil fuels are the largest contributors of global energy and account for 79.83% of total energy used worldwide. Both developed and developing countries use large amounts of fossil fuels in the form of coal, oil and natural gas. The overall annual world consumption of fossil fuels is estimated at 330 EJ (IEA 2001). Fossil fuels in the form of petroleum provides the energy for over 95% of the world's transportation needs (BP 2001), while coal plays a crucial role in the energy mix as one of the largest sources of electricity in most developed countries (USDOE/EIA 2000). Production of fossil fuels, particularly oil, is expected to reach its peak between 2004 and 2005 and this may cause a serious energy shortage to develop sometime between 2008 and 2010 (Salameh 2003)

Biomass energy, mainly in the form of fuelwood contributes about 10.52% of total energy use worldwide (IEA 2001). About 2.5 billion people (half of the world's population) are dependant on biomass for their cooking, heating and lighting (Karenzi 1994). Most of these people live in developing countries. It also plays a significant role in a number of developed countries, for example, the USA obtains 4% of its energy from biomass, and Sweden about 14%; both countries have plans to increase bio energy production and use (Hall 1991). Ongoing technological advances offer the promise of biomass being able to turn into more desirable forms of energy (such as electricity and gaseous fuels) in ways that are both environmentally friendly and economically competitive with fossil fuel alternatives (Bruce 2002).

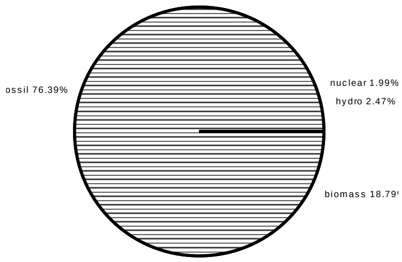
Nuclear energy contributes about 6% of the total energy consumed worldwide (IEA 2001, IEA 2002). It's mainly used in developed countries to generate secondary energy in the form of electricity. In the USA, it provides about 22% of all the electricity generated and it's responsible for about 70% of France's electricity (US DEO/EIA 2000). In Africa, South Africa is the largest consumer of nuclear energy (DME 2000). It provides about 3% of the country's total energy supply.





(a) World (IEA 2001, IEA 2002)
Total=414.6 EJ

(b) Developed countries (IEA 2001)
Total=222.6 EJ



(c) Developing countries (IEA 2002)
Total=192
(Note: 1 EJ = 10^{18} Joules)

Fig. 1. Global breakdown of the different energy forms**.**

Globally, geothermal energy contributes about 0.53% of the total primary energy demand (Fig. 1). About 59 countries utilize geothermal energy for either electric generation or direct use (IEA 2001). America and Asia are the largest producers and consumers of geothermal energy accounting for about 81% of total world consumption and much of it is used for electricity generation (USDOE/EIA 2000). Africa is the lowest consumer of geothermal energy and only consumes 0.7% of the world's total Davidson and Sakona 2002).

Hydroelectric provides about 2.28% of the world's total energy supply (Fig. 1) and is responsible for 20% (2 650 TWh/yr) of all the electricity generated worldwide (HD 2001). It's the most important of the clean, economically feasible, renewable energy option (Baird 1993). Technically, feasible hydropower potential estimated at nearly 15 000 TWh/yr still exists in the world today (Bartle 2002)

1.2.1 Energy distribution and use in developing countries

Fossil fuels, hydroelectric, nuclear and geothermal contribute about 81% of the total energy in developing countries (Fig.1). Industry is responsible for the major share of modern energy consumption, i.e. petroleum, electricity, and gas (Davidson and Sakona 2002). The transport sector also consumes a large share of modern energy and public transport is responsible for a significant share of the total. For example, 53% of the petroleum in Africa is used by the transport sector, 34% by industry and commercial sectors and only 13% is used by households (IEA 2001). Recent trends in Africa have also shown that 6.25 EJ of modern energy is used in industry and commercial while 3.8 and 1.9 EJ is used by the transport and residential sectors respectively (Davidson and Sakona 2002).

In terms of residential energy requirements, a large number of households in developing countries depend on biomass to meet their energy demands (Hall 1991, Biswas and Lucas 1997). Although biomass contributes about 19% of the total energy used in developing countries (Fig. 1), it is an important resource for the majority of households (Karenzi 1994). Almost half of all the people in developing countries are dependent on wood, dung and crop residues, collectively known as "traditional fuels." Three quarters of these live in China, India and sub-Saharan Africa (Postnote 2002). Modern energy sources such as electricity and petroleum-based fuels generally provide only a small part of the energy use of the poor rural people (Murphy 2001). This is mainly because they are expensive and in some cases difficult to obtain locally (Griffin *et al.* 1992). In India for instance, although electricity networks are technically within the reach of 90% of the population, only 43% are actually connected, as many remain unable to afford the cost of connection (Postnote 2002). The International Energy Agency (2001) has forecast that use of traditional biomass will decrease in many countries, but is likely to increase in South Asia and sub-Saharan Africa alongside population growth. The overall forecast by the agency reveals that by 2030, the total number of people reliant on biomass will not have changed significantly.

1.2.2 Energy distribution and use in South Africa

South Africa is the continent's largest energy consumer (primarily coal and petroleum) and Africa's second largest energy producer (behind Algeria) (EIA 2002). Energy consumption levels are significantly higher than many other developing countries, particularly consumption of electricity, where the country consumes half of Africa's electricity with only 5% of her population. South Africa's energy economy is largely coal based (DME 2000) and it accounts for 71% of the total energy supply. The country produces the cheapest coal in the world and has succeeded in developing electricity generation plants that are water efficient and utilize the lowest grades of coal in the world today (EIA 2002). Other energy resources include nuclear, through its substantial uranium deposits, as well as limited hydro and off shore petroleum resources (DME 2000). Renewable energy resources arise mainly from biomass and these account for 5% of the total energy supply (EIA 2002).

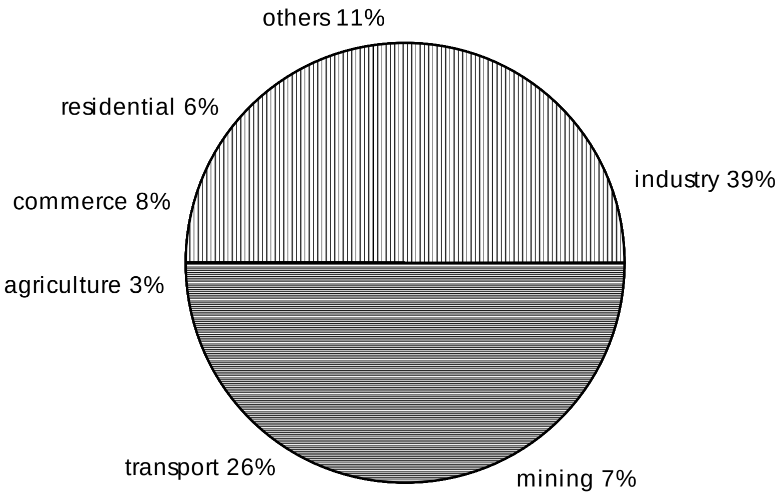


Fig. 2. Share of final energy consumed in South Africa (IEA 2000).

A large share of final energy is consumed by industry, mining and transportation (Fig. 2) (DME 2000). Much of the energy in this sector is consumed in minerals beneficiation, mining and manufacturing. Mining relies much on electricity with 70% of energy consumption on the mines being electricity (DME 2000).

Residential only consumes 6% of the total energy supply in the country (Fig. 2). In this category, households can be divided into two groups: rural and urban households. Nearly 80% of households in urban areas are electrified while in rural areas only about 46% are electrified (Kotze 2001). In urban areas, households use different types of fuels including paraffin, coal, candles, charcoal, gas and electricity (White *et al*. 1997). The use of electricity is restricted in most households because of its high cost (Davis 1998).

In rural areas, however, 96% of households are dependent on fuelwood as their major source of energy for thermal applications (Aron *et al*. 1991, Rensberg *et al*. 1997). In addition to fuelwood, households use paraffin, candles, batteries and reticulated electricity for other applications but find these very expensive and a drain on cash resources (Griffin *et al*. 1992). Apart from reticulated electricity, other methods by which rural people gain access electricity are through solar PV systems and generator sets (Griffin *et al*. 1992, Leitch and Linde 1995). Applications of the available energy resources include: lighting, cooking, space heating, water heating, refrigeration and powering entertainment appliances (Davis 1998). Appliances used include paraffin lamps, paraffin stoves, paraffin heaters, coal stoves, and other electrical appliances like radios, hi-fis, electric kettles, television sets, irons and refrigerators (Griffin *et al.* 1992). Fuelwood related indoor air pollution is one of the major health problems in these areas (Bruce 2002).

1.3 ENERGY TRANSITIONS

1.3.1 A lesson from history

The term "energy transition" denotes a shift away from energy systems, regardless of their scale or relative complexity, towards a new energy order, usually sustainable and efficient (Masera 2000). The general movement is usually from the use of loose biomass to fuelwood, charcoal and later to paraffin, gas, and finally electricity and other modern fuels (Gitonga 2002).

The history of global energy transitions started in the 1800s when the world was fuelled by animal feed, which powered the draft animals on farms, and wood fuel, which was used for domestic heating and cooking and by early industry (Berndt 1978). Several years latter, the Industrial Revolution transformed the world's energy picture, substituting wood with coal on a massive scale (Cleveland 2000). By the time of the First World War, coal accounted for nearly three quarters of the world's energy use, particularly in Europe, Asia and America. Wood and animal feed were rapidly disappearing, the latter due to the introduction of the first tractor in 1911 (Cleveland 2000). Coal's place as the dominant fuel started fleeting and by the 1960s, oil and gas together accounted for more than 70 percent of total energy use: coal had dropped to less than 20 percent (Kaufmann 1994). Electricity played a small but steadily growing role. The increase in the share of primary electricity (electricity generated by hydroelectric, nuclear, geothermal, solar and other primary sources) towards the end of the 1960s was due to the rise in nuclear generating capacity (Cleveland 2000).

These transitions in the past were guided by a combination of energy, economic, technological and institutional factors (Stern 1993). The energy related forces stem from the tremendous economic and social opportunities of the new fuels, and their associated energy converters, offered to earlier ones. The economic usefulness of an energy converter is determined, in part, by its power as well as the rate at which it converts energy to do useful work. In economic terms useful work refers to the use of energy to produce goods and services (Stern 1993). Animate energy converters (humans and draft animals) convert energy to do work at low power outputs. The energetic limits of people and draft animals set very definite economic and social limits. The industrial revolution erased these limits with the introduction of steam engine, which had a power output that dwarfed that of animate resources (Cleveland 2000). The higher power output of the steam engine enabled it to deliver a much larger energy surplus than human labour or draft animals. The higher energy surplus expanded economic opportunities on a much grander scale.

Given the economic changes driven by the new fuels and machines, it is no surprise that labour and heat engines rapidly replaced draft animals once they became available (Stern 1993). In 1850, more than the 90 percent of the work done in the world economy was accomplished by human labour and draft but over the next half-century, engines powered by wood and then coal rapidly displaced the animate converters. By the 1950s, labour and animals had almost been completely displaced (Cleveland 2000).

1.3.2 Energy transition at household level

It has been shown that of all sectors, the household sector experiences the most pronounced changes in its patterns of energy use (Alam *et al*. 1998). The underlying assumption is that as the demand for or the supply of more sophisticated fuels increases a greater number of users make a shift from biomass fuels, to kerosene, LPG and finally electricity (Gupta and Ravindranath 1997, Campbell *et al*. 2003). This shift phenomenon sometimes referred to as "energy transition" usually takes place over time as communities expand (Alam *et al*. 1998). Researchers have developed a number of theories to explain the shift to more convenient and higher quality fuels paralleling the energy transition hypothesis (Kituyi *et al*. 2001). The most commonly used are:

i) Energy ladder theory
ii) Leapfrogging theory

According to the energy ladder theory, changes in energy use patterns usually take the form of a gradual decline of biomass fuels, from exclusive use for all purposes by a large number of households towards use to a smaller degree by a smaller number of households for fewer purposes, with the reverse trend for technologically sophisticated fuels (Campbell *et al*. 2003). Fossil fuels fit in as intermediate fuels. In other words, it's a shift from low-quality fuels, such as biomass, to more convenient and versatile "modern fuels" such as paraffin, gas and electricity (Leach 1987a). Other researchers have carried the ladder analogy further and proposed an "energy pyramid" to symbolize both quantity of fuels used and the quantity of pollution produced going up the energy pyramid (Fig 1.3) (Burning issues undated).

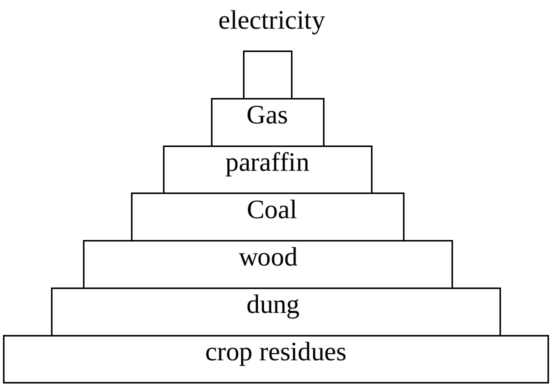


Fig. 3. The energy pyramid.

The “dirty” fuels such as crop residues and dung are at the bottom. Going up the pyramid, fuels can be placed in an efficiency and pollution ranking. Fuels at the bottom of the pyramid are less efficient and produce large quantities of smoke when they’re burned than the ones at the top of the pyramid (Burning issues undated). They also produce less heat for the amount of the fuel and produce more pollution.

Another concept used to explain energy transition at household level is the “leapfrogging” concept (Murphy 2001). In the industry, leapfrogging metaphors are normally used to explain how Newly Industrialized Economies (NIEs), for example South Korea, have tried to catch up with advanced countries by assimilating and adapting the more or less obsolete technology of the advanced countries (Lee and Lim 2000). The catching up process in these countries do not follow the path of technological development of advanced countries but instead skips some stages, or perhaps create their own individual paths, which is different from the forerunners. Similarly, in the energy sector the leapfrogging concept is used to denote a transition from traditional forms of energy (e.g. fuelwood and charcoal) to modern sources (e.g. electricity) (Murphy 2001) without passing through the conventional path of energy development (i.e. fuelwood to coal to petroleum). Such a transition is thought to bring modern energy resources to users quickly and cost effectively. The leapfrogging path is portrayed as clean and sustainable while conventional energy systems are thought to be dirty and wasteful (Murphy 2001).

1.3.3 Factors that drive the change

According to Leach (1987b), fuel choices and substitution are strongly driven by desires for greater convenience, quality service and cleanliness. Even poor people desire modern commercial energy sources that do not entail considerable manual labour for collection and use (Postnote 2002). For example, fuelwood must be either fetched from the bush or bought from traders, and a cooking fire needs tending. At the other extreme, gas and electricity have automatic time controls. The progression to cleaner and efficient fuels, therefore, leads to time savings in obtaining and using fuels, often a crucial factor for the poor (Leach 1987b).

Other researchers have argued that changes in fuel choices occur as availability of commercial fuels improves and incomes increase (Sarmah 2002). As the availability of sophisticated fuels improves consumers have the opportunity of moving up the energy ladder and the door opens to a multiplicity of widely desired devices such as irons, cooling fans, radio and TV and refrigeration

(Leach 1987b). The ability to pay for the new fuel type and ownership of appliances that go with the use of the new fuel is strongly correlated to income (Davis 1998). Wealthier households are less likely to be constrained by the usually high cost of non-biomass fuels and are therefore more inclined to make the transition to more sophisticated alternatives (Campbell *et al*. 2003). At the other extreme, the cost of the new fuels is likely to inhibit the proportion of users among low-income households because of their low purchasing power (Kabede *et al*. 2002). This may result in non-use or restricted use of the new fuel among poor households (White *et al*. 1997).

According to Foley (1995), changes in energy use patterns are as a result of demand. He argues that as household's economic circumstances begin to improve, additional and more diversified energy demands begin to surface and can only be satisfied by non-biomass resources. To this effect Davis (1998) notes that "this formulation provides an explanation for the frequently observed multiple fuel use in low-income households. Basic energy needs continue to be met by biomass fuels while the other energy services introduce other, more versatile fuels into the home."

Fuel substitution is also a result of the efficiency trends of the fuel (Table 1) (Leach 1987b). There is a tendency for households to move towards the use of very efficient fuels. As a result one frequently finds that poor households use the most expensive fuels on the basis of useful energy. The efficiencies of the fuels also vary considerably depending on the type of the equipment and how it's used, for example, a kerosene pressure lamp is 12 times more efficient than a simple wick lamp, and an electric incandescent bulb is about ten times more efficient, an overall range of around 120:1 (World Bank 1986). In terms of cooking, the thumb rule figures are: wood open fire with clay pots 5-10 percent, with aluminium pots 12-15 percent, metal wood stoves 20-30 percent, charcoal stoves 15-35 percent, multiple wick paraffin stoves 15-35 percent, paraffin primus stoves 25-55 percent, gas stoves 40-60 percent and electricity 55-75 percent (World Bank 1986). Table 1 illustrates the performance of the different energy forms as one moves from the inefficient fuelwood to electricity.

Table 1. Energy performances of the different fuel types.

Fuel	Energy Content (MJ/unit)	End use Efficiency (%)
Fuelwood (kg)	15	8-13
Charcoal (kg)	25	20-25
Paraffin (l)	35	30-40
LPG (kg)	48	45-55
Electricity (kWh)	3.6	60-70

State government policies have also been shown to affect household fuel choices. Government intervention usually takes the form of subsides for fossil fuels and electricity (Alam *et al*. 1998). In recent years, most governments of developing countries have adopted the Structural Adjustment Program (SAP) of the World Bank (Reeds 1996). These are economic policies which countries must follow in order to qualify for new World Bank and International Monetary Fund (IMF) loans to help them make debt repayments on older debts owned to commercial banks, governments and the World Bank (Kessler and Dorp 1998). SAPs generally require countries to devalue their currencies against the dollar, lift import and export restrictions, balance budgets, remove price controls and state subsidies (Kessler and Dorp 1998). As a result of the removal of subsides, SAPs often result in deep cuts in programs designed to control prices of basics such as food and energy needs. Campbell *et al*. (2003) noted that the cuts have had negative impacts on low income households and over time, "we might expect not simple energy transition but a growing dichotomy between wealthier households who are able to adopt modern fuels and poorer households who are increasingly forced to choose biomass alternatives." Other government policies that enhance energy transitions include those that promote mass levels of electrification (Habtetsion and Tsighe 2002). Mass electrification benefits poor households in terms of lighting and refrigeration and saves them money on batteries for radios and television (White 1997).

1.3.4 Environmental consequences of energy transitions

With respect to the environment, changes in energy use patterns from biomass fuels to fossil fuels and electricity implies reduced pressure on woody plant resources (Campbell *et al*. 2003). Demand for fuelwood resources may cause deforestation around communities reaching 100 kilometres and even more (WRI 1997). Although clearance of forest for agriculture and the wood industry are known to be the major causes of deforestation in many parts of the world (Gandar 1982), consumption of wood as a fuel can cause severe local impacts on nearby forests (WRI 1997). Even in cities with low levels of per capita consumption of biomass fuels, it has been shown that the large number of people concentrated in a small area can place considerable total demand on forest resources (WRI 1997). Deforestation also contributes to a variety of indirect environmental impacts, including soil degradation, water siltation, and loss of indigenous plant (Gandar 1982, Shackleton 1993). As such, when communities increase their reliance on fossil fuels and electric power, pressure on the surrounding environment decreases. Biomass fuels such as fuelwood and charcoal are replaced by oil and electricity and this eventually reduces deforestation caused by energy demand (Campbell *et al*. 2003).

When biomass is burnt indoors in open fires or poorly functioning stoves, it leads to indoor air pollution (Streets 2003). The smoke contains many substances, several of which damage human health. According to Bruce (2002), "most importantly are particulates, carbon monoxide, nitrous oxides, formaldehyde and polycyclic organic matter which includes carcinogens such as benzo [a] pyrene. Small particles of diameter less than 10 microns and in particular those less than 2.5 microns are able to penetrate deep into the lungs and appear to have the greatest damaging potential… These emissions combine with the often-poor ventilation to produce very high levels of indoor pollution. In developing countries individuals are typically exposed to these very high levels of pollution for between three and seven hours each day over many years. The exposure of women is much higher than men since they do most of the cooking and young children often on their backs are also exposed so that from early infancy children spend many hours breathing smoke." Household energy transition to more efficient fuels, therefore, not only reduces the pressure on the surrounding environment but also reduces the magnitude of the problem of indoor air pollution.

At the extreme end, reliance on fossil fuels and electric power creates new problems, often at the source point of the fuels. According to the World Resources Institute (1997), "the environmental impacts of coal mining, oil and gas drilling and transport can be severe. In Katowice, Poland, for example, local coal mines are causing water and land degradation. In 1992, Katowice's coal mines discharged more than 4, 800 metric tons of salt into the Vistula River each day, leading to major declines in aquatic life. About 20,000 hectares of land in the region are degraded (up from 9, 500 hectares in 1975) by mining excavations, tunnels, land subsidence, waste dumps and flooded areas. Each year, 500 to 600 hectares of additional land is degraded; in 1988, only 88 hectares were reclaimed." Similarly, damming rivers to form lakes for hydroelectric generation as well as the use of coal and petroleum for electricity generation may have far reaching environmental consequences at the point of generation (Section 1.1.1 and section 1.1.2).

1.4 CONTEXT OF THE STUDY

The patterns of energy investments in the apartheid era was mirrored by disparities in the provision of social infrastructure with the consequence that South Africa has a highly unequal distribution of income and access to basic services (Ebernard 1995). Access to energy in the black community, particularly rural areas was limited and was dictated by poverty, neglect and underdevelopment. The types of fuels for the majority of rural households included fuelwood, dung, crop wastes, paraffin and diesel (Aron *et al*. 1991, Griffin *et al*.1992, Rensberg *et al*. 1997). Entertainment appliances were powered mainly by disposable batteries or locally charged lead acid batteries (Griffin *et al*. 1992). Although South Africa produced 60% of Africa's total electricity output during the apartheid era, over 60% of the population (80% of whom were blacks) had no access to electricity (Mosaka-Wright 1995).

When the post-apartheid government was inaugurated in 1994, one of its responsibilities was to address the historical inequalities and a new energy policy that seeks to improve social equity by specifically addressing the energy requirement of the poor was developed (Ebernard 1995). Policies were designed to widen access to adequate and affordable energy services for urban and rural households (Mosaka-Wright 1995). The policies were also aimed at providing "cleaner and safer" forms of energy for low-income households (Spalding-Fecher and Matibe 2003). The Department of Mineral and Energy Affairs through a mass electrification drive, embarked on an accelerated electrification program in most rural areas of South Africa (DME 1998). Because much of the population of South Africa is located in areas far from the current and anticipated electrical grid connections, off grid renewable energy resources, particularly photovoltaic, also played a major role in the electrification exercise (Leitch and Linde 1995). In the period 1994 to 1999, close on 2.8 million households were connected to the national electricity grid increasing the level from about 36% in 1994 to about 68% at the end of 1999 (Kotze 2001). Providing electricity to previously disadvantaged communities has been one of the most successful programs of the government's Reconstruction and Development Program (Spalding-Fecher and Matibe 2003). One of the priorities the government has established in the energy sector is to continue the electrification program and promote energy efficiency through an integrated planning approach (DME 1998).

Studies have shown that as a result of the mass electrification program and the provision of other renewable energy resources such as photovoltaic, patterns of energy use in South Africa have changed (Davis 1998, Palmer 1999). According to Davis (1998), “there is evidence for an energy transition largely driven by income. Unelectrified households tend to move from collected wood to purchased wood and kerosene, whereas, electrified households tend to switch to more extensive electricity use.” There is evidence that the transition is fairy rapid (Palmer 1999) and according to Spalding-Fecher and Matibe (2003), the shift takes five years to complete.

Many of these studies are, however, based on observed differences between electrified and unelectrified households. Longitudinal studies with a clear baseline before electrification for consumption of a range of fuels are scanty. A few that are available are restricted to urban and peri-urban communities (White *et al*. 1997, Palmer 1998). There is need therefore; to establish a model of the post-electrification transition based on disaggregated data representing overall rural energy use patterns before and after electrification. By assessing variations in fuel choices over time, such an approach would cover a wide range of factors that determine a transition and provide a better understanding of the changes in fuel patterns in rural areas. The model would also inform policy makers in prioritizing intervention strategies in the rural energy sector. Such is the nature of this research. It’s is a follow up to the 1991 energy survey in Bushbuckridge district in Limpopo province (Griffin *et al.* 1992). It examined existing energy use patterns and compared the results to those of 1991 to establish the energy transition that has taken place in the last eleven years. No such large scale, quantitative, longitudinal studies have been done in rural areas of South Africa.

1.5 OBJECTIVE OF THE STUDY

To investigate the changes in energy use patterns that have taken place in Bushbuckridge district between 1991 and 2002.

1.6 KEY QUESTIONS

Five key questions were addressed in this study:

1. How have the mix and quantities of different energy forms changed in the sample settlements between 1991 and 2002?
2. Have energy preferences changed between 1991 and 2002 and if so how?
3. Are the changes in use patterns correlated with resource supply?
4. How have patterns of expenditure on energy changed between 1991 and 2002?
5. What has been the key changes in the livelihood socio-economic profiles between 1991 and 2002?

1.7 HYPOTHESIS

There hasn't been any change in patterns of energy use in Bushbuckridge district between 1991 and 2002.

CHAPTER TWO

STUDY AREA AND METHODS

2.1 STUDY AREA

2.1.1 Location

The study was done in the Bushbuckridge district in the southernmost section of the Limpopo province (31°0′E–31°35′E and 24°30′S–25°0′S). This district, defined primarily on a historical apartheid and socio-economic basis, is composed of the former "homelands" areas of Mhala (Gazankulu) and Mapulaneng (Lebowa) (Pollard *et al.* 1998). Like the previous study, five settlements in the Mhala region were selected as sample sites. The settlements were Athol (24°43′S 31°21′E), Okkerneutboom (24°44′S 31°13′E), Rolle (24°44′S 31°13′E), Welverdiend (24°35′S 31°20′E), and Xanthia (24°50′S 31°09′E) (Fig. 4). These settlements are spatially dispersed and represent a range from smaller, isolated settlements (Athol, Welverdiend) to larger, more closely settled settlements lying adjacent to major transport routes (Okkerneutboom, Rolle) (Fig. 4).

2.1.2 Topography and land use

The region forms part of the semi-arid savanna region of the central Transvaal lowveld and has a flat undulating terrain with an altitude that is generally less than 600m above sea level (Shackleton *et al*.1995, Banks *et al*. 1996). There is a range of soil forms depending on the local topography and geology. On the ridge top, soils are shallow, sandy and nutrient poor, whilst on the bottomland, soils are relatively deeper, clayey and nutrient rich (Pollard *et al*. 1998). There are six major land uses in the region: government conservation areas, communal grazing areas around rural settlements, private commercial cattle farms, plantation forestry and commercial crop farms restricted to narrow irrigable belts along rivers (Shackleton 1996). Under communal tenure, the land is zoned by regional authorities into residential and arable plots. The remaining land is used for communal grazing of livestock and harvesting of various natural resources such as fuelwood, thatch grass and construction material.

