A COMPREHENSIVE STUDY AND ANALYSIS ON ENERGY CONSUMPTION PATTERNS IN KENYA

A SYNOPSIS OF THE DRAFT FINAL REPORT

By

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ABBREVIATIONS AND ACRONYMS

AGO	Automotive Gas Oil
CAFORED	S.C. Laboratory of Applied Ecology, Benin
CCAA	Climate Change Adaptation in Africa programme
CDM	the Clean Development Mechanism, Kyoto Protocol
CPS	Centre for Policy Studies, South Africa
ECA	Eastern and Central Africa region
EPA	Electric Power Act
ERC	Energy Regulatory Commission
KIPPRA	Kenya Institute for Public Policy Research and Analysis
KPC	Kenya Pipeline Company
LA-AIDS	Linear Approximate- Almost Ideal Demand System
LPG	Liquefied Petroleum Gas
MSP	Motor Spirit Premium
OLS	Ordinary Least Squares estimation
PES	Public Electricity Suppliers
PLS	Partial Least Squares
SEM	Structural Estimation Model
SUR	Seemingly Unrelated Regression
TOR	Terms of Reference
UNEP	United Nations Environment Programme
UNFCCC	UN Framework Convention on Climate Change

OPERATIONAL DEFINITION OF TERMS

Consumer Satisfaction Index: An economic indicator that measures customer satisfaction.

Energy balance: The difference between the energy produced by 1 kg of the fuel, for example petroleum, and the energy necessary to produce it (extraction), for example drilling or cultivation of energetic plants, transportation, refining among others.

Satisfaction: The consumer's assessment of a product or service in terms of the extent to which that product or service has met his/her needs or expectations.

Willingness to Pay: the maximum amount of money that may be contributed by an individual to equalize a utility change.

Threshold Willingness to Pay: The starting/beginning amount from the maximum amount of money that may be contributed by an individual to equalize a utility change

Elasticities: Is the ratio of the percentage change in one variable to the percentage in another variable. It's a tool for measuring the responsiveness of function to changes in parameter in a unit-less-way.

Demand Elasticities: A measure of how demand change in response to changes in prices or income.

Price Elasticity of Demand: A measure of the responsiveness of demand to a change in price.

Own-Price Elasticity: A measure of the responsiveness of demand for a good to a change in price of that good.

Cross-Price Elasticity: A measure of responsiveness of demand for one good to a change in the price of another good.

Expenditure Elasticity of Demand: A measure of the responsiveness of demand to changes in expenditure on a bundle of similar goods. Shows how the quantity purchased changes (how sensitive it is) in response to a change in the consumer's expenditure, which is a proxy for income.

Hicksian or Compensated Demand: The Hicksian demand function (after British economist Sir John R. Hicks) shows the relationship between the price of a good, and the quantity purchased on the assumption that other prices, and utility, , are held constant.

Marshallian, Ordinary, or Uncompensated Demand: The Marshallian demand function (after British economist Alfred Marshall) shows the relationship between the price of a good, and the quantity purchased, on the assumption that other prices, and the consumer's budget (or income), is held constant.

Almost Ideal Demand System (AIDS): The AIDS demand system is derived from a utility function specified as a second-order approximation to any utility function. Demand is expressed in budget shares.

1 INTRODUCTION

1.1 Background

Kenya's macro-economic environment has undergone significant reforms since the mid 1980s aimed at improving economic performance, attract investments, increase employment opportunities and incomes, and improve the productivity and efficiency of public investments. These reforms have *inter alia* included privatization by the Government, liberalization of commodity prices and exchange rate regimes and tacit withdrawal of the public sector in activities of a commercial nature. In tandem with reforms in other sectors of the economy, the Government has also undertaken structural reforms in the commercial segments of the energy sector, namely electricity and petroleum, with a view to improving the operational efficiency in the sector by eliminating distortions that existed hitherto, induce competition and allow energy prices to move in consonance with market fundamentals and attract investments into the sector.

As Kenya aspires to be a middle income economy as envisaged in Vision 2030, it faces an enormous task of meeting energy needs due to the high expectations in growth to power the economy. The country therefore needs to come up with strategies and investment plans to secure sustainable supply of energy to meet the growing demand. The energy sector is considered a key enabler to achieving vision 2030. Electricity, petroleum and renewable energy are the most potential sub sectors. Even though wood fuels are the most consumed fuels in Kenya, petroleum and electricity are the most dominating fuels in the commercial sector. Other major energy consumption sectors apart from commercial sector, are transport, manufacturing and residential sectors.

The purpose of this report is to present the findings of a study carried out by the Kenya Institute for Public Policy Research and Analysis (KIPPRA) on "A Comprehensive Study and Analysis on Energy Consumption Patterns in Kenya", commissioned by the Energy Regulatory Commission (ERC).

1.2 Objectives of Study

The main objective of this study was to gather accurate data and information on the recent dynamics in energy use patterns in Kenya that would inform the regulatory policies for the Energy Sector. The data included information on energy consumption patterns for households, commercial and industrial consumers and institutions.

The specific objectives of the study were to:

a. Evaluate the energy demand and supply patterns for households, commercial and industrial sectors, transport and institutions by energy type, design, estimate and analyse a demand model for the energy sector in Kenya;
b. Determine and estimate the drivers for fuel choice and fuel switching by the above consumer categories;
c. Evaluate household energy supply sources, energy prices, and average distances to supply points by energy type;

d. Estimate the per capita energy consumption per adult equivalent for household category;
e. Estimate the price elasticities of demand for traded form of energy for the different consumer categories;
f. Estimate threshold willingness to pay for energy services by household consumers;
g. Estimate the share of energy substitution opportunities for the above consumer categories;
h. Estimate the share of energy to the household budgets in rural and urban areas; and
i. Develop a model for assessing consumer satisfaction index in the energy sector in Kenya.

There were a set of specific terms of reference that informed the conduct of the study and these are articulated in the following sections (1.3) of this Executive Summary.

