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The KENYA INSTITUTE for PUBLIC POLICY RESEARCH and ANALYSIS

Strategies for Securing Energy Supply in Kenya

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THE KENYA INSTITUTE FOR PUBLIC POLICY RESEARCH AND ANALYSIS (KIPPRA)

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Kenya Institute for Public Policy
Research and Analysis

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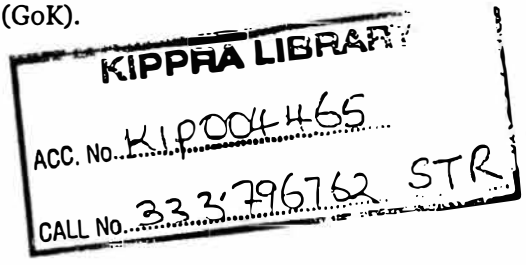

Abstract

Energy fuels virtually all the systems supporting mankind, and is essential in both rural and urban areas. Lack of adequate and reliable energy supply reduces the potential for achieving major structural changes in rural and urban economies. There is a close correlation between economic growth and quality of life and demand for energy. A country cannot expect higher levels of economic growth if energy supplies are constrained. Given the central role of energy in the economy and its potential for poverty reduction and wealth creation, it is critical to assess how Kenya can secure energy supply for now and in the future.

The challenges of energy supply in Kenya include low access to modern energy services, high cost of energy, irregular supply and high cost of energy investments, among others.

This study uses a Strengths, Weakness, Opportunities, Threats (SWOT) analysis framework to assess Kenya's energy supply using data from primary and secondary sources. The study also utilizes case study method to draw from the strategies used to ensure sustainable energy supply in the US, UK, Brazil, China, Malaysia, South Korea, South Africa and Ghana. The strategies used by these countries include diversification of importing sources of oil, increased oil and gas exploration within their countries and abroad, use of cheaper sources of electricity such as coal and natural gas, and conducive policy, legal and regulatory framework to attract private sector participation. Special incentives such as subsidies and tax reductions have been used to encourage the uptake of renewable sources of energy and also energy efficient end-use hardware. Besides, governments support R&D programmes in the energy sector and in some countries use legislation to promote the use of biofuel. Regional co-operation with neighbouring countries has also been pursued to ensure energy security.

Several policy implications are drawn from this study. These include the need for fiscal incentives to promote renewable energy; tax incentives, blending legislation and government procurement to reduce oil dependence; public education, training, procurement of energy saving products, voluntary agreements with industry, and tax incentives to encourage energy conservation and efficiency; government funding and tax incentives for local and international investors to enhance exploration; increased government and private sector funding for R&D; and, financial incentives to encourage supply of energy by the private sector. Others include harmonization of energy policy with other related sectoral policies, legal and regulatory reforms, regional co-operation, establishment of energy policy research institute, and consideration of nuclear energy.

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List of Abbreviations and Acronyms

AFREPEN	-	African Energy Policy Research Network
APERC	-	Asia Pacific Energy Centre
Bkwh	-	billion kilowatt hours
Btu	-	British thermal units
CDM	-	Clean Development Mechanism
EAC	-	East African Community
EAPMP	-	East Africa Power Master Plan
EAPP	-	Eastern Africa Power Pool
ERB	-	Electricity Regulatory Board
ERC	-	Energy Regulatory Commission
ERSP	-	Energy Sector Recovery Project
EU	-	European Union
ESDA	-	Energy for Sustainable Development, Africa
FAN	-	Forest Action Network
GDP	-	Gross Domestic Product
GEF	-	Global Environmental Facility
GW	-	Giga Watts
IEA	-	International Energy Agency
IGAD	-	Inter-Government Authority on Development
IPO	-	Initial Public Offer
IPP	-	Independent Power Producers
KAM	-	Kenya Association of Manufacturers
KEBS	-	Kenya Bureau of Standards
KenGen	-	Kenya Electricity Generating Company.
KEPCO	-	Korea Electric Power Company
KNOCK	-	Korea National Oil Company
KPC	-	Kenya Pipeline Company
KPLC	-	Kenya Power & Lighting Company
KPRL	-	Kenya Petroleum & Refineries Limited
LCPDP	-	Least Cost Power Development Plan
LNG	-	Liquefied Natural Gas
LPG	-	Liquefied Petroleum Gas
MDGs	-	Millennium Development Goals
MSD	-	Medium Speed Diesel
MW	-	Mega watts
NBI	-	Nile Basin Initiative
NEMA	-	National Environment Management Authority
NEPAD	-	New Partnership for Africa's Development
NOCK	-	National Oil Corporation of Kenya

OPEC	-	Organisation of Petroleum Exporting Countries
PIEA	-	Petroleum Institute of East Africa
PJ	-	petajoules
R&D	-	Research and Development
RD&D	-	Research, Development and Demonstration
REA	-	Rural Electrification Authority
REP	-	Rural Electrification Program
RETAP	-	Renewable Energy Technology Assistant Program
SAPP	-	South African Power Pool
SWOT	-	Strengths, Weaknesses, Opportunities and Threats
TARDA	-	Tana and Athi Rivers Development Authority
TERI	-	Total Energy Research Institute
UNFCC	-	United Nations Framework Convention on Climate Change
VAT	-	Value Added Tax
WEC	-	World Energy Council
WESTCO	-	Western Power Corridor Project

1. Introduction

Energy is a pervasive factor in our lives. It fuels agriculture, industry, commerce, transportation and other economic activities; it powers our houses, offices, hospitals and buildings. To individuals, it satisfies basic human needs for food, jobs, clean running water, health services, housing, education, and communications, among others.

The availability and cost of energy has significant impact on economic sectors, especially those that have been identified to drive economic growth in the country. These sectors are information communication technology (ICT)-based industry, tourism, agriculture, wholesale and retail, manufacturing and financial services. The energy needs of these sectors are expected to be enormous.

Energy is also vital in achieving the Millennium Development Goals (MDGs) of halving poverty rates and improving health; it is needed to increase productivity and create jobs. The efficient provision of energy contributes indirectly to poverty reduction through economic growth, and is central to the basic human needs of nutrition, health and education. Energy services also have a direct bearing on poverty reduction through reduced costs of production for goods demanded by the poor, increased crop output, and creation of employment opportunities (TERI, 2001). Moreover, energy production and consumption are inextricably linked with the state of natural resources, such as forests, on which the poor are directly dependent.

Access to adequate energy services is essential in both rural and urban areas. Lack of such access reduces the potential for achieving major structural changes in rural economies, which would be required to enhance income-generating activities and poverty alleviation. Given the central role of energy in the economy and also its potential for poverty reduction and wealth creation, it is critical to assess how Kenya can secure energy supply now and in the future in order to achieve the economic objective of Vision 2030.

1.1 Role of Energy in Sustainable Development

The environment provides raw materials for the energy industry. These include wood fuel, fossil fuel, radioactive minerals, hydropower, geothermal power, insolation and wind. On the other hand, the environment is the recipient of the residues of thermal energy, solid,

liquid and airborne waste produced by energy systems. The pattern and profile of energy use raises important questions about the linkages between energy, the economy and the environment.

One of the most important economic issues is the relationship between energy prices and energy use. Energy prices influence consumer choices and behaviour. High energy prices can lead to high energy bills, which in turn have adverse consequences for business, employment and social welfare. On the other hand, high energy prices can also stimulate exploration and development of additional resources, create incentives for innovation and efficiency improvements, and attract new investment.

Energy system development cannot take place without investment in plants, equipment and energy system infrastructure. A major challenge is meeting the growing demand for energy services to support desired economic growth without incurring the adverse consequences associated with energy use. The environmental degradation associated with the production and consumption of energy, particularly fossil fuels, threatens human health and quality of life and affects ecological balance and biodiversity. Moreover, with the case of increased use of biomass energy, deforestation and land degradation has been on the increase.

Activities related to energy production, distribution and consumption are perhaps the largest single category of benign sources of adverse anthropogenic impacts on the environment. Energy production and use have resulted in increased pollution and an excessive release of emissions. Pollution of the atmosphere, especially indoor pollution, has been linked to acute respiratory tract infections. Among the causes of such infections are emission of sulphur and particulates from energy systems. Fossil fuels are the largest contributors to air pollution owing to the amount of emissions they release into the environment when they burn. These emissions, especially carbon dioxide, methane, nitrogen and sulphur oxides, are responsible for changes in the atmosphere that are affecting the global climate. It has also been estimated that more than 85 per cent of the influence on climate is a direct result of energy use.[1]

Nitrogen and sulphur oxides are precursors to acid rain. They are also involved in the formation of smog, which affects human health and impairs visibility. Given that energy is central to achieving sustainable development goals, the challenge lies in finding ways to reconcile this

[1] http://www.infomonitors.com/euse.html

necessity and demand for energy with its impact on the natural resource base in order to ensure that sustainable development goals are realized.

Energy is a critical input in a country's development process. Its level and intensity of use in a country is a key determinant of the pace of socio-economic transformation. Physical theory shows that energy is necessary for economic production and therefore growth. Energy is an essential input that, in the long run, its availability could constrain economic growth (Stern and Cleveland, 2004).

However, there has been extensive debate on the trend in energy intensity in developed countries, especially after the oil shocks of the 1970s. Stern and Cleveland (2004) have shown that productivity of firms is determined by inputs such as capital, labour and various energy inputs such as coal, oil and technology. The relationship between energy and aggregate output such as gross domestic product (GDP) can be influenced by factors such as substitution between energy and other inputs, technological change, shifts in the composition of the energy input and shifts in the composition of output. However, there is variance in conclusions regarding whether capital and energy are complements or substitutes. Apostolakis (1990) argues that capital and energy act more as substitutes in the long run and more as compliments in the short run.

The quality of energy is also another important issue. Stern and Cleveland (2004) argue that energy quality is an important element in the debate; that the general shift to higher quality fuels reduces the amount of energy required to produce a dollar's worth of GDP and, in a review of past literature, that energy use and output are tightly coupled with energy availability playing a key role in enabling growth. They further argued that reductions in energy intensity are explained by a shift to higher quality fuels.

De Vita, Klaus and Lester (2005) found different price, GDP and temperature elasticities for the consumption of various energy forms. Diesel has the highest long-run GDP and temperature elasticities (in absolute) values (1.96 and -1.12, respectively). Petroleum has the highest long-run price elasticity (-0.86), while electricity is lower (-0.30). Electricity has the lowest long-run GDP elasticity (0.59), while petroleum's (1.08) is between that of diesel and electricity.

Numerous studies have examined the causal relationships between energy consumption and economic growth, with either income or employment used as a proxy for the latter. To date, the empirical findings are mixed or conflicting. Early studies found evidence of causality running from GNP to energy consumption (Kraft and Kraft, 1978). However, others found no causal relationship between Gross National Product (GNP) and energy consumption (Akarca and Long, 1980; Erol and Yu, 1987; Yu and Choi, 1985).

On the causal relationships between energy consumption and employment, Erol and Yu (1987), and Yu and Jin (1992) find evidence in favour of neutrality of energy consumption with respect to employment. One of the reasons for the mixed and conflicting results is the variety of approaches and testing procedures employed in the analyses. Many of the earlier analyses employed simple log-linear models estimated without any regard for the nature of time series properties of the variables involved. Most economic time series, however, are non-stationary (Granger and Newbold, 1974). Thus, the failure to account for such properties may result in misleading relationships among the variables.

Asafu-Adjaye (2000) finds that unidirectional Granger causality runs from energy to income for India and Indonesia, while bi-directional Granger causality runs from energy to income for Thailand and Philippines. In the long run, there is unidirectional Granger causality running from energy and prices to income for India and Indonesia. However, in the case of Thailand and the Philippines, energy, income and prices are mutually causal.

Price effects are relatively less significant in the causal chain. The finding of bi-directional causality or feedback between energy consumption and income imply that a high level of economic growth leads to a high level of energy demand and vice versa. Sica (2006), in a study in Italy, finds evidence of uni-directional relationship running from energy to GDP and this is intuitively reasonable since increased economic growth requires enormous consumption of energy. However, there is no causality linkage between the variables. These results contradict findings by Soytas and Sari (2003) who, by using coal equivalent as a proxy for energy consumption found evidence of long-run uni-directional causality running from income to energy for Italy in the period 1950-1992.

In general, some studies have found evidence of bi-directional, uni-directional or no causality according to the country analysed. Moreover, in some countries, different findings occur for different time periods, leading to no certain conclusions. Although the direction of causality between energy consumption and economic growth still remains controversial, the relationship between energy consumption and economic growth is well established in literature (Aqeel and Butt, 2001). The controversy is whether economic growth leads to energy consumption or that energy consumption is the engine of economic growth. Whatever is the case, what is clear is that a country cannot expect higher levels of economic growth if energy supplies are constrained.

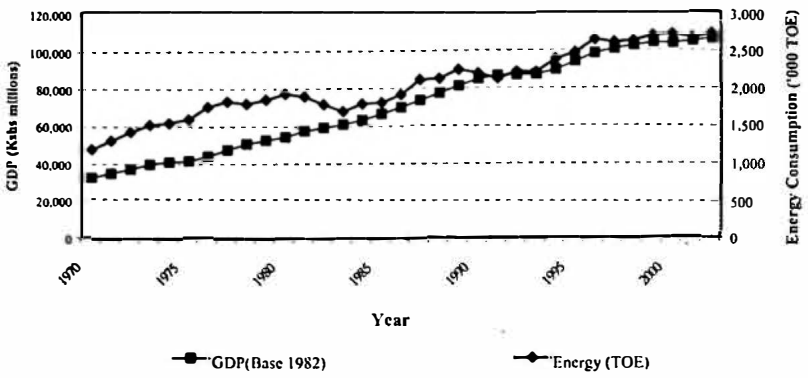
Indeed, there is a close correlation between economic growth and quality of life on one hand, and demand for energy on the other[2] (Oketch, 1998; Kamfor, 2002; Government of Kenya, 2004). This correlation[3] was amply manifested in 2000 by the fall in GDP growth in Kenya to minus 0.3 per cent and the corresponding decline in the demand for petroleum fuels by 1.4 per cent from 3,029 thousand tonnes in 1999 to 2,986 thousand tonnes in 2000. The negative economic growth registered in 2000 was attributable to, among other factors, inadequate supply of electricity due to the severe drought experienced in the country between 1998 and 2000. The supply of electricity declined by 10.7 per cent from 4,432.2 Gwh in 1999 to 3,958.4 Gwh in 2000 and the country faced an unprecedented long period of electricity rationing.

Energy, particularly commercial energy consumption, tends to fluctuate in the same pattern with economic performance. This observation is true for Kenya where real GDP has tended to move in the same trend with commercial energy consumption (Figure 1). In addition, electricity demand is currently growing at 8 per cent, which is higher than that of the GDP that was 6.1 per cent in 2006. This is the correlation that provides a rationale for a SWOT analysis given the country's ambitious growth projections of 10 per cent per annum in the Kenya Vision 2030.

[2] http://www.unsystem.org/ngls/documents/publications.en/voices.africa/number6/vfa6.11.htm.

[3] However, there are exceptions when energy conservation and efficiency measures are pursued aggressively. In such a case, energy consumption can remain stable while GDP grows.

Figure 1: GDP and energy consumption trends in Kenya



This, therefore, makes it imperative for Kenya to undertake critical strategies to ensure an adequate and cost-effective supply of energy for the country to attain the economic growth rate envisaged in the Vision 2030 while protecting and conserving the environment.

1.2 Policy Research Problem

There is a limited (inadequate) supply of energy in Kenya relative to demand. For instance, there is a huge unmet demand for electricity as many people have paid connection fees and are yet to receive electric power. In 2000, the unmet demand for electricity was approximately 25 per cent (Kamfor, 2002). There is also a biomass energy deficit, which in 2004 was estimated at 60 per cent (SOE, 2004). Access to forms of modern energy is very low; the per capita consumption of electricity is 121 kwh, while national access rate of about 15 per cent is below the average of 32 per cent for developing countries (SOE, 2004).

Another problem with energy in the country is the high cost. The price of petroleum products has been rising in the world market and also in the domestic market. The cost of electricity in Kenya, for instance, is four times that experienced in South Africa (the country's main competitor in the region) and more than thrice the power tariffs in China (KIPPRA, 2005). Furthermore, this high cost is compounded by irregular supply; on average, Kenyan firms lose 9.5 per cent of total output as a result of power outages and fluctuations. This loss excludes the loss from damaged equipment as a result of power fluctuations, which for some firms averaged Ksh 1 million in 2001.

A related problem with energy is security of supply. Given the uncertainties (both price and availability) surrounding continued supply of petroleum from the Middle East, changing weather patterns (in view that hydropower is the major source of electricity), and looming terrorist threats, security of energy supply is very critical.

Adequate, affordable and secure supply of energy is, therefore, crucial now and in the future, particularly in the attainment of economic goals as stipulated in Vision 2030 (Government of Kenya, 2006). The overriding goal is to achieve and maintain an economic growth rate of 10 per cent per annum for the next 25 years. This will require a corresponding increase in the supply of energy to drive the economy. This would only be possible if adequate measures are undertaken to successfully harness (at large or commercial scale) solar, plant based, wind, hydro and geothermal forms of energy. Moreover, there are also expected challenges with respect to financing, technology, affordability, environmental safety and security.

As the country enters a new phase in its development effort, there is need to have a policy stance that secures energy supply. Energy policy and projections made so far have not accounted for Vision 2030 targets.