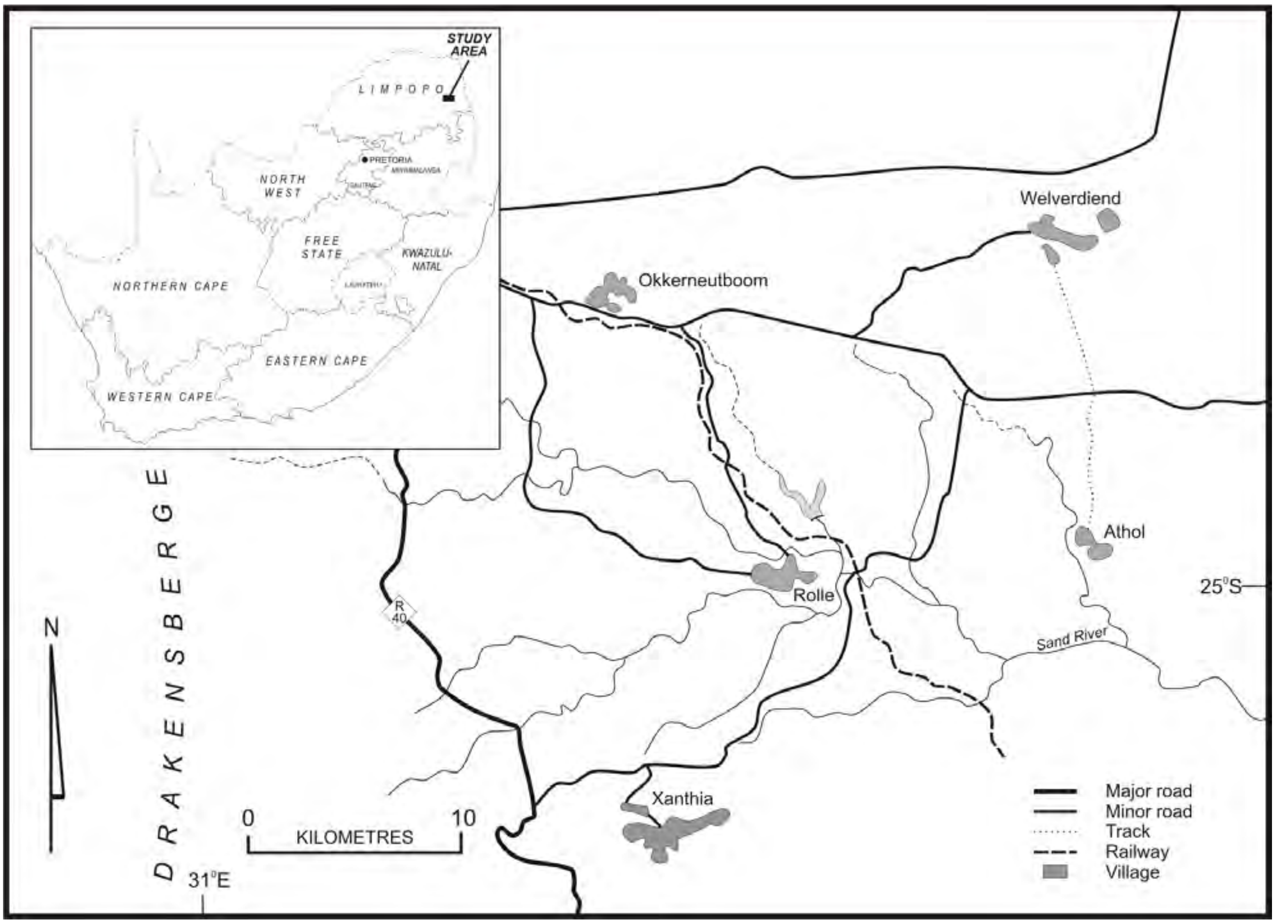


Fig. 4. Location of the sample settlements within the Bushbuckridge district.

2.1.3 Climatic conditions and vegetation

The region generally has a hot sub-tropical climate and climatic conditions are strongly influenced by topography (Pollard *et al*. 1998).). Hot, humid summers and mild winters with moderate temperatures are characteristic of the area and the mean annual temperature is approximately 22°C and increases from southwest to northeast. The mean annual rainfall ranges from 1200mm in the west to 500mm in the east (Shackleton *et al*. 1994). Rainfall is concentrated in the summer season from October to April and is received largely in the form of conventional thundershowers, although periods of cyclonical showers do occur (Shackleton 1998). A major characteristic of the rainfall pattern in the region is the yearly variability and major drought occurs as often as every three and half years in the northern part of the district (Shackleton *et al*. 1995). The vegetation type in the region is broadly classified as moist forest and semi-arid savanna and is characterised by a mixture of trees, shrubs and grasses (Shackleton *et al*. 1995). The commonly found tree species are: *Acacia* species, *Sclerocarya birrea* sub species *caffra, D. cinerea, S. brachypetala, Boscia species, Commiphora* species, *Combretum* species and *Grenia* species (Dyer 1995). In common with other semi-arid savannah systems, vegetation production and recruitment is highly variable from year to year in response to variation in rainfall, the major ecosystem driving variable (Pollard *et al*. 1998).

2.1.4 Population and socio economic conditions

Population figures in the region vary greatly depending on the source (Pollard *et al.* 1998). Latest figures by Giannecchini (2002) indicate that the Mhala region has an estimated population of 750, 000 with an annual growth rate of 2.4%. The residential section (both dense and sparse residential areas) has a high population density of 1856 people per km^2 (Pollard *et al*. 1998). Household size was estimated at 7.8 by Griffin *et al*. (1992) while Tollman *et al*. (1995) estimated it at 6.2 persons for local residents, 6.5 for refugees and 8.1 for households comprising both refugees and locals. For the settlement of Athol, Giannecchini (2002) estimated household population at 9 persons per household.

These settlements are typical of the neglected and underdeveloped settlements in many other former homelands (Pollard *et al*. 1998). Thus, there is inadequate infrastructure, few job opportunities, high unemployment, household dependency on pensions and remittances from migrant workers and a rapid localized population growth (Griffin *et al*. 1992). These factors have resulted in low quality of life in the region. Two thirds of households have at least one member of the family working and 29% of the households in the region have one family member with a pension (Giannecchini 2002). Other activities from which income is generated include: selling clothes and vegetables (Griffin *et al*. 1992).

2.1.5 Energy resources in the region

In the last major survey conducted in 1992, results showed that the majority of households in the region depend on biomass fuels as their source of energy with fuelwood being the major source (Griffin *et al*. 1992). Collected fuelwood accounts for a large proportion of the total fuelwood used in the region although some households buy the commodity from vendors. Other fuel types used include paraffin, candles, gas, coal, dry cell batteries, dung, lead acid batteries and electricity (Griffin *et al*. 1992). Like in many rural areas of South Africa, the region has benefited from the government's Reconstruction and Development Program (ANC 1994) and a lot of households have been electrified.

In the early nineties, the South African government initiated a nation wide program to audit and assess energy use as well as address the decline in fuelwood resources. Several projects were implemented and one such study was in the Bushbuckridge district (Griffin *et al*. 1992). The project surveyed 356 households in six settlements (Athol, Okkerneutboom, Rolle, Welverdiend, Welverdiend-refugee area and Xanthia). The survey showed that a total of 14 fuels were used in the settlements and the extent to which households used the fuels depended on availability of the fuels and several other factors that determine the household's ability to purchase a particular fuel. Eleven years have passed since the original study was done and since then the region has undergone several cultural, economic, social and political transformations (Giannecchini 2002). For example, there has been an increase in the number of households with reticulated electricity and human populations have increased from an estimated 253, 000 in 1991 (Banks *et al*. 1996) to 750,000 in 2002 (Giannecchini 2002). It can therefore be expected that some of the transformations will have brought about changes in energy use patterns in the region.

2.2 METHODS

Methodology is concerned with the relationship of the various parts of the study that leads to the production of the results (Guba 1990). The aim of methodology is to help a researcher and readers understand in broader terms the process of the inquiry (Kaplan 1964). In field research, multiple methods can be used depending on the nature of the investigation and available resources (Zelditch 1962, Jackson 1995). Since the current research was a follow up study, it used the same methods that were used in the 1991 study (Griffin *et al*. 1992).

2.2.1 Interview schedules

An interview schedule was described by Koul (1984) as a tool for gathering data through conversation between the researcher and the researched. According to Frey and Fontana (1991), interviews can take the form of face-to-face verbal interchange or self-administered questionnaires. There are basically two types of interviews used in research: structured and unstructured interviews (Koul 1984, Chambers 1994, Mikkelsen 1996). Structured interviews are those interviews in which the procedure to be followed is standardized and is determined in advance (Koul 1984, Chambers 1994). Unstructured interviews provide greater flexibility, although the series of questions and procedure to be followed are decided upon beforehand (Mikkelsen 1996). In unstructured interview, the interviewer is free to arrange the form and timing of interviews while in structured interviews, the interviewer has to follow the schedule strictly (Koul 1984, Mikkelsen 1996). A structured interview schedule is ideal for longitudinal studies since it does not leave any room for flexibility (Frey and Fontana 1991). It ensures that the same style and approach is followed to gather data from surveys conducted at different time frames. In light of this, the current study used the same comprehensive structured interview schedule that was used in the 1991 study (Griffin *et al.* 1992) to gather data on household fuel use, preferences and socio-economic status. The interview schedule used was exactly the same as that used by Griffin *et al.* (1992) except that questions which, did not relate to energy use were left out. (see appendix c).

A team of three enumerators who are conversant with the area and understand the local language very well were recruited and trained for one week to conduct the structured interviews. Feuerstein (1986) cautions that "familiarity with the community may tend to make interviewers/enumerators feel they know all the answers already and they may record them from knowledge and observation instead of asking the chosen questions." For this reason, the enumerators were reminded, before and after the administration of the questionnaire, to carry out their tasks professionally and avoid being prejudiced. All the interviews were conducted in Tsonga. This appears to be the dominant ethnic group in the region. Where possible the enumerator interviewed the person who did most of the cooking and house work in the household, as he or she would best know the types and quantities of fuels used and would probably have knowledge of the household's income and expenditure. In the absence of such individuals, the enumerator interviewed the best substitute: the head of the household, or failing him/her, one of the older children, or in-laws. The interviewee was allowed to ask for help from other family members in answering some questions, particularly those related to costs and quantities of the different fuel forms.

2.2.2 Fuelwood consumption measurements

Estimates of fuelwood consumption were made based on the respondent's estimates of their daily fuelwood use. The respondents were asked to estimate the amount of fuelwood used on a daily basis and this was weighed and recorded. During the 1991 survey, the accuracy of this method was checked by monitoring fuelwood use in ten Welverdiend households. The household consumption data from the carefully monitored samples were not significantly different to the respondent's estimates of household fuelwood consumption in the same households.

2.2.3 Choosing sample households

Using 1:10 000 aerial photographs (1997) settlement boundaries were defined and household plots demarcated and numbered. Sample size in each settlement was determined from the number of households in that settlement using the following assumptions:

i) there was no change in the variance of the parameters we were investigating from one settlement to the next

ii) a sample of 90 households was the maximum we could logistically cope with.

The following equation was used to determine sample size:

$$n_f = \frac{n_i}{[1+(n_i/N)]}$$

Where N = settlement population size

n_i = sample size for infinite population

n_f = sample size for settlement

From the above equation, recommended sample size for the five settlements were as follows: 69 in Athol (299 households), 81 in Okkerneutboom (830 households), 79 in Rolle (640 households), 77 in Welverdiend (530 households) and 80 in Xanthia (643 households).

The numbers of valid samples collected in the five settlements were: 71 in Athol; 83 in Okkerneutboom; 80 in Rolle, 80 in Welverdiend and 85 in Xanthia. These were selected using a computer generated random number list.

2.2.4 Conventions

Like the previous study, a number of conventions were followed if, for some reason, an enumerator was unable to interview a suitable respondent at a sample household. Such households were regarded as empty/non-residential and in such a case, the enumerator went to another household drawn from the same random number list that was used to select sample houses. Plots were also regarded as empty or non-residential houses if:

i) there was no building present on the sample site
ii) there were only unoccupied or non-residential buildings
iii) respondents refused to be interviewed.

2.2.5 Permission from tribal authorities

Lupele (2002) emphasized the need to ask for permission from traditional leadership before any research can be conducted in the rural set up. In light of this, permission was obtained from tribal authorities and the Indunas of each settlement. The purpose of the study was explained to the Indunas who were requested to publicise the study among residents and encourage them to give their full cooperation.

2.3 DATA INTERPRETATION

2.3.1 Data analysis

Data interpretation involves making sense of what people have said, putting together what is said in one place with what is said in another place, and integrating what different people have said (Patton 1990). Although there are no basic rules of data interpretation, researchers have to do their best with full intellect to fairly represent and communicate what the data reveals in the light of the purpose of the study (Lupele 2002).

In this study, data from the interview schedules was analysed using two computer programs: Microsoft Excel (Excel 2000) and Statistica (Statistica 6.0). The data was first coded and fed into the Microsoft Excel program and was exported latter to the Statistica program to generate some descriptive statistics.

Discrete variables were summarised by determining the frequency of each code within the question. Frequency analysis was undertaken for each sample settlement separately. Summary statistics were calculated for all numeric variables. Normality for all the data was tested using the

Shapiro and Wilk test. Other measures of distribution, for example skewness and kurtosis were also examined. After inspection of these data, it was decided that the arithmetic mean was the best measure of central tendency for the data.

The numeric variables failed the assumption of normality and homogeneity of variances at $p<0.05$. A non-parametric test (Mann-Whitney U test) was, therefore, used to compare the means of the data from the two surveys (1991 and 2002) for the whole region. However, when comparing the means across the individual settlements, the data was transformed using the log transformation to stabilise the variances. Factorial ANOVA was then used to compare the means. Two factors were considered:

i) effect due to settlement
ii) effect due to time (1991 to 2002).

2.3.2 Consumption rates

The "normal" per capita consumption was used. This uses simple head counts, in which each person in the sample, regardless of age or gender represents one unit. Per capita consumption of any given fuel was calculated separately using the following expression:

$$C = C_w/P$$

Where C = consumption
C_w = unit measure of the fuel consumed monthly
P = total sample population (Kituyi *et al.* 2001).

2.3.3 Validity of the results

According to Mbwambo (2000), the reliability from this kind of research depends on the truthfulness of the interviewees and the perception of the interviewer. He observed that rural people can provide false information for a variety of reasons such as fear, prudence, ignorance, exhaustion, hostility and hope of benefits. To increase the validity of the respondent's information, McCormick and James' (1983) findings concerning validity were taken into consideration during the process of data collection. They found that validation is achieved when the subjects recognize the authenticity of the research. One way of achieving this is for the researcher to explain in detail what the research is all about in terms of what they will understand. Thus, the enumerators were trained to explain thoroughly what the study was all about during the introductory process. This approach is supported by Roman (1992), who noted that this particular approach reduces the divide between the researchers and the individual being researched.

CHAPTER THREE

RESULTS

In this chapter, consumption rates of the different fuel types are presented based on the information from the respondents in the five settlements. Uses of the various fuel types are also presented including the advantages and disadvantages of particular fuels. Finally, the socio economic status of each settlement is presented and compared to that of 1991.

3.1 CONSUMPTION OF FUELS

3.1.1 Paraffin

Consumption of paraffin

Paraffin was still an important fuel in the five settlements examined in 2002 with up to 59% of the households interviewed reporting some use of the fuel (Table 2). However, the proportion of households using paraffin was 38% less than that reported in 1991. The decrease was eminent among settlements with access to electricity (Okkerneutboom, Rolle, Welverdiend and Xanthia).

Table 2. Total sample and household (paraffin users only) paraffin use and monthly use rates. Standard errors for household variables are given beneath the means. See methods for an explanation of the units used.

	1991				2002			
Settlement	% HH using fuel	Litres per capita	Litres per HH	Cost per litre	% HH using fuel	Litres per capita	Litres per HH	Cost per litre
A'ol	94	1.3	10.3	R1.45	70	0.6	5.7	R4.70
			1.2	R0.04			0.8	R0.37
O'boom	92	2.0	17.3	R1.38	55	1.7	7.9	R3.98
			1.5	R0.02			1.0	R0.06
R'le	96	1.7	14.4	R1.39	58	0.5	5.3	R4.15
			1.3	R0.03			0.8	R0.08
W'nd	97	1.7	14.6	R1.41	60	0.4	5.2	R3.81
			1.3	R0.03			0.7	R0.14
X'thia	89	1.8	14.8	R1.40	52	0.2	2.9	R4.29
			1.7	R0.03			0.5	R0.07
Mean	94	1.7	14.2	R1.40	59	0.5	5.4	R4.20
Standard error			1.4	R0.03			0.8	R0.14

Per capita consumption rates of paraffin in the region were reported to have dropped from an average of 1.7 litres per capita per month in 1991 to 0.5 litres per capita per month in 2002.

Among all the interviewed settlements Athol, the only settlement that had no access to electricity at the time of the survey, recorded the lowest decrease in the per capita consumption of the fuel.

There was a significant difference in the monthly consumption of paraffin by households in the whole region between 1991 and 2002 (Z = 9.26, $p <$ 0.0001). Respondents in the former year reported a consumption of 14.2 litres per household per month while in the later year consumption was reported at 5.4 litres per household per month. Between the two survey periods, therefore, monthly household consumption of paraffin in the region went down by 62%. The extent of the decrease varied greatly among the individual settlements and was reported to be highest in Xanthia and lowest in Athol (Fig. 5). A comparison of the decrease among the settlements also reviewed a significant difference (F =117.66, df=1.42, p<0.0001).

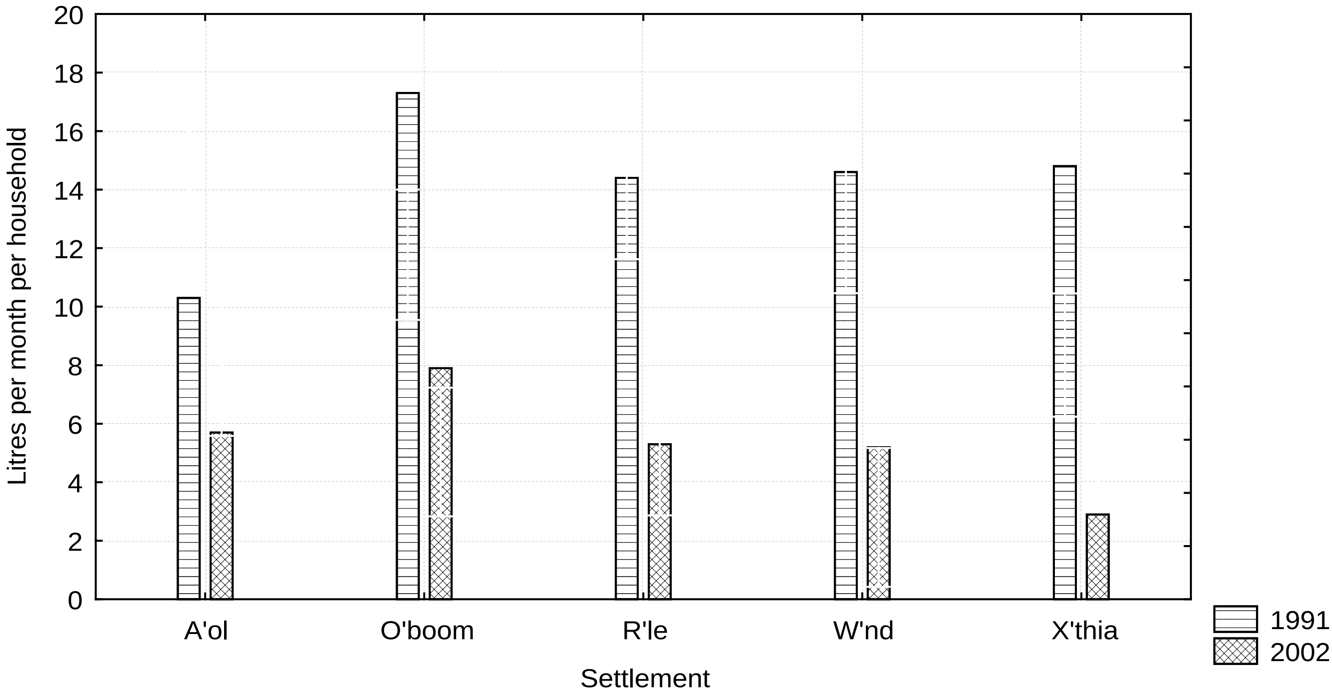


Fig. 5. Monthly household consumption of paraffin by settlements in Bushbuckridge.

The cost of paraffin per litre increased by 300%, from an average of R1.40 to R4.20, between the two survey periods. The price, however, varied among the settlements in 2002 and ranged from R3.81 to R4.70 in Rolle and Athol respectively.

Uses of paraffin

Paraffin was chiefly a fuel for lighting in 1991. On the other hand, respondents interviewed in 2002 largely used it for cooking, with the exception of Athol were paraffin still remained the chief source of energy for lighting (Table 3).

Table 3. Main use of paraffin in households using it. Data show percentage of users.

Main use	1991						2002					
	A'ol	O'boom	R'le	W'nd	X'thia	Mean	A'ol	O'boom	R'le	W'nd	X'thia	Mean
Lighting	92	48	70	82	73	73	76	5	11	25	23	28
Cooking	8	47	30	18	19	24	14	91	80	50	36	54
Ironing		5			5	2	2					0.4
Heating water for washing					2	0.4			4	2		1.2
Heating water for tea					2	0.4		2	2		2	1.2
Refrigeration												
Starting a fire							8	2		2		2.4
Floor polish									5	21	39	13

The introduction of electricity in the region in the late nineties was reported to have enhanced households in the affected settlements to switch from paraffin to electricity as their main sources of energy for lighting (Section 3.1.11). Settlements with electricity only used paraffin for lighting when there was a power failure. The use of paraffin as a floor polish ingredient was a common practice in both years (Table 4). In 1991 year, the contribution this practice made to the consumption of the fuel was reported to be negligible. However, there was overwhelming evidence from the respondents in 2002 suggesting that the contribution the practice makes to the consumption of the fuel cannot be overlooked.

Other secondary uses of paraffin reported by respondents in both years included the use of stoves to boil water for tea and washing as well as starting fires (Table 4). The response in 2002 showed that paraffin was no longer used for domestic space heating and heating irons for pressing clothes as reported in 1991. Households either used irons heated by charcoal or electric pressing irons to press clothes (Sections 3.1.10. and 3.1.11).

Table 4. Other uses of paraffin. Data show percentage of paraffin users.

Settlement	1991						2002					
	A'ol	O'boom	R'le	W'nd	X'thia	Mean	A'ol	O'boom	R'le	W'nd	X'thia	Mean
Cooking	31	38	44	33	24	34	18	2	9	10	7	9
Heating tea water	21	18	44	10	23	23	30	22	28	6	7	19
Lighting	6	29	17	18	20	18	16	9	24	15	23	17
Ironing	11	20	23	7	20	16						
Heating washing water	2	6	7	4	6	5	8	9	15	6	11	10
Making floor polish	2	3	3	12	2	4	16	11	28	11	9	15
Starting a fire	3		1	4	8	3						
Refrigeration			4		5	2	4					0.8
Heating home			1			0.2						
Insecticide		1		1		0.4						
None	57	14	26	33	35	33	14	50	11	10	43	26

Appliances used

Primus stoves and lanterns were the predominant paraffin appliances used by households in both years (Table 5).

Table 5. Appliances with which paraffin is used. Data shows percentage of paraffin users.

Appliance	1991						2002					
	A'ol	O'boom	R'le	W'nd	X'thia	Mean	A'ol	O'boom	R'le	W'nd	X'thia	Mean
Lantern	97	79	87	99	88	90	90	7	30	50	43	44
Primus stove	40	85	72	55	54	61	64	94	89	50	55	70
Fridge			3		6	2	4					1
Paraffin stove			4	1		1						
Heater			1			0.2	2					0.4

Respondents in Okkerneutboom and Rolle continued using primus stoves more than respondents from other settlements with the exception of Athol. There was a great variation in lantern ownership amongst paraffin users in 2002. Lantern ownership ranged from 7% in Okkerneutboom to 90% in Athol. Athol used lanterns more than any other settlement, as it still had no access to electricity. The use of paraffin to run fridges in 2002 was only recorded in Athol. All the remaining settlements used electricity to power fridges (Section 3.1.11).

Reasons for not using paraffin

The reason of expense raised by respondents in 1991 was still eminent among non-users in 2002 (Table 6). Lack of appliances and preference for electricity, a more recent and modern energy source, were also reported as reasons for not using paraffin by non-users.

Table 6. Reasons for not using paraffin. Data are percentage of non-users.

Reasons	1991						2002					
	A'ol	O'boom	R'le	W'nd	X'thia	Mean	A'ol	O'boom	R'le	W'nd	X'thia	Mean
Expensive	25	33	50	50	38	39	48	32	29	13	15	27
No appliances	50	33	50		25	32	62	27	24	41	17	34
Prefer others		17			25	8	5	11	35	38	59	15
Not available locally		17			13	6						
Appliances expensive			50			10						
Poisonous to children					13	3			15	9		5
Against church law	25					5						
Don't like it								11	6		2	4
No special reason				50		10						
No need								22	3	3	12	8
Smells bad								3	3	3	3	2

Other respondents felt there was no need of using paraffin since other fuels could still meet their energy demands. A small number of respondents, however, reported that paraffin smelt bad and could therefore not use it as a source of energy.

Perceived disadvantages and advantages by users

The major disadvantage of paraffin reported by respondents in both years was that it was poisonous (Table 7). Some respondents specifically mentioned poisoning of children while others did not. As such, all responses associated with poisoning were put in the same category: that paraffin is poisonous. Approximately half of the respondents in both years were worried about poisoning. Respondents reported that children sometimes drank paraffin thinking that it was water or some kind of drink. Although the problem of expense was largely reported in 1991, it was less popular among respondents in 2002.

Table 7. Disadvantages of using paraffin by users. Data are percentage of users.

Perceived disadvantage	1991						2002					
	A'ol	O'boom	R'le	W'nd	X'thia	Mean	A'ol	O'boom	R'le	W'nd	X'thia	Mean
Poisonous to children	50	47	50	57	66	54	60	13	57	56	41	45
Expensive	27	27	33	31	23	28	14		2	13	5	7
Fire hazard	17	24	17	18	9	17	20	11	30	21	18	20
Not available	11	8	6	15	11	10						
Cause burns		5	9	6	14	7	4	3	12	9	5	7
Finish quickly	3	5	6	6		4						
Smoky			6			1	4	35	2	2	14	11
Burns children		3				1						
Hurts children				3		1						
No disadvantage	9	8	6			5	2	41	9		16	14
Don't know		9	9	24	9	10	8		9	17	11	9

Flame accidents due to malfunction of paraffin appliances were also reported as one of the disadvantages in both years. Closely associated with this disadvantage were accidental burns due to fall of paraffin lanterns, which affected all age groups. Another disadvantage cited in 2002, but hardly mentioned in 1991 was the smoke associated with paraffin. Some respondents complained that the smoke was a health hazard and made clothes dirty.

Respondents in both years listed uses of paraffin as an advantage of a particular of fuel. As such, lighting and cooking were listed as important advantages of paraffin (Table 8). Paraffin was, however, no longer used for domestic space heating and heating irons for pressing clothes as reported in 1991. Households in 2002 either used electric pressing irons or irons heated by charcoal to press clothes.

Some respondents reported the use of paraffin for making polish in 2002 as an advantage of using paraffin. This also reviewed that the contribution this practise makes to the fuel's consumption cannot be ignored. Another advantage reported in 2002 was that paraffin was easy to use.

Table 8. Advantages of paraffin as reported by paraffin users. Data are percentages of its users.

Perceived Advantage	1991						2002					
	A'ol	O'boom	R'le	W'nd	X'thia	Mean	A'ol	O'boom	R'le	W'nd	X'thia	Mean
Provides light	44	26	39	6	41	31	23	25	10	6	17	16
Lasts	27	6	17		25	15						
Allows cooking	6	20	21	10	5	12	23	25	11	10	17	17
Cooks fast	3	14	16	15	13	12	18	22	70	15	14	28
Relatively safe	9	8	6		5	6						
Easily available	8	11	7	1	9	45	6	2		1		2
For floor polish	8	11	3	15	8	9	50	13	9	15	36	25
Cheap	5	9	4		8	5			2			0.4
Back up fuel		14	4			4						
Starting a fire				3	3	1	4			3		1
Allows ironing		5	3			2						
Smokeless		3	3	3		2			2	3		1
Quick ironing		3				1						
Fast		3				1						
Provides heat			3			1						
Refrigeration			3			1						
No advantage		5	3	30		8		2		30		6
Don't know	6		4		13	5	4	4	2		7	17
Easy to use				18		4	20	20	17	18	8	17

3.1.2 Candles

Consumption of candles

Candles were still popular in 2002 with up to 93% of households interviewed reporting some use of candles (Table 9). Although the percentage of households using candles in 2002 was reported to have gone up by 17%, monthly per capita consumption had dropped by 50%. Consumption rates were reported at 2.4 and 1.1 candles per capita per month in 1991 and 2002 respectively.

Table 9. Total sample and household (candle users only) candle use and monthly use rates. Standard errors for household variables are given beneath the means.

Settlement	1991				2002			
	% HH using fuel	No. per capita	No. per HH	Cost per month	% HH using fuel	No. per capita	No. per HH	Cost per month
A'ol	82	2.9	26.2	R0.38	92	1.1	8.5	R0.78
			5.0	R0.01			1.3	R0.02
O'boom	73	1.3	13.3	R0.40	94	1.1	7.0	R0.09
			1.1	R0.01			0.8	R0.02
R'le	67	3.1	37.5	R0.45	90	1.1	8.2	R0.79
			8.3	R0.09			0.8	R0.02
W'nd	82	3.0	28.0	R0.40	96	1.1	9.2	R0.79
			3.4	R0.03			0.8	R0.02
X'thia	75	1.8	20.7	R0.09	94	1.2	8.5	R0.72
			2.9	R0.54			0.7	R0.02
Mean	76	2.4	25.0	R0.34	93	1.1	8.1	R0.63
Standard error			4.1	R0.10			0.9	R0.02

There was a significant difference in the households' monthly consumption of candles in Bushbuckridge between 1991 and 2002 ($Z= 9.22$, $p< 0.0001$). Consumption was recorded at 25 candles per household per month in 1991 while in 2002, the figure was 8.1 candles per household per month.

The decline varied greatly among the individual villages, ranging from 41% in Okkerneutboom to 78% in Rolle (Fig. 6). Even Athol, which had no access to electricity at the time of the survey, recorded a decline of 68%. An examination of the decline among the individual settlements showed a significant difference in the household consumption of the fuel between the survey periods ($F= 95.02$, $df = 1.56$, $p< 0.0001$).