1.3 Specific Terms of Reference

The specific terms of reference for the renewable energy technologies, downstream petroleum market, and electricity sub-sector included:

1.3.1 Renewable Energy Technologies

a. Review the consumption patterns for solar, wind, firewood, charcoal, crop residues, baggasse and small hydropower and design and estimate a demand model for solar, wind, firewood, charcoal, crop residual and baggasse in Kenya;
b. Estimate the per capita consumption per adult equivalent for solar, wind, firewood, charcoal, crop, residues and baggasse;
c. Estimate the price elasticity of demand for firewood and charcoal by consumers category;
d. Estimate the willingness to pay for solar, wind, firewood, charcoal and crop residues by rural and urban households;
e. Compute average prices and distances to supply points for firewood, charcoal, crop residues and baggasse by geographical location;
f. Estimate the shares of solar, wind , firewood, charcoal and crop residues to households budgets in rural and urban areas;
g. Estimate the type and magnitude of energy savings/conservation potential by consumer category;
h. Develop a framework for gathering and analyzing short frequency consumer based renewable data by type and consumer categories; and
i. Develop a model for assessing the consumer satisfaction index with quality and service standards for traded renewable technologies.

1.3.2 Downstream Petroleum Market

a. Review the supply and demand patterns for Liquefied Petroleum Gas (LPG) Illuminating Kerosene (IK), Industrial Diesel Oil (IDO), Automotive Gas Oil (AGO), Heavy Fuel Oil (HFO), Premium Motor Spirit (PMS) and Candles in the country and estimate a demand equation for LPG, IK, IDO, and AGO;

b. Estimate the proportion of LPG, IK, IDO, AGO, HFO, PMS and Candles in the energy supply portfolio by expenditure, type of fuel and consumer category;
c. Estimate the price elasticity of demand for LPG, IK, IDO, AGO, HFO, PMS and Candles by consumer category;
d. Estimate the budget share of LPG, IK, IDO, AGO, HFO, PMS and Candles on the budget shares for domestic households in urban and rural areas;
e. Estimate the proportional contribution of petroleum based fuels on the operational costs for industrial, commercial and institutions users;
f. Estimate the per capital consumption of LPG, IK, IDO, AGO, HFO, PMS and Candles by the households; and
g. Develop a model for assessing the consumer satisfaction index with service and quality standards for the petroleum industry.

1.3.3 Electricity Subsector

a. Review electricity consumption patterns for various consumer categories in Kenya and estimate a demand model for electricity consumption;
b. Develop a model for assessing the impact of electricity tariff changes on various consumer categories (Household, small industrial, large consumers etc);
c. Develop a model for assessing and estimate the level of price elasticity of demand for electricity for various consumer categories;
d. Develop a model for assessing and estimating the level of willingness to pay for electricity services by the domestic consumer category;
e. Undertake a comparative analysis of the level and competitiveness of commercial electricity tariffs in Kenya relative to her competitors in export market;
f. Estimate the level and cost of standby generation in the power industry in Kenya;
g. Estimate the stock, projected demand and energy utilization of electrical end-use devices at the household level;
h. Estimate the budget share of electricity on the household budget; and consumers in Kenya and develop a model for assessing Consumer Satisfaction index of the industry.

1.4 Interpretation of Terms of Reference

In summary, the terms of reference of this study involved analysis of three broad areas, that is renewable technologies, downstream petroleum market and electricity sub sectors. In the interpretation of the terms of reference, all the objectives of study were critically examined and various tasks developed as per the KIPPRA-ERC contract. Since the energy demand modelling for each of the tasks outlined in the contract involved mainly an integrated system, KIPPRA followed specific methods or approaches in order to realize the TORs. Table 1.1 provides a synoptic view of key deliverables with a link to work packages (WP) and tasks. The work packages column outlines the specific activities KIPPRA undertook in order to realize the objectives of the study.

Table 1: Synopsis of Key Work Activities and Deliverables from the Terms of Reference

Task No and Description	Work Package (WP)	Key deliverables
Task 1 – Trend analysis for energy consumption in Kenya	WP1 - Finalization of Project Description & Inception Workshop	• Project Description Document and Flyer for ERC and KIPPRA websites • Bi-Monthly Progress Reports to ERC
	WP2 - Building a theoretical model and choosing variables	• A Theoretical Model highlighting key variables for in-country petroleum products demand analysis
	WP 3 - Assembly of data sets	• Pre-tested survey instruments (for respondents/key informants) and filled in survey instruments • Organized data sets (on consumption, supply sources, determinants of choice of fuels)
	WP 4 - Exploratory data and consumption trend analyses	• Trends in energy consumption • Descriptive statistics for key variables to be incorporated in modelling phase.
Tasks 2 and 3 – Modelling of energy consumption and demand (factor analysis and econometric models)	WP5 - Basic OLS estimates, functional form(s), diagnostic tests and model dynamics	• Estimated demand functions, energy sub-sector/type for households/enterprises and/or each sub-region in Kenya • Single-equation models of energy consumption and respective elasticity coefficients (i.e., own-price, cross-price, income).
Tasks 4 and 5 – Model for Energy Consumer Satisfaction Index in Kenya	WP6 – A Kenya energy CSI model	• Estimates of 4 CSI indices for energy • A Policy Brief on trends and determinants of energy consumption in Kenya
WP7 - Report writing and final dissemination		• Final Project Report & Discussion Papers • Workshop Proceedings for the Final Dissemination Workshop.

