ENERGY USE AND CONSERVATION IN BOARDING SCHOOLS IN THIKA SUB-COUNTY, KENYA

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ABSTRACT
This paper is based on a research on energy use and conservation in public and private boarding secondary schools in Thika Sub-County, Kenya. Specifically, it examines the energy sources available to schools and energy conservation strategies adopted. The study findings indicate that firewood, electricity, diesel, liquefied petroleum gas (LPG) kerosene and charcoal are the main source of energy for cooking, lighting and laboratories in schools in Thika Sub-County. There was limited use of solar and wind energy. With regard to energy conservation, it was observed that a significant proportion of schools utilized energy saving cookers and energy saving bulbs. They also had strict rules on the use of electricity. It is concluded that over-reliance on firewood, electricity diesel and LPG as sources of energy in schools is not sustainable and may contribute to environmental degradation in Thika Sub-County. Furthermore, the high cost of electricity and fossil fuels may put a strain on school budgets.

Key words Energy use, energy conservation, boarding schools, environmental pollution, environmental degradation

1.0 INTRODUCTION

The importance of energy in enabling countries to meet the goal of sustainable development has been widely acknowledged (UNDP 2010, IEA 2009, Abdulla and Markandyab 2009). For instance, sustainable energy use and conservation would promote current and long term human well-being and ecological balance. The severity and lasting impacts of the oil price shocks of the 1970s convinced many governments, both developed and developing, of the need to consider energy issues seriously in all aspects of national economic policy and planning (Shipper *et al.* 1981). As a

result, many developing countries initiated programmes and policies designed to help reduce oil imports as well as emphasizing the development of domestic energy supplies and promotion of more efficient use of energy resources. However, energy conservation had not received serious consideration in many developing countries, Kenya included, especially with regard to energy systems studies or in government energy policies (Shipper, at *al.* 1981). It has been argued that this is probably due to the perception that conservation entails curtailment of energy use through restrictions in economic activity, for example restrictions in the provisions of goods and services that people want. In practice, more efficient energy use can enhance development, through savings in energy costs.

Although energy fuels economic growth, and is therefore a key concern for all countries, access to and use of energy vary widely among them, as well as between the rich and poor within each country. In fact, 2 billion people, one-third of the world's population rely almost entirely on traditional energy sources and so are not able to take advantage of the opportunities made possible by modern forms of energy (UNEP 2004; WEC 2000; UNDP, 1996). Moreover, most current energy generation and use are accompanied by environmental impacts at local, regional, and global levels that threaten human welt-being now and well into the future.

In Agenda 21, the United Nations has strongly endorsed the goal of sustainable development, which implies meeting the needs of the present without compromising the ability of future generations to meet their needs (WCED, 1987). The importance of energy as a tool for meeting this goal was acknowledged at every major UN conference in the 1 990s, starting with the United Nations Conference on Environment and Development (UNCED, also commonly known as the Earth Summit) in 1992. Access to modern energy services is a prerequisite for sustainable development and for fighting poverty. Energy should be produced and used in ways that support human development over the long term, in all its social, economic, and environmental dimensions (hence the term sustainable energy).

Availability and use of affordable and sustainable energy in critical to the achievement of the Millennium Development Goals (MDGs). For instance, access to affordable and sustainable energy can help to *reduce extreme poverty and hunger*. Energy can make an important contribution by freeing time otherwise used for fuel gathering, food grinding and preparation which can be then

used for income generating productive activities. Energy is required for pumping water, for processing/grinding food and cooking. To achieve the goal of *universal primary education*, energy contributes through powering information and communication technologies, including distance learning; reducing the time spent on daily chores like fuel and water gathering and food production. Sustainable energy contributes to *reducing child mortality* through reducing indoor pollution as well as through making refrigeration available for vaccines and powering modem health equipments. Furthermore, renewable sources of energy can contribute by reducing greenhouse gas emissions, deforestation, and loss of biodiversity and land degradation hence ensuring environmental sustainability (UNDP 2004; UN Millennium Project 2006).