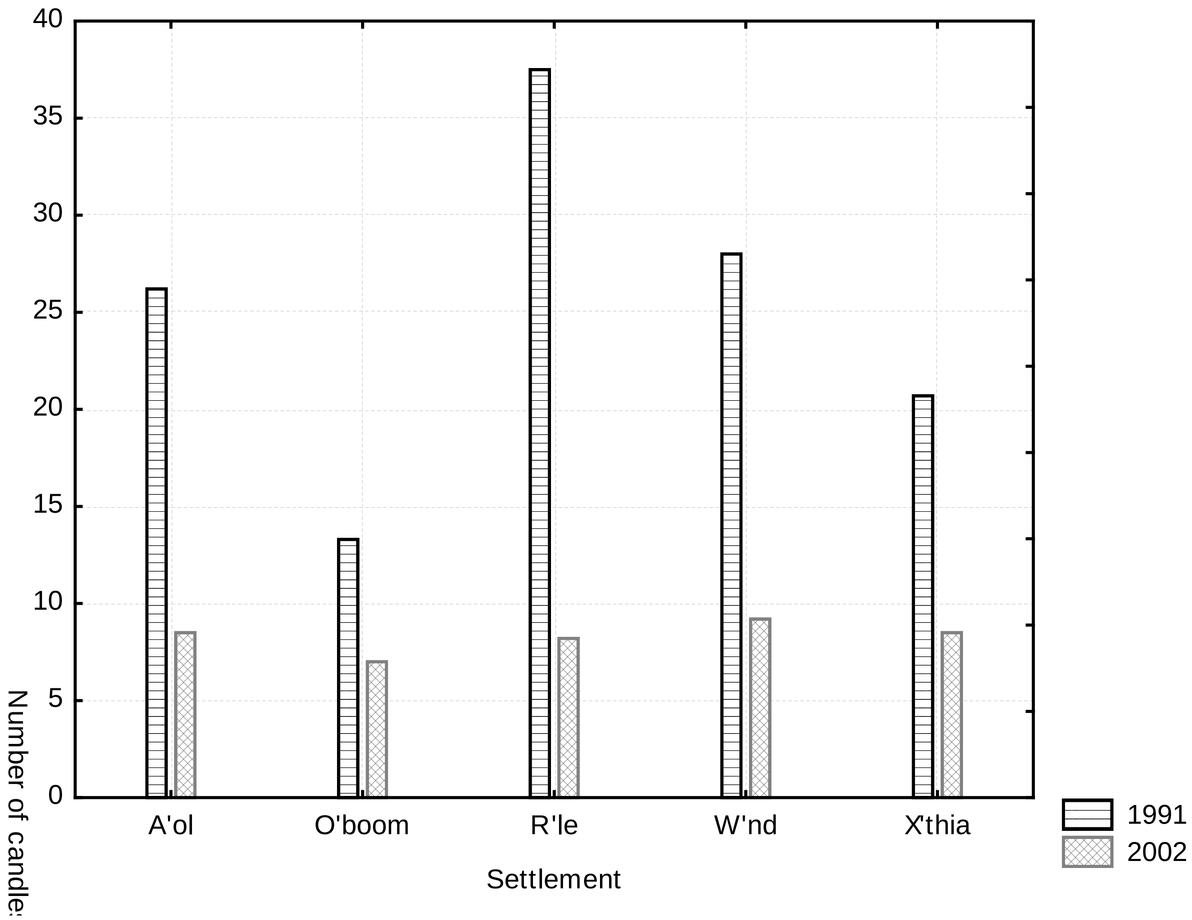


Fig. 6. Monthly consumption of candles by settlements in Bushbuckridge.

Despite the decline in the use of candles, there were indications from respondents suggesting that figures for the monthly usage of candles in 2002 could have been over stated. Most respondents were not sure of the frequency at which they bought candles since they only did so when there was a power failure or in some cases when they were making floor polish. As such, they were only able to state figures at the time of purchase. Exact monthly figures consumed were difficult to establish.

Reasons for not using candles

An outstanding reason for not using candles raised by non-users in both years was that candles posed a significant risk of fire in domestic premises (Table 10). The widely held view in 2002 was that candles, if left directly on top of wooden or plastic tables had the potential to melt through such materials and provide initiation for subsequent fires. The other reason raised by non-users in both years was that they had no need for candles since they could meet their energy demands using other fuels. Some non-users in settlements with electricity preferred the use of electricity to candles for lighting.

Table 10. Reasons for not using candles reported by non-users. Data are percentage of non-users.

Reasons	1991						2002					
	A’ol	O’boom	R’le	W’nd	X’thia	Mean	A’ol	O’boom	R’le	W’nd	X’thia	Mean
Fire hazard	72	83	79	47	54	67	75		25	40		28
No need	12	8	17	12	15	13		67	25	20	50	32
No appliance	17	8	4	6	15	10						
Expensive	5	8	4	12		6		33				7
Finish quickly				12	15	5						
Waste of money	5					1						
No reason				6	8	3						
Other reasons				6		1	25				17	8
Prefer others									63	60	33	31

Perceived disadvantages and advantages of using candles

The risk of fire still remained the major disadvantage of using candles by users (Table 11). Both users and non-users agreed that candles could easily cause domestic fires. In 1991 about two thirds of respondents were reported to have pointed out that the danger of using candles was the propensity for softening due to high air temperature and bending over while alight, thereby causing a fire

Table 11. Disadvantages of candle use reported by candle users. Data are percentages of candle users.

Disadvantage	1991						2002					
	A’ol	O’boom	R’le	W’nd	X’thia	Mean	A’ol	O’boom	R’le	W’nd	X’thia	Mean
Fire hazard	73	73	86	73	76	76	91	76	74	76	83	80
Finish fast	20	14	12	23	15	17	10		1		1	2
Expensive	16	17	12	14	9	14	3					1
Melt when hot	14	12	12	12	24	15						
Not available easily				4	3	1						
Cause burns				8		2						
Dirty				4		1						
Defective on purchase					3	1						
Don’t know	8	14	6	14	7	10	3	3	4	3	5	4
Difficulty to use outdoors							9	21	13	21	14	16

Some respondents in 2002 reported the difficulty of using candles out-doors as one of the disadvantages. Candles were reported to be unreliable and easily got finished when used out doors. The wind easily blew the flame off when used out doors. However, other respondents had no problems with candles

The most popular advantage of candles reported in both years was that they were a good source of energy for lighting (Table 12). Settlements with electricity used candles as back up fuel for lighting when there was a power failure. Also reported in both years was the use of candles as ingredients in making floor polish.

Table 12. Advantages of candle use reported by candle users. Data are percentage of candle users (1991 and 2002).

Advantages	1991						2002					
	A'ol	O'boom	R'le	W'nd	X'thia	Mean	A'ol	O'boom	R'le	W'nd	X'thia	Mean
Provides light	33	37	33	42	44	38	30	72	38	36	60	47
Polish ingredient	28	36	27	50	20	32	64	26	61	64	60	55
Relatively cheap	16	14	14	19	19	16			1	3		1
Easily available	22	9	18	4	15	14						
Smokeless	4	3	6	4	5	4	3	1				1
Long lasting		5	6	10	9	6						
Back up fuel		3		8		2						
Easy to use	4				4	2	18	18	7	7	9	12
Effective		3				1						
No advantage		5				1						
Don't know		7				1	3	5	1	3	3	3

3.1.3 Dung

In both years dung ranked very low in terms of consumption levels and popularity. Only 11% of households reported some use of dung in 1991 and 2.4% in 2002 (Table 13). There were no indications in 2002 either from the respondents, or field observations suggesting that estimates of dung use may have been under-reported for social reasons. The use of dung in the area was simply not common and this fact had less to do with the social stigma cited in 1991.

Consumption of dung

Household monthly consumption of dung decreased by 50% in the settlements surveyed between the two survey periods (Table 13). It was recorded at 103.8 and 50 kg per household per month in 1991 and 2002 respectively.

Table 13. Total sample and household (dung users only) dung use and monthly use rates. Standard errors for household figures are given below the means.

Settlement	1991			2002		
	% HH using fuel	kg per capita	kg per HH	% HH using fuel	kg per capita	Kg per HH
A'ol	6	0.4	64.4	6	0.5	56.0
			46.7			27.0
O'boom	40	18.8	387.5	6	1.9	194.0
			61.5			63.3
R'le	-	-	-	-	-	-
W'nd	4	0.3	65.9	-	-	-
			50.0			
X'thia	4	0.1	10.0	-	-	-
			6.0			
Mean	11	3.9	103.8	2.4	0.48	50.0
Standard error			4.1			45.2

Okkerneutboom reported the highest number of households using dung than any other settlement in both years. Similarly, dung consumption per household of users was several times higher than other settlements. The high use of dung in Okkerneutboom correlates with the scarcity of wood in the settlement. Field observations, however, revealed that dung played a supplementary role. It was not used as the main fuel or on its own, but rather with other preferred but scarce fuels such as wood. One respondent in Okkerneutboom reported that dung was only resorted to under situations of extreme fuelwood scarcity.

Reasons for not using dung by non-users

Though dung was available in all the settlements interviewed in both years, many respondents reported the undesirable characteristics associated with it's combustion, such as the eye irritating smoke and the unpleasant smell, as major reasons for not using it (Table 14). Other reasons cited by non-users were preferences for other fuels and some respondents simply had no use for it.

Table 14. Reasons for not using dung as reported by non-users of dung. Data are percentages of non-users.

Reasons	1991						2002					
	A'ol	O'boom	R'le	W'nd	X'thia	Mean	A'ol	O'boom	R'le	W'nd	X'thia	Mean
Smelly	27	51	24	27	22	30	63	41	33	49	42	46
Don't like it	17	12	24	14	29	19	1			1	5	1
Prefer others	14	7	17	21	20	16	10		15	25		10
No need	36	16	25	41	22	28		29	21	16	41	21
No cattle		5		2		1	13					3
Not accustomed	3	5	6	5	4	5						
Don't know	8	2	6	5	6	5	3		4	4	12	5
Other reasons		9	3	5	1	4	19	1	8	11	11	10
Smoky							4	4	19	16	7	10
Dirty							3		1		2	1
Health hazard									5			1

Perceived disadvantages and advantages of using dung

The smelliness of dung stood out to be major disadvantage reported by respondent in both years (Table 15).

Table 15. Disadvantages of dung use by dung users. Data are percentages of dung users.

Settlement	1991						2002					
	A'ol	O'boom	R'le	W'nd	X'thia	Mean	A'ol	O'boom	R'le	W'nd	X'thia	Mean
Smells bad	75	69	100	67		62	100	100				40
Smoky when burning	50	10		33	100	39						
Health hazard	25	14		33		14						
Finish fast		14		33		9						
Not effective		7			33	8						
Smoke is unhealthy	25					5	50					10
Slow				33	33	13						
Dirty	25	10				7						
Don't know							50					10
Others								50				10

The obnoxious smoke of dung when burnt also discouraged some respondents in 2002 from using it. Many respondents in both years simply said they had no need of dung**.**

The major advantage of dung reported by respondents in both years was that it was collected for free (Table 16). Some respondents in Okkerneutboom and Athol reported quick cooking of dung as an advantage in 1991. Another common use of dung cited as an advantage was it's use in making floors and decorating walls by households which could not afford to buy cement and/or paint. Dung was also used to harden the ground around some houses to reduce dust during windy periods. Field observations showed that this was a wide practise by most poor households in the region and it significantly affected the consumption of the fuel.

Table 16. Advantages of dung use reported by dung users. Data are percentage of dung users

Advantages	1991						2002					
	Athol	O'boom	R'le	W'nd	X'thia	Mean	A'ol	O'boom	R'le	W'nd	X'thia	Mean
Allows/good at cooking	25	38				13						
For free		28	100		67	39	50	100				30
Back up fuel		28		33	33	19						
Quick cooking		7				1	50					10
Easily available		7				1						
Provides heat				33		7						
Long lasting					33	7						
Mosquito repellent	25			33		12						
No advantage	25					5						
Don't know	25	10				7						
Decoration							50					10

3.1.4 Coal

The 1991 survey reported some use of coal in 8% of the households and the major uses of the fuel were cooking and heating. In 2002, however, non-of the interviewed households reported any use of coal. It was no longer an important fuel in the region. The lack of availability was reported to be the major constraint in the use of coal (Table 17). Other reasons also reported for not using coal were lack of appliances, expense and preference for other fuels. A number of respondents simply had no use of coal while others felt coal was a health hazard.

Table 17. Reasons for not using coal advanced non-users of coal. Data are percentage of non-users.

Reason	1991						2002					
	A'ol	O'boom	R'le	W'nd	X'thia	Mean	A'ol	O'boom	R'le	W'nd	X'thia	Mean
No coal stove	59	83	80	70	51	69	37	11	31	19	12	22
Not available locally	31	5	22	22	42	24	45	69	63	73	79	66
Expensive	7	10	2		6	5	20	4	5	5	2	7
Prefer others	4		2	2	1	2	3		4	4	6	0.2
Coal stove expensive	3			3		1			1			
Too smoky	1				1	0.4						
No appliance					1	0.2						
Smelly				2		0.4	1			1		0.4
Too dirty				2		0.4						
Not accustomed		2				0.4						
Don't know				2	1	0.6	3	2	3	3	4	3
No special reason	1				1	0.4						
Other reasons				2		0.4	3	17	4	4	6	5

3.1.5 Gas

Consumption of gas

The percentage of households using gas in Bushbuckridge went down from a recorded 14% in 1991 to 5% in 2002 (Table 18). Per capita consumption rates of gas also reduced from 0.2 to 0.1 kg per capita per month in 1991 and 2002 respectively. Only a few households in 2002 used gas.

There was no significant difference in the monthly household consumption of gas between 1991 and 2002 (Z= -1.01, p> 0.0001). The mean monthly consumption among users in all the settlements was 13.4 and 11.3 kg per household in 1991 and 2002 respectively.

Table 18. Total sample and household (gas users only) gas use and monthly use rates. Standard errors for household variables are given beneath the means.

Settlement	1991				2002			
	% HH using fuel	kg per capita	kg per HH	Cost per Kg	% HH using fuel	kg per capita	kg per HH	Cost per kg
A'ol	11	0.2	14.0	R3.00	13	0.3	17.1	R6.20
			4.7	R0.24			4.7	R0.12
O'boom	13	0.1	10.4	R2.77				
			2.2	R0.18				
R'le	23	0.4	16.0	R3.35	3	0.08	17.4	R5.75
			2.2	R0.46			2.3	R0.55
W'nd	13	0.1	11.3	R3.61	4	0.08	13.7	R4.75
			2.1	R0.46			9.2	R0.81
X'thia	10	0.2	15.8	R2.92	4	0.05	8.4	R6.29
			6.0	R0.40			1.0	R0.51
Mean	14	0.2	13.5	R3.13	4.8	0.1	11.3	R4.59
			3.4	R0.35			3.4	R0.50

The monthly consumption among the settlements varied very little between the two years (Fig. 7). An examination of the variation across the settlements did not review any significant difference (F= 0.092, df 1.45, p>0.0001).

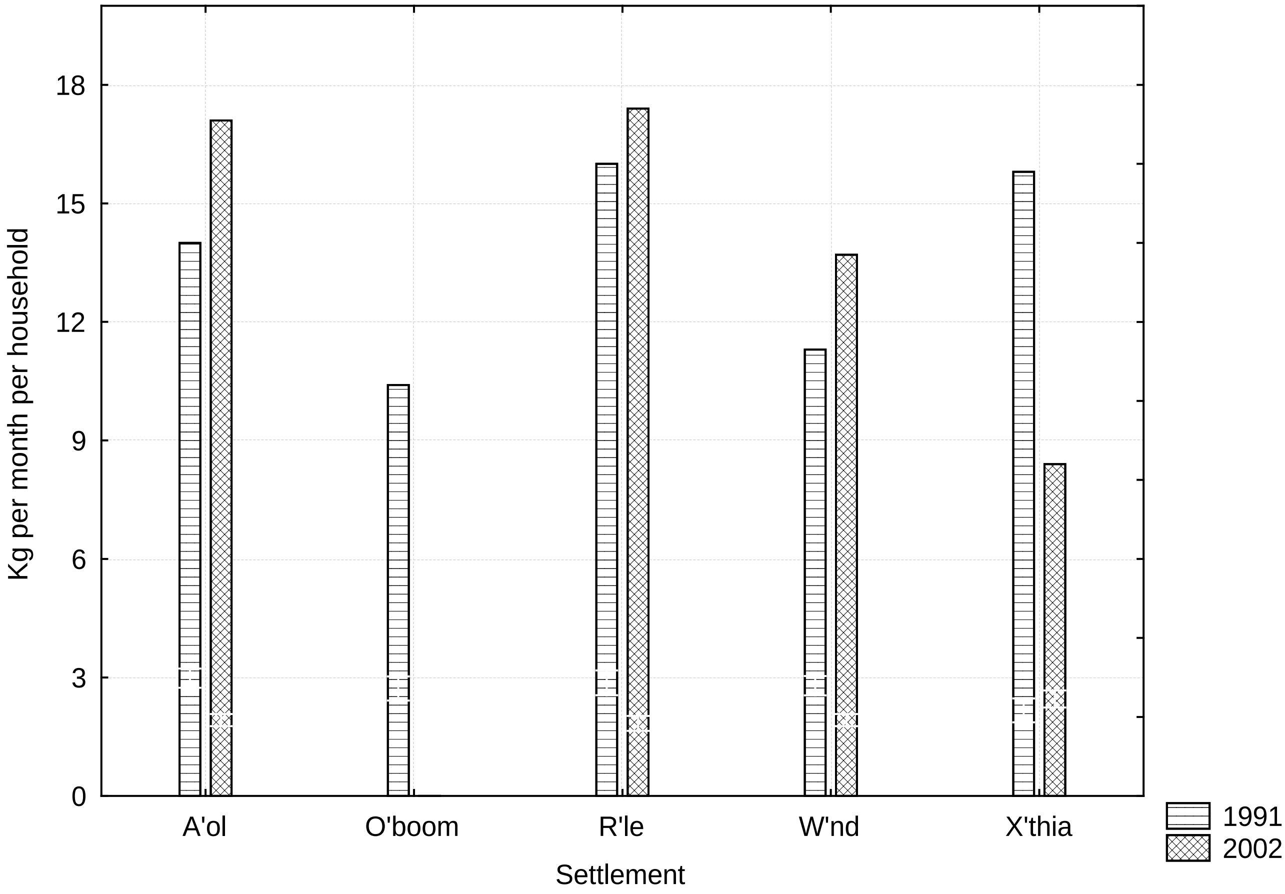


Fig. 7. Monthly consumption of gas by settlements in Bushbuckridge.

Main use of gas

In general, the major use of gas in both years was cooking, with the exception of Athol (Table 19). Respondents in Athol in both years reported the use of gas for refrigeration as the major use of the fuel. Other settlements had switched to electricity for refrigeration purposes.

Table 19. Main use of gas by households using it. Data are percentage of users.

Main use	1991						2002					
	A'ol	O'boom	R'le	W'nd	X'thia	Mean	A'ol	O'boom	R'le	W'nd	X'thia	Mean
Cooking	25	78	47	56	71	55			50	67	100	43
Refrigeration	63	11	41	33	29	35	100		50			30
Lighting	13	11	6			6				33		7
Heating tea water			6			1						

Respondents in 2002 no longer used gas for ironing (Table 20). They had instead switched to electric irons and irons heated by charcoal for the purpose of pressing their clothes. Some respondents in Rolle and Welverdiend reported the use of gas for welding in 2002. This practise was never reported in any settlement in 1991.

Table 20. Other uses of gas by households using it. Data show percentage of users.

Other uses	1991						2002					
	A’ol	O’boom	W’nd	R’le	X’thia	Mean	A’ol	O’boom	W’nd	R’le	X’thia	Mean
Heating tea water		67	12	11	43	27				34		7
Ironing	13	11	12	11	43	18						
Heating washing water	13	22	6	22	14	15						2
Cooking			24	22		9	11					
Refrigeration			6			1						
Heating house				11		2						
None	88	33	65	56	43	57	67	100	67			47
Welding							22		33			11
Lighting												

Appliances with which gas is used

Apart from Athol, users in both years used stoves as their major appliance (Table 21). In Athol, refrigerators remained popular in both years.

Table 21. Appliances with which gas is used by households using it. Data show percentage of users.

Appliance	1991						2002					
	A’ol	O’boom	R’le	W’nd	X’thia	Mean	A’ol	O’boom	R’le	W’nd	X’thia	Mean
Stove	14	78	56	89	57	59	30	50	100	100	100	76
Refrigerator	71	11	50	33	29	39	100	50				30
Hotplate			6		29	7						
Lamp	14	11	6			6						

Reasons for not using gas by non-users

Lack of appliances and expense were largely the reasons for not using the fuel by non-users in both years (Table 22). Many respondents in both years cited the danger of explosion as the second popular reason for not using gas. Other reasons raised in both years included the preference for other fuels, dislike for gas and non-availability of the fuel in the area. Some respondents in 2002 simply had no need of gas. This response either meant they had no energy needs that required the use of gas or they had other fuels that they could use in place of gas.

Table 22. Reasons for not using gas as reported by non-users. Data are percentages of non-users.

Reasons	1991						2002					
	A'ol	O'boom	R'le	W'nd	X'thia	Mean	A'ol	O'boom	R'le	W'nd	X'thia	Mean
No appliances	47	24	57	25	43	39			32	31	28	18
Expensive	21	22	14	40	20	23			32	60	26	24
Dangerous	21	27	20	10	20	20			41	14	35	18
Not available locally	10	27	11	3	20	14	4		1	3		1
Prefer others fuels				10	2	2	2		5	10	2	4
Difficult to obtain				3		0.6	2				2	1
Appliances expensive	5	2		2		2			1		2	0.6
No gas cylinder					2	0.4						
Smells bad					2	0.4						
Not accustomed	5	5	4	4	3	4						
Don't like it					2	0.4	2				5	1
No special reason				3		0.6						
Others											5	1
No need							2		5	3	20	6

Perceived disadvantages and advantages of using gas

Users of gas in both years cited the risk of fire as a major disadvantage of using gas (Table 23). All users in 2002 considered gas as a time bomb in terms of fire risks. In both years, users agreed with non-users that gas was expensive. Gas was also considered to be a health hazard in both years by respondents in Okkerneutboom and Xanthia. One respondent in Xanthia believed that gas was the cause of asthma.

Table 23. Disadvantages of gas use reported by gas users. Data are percentage of users.

Disadvantages	1991						2002					
	A'ol	O'boom	R'le	W'nd	X'thia	Mean	A'ol	O'boom	R'le	W'nd	X'thia	Mean
Fire hazard	50	56	65	33	71	55	89		100	100	34	65
Expensive	25		18	22	29	19	11		50			12
Explosion hazard		11		56		13						
Poisonous	13		12	11		7						
Difficult to transport	25					5						
Not easily available	13					3						
Health risk		11				2					67	13
Smells bad		11				2						
Hurts children				11		2						
Fire hazard due to children					14	3						
Poisonous to children					14	3						
No disadvantage		11				2	11				33	9
Don't know	13	22	24	33	14	21						

The main advantage of gas reported in both years was that it allowed quick cooking (Table 24). The other advantage was that it provided energy for refrigeration.

Table 24. Advantages of gas use as reported by users. Data are percentage of users.

Advantages	1991						2002					
	A'ol	O'boom	R'le	W'nd	X'thia	Mean	A'ol	O'boom	R'le	W'nd	X'thia	Mean
Cooks quickly	13	44	53	33	14	31	30			100	34	33
Smokeless	25	22	18		29	19						
Allows refrigeration			24	22	14	12	37					7
Lasts long	38	11	6		14	14						
Allows cooking		11		22	14	9			50		33	17
Easy to use		11	6		29	9						
Relatively cheap	13	11										
Easily available				11		5						
Allows ironing				11		5						
Provides light				11		5						
Fast				11		5						
No advantage	13		6			4						
Don't know	13	11		11		7			50		33	17

However the use of gas for refrigeration was only reported in Athol in 2002. Other settlements with electricity no longer used gas for refrigeration. A number of respondents in both years did not know of any advantage of gas.

3.1.6 Dry cell batteries

Consumption of dry cell batteries

The proportion of households using dry cell batteries dropped from 86% to 32% in 1991 and 2002 respectively (Table 25). The decline in the use of dry cell batteries was more pronounced in settlements that had access to electricity.

Per capita consumption of batteries decreased from 0.4 to 0.2 per capita per month in 1991 and 2002 respectively. There was no variation in the per capita consumption of dry cell batteries among settlements in the later year.

Table 25. Total sample and household (dry batteries) monthly use rates. Data are percentage of users only.

Settlement	1991				2002			
	% HH using fuel	No. per capita	No. per HH	Cost per HH	% HH using fuel	No. per capita	No. per HH	Cost per HH
A'ol	86	0.4	3.8	R7.64	65	0.2	2.0	R20.1
			0.5	R0.55			0.2	R1.4
O'boom	78	0.4	3.6	R6.05	12	0.04	2.0	R7.0
			0.4	R0.47			0.3	R1.8
R'le	92	0.3	2.6	R8.49	25	0.09	2.3	R12.0
			0.3	R0.48			0.6	R2.0
W'nd	91	0.6	5.1	R5.94	31	0.1	2.2	R10.1
			0.6	R0.51			0.3	R1.4
X'thia	83	0.4	3.3	R7.59	26	0.8	1.9	R8.6
			0.3	R0.54			0.2	R1.7
Mean	86	0.42	3.7	R7.14	32	0.2	2.1	R11.6
Standard error			0.4	R0.51			0.3	R1.7

There was a significant difference in the monthly household consumption of batteries in the region between the two years (Z=3.42, p<0.0001). Consumption of dry cell batteries declined from 3.7 batteries per household per month in 1991 to 2.1 batteries per household per month in 2002. Respondents in 2002 had switched on to electricity to power their appliances.

There was some variation in the proportion of the decrease amongst the individual settlements (Fig. 8). An examination of the decrease showed a significant difference between the two years (*F*= 39.04, *df*= 1.42, *p*<0.0001).

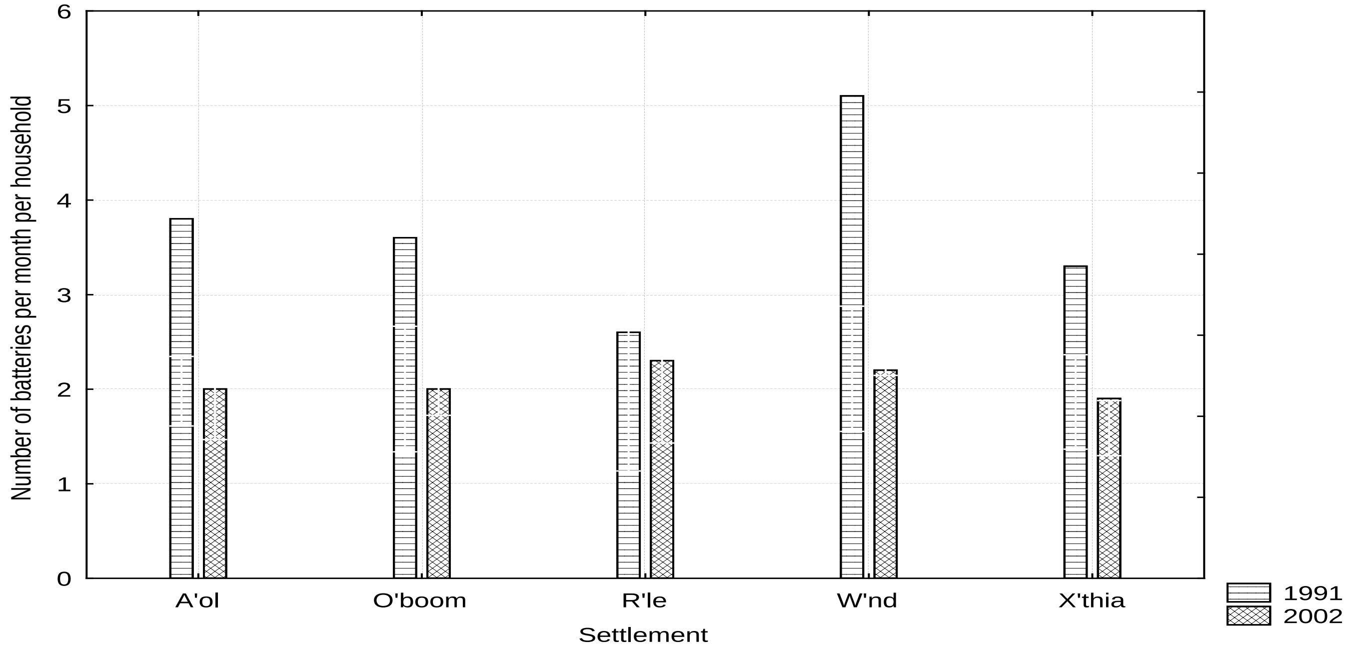


Fig. 8. Consumption of batteries by settlement in Bushbuckridge.

The three most common batteries used by households in both years were PM09's, PM10's and R20PP's. A break down of their monthly consumption is shown in Table 26.

Table 26. Monthly dry cell battery consumption in households using batteries. Data show the number of different batteries used per month.