1.3 Policy Research Questions

The policy questions are:

- What is the status of the energy sector in Kenya?
- What lessons can Kenya learn from other countries in coping with energy challenges?
- How can Kenya cope with energy challenges and, in particular, meet energy requirements that are crucial in achieving the economic objectives of Vision 2030?

1.4 Objectives of the Study

The overall objective of the study is to explore strategies and policy options that will ensure adequate, quality, cost effective and affordable supply of energy to meet Kenya's development needs, while protecting and conserving the environment.

The specific objectives are to:

- Examine the status of the energy sector in Kenya;
- Undertake literature survey on what other countries have done to cope with energy challenges;
- Carry out a SWOT analysis of the energy sector; and
- Propose policy strategies to secure energy supply.

1.5 Conceptual Framework[4]

This study uses the SWOT analysis framework, a simple framework for generating strategic alternatives from a situation analysis. SWOT (sometimes referred to as TOWS) stands for Strengths, Weaknesses, Opportunities and Threats. The SWOT framework was first described in the late 1960s.[5]

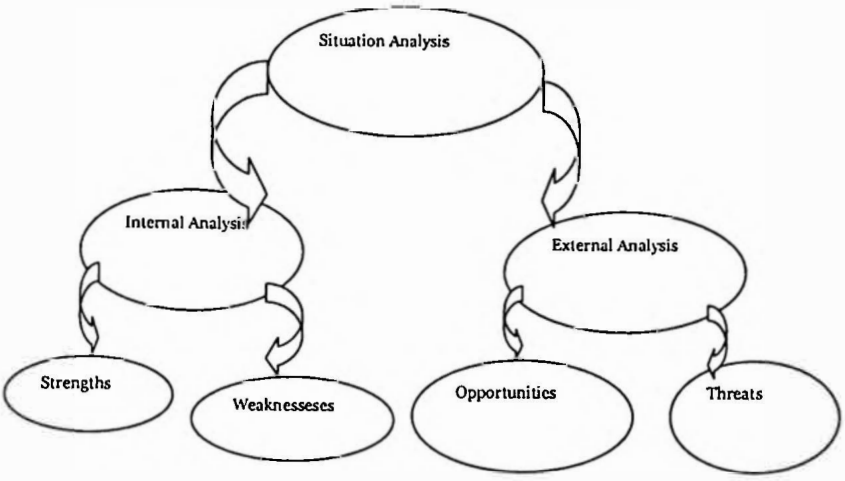
Figure 2 shows how a SWOT analysis fits into a strategic situation. The internal and external situation analysis can produce a large amount of information. The SWOT analysis serves as an interpretive filter to reduce the information to a manageable quantity of key issues. It classifies the internal aspects as strengths or weaknesses and the external situational factors as opportunities or threats.

The study uses the theory of institutions in the context of the SWOT analysis. The New Institutional Economics (NIE) considers that the cost of transacting—determined by institutions and institutional arrangements—is the key to economic performance. Under NIE, some of the unrealistic assumptions of neo-classical economics (such as perfect information, zero transaction costs, full rationality) are relaxed, but the assumption of self-seeking individuals attempting to maximize an objective function subject to constraints still holds. The purpose of the NIE is, therefore, to explain both the determinants of institutions and their evolution over time, and to evaluate their impact on economic performance, efficiency and distribution (Nabli and Nugent, 1989).

Many formal and informal institutions have been used to manage energy resources in different societies. Depending on the dynamics of institutions, the outcomes have a bearing on how the country can secure energy supply in pursuant of Vision 2030.

[4] http://www.ntmba.com/strategy/swot.
[5] Learned *et al* (1969).

Figure 2: A SWOT analysis framework



1.6 Methodology

Data for this study came from several secondary and primary sources including the Internet. Discussions were held with a number of stakeholders who are practitioners in the energy sector. Broadly, the stakeholders included the Kenya Power and Lighting Company (KPLC), the Kenya Electricity Generating Company Limited (KenGen), the Energy Regulatory Commission (ERC), the Kenya Association of Manufacturers (KAM), Global Environmental Facility (GEF), the Ministry of Energy, the Ministry of Planning and National Development, the National Environment Management Authority (NEMA), the Ministry of Agriculture, and non-governmental organizations (NGOs) such as Queconsult.

The choice of countries from which Kenya could learn how to cope with energy challenges was based on those that are already developed (US and EU), have rapidly grown in the recent past (China), are innovators in energy utilization (Brazil), as well as those that Kenya aspires to be (South Korea, Malaysia and South Africa). The study also selected a comparable country (Ghana). Such a comparative perspective would draw invaluable lessons for Kenya in her pursuit of sustained economic development as envisaged in Vision 2030.

1.7 Organization of the Paper

The paper is structured as follows: This section (Section 1) presents the introduction, comprising role of energy in sustainable development, policy research problem, policy research questions, objectives, conceptual framework and methodology. Section 2 presents an overview of the energy sector. Section 3 presents the experience of model countries from which Kenya could learn how they have coped with energy challenges.

The presentation of the model countries is then followed by a SWOT analysis of the energy sector in Kenya, which makes up Section 4. Strategies to secure energy supply are presented in Section 5. Finally, there is the conclusions and policy implications in Section 6.

2. Overview of the Energy Sector

This section presents an overview of the energy sector as a prelude to the SWOT analysis.

2.1 Sources of Energy and Resource Potential

There are three main sources of energy used in Kenya. These are: 1) wood fuel/biomass fuels, 2) petroleum, and 3) electricity, accounting for 70 per cent, 21 per cent and 9 per cent, respectively, of total energy consumption. Alternative renewable energy is also becoming important although it is still insignificant in the country's overall energy mix.

Biomass fuels

Wood fuel has remained the most important source of energy in Kenya, accounting for about 70 per cent of the country's total energy consumption. Eighty per cent of the population depends on it for domestic needs (Kituyi, 2002), providing 90 per cent of the rural households' energy requirement and 85 per cent of the requirements of urban households. This state of affairs has major implications on sustainable development. Unsustainable harvesting, without efforts on reforestation and on-farm planting of wood lots, often leads to deforestation and land degradation.

The main drivers of biomass energy demand are population growth, lack of access to energy substitutes and the growing poverty. About 47 per cent of the Kenyan households use charcoal, more so in urban areas where 82 per cent of the households compared to 34 per cent in rural areas use charcoal.

Total charcoal production is about 2.4 million tonnes (67 million bags of 36kg each).[6] Charcoal continues to be made from wood harvested from trust lands and gazetted forests, representing an annual business worth of Ksh 17 billion (Government of Kenya, 2004). Commercial charcoal production has led to deforestation of large tracts of wooded savannah (Ecoforum, 2002). Improved charcoal production technology has had minimal impact on recovery and production. Some of the

[6] *East African Standard*, Wednesday 20 July 2005: Science, p. 5.

charcoal in Kenya, dubbed environmental friendly, is exported but accurate figures are unavailable.[7]

An alternative source of charcoal that is increasingly gaining recognition is from agricultural wastes such as coffee husks. These sources should be promoted as means of saving further destruction of woodlands and forests.

The current demand for biomass energy far outstrips supply by almost 60 per cent (SOE, 2004). As Table 1 shows, unless deliberate policy measures are implemented to encourage on-farm planting of trees, afforestation programmes and the switch to other forms of energy, the future is uncertain on the adequate supply of wood fuel energy.

Civil society organizations have been active on biomass fuels. Some of these include Forest Action Network (FAN), African Energy Policy Research Network (AFREPEN), Practical Action, Green Belt Movement, and Renewable Energy Technology Assistant Programme (RETAP), among others. These organizations have spearheaded efforts on planting of trees, installation of improved stoves, establishment of woodlots, research on energy issues, and policy advocacy.

Table 1: Projections of biomass consumption/supply

Years	2000	2005	2010	2020
Population	28,686.6	32,694.4	36.810.7	44,981.8
Consumption (tonnes/yr)	35,119.6	39,896.6	44,599.35	53,416.33
Sustainable supply tonnes/yr	15,024.5	15,488.9	16,634.6	19,559.74
Deficit (tones/yr)	(20,095.1)	(24,407.7)	(27,964.8)	(33,856.7)
Deficit (%)	-57.2	-61.2	-62.7	-63.4
Deficit (tonnes/ person)	-0.7	-0.75	-0.76	-0.75

Source: Kamfor (2002).

[7] In the 1960s, a large company in Western Kenya started producing over 70,000 tonnes of sustainable charcoal annually and exported 35,000 tonnes to the Tororo Cement Factory in Uganda.

Petroleum

Petroleum fuels are the most important sources of commercial energy in Kenya and are mainly used in the transport, commercial and industrial sectors. The country relies entirely on imported petroleum products, which accounted for about 16 per cent of the total import bill in 2002 and consumed about 31 per cent of the country's foreign exchange earnings from merchandise exports. Consumption of petroleum products was 2.4 million metric tonnes, with a per capita consumption of 76.2 kg. Projected growth with anticipated economic recovery is about 2 per cent per annum (Government of Kenya, 2004).

Kenya's oil imports have not seen major shifts apart from the sharp increases during the power crisis of 1998-2000 when the country imported extra tonnes of oil to meet increased demand for thermal electricity generation. In 1998, the country imported 2,157.7 tonnes of crude petroleum and 1,387.8 tonnes of petroleum fuels. This declined to 1,493.4 and 1,023.5 tonnes, respectively, in 2002, mainly due to increases in hydroelectricity generation and easing of power crisis in the country. Fuel consumption rose from 2,633,626 cubic metres in 2003 to 3,730,620 cubic metres in 2006.[8]

Despite the zero rating of Liquefied Petroleum Gas (LPG) in 2004 and the Common External Tariff in 2005, consumption of LPG still remains low. A recent study shows that 7.8 per cent of households use cooking gas nationally with 23 per cent in urban areas (9.9 kg per capita) and 1.8 per cent in the rural areas, which makes up 3.7 kg per capita (Kamfor, 2002). In 2005, per capita consumption of LPG was 1.4 kg. This is extremely low compared to Senegal with a per capita consumption of 12.2 kg (The population of Senegal is about a third of Kenya and its economy is also smaller).

The petroleum sector was liberalized in 1994. However, direct government involvement in the petroleum industry remains in the oil refinery where it co-owns the Kenya Petroleum Refineries Ltd (KPRL) with three private companies (Shell, BP and Caltex) on a 50-50 equity basis. There is also government presence in oil storage facilities at Kipevu, capable of holding 1.5 million barrels, in the Kenya Pipeline Company (KPC), and in the National Oil Corporation of Kenya (NOCK).

[8] Petroleum Institute of East Africa (PIEA).

NOCK started downstream activities in March 1988 with importation of the first crude oil cargo. This was in fulfilment of the government mandate for NOCK to supply 30 per cent of the country's petroleum requirements. These supplies were sold to major oil marketers at a small margin in bulk prior to processing. NOCK is currently considering entry into market segments, which include export, LPG, Jet A1 and fuel oil.

The private sector has an extensive network of distribution and marketing outlets in different parts of the country and accounts for about 99.4 per cent of the total market sales of petroleum fuels. Five oil companies[9] control 83 per cent of the market.[10] Total Kenya leads with 21.9 per cent share, Kobil 18.4 per cent, Shell/BP 17.1 per cent, Chevron 16.6 per cent and Mobil 8.4 per cent. The remaining 17.6 per cent is shared by NOCK and 18 of the independent fuel vendors, majority of them having less than one per cent share. Collectively, the oil companies have installed about 1000 filling and service stations countrywide. The private sector also provides oil export services to Uganda, Rwanda, Burundi, Eastern parts of the Democratic Republic of Congo (DRC), Southern Sudan and parts of Northern Tanzania.

NOCK, on the other hand, has seen its market share decline from about 2 per cent in 2000 to about 0.6 per cent in 2003 through competition and has, thus, failed to live to the original government objective of using the company to regulate petroleum market prices following the deregulation of the industry in 1994.

Kerosene, as a cooking and lighting fuel, is important for the poor in rural and urban areas and has in some cases been a substitute for wood fuel. It is used by approximately 92 per cent of all households (rural—94% and urban—89%), mainly for lighting. Nationally, kerosene consumption is 12 litres per capita, with urban areas having a per capita of 23 litres/year and rural areas 8.6 litres/year (Kamfor, 2002).

The demand for petroleum has the potential to increase. With increased economic growth coupled with good performance in transport, road construction, manufacturing, and thermal power generation, the demand is expected to increase rapidly over time.

[9] Mwaniki Wahome, "Doing the sums on oil sales: A draft Bill may rock the industry further after the pullout by Mobil." *Daily Nation*, Tuesday 7 November 2006.

[10] The market shares in 2000 were: Mobil Oil, 14.7 per cent; Shell/BP, 31.4 per cent; Total, 19.1 per cent; Caltex, 16.7 per cent and Kobil, 12.2 per cent (Kamfor, 2002).

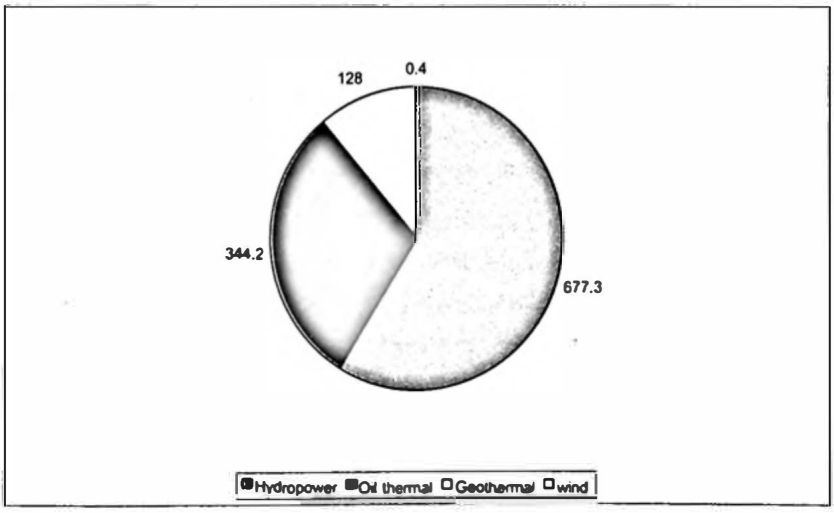
Electricity

The major sources of electricity in Kenya are hydropower, geothermal and thermal. The installed power capacity, as at 30 June 2006 was 1,155.0 MW, distributed as follows: Hydropower 677.3 MW, oil thermal 344.2, geothermal 128.0 MW, and wind 0.4 MW (KPLC, 2006; see also Figure 3).[11] The effective capacity is 1,075 MW against a peak demand of 1,050 MW. The key players in the power sector are KPLC, KenGen, IPPs, ERC, REA, and the Ministry of Energy.

The generation of electricity in Kenya has several players, chief among them being the state-owned KenGen and four IPPs. KenGen accounts for about 82 per cent of the country's total installed generation capacity.[12] KPLC has power purchase contracts with KenGen and the IPPs.

IPPs entered the domestic market in late 1997 when Iberafrica and Westmont began commercial production with a combined capacity of

Figure 3: Sources of electricity and effective power generation in Kenya (MW), 2006



[11] The proportion of hydropower has varied between 38 per cent and 76 per cent of the generation mix due to poor rainfall. As result, thermal generation has been used to meet the shortfall, varying between 16 per cent and 33 per cent of the mix. Reliance on thermal energy generation requires importing expensive petroleum fuels (ESDA, 2002c).

[12] Additional 60 MW is soon to be added by November 2007 to the national grid from the Sondu Miriu power project. A planned Sang'oro dam on the Sondu Miriu River is expected to be ready by 2010, and will add 21.2 MW.

87 MW. Their entry into the sub-sector was in response to crippling shortages in power supply. Currently, there are three large IPPs – Iberafrica, Tsavo Power and/or Power Inc.[13]—which account for about 18 per cent of electricity generated. Agreko[14] has been brought in under the emergency power generation plan. Contracts with IPPs were initially rigid and the unit cost of electricity from them was very high (Ikiara and Mutua, 2003), but the contracts are now much more flexible and can be stopped or revised within a short period. Westmont did not renew its licence with the Electricity Regulatory Board (ERB) after its expiry in October 2004, while Mumias Sugar Company has been supplying power to the national grid since September 2005.

The demand for power has been increasing and unless planned projects are implemented according to schedule, there will be severe supply shortfalls. Based on demand forecasts by the Ministry of Energy,[15] the demand will rise from 5,641Gwh in 2004/05 to 24,957 Gwh in 2025/26 financial year with a corresponding net system peak of 4,070 MW. Based on these forecasts, the Ministry has simulated a Least Cost Power Development Plan with sensitivity analysis on low and high forecasts (Appendix 1).

There is still available potential for production of electricity. This is hydropower 1,558MW, co-generation 300 MW and geothermal 2,000 MW (Government of Kenya, 2004). Moreover, it is claimed that the exploitable geothermal potential could be higher than currently estimated if more efficient technologies are used (SOE, 2004).

A new management company, Manitoba Hydro International, was contracted in 2006 under the Energy Sector Recovery Project (ESRP) funded by the World Bank to streamline operations of KPLC. However, it is still too early to assess its impact.

[13] Power Inc is the only Independent Power Producer (IPP) in geothermal generation.
[14] Agreko was contracted in April 2006 to supply power to hedge against any anticipated shortfall. According to the contract, it was supposed to supply up to 44 MW by 13 May 2006 in phase one, up to 80 MW in phase two by June 2006, and up to 100 MW by August 2006. It is currently supplying 80 MW of power. Plans are underway to supply an additional 100 MW of electricity to hedge against erosion of the reserve capacity.
[15] These forecasts do not factor in the high role of growth envisaged in Vision 2030; they are based on "business as usual".