However, it is widely acknowledged that energy production, transformation, transport and use have significant impacts on the environment (Muthoka, *et al*. 1998; Rosen and Dincer 1997, Strong 1992; Anon 1989). For instance, the use of energy has been linked to some environmental effects, the most significant of which is global warming linked to carbon dioxide and other greenhouse gases emitted by fossil fuel consumption (United Nations 1992).

1.1 METHODOLOGY AND STUDY AREA

1.1.1 METHODOLOGY

This study was carried out in 2008 relied on both primary data and secondary data. Primary data was derived from 17 (from a total population of 47 schools) private and public boarding secondary schools in Thika Sub-County. The Head teachers were interviewed using a designed open and closed questionnaire. Other primary data collection instruments included informal interviews with stakeholders as well as direct observations by the researchers and assistants. Secondary data was extracted from published and unpublished materials including books, journals, policy documents and the internet.

1.1.2 THE STUDY AREA

Thika Sub-County is one of the twlve Sub-Counties that form Kiambu County. It lies between latitudes 3° 53’ and 1° 45’ south of Equator and longitudes 36° 35’ and 35° and 37° 25’ east. Figure 1 shows the administrative units of Thika Sub-County. It borders Nairobi City to the south, Kiambu District to the West, Maragua District to the north and Machakos District to the east. The district

has a total area of 1,960 KM^2. Sub-County is divided into six administrative divisions with Ruiru being the largest and Gatundu South being the smallest. The other divisions are Kakuzi, Gatanga, Kamwangi and Gatundu South.

The population of private and public boarding secondary schools in the study was 47 (in 2007). The schools were mainly concentrated in Gatanga, Gatundu and Kamwangi Divisions. The schools enrolment rate is estimated at 70% for both boys and girls. The secondary school going age group comprises 9.3 % of the total population and was estimated at 72,242 in 2008. The school drop-out was estimated to be 5.2% (Thika District Strategic Plan 2005-2010).