2 LITERATURE SURVEY

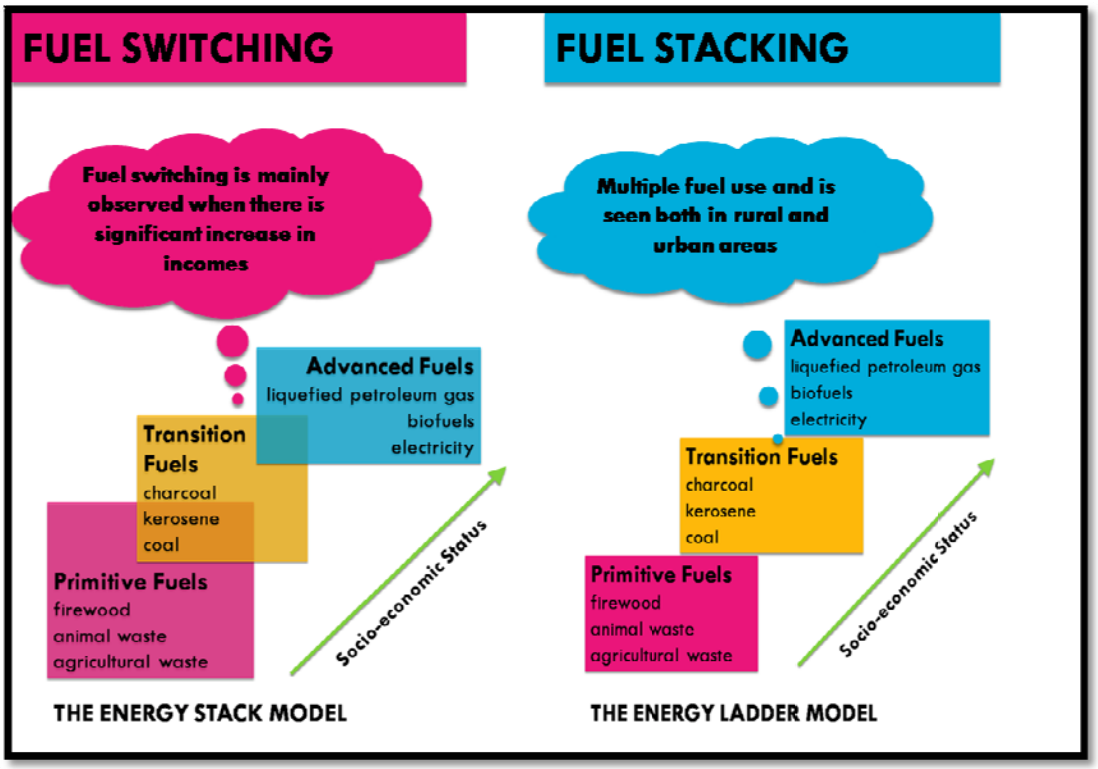
2.1.1 Energy Demand

Energy is mainly consumed in four sectors, namely the manufacturing, commercial, transport, residential, power generation, and street lighting. The transport sector is the largest consumer of petroleum products followed by the manufacturing sector and other sectors such as agriculture, tourism, power generation, and government. The issue of analyzing and predicting energy products demand is crucial for the government and stakeholders and there is substantial body of literature estimating its determinant. In most of these studies that have been done, , demand for each energy products is integrated within energy demand analysis as a whole. For instance, household energy demand is for consumption while the industrial and commercial sectors demand energy as an input in production.

Two major approaches to energy demand analysis are macro and sectoral demand analysis. Macro demand analysis considers demand as a function of population, income and prices. Sectoral demand analysis examines the structure of sector and sub-sectors and their energy consuming activities, including equipment. Many attempts have been made to model the effect of price changes and other factors on domestic demand both for total of all forms of energy and for specific types of fuel.

The reviewed studies reveal that in the residential sector, there is an extensive empirical literature on household energy demand with most papers using micro data and econometric single equation models for household demand of electricity, gasoline and car fuels. Baker et al. (1989) for example uses a quadratic model to estimate gas and electricity expenditure in the United Kingdom, including several energy prices as regressors in each single equation. The study however pays relatively little attention to the estimation of household energy demand through multiple equations modelling (see also Nicol, 2003).

Figure 1: Fuel Stacking and Fuel Ladder Models



Source: Sclag and Zuzarte (2008)

The studies reveal that there are two main models that are widely used to explain household energy allocation behaviour. These are the fuel stacking and fuel ladder models (see Figure 1). The fuel ladder model suggests that as people become richer, they may be expected to move from traditional biomass fuels to more advanced and less polluting fuels (e.g. from wood to charcoal, kerosene, and then to gas). The fuel ladder model on the other hand postulates that fuel switching is mainly observed when there is significant increase in income.

Consistent with energy demand modelling principles and considering the practical availability of data, energy demand and supply models were estimated for each enterprise and fuel type where applicable. In determination of the choice of energy use, a probit model was used and a complete energy demand model was estimated to generate demand elasticities of the different fuel types and enterprises.

2.1.2 Energy Policy Interventions: The State of the art

Various policy interventions and strategies have been used to improve access, ensure security of supply of affordable energy and achieve efficiency and conservation. These have been implemented by individual countries or unions such as the European Union or even within economic blocks. Table 2.1 summarises some of the policy experiences and recommendations from other countries that have been implemented with success.

Table 2.1: Policy experiences from other countries

Country	Policies Issues	Policies recommended
Senegal	Switching from charcoal to LPG	• A poor targeting subsidy on fuel/equipment having both an environment benefit(avoiding deforestation) and a basic need support for lower income groups • Subsidies were on smaller LPG bottles/cylinders of 2.7 and 6 kg LPG bottles. • Increased reliability of LPG supply
Senegal	Low LPG penetration	• Senegal adopted LPG as cooking fuel, increasing demand substantially. • Exempted modern fuel appliances from import duties • Introduced direct fuel subsidies on LPG fuel cylinder funded by taxes on other petroleum products, and offering discounts on smaller units of LPG fuel.
Burkina Faso		• Introduced forest taxes and levies in an effort to drive up the market price of firewood, which is the main fuel of choice for both rural and urban areas
Tanzania		• Uptake of LPG has been limited due to the unavailability of the fuel and equipment, but the introduction of tax reductions has improved situation. • Providing direct subsidies to LPG, creations and establishment of LPG market.
South Korea	Low utilization of wind power	• Increase contribution of wind energy to national grid by providing subsidies in wind power exploration
Tanzania	Low levels of commercial energy use and low electricity access	• Developed REA(Rural Energy Access) and REF(Rural Energy Fund) • REAs responsible for rural energy development by promoting new investments in modern energy for rural areas while REFs responsibility is to provide capital subsidies to bring down the cost of energy services
Barbados	Low energy efficiency and limited conservation measures	• Implementing economic incentives to promote energy conservation; efficient energy use; promoting renewable energy sources • Introducing standards for efficient energy use in technologies; • Encourage the large-scale generation of energy using