Battery type	1991						2002					
	A'ol	O'boom	R'le	W'nd	X'thia	Mean	A'ol	O'boom	R'le	W'nd	X'thia	Mean
PM10	1.1	0.9	1.2	1.3	1.6	1.2	1.1	0.0	0.4	0.2	0.1	0.4
PM09	1.1	1.1	0.7	0.7	0.8	0.9	0.6	0.7	1.1	0.9	0.7	0.8
R20PP	1.5	1.3	0.6	2.9	0.9	1.4	0.3	1.3	0.7	0.8	1.1	0.8
R6PP	0.0	0.2	0.0	0.1	0.0	0.1	0.0	0.0	0.1	0.3	0.0	0.1
Total	3.8	3.6	2.6	5.1	3.3	0.7	2.0	2.0	2.3	2.2	1.9	0.4

Athol had the highest consumption of large batteries in both years. This was attributed to the fact that households in the settlement still depended on energy from dry batteries to power appliances that provide entertainment. In both years, R20PP batteries were popular in all the settlements. This was attributed convenient for appliances like torches clocks and portable radios.

Appliances with which batteries are used

In 1991, batteries were predominantly used to power appliances that provide entertainment in the form of music, news and so on (Table 27). However, with four settlements having access to electricity, only Athol still used batteries for such purposes. As earlier pointed out R20PP batteries were still popular in all the settlements because of their size.

Table 27. Appliances with which dry cell batteries are used. Data are percentage of users only.

	1991						2002					
Appliance	A’ol	O’boom	R’le	W’nd	X’thia	Mean	A’ol	O’boom	R’le	W’nd	X’thia	Mean
Radio	67	87	42	58	69	65	85	40	60	60	45	58
Radio cassette	38	24	28	33	31	31						
Hi-fi	16	18	23	15	32	21	7		10			3
Torch	12	9	9	30	8	14	4	50	10	20	27	22
Tape recorder	16	11	17	17	8	14						
Watch								20	15	8	32	15
Alarm										4		0.5
Remote										12		2

Reasons for not using batteries

Lack of appliances, which use batteries, was cited in both years as the most predominant reason for not using dry battery cells (Table 28). Most respondents in 2002 felt they had no need of batteries because they had acquired appliances that could be powered by electricity. Some respondents also reported that batteries were difficult to find locally.

Table 28. Reasons for not using dry cell batteries. Data are percentage of non-users.

Appliance	1991						2002					
	A'ol	O'boom	R'le	W'nd	X'thia	Mean	A'ol	O'boom	R'le	W'nd	X'thia	Mean
No appliance	100	88	67	83	100	88	64	8	28	24	35	32
Expensive		6	17			5	20		5		5	6
Appliance expensive												
No need		6	17			5		4	15	2	10	6
Finish fast				17		3						
Prefer electricity							20			73	54	29
Difficulty to find locally							4	88	52			29
Dangerous to children									2			0.4

Disadvantages and advantages of using batteries

Respondents cited the reason of expense in both years as the main disadvantage of using batteries (Table 29). However, the most predominant disadvantage in 2002 was that dry battery cells finish fast. Batteries were also associated with poisoning of household members. This usually affected children who at times chewed on them and / or ate their contents.

Table 29. Disadvantages of using dry cell batteries. Data are percentage of users only.

Disadvantage	1991						2002					
	A'ol	O'boom	R'le	W'nd	X'thia	Mean	A'ol	O'boom	R'le	W'nd	X'thia	Mean
Expensive	45	38	40	35	37	39	20	10	10	16		11
Poisonous to children	23	29	31	37	30	30						
Finish fast	17	16	13	19	10	15	23	40	25	48	23	32
Poisonous	13		8	6	13	8	46		40	12	18	23
Not available locally	5				10	3						
Defective on purchase	5		3			2						
May damage appliance	3	6				2						
No disadvantage	12	13	16	10	7	12	2	50	20	8	41	24
Don't know		11		16	7	7	15		10	28	18	14

Some uses of batteries were also reported as advantages (Table 30). As such provision of entertainment was cited as the most popular advantage of batteries in both years. The other advantage included the provision of light. Unlike 1991, non-of the respondents felt batteries were long lasting.

Table 30. Perceived advantages of dry battery cells. Data are percentage of users.

Advantage	1991						2002					
	A'ol	O'boom	R'le	W'nd	X'thia	Mean	A'ol	O'boom	R'le	W'nd	X'thia	Mean
Provides news, entertainment	48	48	55	54	57	52	74	40	75	76	86	70
Long lasting	32	18	28	17	25	24						
Relatively easily available	8	23	9	13	10	13	2					0.4
Relatively cheap	3		6	6	5	4	7			4		1
Provides light	3			11		3	2	50	30			16
Easy to use												
Safe fuel		4				1						
No advantage	5	4	4			3						
Don't know	3	5		8	10	5	15	10		20	14	12
Can be used as medicine							2					0.4

3.1.7 Lead acid batteries

The proportions of households using conventional car batteries were far lower than dry batteries in both years. Only 9% and 8% of households used car batteries in 1991 and 2002 respectively. However, Athol recorded an increase in the number of households using car batteries, i.e., from 6% in 1991 to 34% in 2002. 75% of the users in Athol also reported the use of solar panels to recharge their batteries. This cheaper and convenient means of recharging batteries could have contributed to the increase in the use of car batteries in the area in 2002.

Use rates of lead acid batteries

The 1991 report used monthly expenditure on car batteries as a measure of consumption rates of the fuel. However this method could not be used in 2002 because over 75% of users charged batteries on there own. Some used the batteries in their cars during the day and to power appliances in the night. Others simply used solar panels to recharge their batteries. The use of monthly expenditure on car batteries as a measure of consumption rates would have, therefore, given misleading results.

Appliances with which lead acid batteries are used

In both years, hi-fis were reported to be the most popular appliance for which lead acid batteries were used (Table 31). Almost half of the respondents in both years reported the use of lead acid batteries to power television sets. They were also used to power tape recorders and radios.

Tables 31. Appliances in which lead batteries are used by households using them. Data are percentages of users.

Appliance	1991						2002					
	A'ol	O'boom	R'le	W'nd	X'thia	Mean	A'ol	O'boom	R'le	W'nd	X'thia	Mean
Hi-fi	25	60	25	50	67	45			100	100	100	60
Television	50	40	45	33	33	40	50		50	50		30
Radio			9	17		5	42					8
Radio cassette					33	6	4					1
Tape recorder	25					5	50					10
Refrigerator		20		17		7	8					2
Light												

Reasons for not using lead acid batteries by non-users

Generally, settlements in 2002 with electricity preferred using electricity to power their appliances (Table 32). Another eminent reason cited by users in both years was the lack of appliances that use lead acid batteries. The reason of expense was still popular in Athol. Other respondents in both years felt they had no need of lead acid batteries.

Table 32. Reasons for not using lead acid batteries reported by non-users. Data are percentages of non-users.

Reasons	1991						2002					
	A'ol	O'boom	R'le	W'nd	X'thia	Mean	A'ol	O'boom	R'le	W'nd	X'thia	Mean
No appliances	27	41	13	43	28	30	50	1	18	27	30	25
Battery expensive	21	16	26	5	15	17	75		13		15	10
No need	12	6	13	12	1	9	33	25	35	39	31	33
Charging expensive	5	12	11	5	13	9	25	1	13	9	5	11
Nowhere to recharge	5	1	3	7	4	4		2	6	5	7	4
Damage appliance	2	4	2	2	1	2						
Expensive appliance	2					0.4						
Don't know it	21	9	16	5	22	15	8		3	2	2	3
No special reason	8	10	11	21	15	13						
Other reasons	3	1	3	3		2			4		2	1
Prefer others							17	71	21	36	21	33

Perceived disadvantages and advantages of using lead acid batteries

Risk of acid burns resulting from the less than careful handling of lead acid batteries was the major disadvantage cited in both years (Table 33). Some respondents reported that acid "burnt" their clothes.

Table 33. Disadvantages of using lead acid batteries. Data are percentage of users.

Disadvantage	1991						2002					
	A'ol	O'boom	R'le	W'nd	X'thia	Mean	A'ol	O'boom	R'le	W'nd	X'thia	Mean
Acid burns	50	40	33	50	50	45	67		50	50		33
Expensive	50	60	25	17	50	40	26		50			15
Damage appliances			25	17		8						
Quickly finish			8		25	7	4					1
Hurt children			8			2						
No disadvantage			17	17		7	13			50	100	33
Don't know			8	33		8						

The reason of expense was a common disadvantage in 1991 and was also mentioned by respondents in Rolle in 2002. A number of respondents in both years however had no problem with the use of batteries.

The use of lead acid batteries to power appliances to provide entertainment was cited as a major advantage in both years (Table 34).

Table 34. Advantages of using lead acid batteries. Data are percentage of users only.

Advantage	1991						2002					
	A'ol	O'boom	R'le	W'nd	X'thia	Mean	A'ol	O'boom	R'le	W'nd	X'thia	Mean
Long lasting	50	40	50	50	25	43	13					3
Provides entertainment	25	20	25	17	25	22	54		50	100	100	61
Relatively cheap			25		25	10	8					2
Replaces electricity	25	20		17		12	21		50			14
Back up fuel		20		17		7						
Provides light		20		17		7						
Other use of fuel			8			2						
Allows refrigeration				17		3						
No advantage			17		25	8						
Don't know			8			2	4					1

3.1.8 Generators

A few households used generators in 1991 while in 2002, none of the respondents reported any use of generators. Reasons for not using generators were mainly lack of appliances and expense (Table 35). The high cost of generators as well as the cost of running them prohibited most of the respondents from using it. Respondents in 2002 simply preferred electricity to generators, a recent energy in the region. Other reasons cited in both years were non-availability of the fuel, high fuel expenses, and non-availability of the appliances.

Table 35. Reason for not using generators reported by non-users. Data are percentage on non-users.

Reason	1991						2002					
	A'ol	O'boom	R'le	W'nd	X'thia	Mean	A'ol	O'boom	R'le	W'nd	X'thia	Mean
No appliance	54	58	43	62	45	52	65	56	55	66	56	60
Expensive	33	19	29	14	22	23	45	23	36	48	15	33
Fuel expensive	3	1	6		7	3	6	2	6	8	2	5
Not available	3	6	3		3	3	2		33	8	8	10
No need	1	3	1	3	1	2	5	12	14	5	5	8
Appliance expensive	4		3		3	2	9	2	8	2	2	5
Noisy			4		1	1			4			1
Appliance not available	1		1		1	1	9	23	15		40	17
Not accustomed	1	1		2		1	1	2	2	2	1	2
Don't know	1	10	4	6	7	6	5	4	8	2		4
No special reason	3	4	7	18	9	8	1		8			2
Prefer electricity								66	71	68	58	53
Other reasons	1		1			0.4			2			0.4

3.1.9 Crop wastes

Consumption of crop wastes

Field observations indicated that respondents mixed the use of dry grass with agricultural residues. The two types of fuels were, therefore, categorised as one, i.e. crop wastes. The proportion of households using crop residues was reported at 20% in 1991 and 29% in 2002 (Table 36).

Table 36. Proportion of households using charcoal. Data are percentage of users only

Settlement	Percentage of users	
	1991	2002
A'ol	21	31
O'boom	39	33
R'le	19	25
W'nd	22	21
X'thia	22	29
Mean	25	28

Respondents could not easily estimate the quantity of the fuel they were using because of the type and intermittent use of the fuel. It mainly consisted of dry maize stalks or cobs and was only used once in a while mainly to kindle other fires. The actual consumption rates were therefore difficult to establish.

Reasons for using crop wastes

Although the use of crop wastes was popular among all the settlements in both years, its role among users in 2002 was very insignificant. They were largely used for kindling other fires in both years (Table 37).

Table 37. Reasons for using crop wastes. Data are percentage of non-users.

Reason	1991						2002					
	A'ol	O'boom	R'le	W'nd	X'thia	Mean	A'ol	O'boom	R'le	W'nd	X'thia	Mean
Start a fire	100	37	93	33	94	71	100	100	100	100	100	100
Back up fuel		42	7	33	6	18						
Freely available		8		33	6	9						
To warm self quickly		13				3						
Cheap				33		7						
To warm water		4				1						
To brew beer		4				1						
Other reasons		8				2						

Other reasons cited by users for using crop wastes in 1991 were warming self, warming water as well as brewing beer. Some respondents preferred the use of this fuel because it was obtained for free.

Reasons for not using crop wastes

In both years, the outstanding reason for not using crop wastes was that they burn quickly (Table 38). However a good portion of respondents simply had no use of crop wastes as a fuel. They preferred other fuels to crop wastes. Some respondents said crop wastes were feed for animals. They considered crop wastes to be exclusively animal feed. 6% of respondents in Athol complained of the low calorific content of crop wastes that resulted in more being burnt to get the same amount of energy as from wood.

Table 38. Reasons for not using crop wastes. Data are percentage of non-users.

Reason	1991						2002					
	A'ol	O'boom	R'le	W'nd	X'thia	Mean	A'ol	O'boom	R'le	W'nd	X'thia	Mean
Burn too quickly	53	38	45	26	43	41	45	41	33	44	20	37
Not necessary	16	12	22	33	15	20	24	54	50	38	70	47
Prefer other fuels	15	7	14	13	26	15	4	2	10	10	11	7
Used else where	9	19	5	15	4	10						
Not effective	2	7	2	4	2	3						
Insufficient heat							6					1
Smoky							6	2		6		3
Children use the			5		4	2						
Not accustomed		12	3			3						
No special reason	5	5	5	13	9	7	14		5	2	2	5
Other reasons	2	9	2	11	9	7	8	2		5	2	3

3.1.10 Charcoal

The English word "charcoal" generally refers to the black substance made by partial burning of wood slowly in an oven with little air (Oxford Advanced learners dictionary). However, the Tsonga language of Limpopo Province is not descriptive enough as to draw a distinct line between the black substance and the red-hot substance from burning fuelwood. Both substances are simply called "*makala*" meaning charcoal. The 1991 report restricted the use of the word "charcoal" to the black substance only. However, this was inappropriate and as such, this report considered both substances as charcoal. Based on this kind of categorisation, it was clear that charcoal was popular in the area in 2002 with an average of 51% of the households using it mainly for heating irons to press clothes.

Consumption of charcoal

The consumption rate of charcoal was difficult to measure because of the way in which it was used. It was usually collected directly from live domestic fires into pressing irons. Quantities used depended on the size of the pressing irons and the quantity of clothes to be pressed. In terms of percentages, the proportion of households using domestic charcoal ranged from 18% in Rolle to 87% in Okkerneutboom (Table 39).

Table 39. Proportions of households using charcoal in 2002. Proportions are percentage of users.

	Settlement					
	A'ol	O'boom	R'le	W'nd	X'thia	Mean
Percentage	83	87	18	51	22	52

Charcoal was almost exclusively used for ironing with only two households in Rolle reporting using it for baking.

Reasons for not using charcoal

Reasons given in 1991 were strictly in reference to commercial charcoal. Non-availability of commercial charcoal was reported as the main constraint for not using the fuel in 1991 (Table 40).

Table 40. Reasons for not using charcoal. Data are percentages of non-users.

Reasons	1991						2002					
	A'ol	O'boom	R'le	W'nd	X'thia	Mean	A'ol	O'boom	R'le	W'nd	X'thia	Mean
Not available locally	17	6	8	28	14	15						
Difficult to collect							17	17	8		9	10
Prefer other fuels	4	1	6			2	8	46	38		100	38
Don't like it	1	1		3		1	8		5	5	5	4
Expensive	1	1		1		1				3		1
No need		3		1	1	1	33	33	27	21	18	26
Not accustomed			3			1			2			0.4
Don't know it	74	89	82	54	83	76						
No reason	4		3	12	3	4	17				6	5

However preference for other fuels and lack of appliances were cited as the main reasons for not using charcoal in 2002. Other reasons were the difficult that was involved in collecting it from the fire and other respondents simply did not like the fuel.

Perceived disadvantages and advantages of using charcoal

The major problem users in 2002 had with the fuel were that it made clothes dirty (Table 41). Irons when heated using charcoal sometimes left white ash on clothes. The other disadvantage was that the uncontrollable heat from heated irons sometimes resulted in clothes being burnt. Other respondents had no problems with the use of the fuel.

Table 41. Disadvantages of using charcoal. Data are percentages of users.

Reasons	Settlement					
	A'ol	O'boom	R'le	W'nd	X'thia	Mean
No problem	0	33			11	9
Don't know	2		14	7	21	9
Makes clothes dirty	22	33	14	20	16	21
Burns clothes	76	50	79	73	33	62

The major advantage cited by user was that domestic charcoal met the need of pressing clothes (Table 42). The other advantage was that it was obtained for free.

Table 42. Advantages of using charcoal. Data are percentages of users.

Reasons	Settlement					
	A'ol	O'boom	R'le	W'nd	X'thia	Mean
Good for ironing	88	83	86	83	68	82
It's free	15	17	14	17	37	20

Respondents who could not afford buying electric pressing irons found it cheaper to use irons heated by charcoal.

3.1.11 Electricity

In 1991 only three households in the entire sample settlements had access to electricity. Those who used electricity either lived in Rolle or Okkerneutboom. Reticulated electricity was not available in the other settlements. In the late nineties there was massive electrification of households in Okkerneutboom, Rolle, Welverdiend and Xanthia (See below) such that at the time of the survey almost all households in the four settlements were electrified. Only Athol had no access to reticulated electricity.

Main use of electricity

Electricity was mainly used for lightening (Table 43).

Table 43. Main uses of electricity. Data are percentage of users in 2002 (Note: electricity was unavailable in Athol).

Use	Settlement				
	O'boom	R'le	W'nd	X'thia	Mean
Lighting	90	86	84	84	86
Powering entertainment appliances	5	7	6	9	7
Refrigeration	3	6	6	5	5
Cooking	2	1	1	1	1
Others	1	1	3		1

All households using electricity reported using it for lighting. A vast majority said that electricity was their main or only fuel for lighting. The high cost of electricity prohibited most households from using it for cooking.

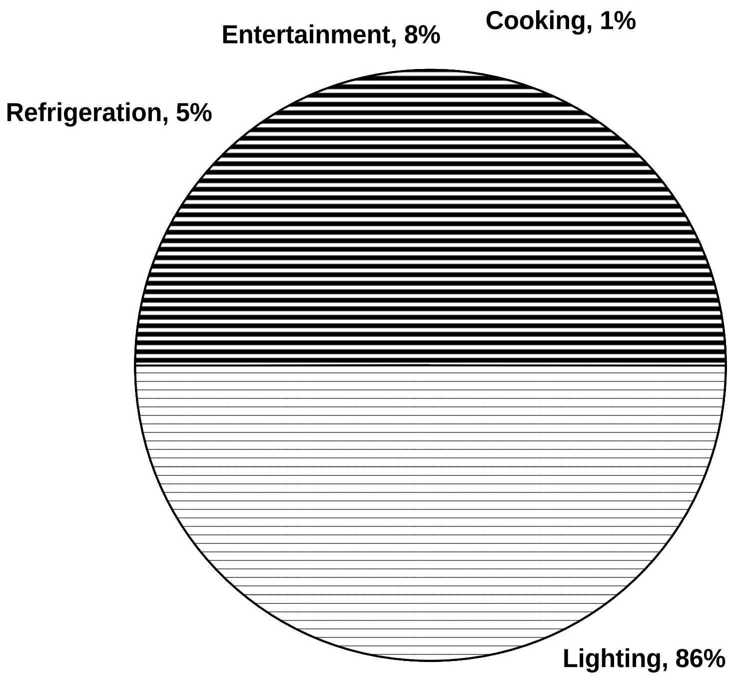


Fig. 9. Main use of electricity by users in Bushbuckridge (2002 only).

Other uses of electricity included powering electrical appliances that provide entertainment, refrigeration, pressing clothes and cooking (Table 44).

Table 44. Other uses of electricity. Data are percentage of users in 2002 (Note: electricity was unavailable in Athol).

Use	Settlement				
	O'boom	R'le	W'nd	X'thia	Mean
Lighting	11	16	14	8	10
Powering electrical appliances	49	59	52	50	42
Refrigeration	29	39	33	34	27
Cooking	13	16	9	6	9
Others	1	3	3		1

Over 50% of the respondents used electricity to power entertainment appliances. A small percentage of houses that used electricity for cooking preferred doing so on a few occasion. Very few households exclusively used electricity for cooking.

Expenditure on electricity

Monthly expenditure on electricity in 1991 ranged from R21 to R92 per household. It appears connection fee was a significant expense to all the users and it ranged from R900 to R1091. In 2002, however, monthly expenditure varied from one settlement to another and ranged from R42 in Xanthia to R73 in Okkerneutboom (Table 45).

Table 45. Expenditures of installation and monthly use by users in 2002. Data are percentages of users only (Note: electricity was unavailable in Athol).

	Settlement				
Expenditure	O'boom	R'le	W'nd	X'thia	Mean
Cost of installation	R67	R123	R82	R62	67
Monthly expenditure	R73	R71	R62	R42	50

Installation was more expensive for residents in Rolle than Xanthia at an average of R123 and R62 respectively. Monthly expenditure was highest in Rolle and Okkerneutboom.

Okkerneutboom, Welverdiend and Xanthia reported having electricity installed in 1997 while Rolle reported having it in 1998.

Reasons for not using electricity

Respondents in Athol reported the non-availability of electricity in the area as the main reason for not using electricity (Table 46). The other four settlements had access to electricity. A few households that had no electricity in the four electrified settlements were built after the electrification exercise. They cited current costs of installation as the major reason for not installing electricity in their houses.

Table 46. Reasons for not using electricity. Data are percentages of users in 2002 (Note: electricity was unavailable in Athol).

Reason	Settlement					
	A'ol	O'boom	R'le	W'nd	X'thia	Mean
Not available locally	90					18
No appliances	8		20			6
Don't know	2					0.4
Expensive to install			80	100	100	5

Perceived disadvantages and advantages of using electricity

The major disadvantage of electricity cited by many respondents was that it was dangerous (Table 47). A number of them reported a few incidents of mild electric shocking as a result of stepping on or handling naked live wires. Closely associated to this disadvantage was the damage electricity caused to appliances if not used properly. Some respondents reported that they have had some appliances burnt because of wrong connections. The other disadvantage was the cost components associated with the use of electricity. The major cost components were electric bills, bulbs and other appliances that go with the use of the fuel. Most electricity appliances were said to be single-purpose kind of appliances. Consumers had to buy separate appliances for almost each individual purpose and this made the use of electricity expensive. Another disadvantage cited by users were power failures during a storm. This usually left the consumers without means for lighting.

Table 47. Disadvantages of using electricity. Data are percentage of users in 2002 (Note: electricity was unavailable in Athol).

Reasons	Settlement				
	O'boom	R'le	W'nd	X'thia	Mean
Expensive	17	9	14	9	10
Dangerous	28	63	62	58	42
Fire hazard				58	12
Power failures and disconnection	1	7	14	8	6
Don't know	1	1	3	6	2
Difficult to use				1	0.2
Nothing	47	17	3	13	16
Appliances are expensive		4	1	1	1
Burns appliances	4	4	3	14	5

Many respondents cited the wide use of electricity as the major advantage of the fuel (Table 48). Electricity was a multi-purpose kind of fuel. Many respondents also said electricity could meet certain specific needs that other fuels like wood could not. Other reasons cited as advantages were that electricity was easy to use, clean and fast.

Table 48. Advantages of electricity. Data are percentage of users

Perceived advantage	Settlement				
	O'boom	R'le	W'nd	X'thia	Mean
Widely applicable	43	55	60	44	40
Clean	5	7	6	10	6
Easy to use	16	3	3	4	5
Modern	4	11	13	15	9
Meets specific needs	30	27	13	29	20
No advantage				4	1
Don't know	2	1		3	1
Fast	2	3	5		2

3.1.12 Purchased wood

Consumption of purchased wood

The mean proportion of households purchasing wood in the area was 27% and 31% in 1991 and 2002 respectively (Table 49). In both years Okkerneutboom had the highest percentage of households purchasing wood. This correlates with the wood scarcity in the area.

The mean per capita consumption of purchased wood increased slightly from 19.9 kg per capita month in 1991 to 20.1 kg per capita per month in 2002. Increased dependency on purchased wood may be an indication of increasing scarcity of wood in the area.

Table 49. Total sample and household (wood purchasers only) bought wood use and monthly use rates. See materials and methods for an explanation of the units used. Household data show the mean above the standard error.

Settlement	1991				2002			
	% HH using fuel	kg per capita	kg per HH	Cost per kg	% HH using fuel	kg per capita	kg per HH	Cost per kg
A’ol	1	0.0			8	4.1	351.1	0.25
							110.5	0.03
O’boom	68	32.6	373.8	R0.13	63	35	344.0	0.25
			39.4	R0.01			37.5	0.01
R’le	34	36.4	762.3	R0.08	48	35.5	496.0	0.22
			109.8	R0.01			47.5	0.01
W’nd	19	16.6	858.1	R0.07	20	16	564.0	0.21
			226.7	R0.01			65.6	0.02
X’thia	15	13.7	602.5	R0.26	16	10	398.0	0.18
			140.2	R0.19			75.1	0.02
Mean	27.4	19.9	519.0	R0.14	31	20.1	430.6	0.22
							67.25	0.02

Reasons for not buying wood

In both years more than 50% of the respondents who did not buy wood saw no need of doing so because they could still collect it for free (Table 50). Nevertheless, the percentage of respondents with this view had greatly reduced in 2002 meaning that there was an increasing number of people who no longer considered wood to be a free commodity. In both years, the reason of expense was popular among non-users. A few non-users cited the difficult of finding traders as a reason for not using purchased wood

Table 50. Reasons for not buying wood reported by non-users. Data are percentage of non-users.

Reasons	1991						2002					
	A’ol	O’boom	R’le	W’nd	X’thia	Mean	A’ol	O’boom	R’le	W’nd	X’thia	Mean
Collect for free	100	77	92	95	92	91	78	26	48	80	83	63
Don’t use wood		4	7		3	3		16	5	15	2	8
Expensive		14		4	3	4	18	55	38		15	25
Difficult to get locally		4		2		1		4	5	1		2
Get wood elsewhere			2			0.4						
No special reason					2	0.4			5			1
Fear of arrest							3			4		1

Perceived disadvantages and advantages of purchased wood

The high cost of wood was reported to be the major disadvantage of purchased wood in both years (Table 51). Most respondents considered the price of fuelwood to be exorbitant. The fuel was also said to be difficult to get. This was in agreement with non-users who reported the difficulty of finding traders as a reason for not using purchased wood.

Table 51. Disadvantage of using wood. Data are disadvantages reported by users of purchased wood.

Disadvantage	1991						2002					
	A'ol	O'boom	R'le	W'nd	X'thia	Mean	A'ol	O'boom	R'le	W'nd	X'thia	Mean
Expensive	100	80	100	62	82	85	83	94	84	81	79	84
Finish quickly		8	8	8	9	7						
Not easily available		4		8		2		4	13	7	7	6
Risk of arrest				8	9	3		3		6	7	3
Burns children				8		2						
Wet on purchase			8			2						
Can cause burns				8		2	16					3
Difficult to use				8		2						
No disadvantage		10	8	8		5		4	3		7	3
Don't know		6		15	9	6			8	13		4

The major advantage reported in both years was the ease with which purchased wood arrived home (Table 52). Respondents who purchased wood associated wood collection with a lot of drudgery.

Other advantages reported in both years were that purchased wood allowed cooking, it lasted long, was easy to use and was a good back-up fuel. Some of the respondents in Okkerneutboom and Rolle stated that they had no other way of obtaining wood apart from purchasing it.

Table 52. Advantages of purchased wood. Data are percentage of users.

Advantage	1991						2002					
	A'ol	O'boom	R'le	W'nd	X'thia	Mean	A'ol	O'boom	R'le	W'nd	X'thia	Mean
Easily available	100	31	48	31	36	49	25	44	60	56	85	54
Allows cooking		17	28	38	45	26		2	13	6		4
Long lasting	100	14	24	8	27	35		10	3		7	4
Back up fuel		8				2		16	3	6		5
Easy to use			12	8		4	50		8	13	1	14
Quick cooking		4		8	9	4	50		6			11
Allows ironing				15		3						
Effective				8	9	3						
Provides heat				15		3						
Familiar		4				1						
No risk of arrest		4				1		15	3	6		5
No advantage		6	8	8		4						
Don't know		10		8		4	25		11	13	14	13
Cheaper/ free								2	3	12		3
Convenient								3	5	6		3
No other alternative								15	6			4

3.1.13 Collected wood

Most of the fuelwood in the region is gathered free of charge from the surrounding environment. Wood collectors either cut live wood or collect dead wood.

Collection of wood

There was a high incidence of wood collection in the region in both years. Over half of the households surveyed collected wood (Table 53). The proportion of households gathering wood in Bushbuckridge decreased from a reported 78% in 1991 to 64% in 2002.

There was a significant difference in the time spent on wood collection in the region between 1991 and 2002 ($Z = 3.20$, $p < 0.0001$). The time spent on trips increased from a reported mean of 3h59 in 1991 to 4h28 in 2002. Collectors spent more time searching for wood in 2002 than they did previously.