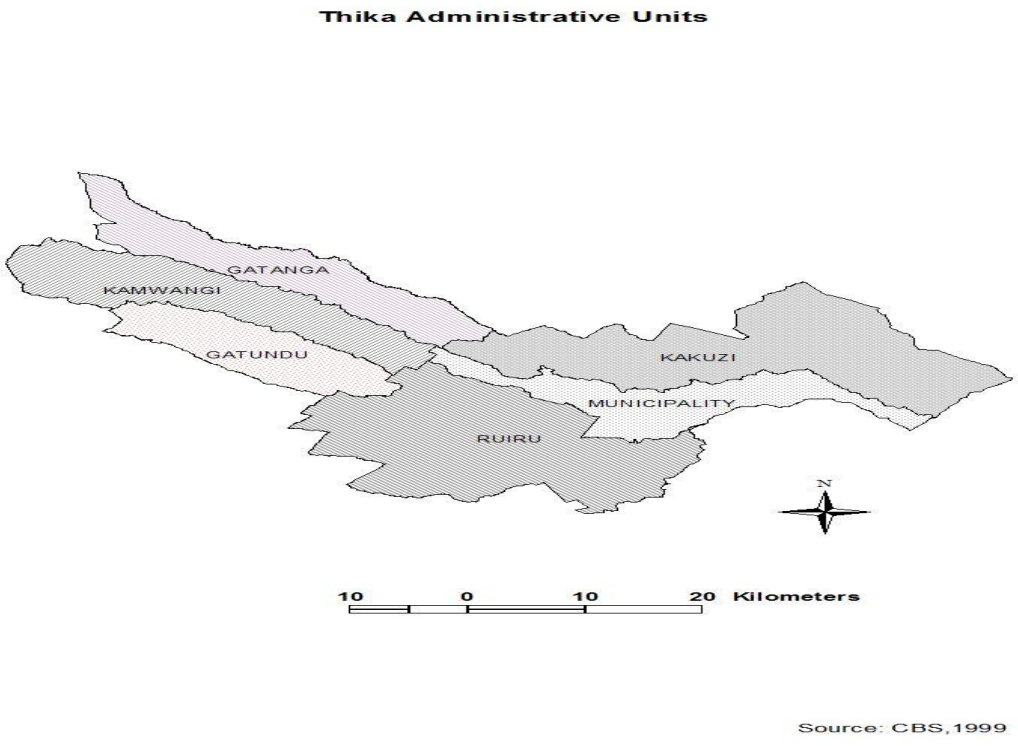


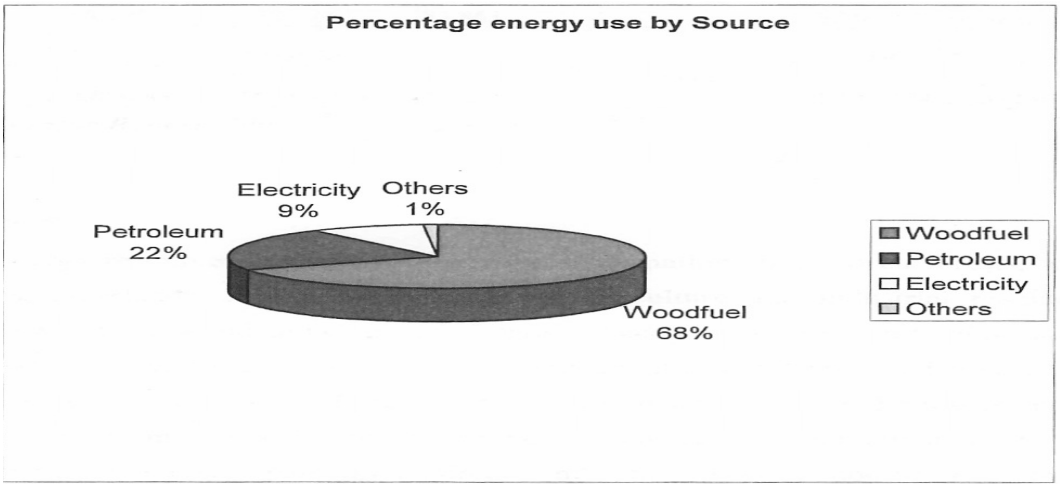
Figure 1: Thika Sub-County Administrative Units

1.3 RESULTS AND DISCUSSION

1.3.1 ENERGY USE

Firewood and charcoal are the main sources of energy for schools, private institutions as well as households in Kenya. For example, in Kenya about 70% of the country's energy is directly supplied by firewood and charcoal (Hankins, 1987). Other important energy sources include petroleum and electricity (Figure 2). The cost of purchasing these fuels is increasing as supplies diminish in many rural areas and as demand in the urban areas increases. The increase in price is putting severe strain on the finances of many institutions and households.

Figure 2: Percentage of Energy Use



Source: Republic of Kenya (2004).

Schools in Thika Sub-County largely depend on firewood as the main source of energy (Table 1). They mainly depend on the nearby abandoned coffee farms widely distributed in the district for their firewood needs. For instance, coffee stumps and stems have a ready market in schools. The remains of tea pruning are also widely used in schools.

A significant percentage of schools (70%) use electricity where connection from the national grid is possible, mainly for lighting. For heating and cooking, schools revert to firewood. In the laboratories schools will occasionally use LPG for conducting experiments. Diesel accounts for 41.8% of the total energy utilized and is used for powering generators. On the other hand, solar energy is widely used in schools which are isolated from the main electricity grid. Biogas can also

supply schools with very cheap energy at minimum cost but its adoption by schools has been very low due to lack promotion. It is clean energy with low emissions of greenhouse gases. Wind energy is not used by schools in Thika Sub-County.

Table 1: Energy types used in schools in Thika Sub-County

Energy Type	Frequency (N=17)	Percentage
Firewood	17	100
Charcoal	5	29.4
Electricity	12	70.6
Cooking Gas	8	47.1
Kerosene	4	23.5
Biogas	1	5.9
Diesel	7	41.8
Solar energy	2	11.8
Total	56[a]	330.1[b]

56[a] represents the total number of responses to the variable, *energy types used in schools*, which is a multiple response variable.
333.1[b] represents the total percentage of all responses to the variable, *energy types used in schools*, which is a multiple response variable.
Source: Field Data, 2007

It will also be noted that the energy resources available for use in schools in the study area vary between and within agro-ecological zones. With regard to firewood, its availability within and between ecological zones is influenced by climatic conditions, soils, agricultural and economic activities and infrastructure. For instance, the tea zone is within the high potential areas and is likely to suffer firewood deficits due to extensive clearing of forests to establish tea plantations. This condition may be moderated if the zones are neighboring forest areas. Coffee zones are likely to have additional firewood supplies due to widespread clearing of coffee plantations. The drier lower zone with a relatively lower population density, has excess firewood supplies (Maina 2007).