		renewable sources; • Promoting research and development into renewable energy; • Implementing disaster management initiatives to mitigate against climate change
South Korea		• Improve industrial power efficiency through tax credits for high efficiency technology conversions
Canada, France, Germany, Italy, Japan United Kingdom and United States	Enhancing energy efficiency and energy saving	• Updating building code requirements • Developing systems to enhance scope and stringency of appliance efficiency standards • Developing rules on tyre pressure • Phasing out incandescent light bulbs • Collected data on the energy performance of existing buildings
Canada, France, Germany, Italy, Japan United Kingdom and United States	Diversification of the energy mix	• Renewables and Bio fuels obligations and other incentives in place • Nuclear Waste Disposal Act enacted and new incentives for nuclear power for Canada, Japan and US
Canada, France, Germany, Italy, Japan United Kingdom and United States	Increasing transparency, predictability and stability of global energy markets	• Improving competition in energy markets by reduction of dominance, establishment of independent regulators, introduction of new products and market liberalization • Increasing independence of gas and electricity networks • Data transparency and free flow of information • Independent regulation of the energy market • Implementing emergency response measures (compliance with IEA oil stock obligation) • Good governance of public revenue and actions to reduce corruption

Source: IEA (2009) and Sclag and Zuzarte (2008)

2.1.3 Consumer Satisfaction Index

Consumer satisfaction is a term mainly used in the business world. It is a measure of how products and services supplied by a company meet or surpass customer expectation. It is seen as a key performance indicator within business or service delivery. While customer satisfaction is the consumer's assessment of a product or service in terms of the extent to which that product or service has met his/her needs or expectations, Consumer Satisfaction Index (CSI) is an economic indicator that measures customer satisfaction. Consumer satisfaction has become a vital concern for companies and organizations in their efforts to improve product and service quality, and maintain customer loyalty within a highly competitive market place.

The basic structure of the CSI model has been developed over a number of years and is based upon well established theories and approaches to consumer behaviour, customer satisfaction and product and service quality (see Fornell, 1992; Fornell et al., 1996). Although the core of the model is in most respects standard, there are some variations between the SCSB (Swedish), the ACSI (American), the ECSI (European), the NCSB (Norwegian) and other indices. This study adopts the European Consumer satisfaction index (ECSI) give that it is an adaptation of the Swedish Customer Satisfaction Index and is compatible with the American Customer Satisfaction

Index (Bayol et al., 2000). It is based on well-established theories and approaches in customer behaviour and it is to be applicable for a number of different industries. The European Customer Satisfaction Index (ECSI) model uses six constructs, namely, image, customer expectations, perceived quality of hardware and software, perceived value, customer satisfaction, and customer loyalty. In this study the ECSI model contains first, a core model, that is, the traditional variables which include perceived quality, expectations, perceived value, satisfaction index and loyalty. The second model adds two optional latent variables: image and complaints.

2.1.4 The Willingness to Pay

Willingness to Pay (WTP) is an economic concept, which aims to determine the amount of money a consumer is willing to for the energy product, which indicates the value to the consumer for that energy product. The consumers' WTP is becoming increasingly popular and is one of the standard approaches that is used by market researchers and economists to place a value on goods or services for which no market-based pricing mechanism exists [koss (2001) and Gill et al. (2000)].

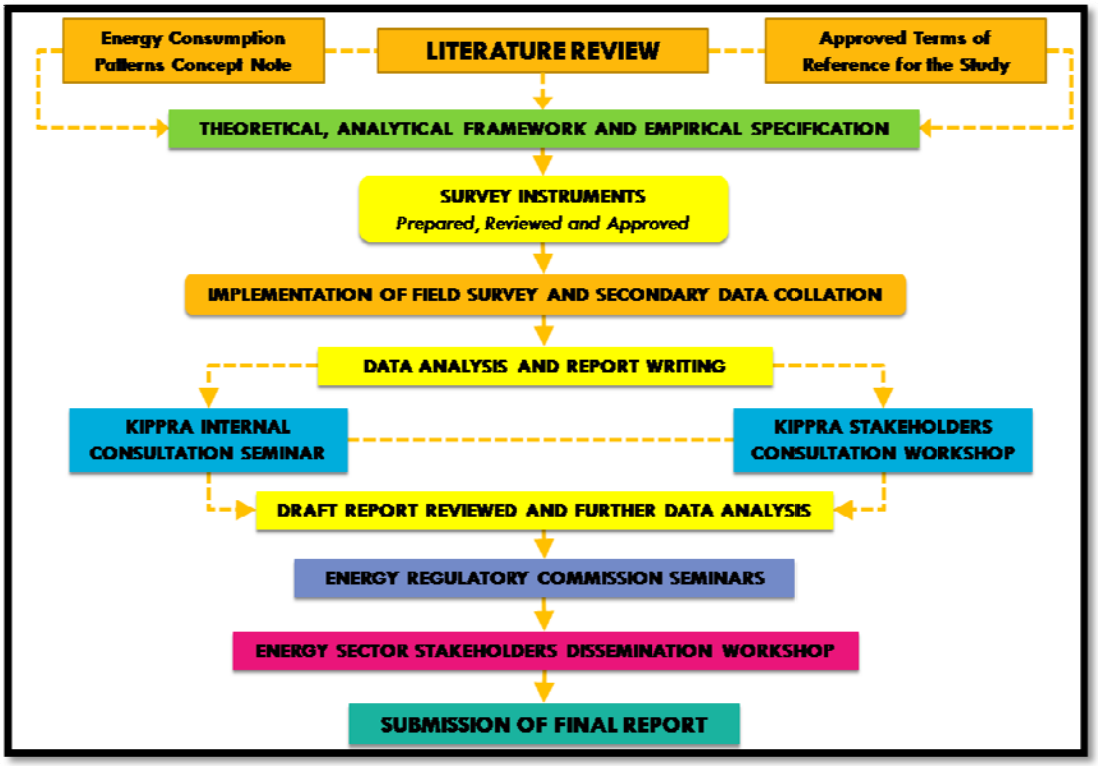
Literature suggests that two approaches are being used to analyze the consumers' WTP. The direct approach, involves taking a survey through a structured questionnaire of consumers' WTP specified prices for hypothetical services, also referred as Contingent Valuation Method (CVM). The indirect approach involves observing consumers' behavior and modeling of behavior based on the approximate expenditure in terms of time and money to obtain the goods or services and infer about WTP through measurement of revealed preference [Kristrom and Laitila (2003), Raje et al. (2002), Cookson (2000)]. The revealed preferences approach derives WTP values indirectly from the actual market behavior of individuals. In this study, both direct (CVM) and indirect methods were used to determine the WTP for renewable energy sources by rural and urban households in Kenya.