Table 53. Duration of wood collection trips and time spent monthly per household on wood collection. Data show the mean above the standard error.

Settlement	1991			2002		
	% HH using fuel	Overall trip	Collection time	% HH using fuel	Overall trip	Collection time
Athol	97	3h27	1h31	94	3h53	Ih41
		0h11	0h11		0h16	0h14
O'boom	51	4h37	2h03	28	5h38	2h38
		0h27	0h24		0h23	0h12
Rolle	68	3h59	2h08	45	4h19	2h11
		0h15	0h24		0h17	0h18
W'end	90	4h28	2h21	78	4h49	2h39
		0h16	0h15		0h13	0h13
X'thia	83	3h27	1h57	79	3h40	1h45
		0h12	0h16		0h13	0h25
Mean	78	3h59	1h38	64	4h28	2h11
Standard error						

There was some variation in the extent of the increase in wood collection trips among the individual settlements (Fig. 10). The increase in time was highest in Okkerneutboom and lowest in Athol. An examination of the increase among all the settlements reviewed a significant difference (F= 12.05, df= 1.40, p<0.0001).

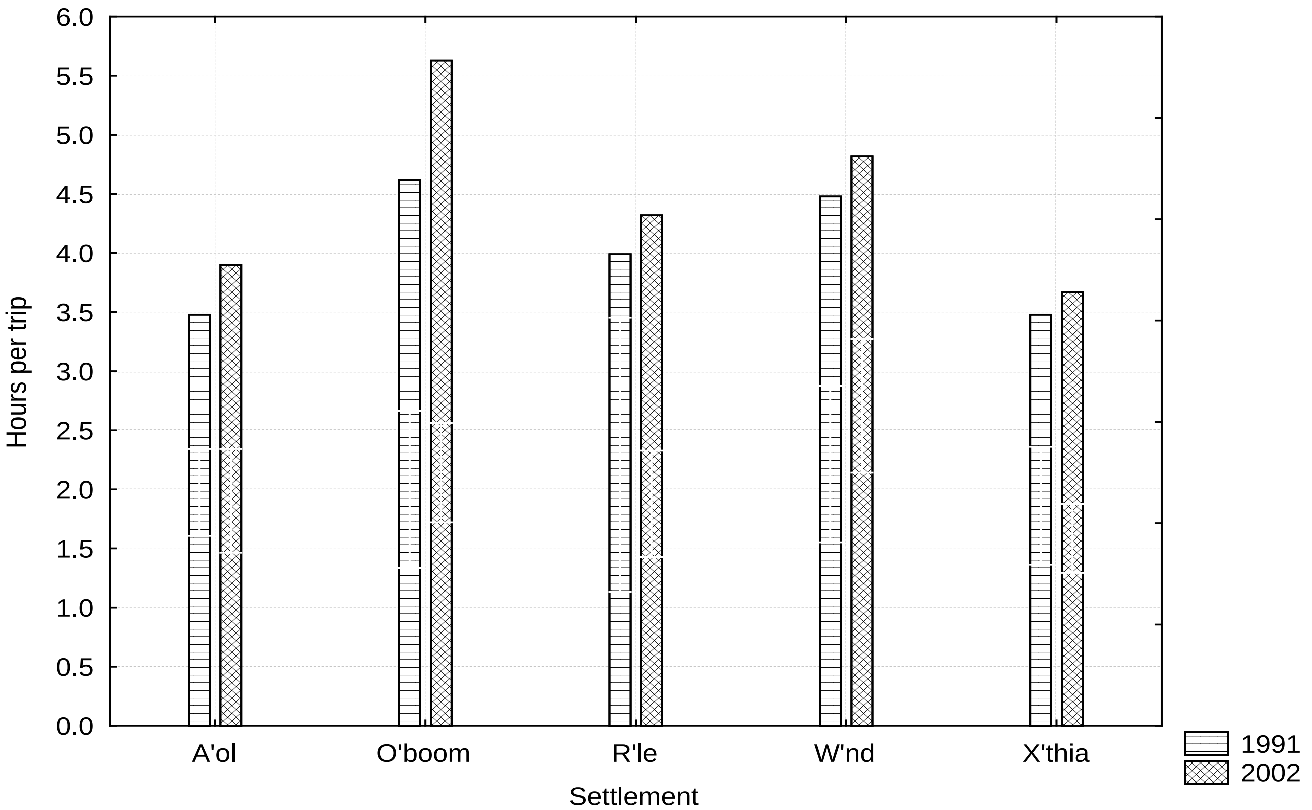


Fig. 10. Mean collection times of wood by settlements in Bushbuckridge.

Species preference

Respondents in both years showed a distinct preference for particular tree species as sources of fuelwood (Table 54).

Table 54. Tree species most preferred by residents for fuelwood. Data show percentage of wood collectors.

Species Name	1991						2002					
	A'ol	O'boom	R'le	W'nd	X'thia	Mean	A'ol	O'boom	R'le	W'nd	X'thia	Mean
Acacia burkeii	6	5		8		4	11	4		6		4
Acacia swazica										2		0.4
Bauhinia galpinii				10		2				8		2
Combretum apiculatum	3	5	4			2	3	4	3		3	3
Combretum collinum				3	15	4	3	4		2	10	4
Combretum hereroense	4			8		2	7	4	3	11		5
Combretum imberbe	6		4	15		5	9	9	3	5	15	8
Dalbergia melanoxylon	22	11	16	5		11	9		6			3
Dichrostachys cinerea	32	38	22	47	5	29	29	30	36	58	21	35
Diospyros mespiliformis		5				1	6	4	3		3	3
Euclea natalensis										8		2
Faurea saligna					32	6					7	1
Lonchocarpus capassa							1					0.2
Parinari curatellifolia					10	2					3	0.6
Pterocarpus rotundifolius	3					0.6						
Sclerocarya birrea		8				2			3		2	1
Strychnos madagascariensis	4		6			2						
Terminalia sericea	13	19	30		32	16	14	9	17	2	31	15

Athol and Rolle respondents in both years had the same fuelwood preferences. The most popular fuelwood species in the two settlements were *D. melanoxylon, D. cinerea* and *T.sericea. A. burkeii* was also popular among respondents in 2002.

Respondents in O'boom in both years showed preference for *D. cinerea* and *T. sericea. D. melanoxylon* and C. *imberbe* were only reported to be preferred species in 1991 while *C. imberbe* was preferred in 2002.

Combretum species were popular in Xanthia and Welverdiend in both years. *C. colllinum* and *C. imberbe* was reported in Xanthia while *C. hereroense* was reported in Welverdiend. Other popular species in the two settlements included *D. cinerea* and *T. sericea. D.cinerea* and *T.sericea* were the most popular species overall. Almost all the settlements showed preference for the species.

It is important to note that more tree species were mentioned in 2002 than in 1991 for every village. This was an indication that during collection exercises, collectors were no longer as selective as they were in 1991. Fuelwood scarcity was slowly ruling out choices collectors used to make in the past. Species that were previously ignored were considered for collection in 2002. This was more evident in Okkerneutboom were collectors reported scavenging for any piece of wood.

Species mentioned in the respondent’s list of most preferred species were also mentioned in the list of the other five species preferred by respondents (Table 55).

Table 55. Tree species given in the wood collectors' list of five preferred species. Data show percentage of collectors mentioning any species

Species Name	1991						2002					
	A'ol	O'boom	R'le	W'nd	X'thia	Mean	A'ol	O'boom	R'le	W'nd	X'thia	Mean
Acacia ataxacantha		8				2						
Acacia burkeii	31	16	8	21		15	21	13	25	25	6	18
Acacia gerrardii	7			24		6						
Acacia swazica		5				1						
Afzelia quansensis					7	1	6	4	3	29	27	14
Bauhinia galpinii			6	58		13		13		45		12
Combretum apiculatum	28	22	22		15	17	31	30	22	16	22	24
Combretum collinum	15		14	39	78	29	3		3		9	3
Combretum hereroense	26		6	66		20	26	13	6	50	3	20
Combretum imberbe	40	27	28	48		29	19	22	14	32	7	19
Dalbergia melanoxylon	62	35	32	42	8	36	47	26	11	24	4	22
Dichrostachys cinerea	85	68	64	89	49	71	51	39	19	40	84	47
Diospyros mespiliformis	31	8	44	8	15	21	28	17	25	13	6	18
Euclea natalensis				11		2	6		10	27	15	12
Faurea saligna					68	14	1				33	7
Lonchocarpus capassa		5	8			3	3		11			3
Maytenus senegalensis	10	11	6	11		8	15	4	6	3	3	6
Parinari curatellifolia		24			53	15		4	3		12	4
Peltophorum africanum		11	14		10	7	3				1	1
Pterocarpus angolensis		16	10		7	7	6		6	21	17	10
Pterocarpus rotundifolius									6	2		2
Schotia brachypetala		5	6			2						
Sclerocarya birrea	40	46	36	6	22	30	43	30	19	13	7	22
Strychnos madagascari-ensis	18	11	24		8	12	17		22			8
Strychnos spinosa			8			2	3					0.6
Terminalia sericea	68	73	82	13	93	66	49	17	28	11	25	26
Trichilia emetica							1				3	1

There was a general increase in fuelwood scarcity between the two years (Table 56). Some of the tree species that were reported to be easy to collect in 1991 were reported to be difficult to collect in 2002.

Table 56. Collection difficulty associated with tree species preferred by wood collectors for fuelwood. Data show median difficulty where 1 = easy; 2 = moderately 3 = very difficult.

Species Name	1991					2002				
	A'ol	O'boom	R'le	W'nd	X'thia	A'ol	O'boom	R'le	W'nd	X'thia
Acacia ataxacantha		2			3					
Acacia burkeii	2	2	3	2		2	2	3	1	3
Acacia gerrardii	2	1	2	1						
Acacia swazica	2	2	1	3						1
Afzelia quanzensis			1		1	1	3	3	2	
Bauhinia galpinii			2	1			2		1	2
Combretum apiculatum	2	3	1	3	2	2	2	1	2	2
Combretum collinum	2	1	1	1	1	3				2
Combretum hereroense	2	1	2	1		2	2	3	1	3
Combretum imberbe	2	2	2	3		2	1	2	2	2
Dalbergia melanoxylon	2	2	2	2	2	1	2	2	2	2
Dichrostachys cinerea	2	2	1	2	1	1	2	2	1	1
Diospryros mespiliformis	1	2	2	1	2	1	1	2	1	2
Euclea natalensis		1	1	1		3		2	2	1
Faurea saligna					2	3				1
Loncocarpus capassa	1	1	1			2		2		
Maytenus senegalensis	2	2	2	1		1		3	3	3
Parinari curatellifolia		1	1		1		3	2		2
Peltophorum africanum	2	1	2	1	2	2				3
Pterocarpus angolensis		2	2		2	2		3	2	2
Schotia brachypetala		2	2	1						
Sclerocarya birrea	1	1	1	1	1	2	2	2	2	2
Strychnos madagascariensis	1	2	2		2	3	2	2		
Strychnos spinosa		1	1		1	2				
Terminalia sericea	1	1	1	3	1	2	2	2	2	1
Trichilia emetica		1	1		1					3

I

Frequency of woodcutting

In Bushbuckridge, fuelwood gatherers generally cut live trees due to dead wood scarcity. The proportion of households cutting wood in the region was 53% and 49% in 1991 and 2002 respectively (Table 57).

Table 57. Incidence of tree cutting by respondents. Data show percentage of wood collectors cutting or not cutting, while data on cutting frequency are percentage of woodcutters.

Frequency of cutting	1991						2002					
	A'ol	O'boom	R'le	W'nd	X'thia	Mean	A'ol	O'boom	R'le	W'nd	X'thia	Mean
Cut	30	34	55	76	72	53	55	61	50	40	40	49
Very often		11	7		21	8	3		6	2		2
Often			4		7	2	3	9	3	2	6	5
Sometimes	65	44	78		50	47	39	39	39	31	30	36
Rarely	35	44	11		21	22	10	10	3	6	4	8
Don't cut	70	66	45	24	28	47	43	39	47	60	58	49

Most respondents in 2002 were reluctant to admit their involvement in wood cutting, except were this was obvious, such as a pile of recently cut wood within the vicinity. Such reluctance was related to fears of arrest by Indunas and other law enforcers. It is, therefore, likely that the figures in Table 57 were understated.

Reasons for increased difficulty

Over 60% of respondents in 2002 reported that wood collection was more difficult at the time of the survey than it was five years earlier (Table 58). This view was popular across all the settlements. Interestingly, respondents in 1991 gave a similar response suggesting that wood collection has been difficult in the area for a long time.

Table 58. Changes in collection difficult since five years before the study. Data are percentage of wood collectors.

Changes in wood collection	1991						2002					
	A'ol	O'boom	R'le	W'nd	X'thia	Mean	A'ol	O'boom	R'le	W'nd	X'thia	Mean
Become difficulty	78	84	78	26	81	69	67	70	53	63	57	62
No change	9	14	16	16	16	14	23	26	42	24	42	31
Undecided	13	3	6	57	3	16	10	4	6	15	1	7

The common reason advanced in both years for the increased difficulty of wood collection was that dry wood was not easily available (Table 59). Closely associated with this reason was increased population. In both years some respondents attributed the shortage of dead wood to increased population. The reason of restricted tree cutting raised in 1991 was also reported in 2002. It was commonly asserted in both years that the practise of woodcutting was free from permits five years earlier. As earlier reported, this answer has two different connotations either or both of, which could have been intended by the respondents. The first is that it was easy to get wood in the past as one could cut live wood, which is now not allowed, and which makes wood collection more difficult. The second connotation is that woodcutting in the past killed many trees thereby decreasing wood production and causing less wood to be available at the time of the survey.

Table 59. Reasons for cutting trees reported by wood collectors who said that they did sometimes cut trees. Data are percentage of tree cutters.

Reason	1991						2002					
	A'ol	O'boom	R'le	W'nd	X'thia	Mean	A'ol	O'boom	R'le	W'nd	X'thia	Mean
Dry wood available in the past	58	48	53	29	63	50	66	35	87	49	42	56
Fewer people in the past	25	30	21	35	27	28	30	7	16	13	32	20
Free cutting allowed in the past	11	24	18	15	10	78	4	17	21	33	11	17
More building due to resettlement				15		3						
Fewer people in the past; refugees blamed												
Don't know							1	24	5			6
Growing old							3		6	5	13	5
Presence of criminals in the bush								17	5	3	3	6

Some respondents in the later year said they were growing old and had no strength to gather wood. These were mainly old respondents staying alone or with young grandchildren. Another reason cited by respondents mainly in Okkerneutboom was that thugs sometimes attacked women in the bush thus making the exercise of wood collection risky and difficulty.

Suggestions proposed for improving the "wood collection problem"

In 2002, a majority of respondents in settlements with electricity proposed that the government should reduce electricity tariffs to enable them use it for cooking (Table 60).

Table 60. Suggestions proposed by wood collectors for improving the "wood collection problem". Data are percentage of wood collectors.

Improvement suggestion	1991						2002					
	A'ol	O'boom	R'le	W'nd	X'thia	Mean	A'ol	O'boom	R'le	W'nd	X'thia	Mean
Allow cutting of trees	28	43	26	15	19	26	4	4	8	5		4
Supply electricity	25	22	30	24	22	25	90		8	5	5	22
Nothing can be done	4	5	10	5	5	6						
Stop cutting of trees	3			5	3	2						
Buy wood			4	3	5	2						
Open other lands to collectors				6		1	2		6	10	7	5
Use other fuels	3		6			2						
Stop commercial wood collection					7	1						
Use transport to collect further a field				3		0.6						
Government to decide												
Government to supply wood								4	3	19	13	8
Cut more trees					5	1						
Stop long distance collection					5	1						
No problem noted				3		0.6						
Don't know	32	32	20	27	25	27	4		11	11	12	8
Reduce electricity tariffs								65	56	52	51	45
Need protection from criminals								36	7		3	9
Government to supply electrical appliances									8	2	13	5

At the time of the survey, the use of electricity was restricted for lighting and powering entertainment appliances (section 3.1.11).

Like in 1991, some respondents in 2002 proposed the removal of legal protection of trees to allow uncontrolled cutting of trees. Some of the respondents, however, felt collectors should be allowed to collect fuelwood from protected areas.

3.1.14 Wood use

Monthly household and sample fuelwood consumption were based on respondent's estimates of their daily use (Table 61).

Table 61. Total sample and household (wood users only) fuelwood use and monthly use rates. Data are based on respondent's estimates of their daily use. See methods for an explanation of the units used. Household data show the mean above the standard error.

Settlement	1991			2002		
	% HH using fuel	kg per capita	kg per HH	% HH using fuel	kg per capita	kg per HH
A'ol	99	42.1	309.3	100	46.5	321.0
		2.4	22.3		2.7	19.6
O'boom	96	31.3	251.0	88	38.4	270.7
		2.3	17.5		2.8	20.7
R'le	96	37.5	306.2	89	40.7	306.6
		2.2	28.0		2.8	20.6
W'nd	99	46.7	399.9	96	45.4	331.1
		2.1	27.2		2.8	20.4
X'thia	93	45.0	353.0	96	53.8	358.6
		2.6	22.5		2.6	19.2
Mean	97	40.5	323.9	94	44.9	317.2.2
Standard error		2.3	25.5		2.7	20.1

There was a slight decrease in the mean percentage of households using wood from a reported 97% in 1991 to 94% in 2002. Okkerneutboom and Rolle reported the highest decrease.

Mean per capita consumption rates for all the settlements were recorded at 40.5 kg and 44.9 kg per capita per month in 1991 and 2002 respectively.

A comparison of the household monthly consumption of fuelwood for all the sample settlements between the two survey periods reviewed no significant difference (Z= -0.9, p>0.0001). Monthly household consumption of wood was reported at 323.9 and 317.2 kg per capita per month in 1991 and 2002 respectively.

The change in consumption varied from one settlement to another and a comparison across the settlements also reviewed no significant difference (F=0.099, df=1.40, p>0.0001) (Fig 11)

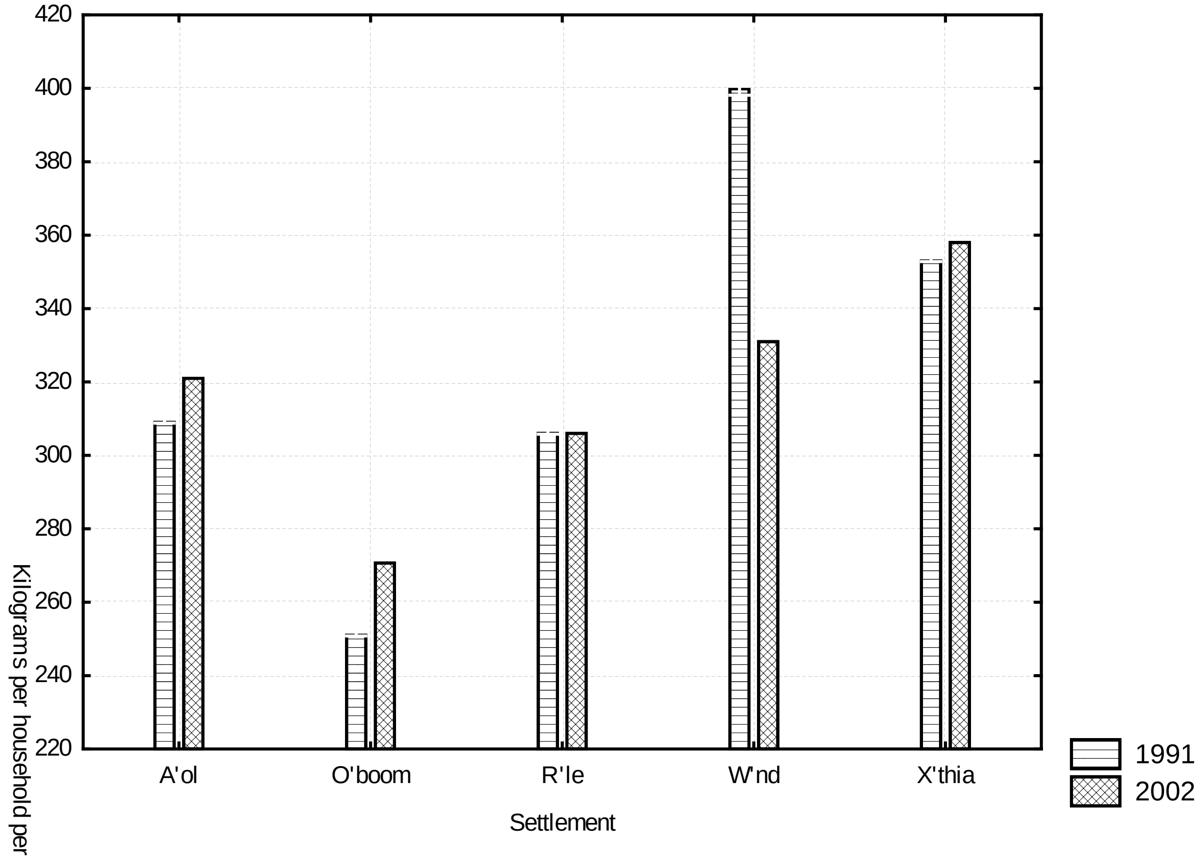


Fig. 11. Monthly household consumption of wood by settlements in Bushbuckridge.

Main use of wood

In both years fuelwood was mainly used for cooking (Table 62). Few households reported the use of fuelwood for heating water and making outside fires.

Table 62. Main use of fuelwood in households using the fuel. Data are percentage of users.

Main use	1991						2002					
	A'ol	O'boom	R'le	W'nd	X'thia	Mean	A'ol	O'boom	R'le	W'nd	X'thia	Mean
Cooking	100	100	99	94	100	99	96	92	100	94	98	96
Outside fire			1	4	1	1						
Heating water	3	7			21	6						

The most common secondary use of wood reported in 1991 was making outside fires and heating water for tea (Table 63). Outside fires were mainly for social reasons. Most respondents in 2002 reported the use of fuelwood to heat washing water as the major secondary use of the fuel. The second common use in 2002 was heating water for tea

Table 63. Other uses of wood in households using the fuel. Data are percentage of users.

Other uses	1991						2002					
	A'ol	O'boom	R'le	W'nd	X'thia	Mean	A'ol	O'boom	R'le	W'nd	X'thia	Mean
Outside fire	96	49	73	65	71	71	24					5
Heating tea water	90	46	86	32	91	69		16	28	48	52	29
Heating water	33	10	30	4	36	23	82	58	62	48	58	62
Ironing	45	16	29	30	23	29						
Heating home			1		3	0.2		1				0.2
Cooking		1		4		1	3					0.6
Melting candles			1			0.2						
Brewing beer		1				0.2						
None	1	14	1	13	5	7		23	8	6	6	9

Disadvantages and advantages of using wood

The most common disadvantage of fuelwood that was mentioned in all settlements in both years was the drudgery involved in obtaining it (Table 64). Since wood is transported mainly by head-load, the potential for fatigue and adverse health effects are high. Another disadvantage of wood use mentioned in both years was the risk of fires. Closely associated with this disadvantage were accidental burns mainly to children. The eye irritating smoke from burning wood was widely reported by respondents in 2002. This reason was not popular in 1991 and it's not clear why a lot of respondents suddenly cited it in 2002. However it appears most respondents in 2002 were comparing the use wood to electricity. There was an interesting disadvantage reported by some respondents in 2002 alone. They said fuelwood was sometimes used as a weapon during domestic fights. Young couples found fuelwood to be a handy weapon.

Table 64. Disadvantages of fuelwood use reported by users. Data are percentage of users.

Settlement	1991						2002					
	A'ol	O'boom	R'le	W'nd	X'thia	Mean	A'ol	O'boom	R'le	W'nd	X'thia	Mean
Not available	35	33	26	37	36	33	37	10	23	44	29	29
Burns children	10	17	17	19	23	17			11	6		3
Difficult to transport	10		11	9	20	10						
Smoky	14		16	4		7	15	70	34	23	28	34
Fire hazard	12	7	13	9	6	9	21	4	11	21	17	15
Can cause burns	6	7	3	10		5						
Expensive	3	14	3		3	5						
Risk of arrest		3		5		2						
Collection is dangerous	3		3		3	2	5				1	1
Fire hazard due to children				3	3	1	17					3
Slow				3	3	1						
Produce unwanted heat				3	3	1						
No disadvantage	14	3	13	9	8	9		14				3
Can be used as a weapon							4	1	1		1	1
Don't know		16	7	66	5	19	4	3	18	5		6

The use of fuelwood to cook was reported by many respondents in both years as an advantage of using the fuel (Table 65). Table Closely associated with this advantage was widely held view that wood cooks fast.

Table 65. Advantages of fuelwood reported by fuelwood users. Data are percentage of users.

Advantages	1991						2002					
	A'ol	O'boom	R'le	W'nd	X'thia	Mean	A'ol	O'boom	R'le	W'nd	X'thia	Mean
Allows cooking	36	29	26	49	39	31	7	5	10	1	7	6
Obtained for free	29	7	16	16	29	19	21	7	8	30	24	8
Quick cooking	16	12	21	7	11	13	62	75	68	70	73	70
Long lasting	9	16	7	7	21	12						
Produces heat	7	7	10	22	9	11						
Effective	7	9	14	6	5	8						
Easily available	7		4	9	5	5						
Familiar		4	4			2					3	0.6
Allows ironing	3	4		9		3						
Easy to use	3		3		5	2	18	8	20	19	18	17
Smokeless		9				2						
Safe fuel			3			0.6						
Don't know		12	7	4		5	1	7	10	3	3	5

3.2 PATTERNS OF FUEL CHOICE

In both surveys, households used mixtures of fuels to meet different end uses. It was common for a household to use different fuels for different end uses or use multiple fuels for a single end use.

3.2.1 Fuel choice for thermal applications

Fuelwood was the staple energy form for thermal applications in both surveys (Table 66). Even households that had access to electricity in 2002 continued using fuelwood. Electricity did not displace the other fuels in as far as cooking and other thermal applications were concerned.

The paraffin/wood combination was more popular in 1991 than in 2002. Only one percent of households used electricity for thermal purposes in 2002.

Table 66. Fuel choice for cooking. Data show percentage of users.

	1991						2002					
Fuel choice	A'ol	O'boom	R'le	W'nd	X'thia	Mean	A'ol	O'boom	R'le	W'nd	X'thia	Mean
Wood only	70	29	27	45	53	45	56	31	23	46	65	44
Paraffin only	0	0	0	0	2	0.4	0	3	1	0	0	0.8
Electricity only	0	0	0	0	0	0	0	2	1	3	1	1.4
Paraffin & wood	29	66	67	48	41	50	44	25	18	19	6	22
Electricity & wood	0	0	0	0	0	0	0	14	28	18	18	16
Electricity & paraffin	0	0	0	0	0	0	0	7	9	3	3	4
Electricity, wood & paraffin	0	0	0	0	0	0	0	18	20	11	7	11
Gas, wood & paraffin	1	5	7	7	4	4.8	0	0	0	0	0	0

3.2.2 Fuel choice for lighting

The candles/paraffin combination was popular for lighting in 1991 while in 2002 households mostly used a combination of candles with electricity (Table 67).

Table 67. Fuel choice for lighting. Data show percentage of users.

Fuel choice	1991						2002					
	A'ol	O'boom	R'le	W'nd	X'thia	Mean	A'ol	O'boom	R'le	W'nd	X'thia	Mean
Paraffin only	22	17	32	20	33	25	4	0	0	0	0	0.8
Electricity only	0	0	0	0	0	0	37	0	0	3	0	8
Candles only	14	38	25	23	8	21	0	2	0	5	6	3
Electricity & candles	0	0	0	0	0	0	0	92	80	79	78	66
Electricity & paraffin	0	0	0	0	0	0	0	3	2	8	8	4
Candles & paraffin	64	45	43	57	59	54	59	0	5	0	0	13
Candles, paraffin & electricity	0	0	0	0	0	0	0	3	13	5	8	6

Between the survey periods, access to electricity enhanced the shift towards the use of electricity as a source of energy for lighting in the electrified settlements. Households only used candles for back-up purposes when there was a power failure or when they did not have enough money to purchase pre-paid electricity cards. However, in Athol, the candle/paraffin combination retained its importance.

3.2.3 Fuel choice for powering entertainment appliances

It was apparent that electrified households in 2002 had made a shift from dry cell batteries to electricity to power entertainment appliances (Table 68). However, the dry cell/electricity combination was also common in 2002. It appears there were certain end uses that could only be met by dry cell batteries. These included powering torches, portable radios and watches. At the time of the second survey lead acid batteries were only popular in Athol.

Table 68. Fuel choice for powering entertainment appliances. Data are percentage of users.