2.2 Alternative Renewable Energy Resources

Renewable energy resources include solar energy, windmills, power alcohol and biogas. Programmes for their increased development and use have been formulated and are intended to supplement and conserve, where appropriate, other major sources of energy.

Since they are renewable, these sources of energy have the potential to contribute to social, economic and environmental dimensions of sustainable development. Their contribution (other than biomass) to the overall energy supply is miniscule, despite efforts by the civil society promotion of the related technologies. The contribution, however, could be significant in the years ahead if appropriate strategies are put in place.

Kenya has great potential for use of solar energy throughout the year because of its strategic location near the equator. On average, the country receives 4-6 kW/M²/day of solar energy (or 1.54 billion tonnes of oil equivalent). Despite this potential, the contribution of solar to national energy supply is minimal, with only 1.2 per cent of households using it for lighting, water heating and, to a smaller extent, cooking. The constraints hindering the development of this energy are low quality solar panels and inadequate technical capacity for installation and maintenance.

It is estimated that up to 4 MW of photovoltaic (PV) power is currently installed in Kenya. The demand for electricity generated from home-based PV systems is projected to reach 22 GWh annually in the fiscal year 2019/20 from an installed capacity of 10 MW_e. This represents an annual growth rate of 20,000 units per year, as has been the case for the period 1999/2000-2002/03 (Government of Kenya, 2004).

The installed capacity of wind turbines is 550 kW located at Ngong and in Marsabit. So far, these systems have performed relatively well, generating an estimated 1.6 GWh annually.

2.3 Policy, Legal and Regulatory Framework

Kenya has effected a number of policies to address energy issues in support of its development challenges. These have included formulation of a national energy policy and improvements in the energy planning process, among others.

The energy policy in Kenya has evolved through sessional papers, regulations and Acts of Parliament. The focus in the past has been on the electricity and petroleum sub-sectors. Before Sessional Paper No. 4 of 2004 on Energy, Kenya did not have a comprehensive energy policy. What existed were sketchy indicative and informal packages and statements, which were presented in different government policy documents (Okech, 1998). These were mainly short-term, supply oriented, and weak in environmental and technological aspects.

The Sessional Paper No. 10 of 1965 dwelt on the Electric Power Act (Cap 314) that was used to regulate the sector (Government of Kenya, 1965). In 1984, there was the National Energy Policy and Investment Plan (Government of Kenya, 1984), which focused on the importance of energy availability, effective use of energy, generation of the resource, potential of domestic energy sources and increasing capacity of electricity generation. It also had guidelines on the wood fuel sector, encouraging domestic substitution and promotion of alternative sources of energy, manpower development, effective co-ordination, and energy distribution network. However, these guidelines were silent on environmental aspects of energy-related activities and deficient on consumer interest and involvement in energy activities.

In the 1984/88 Development Plan, the focus remained on the supply of petroleum, electricity and wood fuel (Government of Kenya, 1983). The Plan was silent on other sources of energy such as coal, solar, wind, ethanol and other biomass resources. This was followed by *Sessional Paper No. 1 of 1986 on Economic Management for Renewed Growth*, which did not focus much on the power sector; it called for the establishment of the Department of Price and Monopoly Control within the Ministry of Finance to monitor action in restraint of trade and to enforce pricing in various sectors, including petroleum (Government of Kenya, 1986). In the 1989/93-plan period, the government aimed to direct efforts towards development and exploration of renewable energy resources such as solar, wind, biogas and wood fuel and towards the use of efficient kilns and cook stoves (Government of Kenya, 1988). In the 1994/99 Development Plan, the concern for sustainable use of energy resources was raised, although nothing tangible was implemented.

The next significant legislative development came in 1997 in the form of the Electric Power Act, which was enacted to replace Cap 314 in order to take in new developments on board and to make it more responsive to private sector participation in the provision of electricity.

Nevertheless, this new Act was still inadequate in terms of providing incentives to the private sector and in accelerating electrification in the country. The Act led to the establishment of the ERB in 1998, with the objective of regulating the generation, transmission and distribution of electric power in Kenya. The same Act unbundled the generation of power from transmission and distribution, as a result of which KenGen was established with the mandate of generating electricity from hydro, geothermal, thermal and other sources. The Act also provided for rural electrification based on supply for a limited scale using renewable energy technologies.

However, the Act did not allow for an independent watchdog or a strong regulatory framework because the final authority for power generation licences was vested with the Ministry of Energy. There was no provision for IPPs to supply power directly to consumers because of KPLC monopoly in transmission and distribution, which makes it very difficult to set up commercial renewable generation and mini grids in remote areas, e.g. small hydroelectric stations. The licensing procedures for power generation were bureaucratic, cumbersome and centralized.

Now, the national energy policy has a number of broad objectives, including ensuring adequate, quality, cost effective and affordable supply of energy to meet development needs, while protecting and conserving the environment. These are contained in the Economic Recovery Strategy for Wealth and Employment Creation and in Sessional Paper No. 4 of 2004 on Energy.

The specific objectives of the energy policy are to:

- provide sustainable quality energy services for development;
- utilize energy as a tool to accelerate economic empowerment for urban and rural development;
- improve access to affordable energy services;
- provide an enabling environment for the provision of energy services;
- enhance security of supply;
- promote development of indigenous energy resources; and
- promote energy efficiency and conservation as well as prudent environmental, health and safety practices.

Prior to the mid-1990s, the government policy on electric power development emphasized continued state monopoly in commercial generation primarily to ensure low consumer tariffs. This was possible because the government was able to mobilize the bulk of the needed development finances from its development partners on soft terms. For similar reasons, the government mobilized resources for the expansion of the transmission network, while KPLC financed the expansion of the distribution network jointly with consumers. Due to corruption, slow pace of resource mobilization and reduced capital inflows from development partners, coupled with low consumer tariffs that left no residual funds after providing for operations and maintenance expenditure, the power sub-sector begun to experience lapses in the implementation of planned projects. These lapses impacted negatively on electricity supply with rising generation shortfalls from 1995.

There have also been policies and Acts on the petroleum sub-sector. The Petroleum Act (Cap 116) has been in use for a long time. The Petroleum Exploration and Production Act enacted in 1984 gave the National Oil Corporation of Kenya (NOCK) the mandate to oversee oil exploration activities in the country. The new energy policy proposes the replacement of the Petroleum Act with new legislation consistent with a liberalized petroleum sub-sector[16] that will, *inter alia*, establish a one-stop-shop for licensing importers and wholesalers of petroleum fuels, and also establish an inspectorate to enforce compliance with petroleum regulation and oversee petroleum industry operations.

Laws governing energy development and distribution were scattered across the following Acts: the Electric Power Act; the Petroleum Act; the Forests Act; the Water Act; the Environmental Management and Co-ordination Act; and the Physical Planning Act. Other legislations that are relevant to the operations of the energy sector are Licensing Act, Standards Act, Trade Licensing Act, Local Government Act, Weights and Measures Act and Monopolies Act.

On 28 December 2006, the Energy Bill, which had been in preparation since 2004, received presidential assent and became the Energy Act of 2006. The Act seeks to "amend and consolidate the law relating to energy, to provide for the establishment, powers and functions of the Energy

[16] The petroleum industry was liberalized in 1994, just like most markets in Kenya at that time.

Regulatory Commission and the Rural Electrification Authority, and for connected purposes". More specifically, this Act provides for a more flexible licensing system, including for small systems and for distribution and bulk sale by independent producers. The Act transformed the ERB into ERC, in order to cover all sub-sectors and to reinforce the regulator's independence and prerogatives (removal from the State Corporation Act, capacity to license without the Minister's final decision, prerogative to adopt secondary legislation). Finally, the Act has created an independent Rural Electrification Authority (REA) to manage the Rural Electrification Programme and the Rural Electrification Fund.

Thus, the Energy Act of 2006 intends to address the current disparities in sub-sector regulations and bring regulation and enforcement of energy sector activities under one body, the Energy Regulatory Commission. Box 1 presents the specific measures that are planned for implementation within the Sessional Paper No. 4 of 2004 on Energy.

Box 1: Summary of measures contained in Sessional Paper No. 4 of 2004

Electricity sub-sector[17]

- Creation of the Energy Regulatory Commission (ERC) to regulate the energy sector. It will serve as a one-stop shop for permitting and licensing of generation.
- Establishment of a state-owned Geothermal Development Company to be in charge of geothermal resource assessments and sale of steam to future IPPs and KenGen for electricity generation.
- Creation of a Rural Electrification Authority (REA) to accelerate the pace of rural electrification.
- Unbundling of KPLC into two entities, one for transmission which will be state-owned, and the other for distribution, which will be private-owned.
- Privatization of KenGen over time, starting with an Initial Public Offering (IPO) of 30% of its equity through the Nairobi Stock Exchange.
- Promoting private or community-owned vertically integrated entities either operating renewable energy power plants or hybrid systems, to coexist with licensed electricity distributors.
- Allowing power generation companies to access bulk electricity.

[17] The creation of ERC and REA as well as the privatization of KenGen have already been done.

consumers through power transmission network.

- Creation of a domestic power pool with a provision for wholesale and retail markets to create competition and thus reduce the cost of electricity.
- Privatization or concessioning of isolated power stations to reduce operating costs and thus free up resources for rural electrification expansion.
- Increasing lifeline tariff to domestic consumers of up to 50 kwh per month to at least cover the cost of generation.

Petroleum sub-sector

- Divestiture of government interests in oil refining and marketing, and eventually in the Kenya Pipeline Company (KPC).
- Promoting investments in oil refining, including supply and distribution of petroleum products throughout the country.
- Financing of strategic stocks by the government and the private sector, equivalent to 90 days demand in the medium to long term.
- Enhancing explorations for fossil fuels, particularly hydrocarbons, through sub-division of exploration acreage into smaller blocks and collection of additional geological agrochemical and geophysical data to attract more oil prospecting companies.

Renewable energy

- Designing incentive packages to promote private sector investments in renewable energy and other off-grid generation.
- Licensing charcoal trade.
- Providing requisite support for research and development in emerging technologies like co-generation and wind energy generation.
- Promoting co-generation in the country's sugar belt through an attractive bulk tariff regime.

Source: Government of Kenya (2004).

3. Addressing Energy Challenges: Lessons from Selected Countries

This section presents brief discussions of how South Africa, South Korea, Malaysia, United States, the European Union, Brazil, China and Ghana have surmounted and continue to deal with energy challenges. The lessons learnt are meant to inform how Kenya could achieve the target under Kenya Vision 2030 given that energy is a key component. The comparison is made according to energy sources, energy mix, demand/ supply, and policy and institutional frameworks.

3.1 South Africa

South Africa is the largest energy consumer and the second largest energy producer in Africa. It also has the second largest oil refining capacity in the continent amounting to 488, 297 barrels per day. In 2004, about 75.4 per cent of total energy consumption in South Africa came from coal, followed by oil (20.1%), nuclear (2.8%), natural gas (1.6%), and hydroelectric power (0.1%).[18] Eskom, a parastatal company, is one of the largest utilities in the world and generates nearly all of South Africa's electricity. Its 35,060 MW of nominal generating capacity, which is primarily coal-fired (34,532 MW), includes one nuclear power station at Koeberg (1,930 MW), two gas turbine facilities (342 MW), six conventional hydroelectric plants (600 MW), and two hydroelectric pumped-storage stations (1,400 MW). South African municipalities also own and operate 2,436 MW of generating capacity, and an additional 836 MW of generating capacity is privately held.

The country has a highly developed synthetic fuels industry supported by abundant coal resources, offshore natural gas and condensate production in Mossel Bay. South African Coal, Oil, and Gas Corporation (Sasol), with a capacity of 150,000 barrels per day, and the national oil company (PetroSA), with a capacity of 50,000 bbl/d, are the major producers of synthetic fuel in South Africa. Sasol is importing gas from Mozambique through a 536-mile transport pipeline, owned by a joint venture between Sasol, South African Government, and the Government of Mozambique. The country had 353 billion cubic feet of proven natural gas reserves by January 2006.[19]

[18] http://www.eia.doe.gov/emeu/cabs/South_Africa/Bacground.htm.
[19] http://www.eia.doe.gov/emeu/cabs/South_Africa/NaturalGas.htm.

Petroleum used in South Africa is mainly imported from Saudi Arabia and Iran.[20] As a move to diversify its sources of imported crude and reduce its dependence on the volatile Middle East, Nigeria is now the third largest supplier of imported oil. Other major oil sources include Angola, Gabon and Cameroon.

PetroSA has made oil and gas discoveries and the country had proven oil reserves of 15 million barrels of oil by January 2007. The government has been providing funds for exploration.

As part of its rural electrification programme, efforts are being made to provide rooftop solar power systems to rural areas. A 100 MW solar thermal power plant is planned for Upington in the Northern Cape for 2007. Other planned projects include a biogas initiative at several landfill sites throughout the country, wind farms near Darling in the Western Cape, and a small hydro plant in Bethlehem in the Free State.

South Africa's excess electricity capacity will likely be exhausted by 2011. However, if the country's economy grows at a higher rate than expected, capacity may be exhausted by 2007. In 2004, fears that electricity was becoming unaffordable for the poor forced the National Electricity Regulator (NER) to stop charging inflated electricity rates to generate income into new generation initiatives. The 2004 tariff rate of 2.5 per cent was set below the rate of inflation to ensure that electricity was affordable for everyone.

South Africa together with the Democratic Republic of the Congo (DRC), Namibia, Angola and Botswana are involved in the Western Power Corridor Project (WESTCO) that proposes to construct a 3,500-MW hydropower station at Inga Dam in the DRC and interconnected power lines.

In September 2003, the South African National Assembly passed the Petroleum Pipelines Bill, which plans for privatization of oil and gas pipelines and guarantees the future oil supply of the Natref refinery. Legislative amendments have been made to improve transparency in the petroleum sub-sector, govern fuel specifications, and allocate retail sites. In 2005, South Africa launched the National Energy Regulator of South Africa with a mandate to regulate policy over the entire energy industry and is responsible for implementation of the energy policy.

[20] As of 2004, crude oil imports were Saudi Arabia (43%), Iran (43%), Nigeria (7%) and others (7%).

3.2 South Korea

South Korea's rapid industrialization process over the past several decades has resulted in the country's industrial sector energy consumption increasing by more than 300 per cent, from 1.0 quadrillion (quads) in 1985 to 4.2 quads just over a decade later. The country imports all its petroleum requirements, most of it from the Middle East.

Coal is the second most prevalent fuel, although its usage has stayed relatively static as consumption of more environmentally friendly natural gas and non-carbon-emitting nuclear power have increased. Total power generation was 57 gigawatts in early 2003. The country uses a combination of thermal (oil, natural gas and coal), nuclear and hydro as sources of power. The country now has 20 operational nuclear power reactors that provide 40 per cent of the electricity requirements. It plans to build an additional nine nuclear plants by 2015.

Renewable energy, mainly hydropower, is slowly increasing in importance in South Korea's Alternative Energy R&D programmes focus on activities that will provide renewable energy technologies to the largest percentage of the population. The programmes aim to develop solar thermal energy, photovoltaic power and fuel cells in order to increase renewable energy in its total energy mix. The goal is to have solar, wind and tidal power provide approximately 5 per cent of total power generation by 2011. The government is giving subsidies to encourage the exploitation of wind energy in the country. Industrial energy conservation is also encouraged through tax credits for high efficiency technology conversions.

The power sector in the country has been liberalized. The power generation part of Korea Electric Power Corporation (KEPCO) was split into six separate subsidiaries in order to spur generation (Korea south-East Power Co. Ltd, Korea Midland Power Co. Ltd, Korea Western Power Co. Ltd, Korea Southern Power Co. Ltd, Korea East-West Power Co. Ltd, Korea Hydro and Nuclear Power Co. Ltd). KEPCO remains a transmission and distribution monopoly. It provides a number of public services such as campaigns to promote electricity savings and extensions to the grid to supply remote areas, which cannot be served profitably (UNEP, 2003). Legislation also established the Korea Power Exchange and the Korea Electricity Commission. However, complete liberalization was suspended in 2004, which would have meant selling all the generation subsidiaries (except the one of hydro and nuclear),

unbundling of distribution and establishing regional distribution companies. The prices of oil products have been deregulated except for LPG. The country's energy policy has been driven by consideration of energy security, and the policy is to continue to have nuclear power as a major element of electricity production.[21]

South Korean Government has established the National Vision for Environmental Policies in the 21st century. This policy framework emphasizes promotion of green development schemes, such as increased usage of photovoltaic power and fuel cells,[22] as well as the introduction of natural gas buses in large cities such as Seoul and Pusan. The government is using fiscal incentives such as exemption from value-added tax and acquisition taxes to promote the use of natural gas in the public transport system. Other measures include promotion of use of electric vehicles, raising parking fees and collecting tolls on high-traffic roads.

South Korean's total reliance on oil imports has led to a policy of securing and diversifying the oil supply. The country has both short-term and long-term strategies of meeting its oil requirements. In the short term, the country has a strategic reserve equivalent to 90 days, which is managed by the state-owned Korea National Oil Corporation (KNOC). In the long term, the country is engaging in international oil and gas exploration in Yemen, Argentina, Peru, Libya and Vietnam, among others.