3 THE STUDY METHODOLOGY

3.1 General Approach

The study utilised both primary and secondary data for the analysis. Secondary data were obtained from official statistical publications including Statistical Abstracts, Economic Survey, Kenya Power and Lighting Company Limited Annual Reports and Tariff booklets, and Ministry of Energy's summaries of the petroleum sector data. Primary data on the other hand were obtained from the energy field work using personal interviews.

Figure 2: General ERC Energy Consumption Patterns Study Approach



3.2 Sampling and Sample Implementation

This study utilized a combination of survey and non survey techniques to collect data, estimate energy consumption patterns, willingness to pay, develops a consumer satisfaction index for the energy sector, and estimates energy efficiency and conservation gains in Kenya. The energy field study involved interviewing two categories of respondents, namely, consumers (enterprises and households), and suppliers, producers and players in the energy chain. This implied drawing sample of intended respondents from two types of frames under the custody of the Kenya National Bureau of Statistics (KNBS) namely, the Central Register of Establishments, otherwise known as Master File and the National Sample Survey and Evaluation Programme (NASSEP). From the sampling frame, a total of 6,346 were administered. With regard to energy consumers, a total of 3,665 households and 1,663 enterprises were interviewed while in the energy supply chain, 857 energy providers' interviews were done.

Data Reliability

Sampling is the scientific method utilized by statisticians to achieve what a census would do at a fraction of the cost of the census. The beauty of the sample is that owing to its small size; errors can be controlled, hence improving quality of data collected. The energy field study involved interviewing two categories of respondents, namely Households and Institutions, both producer/provider and consumer of energy.

The primary data was obtained using research instruments that were thoroughly reviewed by experts in the energy sector, academicians and statisticians both at KIPPRA and other peer

institutions. The data was collected from all eight provinces in the republic using a scientifically selected random sample both for households, enterprises and energy supply chain players. The study uses both primary and secondary data sources. The secondary data were obtained from the Kenya National Bureau of Statistics, the International Energy Agency, World Development Indicators by the World Bank, and the KIPPRA Data Compendium among other credible sources. The methodology used in data collection as well as the secondary data sources in the energy are reliable and highly credible.

4 THE ENERGY SECTOR ANALYSIS

4.1 The Energy Sector Regulatory Framework: A Historical and Futuristic Perspective

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. The Sessional Paper No. 10 of 1965 dwelt on the Electric Power Act (CAP 314) that was used to regulate the sector. This was followed by the Sessional Paper No. 1 of 1986, which however, did not focus much on the power sector. The Sessional paper called for the establishment of the Department of Price and Monopoly Control (DPMC) within the Ministry of Finance, under new legislation, to monitor action in restraint of trade and to enforce pricing in the various sectors. This also included the petroleum sub-sector.

In 1981, the National Oil Corporation of Kenya Limited (NOCK) was established by the government and incorporated under the Companies Act (Cap 486). The company's main objective then was to coordinate oil exploration (upstream) activities. In 1988 the company was mandated on behalf of the government to supply 30% of the country's crude oil requirements that would in turn be sold to oil marketing companies for refining and onward sale to consumers. The Petroleum Act (Cap 116) for a long time was used to guide operations in the sector. In addition to this legislation there was the Petroleum Exploration and Production Act that was enacted in 1984. It gave NOCK the mandate to oversee oil exploration activities in the country. In 1994, there was further implementation of policies to liberalize most of prices and sectors in the country such as removal of exchange rate controls; interest rates decontrol and price decontrol that included petroleum products among other goods in the consumer basket. It was during this period that the oil industry was deregulated and NOCK lost its mandate to supply the 30% of the country's crude oil requirement. The company therefore had to formulate new survival strategies that saw its entry into downstream operations.

The energy sector witnessed further developments in policy which saw the unbundling of the Kenya Power and Lighting Company into three entities with the enactment of the Electric Power Act No. 11 of 1997. These were the Kenya Power and Lighting Company that was to carry out transmission and distribution functions, the KenGen to carry out the generation function and the Electricity Regulatory Board (ERB) to regulate the power sector in 1998. The Act aimed at facilitating private sector participation in the provisions of electricity services. The Act also allowed Independent Power Producers (IPPs) to enter into Power Purchase Agreements (PPAs) with KPLC to add more power into the grid.

In 2004, the Ministry of Energy in consultation with stakeholders in the sector developed the Sessional Paper No. 4 of 2004. This 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. 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.

Following the Sessional paper, the government enacted the Energy Act No. 12 in Dec 2006 which converted ERB to ERC in 2007 to offer regulatory stewardship to electricity, petroleum and new and renewable sub-sectors. ERC is mandated by the Energy Act, 2006 to carry out the following functions: regulate the electrical energy, petroleum and related products, renewable energy and other forms of energy; protect the interests of consumer, investor and other stakeholder interests; maintain a list of accredited energy auditors as may be prescribed; monitor, ensure implementation of, and the observance of the principles of fair competition in the energy sector, in coordination with other statutory authorities; Provide such information and statistics to the Minister as he may from time to time require; and Collect and maintain energy data; prepare indicative national energy plan; and Perform any other function that is incidental or consequential to its functions under the Energy Act or any other written law[1]. Other institutions created with the enactment of the Act were the Rural Electrification Authority (REA) and the Energy Tribunal. Recently, the government has created two other key institutions in the sector. These are the Geothermal Development Company[2] and Kenya Electricity Transmission Company (KETRACO)[3].