Fuel choice	1991						2002					
	A'ol	O'boom	R'le	W'nd	X'thia	Mean	A'ol	O'boom	R'le	W'nd	X'thia	Mean
Dry cell batteries only	82	74	82	86	80	81	44	12	25	31	26	28
Lead acid batteries only	2	3	6	5	3	4	10	0	1	3	0	5
Electricity only	0	0	0	0	0	0	0	70	53	45	59	45
Dry cell batteries & electricity	0	0	0	0	0	0	0	0	0	4	1	1
Lead acid batteries & dry cell batteries	4	4	10	4	3	5	21	0	0	0	0	4
None	12	19	2	5	14	10	25	18	21	17	14	17

3.2.4 Fuel choice for refrigeration

Most households had no refrigerators in both surveys. However, a few who had refrigerators mainly used gas and electricity in 1991 and 2002 respectively (Table 69).

Table 69. Fuel choice for refrigeration. Data are percentage of users.

Fuel choice	1991						2002					
	A'ol	O'boom	R'le	W'nd	X'thia	Mean	A'bool	O'om	R'le	W'nd	X'thia	Mean
Gas	100	100	100	100	67	93	100	0	7	10	10	25
Paraffin	0	0	5	0	33	7	0	0	0	0	0	0
Electricity	0	0	0	0	0	0	0	100	93	90	90	75

3.2.5 Number of fuels used per household

The majority of households in both years used four or more fuels within the household (Table 70). 30% and 26% used three fuels in 1991 and 2002 respectively. In 2002 even electrified households continued using multiple fuels. The number of fuels used by electrified households was almost similar to that of the unelectrified settlement of Athol. This meant electricity did not displace the other fuels completely. It was more of an additional fuel than a displacement for the other fuels.

Table 70. The number of fuels used per household.

Settlement	1991				2002			
	One fuel	Two fuels	Three fuels	Four or more	One fuel	Two fuels	Three fuels	Four or more
A'ol	1	10	40	64	0	5	27	54
O'boom	2	6	25	60	2	20	25	62
R'le	1	5	25	58	1	19	26	59
W'nd	1	7	35	63	1	16	30	57
X'thia	0	7	30	65	1	10	22	58
Mean	1	7	30	62	1	15	26	58

3.3 CHANGES IN FUEL EXPENDITURE

Changes in the patterns of expenditure on each fuel were summarised as average figures for those households using the fuel and were also averaged over the entire region (Tables 71 and 72). The first set of figures gives an indication of the absolute amount of money that households spent on individual fuels while the second set of figures gives an indication of relative importance of each fuel on the energy budget.

Table 71. Fuel expenditure by users (R per month).

Fuel	1991						2002					
	A'ol	O'boom	R'le	W'nd	X'thia	Mean	A'ol	O'boom	R'le	W'nd	X'thia	Mean
Paraffin	15	24	20	21	21	20	27	31	22	20	12	22.4
Candles	5	11	17	19	10	12.4	7	5	6	7	6	6.2
Coal	44	24	26	14	0	21.6						
Gas	42	28	54	41	46	42.2	106	0	100	6.5	53	53.1
Dry cell batteries	29	22	22	30	25	21.6	40	14	28	22	16	24
Lead acid batteries	6.5	7.7	8.5	15.4	13.2	10.3	11.3	0	8	10	0	5.9
Generators (Diesel)		64	8.5	120	68	52.1	-	-	-	-	-	-
Electricity	-	-	-	-	-			73	71	62	42	49.6
Wood	-	48	61	60	156	65	88	86	109	118	171	96.8

Table 72. Fuel expenditure by all (R per month).

Fuel	1991						2002					
	A'ol	O'boom	R'le	W'nd	X'thia	Mean	A'ol	O'boom	R'le	W'nd	X'thia	Mean
Paraffin	14	22	19	20	19	18.8	19	17	13	12	6	13.4
Candles	4	9	11	14	8	9.2	6	5	5	7	5	5.6
Coal	1.3	4	3	1	0	1.9	-	-	-	-	-	-
Gas	5	4	12	5	5	6.2	1	0	3	3	2	1.8
Dry cell batteries	25	17	20	27	21	22	26	2	7	7	4	9.2
Lead acid batteries	0.4	0.5	1.3	1.4	0.8	0.9	2.4	0	0.1	0.1	0	0.5
Generators	0	3	25	5	3	7.2	-	-	-	-	-	-
Electricity	0	0	0	0	0	0	0	73	70	61	42	49.2
Wood	0	33	21	11	23	17.6	7	54	52	24	11	29.6
Total	49	93	112	84	80	83.8	61	151	150	114	70	109.3

There was an increase in average monthly expenditure on energy in the region from R84 to R109 per month in 1991 and 2002 respectively representing a 30% increase over the past 11 years, or an annual increase of 2.6%, which is well below the inflation rate over the same period. These figures represent means of 15% and 8% of the total claimed household incomes respectively (Table 71). It is clear that electricity was responsible for the observed sudden increase in fuel expenditure. The percentage of households purchasing wood in all the sample settlements had increased and households were spending more money on wood in 2002 than they did in 1991. This could be attributed to increased difficulty in fuelwood collection, particularly in Okkerneutboom and Rolle. Consequently, the two settlements had the highest percentage of wood purchasers and spent more money on fuelwood than the other three settlements. About 33% of their total fuel expenditure was spent on fuelwood. Results also showed that collected fuelwood played a very important role in the economy of rural households. Settlements with a relatively higher percentage of wood collectors (Athol, Welverdiend and Xanthia) reported lower energy budgets than the other two settlements with a lower percentage of wood collectors (Okkerneutboom and Rolle).

3.4 RELATIONSHIP IN USE PROFILES

A correspondence analysis was done to explore the relationships in use profiles of the different fuels at the time of the second survey (Fig. 12). It illustrated graphically the differences and similarities between settlements as determined by the frequency of use of the different fuel types. The relationship between settlements and fuel types on the scatter plot were examined independently.

The relationship between elements in the scatter plot was determined by considering the angle that the two or more points make with each other on being joined to the origin by a straight line, and not the distance between these two points. If the angle was small then the elements were closely associated and conversely if the angle was large and approached 180° then there was little relationship between the two elements.

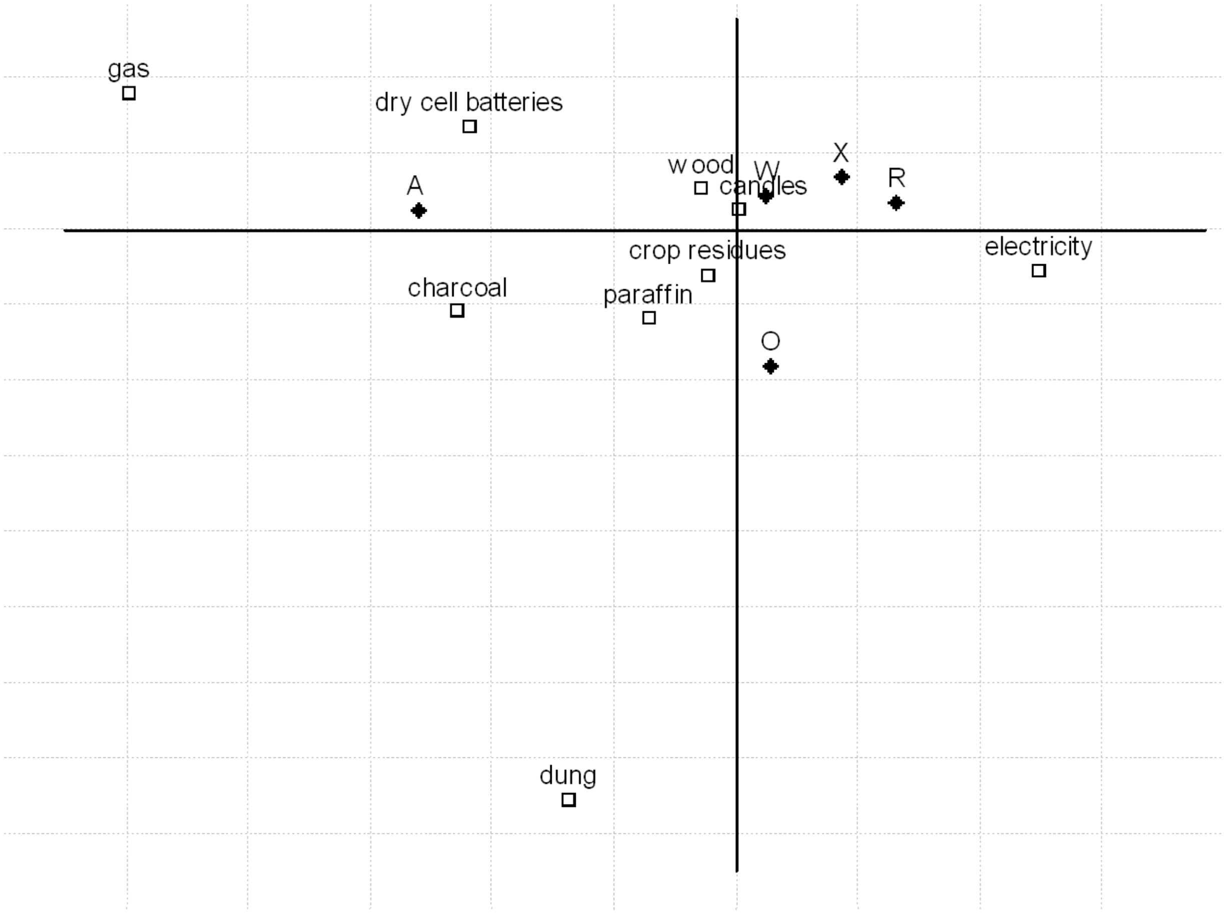


Fig. 12. A correspondence analysis plot of settlements – fuel types data (Settlements: A= Athol, O= Okkerneutboom, R= Rolle, W= Welverdiend, X= Xanthia).

The distribution of the settlements on the scatter plot showed that Rolle (R), Welverdiend (W) and Xanthia (X) were grouped close to one another. This indicated very little differences in their patterns of fuel use. On the hand, the large angles between the point representing Athol and those of the other settlements indicated distinct differences in fuel use practises in this settlement. Okkerneutboom (O) by virtue of its position showed greater similarity to the other three electrified settlements (Rolle, Welverdiend and Xanthia) than to Athol.

By examining the position of the fuel types, it was evident that all the settlements used a combination of different fuels. Paraffin, candles, crop residues and wood were closely associated with all the settlements. Gas, charcoal and dry cell batteries were more associated to the unelectrified settlement of Athol distinguishing it from the other electrified settlements. This suggests that this settlement still relies on gas and dry cell batteries to power entertainment appliances and for refrigeration purposes. Electricity on the other hand was associated to Okkerneutboom, Rolle, Welverdiend and Xanthia. The angle between the points representing dung and Okkerneutboom is very small indicating that dung was more eminent in Okkerneutboom than the other settlements.

3.5 SOCIO – ECONOMIC FACTORS

Household size in the region decreased from a reported mean of 7.7 in 1991 to 6.8 in 2002 (Table 73). Households in the former year had 15% of the people absent at any given time while in the later year the percentage went down to 13%.

Average household incomes had generally gone up by almost 100% in 2002 ($p<0.001$). Incomes were higher in Rolle than the other settlements. In both years there was little variation between settlements with regard to household size and the percentage of each household employed or otherwise earning money. The differences in household mean income were largely attributed to variations in the quantity of the money earned by breadwinners. Employed people were the largest contributors of household incomes. Income from old age pensioners, disability pension, private company pension, doctor’s pension and the child support grant also contributed significantly to household incomes in all the sample settlements. Individuals in the informal sector were the least contributors.

Household incomes were derived from the monies brought back to the household by individual household members. As such, the figures do not necessarily reflect the salaries of employed people but only part of the income that they retain to the household. Contributions from individuals in the informal sector were very difficult to determine. Most of them did not have steady sources of income and they only made contributions of some kind once in a while. Most of the respondents did not know the actual salaries of migrant workers, unless in instances were they were available at the time of the interview. They were sometimes reported as buying significant quantities of food or clothing at their places of work and bringing those, rather than cash, back home. Calculation of household income did not take into account contributions of this nature. Therefore, the average incomes in Table 73 are underestimates of the money spent by each household per month.

Rolle still had the largest number of rooms in the main buildings with an average of 5.1 rooms per household. In terms of rooms per household, the region recorded an increase of 11% between the two years. The increase was highest in Athol and lowest in Welverdiend.

The number of beds, bicycles and vehicles per household were used as indicators of relative poverty or wealth in the 1991 report. This method was not very reliable since it did not take into consideration the state and condition of the vehicles. Most of them were spotted resting on stones and some of the bicycles referred to were mere remains of what once used to be bicycles. As such, the results were largely based on “past glory.” Field observations reviewed that television sets, hi-fi, refrigerators and other electrical appliances were the best indicators for measuring relative wealth or poverty of a household. Nevertheless, based on results in Table 73 indicators among settlements differed little between the two years.

Another parameter used as an indicator of relative wealth was the frequency of meals containing meat. Households in 1991 claimed to eat meat 9-13 times per month while in 2002, households claimed to eat meat 1-18 times per month.

Table 73. General household parameters. Standard errors are given below the means. Earners are those who contribute to household incomes, while employed people are those paid a regular wage by an employer. Pensioners receive a regular pension or remittance and migrants are employed people who rarely sleep at home and eat at home. Occasionally, pensioners and employed people need not contribute anything to the household income and so need not be earners. Income is considered to be the amount of money contributed by a person to the household.

	1991						2002					
	A'ol	O'boom	R'le	W'nd	X'thia	Mean	A'ol	O'boom	R'le	W'nd	X'thia	Mean
No. of people	7.2	7.8	8.0	8.4	7.4	7.8	6.9	6.2	6.7	7.0	6.4	6.6
	0.5	0.5	0.6	0.5	0.4	0.5	0.5	0.4	05	0.4	0.4	0.4
Household	561	530	724	384	642	568	1112	958	1360	1038	1258	1145
incomes	70	58	221	36	88	95	142	25	58	88	120	87
Income per	217	209	213	169	223	206	512	509	458	557	566	520
pensioner	8	18	13	22	18	16	31	26	34	31	28	30
Income per	306	297	356	238	354	310	410	490	530	390	480	460
earner	24	26	57	17	31	31	71	82	48	61	63	65
Income per	313	247	382	239	380	312	860	740	910	680	755	789
employed person	36	26	75	23	42	40	48	71	62	55	57	58
Income per	319	257	331	241	368	303	670	620	590	600	710	638
migrant	50	40	44	24	47	41	61	49	63	48	55	51
% Absenteeism:	15	15	12	15	19	15.2	18	12	11	14	9	12.8
meals	2	2	2	2	2	2	2	2	2	2	2	2
% Absenteeism:	14	16	12	15	18	15	18	15	14	13	16	15.2
sleep	2	2	2	2	2	2	2	3	2	2	2	2
No. rooms main	2.2	3.2	3.6	3.0	3.0	5	3.5	4.6	5.1	5.0	4.4	4.5
house	0.2	0.2	0.3	0.2	0.2	0.22	0.3	0.3	0.3	0.3	0.2	0.3
No. rooms all	4.3	4.9	5.8	5.0	5.0	5	5.2	5.6	6.2	5.9	5.5	5.7
buildings	0.3	0.3	0.5	0.3	0.3	0.3	0.2	0.3	0.4	0.3	0.3	1.5
No. beds	1.9	2.6	2.9	2.8	2.8	2.6	2.1	3.0	3.1	2.9	3.1	2.8
	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
No. bicycles	0.3	0.2	0.4	0.3	0.3	0.3	0.2	0.1	0.4	0.2	0.2	0.2
	0.1	0.1	0.1	0.1	0.1	0.1	0.3	0.1	0.2	0.1	0.2	0.2
No. vehicles	0.1	0.1	0.3	0.2	0.2	0.18	0.2	0.1	0.2	0.4	0.1	0.2
	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Frequency Meat meal per month	9-13	9-13	9-13	9-13	9-13		1-18	1-18	1-18	1-18	1-18	

Both surveys revealed that households kept livestock and poultry in all the sample settlements (Table 74). In terms of mean numbers per household, poultry were the most common, followed by cattle. Pigs were less common in both years. There was a significant difference in the number of poultry in the sample settlements between the two survey periods ($Z = 3.87$, $p<0.0001$). On average, households kept more poultry in 2002 than they did in 1991 (Table 74).

Table 74. Livestock and poultry ownership. Data are mean number of animals per household. Standard errors are given below the mean.

Live stock	1991						2002					
	A'ol	O'boom	R'le	W'nd	X'thia	Mean	A'ol	O'boom	R'le	W'nd	X'thia	Mean
Cattle	4.0	0.9	2.6	6.5	4.5	3.7	3.2	0.6	1.0	5.0	1.8	2.3
	0.8	0.4	0.9	1.5	1.3	1.0	0.7	0.3	0.3	1.0	0.5	0.6
Goats	2.6	0.9	1.4	3.5	2.6	2.2	0.5	0.3	0.5	1.7	0.6	0.7
	0.5	0.3	0.4	0.6	0.5	0.5	0.1	0.1	0.1	0.4	0.2	0.2
Pigs	0.5	0.4	0.5	0.6	0.3	0.5	0.2	0.1	0.1	0.2	0.2	0.2
	0.2	0.1	0.2	0.2	0.1	0.2	0.1	<0.1	<0.1	0.1	0.1	0.1
Poultry	5.7	2.9	7.7	5.3	6.7	5.7	9.1	9.0	8.1	9.0	9.0	8.8
	0.9	0.5	1.5	0.8	1.0	0.9	1.0	1.0	1.0	1.0	1.0	1.0

CHAPTER FOUR

DISCUSSION

In this chapter, a synthesis of the findings of the present study is presented with particular reference to the key questions posed at the beginning of the study. Changes in the prevalence of the fuels are also discussed and conclusions and recommendations are made.

4.1 PREVALENCE OF THE DIFFERENT FUEL TYPES

In both surveys the majority of households in all the settlements used paraffin, though the mean volume consumed by each household per month had decreased in 2002. Users of paraffin in 1991 mainly used it for lighting while in 2002 users mainly used it for cooking. More than half of the users were worried about poisoning and flame accidents due to malfunction of paraffin appliances. Similarly, a lot of household were reported to be using paraffin in some metropolitan areas of Cape Town, East London and Durban, and most users found it to be volatile and dangerous to use (White 1997). The extent to which flame accidents occurs from paraffin appliances is not known in South Africa, however, rural areas in the third world country of Bangladesh were reported to have 40% of accidental burns caused by the less than careful handling of paraffin lamps and malfunction of some primus stoves (Laloe 2002). Considering the wide use of the fuel for heating and cooking in rural areas of South Africa (SALDRU 1995), efforts should be made to make paraffin appliances safe and to secure domestic dwellings against accidental fires.

Households in both surveys also reported the wide use of candles. Almost half of the respondents in electrified households used candles mainly for back-up purposes and in times when they did not have enough money to purchase pre-paid metre cards. Some of the electrified households were not fully wired, and often had only one connection point and one light in one room only. The rest of the rooms had to be lighted using other fuels, usually candles. Most users of electricity also found it difficulty to monitor consumption with prepaid meters and they worried about not having power once they run out of units. They therefore, had to depend on other fuels, mainly candles when their pre-paid metre cards had ran out of units. It is, therefore evident that candles still play an important role in the region in as far as lighting domestic dwellings is concerned due to lack of confidence in the supply as well as inadequate wiring in some households.

Dung was used in significant quantities only by Okkerneutboom residents and was largely used as a supplementary fuel. The high use of dung correlates with the high scarcity of wood in the settlement. A similar trend was reported in India were households with less access to fuelwood resources used more dung than those with an adequate supply of fuelwood (Mahapatra *et al.* 1991). In any given area, estimates of dung production are based on the available animal population (Amoo-Gottfried and Hall 2000). Considering the population of livestock in the region (Giannecchini 2002) wastes from livestock theoretically represent a largely untapped pool of energy. However, like in many other developing countries, it appears that no effort has been made in South Africa to make the use of dung desirable and hence there is a lot of social stigma attached to the use of the fuel. Designing efficient and smokeless “dung stoves” could enhance the full exploitation of the resource in the region. It would also help households in some regions of South Africa were dung is widely used. For example, Ward (1995) found that 90% of households in Transkei used dung while in Lebowa, 95% of households reported some use of dung.

The use of dry cell batteries was no longer popular in the sample settlements with the exception of Athol. Only 32% of households used dry cell batteries in 2002. This figure is almost a third of what was reported in 1991 and is also lower than the 73% that was reported by Eberhard (1986). The disparity is largely as a result of households switching on to the use of electricity to power entertainment appliances. However, in the unelectrified settlement of Athol households continued using dry cell batteries on a large scale. This clearly indicates that in the absence of electricity households in rural areas depend on dry cell batteries to power their entertainment appliances but once electricity becomes available they quickly switch on to electricity. It is, however important to note that R20PP batteries were still being used widely in all the settlements to power appliances that could not be powered by electricity, for example torches, clocks and portable radios.

Coal and generators were no longer used in all the settlements at the time of the second survey. The non-availability of coal was reported to be the major constraint in the use of coal. On contrary, the SALDRU (1995) survey reported a wide use of coal in some rural areas of South Africa. However, the survey also revealed some regional variations in the use of the fuel. According to Davis (1998), “although coal is likely to be used extensively in rural localities close to coal fields, it is evident that the rural distribution network is not extensive.” Being far away from a coal field, the supply of coal in the Mhala region is very limited. If the use of this energy carrier is to be extended to this region, the distribution network must be improved. Similarly, none of the households reported the use of generators in 2002. The high cost of generators prohibited the majority of households from using them. This shows that although some authors have proposed the use of generators as an option for delivering energy in developing countries (Postnote 2002), the technology is out of reach for most of the households in rural areas.

Households also reported the use of gas (liquid petroleum gas) though this fuel was not widely used in both survey periods. Only 14 % and 5 % of the households reported using gas in 1991 and 2002 respectively. This is comparable to the 8% that was reported by SALDRU (1995) for rural households of South Africa. Many respondents consider it to be a very expensive fuel and very dangerous in case of an explosion. White (1997) notes that the fears about the explosiveness of gas should be addressed and put to rest to encourage its wide use. The relative cost of the fuel increased by 3.5% per year.

Other fuels reported in both surveys included charcoal and crop residues. Households reported the use of charcoal for ironing clothes though the type of charcoal reported was categorized as fuelwood in the 1991 survey. The wide use of charcoal for ironing clothes by electrified households in 2002 indicated that a good portion of them had not yet acquired electric pressing irons. As for crop residues, they were mainly used to rekindle other fires. It was difficult to establish the exact amounts used because the fuel was usually used intermittently. This was unlike in Zimbabwe were the only crop residue used were maize cobs and consumption rates were easy to measure because maize cobs were normally loaded in quantities that are just sufficient for the combustion session (Marufa *et al*. 1996).

Results showed that there was a tremendous increase in the number of households with access to electricity at the time of the second survey. During the 1991 survey, only three households had access to electricity in all the sample settlements while in 2002, almost all the households in Okkerneutboom, Rolle, Welverdiend and Xanthia had been connected to the national grid. Only the settlement of Athol had no access to electricity. This was largely as a result of the new energy policies of the new government that are aimed at widening adequate and affordable energy services for rural households (ANC 1994, Mosoka-Wright 1995). Only high-income households were likely to have electricity at the time of the 1991 survey and the connection fees ranged from R900 to R1091 at the 1991 value of the South African Rand (Griffin *et al*.1992). However with the new policies in place, households reported paying connection fees ranging from R62 to R123 in 1997/8 and as a result almost 100% of households were electrified in four settlements. It’s therefore clear that, in as far as connecting households to the national grid is concerned; the mass electrification program of the post apartheid government has been a success story in the four electrified settlements.

In both surveys, fuelwood, whether purchased or collected was the most widely used fuel in all the sample settlements. About 78% and 70% households collected fuelwood in 1991 and 2002 respectively, while the percentage of households purchasing fuelwood rose from 27% in 1991 to 35% in 2002. A few households collected and purchased wood at the same time. The slight increase in the percentage of households purchasing fuelwood possibly indicates that there was an increase in fuelwood scarcity in the local environment around the settlements. This result was also supported by the increased time in fuelwood collection trips. The average duration of fuelwood collection trips increased from 3h59min in 1991 to 4h28min in 2002, a 12% increase. Aerial photographic analysis of the other settlements in the district has also shown that there has been a decrease in fuelwood resources in the region (Pollard *et al*. 1998, Giannecchini 2002). Fuelwood collection was unquestionably more arduous and time-consuming in Okkerneutboom and Rolle. Consequently, fuelwood collectors from the two settlements spent more time on fuelwood collection trips than collectors from the other settlements. A large portion of those who used fuelwood in the two settlements purchased most of their fuelwood or supplemented collected fuelwood with bought fuelwood. Like in the previous survey, purchased fuelwood in the two settlements was more expensive than in the other three settlements.

Despite the increase in fuelwood scarcity, the majority of households continued using wood as their main source of energy for thermal applications. This emphasises the importance of fuelwood as an energy source for cooking, heating water and keeping warm in the rural set up, and to drive the point home Gandar (1994) referred to fuelwood as a staple energy source for most rural households. He further stated that the primacy of fuelwood in the rural economy (of South Africa) would continue in the medium term at least, even if a vigorous programme of rural electrification and access to transitional fuels were improved. This proved to be the case for the majority of the households at the time of the second survey.

Fuelwood collectors in both surveys generally showed a distinct preference for particular species. Respondents in Athol, Okkerneutboom and Rolle preferred *D. cinerea*, *T. sericea* and *D. melanoxylon* while respondents in Welverdiend and Xanthia preferred *Combretum* species. Results also showed that more species were mentioned in 2002 than in 1991 for each settlement as most preferred by fuelwood collectors. The increase in the number of species could possibly be ascribed to the increase in fuelwood deficit in the area. Studies have shown that in prime fuelwood environments, such as forests under minimal pressure, traditionally preferred species are selectively harvested first before other species (Tietema *et al*. 1991, Osei 1996). Preference is utilized until scarcity rules out such choices and once this happens, fuelwood collectors resort to less popular species thus widening the range of collected species. It can be expected therefore, that as fuelwood becomes scarcer in the region, there will be a further shift to less preferred species. This is even more eminent in Okkerneutboom and Rolle were fuelwood collectors reported scavenging for any piece of wood irrespective of its burning properties. As was noted in the 1991 survey, ease of collection was not the only determining factor for species popularity as *A. burkeii* and *C. apiculatum* remained popular fuelwood species in spite of their being fairly difficulty to collect. Although reasons for the observed trend were not clear, Kgathi (1987) showed that *C. apiculatum* has good cooking and heating properties. This could, possibly be the reason for its popularity among fuelwood collectors.

Cutting of live trees without permits was reported in both surveys and the percentage of woodcutters rose from the reported 53% in 1991 to 56% in 2002. It's however likely that both figures were understated since most of the respondents were reluctant to admit their involvement in woodcutting for fear of arrest by Indunas or other law enforcers. Eberhard (1986) encountered similar difficulties in the area, while Kennedy (1990) was reported by Griffin *et al*. (1992) to have omitted questions about woodcutting because of the unreliability of the respondents. Considering that deadwood is generally favoured over live wood for energy purposes (Shackleton and Prins 1992) the reported high incidents of woodcutting imply that deadwood is scarce in the region. According to Gandar (1984), "in well wooded areas fuelwood gathering is confined to deadwood and has minimal harmful effects. With rural over-crowding however, there is a large demand for wood but diminished supply because of clearance of fields and the cutting of live trees for hut and kraal building. Firewood gatherers are eventually compelled to turn to the remaining live trees thus diminishing supply even more." Similarly Shackleton (1998) noted that when demand for dead wood cannot be met in the immediate vicinity of the settlements, communities resort to the harvesting of live wood to supply their energy needs. Some of the well documented effects of tree cutting include those that lower species diversity (Shackleton 1993) as well as those that expose the soil to sheet erosion (Gandar 1982). It has also been shown that as a result of tree cutting the so called sponge effect of trees in catchment areas is lost, so rivers alternately flood and desiccate, the former being physically destructive, and the latter disastrous for man and beast (Gandar 1994).

4.2 CHANGES IN THE MIX OF THE DIFFERENT ENERGY FORMS

Results showed that the majority of the households continued using mixtures of fuels and generally showed little tendency of narrowing down towards the complete use of sophisticated fuels as the concept of the energy ladder suggests. Households either used different fuels for different end uses or used two or more fuels for one application. The 1991 survey revealed that, 62% of the households in the sample settlements used four or more fuels to meet their domestic energy needs and in 2002, 58% of the households in the four electrified settlements as well as the unelectrified settlement of Athol continued using four or more fuels to meet their energy needs. The trend implied that for the majority of households, the newly introduced fuels, i.e. electricity and solar panels, were additional fuels rather than a displacement for the other fuels. This could be ascribed to a number of economical limitations particularly those related to expense and the cost of appliances that go with the use of such fuels. For example, households making a transition to exclusive use of electricity would need sufficient income to pay monthly electric bills and purchase the appliances necessary to make the exclusive use of electricity possible. The money spent on electricity would have to compete with the other household needs such as children's school fees, food and health expenses. Only a few high-income households would, therefore, afford a complete shift from multiple fuels to exclusive use of a few sophisticated fuels for all purposes. Consequently, only 1% of households in electrified households had completely substituted all the other energy sources for a single one, i.e. electricity. These were mostly high-income households with relatively small family sizes. Other high-income households with huge families continued using multiple fuels. Davis (1998) also reported similar results in some former homelands of South Africa were a large portion of electrified households used mixtures of three or more fuels, particularly low-income households. To this effect, he concluded that "Low income households have fuel patterns similar to those of unelectrified households, and for these households electricity is an additional fuel and an additional expense…Even the switch to electricity for lighting is incomplete as many households continue to use candles in conjunction with electricity."