It is apparent from the results that there is overreliance on firewood, electricity, cooking gas, diesel and kerosene as the main sources of energy for both cooking and lighting. Whereas firewood and hydro-electricity are renewable sources of energy, it was observed that schools have not established

their own wood lots or forest plantations. Hence, the availability of firewood for future use is not guaranteed. Furthermore, schools in the study area predominant rely on the national grid for their electricity (some of which is generated by burning diesel) needs, making them vulnerable to high electricity costs, hence straining their budgets and contributing to environmental pollution. The use of diesel and cooking gas should be limited because these energy sources are not renewable and may contribute to environmental degradation and accidents.

1.3.2 ENERGY CONSERVATION STRATEGIES

Energy conservation is the practice of decreasing the quantity of energy used while achieving a similar outcome or end use. This practice may result in increase of national security, personal security, financial capital, human comfort and environmental value. Individuals and organizations that are direct consumers of energy may want to conserve energy in order to reduce energy costs and promote environmental protection. Industrial and commercial users may want to increase efficiency and maximize profit (GEF/KAM 2006).

For schools, energy conservation contributes to reduced energy costs and promotion of environmental protection. To establish the energy conservation strategies in schools in the study area, a questionnaire was administered to head teachers of schools.

Of the respondent school heads, 76.5% practice energy conservation in one way or another mainly in their kitchens. The use of energy saving cookers is the predominant energy conservation practice. It was noted that the use of the energy saving devices especially in the kitchens helped in the conservation of wood fuel. With regard to the use of electricity, schools have established rules on lighting and the use of lights. However only 35% schools have installed energy saving bulbs as an energy conservation strategy. Head teachers of some schools indicated that they had not switched to energy saving bulbs due the financial difficulties associated with their (energy saving bulbs) initial cost and replacement. All schools have rules on electricity use including switch-on and switch-off time and the loading of electrical sockets. Only 12% of the schools had already installed solar panels while 15% have established their own wood lots or forest plantations. No schools were observed to have installed wind pumps or biogas digesters.

Head teachers of schools were also asked about their awareness and training on environmental issues. Table 4 shows the results. More than half (58.8%) have some form of environmental education; 35% have heard of greenhouse gases; 41% have attended some form of training on energy conservation; 71% of the respondents are aware of climate change; and 59% have heard of global warming; and 53% attribute global warming to climate change. The results are shown in Table 2.

Table 2: **Awareness and Training on Environment Issues**

Awareness and training	**Frequency (N=17)**	**Percentage**
Those with environmental education	10	58.8
Heard of green house gases	6	35.3
Attended training on energy conservation	7	41.2
Heard of Global Warming (GW)	10	58.8
Heard of Climate Change (CC)	12	70.6
Linking Contribution of GW to CC	9	52.9
Total	**54**[a]	**317.6**[b]

54[a] represents the total number of responses to the variable, *awareness and training on environment issues*, which is a multiple response variable.
317.6[b] represents the total percentage of all responses to the variable, *awareness and training on environment issues*, which is a multiple response variable.
Source: Field Data, 2007

It is apparent that schools in the study area have not fully embraced energy conservation strategies and even in situations where they have been adopted, the range is limited. For instance, there is overreliance on energy saving cookers that use firewood at the expense of renewable and cheaper energy sources such as biogas. The predominant use of electricity for lighting at the expense of other alternative energy sources such as wind and solar energy is another example. There is also some awareness on environmental education and training.