The future of the energy sector in Kenya is bright. In the electricity sector, green electricity is going to be the energy of the future. Government efforts to increase power generation are in geothermal and wind sources of electricity. GDC has embarked on an ambitious programme to increase the number of wells in Olkaria and other potential areas while in wind, KPLC has already signed a PPA with Lake Turkana Power Company to supply 300MW of electricity. In petroleum; there have been increased activities in exploration of hydrocarbons in Northern and Coastal regions in the country. The government has also intensified search for coal deposits in Kitui. Lastly, future government policy in energy is leaning towards improvement of the working modalities with Public Private Partnerships (PPPs). All these initiatives are aimed at ensuring security of energy in the country in order to meet increased energy demand as envisaged in vision 2030

[1] See ERC Website and the Energy Act No. 12, December 2006.

[2] The Geothermal Development Company (GDC) is a 100% state-owned company, formed by the Government of Kenya as a Special Purpose Vehicle to fast track the development of geothermal resources. Geothermal energy is an indigenous, abundant, reliable and environmentally-friendly source of electricity.

[3] Kenya Electricity Transmission Company Limited (KETRACO), which is wholly owned by the Government, was incorporated on 2nd December, 2008 under the Companies Act, Cap 486, pursuant to the reforms envisaged under Sessional Paper No. 4 of 2004 on Energy.

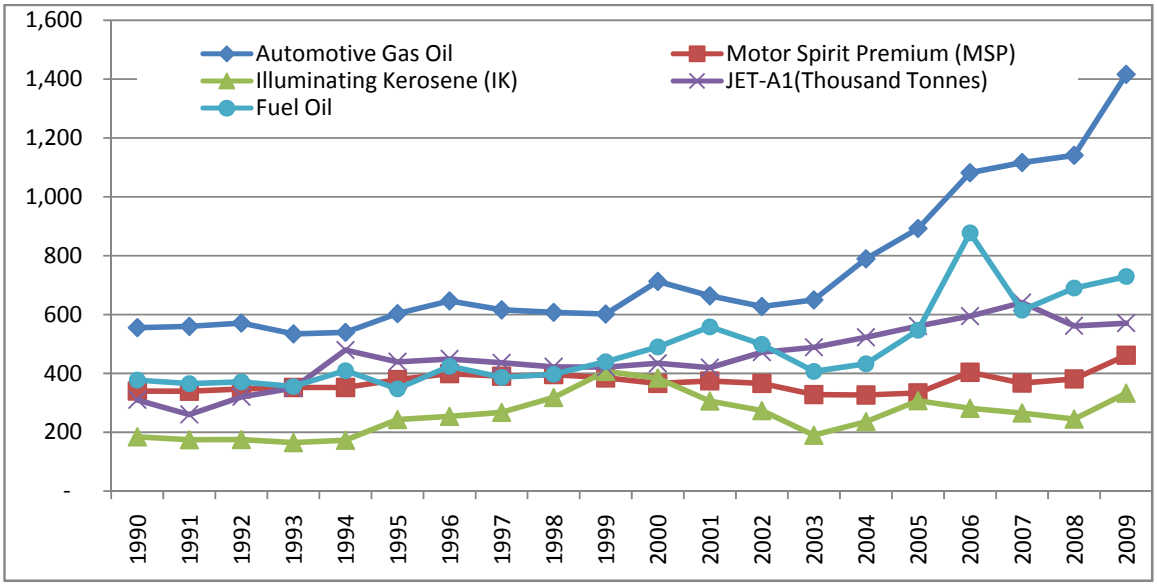
4.2 Energy Consumption Trends

In Kenya, energy resources comprise commercial and non-commercial. Commercial energy mainly comprises of petroleum products and electricity, while non-commercial comprises of biomass, and to a lesser extent solar energy, wind power and biogas. From the National Energy Matrix, total final energy consumption in Kenya in 2009 was 14,353.8 thousand tonnes of oil equivalent while the total primary energy supply was 18,215.99. Petroleum fuel accounts for about 28.57% of the total final energy consumption while electricity and combustible renewables accounts for about 3.11% and 67.65% of the total final energy consumption. The energy sector contributes about 9.49 % to GDP with the petroleum sector, electricity and fuel wood sector contributing 8.4%, 0.6 % and 0.4% respectively. The GDP per unit of oil equivalent is PPP US$ 2.98 compared to that of Botswana of US$ 12 and Tanzania US$ 2.53.

The use of LPG at homes, educational and health institutions has risen from slightly over 40 thousand metric tons in 2003 to 80 thousand metric tons in 2008. Motor gasoline which is mostly used in the transport of passengers and goods may not have made any remarkable growth owing to the efficiency of the vehicles entering the domestic market, in spite of the rise in numbers. Automotive gas oil, the dual purpose fuel consumed by transport and agriculture, had a six fold rise between 2003 and 2008. Other products which recorded increased consumption include lubricating oils, as proof of the growth of transport vehicles and machinery for use in agriculture and manufacturing industries. Illuminating kerosene the most popular fuel for use by households in lighting and cooking used about 300 thousand cubic metres in 2008 as compared to about 200 thousand cubic metres consumed in 2003.

Figure 4.1 shows consumption of selected petroleum products (000s tons). In general, the demand for petroleum products increased from 3,185 thousand tonnes in 2008 to 3,656 thousand tonne in 2009. This demand growth was driven by mainly automotive gas oil which stood at 1,416 thousand tonne in 2009 up from 1,141 thousand tonnes. Others factors which also increased growth of demand were MSP, illuminating Kerosene and fuel oil.