The above observation also indicates that changes in energy use patterns in the region cannot be generalized and are not a straight path as explained by the concept of the energy ladder. Fuel security for most households is still necessitated by a combination of a range of fuels. According to Gitonga (2002) "household energy transitions in developing countries have both horizontal and vertical trends with several fuel mixes as one moves from one poverty level to another. The transitions are highly influenced by peoples' response to cultural, economic and social values within the environment. They are not pure a movement from dirty to clean fuels as one gets more resources but a form of coping strategy. The coping strategy differs from one level of affordability to the next but all have similar characteristics." For this reason, newly introduced sophisticated fuels must not be regarded as the sole providers of all future energy needs in the region but rather as components of an energy mix (White *et al*. 1997). Accepting an affordable fuel mix for low-income households in particular would focus attention on the problems currently associated with fuels like wood, paraffin, candles and batteries. Spalding-Fecher *et al*. (2003) outlined some of the problems associated with the other fuels as follows:

i) *Paraffin*- Health impacts such as pulmonary pneumonia from ingestion and deaths from accidental fires, displacement and loss of property resulting from fuel-related carbonmonoxide poisoning form inhaling combustion fumes. Others include burns and fires.

ii) *Domestic use of wood and coal*- health impacts such as respiratory ailments and deaths resulting from indoor air pollution and social costs of fuelwood scarcity

iii) *Gas*- life threatening explosions if not properly used.

iv) *Candles*- loss of property, burns and death caused by accidental fires.

v) *Dry cell and lead aid batteries*- poisoning of children and acid burns as a result of a spillage.

vi) *Dung*- the eye irritating smoke and the unpleasant smell of the fuel.

4.3 CHANGES IN THE QUANTITIES OF THE DIFFERENT ENERGY FORMS

Monthly consumption of fuels, whose end uses were previously associated with lighting, powering entertainment appliances and refrigeration had declined at the time of the second survey in the four electrified settlements. The affected fuels included paraffin, candles, dry cell batteries, lead acid batteries, and gas. Generators were no longer in use. It was clear that the reported decline was offset by a corresponding rise in the use of electricity to meet the respective end uses. To some extent, this trend provides support for the existence of a shift in patterns of energy use of the following nature:

i) from lead acid and dry cell batteries to electricity to power entertainment appliances.

ii) from paraffin and candles to electricity to light domestic dwellings.

iii) from gas and paraffin to electricity for refrigeration and in some cases for cooking.

iv) from generators to electricity for lighting and powering other electrical appliances

This shift is supported by White *et al*. (1997) who noted that for most low-income households, "the suitability of electricity for lighting and running appliances is beyond dispute. It puts an end to the dim and dangerous light of a candle or paraffin lamp, and to the trouble and expense of dry cells or recharging car batteries." It is, however, important to note that the mentioned changes are not as simple as the energy ladder or leapfrogging concepts suggest. Most households were selective in the way they used electricity to replace the other fuels. For example, a household would use electricity to power a television set and at the same time use dry cell batteries to power a radio cassette.

In terms of cooking energy, fuelwood retained its traditional importance in all the sample settlements with over 90% of the households reporting use. There were no quantitative trends supporting the existence of a shift from fuelwood to other fuels, particularly electricity. Monthly consumption of fuelwood remained the same in the region. Only about 1% of the households in the region used electricity alone for all thermal purposes. A few households that used paraffin and gas for cooking did so in combination with fuelwood. The continued use of wood could be attributed to the fact that it was obtained for free and was believed to cook faster than the other fuels. In cases where it was purchased, it was relatively cheaper than the other fuels. The mean annual increment in the price of fuelwood over the past 11 years was only 4.2%. This was a lot less than the other commercial fuels, and less than the inflation rate. Additionally the use of fuelwood for cooking and heating does not require the use of expensive appliances. The observed trends are in agreement with White (1997) who observed that the majority of poor people who have access to electricity avoid using it for those needs that have a high-energy demand and for which the appliances are specialised and relatively expensive, such as cooking and space heating. Similar results were obtained in Zimbabwe and Kenya were rural inhabitants preferred using wood for thermal applications because it was a free commodity and in cases were it was purchased it was relatively cheaper than other fuels (Marufa *et al*. 1996, Kituyi *et al*. 2001).

It can, therefore, be expected that sophisticated energy sources, particularly electricity, have restricted levels of domestic use in the region. These levels range from use for lighting only, through use to power entertainment appliances, then increasing levels of use in refrigeration and cooking to exclusive use for all domestic energy need. Most households are unable to enter the level of use for cooking or exclusive use for all domestic energy needs, due to the high cost of electricity and the inability to purchase appliances that go with the use of electricity. Gitonga (2002), therefore, cautions planners to be careful in using the energy theories without modifying them to fit particular regions' cultural, social and economic perspectives in relation to the use of energy. In light of this, an "energy web" could, perhaps, be used to denote the energy transition that has taken place in the four electrified settlements (Fig. 13).

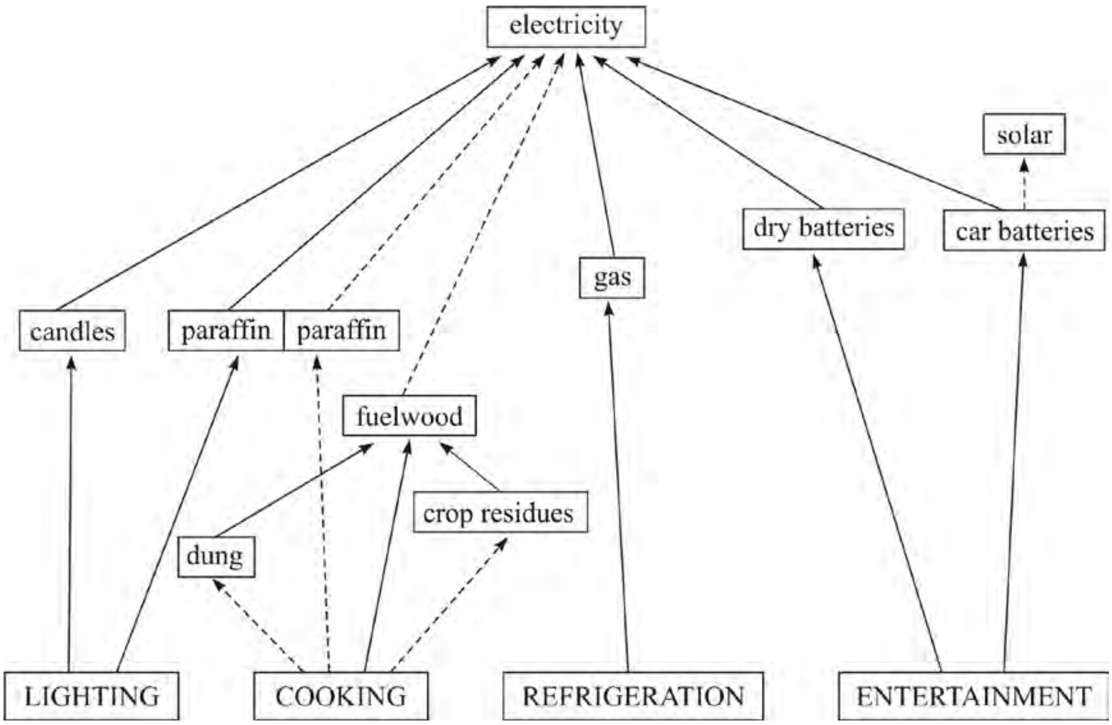


Fig. 13. An “energy web” denoting the kind of energy transition in the Bushbuckridge district.

The above figure is more realistic and gives a more detailed picture of the nature of the transition in the sample settlements between 1991 and 2002. It’s more elaborative than either the energy ladder or leapfrogging theories. A discontinuous line in the figure stands for a transition path involving households while a continuous line stands for a transition path for the majority of households. As can be seen from the figure, going up the energy web fuel types become more efficient and cleaner. Fuel switching in favour of electricity is only evident in as far as lighting, powering entertainment appliances and refrigeration are concerned. The majority of households in Bushbuckridge have achieved this transition. For thermal application, however, there is a dead end on fuelwood. Only a few high-income households have managed to move on to the use of electricity for cooking. The above model can also be used to explain the energy transitions reported by White (1997), White et al (1997), Davis (1998) and Murphy (2002). It explains the energy transitions reported in the respective regions.

4.4 EFFECT OF RESOURCE SUPPLY ON ENERGY USE PATTERNS

There were basically two energy sources that were introduced in the sample settlements between the survey periods: electricity and solar energy. As was mentioned in the other section, four of the five settlements had access to electricity while 8% of the households in the unelectrified settlement of Athol had access to solar energy. Results showed that almost all the households with electricity used it for one or more end uses depending on capability, while in Athol, all the households with solar panels used them to recharge lead acid batteries that they later used to power entertainment appliances. This was clear evidence that new energy resources created their own demands once they became available to the households. What separated households that used sophisticated energy forms from those did were not was mainly the availability of the resources. As the new energy resources became available, residents were willing to be connected and/or engage in some form of domestic use. Kabede *et al*. (2002) also reported a correlation between resource supply and changes in fuel preferences in the urban poor of Ethiopia.

It must be emphasised however, that the extent to which these new resources were integrated into households' daily pattern of energy use was largely guided by a number of social, cultural and economic factors. From this view, it is clear that energy projects may fall short of their objectives if planners do not consider the conflict between rural people's capabilities and the new energy resources. Murphy (2001) observed that many projects have failed because designers have oversimplified the social and cultural relationships existing in the implementation context of the new energy resources. He elaborates three key abstractions that limit the absorption of the new technologies in most developing countries:

i) Households as whole are often the primary targets of rural energy projects. Household relationships are however complex, extended and stepped in traditions, social and cultural institutions. By homogenising the households into a simple unit of analysis, intrahousehold inequalities may be ignored or blurred. The lack of understanding is then incorporated into projects designs and it may limit the distribution of benefits from an energy related initiative.

ii) Too often the success of dissemination projects is determined by the number of households that have adopted the new resource. Adoptions levels are estimated by such statistics as the number of PV systems disseminated or the number of new connections to the electrical grid made. These figures are ideal because they can be readily used to estimate the economic and environmental impacts from a project. However, adoption levels tell us very little about the sustainability of the new resources or the efficacy with which they are utilized. More specifically, these statistics do not tell us how efficiently and safely rural people are using the energy. Without this kind of information, it is impossible to determine whether or not the resource is being absorbed into the rural context.

iii) Energy problems are viewed from a supply-gap perspective. Planners see as their main role to identify energy supply gaps and fill them through the dissemination of technologies or through increases in available energy supplies. Once the gap is filled, it is assumed that stable and efficient energy markets will develop to maintain the supplies and/or sustain technological change. However, energy resource access regimes are usually complex and continually in flux, particularly when a resource shifts from a lower economic value to a higher one. In light of this, one can imagine a situation where more efficient fuels or technology markets actually reduce poor people's access to energy instead of improving it. Planners must therefore, understand existing social institutions and common property regimes and come to terms with the constraints on equity and dissemination created by social identities, hierarchies, norms and rules.

The above abstractions demonstrate that availability of the resource alone is not enough to spur a transition effectively. Adoption and dissemination of the new resource has to be supported by social, cultural and economic institutions. These institutions may include people's daily behavioural patterns (Scott 1995), NGOs, volunteer services, church groups and other multilateral organisations. To articulate the argument, similar views can be drawn from the RDS (1995) discussion document for public comment. According to the document, there have been very few links between consumers and policy development, planning or implementation processes in the energy industry, so that the energy policies and strategies have seldom been developed in cooperation with the sectors in rural areas. The document suggests strategies to integrate energy and rural development concerns into local decision making some of which include the following:

i) A capacity building program at community and local government level, including energy users, suppliers, and facilitators, to empower people so that energy initiatives become driven by demand and people are able to make rational and informed decisions.

ii) An energy planning process that incorporates local participation in needs assessment and prioritisation. Access to facilitation services may be useful, including field workers and the proposed community development facilitators working for local councils.

iii) Improved availability of information on realistic options. It is up to local governments (institutions) to determine the range of options that can be pursued, within the limits of affordability.

In the Bushbuckridge district, a number of organisations have been established to do research in the water, health and forestry sectors. Since energy use patterns directly affects the health of the people and has a direct impact on the quality of the local environment, such organisations could incorporate energy research sectors into their programs to create a link between rural energy users and policy makers. Examples of organisations currently working in the region include:

i) Working for water (WfW). It seeks to address the effects of alien plants on South Africa's water.
ii) Danced Community Forestry Project (Danish Cooperation for environment and development). It addresses the problems of the environmental degradation and sustainable utilisation of natural resources.
iii) AWARD (Association for Water and Rural Development). Their aim is to improve the quality of rural communities in the ex-homeland areas of South Africa.
iv) Health System Development Unit (HSDU). It's located in the former homeland of Gazankulu and is focussed on bringing quality health services to the rural poor and those disadvantaged by the apartheid regime (Pollard *et al*. 1998).

Energy programs have succeeded in Kenya using similar community-based organisations. For example, the GTZ (Deutsche Gesellschaft fur Technische Zusammenarbeit) Women and Energy Program has been pivotal in energy dissemination projects since 1983 (GTZ 1994). Similarly, if the newly introduced energy resources in Bushbuckridge district are to address the energy needs of the local communities more effectively, rural end users must be involved in the policy process through existing social institutions.

4.5 CHANGES IN PATTERNS OF EXPENDITURE ON ENERGY

Total fuel expenditure on paraffin, candles, dry cell batteries, lead acid batteries, gas and generators had generally decreased between the two survey periods, with the exception of Athol. This is an indicator of the falling demand for these fuels. As was mentioned in previous section, the decline in demand is as a result of the increase in the use of electricity to meet the end uses that where previously met by such fuels. The trend, therefore, provides support for the existence of a shift in patterns of energy use mentioned earlier on.

Households in the four settlements with electricity (Okkerneutboom, Rolle, Welverdiend and Xanthia) spent more money on energy than the ones in the unelectrified settlement (Athol). On average, they spent over 50% of their total fuel expenditure on electricity. This was a clear indication that electricity was the most expensive fuel on the energy budget of most electrified households in the region. Similarly, in the city of Hyderabad in India, households spent half their energy expenditure on electricity (Alam *et al.* 1998). Studies done in other developing countries have also shown that electricity is the most expensive source of energy for most low-income households (Gupta and Ravindranath 1997, Kituyi *et al.* 2001, Priyantha and Attalage 2001 and Kebede *et al* 2002).

4.6 CHANGES IN SOCIO-ECONOMIC PROFILES BETWEEN 1991 AND 2002

The best method of measuring relative wealth or poverty remains a subject of debate among researchers (Ravallion 1996). Results of this study only provided an income based measure as well as “basic needs indicators.”

There was an increase in average household incomes in the region from R568 to R1, 145 at 1991 and 2002 values of the South African Rand respectively. These incomes translate into mean per capita incomes of R73 and R173. It was clear that both incomes were below the 1993 poverty line calculated at R267 per capita per month (US$67) by the Institute for Planning Research - University of Port Elizabeth (Carter and May 1999). This is the minimum monthly per capita expenditure for a family in rural areas of South Africa to satisfy its basic needs. It is, however important to note that the scaled per capita expenditure in the region was higher than the claimed income since some of the earners preferred buying significant quantities of food and clothing from their places of work and bring those, rather than cash, back home.

There was very little change in the kind of activities from which households in the region generated their income. Wage labour and micro enterprise activities were still very common. Wage labour included migrant labourers, farm labourers, housemaids and gardeners while micro enterprise activities included hawking, making of clothes and handicrafts. Pensions and disability grants continued to be of critical importance to a majority of household incomes in the region. Agriculture for own consumption or sale was not popular in both periods.

On average the number of rooms per household had increased from 5 to 6 in 1991 and 2002 respectively. The increase was more significant in Athol because of the newly built houses by the government. Apparently it was the only settlement that had benefited from the housing policy of the Housing White Paper 1994 (Huchzermeyer 2001) in the region. In terms of building type, almost 90% of the main buildings in the region were made of cement, 4% clay blocks and 6% wood and mud. This result contradicts May's (May *et al.* 1995) report that 22% of the rural black population in South Africa live in homesteads with rustic or temporally roofing, such as plastic sheeting or card board. Such kinds of makeshift houses were not very common in the sample settlements. Most households in Xanthia had access to piped water while in Rolle households had pipes installed but were not functional in most parts of the settlement. Athol had installed communal standpipes but only a few were functional. In Okkerneutboom there was a serious water problem and there were generally no installed pipes in most parts of the settlement.

Other indicators of relative wealth and poverty like frequency of meals containing meat, ownership of beds, bicycles and vehicles remained the same. However, it appears that since the introduction of electricity in the region, a number of households had acquired some electrical appliances like television sets, hi-fi and radios that use electricity. It appears electricity, plays an important role in the livelihoods of inhabitants in this region.

In a nutshell, it appears that, between the two survey periods, there has been very little change in the social economic status of many households in as far as incomes and activities that bring in incomes are concerned. Absorption of the new energy resources in the region (particularly electricity), can be expected to be poor since most households are not economically empowered to afford full use of the resources. This view is echoed by Murphy (2001) who noted that without increases in the per capita income levels, and/or economic incentives to encourage household investment in electrical appliances, the returns of rural electrification projects would continue to be poor in as far as cooking energy is concerned.

4.7 CONCLUSION

Households from the five settlements in Bushbuckridge were surveyed. The survey highlights that households in the sample settlements have witnessed pronounced changes in their patterns of energy use in the past eleven years. We therefore, reject the hypothesis that there hasn’t been any change in patterns of fuel use in the region between 1991 and 2002.The introduction of electricity has certainly played a major role in spurring the transition. Electrified households tend to shift to a wider use of electricity. However, there is a body of evidence suggesting that the shift pattern is not a straight path as suggested by the concept of an energy ladder or the leapfrogging concept. By examining the pattern of change in households’ monthly consumption rates of the different fuels, it is evident that the shift pattern is restricted to particular end uses: i.e. lighting, powering entertainment appliances and refrigeration. The transition does not gravitate towards end uses with a high-energy demand such as cooking and heating. Only 1% of families with relatively small family sizes have completely displaced the other fuels with electricity. The high cost of electricity and the appliances that go with its use are the major constraints towards complete substitution of the other fuels with electricity. Other reasons include the preference for traditional fuels and fear of electricity shocks as a result of malfunction of appliances.

For cooking and other thermal applications, fuelwood still retains its traditional importance as the staple energy source for almost 94% of the households in the region. A few households, however, do use fuelwood in combination with paraffin, gas and electricity but even in such cases the other fuels largely play a supplementary role. Fuelwood is preferred over other fuels because it’s obtained for free and is relatively cheaper than other fuels. It is also widely believed that it cooks faster than the other fuels.

Households have continued using mixtures of fuels despite having access to electricity. The kind of fuels commonly used in all the settlements includes paraffin, candles, dry cell batteries, crop residues, fuelwood and charcoal. Dung is used in significant quantities in Okkerneutboom while gas and lead acid batteries are mainly used in Athol. More than half of the electrified households generally have fuel choices similar to the households in Athol. This shows that for most households, electricity is an additional fuel and not a displacement for other fuels. There is a tendency for households to hold on to several other fuel types even after having access to electricity for back-up purposes and/or to cushion expenditure on electricity. This tendency has been aggravated by the incomplete wiring in most households, inconsistent power supply during thunderstorms and failure to purchase prepaid meter cards.

The study has also shown that there is an indisputable link between resource supply and patterns of fuel use. Access to a fuel is the first requirement towards use of that particular fuel. However, if resources are to be fully appreciated and absorbed by the users in the region, planners must understand capabilities existing in the region and apply them in their dissemination programs. Energy planning processes must also incorporate local participation if the transition is to be meaningful. Already existing social institutions may be useful in linking consumers to policy makers.

There has been an increase in fuelwood scarcity in the region between the two survey periods. Consequently, the amount of time and effort that go into fuelwood gathering has also increased meaning that the opportunity of channelling human energy into development projects has decreased. Non-availability of dry wood is the major cause of the deficit. This has resulted in an increase in incidences of woodcutting. Most fuelwood collectors are no longer deterred by the risk of arrest to desist from their practices of tree cutting since they have limited affordable alternatives. There is urgent need therefore, to address alternatives, for ecological, economical and social reasons. Purchased fuelwood is already an alternative in Okkerneutboom and Rolle were fuelwood collection is more arduous and time consuming. Most fuelwood collectors reckon that the reduction of electricity tariffs would improve the "fuelwood collection problem." The underlying assumption is that once electricity tariffs are reduced most users of fuelwood would switch on to the use of electricity for all applications and do away with the use of wood.

Patterns of energy expenditure in the region have also changed in the past ten years. Among the electrified households, electricity has substituted paraffin as being the most expensive fuel on the energy budget of most households. It constitutes over half of their total household fuel expenditure. This emphasizes the importance of its high quality energy for lighting, refrigeration and powering entertainment appliances.

Employment opportunities in the region are still limited and there have been no changes in the activities from which households derive their incomes. Migrant wages, old age pension and the informal sector have continued to be the major contributors of income to most of the households. The mean monthly incomes are still below the 1993 poverty line. The region, therefore, still remains poverty stricken.

Finally, the study points out that the increase in the number of households with electricity has certainly been as result of the new energy policies of the new government that seeks to improve social equity by providing affordable electricity to the poor. The heavily subsidised connection fees have enabled almost all the households in four settlements to get connected to the national grids. There is no doubt therefore, that the mass electrification program has benefited a lot of poor households in the region, although its not fully utilised. There is keen interest by residents in Athol to have access to electricity so that they can also benefit from the Reconstruction and Development Program of the ANC government.

4.8 RECOMMENDATIONS

i) A number of households have indicated their willingness to switch to the use of electricity for all applications once electricity tariffs are reduced. Policies that help to remove the cost barriers would speed up the transition. Electricity subsidies to low-income communities, with cost recovery strategies, through higher tariff for high-income communities would help.

ii) The health and environmental impact of the fuels, other than electricity, should be addressed. Planners must seek means of making the use of other widely preferred fuels, like fuelwood and paraffin, efficient, favourable and safe.

iii) Residents in Athol are keen to be connected to the national grid. Policy makers in the region must look with a degree of urgency at the provision of electricity to this settlement.

iv) There is need to reduce the gap between end users of the energy resources and policy makers. Community participation should be encouraged in the process of dissemination of the energy resources. Already existing social institution may be useful in achieving this approach.

v) There is need for energy information centres for the locals to have access to energy information to help them make realistic options. This can be done through community authorities like the Indunas and their assistants.

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APPENDIX A

A.I SETTLEMENT PROFILES

Athol	**1991**	**2002**
-Co-ordinates	24°43′31°21′	24°4331°21′
-No of households	260 (1988)	-
-Individuals per household	7.78	6.9
-Estimated population	1882	-
-Sample size	70	71
-Mean household incomes	R561	R1, 112
-Rainfall	580mm	580mm
-Altitude	400m	400m

Okkerneutboom		
-Co-ordinates	24°36′31°07′	24°36′31°07′
-No of households	815 (1988)	-
-Individuals per household	7.81	6.2
-Estimated population	6365	-
-Sample size	72	83
-Mean household incomes	R530	R958
-Rainfall	680mm	680mm
-Altitude	615m	615m

Rolle	**1991**	**2002**
-Co-ordinates	24°44′31°13′	24°44′31°13′
-No of households	521 (1988)	-
-Individuals per household	8.04	6.7
-Estimated population	4189	-
-Sample size	73	80
-Mean household incomes	R724	R1360
-Rainfall	690mm	690mm
-Altitude	460m	460m

Welverdiend		
-Co-ordinates	24°35′31°20′	24°35′31°20′
-No of households	501 (1988)	-
-Individuals per household	8.39	7.0
-Estimated population	4189	-
-Sample size	73	80
-Mean household incomes	R384	R1, 038
-Rainfall	560mm	560mm
-Altitude	480m	480m

Xanthia		
-Co-ordinates	24°50′31°09′	24°50′31°09′
-No of households	621 (1988)	-
-Individuals per household	7.41	6.4
-Estimated population	4189	-
-Sample size	72	85
-Mean household incomes	R642	R1, 528
-Rainfall	850mm	850mm
-Altitude	610m	610m

APPENDIX B

B.1 BOTANICAL AND TSONGA PLANT NAMES

Botanical name	Tsonga name		Settlement .
		(1991)	(2002)
Acacia ataxacantha	rithathawa	X	
	xihakaboyi		
Acacia burkeii	nkaya	A O R W	A O R W X
Acacia gerrardii	mbhota (mbhote, mboto)	A O R W	
Acacia nigrescens	xikaya	A O R W	
Acacia sieberana	mololo		
Acacia swazica	musavani	O	W.X
	nsavana (msavana)		
Afzelia guanzensis	muvhangaza (muvhangazi	R X	A O R W X
	mvangaza)		
Albizia harveyii	mxangwa	A	
Bauhinia galpinii	ndzhololwana	RW	O W X
	(ndzhololwani)		
Breonadia salicinia	mhlubi	R	
Carissa edulis	ntshuguri	O	
Colophospermum mopane	nxanatsi	A O	
Combretum apiculatum	xikukutsu	A O R W X	A O R W X
Combretum collinum	mpoza	A X	A O X
	Ndzhuva	A O R W X	A O R W X
	ndzhuva-makala	A	
	ntshongwe (ntshongo)	X	X
Combretum hereroense	xikhavi	A O R W	A O R W X
Combretum imberbe	mondzo	A O R W	A O R W X

Botanical name	Tsonga name	Settlement (1991)	(2002)
Dalbergia melanoxylon	xipalatsi	A O R W X	A O R W X
Dichrostachys cinerea	ndzenga	A O R W X	A O R W X
Diospyros mespiliformis	ntoma	A O R W X	A O R W X
Euclea natalensis	nhlangula	O R W	
Faurea saligna	mthlekwana	X	A X
	(mhlekwana,nw'a, muthekwana)		
Ficus sp. (cf. natalensis)	ndhozi	X	
Ficus stuhlmanii	xirhomberhombe	O	
Ficus sycomorus	nkuwa	R	
Lonchocarpus capassa	mbhandzu	A O R	A R
	mbhandzwa		
Maytenus senegalensis	swihlangwa	A	A
	switshovana (ritshovana)	A	
	xihlangu	O W	
	xihlangwa	A O R W	A O R W X
Parinari curatellifolia	mbulwa (mpulwa)	O R X	O R
	mpula	X	O R X
Peltophorum africanum	nhlahlane (nhlahlana,	A O R W X	A X
	nhlahlanhli, mhlahlane)		
	nxuva	A	A X
Pilostigma thonningii	xikolokotlo	X	
Pterocarpus angolensis	morhotso (mrhotso)	O R X	A R W X
Pterocarpus rotundifolius	nxelele (nxelelo)	A O R W	R W
Rhus pentheri	fufu (mfufu)	A R	
Schotia brachypetala	chochelamandleni	O R X	
	muhuvhuvhu	R	
	xinopinopi (nopi)	O	
Sclerocarya birrea	nkanyi	A O R W X	A O R W X
Strychnos madagascariensis	nkwakwa	A O R X	A O R
	ntshosaxilombi		
Strychnos spinosa	nsala	O R X	A
Terminalia sericea	nkonola	A O W R X	A O R W X

Botanical name	Tsonga name	Settlement (1991)	(2002)
Terminalia sericea	nsusu(nsunsu)	A O W R X	A O R W X
Trichelia emetica	nkuhlu	O R X	X
no specimens found	mbuhovhovho	R	
no specimens found	msavayi	O	
no specimens found	mtlhokwana (nthokwani, ntlhekwana)	X	
no specimens found	muhekwani	X	
no specimens found	mvhomuhlovho	A	
no specimens found	nghozi	X	
no specimens found	xipulanwana		

APPENDIX C

C.1 INTERVIEW SCHEDULE: ENGLISH

Date……………………Village name…………………………………………………………….
Reference number of household..………………………………………………………………
Enumerator's name……………………………………………………………………………...

A. GENERAL INFORMATION ON RESPONDENT

(Note: if possible, interview the person who does most of the cooking. If they are not available interview any adult household member, preferably a woman. If you speak to another household member first, do not use their answers to fill in the questionnaire, but wait until you are speaking with the person you interview)

1. Do you do most of the cooking? [YES] [NO]
2. Are you the head of the house? [YES] [NO]
3. When did you move to this plot?………………………………………………………….….