3.3 Malaysia

The main sources of energy in Malaysia by 2005 were crude oil and petroleum products (50.8%), natural gas (39.9%), hydro (3.4%) and coal and coke (5.9%). Malaysia has approximately 16 GW of electric generation capacity, of which 87 per cent is thermal (mainly gas) and 13 per cent is hydroelectric. In 2003, Malaysia generated around 79 Bkwh of electricity. Expansion in the manufacturing and transport sectors increased energy consumption from 928.2 petajoules (PJ) in 1995 to 1,167.1 PJ in 2000. Primary energy demand is expected to grow from 56 Mtoe in 2002 to 147 Mtoe in 2030.

[21] http://www.uic.com.au/nip81.html.

[22] These are more promising forms of alternative energy. A fuel cell is similar to a battery but do not wear out. As long as there is a source of fuel, the fuel cell will produce electricity.

Malaysia has proven oil reserves of 3.0 billion barrels, down from a peak of 4.3 billion barrels in 1996. Oil production has been rising since 2002 as a result of new offshore development. In 2005, the country's total oil production averaged 871,000 barrels per day (bbl/d), up from an average of 860,000 bbl/d in 2004. The country's oil demand has been growing at a much slower rate than its economic output, due largely to the conversion of oil-fired power plants to natural gas. Petronas, the state oil and gas company, has embarked on an international oil exploration and production strategy. The country has secured several exploration acreages in Algeria, Angola, Chad, Gabon, Libya and Sudan, among others. Petronas has also invested in the extraction of coal in Indonesia.

The country has six refineries, with a total processing capacity of 544,832 bbl/d. The three largest are Shell Port Dickson refinery and the Petronas Melaka-I and Melaka-II refineries, which have capacities of 92,832 bbl/d and 126,000 bbl/d, respectively. With the rapid rise in crude oil prices over the last two years, Malaysia's subsidized prices for retail petroleum product sales have become quite costly for the government.

Malaysia has 75 trillion cubic feet (Tcf) of proven natural gas reserves. Natural gas production has been rising steadily in recent years, reaching 1.9 Tcf in 2003. Its consumption in 2003 was estimated at 1.0 Tcf. To develop oil and gas reserves in a sustainable manner, the country formulated the National Depletion Policy in 1980 that fixed the maximum daily oil and gas production levels.

Malaysia has set sustainable development and diversification of energy sources as the country's main energy policy goals. The Five-fuel strategy recognizes renewable energy resources as the fifth fuel after oil, coal, natural gas and hydro. The 9th five-year plan (2006-2010) stresses on security, reliability and cost-effectiveness of energy supply. The country is undertaking reforms in its power sector to make it more competitive and lower costs. Three major utilities, which dominate power generation and distribution in Malaysia, have been restructured and one of them privatized. The market was opened to independent power producers (IPPs) in 1994. Bio-diesel was recently introduced and is expected to be enforced by 2008 through compulsory blending 5 per cent of biofuel with diesel.

The energy price is low in the country due to subsidies by the government. While the prices are not expected to increase dramatically, the government has already put in place measures to promote energy

efficiency and energy conservation that will include the industrial sector as long-term efforts. Renewable energy is being promoted through fiscal incentives such as exemption of income tax and import duty and sales tax exemption on imported hardware. Research and Development (R&D) has been ongoing focusing on product innovation, palm diesel, renewable technologies, hydrocarbon exploration and enhancement of fuel cell performance.

3.4 United States

The United States is the largest energy consumer in the world, with primary energy consumption in 2001 accounting for 24.5 per cent of the world total at 2,237 million TOE. Most of the electricity in the country is generated from coal plants (the country is self-sufficient in coal, which is a cheap source of electricity). The country also derives energy from nuclear power, which can yield large volumes of power that is relatively cheap with lower negative environmental effects. It also has a well-developed hydro-generation component and imports power from Canada as well.

Energy conservation is being promoted in the country through the use of speed limits on highways, fuel-efficient cars, better insulation of houses, and more energy efficient end-use appliances. The use of hydrogen where cars and factories are powered by fuel cells is being considered, where to generate large volumes of hydrogen, electricity is used to electrolyse water. Other plans include increased use of renewable energy such as solar, wind and methane. To promote the use of renewable energy, a range of incentives have been proposed. These include tax breaks for small, decentralized micro generation, solar panels on roofs, and establishment of windmills.

A new energy policy (Energy Policy Act of 2005) was enacted. Efforts to increase the use of biofuels (ethanol and bio-diesel) are being stepped up. Opportunities are large due to food supply surplus. There are legislative proposals to increase the use of ethanol up to 25 per cent. However, biofuels require a large amount of land and are thus expensive to produce. Biofuels are meant to supplement (augment) but not replace fuel consumption.

Recently, the government came up with the twenty in ten, an ambitious goal to help reduce America's dependence on oil. The plan seeks to reduce the country's dependence on oil by cutting petroleum

consumption by 20 per cent in the next 10 years, encouraging the use of fuel efficient cars (e.g. hybrids) through tax credits, promoting research on alternative fuels like biofuel, stepping up domestic oil production, doubling current capacity of petroleum strategic reserves, addressing energy security and climate change, and investing in clean-coal technology, wind, solar energy and safe nuclear power.

3.5 European Union

In the European Union (EU), member countries are pursuing various strategies. With no domestic oil production, France has relied heavily on the development of nuclear power, which accounts for about 80 per cent of its electricity. Denmark, Germany and Spain rely heavily on wind energy as a source of electricity. In 2002, Germany passed a law for a phase-out of nuclear energy; the country plans to raise[23] the share of renewable sources to 27 per cent of all energy sources by 2020. The EU recently set a goal that 22 per cent of all electricity and 12 per cent of all energy will be from alternative sources by 2010.

Natural gas and oil dominate the United Kingdom (UK) primary energy supply with an aggregate total of 74 per cent. The country is the largest producer of oil and gas in the EU. It also has coal reserves. Coal and nuclear provides 17 per cent and 7 per cent of total energy, separately. Renewable sources (2%) have increased significantly, although the share is still below the EU-27 average (6%). In 2004, the UK became a net energy importer for the first time since 1993 (although still remaining a net exporter of oil and still maintaining one of the lowest import dependencies in the EU-27). In 2004, gas accounted for 40 per cent, coal (33%), and nuclear accounted for 20 per cent in electricity generation.

In the UK, there is debate on the provision of energy while addressing climate change concerns. The primary focus is the need to shift the country decisively to a low carbon economy to address the concerns of climate change while at the same time addressing the implications of reduced domestic production of oil, coal and nuclear energy. The electricity sector was restructured in 1990 in which the state-owned central electricity generating board was divided into the National Grid

[23] "Cloudy Germany is a solar power hotspot", *East African Standard*, Tuesday, 31 July, 2007, p. 21.

Company, responsible for transmission, and three generating companies.

Efforts are being made to reduce carbon dioxide emissions in the EU by 60 per cent by 2050 through improved energy efficiency combined with use of renewable energy and gas fired power stations to replace nuclear power and for coal electricity generation, together with a move towards more efficient vehicles, low carbon fuels and hydrogen for transportation. Renewable energy is expected to satisfy about 10 per cent of electricity demand by 2010 and 20 per cent by 2020.

Other *strategies* being pursued include: demand management, substitution of energy delivery by hydrogen technology, boosting renewable sources of energy by obligating electricity suppliers to source 3 per cent of their electricity sales from renewables, giving financial mechanisms, continuing the production of nuclear power by adopting better technologies, and innovations in the transport sector such as use of hybrid vehicles.

3.6 Brazil

In 2001, Brazil consumed about 8.8 quadrillion Btus (quads) of energy. Petroleum accounts for about 51 per cent of the country's total energy consumption, with the others consisting of: hydroelectric power, 31 per cent; renewable energy sources, 13 per cent; natural gas 4 per cent; and, nuclear 1.7 per cent. The country has its own oil, coal and natural gas reserves although it imports to supplement. Its proven reserves were estimated at about 11 billion barrels of oil, 11 trillion tcf of natural gas and 11 billion short tons of coal as of January 2005 (1 metric ton=1.1023 short tons). Petroleum demand is held down by policies requiring 25 per cent blending of ethanol in the fuel mix. Sources of electricity in the country are coal and hydropower, with the latter being dominant (85%).

Brazil, the most successful country in biofuel production, is using 50 per cent of its yearly sugar cane production to satisfy 40 per cent of its automobile fuel needs while fast felling down trees to grow more soybeans and sugar cane. This, however, raises concern of the impact of this approach on deforestation.

Energy demand in the country is estimated to be growing at 3.5 per cent annually. The projected demand is to be met through construction of five nuclear power 1,000 MW plants, large hydroelectric projects

adding about 88,000 MW, micro-hydroelectric projects adding 7,800 MW, expansion in natural gas, steady increase in the use of wind energy, and major expansion in bio-diesel. The country is also pursuing energy integration with neighbouring countries such as Argentina, Bolivia and Venezuela for gas and electricity supply.

Since the mid-1990s, the Brazilian energy sector has undergone structural changes. In the oil sector, there has been auctioning off of exploration blocks and the transfer of a growing share of Petrobras into the hands of the private sector. In the power sector, virtually all distribution capacity has been transferred to private ownership while a substantial size of the generation capacity has been sold to both domestic and foreign investors. However, transmission and distribution remain regulated, with provisions for open access.

Incentives such as guarantee of power sale contracts at given prices have been offered to stimulate development of biomass co-generation, wind and small hydro generators. Brazil passed a law in 2000 creating a national fund to facilitate investment in public energy efficiency and energy R&D. Utilities have been mandated to invest 0.5 per cent of their revenues for energy efficiency and energy R& D while 0.5 per cent is to be transferred to the national fund. So far, utilities have invested almost US$ 180 million in R& D programmes since 1998 (Jannuzi, 2005).

3.7 China

China is richly endowed with energy resources, but due to the rise in energy demand driven by economic growth, it became a net energy importer in the early 1990s. The country is ranked second in primary energy consumption, consuming 9.2 per cent of the world's total (Hyun-jae, 2003). In 2002, China consumed 998 million tonnes of oil equivalent, which grew by another 15 per cent in 2003.

The country has reserves of oil and coal. Coal accounts for 75 per cent of the total commercial energy supply in China. About three-quarters of electricity is produced from coal. The use of nuclear power is increasing with the country constructing two to three nuclear plants every year until 2020. Nuclear power is planned to increase by a factor of five to 32 GW by 2020, using the latest pebble bed reactor technology. Major hydropower projects are being developed with the 18.2 GW Three Gorges dam on the Yangtze River planned for commissioning in 2009. Hydroelectric capacity in China is planned

to increase from 108 GW in 2004 to 246 GW by 2020 and contributes 25 per cent of the nation's requirements.

Nevertheless, China also imports petroleum products due to its huge demand for energy. Its oil import dependency on the Middle East is projected to increase from 46 per cent in 1999 to 67 per cent in 2025. The country[24] has set out to reduce energy consumption by shutting down factories that consume high levels of electricity and fossil fuels. It has also started an emergency oil stock programme (Hyun-jae, 2003). Construction of a storage facility in the eastern province of Zhejiang begun in 2003 (WEC, 2005).

China's strategic approach to energy security includes strengthening bilateral ties with regional producers and acquisition of rights and businesses in other countries, including Kenya, by Chinese oil companies.[25] The country has a new energy policy that has a great commitment to energy efficiency and reduction of energy intensity in the economy.

The country is making efforts to promote the use of renewable energy supplies. Currently, the government is drafting a bill to promote the use of renewable energy, which is expected to be enacted by the end of 2007.[26] The target is to generate 15 per cent of China's energy requirement by 2020 from renewable sources. Projects include solar, biomass and especially wind. Power companies with an installed capacity of more than 5 GW will have to ensure that 5 per cent of output is powered by renewable sources by the year 2010. This figure will increase to 10 per cent by 2020. Government incentives include tax concessions and subsidies to offset investment costs and the companies will also be allowed to charge higher tariffs for renewable supply sources.[27]

3.8 Ghana

The total electricity generating capacity in Ghana is about 1,650 MW comprising 1,100 MW of hydro and 550 MW of thermal.[28] The power system in Ghana is run by two utilities: the Volta River Authority and

[24] Fidel Castro, "Ethanol production isn't as good as it sounds", *East African Standard*, Monday, 16 April 2007.
[25] http:/www.iias.nl.
[26] http://www.chinadaily.com.cn.
[27] http://www.sacu.org/cifsf.html.
[28] http://www.energymin.gov.gh/electricity.html.

Electricity Company of Ghana . The former is responsible for generation and transmission of electricity and supplies electricity in bulk to ECG, which is responsible for distribution of electricity throughout the southern part of the country. VRA also distributes power in northern Ghana through its subsidiary—Northern Electricity Department.

There are two regulatory bodies established by Acts of Parliament—the Energy Commission and the Public Utilities Regulatory Commission —to ensure the proper functioning of all players in the energy sector and to create a conducive environment for protection of private investment in the sector. Ghana, in conjunction with Benin, Togo and Nigeria are involved in a joint West African Gas Pipeline Project[29] to source natural gas from Western Niger Delta.

The petroleum industry has been liberalized since 2005 but the activities of oil marketing companies and other distributors are subject to oversight by the National Petroleum Authority. This is a state-run company that manages petroleum strategic reserves in the country.

3.9 Key Lessons

These model countries still have considerable energy challenges. Most of them rely on cheaper sources of electricity such as coal and nuclear, have their own domestic sources of petroleum and gas, and are also undertaking further exploration both locally and internationally. Co-operation in energy provision and diversification of importing sources of petroleum products are also being pursued to increase energy security. The use of renewable sources of energy is still lagging behind although there are ongoing efforts (largely fiscal incentives) to increase their energy share.

Denmark, Germany and Spain rely on wind energy and they have been able to do this through generous government subsidies. With the exception of Malaysia and South Africa, nuclear energy is a significant share in the energy mix. Brazil is the most successful with biofuel but this has come from use of compulsory legislation in blending. The US is also considering legislations and a package of incentives to increase production and use of biofuels.

[29] http://www.energymin.gov.gh/explration.html.

Most of the countries selected are also supporting programmes in energy conservation, efficiency and Research & Development (R&D). Considerable changes in policy, legal and regulatory frameworks have been undertaken to stimulate private sector participation and increase efficiency. However, results are mixed as to what are the optimal arrangements of institutional and legal framework. China, for instance, does not have a ministry of energy while South Korea halted the privatization of the power sub-sector in 2004. State involvement in the energy sector is still dominant in Brazil, Malaysia, South Korea, South Africa and China.

4. A SWOT Analysis of the Energy Sector

The energy sector in Kenya has some strengths, weaknesses, opportunities and threats. These are discussed below to understand how the sector is prepared or otherwise to realise the ambitious Vision 2030.

4.1 Strengths

Based on the SWOT analysis, various strengths were identified. These include energy consumption levels; regulatory reforms; exploration efforts; biofuel efforts; co-generation, wind and solar; afforestation, re-afforestation and agroforestry; and energy conservation and efficiency.

Energy consumption levels

Kenya has relatively been able to meet her energy needs. This is in sharp contrast to Uganda and Tanzania that have been undertaking a crippling power rationing programme that does not have an end in sight. The last time Kenya experienced unprecedented power shortages was in 1999 and 2000.

Per capita consumption of power in Tanzania is 46 kwh[30] compared to Kenya's 121 kwh. Only about 3-5 per cent of the population in Uganda[31] has access to electricity compared to Kenya's 15.3 per cent. Kenya accounted for almost 60 per cent of commercial energy consumption in the Great Lakes Region in 2001.[32] In the same year, Kenya consumed 3.98 Bkwh, Tanzania 2.75 Bkwh and Uganda 1.62 Bkwh. Total electricity generation in these countries was estimated at 4.033 Bkwh, 2.905 Bkwh, and 1.928 Bkwh in 2001, respectively. The installed grid capacity (MW) by 2003 were: Kenya 1,160, Tanzania 863, Ethiopia 450, Uganda 240, and Eritrea 60 (ESDA, 2003c).

Policy, legal and regulatory reforms

A number of proactive measures have been undertaken to address energy challenges in Kenya. These measures include: revamping KPLC management, publication of Sessional Paper No. 4 of 2004 on Energy,

[30] http:// www.areed.org/country/tanzania/energy.pdf.
[31] http://www.eia.doe.gov/emeu/cabs/eafrica.htm.
[32] http://www.eia.doe.gov/emeu/cabs/eafrica.htm.

the general development of the sector under the World Bank-funded Energy Sector Recovery Project, and the enactment of the Energy Act 2006.

The new Act will establish the Rural Electrification Authority that will spearhead and fast-track implementation of rural electrification schemes. In addition, a geothermal development initiative has been enhanced to achieve sustainable electricity supply. The private sector participation in the energy sector is strong with four IPPs already engaged in generation. KenGen has already been listed in the Nairobi Stock Exchange and is one of the profitable and respected companies in Kenya's corporate scene. The Department of Renewable Energy in the Ministry of Energy is currently developing a biofuel strategy in collaboration with stakeholders. Energy centres have also been established to promote the use of renewable energy technologies.

Exploration efforts

There are ongoing explorations for oil and gas, coal and geothermal. Kenya has currently no oil and gas production. Even though there has been no commercial discovery, there are positive prospects. In 1982, the Petroleum Exploration and Production Act, Cap 308, was enacted to govern petroleum exploration and improve incentives to companies involved in exploration. The period beginning 1983 saw significant exploration activities with five of the offered blocks taken up by oil companies, leading to the drilling of 12 wells by 1993.