1.3.3 ENERGY USE AND INDOOR POLLUTION

The production, transformation, transports and use of energy has been noted to have significant effects on the environment (Muthoka *et al.* 1998). These effects vary widely depending on the source of energy, the technology used in its production as well as the use it is put into. For instance,

the burning of fossil fuels leads to the release of waste products that can damage human health and pollute the environment. Fossil fuel combustion accounts for significant proportions of sulphur oxides, nitrogen oxides, carbon monoxide, particulate matter, carbon dioxide as well as volatile organic compounds released to the environment (Department of Environment, USA, 1989). Biomass harvesting and use for energy on the other hand has been associated with serious environmental degradation and indoor air pollution (Republic of Kenya, 2004). The burning of firewood produces a variety of noxious gases such as carbon dioxide, methane, sulphur oxides and particulate matter.

To establish whether energy use had contributed to indoor pollution in schools in Thika Sub-County, head teachers were asked whether they had received complaints regarding smoke, heat and general indoor pollution from their kitchen staff. Table 3 shows the results. On smoke, over half (53%) of the head teachers indicated they had received complaints from their staff. However, only 17.6% of the head teachers received complaints often about smoke pollution and 23.5% rarely received complaints. Regarding heat, 41.2% of the head teachers indicated that they had received complaints from their kitchen staff; 11.8% indicated that they rarely received complaints and 5.9% of the head teachers indicated that they received complaints often.

Table 3: Heat and Smoke Complaints

Type of complaint	**Frequency (N=17)**	**Percentage**
Smoke complaints		
Received staff complaints of smoke	9	52.9
Received staff complaints rarely	4	23.5
Received staff complaints often	3	17.6
Heat complaints		
Received staff complaints of heat	7	41.2
Received staff complaints rarely	2	11.8
Received staff complaints often	1	5.9

Source: Field data 2007

The low number of complaints from heat exhaustion could be due to lack of awareness and ignorance on the part of the kitchen workers since most kitchens were observed to have poor ventilation. It may also due to fear by kitchen workers that complaints would lead to loss of their jobs. The frequency of reporting of complaints to head teachers for both smoke and heat is low. This may be due the fact that head teachers may also not a given a true picture of the situation on the ground as this will have reflected negatively on them. The researchers were not allowed to directly interview kitchen staff in order to verify the responses of head teachers.

In theory, complete combustion of firewood in a combustion device like the cook stoves used in schools should result in the release of carbon dioxide and water which are not strictly regarded as pollutants. However, it is difficult to ensure complete combustion due the heterogeneous nature of the combustion process, lack of proper control and design constraints. Hence, the emission of pollutants in school kitchens is inevitable although it will be influenced by types of stoves and the firewood used.

From the research findings, it is apparent that indoor pollution is prevalent in schools in Thika Sub-County. The other environmental effects are related to use of firewood, diesel and electricity have been noted above. The use of unsustainable sources of firewood may contribute to deforestation, loss of soil fertility, micro-climate modification and other related effects. The combustion of diesel (to power generators) is associated with air pollution and accounts for significant amounts of sulphur oxides, nitrogen oxides and carbon dioxide released to the atmosphere. On the hand, the reliance on the national grid for electricity supplies may contribute to atmospheric pollution associated with its (thermal component) generation.

1.3.4 CONCLUSION

On the basis of the findings of this study, it is concluded that overreliance on firewood as a source of energy in schools in the study area is unsustainable and may lead to environmental degradation. This is because schools have not established their own wood lots and rely on abandoned coffee farms to meet their wood fuel needs. The use of electricity and fossil fuels may put a strain on schools as well as contributing to environmental pollution. It is recommended that that school

establish their own forest plantation and explore the use of alternative renewable sources of energy such as solar and wind energy as well as biogas.

Energy use in schools in the study area has various adverse environmental effects including atmospheric pollution, exposure to heat and indoor pollution in school kitchens. It is recommended that schools integrate the principles of cleaner production into their energy use. This would entail for example the replacement/repair of equipment/machinery is causing air pollution or ensuring the installation of proper ventilation systems in school kitchens.

Energy conservation has not been fully embraced by schools in the study area. There is need for schools to diversify their energy conservation strategies, in order to reduce their energy costs and protect the environment.

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