B. SOURCES OF ENERGY

4. Which of the following energy types do you use?

[PARAFFIN] [CANDLES] [DUNG] [COAL] [GAS] [DRY CELL BATTERIES]
[CAR BATTERIES] [GENERATORS] [CROP RESIDUES] [CHARCOAL] [ELECTRICITY]
[WOOD]

B.1. PARAFFIN

6. Do you use paraffin? [YES] [NO]

(IF NO, fill in Q7 and go to Q13)

7. IF NO, can you give me reasons why you do not use paraffin?

……………………………………………………………………………………………………
……………………………………………………………………………………………………

[TOO EXPENSIVE] [NOT AVAILABLE LOCALLY] [NO APPLIANCES] [APPLIANCES]
[TOO EXPENSIVE] [PREFER OTHER FUELS]
[NO PARTICULAR REASON/DON'T KNOW]

8.What do you use paraffin for the most?

[COOKING] [HEATING WATER FOR WASHING] [HEATING] [WATER FOR TEA] [HEATING HOUSE] [LIGHTING] [IRONING]

OTHER (………….………..……………..………………………………………………….)

9. What paraffin appliances do you use?

[PRIMUS STOVE] [PARAFFIN STOVE] [HEATER] [FRIDGE] [LANTERN]

OTHER (……..……………………………………………………………………….……..)

10. I would like to ask a little more about how often you buy paraffin, how much you use and what it costs.

COMPLETE THE FOLLOWING TABLE.

How often do you buy paraffin?	What size bottle do you use?	How many bottles do you buy?	What is the price per bottle?	Total cost

*Total amount (l) per week/per month…………………………………………………….

*Total cost per week /per month………………………………………………………..

11. Where do you buy your paraffin? (FILL IN NAMES)

HAWKER (…..……………………………………………………………………………...)

SHOP (………………..…………………………………………………………………..)

GARAGE (…..………………………………………………………………………………)

OTHERS (…………………………………………………………………………………...)

12. I would like to find out more about what you think about paraffin as a fuel. Please would you tell me what you like about paraffin and what you do not? (NB. SEE ATTACHED NOTE TO ENUMERATORS-THIS MUST BE READ)

a. Problems/disadvantage:……………………………………...……………………………

……………………………………………………………………………………………….…

b. Good things/advantages:……………………………………………………...………………

………………………………………………………………………………………………..

B.2 CANDLES

13. Do you use candles? [YES] [NO]

(IF NO, fill in question 14 and go to question 18)

14. IF NO, can you give me reasons why you do not use candles?

……………………………………………………………………………………………………..
..…………………………………………………………………………………………………
[TOO EXPENSIVE] [DANGEROUS/FIRE HAZARD] [NOT AVAILABLE LOCALLY] [HAVE A GAS /PARAFFIN LANTERN] [DON'T NEED THEM] [NO PARTICULAR REASON/DON'T KNOW]

15 I would like to know a little more about how many candles you use and what they cost. Firstly, do you usually buy your candles singly or in packets?

(FILL ANSWERS INTO EITHER OR BOTH OF THE FOLLOWING TABLES)

SINGLE CANDLES

How often do you buy candles?	How many do you buy?	What is the price per candle?	What is the total cost?

PACKETS

How often do you buy candles?	How many do you buy?	What is the price per candle?	What is the total cost?

*Total number of candles used per week/per month………………………………………

*Total cost of candles per week/per month………………………………………………..

16. Where do buy your candles? (FILL IN NAMES)

SHOP (………..…………………………………………………………………………...…...)

OTHER (…………………..………………………………………………………………...)

17. I would like to find out more about what you think about candles. Please would you tell me what you like about candles and what you do not.

(NB. SEE ATTACHED NOTE TO ENUMERATORS – THIS MUST BE READ)

a. Problems/disadvantages:…………………………………………………………………..

……………………………………………………………………………………………..

b. Good things:……………………………………………………………………………….

……………………………………………………………………………………………..

B.3 DUNG

18. Do you use dung for fuel? [YES] [NO]

(IF NO, FILL IN Q19 & GO TO Q 24)

19. IF NO, can you tell me why you do not use dung?……………………………………………

……..

[DON’T NEED IT] [DON’T LIKE IT FOR BURNING] [SMELLY]

20. Do you collect your own, do you buy it, or do you collect and buy it?

[COLLECT OWN] [BUY] [COLLECT AND BUY]

(IF COLLECT, FILL IN Q21; IF BUY, FILL IN Q22; IF BOTH, FILL IN Q21 &Q22)

21. IF COLLECT, I would like to know a little more about how often you collect & how much you collect?

COMPLETE THE FOLLOWING TABLE.

How often do you collect dung?	How much do you collect?

*Total amount of dung collected (kg) per week/per month…………………………

22. IF BUY, I would like to know a little more about how often you buy, how much you buy and what it costs?

COMPLETE THE FOLLOWING TABLE.

How often do you buy dung?	How much do you buy?	What is the cost per unit?	Total cost?

*Total amount of dung (kg) bought per week/per month……………………………………

*Total cost per week/per month…………………………………………………………..

23. I would like to find out what you think about dung as a fuel. Please would you tell me what you like about dung and what you do not?

(NB. SEE ATTACHED NOTE TO ENUMERATORS – THIS MUST BE READ).

a. Problems/disadvantages:…………………………………………………………………...

…………………………………………………………………………………………………..

b. Good things/advantages:…………………………………………………………………..

…………………………………………………………………………………………………..

B.4 COAL

24. Do you use coal? [YES] [NO]

(IF NO, FILL IN Q25 AND GO TO Q32)

25. IF NO, can you tell me why you do not use coal?……………………………………………..
……………………………………………………………………………………………….….
[EXPENSIVE] [NOT AVAILABLE LOCALLY] [TOO DIRTY] [TOO SMOKY]
[NO COAL STOVE] [COAL STOVE TOO EXPENSIVE] [PREFER OTHER FUEL TYPES]
[NO PARTICULAR REASON/DON'T KNOW]

26. a. What do you use coal for the most?
[COOKING FOOD] [HEATING WATER FOR WASHING] [HEATING WATER FOR TEA]
[HEATING HOUSE]
OTHER (……………………………………………………………………….……………....)

b. What else do you use coal for?
[COOKING FOOD] [HEATING WATER FOR WASHING] [HEATING WATER FOR TEA]
[HEATING HOUSE] [NOTHING]
OTHER (……………………..………………………………………………..………………….)

27. Do you have a coal stove? [YES] [NO]

28. IF YES, what is the type & size of your stove?………………………………………….….

29. I would like to know a little more about the amount of coal you use, how often you buy coal & what it costs.

COMPLETE THE FOLLOWING TABLE

How often do you buy coal?	What size bag do you buy? (kg)	How many bags do you buy?	What is the price per bag?	What is the total cost?

(Try and establish how often people buy coal, i.e. once a week, once per two weeks, once a month etc.)

*Total amount (kg) used per week/per month……………………………………………..

*Total cost per week/per month……………………………………………………...…

30. Where do you buy coal from? (FILL IN NAME)
HAWKER (……………………………...……………………………………………………..)
SHOP (…………………….……………..……………………………………………………..)
COAL MERCHANT (………………………………...…………………………………….)
OTHERS (…………………...…………………..……………………………………………...)

31. I would like to find out more about what you think about coal as a fuel. Please would you tell me what you like about coal & what you do not. (NB. SEE ATTACHED NOTE TO ENUMERATORS – THIS MUST BE READ)

a. Problems/disadvantages:…………………………………………………………………………...

……………………………………………………………………………………………………..

b. Good things/advantages:………………………………………………………………...…………

……………………………………………………………………………………………………..

B.5.GAS

32. Do you ever use gas? [YES] [NO]

(IF NO, FILL IN Q33 & THEN GO TO Q38)

33. IF NO, why do you not use gas as a fuel?……………………………………………………..

……………………………………………………………………………………………………..

[TOO EXPENSIVE] [TOO DANGEROUS] [NOT AVAILABLE LOCALLY] [DIFFICULT TO OBTAIN LOCALLY] [GAS APPLIANCES TOO EXPENSIVE] [PREFER OTHER FUEL TYPES] [NO PARTICULAR REASON/DON’T KNOW] [NO APPLIANCES]

34. a. What do you use gas for the most?

[COOKING] [HAETING WATER FOR WASHING] [HEATING WATER FOR TEA]

[LIGHTING] [HEATING HOUSE] [IRONING]

OTHER (…………………………………………………………………………………..…...)

b. What else do you use gas for?

[COOKING] [HEATING WATER FOR WASHING] [HEATING WATER FOR TEA] [LIGHTING] [HEATNG HOUSE] [IRONING]

OTHER (………………..……...……………………………………………………………….)

35. I would like to ask you a little more about how often you buy gas, how much you use and what it costs. Could you also tell me what gas appliances you have?

COMPLETE THE FOLLOWING TABLE

What is the size of your bottle?	How often do you fill it?	What does it cost to fill? (R)	What appliances is it used for? (i.e. stove with oven, gas rings, heater, fridge, gaslight, other

*Total amount of gas (kg) used per week/month…………………………………………….

*Total cost of gas used per week/per month…………………………………………………

36. Where do you buy your gas? (FILL IN NAME)

SHOP (………………………….…………………………………………………………...)

GARAGE (………………………………………………………………………….….....)

OTHER (……………………………………………………………………………….....)

37. I would like to find out more about what you think about gas as a fuel. Please would you tell me what you like about it & what you do not. (NB. SEE ATTACHED NOTE TO ENUMERATORS – THIS MUST BE READ).

a. Problems/disadvantages:……………………………………………………………………...

……………………………………………………………………………………………………..

b. Good things/advantages:……………………………………………………………………...

……………………………………………………………………………………..……………

B.6. BATTERIES

B.6.1. Dry/cell batteries

38. Do you use dry batteries? [YES] [NO]

(IF NO, FILL IN Q39 & GO TO Q43)

39. IF NO, can you give me reasons why you do not use dry batteries?……………………………..

[TOO EXPENSIVE] [NO RADIO OR OTHER APPLIANCE] [NO SUPPLIER LOCALLY]

40. I would like to find out more about the kind of batteries you use, how many you use, how often you buy batteries and their cost. Could you also tell me what you use batteries for.

COMPLETE THE FOLLOWING TABLE

What size batteries do you use?	How many do you use?	How often do you buy batteries?	What is the cost per battery?	What is the total cost?	What do you use the batteries for? (i.e. torch, radio, tape recorder, hi-fi, other)

*Total number used per week/per month…………………………………………………….

*Total cost per week/per month……………………………………………………...

41. Where do you buy your batteries?   (FILL IN NAME)

HAWKER (……………………………………………………………………………….....)

SHOP (…………………………………………………………………………..…..)

OTHER (…………………………………………………………………..………...)

42. I would like to find out what you think about using batteries. Please tell me what you like about them & what you do not. (NB. SEE ATTACHED NOTE TO THE ENUMERATORS – THIS MUST BE READ)

a. Problems/disadvantages:…………………………………………………………………..

………………………………………………………………………………………………..

b. Good things/advantages:…………………………………………………………………...

………………………………………………………………………………………………..

B.6.2. Car batteries

43. Do you use a car battery/batteries in or around your house?   [YES]   [NO]

(IF NO, FILL IN Q44 & GO TO Q48)

44. IF NO, can you give me reasons why you do not use car batteries?…………………………….….

…………………………………………………………………………………………..…….

[TOO EXPENSIVE TO BUY THE BATTERY] [TOO EXPENSIVE TO CHARGE THE BATTERY] [NO WHERE TO RECHARGE THE BATTERY] [DON'T KNOW ABOUT IT OR HOW TO USE IT] [HAVE NO NEED] [NO PARTICULAR REASON/DON'T KNOW]

45. I would to like know a little more about how it costs you to use battery and what you use it for.

COMPLETE THE FOLLWING TABLE

How many batteries do you have?	How often do you recharge them/it?	What does it cost per charge?	What do you use the battery for? (i.e. hi-fi, TV, radio, lighting, other)

*Total cost per week/per month………………………………………………………………..

46. Where do you get your battery/batteries recharged?…………………………………………….
…………………………………………………………………………………………………….

47. I would like to find out more about what you think about using car batteries for household electricity needs. Please would you tell me what you like about them and what you do not. (NB. SEE ATTACHED NOTE TO ENUMERATOS – THIS MUST BE READ).

a. Problems/disadvantages:……………………………………………………………………….
…………………………………………………………………………………………………..…

b. Good things/advantages:……………………………………………………………………….
…………………………………………………………………………………………………..…

B.7. GENERATORS

48. Do you use a generator? [YES] [NO]

(IF NO, FILL IN Q49 AND GO TO Q55)

49. IF NO, can you give me reasons why you do not use a generator……………………………….
……………………………………………………………………………………………………..

[TOO EXPENSIVE] [PETROL/DIESEL TOO EXPENSIVE] [PETROL/DIESEL NOT AVAILABLE] [NO APPLIANCES] [APPLIANCES TOO EXPENSIVE] [NOISY] [HAVE NO NEED] [NO PARTICULAR REASON/DON’T KNOW]

50. Where do you get the fuel to run the generator? (FILL IN NAME)

SHOP (…………………………………………………………………………………………....)

GARAGE (……………………………………………………………………………………......)

OTHER (……………………………………………………………………………………………)

51. What do you use the generator for the most?

[RADIO/TELEVISION/HI-FI] [LIGHTING] [COOKING] [REFRIGERATION] [IRONING] [NOTHING]

OTHER (…………………………………………………………..………………………..)

52. What else do you use your generator for?

[RADIO/TELEVISION/HI-FI] [LIGHTING] [COOKING] [REFRIGERATION] [IRONING] [NOTHING]

OTHER (…………………………………………………………………………………………….)

53. I would like to ask you a little more about how often you buy fuel for your generator, how much you use, and how much it costs.

COMPLETE THE TABLE

What size container do you fill?	How many containers do you fill?	How often do you fill them?	What is the price of each container?	Total cost

*Total amount (l) used per week /per month…………………………………………….

*Total cost per week/per month………………………………………………………….

54. I would like to find out more about what you think of petrol or diesel generators. Please would you tell me what you like about generators and what you do not. (NB. SEE ATTACHED NOTE FOR ENUMERATORS – THIS MUST BE READ).

a. Problems/disadvantages:…………………………………………………………………...

……………………………………………………………………………………………..

b. Good things/advantages:…………………………………………………………………...

……………………………………………………………………………………………..

B.8. CROP RESIDUES

55. Do you ever use crop residues for fuel? [YES] [NO]

56. a. IF NO, can you tell me why you do not use crop residues?………………………………….

……………………………………………………………………………………………

[NOT NECESSARY] [CHILDREN USE THEM] [BURN TOO QUICKLY]

[NO PARTICULAR REASON]

b. IF YES, can you tell me why you use crop residues?………………………………...………..

[FREELY AVAILABLE AT THE END OF SUMMER] [FOR STARTING FIRE] [AS A BACK UP FUEL WHEN THERE IS NO OTHER FUEL]

B.9. CHARCOAL

57. Do you use charcoal? [YES] [NO]

(IF NO, FILL IN Q58 AND GO TO Q63)

58. IF NO, can you tell me why you do not use charcoal?………………………………………..

…………………………………………………………………………………………….….

[TOO EXPENSIVE] [NOT AVAILABLE LOCALLY] [DON'T LIKE IT] [DON'T KNOW IT]

[PREFER OTHER FUEL TYPES] [NO PARTICULAR REASON/DON'T KNOW]

59. What do you use charcoal for?

[COOKING FOOD] [HEATING WATER FOR WASHING] [HEATING HOUSE]

OTHER (…………………………………………………………………………..…………...)

60. I would like to ask you a little more about how often you buy charcoal, how much you use and what it costs.

COMPLETE THE FOLLOWING TABLE.

How often do you buy charcoal?	What size bag do you buy? (kg)	How many bags do you buy?	What is the price per bag?	What is the total cost?

Total amount (kg) used per week/per month?……………………………………………...

Total cost per week/per month?……………………………………………………….

61. Where do you buy charcoal from? (FILL IN NAMES)

HAWKER (…………………………………………………………………………………….)

SHOP (………………………………………………………………………………………)

MERCHANT (…………………………………………………………………………………)

OTHER (…………………………………………………………………………………….)

62. I would like to find out more about what you think about charcoal as a fuel. Please tell me what you like about charcoal and what you do not (NB. SEE ATTACHED NOTE TO ENUMERATOR – THIS MUST BE READ).

a. Problems/disadvantages:…………………………………………………………………..

……………………………………………………………………………………………..

b. Good things/advantages:…………………………………..……………………………….

………………………………………………………………………………….……….

B.10. ELECTRICITY

63. Do you use electricity? [YES] [NO]

(IF YES, GO TO EXTRA PAGE; IF NO, FILL IN Q64 AND GO TO Q65)

64. IF NO, can you give me reasons why you do not use electricity?……………………………..…

……………………………………………………………………………………………………..

[NOT LOCALLY AVAILABLE] [TOO EXPENSIVE] [NO APPLIANCES] [TOO EXPENSIVE] [HAVE NO NEED] [TOO DANGEROUS] [PREFER OTHER FUELS] [NO PARTICULAR REASON/DON'T KNOW]

C. WOOD

C.1 PURCHASED WOOD

65. Do you ever buy wood? [YES] [NO]

(IF NO, FILL IN Q66 AND GO TO Q70)

66. IF NO, can you give me reasons why you do not purchase wood?………………………………

………………………………………………………………………………………………...…...

[CAN'T AFFORD TO] [NO NEED–COLLECT FOR FREE] [NOT AVAILABLE LOCALLY] [NO PARTICULAR REASON/DON'T KNOW]

67. I would like to know a little more about how often you buy wood and the amounts you buy. Could you also please tell me how much it costs.

COMPLETE THE FOLLOWNG TABLE

How often do you buy wood?	How much do you buy? State unit* No unit	Cost per unit?	Total cost?

Units may be bundles, wheelbarrow loads, or bakkie loads. Need to obtain estimates of the amount of wood (kg's) in each of these units.

*Total amount of wood (kg) used per week/per month……………………………………....

*Total cost of bought wood per week/per month…………………………………………….

68. Where do buy wood? (FIIL IN NAMES) [WOODLOT] [SAWMILL] [HAWKER]

BAKKIE OWNER (…...…………………………………………………………..…………...)

SHOP (……………………………………………………………………………..…………..)

OTHER (…………………………………………………………………………..………...)

69. I would like to find out what you think about buying wood. Could you please tell me what you like and what you do not like about buying wood. (SEE ATTACHED NOTE TO ENUMERATORS – THIS MUST BE READ).

a. Problems/disadvantages…………………………………………………………………….…...

…………………………………………………………………………………………………..

b. Good things/advantages………………………………………………………………………

………………………………………………………………………………………………..…

C.2. COLLECTED WOOD

70. Do you collect wood? [YES] [NO]

(IF NO, FILL IN Q71 AND GO TO Q85)

71. IF NO, can you give me reasons why you do not collect wood?………………………………..

[NONE AVAILABLE] [DON'T USE WOOD] [NO TIME] [OTHER]

72. Where do you collect wood?……………………………………………………………….

……………………………………………………………………………………………..…

73. How long does it take you to walk there?……………………………………………………..

……………………………………………………………………………………………..….

74. a. What time do you leave to collect wood?…………………………………………………...

b. What time do you return home?……………………………………………………………

75. How often do you cut live wood for firewood?

[VERY OFTEN] [OFTEN] [SOMETIMES] [RARELY] [NEVER]

76. Is it more difficult to collect wood now than it was five years ago?

[YES] [NO] [DON'T KNOW]

(IF NO, OR DON'T KNOW, THEN GO TO Q78)

77. IF YES, why?………………………………………………………………………….…….

……………………………………………………………………………………………..

78. How do you think the problem of wood collection could be solved?…………………………

……………………………………………………………………………………………..

……………………………………………………………………………………………..

79. Could you give me the Tsonga (local) names for the tree you prefer most for burning? (INDICATE WITH*). Could you then give me 4 other names of trees, which have good wood for burning (INDICATE WITH /). How difficult is it to find these woods? (FILL IN THE NAMES OF WOODS ON THE BLANK LINES)

Preferred species	Easy to locate	Moderately difficulty to locate	Very difficulty to locate

C.3. WOOD USED FOR FUEL

80. Please show me how much wood you use in a day?…………………………………………..….

(ENUMERATORS MUST ASK THE RESPONDENTS TO PUT OUT A PILE OF WOOD CONTAINING THE AVERAGE AMOUNT USED PER DAY. THIS PILE MUST BE WEIGHED, AND THE MASS RECORDED)

81.a. What do you use firewood for the most?

[COOKING] [HEATING HOME] [KEEPING WARM OUTSIDE IN WINTER] [HEATING WATER FOR WASHING] [HEATING WATER FOR TEA]

OTHER (……………………………………………………..…………………………………...)

b. What else do you use firewood for?

[COOKING] [HEATING HOME] [KEEPING WARM OUTSIDE IN WINTER] [HEATING WATER FOR WASHING] [HEATING WATER FOR TEA] [NOTHING]

82. Do you burn wood in stove? [YES] [NO]

83. IF YES, what type of stove do you use?

[METAL/IRON] [MUD] [CLAY] [OTHER]

84. a. If you cook on a fire, where do you make your fire, in summer?

[IN HOUSE] [COOKING SHELTER] [OUTDOORS]

b. And in winter? [IN HOUSE] [COOKING SHELTER] [OUTDOORS]

85. I would like to find out what you think about using wood as a fuel. Please would you tell me what you like about it and what you do not. (NB. SEE ATTACHED NOTE TO ENUMERATORS – THIS MUST BE READ).

a. Problems/disadvantages………………………………………………………………………

…………………………………………………………………………………………………..

b. Good things/advantages………………………………………………………………………

…………………………………………………………………………………………………..

C.5 WOOD SALES

86. Do you ever sell wood? [YES] [NO]

87. Where do you get the wood you sell?……………………………………………………….

…………………………………………………………………………………………………….….

88. How much money do you make per month from selling wood?…………………………………

E. STRUCTURE OF THE HOUSEHOLD, INCOME AND EXPENDITURE

89. Complete the table (NB. SEE ATTACHED NOTES TO ENUMERATORS – THESE MUST BE READ).

First name	Year born	STD passed or tertiary Education	*At school /, T, N	#Sleep at home /, W, X	#Eat at home /, W, X	Job or source of income	Money contributed per month

- - for at school: / = yes, at school; T = tertiary institution; N = no

@ - If at school: is the person repeating a year (R) or not (N).

- Eat/slepp at home: / = yes, often; W = weekends only; X = rarely.

* Total household income……………………………………………………………………….
.

F. SOCIO – ECONOMIC INFORMATION

90. How many livestock do you have?

CATTLE……………………………

GOATS……………………………..

PIGS………………………………..

POULTRY…………………………

91. Does your household posses a bicycle? [YES] [NO]

IF YES, how many?……………………..

92 Does your household posses a vehicle? [YES] [NO]

IF YES, how many?……………………………..

93. How many rooms are there to the household? (including all buildings)

…………………………………………………………………………………………………..

94. How many rooms are there in the main building/buildings?……………………………………..

95 How many beds do you have?……………………………………………………………………….

96. Approximately how many times does your family eat meat?

[<1X PER MONTH] [1X PER MONTH] [2X PER MONNTH] [3X PER MONTH]

[1X PER WEEK] [2-3X PER WEEK] [4-5X PER WEEK] [6-7X PER WEEK] [>7X WEEK]

97. Nature of the fence around the plot (NB – NOTE WHAT YOU SEE, NOT WHAT YOU ARE TOLD):

[ABSENT] [MOSTLY WOOD LATTICE] [WOOD AND SINGLE STRAND OF WIRE–NEEDS REPAIR] [WOOD AND SINGLE STRAND OF WIRE–WELL MAINTANED] [STEEL DROPPERS AND SINGLE STRAND OF WIRE] [WIRE MESH]

98. What are your houses and rooms built of? (NB – NOTE WHAT YOU SEE, NOT WHAT YOU ARE TOLD).

	Wood and mud daub	Clay bricks	Cement bricks	Baked bricks
Main house				
Other buildings				

B10. ELECTRICITY

Ask the following questions only if the respondent answered YES when asked whether they use electricity as an energy source (Q63).

102. What do you use electricity for?

[HEATING WATER ON HOTPLATE FOR WASHING] [HEATING WATER IN A GEYSER] [HEATING WATER FOR TEA] [HEATING HOUSE] [COOLING HOUSE] COOKING] [LIGHTING] [IRONING] [REFRIGERATION] [RADIO/TELEVISION/HI-FI] OTHER (……………………………………………………………………………………………….)

103. How much do you spend on electricity every month?……………………………………….……

104. How much did it cost to install electricity in your house?…………………………………….…..

105. How long have you used electricity in your house?………………………………………….…

106. I would like to find out more about what you think of electricity for your household energy needs. Please would you tell me what you like about electricity and what you do not. (NB. SEE ATTACHED NOTE TO ENUMERATORS – THIS MUST BE READ).

a. Problems/disadvantages:…………………………………………………………….……………..

……………………………………………………………………………………………….….

b. Good things/advantages:……………………………………………………………………..

……………………………………………………………………………………………….….

NOTES TO ENUMERATORS

QUESTION 7, 14, 19, 25, 33, 39, 44, 49, 56a, 58, 64,66, 71

WHY ARE PEOPLE NOT USING A PARTICULAR FUEL.

Try and get the interviewees to answer without prompting and either enter the answer in the space provided or cross it off from the options. If respondents have difficulty in answering, prompt with the options given asking them to think of other reasons as you go along. Try and avoid indirectly answering the question for them.

Remember that more than one of the options may apply. If you obtained the response by prompting, write a P in the corner of the box.

QUESTIONS 12, 17, 23, 31, 37, 42, 47, 54, 62, 106

ADVANTAGES AND DISADVANTAGES OF THE DIFFERENT FUEL TYPES

Prompting may be necessary if people do not readily give an answer.

Under problems/disadvantages consider whether the fuel:

Is expensive;

Is not easily available;

Is difficult to get in terms of transport (i.e. too heavy to carry and therefore needs a vehicle);

Is difficult to get in terms of time;

Has side effects like smoke, which could be a health hazard;

Is dangerous or a health hazard;

Is dirty;

Requires appliances that are too expensive to use the fuel effectively;
Can only be easily used in certain weather conditions (e.g. difficult to use wood in wet weather).

Under advantages consider whether the fuel:
Is easily available;
Is easy to use;
Is quick to use;
Is clean;
Is safe;
Is a good back up fuel when wood (or coal, etc.) runs out or when the weather will not allow wood (or coal etc.) use;
Is inexpensive relative to other bought fuels, or is free;
Burns well;
Saves time collecting wood which may be difficult to find;
Is good at meeting specific needs (e.g. light).

QUESTION 69
BOUGHT WOOD
Here look at the advantages and disadvantages of BUYING wood. Under disadvantages consider whether:
buying wood is expensive;
wood is not always available for sale;
the types of wood has to be chopped as pieces are too large.

Under advantages consider whether buying wood:
saves time otherwise spent collecting wood;
saves effort otherwise spent collecting wood;
provides wood in wet weather when it not possible to collect wood;
ensures a constant supply of wood;
allows buying in bulk.

QUESTIONS 102.
ELECTRICITY
Under problems/disadvantages consider whether electricity:

Is expensive to install;

Is expensive to maintain;

Needs expensive appliances to use;

Is not easily available;

Is dangerous (especially for children).

Under advantages consider whether electricity is:

Is easy to use;

Is clean to use;

Is safe;

Is cheaper than other fuels that are bought;

Is time saving;

Is widely applicable (provides energy for cooking, lighting, entertainment, refrigeration, etc.);

Is modern and up-date.

QUESTION 89

HOUSEHOLD STRUCTURE

FIRST NAME – List the Christian names of all people associated with the household: per members and migrants. If people are unwilling to give names enter numbers. Prompt to make sure no one is left out, e.g. boarders.

YEAR BORN – enter the year each person was born (ask people to estimate only if they do not know).

STD PASSED – obtain the education status of each household member, i.e. highest standard passed at school or any tertiary education, e.g. H.Dip.Ed, B.Ed., B.A., etc. For children at school write down the last standard they passed. Use a X to indicate those who have not attended school at all. xxxxxxx

AT SCHOOL – indicate with a tick (/) those children still attending school, and mark those who are not studying at the present with an N. Use a T to indicate people at a tertiary institute (e.g. University, Technikon, Training College).

SLEEP AT HOME – ask if the household member lives permanently at home (/), is a weekend migrant (W), or more rarely (X).

EAT AT HOME – ask who eats at home almost every night (/) – it may include people from surrounding homesteads who do not sleep with the household but eat there – prompt for this. Ask if anyone comes home and eats with the household only at weekends (W), or more rarely (X).

JOB/PLACE OF WORK/SOURCE OF INCOME – indicate if the person is employed and what they do, or if unemployed, indicate how they contribute to household income (i.e. selling vegetables). Write N/A in the column for children unless they have a part-time after hours job (e.g. herd-boy).

MONEY CONTRIBUTED PER MONTH – ask the amount of income contributed to the household by each person per month. Include: salaries from people who live permanently at home, remittances from migrants, pensions, disability grants, income from self-employed members, e.g. craftsmen, farmers, herbalists, cash earned by unemployed household members for vegetables, craft products, wood, etc. Write N/A for school children unless they have part-time jobs out of school hours and contribute their earnings to the household.

If respondents are unable or unwilling to detail the income of all household members, then ask them to state the total income of the household.