The period between 1993 and 1999 registered low exploration activities mainly due to depressed international crude oil prices, which made it unattractive for prospecting companies to venture into areas perceived to be marginal. Most of the exploration activities undertaken during this period largely consisted of collection and analysis of primary data by the National Oil Corporation of Kenya.

Kenya has indications of good petroleum potential with four large-sized sedimentary basins believed to hold hydrocarbons. These are:

(a) Anza Basin, which covers nearly the entire North-Eastern province and a sizeable portion of Eastern Province;

(b) Mandera Basin, which borders the Ethiopian and Somali basins;

(c) Tertiary Rift Basin, which covers the Turkana area and some portions of Western Province; and

(d) Lamu Basin, which covers Kenya's coastal area and the Indian Ocean.

The sedimentary basins are divided into 9 exploration blocks, covering a total of 325,060 km², some of which are leased.

Since the year 2000, exploration activities have picked up markedly and three Production Sharing Contracts (PSCs) are currently in operation in the Lamu Basin. Some of the companies that have signed oil exploration agreements with the Kenya are from Australia and China. Other ongoing activities in exploration include acreage promotion through sale of geological data to prospective oil companies, exhibitions at international geological seminars and conferences, and advertisements in selected petroleum publications with wide international readership and on the Internet. Basin-to-basin studies are also being undertaken by NOCK through limited consultancies in specialized areas. These activities are meant to minimize risks to potential oil prospecting companies by providing primary data on source rock formations in all sedimentary basins in the country.

Kenya also has no known commercial coal deposits. Exploratory drilling has been in progress in Mui Basin in Kitui and Mwingi Districts and Taru basin in Kwale and Kilifi districts. Preliminary findings in Kitui/Mwingi have been encouraging although a lot more work remains to be done. Estimates show that the coal deposits could generate Kenya's electricity needs for the next 35 years.

Exploration for geothermal energy is also ongoing in the high potential areas of the Rift Valley. KenGen has conducted surface scientific studies in Suswa, Longonot and Eburru and Menengai. Six exploratory wells were drilled at Eburru. More exploration work is ongoing in the Lake Baringo area. Other high potential areas earmarked for further exploration include Silali, Emurauangogolak, Paka, Korosi, Barrier volcanoes and Arus—Lake Bogoria.

Biofuel

There are plans for the introduction of bio-diesel in the refinery/blending of public transport fuels in Kenya. *Jatropha Curcas*, locally known as "mbariki", is a plant whose seeds have the potential to produce bio-

diesel. This form of diesel has been around for a while and is being used by small firms/enterprises for different purposes. Attempts on biofuel in the past by Agro-chemical and Food Complex in Muhoroni[33] and the Kisumu Molasses plant were not successful. By then, the government was subsidizing operations of the former to produce gasohol (10% alcohol, 25% regular petrol and 65% super petrol). As the price of petrol became cheaper, it was no longer viable. The two plants still produce power alcohol, which is exported.

Several initiatives are being undertaken by many organizations to promote the production of biofuel in the country, such as Green Africa foundation,[34] Vanila Jatropha Development Foundation, and Energy for Sustainable Development Africa Ltd, among others. The government has pledged to support all initiatives geared towards the production of bio-diesel.[35] In this regard, the Department of Renewable Energy, with the collaboration of stakeholders, is developing a biofuel strategy.

Nevertheless, liquid biofuels are still relatively minor sources of energy use and are produced in a few countries. Brazil and the United States are the largest producers of ethanol for transport, accounting for about 90 per cent of world production (Hazell and Pachauri, 2006). Both countries currently produce about 16 billion litres per year, and ethanol has displaced 40 per cent of petroleum use in Brazil, but only 3 per cent in the United States. The primary source for ethanol is sugar cane in Brazil and maize in the United States. China, India and Thailand are also main players in biofuel.

However, despite the exciting prospects for biofuel, many important questions remain unresolved about its implications for the poor, food security, the environment and international trade. For instance, an increase in the production of biofuel would imply putting more land under oil crops. This may have negative repercussions to the environment and also food security. Besides, in areas with insecure land tenure, the poor may be dispossessed of land, with the result that poverty and food insecurity may increase. Use of maize as a source of biofuel

[33] The company produced gasohol for about 10 years.

[34] Martin Mutua, "Japanese officials visit bio-diesel seed farm", *East African Standard*, Thursday 7 September 2006, p. 18.

[35] Elizabeth Mwai, "Firms explore bio-diesel option", *East African Standard*, Tuesday, 22 August 2006, p. 7.

may lead to a rise in maize prices, which is major staple food in the country.

Co-generation, wind, and solar energy

Co-generation using bagasse as a primary fuel is common practice in the domestic sugar industry in Kenya.[36] The industry comprises seven sugar companies producing an average of 1.8 million tonnes of bagasse with fibre contents of about 18 per cent by weight annually. Out of this quantity, about 56 per cent is used in co-generation using an installed capacity of 25 MW and the balance disposed at cost. Mumias is the only sugar company among the seven factories that is self-sufficient in electricity production and has the capacity to export about 2 MW of surplus power to the national grid.

The potential for electricity generation from bagasse has been estimated at 300 MW for the seven existing sugar companies at the current capacity. Co-generation is significant in other countries. In China in 1993, for instance, it accounted for almost 12 per cent of installed thermal power generation capacity.[37]

Kenya has a proven wind energy potential of as high as 346 W/m² in some parts of Nairobi, Eastern, North Eastern and Coast Provinces. With improved technology, this wind energy can be harnessed especially in those areas that are far off from the national grid.[38] The Ministry of Energy, with the assistance of Denmark, recently completed preparing a broad National Wind Atlas. The government is also promoting the development of wind-diesel hybrid systems for electricity generation.

There is potential too with solar energy. The country receives all year round solar insolation coupled with moderate to high temperatures estimated at 4-6 kwh/m²/day.

Afforestation, re-afforestation and agroforestry

Civil society organizations and non-governmental organizations have been spearheading efforts to encourage the adoption of agroforestry technologies

[36] Simultaneous production of heat and electricity.

[37] www.pnl.gov/aisu/pubs/roadmap.htm

[38] The major draw back with this effort is the intermitting nature of this energy source.

and establish woodlots. Supply enhancement initiatives such as afforestation and re-afforestation are also being done. With efforts being spearheaded by World Agroforestry Centre and a number of civil society organizations, this provides an avenue for increased biomass energy supply.

Compared with China, Kenya's afforestation efforts are miniscule. In the past two decades, over 35 billion trees have been planted in China.[39] At present, the total area afforested by aerial sowing has reached 8.68 million hectares. Currently, the forest coverage rate has increased to 16.55 per cent.

Energy conservation and efficiency

There have been ongoing efforts on energy conservation and efficiency, which have the potential of reducing overall energy demand and, therefore, costs of production. GEF-KAM project, an initiative under the Kenya Association of Manufacturers, aims to remove barriers to energy conservation and efficiency in SMEs. Through this project, a national Energy Management Award Scheme was launched, and certified energy managers have been trained. With adoption of new end use technologies, energy conservation and efficiency can be achieved and the use of energy conservation bulbs is a case in point. The end use technologies include those relating to industrial boilers, furnace and kiln as well as electrical equipment, gas cook-stoves, electric stoves, kerosene stoves and improved charcoal stoves.

There is considerable potential for technology improvements in Kenya, especially for small and lighter cars, low or zero emission vehicles, and hybrid cars. Energy efficiency in the transport sector is also increasing gradually.

Improvement of roads, construction of by-passes and generally decongestion measures such as promotion of non-motorized transport, restricted zones in the city centres, and land-use planning, complemented by efficient mass transit systems are also expected to lower fuel consumption in the transport sector.

[39] www.china.org.cn/english/features/38276.htm

4.2 Weaknesses

Weaknesses within the energy sector in Kenya include the following: high cost of energy, high cost of energy investments, low access to modern energy services, inefficiency, inadequate data, inadequate capacity, inadequate legal and regulatory framework, and environmental degradation.

High cost of energy

The high cost of energy is one of the biggest bottlenecks to economic activity in the country (KIPPRA, 2005). The country continues to lose investments to other countries partly because of this problem, with considerable cost on socio-economic development.

The cost of power in Kenya is much higher than in Egypt, South Africa and Ethiopia. Kenya's power costs about US 9 cents/kwh compared to Egypt's US 4 cents/kwh, Ethiopia's US 3.9 cents/kwh and South Africa's US 2 cents/kwh (Kamfor, 2002). The low cost of power in other countries is due to government subsidies, use of cheaper sources of electricity (such as coal and natural gas), and use of large hydro-electric plants that have already repaid investments costs because they were established many years ago.

A recent study shows that indirect taxes on KPLC and existing IPPs increase electricity retail tariff by Ksh 0.06/kwh, excluding value added tax (VAT) and Ksh 0.87/kwh including output VAT, respectively (KIPPRA, 2006). Kenya's household tariffs are almost two times those of South Africa and almost three times those of India (see Annex 2; KIPPRA, 2006). The same study shows that industrial electricity tariffs were 77.4 per cent cheaper in South Africa than in Kenya over the 1997-2005 period (Annex 3). This pattern is also observed with respect to South Korea and Thailand at 32.6 per cent and 23.8 per cent, respectively.

As a result of high retail electricity tariffs, there has been a significant increase in power thefts and this has impacted negatively on KPLC's revenue. The default rate has also been on the increase due to falling consumer incomes experienced during the period 1997-2005. These factors have negatively affected the ability of KPLC to strengthen its transmission and distribution systems, thus further contributing to its

losses. Consumer tariffs are also high largely due to operational inefficiencies and high taxes (e.g. VAT at 16%).

The average price of electricity is expected to increase because new power development is carried out on the basis of a rolling 20-year Least Cost Power Development Plan.[40] The Plan requires that the next least cost project be brought into production. This has implications on future tariffs, which are likely to increase over time,[41] and it also means that new sources of electricity to be developed are likely to be more expensive than those already developed *ceteris paribus*.

The problem of high cost is compounded by unreliability of supply. On average, Kenyan firms lose 9.5 per cent of total output because of power outages and fluctuations. This loss excludes the loss from damaged equipment as a result of power interruptions, which for some firms averaged Ksh 1 million in 2001.

Petroleum prices are also very high in the country given the high taxation of petroleum products. For example, taxes and levies account for 33.9 per cent and 29 per cent of the pump prices of premium motor spirit and diesel products (KIPPRA, 2006). Diesel in Malaysia, China and Egypt has been found to be 71.1 per cent, 44 per cent and 87 per cent cheaper than in Kenya, while premium motor spirit is about 60 per cent, 48 per cent and 70 per cent cheaper, respectively (KIPPRA, 2006). Along with this, the market structure for the petroleum sector is not adequately competitive and the cost is, therefore, high (KIPPRA, 2006). The entry into the market by many small-scale fuel suppliers has injected some competition in the market. There have been, however, some complains that some of the small-scale suppliers adulterate fuel.

High dependency on imports coupled with the sensitivity of domestic prices to changes in the international oil market have led to increasing oil prices. This is likely to have considerable negative consequences given that the current level of oil dependence is high (at 3.5% of GDP) and is likely to rise further as the country industrializes (EAC, 2006). The problem of high oil prices tends to increase production costs of electricity.

[40] This is a national electric power development plan showing an array of viable power projects starting from the least cost to the most expensive.

[41] Even the line power tariff will be adjusted to reflect the cost of power generation. The subsidy will only remain for the category of consumers that use up to 50 kWh. The rest will have to pay a price of Ksh 6.65 for the first 50 units consumed, for which they had previously been charged only Ksh 1.55. Even KPLC employees who have been enjoying a subsidy will now have to pay unless the company pays for them. Likewise, KPLC installations will also pay at the commercial and industrial rates (ERB, 2005).

Likewise, the price of Liquefied Petroleum Gas (LPG) is high, and therefore reflecting its low use nationally. A policy geared towards the removal of taxes on all LPG-associated cooking appliances will enable those in the low-income bracket to acquire them.

High cost of energy investments and inadequate financing

The energy sector is faced with high investment costs. For instance, about US$ 2 million are required to put up a hydropower plant to produce 1 MW of electric power. Current estimates show thatKenya requires US$ 1 billion (about Ksh 70 billion) to produce about 500 MW. Installations costs are also high at Ksh 180,000 per consumer in the rural areas. It is also very expensive to drill test-wells in the course of oil exploration. It costs Ksh 400 million (over US$ 5 million) to drill one well.

With the changes provided in the Energy Act 2006, oil marketers may be forced to merge in order to survive. Current estimates show that it costs about Ksh 70 million to set up a fully-fledged retail outlet that meets the standards as stipulated in the law.[42] For an oil company to break even and have an impact, it may have to control at least 10 per cent of the market.

Moreover, the country does not have strategic petroleum reserves. Essentially, Kenya ought to have emergency oil stocks to last about 90 days of consumption. However, oil companies are mandated to maintain a minimum of 20 days operating stock. This is due to high storage costs, limited capacity of the oil storage facility at Kipevu, limited processing capacity of Kenya Petroleum Refinery Limited (KPRL), and tying up of capital. Oil companies are thus forced to tender for the importation of crude oil on a monthly basis in the spot market.

A related problem is the inadequate financing of energy investments. Investment requirements in the energy sector are large and meeting energy investment needs is a problem in Kenya. Given the limited public budget, the country should rely on increasing the share of private sector investment. However, governments face challenges in attracting energy sector investments that can provide energy at a reasonable cost. Besides, investments in energy projects have to compete with equally deserving development and social projects.

[42] Mwaniki Wahome, "Doing the sums on oil sales: A draft Bill may rock the industry further after the pullout by Mobil." *Daily Nation*, Tuesday 7 November 2006.

Investments in the energy sector have generally been very low in Kenya. In comparison, the power sector as a percentage of GDP has been estimated to be above 3 per cent for China and Thailand, below 2 per cent for South Korea, and below 1 per cent for the US over the period 1981-1999 (APERC, 2003). Investments requirements in the power sector for 2006-2026 as a percentage of GDP are about 0.01 per cent for Kenya,[43] which is very low compared to the 2000-2020 estimates for China (2.62%), South Korea (1.27%) and the US (0.28%).

Despite liberalization of power generation, the country has experienced serious difficulties in attracting private sector investments as well as serious delays in concluding power purchase agreements with successful IPPs. These resource mobilization constraints have contributed to electricity deficits under dry hydrological conditions, with negative impacts on the performance of the economy. Moreover, the IPPs tariffs have been higher than expected due to poor response by the private sector during international bidding. A similar problem of inadequate financing is evidenced with the ongoing oil exploration in the country where only foreign companies are involved.

Inadequate access to modern energy services

About 15.3 per cent of the population in Kenya has access to electricity, with 46 per cent for urban areas and 3.8 per cent for the rural areas (Kamfor, 2002). However, current estimates show that the access rate is 6 per cent in rural areas. This is among the lowest in developing countries, which have an average of 32 per cent (SOE, 2004). In Ghana for instance, 80 per cent of the population have access to electricity, while in South Africa it is 66 per cent (ESDA, 2003c); and 98 per cent in China (WEC, 2005).

Electricity consumption per capita is low in Kenya at 121 kwh against 1,969.5 kwh in Brazil, 12,235.1kwh in the US, 768.5 kwh in China and 4,11kwh in India.[44] In South Korea, per capita consumption in 2002 was 6,172 kwh.[45] Those without access to electricity in Kenya have opted for batteries and generators. About 8.5 per cent of the households use batteries (Kamfor, 2002), which are expensive and have disposal

[43] This is from estimates provided by the Least Cost Power Development Plan.
[44] www.un.org/esa/ffd/Multi-StakeholderConsultations/NGOs Andre%20Felipe%20Simoes.ppt.
[45] http://www.uic.com.au/nip81.htm.

problems. Petroleum generators are also being used in rural and peri-urban areas.

The inadequate access to electricity in the rural areas has not changed much despite the existence of the Rural Electrification Programme (REP) that was set up in 1974. The Programme is constrained by low funding although it collects almost Kshs 1 billion annually in the Rural Electrification Fund. The Fund lacks transparency and accountability, makes no provision for urban poor or social utilities, and has failed to deliver services.

For the petroleum sub-sector, access problems are brought by limited supply facilities for fuels including LPG, domestic production of motor fuels, which do not meet international quality standards, inadequate distribution infrastructure in the remote parts of the country, and an oligopolistic market. LPG is not widely used with only 7.8 per cent (23% urban and 1.8% rural) households using it (Kamfor, 2002). The average per capita consumption is only 3.6 kg and 9.7 kg for rural and urban areas, respectively.

System losses and other energy use inefficiency

Available figures show that loss in distribution is not so much dependent on the source of electricity but on the distance and linkage between the generation and demand (or load) areas. The main generation areas are Mombasa, along the Tana and Turkwel Rivers, and Naivasha, while the main load areas (or consumption areas) are Nairobi, Eldoret, Kisumu and Nakuru. These distances are significant and, given the state of the transmission system, substantial losses are incurred. The situation is worse during the dry season when power has to be transmitted all the way from Mombasa as the amount of electricity generated from the dams along the Tana River declines. Scattered urban centres and villages in the country also make it expensive to connect to the national grid.