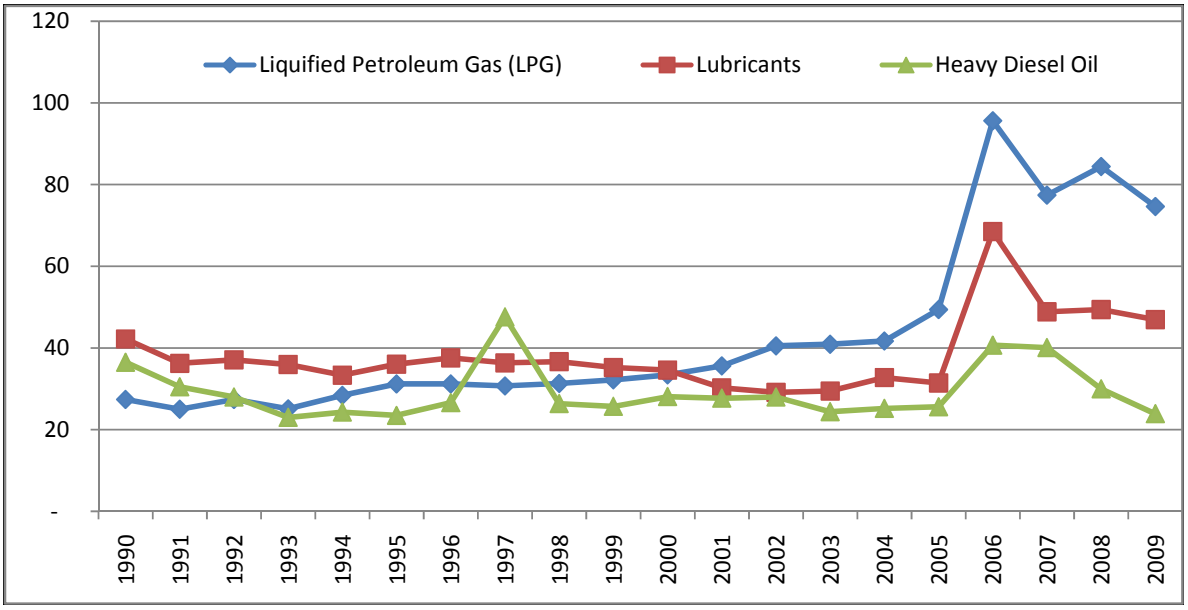
Figure 4.1: Consumption of selected petroleum products (000s tons).



Source: Computation from KNBS data, Various Issues

The consumption of each of the petroleum products has on average been increasing over time. Note that with an exception of kerosene and jet fuel which recorded a decelerated increase in consumption in the year 2006, the consumption of the other petroleum products increased. Figure 4.2 shows consumption of selected petroleum products (000s tons)

Figure 4.2: Consumption of selected petroleum products (000s tons)



Source: Computation from KNBS data, Various Issues

The transport sector which includes land, water and air transport is the largest consumer of petroleum products followed by the manufacturing, power generation and agriculture, respectively. Over the years, the transport sector generally consumed 70% of the total net

domestic sales of petroleum products as compared to the manufacturing sector, which consumed less than 20% of the total net domestic sales of petroleum products.

The wholesale prices for various petroleum products including motor spirit premium, motor spirit regular, automotive gas oil, illuminating kerosene, LPG, heavy diesel oil have been increasing over time. In 2009 there was a sharp decline in prices for these petroleum products as a result of financial crisis and the fall in demand for crude oil.

Sources of electricity in Kenya are hydro, thermal oil, geothermal and co-generation, with hydro being the highest contributor of electricity. KNBS data shows that all consumer categories recorded an increased demand in electricity with domestic, commercial and industrial, and rural electrification increasing by 10.8, 7.6 and 3.5% respectively. Standby generation involves use of generators during times of high demand on utilities to avoid extra "peak-demand" charges or during periods of power shortage and outages in order to ensure continuous supply of power. From KIPPRA energy study, standby generation is estimated at about 22 percent in the manufacturing sector and 31 percent in the furniture related enterprises respectively. Other sectors such agro industry, construction related industries, machinery, metals and chemical plants have high standby generation levels.

Comparative electricity tariffs

The Electricity tariff in Kenya in 2008 was US Cents 9.4 per kWh. This was higher than that of South Africa (US Cents 6.6 per KWh) and Egypt (US Cents 3 per KWh) who are her major competitor in trade and services in East and South Africa India which has one of the highest populations in the world and is currently experiencing growth rate of about 10% has very low and competitive tariffs (5.38US cents per kWh) and this is good for the households and industry. The UK and Singapore have some of the highest tariffs in the World at 21.9 and 18.4 US cents per kWh respectively compared to the USA and South Korea. Although power tariffs in South Africa are lower than that of Kenya, there is a general trend for them increasing while those in Kenya between 2005-2008 have remained fairly stable. Table 4.1 shows the electricity tariffs in Kenya, according to the National Energy Survey 2009, the electricity tariffs Kshs/kWh are lowest for households (Kshs. 11.38/kWh) but highest in transport and communications (Kshs. 13.21/kWh) firms and manufacturing sector (Kshs. 13.01/kWh). These two sub sectors comprise the large commercial/industrial from the KPLC consumer category.

Table 4.1: Electricity Tariffs in Kenya

Sector	Kshs/kWh
Agriculture	12.16
Manufacturing including mining and quarrying	13.01
Electricity and water	11.95
Trade including tourism and insurance	11.80
Transport and communications	13.21
Community and social institutions including government	11.76
Households	11.38

Source: National Energy Survey, 2009

It is apparent that for the foreseeable future electricity tariffs will continue to rise. On the face of it, this constitutes a major risk to Kenya's competitiveness and seems to fly in the face of the need to provide reliable and affordable electricity as a national strategic imperative which is not necessarily true. However, tariff setting as outlined in the Energy Policy of 2004 and the Energy Act 2006 has been focussed on maintaining competitive electricity tariffs despite various challenges in the cost of generation and transmission of power. Unbundling of transmission functions and establishment of geothermal development company and other initiatives to increase supply of green energy such as wind are some of the strategies being implemented to reduce the cost of power in Kenya.

Fuel wood is widely consumed for cooking. Fuel wood and charcoal are measured in stacked cubic metres, though extreme variations in the data suggest problems in the data collection process or episodes of improved application of the regulatory framework. Renewable technology is the way forward to Kenya's energy security but the energy productions from these sources have been limited. Small hydro still takes a major share of the total renewable energy sources. In 2009 it had a total production of 46 KWh while cogeneration and wind had 4 KWh and 0.3 KWh respectively.