Taking this into account, the 2006 losses for KPLC are estimated to be 18.2 per cent, which are high compared to the average worldwide losses in transmission and distribution of about 10 per cent. These losses have been estimated at 7.2 per cent for the USA in 1995, 7.4 per cent for the UK in 1998 and 7.18 per cent for China in 2005. KPLC plans to reduce

system losses to 15 per cent by 2007 and to 12 per cent by 2025.[46] However, the losses are much higher in India (27%) and Nigeria (33%) (IEA, 2002). There is also the problem of voltage fluctuations and intermittent power outages at 11,000 per month, which cause material damage and loses in production (Government of Kenya, 2004). Connecting co-generated electricity from sugar companies to the national grid is also problematic. There is an inherent weakness with the connection that needs to be overcome in order to exploit the existing potential from sugar companies.

Inadequate long-term planning

Empirical studies at the country level are needed to establish demand and supply trends, emission levels, access and affordability, impact on environment, inequality and poverty. These need considerable data, which is not available in the form and adequacy needed. Lack of quality, timely and regular data/information usually leads to poor planning, monitoring and evaluation. In addition, environmental sustainability indicators need to be established. The Kenya National Bureau of Statistics has financial and human capacity constraints in the collection of adequate data in the country.

There is an associated problem of data storage. Some of the national data centres have inadequate physical facilities and obsolete systems. They not only lack back-up systems, but they also use incompatible data formats. There is, therefore, need for institutional linkages and networking. Other issues on data include duplication of effort in data collection and generation, weak co-ordination and linkages between the data institutions and users of the information.

There is also paucity of data on aggregate and sectoral energy needs. This has been aggravated by the use of energy planning models that not only rely on questionable data, but also were developed for countries with very different energy dynamics. At the same time, Kenya has historically failed to undertake comprehensive energy planning. It is only in the past few years that energy has received the attention it

[46] KPLC has invested a total of Ksh 285 million in reinforcement and expansion of the transmission system. They also undertook a $153 million Distribution System Reinforcement and Upgrade under the donor-funded Energy Sector Recovery Project (ESRP). This project aims to improve efficiency, reliability and the quality of supply, as well as increasing access to electricity.

deserves in national planning. Unfortunately, some of the poor quality data is still being used in the planning processes today, re-emphasising the need to establish quality databases.

The basis for power development planning has been a twenty-year rolling Least Cost Power Development Plan (LCPDP) revised annually to take account of new information. However, because of resource constraints, the LCPDP updates have hitherto tended to rely on inadequate information on economic costs for developing both geothermal and hydropower projects.

Data on biomass resources in the country is limited. The true status of biomass resources is unknown and official data collection efforts are weak, non-existent or outdated. Data needed for planning is not easily accessible in one place and this has hampered the development of an effective policy. Information is scattered among non-governmental organizations, the Forest Service Authority, and private biomass companies.

Inadequate capacity

Capacity limitation is a serious problem faced by many institutions within the energy sector. With the increase in the number of oil trading companies, adulteration of motor fuels (i.e. petrol or petrol oil mixed with kerosene), which is done for financial gain has been on the rise. This poses a problem to the consumer in terms of vehicle breakdown and associated high cost of maintenance, and also erodes government's revenue as kerosene attracts lower duty and taxes than the other two products.

The Kenya Bureau of Standards (KEBS) under the Standards Act is mandated to deal with problems of this nature. However, KEBS does not have adequate resources to address the menace. The government, as a temporary measure, has engaged a private inspection company to assist in the detection of adulterated fuel through a fuel marking mechanism . The challenge is, therefore, to enforce the Petroleum Act, Customs and Excise Act and the Standards Act to ensure that the consumer gets quality fuel commensurate with value for money and the government does not lose revenue.

Lack of capacity also constrains KenGen and KPLC to improve electricity generation and distribution to meet the increasing industrial and residential demand. ERC is also facing constraints in discharging its regulatory mandate in the power sub-sector. The goal of connecting a minimum of 150,000 new consumers per year to the electricity grid, expansion of the rural electrification programme, and investment in upgrading and strengthening the national electricity grid are some of the capacity constraints. With the growing demand (peak power demand is about 1,050 MW)[47] amid limited supply capacity, the country is likely to be plunged into darkness should it be necessary to shut down any plant for maintenance. The reserve capacity has seriously been eroded to below 7 per cent against the 15 per cent industry standard.

The supply problem in the country is particularly acute during drought when dam reservoirs are low, and when some of the hydroelectric generating plants break down or are out of service for maintenance (Kamfor, 2002). Part of the problem is related to the challenges faced by KenGen, KPLC and ERC. KenGen is facing challenges ranging from inadequate funding for new power projects, shortage of manpower, high cost of desiltation of power dams, changes in weather, over-reliance on a single customer, use of obsolete equipment, and high cost of equipment. For KPLC, the constraints include high system losses, high overhead costs and persistent power outages. Shortage of power economists, environmental experts, and general capacity limitations are some of the limitations faced by ERC. Inadequate funding and capacity also explains low exploration efforts by NOCK.

The Kenya Pipeline Company (KPC) is also facing capacity problems in meeting the surging demand for petroleum products in the western region of the country and demand from Uganda, Rwanda, northern Tanzania, Burundi, eastern Democratic Republic of Congo, and Southern Sudan. The company is also facing stiff competition from lorries and trucks that deliver petroleum products as well as frequent theft of products along its pipeline. Apart from the capacity limitation of KPC, the frequent supply shortages of petroleum products are due to the breakdown at KPRL and the limited storage capacity at the Kipevu Oil Storage Facility. KPRL is also experiencing difficulties in meeting product specifications such as the octane rating for petroleum and sulphur for

[47] http://www.energy.go.ke/speeches/PIEA%20LUNCHEON.pdf

petrol oil. Due to the limited capacity, there is congestion of petroleum products at the Kipevu Oil Storage Facility.

The supply of LPG has been constrained by the limited production capacity of the refinery, which stands at an average of 28,000 tonnes annually, and by lack of adequate import handling facilities in Mombasa and associated evacuation facilities to Nairobi and other upcountry destinations. The rail would have offered a viable alternative to transport of petroleum products but it is in poor condition. There has been limited investment in replacement and upgrading of the rail network. The network, running from the coast to hinterland, offers little effective distribution opportunities from the main trade routes. The use of rail is also limited by slow speed trains, poor maintenance and high tariffs. As a result of these problems, over 80 per cent of oil products are transported by road, as it is the only available means to reach even the remote areas. However, road transportation is also faced with challenges that include higher vehicle maintenance costs and fatalities due to the poor state of roads.

Inadequate policy, legal and regulatory framework

Until October 2004 when Sessional Paper No. 4 on Energy was formalised, Kenya operated without a comprehensive energy policy. Up to this point, the commercial energy sub-sectors have operated on *ad hoc* government policy publications with the renewable energy sub-sector inadequately considered in the 5-year national development plans. Even with the sessional paper, some of the provisions cannot be implemented without being backed by legislation. The Energy Act 2006, which makes provision for wide ranging reforms and integrated planning in energy, is yet to become fully operational. This is in contrast to Uganda, which enacted the New Electricity Act in 1999, providing for the liberalization of the power sector, the introduction of new private sector electricity service providers, and privatization of existing assets. The exploration, development and production operations of oil and gas in the country for instance are governed by outdated laws. Further, there is generally inadequate implementation of both legal and regulatory frameworks and policies in Kenya due to weak implementation and enforcement capacity.

Current policy causes confusion as it is split across many government departments creating conflict and unclear lines of responsibility on who

should take lead. For instance, the development of biomass energy is handled by the Kenya Forest Service (pushing for a ban in charcoal production), the Renewable Energy Division of the Ministry of Energy (grappling with charcoal policy issues), and the Ministry of Agriculture (promoting agroforestry for wood fuel). Permits for charcoal transportation are issued by the provincial administration, while the Forest Service Authority is trying to protect and manage forests on the other. Permits for selling charcoal are issued by the local authorities and the Ministry of Trade. Another area of conflicting institutional mandates among government departments and parastatals regards watershed rehabilitation and sustainable wood fuel production in Masinga. It is not clear whether it is KenGen, Kenya Forest Service, Water Resources Management Authority, Ministry of Energy, and/or Tana River Development Authority (TARDA) who are responsible.

The petroleum sub-sector has experienced proliferation of substandard fuel dispensing facilities and services, including the mixing of motor fuels with kerosene and dumping of export fuels for illicit financial gains at the expense of both the consumer and government revenue. However, with the enactment of the Energy Act 2006, the situation is expected to improve, with full operationalization of the Act. However, this is subject to proper enforcement of the Act and effective monitoring and evaluation.

Weakness in policy has also been manifested in energy planning and policy making. Firstly, planning has focused on electricity and petroleum sub-sectors and tended to neglect other sources of energy such as biomass. Secondly, the process is not integrated or holistic; systematic planning is done only for the electricity sub-sector. Although the petroleum sub-sector has not benefited from such systematic planning,[48] a broad policy framework was put in place after the deregulation of the sub-sector in 1994. Thirdly, with the exception of electricity, most projections in the energy sector rely on historical growth, which often results in inaccurate figures in planning. This has also tended to hinder radical and "out-of-the-box" thinking in the planning process; for instance, the projections used have failed to include conservation and efficiency targets,[49] and the effects of technological developments on these. Estimations of demand for and

[48] However, private oil companies formulate strategic plans.

[49] With the exception of electricity.

supply of biomass fuels, for instance, have not been reliable in the past (Kituyi, 2002). In essence, no one has established the real demand and supply of this form of energy upon which majority of the poor rely.

A related critical weakness is the fact that national planning in its entirety has not been hinged on what one may term a nationally shared purpose or vision. In particular, the process has always been presumed to be the sole responsibility of government, with other stakeholders appearing at the end only, either as critics or as commentators who have no role in contributing to the realization of the vision of national development and growth.

The Ministry of Planning and National Development has been plagued with periodic mergers and separations from/with the Ministry of Finance, usually on the basis of political considerations and other expediencies.[50] This trend has often reduced the concentration of the Ministry of Planning and National Development and capacity to play on national policy development as well as oversee its management and implementation. Weak linkages between the Ministry and the line ministries, as well as with its field officers at the provincial and district level, constitute another source of ineffectiveness in the planning process.

There are gaps in the current energy policy that have been identified through stakeholder consultations. The policy does not give adequate coverage on poverty reduction, gender, biomass fuels (particularly on wood and charcoal production, processing, and marketing) and other renewable sources of energy such as solar, wind and biogas. Despite the significant potential in biofuel development, the energy policy does not elaborate the government strategy towards harnessing the potential. The policy also does not contain deliberate proposals or provisions for decongestion of traffic and improvement of the quality of roads, targeting road improvement as a fuel reduction option, and elimination of leaded petrol and ordinary diesel from the market. Similarly, provisions such as promotion of mass transport in cities, construction of ring roads, flyovers and by-passes; repair of dilapidated roads, promotion of use of bicycles, and gradually eliminating very old vehicles from the roads, quality of smoke and vapour emitted from vehicles, and annual vehicle inspection

[50] This problem is not just with the Ministry of Planning and National Development. Other ministries as well face similar problems.

programmes should have been part of the energy policy. Some of these are special provisions in the Traffic Act, Kenya Roads Board Act, and the first national communication to the United Nations Framework Convention on Climate Change (UNFCCC). Moreover, there are no implementation strategies and targets for biomass energy in the policy.

Another weakness with the energy policy is the lack of consistency with policies in related sectors. It is noted that a number of sectors are crucial to the achievement of energy sector objectives such as water development, agriculture, forestry, universities and research institutes. UNEP (2006) undertook a mapping analysis to assess the extent to which the energy policy is aligned to the achievement of national development objectives spelt out in the ERS and the degree to which the energy policy takes into consideration issues in related sectors. The major conclusions of the study were:

- The forestry policy largely contributes to the objectives of the energy policy. These two policies are considerably well integrated, as there are provisions in each policy that supports the other. However, integration needs to be deepened further.
- The environmental policy is fairly well integrated with the energy policy. The policy provides for the development of energy policy and legislation, EIA for all energy projects, incentives for energy conservation and private sector investments, among others. Likewise, the energy policy recognizes the need to and makes provisions for environmental protection and conservation.
- Although there is some evidence of harmony and integration of water and energy policies, there is little recognition of the needs of the water sector in the energy policy. Yet, energy is essential for sourcing and supplying water to users.
- Although the energy policy is not very explicit, there are provisions that are made on health alongside environmental and safety regulations to mitigate adverse impacts of energy systems. However, the health policy does not seem to recognize the energy sector, yet critical services cannot be provided without energy.
- The poverty reduction strategy provides for rural electrification and increasing private sector participation in power generation, transmission and distribution. Although the energy policy recognizes poverty alleviation, there are no sufficient provisions

to achieve that. To deepen the integration, provisions such as targeted fiscal incentives are needed to ensure lower costs of energy for the poor, the micro and small enterprises.

- There is little or no integration with the other sectoral policies such as agriculture, small and micro enterprises, health, wildlife, fisheries and tourism.
- In policy making or revisions in the future, it is imperative that integration with related sectors be seriously considered.

Environmental degradation

The impact of energy production and consumption include atmospheric pollution, deforestation, climate change, soil erosion and siltation of hydropower reservoirs and river systems, among others. Atmospheric pollution and contamination of groundwater resources and rivers impact on the health of all who consume the water directly or indirectly through the food chain. Uncontrolled use of energy can lead to the destruction or degradation of the natural environment through damage to catchment areas from deforestation (by over 50,000 hectares per year), soil, water and wind erosion (UNEP, 2006). Consequently, any efforts geared towards increasing kerosene consumption especially in rural areas will undoubtedly relieve pressure from wood. Indeed, the government has often used the policy of tax reduction or exemption for kerosene for this purpose and also as a poverty mitigation measure. However, key emerging concerns are the impact of kerosene on the levels of indoor air pollution and consequent health impacts on the poor, and the adulteration of other fuels with kerosene.

There are emissions of pollutants, mainly carbon dioxide (CO_2), nitrous oxides, dinitrogen oxide, sulphur dioxide, volatile organic compounds, lead and particulate matter (PM) as a result of diesel and petrol combustion by motor vehicles. At the reported fuel consumption levels in 2004, a total of 1.93 Tg (1Tg = 10^{12} g) of carbon dioxide was emitted through combustion of petrol, while 2.94 Tg carbon dioxide was attributed to diesel combustion (UNEP, 2006).

Ambient lead concentrations in urban centres are likely to decline drastically following the phasing out of leaded petrol in the country. Sulphur dioxide and nitrogen dioxide emissions are emitted at annual average rates of 5.545 ug/m^3 and 2.464 ug/m^3, respectively. The current

levels are well below the maximum allowable annual levels of 50 ug/m^3 and 100 ug/m^3 for sulphur dioxide and nitrogen dioxide, respectively, although they are expected to increase (ERB, 2005). Although there is lack of data, it is evident that air quality in urban towns is lower than in rural areas due to higher concentration of vehicles, industries and people in urban areas.

Although hydropower is regarded as being environmentally sound, its generation requires a dam and a reservoir. The construction of these structures destroys the natural ecosystem and displaces human populations, taking up a significant portion of productive land. For instance, the construction of Masinga Dam reservoir displaced over 1,000 families (ELC, 1985), while the construction of Kindaruma, Kamburu and Masinga hydro dams flooded an area of 15, 10, and 120 km^2, respectively (ELC, 1985). Kiambere Dam inundates an area of 25 km^2 and a further 100 km^2 is set aside as a buffer zone for its protection (SOE, 2004). During the construction of Kiambere Dam, more than 5,000 families were displaced. Similar problems have been experienced in China and Brazil regarding their large hydroelectric projects where delicate ecosystems have been flooded and indigenous people displaced. On the other hand, such dams provide a suitable living and breeding grounds for disease vectors such as mosquitoes and bilharzia worms (SOE, 2004). Moreover, the creation of power line corridors leads to further loss of biodiversity.

4.3 Opportunities

There are opportunities in the energy sector and, while some are emerging, others may need to be initiated. They include availability of renewable technologies, regional co-operation and possibilities of use of nuclear energy.

Alternative sources of petroleum products

Kenya has been importing oil from the Middle East, in particular from Saudi Arabia. Transport costs, therefore, form a major component of pricing. Moreover, being heavily dependent on the Middle East is risky as any oil crisis originating from the visibly unstable region could seriously disrupt the supply stability in Kenya.

Negotiations are underway of getting petroleum products from Libya on concessionary terms. Given that Sudan, Kenya's immediate

neighbour has significant oil deposits, it is time that the country starts sourcing oil nearby.[51] This can be done either through building of a direct oil pipeline to Sudan or through the sea from Port Harcourt.[52] Sudan is currently exporting 425,000 barrels per day of crude and 30,000 tonnes per month of petroleum products.[53]

It is also worthy noting that Uganda has discovered oil reserves[54] estimated between 100 million to 250 million barrels with an expected production of 14,000 barrels per day. Likewise, Tanzania has discovered viable oil deposits along its coast.[55] Such developments are encouraging as more possible sources are realised. Although there are fears over lost revenues due to zero-tariff structure for goods imported from a COMESA member country, increased economic activities due to cheap petroleum products could compensate such losses.

Availability of renewable technologies

Renewable technologies are available in the developed countries to harness alternative sources of energy that Kenya could make use of. However, the costs are generally still high.[56] Wind and solar energy sources are highly capital-intensive technologies. Besides, solar panels are still prone to theft because of their longer shelf life. There are also battery storage problems implying additional maintenance and replacement.

However, it is encouraging to note that the costs of renewable energy have generally been declining. For instance, the costs of solar and wind power have both decreased since 1980. Wind power decreased from 10 cents a kilowatt hour in 1980 to 4 cents a kilowatt hour in 2003. Solar power used to cost US$1 for a kilowatt hour in 1980, but in 2003 the cost declined to 20-25 cents a kilowatt hour. The cost of renewable energy varies in different locations throughout the world as shown on Table 2. The table also shows that fossil fuels and nuclear energies are still much more inexpensive than the renewable energies.

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[51] Rights activists are however pressurising Indian, Malaysian and Chinese companies in the oil industry to reprimand Sudan over the Darfur conflict.

[52] There are fears that oil from Sudan is of lower quality, although this is mainly an adulteration problem.

[53] 'Sudan exports 425,000 barrels daily', *East African Standard*, Tuesday, 31 July, 2007, p.5.

[54] "Heritage oil plans drilling two more wells in Uganda". *East African Standard*, Tuesday June 26, 2007, p. 21.

[55] Ernest Mpinganjira, " Dar's oil invites Americans", *Sunday Standard*, July 8, 2007, p. 25.

[56] Solar is all capital costs. There has been a sharp rise in the costs of raw materials recently.

Table 2: Cost of production of electricity from different primary energy sources

Energy type	Cost per kwh (US cents)
Solar	20-25
Wind	4
Geothermal	5-8
Biomass	9
Tidal	7
Coal	1.83
Nuclear	1.92
Gas	3.3

Source: http://academic.evergreen.edu/g/grossmaz/alfordem.html.

As technology develops, alternative energy will become a cost-effective option. The cost of wind energy, for instance, is expected to decline by about 35-40 per cent by 2006 (Chapman *et al.*, 1998) as more and more large plants are built and advanced technology introduced. The use of such technologies would require fiscal incentives such as subsidies and tax reductions to encourage uptake. Germany and Spain have managed to harness wind energy through generous state subsidies.[57]

Regional initiatives

The Kenyan power system is interconnected with the Ugandan system through a 132 kV double circuit from which 30 MW of power was earlier on being imported. Plans to interconnect with the Southern Africa Power Pool (SAPP) through Tanzania and Zambia are at an advanced stage. It was expected that the construction[58] of a power line to connect Kenya's national grid to the SAPP would begin in March 2007. However, discussions with the Ministry of Energy officials indicate that this source could be expensive; the supplier was to charge US cents 5 per kwh, which is higher compared to other sources.

[57] http:/academic.evergreen.edu/g/grossmaz/elquiscl.html.
[58] Elizabeth Mwai," Tanzania power line starts in March", *East African Standard*, Friday, 8 December, 2006, p. 8.

The Eastern Africa Power Pool (EAPP) was launched in February 2005. Its objectives are to secure power supply for the sub-region, increase access rate of power by the population, reduce electricity production costs, provide efficient co-ordination in power production, and create, in the framework of NEPAD, a conducive environment for investment in energy. The countries involved include Burundi, the DRC, Egypt, Ethiopia, Kenya, Rwanda, Sudan, Tanzania and Uganda. With these cross-border transmission grid interconnections, Kenya will enhance power supply security particularly during periods of severe droughts, in addition to helping in making prudent decisions on generation capacity additions. The challenge is, therefore, to pool adequate financial resources from domestic, bilateral and multilateral sources to ensure timely implementation of these regional power interconnection projects.

In addition, the East Africa Power Master Plan (EAPMP), which shows that there are economies of scale associated with electricity interconnection and trade within EAC countries. The plan demonstrates that the development of hydro projects in Uganda and Tanzania would increase EAC capacity to produce cost-effective electricity and reduce its level of imported oil dependence. In line with this, plans are underway for KenGen, together with Uganda Electricity Transmission Company Ltd, to build Bujagali Dam in Uganda to generate 420 MW along the River Nile by 2010. With the discovery of huge deposits of cheap natural gas in Songo Songo, Tanzania, opportunities exist for cheaper generation of electricity. Already, a gas pipeline is being built from Songo Songo to Mombasa. In addition, Tanzania has coal deposits that Kenya could utilize to generate cheaper electricity.

Kenya could also consider importing power from Ethiopia, which is able to generate cheaply from the Blue Nile. Feasibility studies[59] on a connection to the Ethiopian grid are soon to be conducted. Already KPLC, KenGen and the Ethiopian Electric Power Corporation have signed a memorandum of understanding. This is meant to tap cheap power from the many small hydro potential that exists in Ethiopia.

Although still in its infancy, the Nile Basin Initiative (NBI) has ambitious plans to interconnect the electricity grids of the basin countries and create a market for the countries to trade energy, and increase the amount of energy available in those countries through

[59] *Ibid.*

hydroelectric power. The interconnection projects are: Kenya-Uganda, Uganda-Rwanda, Rwanda-Burundi and Rwanda-DRC (KPLC, 2006).

Possibilities of using nuclear energy

Nuclear energy provides another option for the country to deal with energy supply limitation. This source of energy is relatively environmental friendly. Opinions are still diverging on this form of energy but the option remains open. Countries that are already using nuclear energy include China, Brazil, France, US, UK and South Korea. Malaysia is considering using nuclear as an energy source. The caution with nuclear as a source of energy is the capacity for the country to safely handle processing, transportation and disposal of nuclear waste, and deal with threats from terrorism:

The most crucial factor affecting the prospect of growth of nuclear power is its underlying economics. A nuclear plant involves an upfront investment ranging from US$ 2.7 to 4.3 billion. Thus, nuclear energy generation incurs higher construction costs in comparison to fossil fuels, yet operating costs are significantly lower following the initial investments. Furthermore, nuclear power generation is largely immune to changes in the cost of raw material supplies, as a modest amount of uranium, which comes largely from stable regions of the world, can keep a reactor running for decades. Therefore, new nuclear power plants offer an economic way to generate base-load electricity.

4.4 Threats

The main threats facing the energy sector in Kenya are climate change, insecurity and fluctuating world oil prices.

Climate change

Climate change is becoming an important threat to energy supply. As global warming increases, there are concerns that this may jeopardise the supply of energy given that about 60 per cent of the electricity is from hydro generation. Besides, the bulk of the hydro-generation is on the River Tana, which is risky in the light of changing weather patterns. Only Turkwel power station is on a different water catchment basin. The completion of the Sondu Power project will therefore minimize further the impact of weather on power generation. Given

that biomass fuels are sensitive to climate change, it is expected that increasing desertification as a result of climate change will lead to a critical decline in supply.

An adequate and secure supply of energy is required to accelerate socio-economic development and, in particular, reduce poverty and ensure the protection of the environment. It should be noted that the Energy Act 2006 does not address the challenges of climate change and its impact to the energy sector.

Insecurity

Energy security is an important and fundamental national strategy and a goal in itself. It implies access to energy at all times in various forms and in sufficient quantities at affordable prices. Insecurity could be in the sense of physical interruption and also geopolitical risk, for example, a terrorist threat. The increasing dependency of petroleum products from the Middle East, for instance, is a cause of concern as any supply crises in this unstable region could create supply shortage, which no swing producers could compensate for.

Another cause of concern is the fact that Kenya imports all the petroleum products with an import bill, which is becoming unsustainable. With increasing threats of terrorism and fluctuating world oil prices, security of supply is very crucial. Kenya must tackle this problem by introducing a security strategy of energy supply aimed at reducing the risks linked to this external dependence.

Fluctuating world oil and gas prices

Fluctuating and general increase in world oil prices is a serious threat to the energy sector. Due to its multiplier effect, the rising cost of fuel is impinging negatively on the economy. The total oil import bill was Ksh 99 billion in 2005, out of which crude oil import bill was Ksh 52 billion, while processed oil import bill was Ksh 47 billion, which is 23 per cent of total Kenyan imports.

The Organization of Petroleum Exporting Countries (OPEC), through setting oil production quotas and acting as a cartel, has also been the reason behind increasing oil prices. The supply in this case is determined by how many barrels of oil producers are willing to pump, refine and

transport at any given time. This is affected more by international politics and less by international economics. Moreover, supply bottlenecks in OPEC producers such as Nigeria and Iran are also a cause of concern. Russia, a major producer of natural gas, is negotiating with Iran to have an OPEC-like organization on natural gas.

5. Strategies for Securing Energy Supply

The strong correlation between GDP growth and energy demand means that future demand levels, security of supply, energy mixes, production levels and general market dynamics will increasingly become key issues. Energy has played and will continue to play a principal role in promoting economic growth and improved human well-being. However, meeting the energy requirements to ensure further social and economic progress with environmental requirements will be a critical challenge. In this section, strategies to secure the supply of energy services are proposed. It is envisaged that ultimately this will make the country cope with the current energy challenges.

5.1 Increasing the Supply of Energy Services

Energy demand will continue to rise as population rises and the need for services increases. Forecasts of long-term energy demand factoring improved efficiency and technologies should be made and the resulting information disseminated far and wide. This will ensure that system expansion and improvements are done before supply problems arise by sending signals to developers and investors. Effective planning and eventual timely implementation are therefore necessary to ensure adequate and cost effective supply of energy services.

The Sessional Paper No. 4 of 2004 on Energy has made bold proposals to increase the supply of electricity. The suggestions being proposed in this paper are actually meant to strengthen the provision of energy services. They include promoting small hydro projects, co-generating by sugar cane factories, enhancing wind power generation, and increasing geothermal production. Fiscal incentives such as tax holidays for investors and duty exemption for imported hardware in these areas should be considered. Investors in power projects in the rural areas will require special treatment that may include considerable longer tax holidays.

Currently, there are measures being undertaken to ensure adequate supply of petroleum products. KPC is fast tracking capacity enhancement of the Mombasa -Nairobi pipeline which, on completion, will double the current flow rate of 440,000 litres an hour. This will reduce congestion at Kipevu and therefore lower the cost of imported oil products as importers will be able to bring in large shipments, and also lower demurrage charges paid by importers due to the inability of the KPC to move products from the refinery fast enough.

Although the early signs of concessioning of the Kenya Railways are not encouraging, it is expected that a fully rejuvenated railway system ultimately would be able to transport petroleum products from Mombasa to destination areas very fast and ensure adequate supply. Regional future initiatives such as construction of a pipeline from Dar es Salaam to Mwanza, the construction of a pipeline to transport crude oil[60] from Uganda to Mombasa, or establishment of a refinery in Uganda, and the establishment of a petroleum refinery in Southern Sudan would ensure adequate supply of petroleum products in the country and in the region. Besides, there are plans to build a railway line to Southern Sudan through which Kenya could source oil products nearby.

There are ongoing efforts[61] to increase the supply of LPG.[62] These are:

- Construction of an LPG jetty by a private sector investor through a long-term concession granted by Kenya Ports Authority.
- Construction of a modular 6,000 metric tonne import handling, storage and bottling facility in Mombasa through public private partnership.
- Construction of a 2,000 metric tonne modular storage and bottling facility in Nairobi, through public-private partnership.
- Upgrading of the Kenya Petroleum Refineries Limited.

On completion, LPG production will be increased sharply to 115,000 metric tonnes annually. Adequate incentives are also needed to attract more private sector participation in LPG storage facilities. The Kenya Oil Company Ltd (Kenol) has made some investments in storage facilities. Other players should also be encouraged to enter the market.

Although the country should continue promoting the use of LPG as a substitute for biomass energy, both LPG and its supply infrastructure are comparatively costly. Therefore, the transition towards cooking with LPG will be confined to affluent areas and/or affluent households for some period of time, implying that biomass energy will continue to be relevant and important to a large degree in the short and the medium

[60] Adequate oil reserves have been discovered in Uganda.

[61] Speech by Hon. Henry Obwocha, Minister for Energy, during the Petroleum Institute of East Africa Luncheon on 19th July 2006.

[62] The Kenya Government is seeking support from Libya on the $45 million liquid petroleum gas facility and $ 22 million truck and rail loading projects (http://www.nationmedia.com/eastafrican/current/ News/news0406071.htm).

term. It is thus crucial that the supply of biomass energy is adequate to meet demand at reasonable costs and on a sustainable basis (Box 2).

The strategies include on-farm agroforestry, village woodlots, community forests, afforestation and re-afforestation programmes possibly through modified use of the *shamba system*, appropriate technologies for production of charcoal, and promotion of improved cooking stoves and charcoal kilns.

5.2 Policy, Legal and Regulatory Reforms

The Energy Regulatory Commission (ERC) must encourage and enhance competition to ensure that lower prices and more value-added services are realized. Competition is likely to encourage innovations that may ultimately reduce consumer prices. This can be achieved by adoption and enforcement of fair, clear and effective market rules and by ensuring that consumers are provided with sufficient information to make informed energy-related decisions. There is need to develop appropriate market structures and to encourage greater competition in the energy sector. Such an approach is broader than concerns with cost recovery and public sector reforms. It calls for special attention to the essential issues of freeing entry, removing restrictions on ownership and

Box 2: Elements of sustainable charcoal or firewood production

i) Trees used in the production of sustainable biomass fuels do not come from protected areas of forest.

ii) Trees used are certain species, e.g. eucalyptus.

iii) Trees are planted, grown and harvested from farms for the purpose of charcoal and firewood production, where reforestation and replanting takes place to replace the stock used.

iv) The production process includes specific charcoal kilns with increased efficiency.

v) Waste materials are converted into fuel, e.g. coffee husks and charcoal dust.

Source: ESDA (2003b).

management, enabling technological choice, and permitting market forces to determine costs and prices.

With electricity, for instance, creation of a power pool with wholesale and retail markets will create competition. It is envisaged that there will be a power pool with independent power distribution companies. Generating companies would sell to the power pool, and consumers would purchase electricity from the distribution company. Large industrial consumers will have the choice of purchasing power from the pool, from the distribution companies or directly from generating companies. Restructuring should enable greater private sector participation, introduce elements of competition, and minimize monopolistic segments of the sub-sector. This is likely to reduce the price of electricity.

In order to improve energy affordability to the poor, a special fund can be established besides the current lifeline tariff. Unbundling of transmission and distribution of electricity should, therefore, go on. However, it is noted from the Californian reform experience that a free market system does not always deliver on many fronts, including efficient service provision, competition or consumer choice as electricity markets are vulnerable to monopoly (Mbogo *et al.*, 2001). It is therefore suggested that the reforms proceed gradually in Kenya.

In the petroleum sub-sector, incentives are needed to encourage the entry of independent dealers to enhance competition. The planned upgrading of KPRL by the government with the support of foreign investors[63] is a good strategy given that it may be used in the near future to also refine crude oil from Sudan and Uganda. There is also a limited refinery investment worldwide. Gradually, the government share should decline as more private investors acquire equity. Possibilities of privatization of KPC and the storage facilities the company owns should also be considered as this may inject efficiency and ensure optimal use of the facilities.

There is need to develop policies regarding wood fuel, charcoal, and biofuel in the country. ERC, in co-operation with other agencies, also needs to develop and maintain energy emergency response plan to mitigate any unforeseen disruption. There is need to establish and maintain strategic petroleum reserve capacities of 90 days, as stated in the energy policy.

[63] State-owned Tamol of Libya is among foreign investors that have expressed interest (http://www.nationmedia.com/eastafrican/current/news/news0406071.htm).

5.3 Energy Conservation and Efficiency

Energy conservation and efficiency are tools to achieve lower costs, reduce harmful environmental impacts, improve productivity, and provide greater value to consumers. These will work together to reduce energy demand.

Energy conservation is a matter of changing attitudes. Continued and enhanced information and education of consumers about the advantages of energy conservation and efficiency is critical. The government can act as an *advocate* for energy efficiency and sustainability through public education, training and procurement programmes.[64]

Energy efficiency programmes are seriously under-funded. In partnership with the private sector and civil society organizations, the government should increase funding for energy efficiency programmes and provide incentives to utilities and energy companies to undertake advocacy activities. All the efficiency increasing opportunities along the energy value chain should be exploited from generation, transmission and distribution to end uses for the case of power.

Technological advancement must focus on increasing demand and supply side efficiencies, improving the environment by creating cleaner energy conversion technologies at all levels of energy production and end use. As new energy use facilities are installed, either to add to capital stock or to replace older units, energy intensity can be expected to decline. Better technologies are also needed to prevent wasteful consumption and reduce health risks as well as environmental hazards. It is widely acknowledged that improvements in end-use efficiency for cooking and heating may lead to biomass energy savings of up to 80 per cent.

In the same vain, more efficient charcoal conversion technologies can reduce feedstock by up to 50 per cent. Incentives are thus needed to encourage adoption of such technologies. Raising peak rate tariffs, lowering night rates and incentives to alter factory work schedules to balance consumption between day and night are also important. The

[64] These are government procurement programmes that are geared towards energy saving products.

envisaged ERC could stimulate this through economic incentives such as rebates and subsidies.

Current budgetary support to energy service companies by donors and the government should be enhanced. Proposals to reduce vehicle congestion such as mass transport systems, bypasses and enhanced roads maintenance programmes will also help reduce energy demand. Land-use planning that locates jobs, services and housing in close proximity can also reduce energy demand by reducing the daily distance travelled.

Other measures that may be used to promote energy conservation and efficiency include price and tax incentives, standards and labelling, refurbishing old hydroelectric plants, creating energy efficiency funds by financial institutions, requiring mandatory energy efficiency audits by financial institutions as a prerequisite for lending, and voluntary agreements with industries.[65]

5.4 Broadening and Changing Energy Mix

There is need to diversify the energy resource base as much as possible. This can address the risks of supply disruptions or price volatility of a single fuel. Strategies to encourage supply and use of alternative fuels is the best way forward.

Use of nuclear energy offers an opportunity for the country to change its energy mix. As a proven and environmentally benign technology and with its potential as a sustainable long-term energy supply into the distant future, nuclear power can be an important contributor to sustainable development. It is a multipurpose power source providing base load electricity and offering a wide range of potential applications in the non-electric sector. However, for nuclear power to play its full role in a less fossil fuel dependent age, its acceptance by the public and at the political level is vital.

The country should continue promoting the use of LPG. The use of natural gas for transportation and generating electricity should also be promoted. Given that Tanzania has natural gas reserves, Kenya should increase its usage.

[65]These are "contracts between the government and industry" that set "negotiated targets with commitments and time schedules on the part of all participating parties.

Efforts should also be made to promote the supply of renewable energy sources through legislation, fiscal and financial incentives. Wind power concessioning to the private sector could lead to rapid development of wind energy. Compulsory blending of fuel with bio-diesel, for example, may lead to an increased supply of bio-diesel. However, there is a caveat with regard to the use of bio-diesel.[66] Proposals being floated are mixing fossil fuels with biofuels at around 5 per cent. This may, however, raise prices of agricultural products. Moreover, it is still not clear whether biofuels are viable without government subsidies. Nevertheless, in the interest of diversification and changing the energy mix, a limited production and use of biofuel in the country should be seriously considered. Subsidies and tax credits are thus essential in order to make the production of the biofuels competitive with oil until economies of scale are realized.

Cost remains a barrier in many instances, as does the problem of storage (during off-generation periods) for such sources as wind and photovoltaics. Although current applications are concentrated in "off-the-grid" situations, new ideas may bring new opportunities; for instance, embedding PV in the exterior of buildings. The extensive use of such an innovation could have an impact on peak electric demand. Tax incentives are thus needed to make PV systems affordable to low-income groups.

5.5 Reducing Oil Dependency

The total dominance of oil as a transportation fuel is a cause of concern. However, plug-in hybrid engines, biofuels and other technologies can reduce such dependence. Fiscal incentives such as duty free importation of hybrid vehicles, government procurement of such vehicles for its fleet, and legislation on compulsory blending of fuel are likely to be helpful.

5.6 Exploration

The government must continue to encourage exploration of oil, gas, coal and geothermal in the country. Thus, there is need to increase

[66] Fidel Castro, "Ethanol production isn't as good as it sounds", *The Standard*, Monday, April 16, 2007.

government and private sector funding for oil, natural gas, coal and geothermal exploration in the country.

The planned establishment of Geothermal Development Company is expected to undertake geothermal resource assessment including exploration, appraisal and production drilling in prospective areas. Local, regional and international partnerships and incentives to the private sector are needed to intensify exploration activities.

5.7 Research, Development and Demonstration

Government supported research, development and demonstration (RD&D) may bring technological advances that help decrease reliance on fossil fuels. Thus, there is need to provide public funding for energy related RD& D technologies, processes and services. Domestic, regional and international partnerships should be sought towards RD&D. In other countries, the share of R&D in energy[67] (both public and private) as a percentage of GDP are 0.042 per cent in US and 0.0003 per cent in Brazil (1999), and 0.0024 in Japan (1997). The absolute amounts are significant; for instance, Japan US$ 6.8 billion and Brazil US$ 176.8 million. Utilities in Brazil are required by law to dedicate 1 per cent of their revenues to R&D programmes.

Because of the high risk inherent in R&D investments, the government should grant more direct, upfront grant support based on the concept of risk sharing to the private sector. The country should consider incentive schemes to boost R&D activities, particularly to encourage the private sector. These schemes could largely be tax-based.

5.8 Attracting Internal and External Financing

There is need for additional capital to finance needed energy investments, since domestic funding sources are limited. Thus, incentives to attract capital from external sources for energy investments are both desirable and urgent. The Rural Electrification Authority (REA) could, with the help of community leaders, use resources from the Constituency Development Fund to finance small and micro power projects in the rural areas.

The country could explore opportunities provided by the Clean Development Mechanism (CDM) facility as a source of funding. Under

[67] www.worldenergy.org.

CDM, rich countries can keep within their Kyoto emissions limits by funding cuts in poor countries, getting the so-called carbon credits in return. In fact, in the framework of East Africa Power Master Plan (EAPMP), the plan calls for identification of Kyoto credits that may arise from its implementation as a source of finance (EAC, 2006). Currently, KenGen is expecting to receive about US$ 1 million annually for the sale of emission credits once the Kipevu thermal plant is fully upgraded[68] by April 2009.

5.9 Regional Co-operation and Initiatives

Considering the critical role of energy and the grave consequences of a disruption, it is imperative to ensure energy security. Yet, countries are limited in what they can do alone to strengthen energy security, and the few options they have entail excessive costs or limited effectiveness. In this respect, energy co-operation with other countries in the region offers an effective and mutually beneficial option.

The country therefore should continue seeking co-operation under the umbrella of EAC, IGAD, NBI and NEPAD to meet this objective.

In order for Kenya to secure energy supplies for its population, it is critical that the country becomes proactive in forging cross-national partnerships in exploration, investment, oil stockpiling, transportation and distribution in the region. Opportunities abound with coal and natural gas in Tanzania, oil in Sudan, Tanzania and Uganda, and hydropower in Uganda and Ethiopia. Kenya ought to adopt the model of China in seeking such partnerships. It is not enough just to concentrate on domestic oil exploration.

A comprehensive assessment of various options for co-operation and specific projects should be undertaken. Information sharing across countries should be encouraged to facilitate consensus formulation and confidence building. This can lead to development of joint policy co-ordination agenda as well as optimal financing schemes. Eventually, institutional frameworks for multilateral regional energy co-operation such as treaties and charters can be created for stable co-operation.

[68] An annual abatement of 122,650 tonnes of carbon dioxide equivalent, which will be sold as Certified Emission Reductions (CERs), is expected from the Kipevu combined cycle upgrade project (http://www.kengen.co.ke).

6. Conclusion and Policy Implications

6.1 Conclusion

There is a close correlation between economic growth and quality of life on one hand, and demand for energy, on the other. Energy is a very critical resource and its effective use is a key instrument for the whole development process and the achievement of national development objectives. Adequate, affordable and secure supply of energy is, therefore, currently crucial and also in the future, particularly in the attainment of economic goals as stipulated in Vision 2030.

The major sources of energy in Kenya are wood fuel, petroleum and electricity, which account for 70 per cent, 21 per cent, and 9 per cent, respectively, of total energy consumption in the country. Renewable energy is also becoming important although it remains insignificant in the country's overall energy mix.

Before the Sessional Paper No. 4 of 2004, there was no comprehensive energy policy in Kenya. Policy considerations consisted of statements that were overly short-term in nature, supply-oriented and weak in environmental and technological aspects. There are shortcomings in the way energy planning is done in the country. These include a process that is generally not very systematic or well organized, inadequate stakeholder consultation, lack of continuity in representation, inadequate integration of social and environmental issues, inadequate integration with policies in related sectors, and weak data systems, among others.

Model countries have also faced energy challenges but have been able to cope. The strategies used include diversification of importing sources of oil, increased oil and gas exploration within their countries and abroad, use of cheaper sources of electricity such as coal and natural gas, and conducive policy, legal and regulatory framework to attract private sector participation. Special incentives such as subsidies and tax reductions have been used to encourage the uptake of renewable sources of energy and also energy efficient end use hardware. Besides, governments support R&D programmes in the energy sector and also use legislation to promote the use of biofuel. Regional co-operation with neighbouring countries has also been pursued to ensure energy security.

A SWOT analysis on the energy sector reveals that Kenya has relatively been able to meet her energy needs in comparison with the neighbouring

countries. The Kenya government has also been proactive towards energy sector development through revamping KPLC management, publication of Sessional Paper No. 4, and the enactment of the Energy Act 2006. Other strengths include oil, gas and coal exploration, ongoing biofuel initiatives, co-generation from sugar factories, wind and solar initiatives, afforestation and agroforestry, and energy conservation and efficiency.

The weaknesses in the energy sector include high cost of energy, high cost of energy investments and inadequate financing, low access to modern energy services, inadequate long term planning, capacity constraints, inadequate legal and regulatory framework, and environmental degradation.

Opportunities that were identified comprise diversification of sources of petroleum products, availability of renewable technologies, regional initiatives and possibilities of nuclear power. The threats include climate change, insecurity and fluctuating world oil prices.

Diverse strategies emanating from lessons from other countries and the SWOT analysis are proposed to secure energy supply. Broadly, these include proactive measures to increase the supply of energy services, policy, legal and regulatory reforms, energy conservation and efficiency, broadening and changing energy mix, reducing oil dependency, increased exploration, research and development, attracting adequate financing, and regional co-operation.

6.2 Policy Implications

Evidence from the SWOT analysis and lessons from other countries shows that Kenya could cope with energy challenges even with the ambitious Vision 2030 targets. Thus, interventions that improve the supply of energy services in the country are desirable. These include:

1. Incentives to promote the development and use of renewable energy. Tax incentives such as duty waivers, duty reduction and removal of VAT on imported components of renewable energy technologies are needed to promote their uptake. Consideration of a 100 per cent depreciation allowance in the first year of operation, tax holidays of up to 10 years for power plants using renewable energy, and tax holidays on dividend income made from investments on domestic sources are also worthy considering. Provision of credit facilities for consumers and

entrepreneurs to acquire renewable energy hardware is also crucial. The government could give incentives to financial institutions to encourage such lending. Legislation can be considered making blending compulsory in order to encourage the use of biofuel.

2. Reduction of dependency on oil. The government should aim at reducing oil dependence by establishing tax incentives for hybrid vehicles, legislation on blending, and having proactive government procurement programmes that encourage the state to purchase such vehicles.

3. Encouraging conservation and efficiency. Awareness campaigns are crucial through public education and training. The government can act as a catalyst by increasing procurement of energy efficient products. Proposals to reduce vehicle congestion, such as mass transport systems, bypasses and enhanced roads maintenance programmes, land-use planning that locate jobs, services and housing in close proximity, price and tax incentives, standards and labelling, creation of energy efficiency funds by financial institutions, requiring mandatory energy efficiency audits by financial institutions as a prerequisite for lending, and voluntary agreements with industries can be considered.

4. Increased oil and gas, coal and geothermal exploration. This can be done through increased government funding for these activities, encouraging public-private partnerships, and upfront government grant support to reduce risks to the private sector.

5. Support for research and development programmes in the energy sector. Policy research should also be supported. Increased public funding and encouraging domestic, regional, and international partnerships for R&D programmes are important. Incentive schemes that are largely tax-based to encourage the private sector could also be considered.

6. Harmonization of policies. Consistent harmonization and integration of energy policy with other sectoral policies is crucial for synergy. These include forestry, agriculture, water and land.

7. Encouraging private sector investment in the supply of energy services. Financial incentives and low-cost loans could be appropriate. Income tax exemptions on interest incomes to domestic creditors, including commercial banks and institutional

investors extending loans to investors engaged in power generation, transmission and distribution is also appropriate.

8. Strengthening of public institutions to supply energy services and also improve long-term planning. Increased funding and staff development are crucial. Improved ministerial co-ordination is important especially with regard to long-term planning so that energy needs for each sector are factored in. Capacity building for communities is also important in order to promote agroforestry and community woodlots. The civil society organizations could assist in this.

9. Adoption of nuclear energy. Nuclear energy should be considered to increase the energy mix as a long-term measure. With supervision from the Atomic Energy Agency, the country could easily rely on this form of energy to cope with supply challenges.

10. Regional co-operation. Finally, regional co-operation in the provision of energy services should be enhanced. Considerable opportunities exist through regional collaboration for Kenya to access energy in the region cost-effectively. Sourcing for oil from Sudan, importing power from the South African and the Eastern African Power Pools are some of the efforts that can yield good dividends. Diversifying sources of imported oil and also importing alternative fuels further increases energy security.

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Annex 1: Least Cost Power Development Plan

Year ending 30th June	Station	Type	Cost US$ (millions)	Added Capacity	Total Capacity	System Peak	Reserve Margin MW
2006	Former Westmont	GT		43	1,080	1,070	10
2007	Rabai Medium Speed	MSD	67.2	80	1,160	1,220	(60)
	Lanet Medium Speed	MSD	67.2	80	1,240	1,220	20
	Eldoret Medium Speed	MSD	67.2	80	1,320	1,220	100
	Raise Masinga Dam	HYDRO		0	1,320	1,220	100
2008	Sondu-Miriu	HYDRO	153.36	60	1,380	1,370	10
	Sondu Additional Plant	HYDRO	53.8	20.6	1,401	1,370	31
	Sondu-Kisumu 132 kV	LINE	14	0	1,401	1,370	31
	Kindaruma 3rd Unit	HYDRO	10	20	1,421	1,370	51
	Kiambere Rehabilitation	HYDRO	5.87	20	1,441	1,370	71
	Kipevu GT 1& 2	GT		-60	1,381	1,370	11
	Kipevu Combined Cycle	CC	40	120	1,501	1,370	131
	Olkaria II 3rd Unit	GEO	58	33.6	1,534	1,370	164
	OrPower 4	GEO		36	1,570	1,370	200
2009	Nairobi South Fiat	GT		-10	1,560	1,520	40
	Olkaria IV	GEO	147.5	67.2	1,627	1,520	107
	Coal	COAL	240.1	150	1,777	1,520	257
	Mombasa-Nairobi 330 kV	LINE	90.4		1,777	1,520	257
	Import	IMPORT		50	1,827	1,520	307
	Arusha-Nairobi 330 kV	LINE			1,827	1,520	307

GEO=Geothermal; CC=Combined Cycle; GT=Gas Thermal; MSD=Medium Speed Diesel

2011	Coal	Coal	164	150	1,977	1,820	157
2012	Geothermal IMPORT	GEO IMPORT	147.5	67.2 100	2,045 2,145	1,970 1,970	75 175
2013	Coal	COAL	240.1	150	2,295	2,120	175
2014	Coal	COAL	164	150	2,445	2,270	175
2015	Coal	COAL	164	150	2,595	2,420	175
2016	Gas turbine in Lanet Geothermal Olkaria-Nairobi 220 kV	GT GEO LINE	47.6 147.5 23.2	90 67.2	2,685 2,752	2,570 2,570	115 182
2017	Coal Mombasa-Nairobi 330kV	COAL LINE	164 90.4	150	2,902	2,720	182
2018	Geothermal Import	GEO IMPORT	147.5	67.2 100	2,969 3,069	2,870 2,870	99 199
2019	Retire Kipevu I Diesel MSD in Mombasa Coal	MSD MSD COAL	 67.2 240.1	-75 80 150	2,994 3,074 3,224	3,020 3,020 3,020	(26) 54 204
2020	Retire Iberafrica MSD in Nairobi Coal	MSD MSD COAL	 67.2 164	-56.6 80 150	3,167 3,247 3,397	3,170 3,170 3,170	(3) 77 227

2021	Geothermal	GEO	295	134.4	3,532	3,320	212
	Olkaria-Nairobi 220 kV	LINE	23.2				
2022	Retire Kipevu II diesel	MSD		-73.99	3,458	3,470	(12)
	MSD in Mombasa	MSD	67.2	80	3,538	3,470	68
	GT Lanet	GT	87.9	180	3,718	3,470	248
	Mombasa-Nairobi 330 kV	LINE	90.4	0			
2023	Coal	COAL	164	150	3,868	3,620	248
2024	Coal	COAL	240.1	150	4,o18	3,770	248
2025	Geothermal	GEO	147.5	67.2	4,085	3,920	165
	Import	IMPORT		100	4,185	3,920	265
2026	Coal	COAL	164	150	4,335	4,070	265

Source: Government of Kenya, 2006)

Annex 2: Electricity end-use prices for households per kwh (in US$ converted using exchange rates)

Country	1997	1998	1999	2000	2001	2002	2003	2004	2005
India	0.032	0.029	0.029	0.033	0.035	0.035	0.074	0.079	0.089
South Korea	0.097	0.069	0.081	0.033	0.035	0.035	0.040	n.a	n.a
South Africa	0.046	0.041	0.042	0.040	0.036	0.032	0.048	n.a	n.a
Thailand	0.067	0.056	0.058	0.060	n.a	n.a	n.a	n.a	n.a
United Kingdom	0.125	0.121	0.117	0.107	0.101	0.105	0.116	0.138	0.149
United States*	0.084	0.083	0.082	0.082	0.086	0.085	0.087	0.090	0.093
Kenya**	0.091	0.088	0.074	0.102	0.124	0.105	0.089	0.082	0.093

* Price excluding tax

** Year is fiscal e.g. 1997 is July 1996 to June 1997.

Annex 3: Electricity end-use prices for industry per kwh (in US$ converted using exchange rates)

Country	1997	1998	1999	2000	2001	2002	2003	2004	2005
India	0.032	0.029	0.029	0.033	0.035	0.035	0.074	0.079	0.089
South Korea	0.097	0.069	0.081	0.033	0.035	0.035	0.040	n.a	n.a
South Africa	0.046	0.041	0.042	0.040	0.036	0.032	0.048	n.a	n.a
Thailand	0.067	0.056	0.058	0.060	n.a	n.a	n.a	n.a	n.a
United Kingdom	0.125	0.121	0.117	0.107	0.101	0.105	0.116	0.138	0.149
United States*	0.084	0.083	0.082	0.082	0.086	0.085	0.087	0.090	0.093
Kenya**	0.091	0.088	0.074	0.102	0.124	0.105	0.089	0.082	0.093

* Price excluding tax

** Year is fiscal e.g. 1997 is July 1996 to June 1997.

Source: KIPPRA (2006).