4.3 Energy Demand and Supply Trends

4.3.1 Energy demand

This section provides discussion on results for energy demand for household, enterprises(consumers) and energy providers; willingness to pay for improved services for both household and energy providers; consumer satisfaction and lastly efficiency and conservation measures.

Household Sector

The analysis showed that about 70% of the consumers use biomass while 30% use other fuels. This supports well known studies that biomass provides 70% of the energy requirements (Kituyi, 2002, Kamfor 2002). The study showed kerosene to be mostly used for lighting (52%) while biomass was widely used for cooking (60%). The survey data showed that users of charcoal and fuel wood in Nairobi have to travel on average 0.59 and 6.44 kilometres respectively to access the fuel they need. With an exception of the transport fuels, average monthly consumption per household was high for electricity (386.01 Mega Joules) compared to the other fuels. The energy budget shares for households differed across the provinces, fuels as well as location, either rural or urban. Fuel wood had the highest energy budget share on average for both rural (11.6 %) and urban (9.34 %) compared to the other fuels.

The findings indicated that Nyanza households utilised a larger proportion of their energy budget on charcoal compared to other urban households. Note that the penetration of fuel wood in the rural areas was 77.2 percent implying most of the households in the rural areas use fuel wood. Connectivity to electricity in Kenya varied greatly across provinces with Nairobi having the highest connection with 53.47 % of total households. Central province was second with 42.4 % while North Eastern and Western Provinces had the list connection rates of 14.5 percent and 14.7 %

respectively. The national connection rate was estimated to be 28.9 %. The results indicated fuel stacking where 54% of the households used two fuels with 2% using only one fuel type. Cost of installation was the most cited reason for not using LPG, Electricity and Solar Energy Sources with most households classified as lower income groups not utilizing these fuels.

Analysis of fuel types in Kenya by urban and rural areas shows that the most popular fuel types in terms of their various uses are: kerosene (80%), followed by charcoal (60), fuel wood (55%), electricity (37%) and LPG (21%) in that order. The usage of fuel wood, charcoal and kerosene in rural areas is higher, compared to urban areas. However, the use of LPG and electricity in the rural areas is lower, compared to that of urban areas. While lower prevalence of electricity use in rural areas can be attributed to lack of connectivity, lower LPG use can be attributed to lack of access and information. Overall, the use of renewable energy from solar, biogas and wind is very low in Kenya with 3%, 0.2% and 0.1% respectively.

The usage of fuel types by various income categories[4] reveals that the use of Material residue, kerosene and fuel wood declines with rise in income (higher quintiles). However, the trend for use of charcoal, electricity, biogas and solar is reverse. The use of these fuels increase with rise in income. Given that charcoal is regarded as 'unclean fuel', we would expect households to substitute it with more clean fuel as income increases. However, the results of the study show that usage of charcoal does not change with increase in income.

The energy choice model results showed that demand for cooking fuels such as fuel wood, charcoal, kerosene, electricity and liquefied petroleum gas(LPG) are driven by certain key factors and vary depending on whether the household is located in rural or urban areas. The key determinants for kerosene choice at the household were occupation, total energy expenditure, household size, fuel wood price, education level and price of LPG. With regard to fuel wood choice, important factors included the price of fuel wood which has a negative coefficient, household size and total expenditure. The key determinants of choice for use of charcoal included household size, price of charcoal, price of fuel wood, education level, and both formal and informal employment. The regional dummies for Central were positive implying that a household in Central Kenya is likely to use charcoal compared to Nairobi. The choice of electricity was determined by employment level, price of wood fuel, and education level. Interestingly, households in urban areas would consume MSP even if the price increases. All regional dummies had positive coefficients but not statistically significant. The key determinants of AGO include formal employment, its own price, total energy expenditure at the household level and price of lubricants.

[4] The income categories in this section refer to five (5) different income groups. Where, quintile 1 refers to households with the lower income levels who earn less than Kshs. 6,119. Quintile 2 refers to households with income levels between Kshs. 6,120 and Kshs. 9,319. While Quintile 3 and 4 refers to households with income levels between Kshs. 9,320 and Kshs. 13,015 and Kshs. 13,016 and Kshs. 20,408 respectively. Quintile 5 refers to households with income levels above Kshs. 20,409.

The findings indicated that different factors significantly affect the fuels hence policies targeting these factors should be fuel specific. Household size, kerosene total expenditure, kerosene price, fuel wood price, charcoal price, LPG price, female, education level, were some of the key determinants of kerosene budget share. As the household size increases, the budget share on kerosene declines. This could be explained by the fact that as the household size increases, the household switches to other fuel types such as charcoal and fuel wood supporting our earlier finding on fuel stack hypothesis. Share of budget for LPG in Kenya is mainly driven by household size, total expenditure on LPG, kerosene prices, fuel wood price and its own price. As the price of charcoal increases, the budget share on LPG increases. From the analysis, urban households are more likely to increase demand for LPG than those in rural areas. Budget share for MSP is mainly driven by employment both formal and informal, its own price which is positively related with the budget share, i.e. as its own price increases, the budget share allocated to MSP increases as well. In urban areas, only its own price and price of MSP are statistically significant. The budget share for charcoal was driven by various factors ranging from socioeconomic, prices, education and location of households among other factors. Demand for charcoal is inversely related to its own price. That is, as the price increases, less of it is demanded. Other important factors in the demand for charcoal included household size, price of LPG, as well as primary education which is inversely related to demand. Households in urban areas were more likely to use charcoal than those in rural areas, while Eastern, Rift Valley and Western provinces had negative influence on demand for charcoal.

Energy consumption pattern in Kenya portrays more of fuel stacking than fuel switching, where households are observed to be using multiple fuels (the use of more than one or various fuels to meet different energy demands). Fuel switching occurs when a household opts or chooses to completely shift and use a new fuel. (fuel mixes).

Elasticities

Price elasticity of demand is an elasticity used to show the responsiveness of the quantity demanded of a good or service to a change in its price. More precisely, it gives the percent change in demand one might expect after a percent change in price. The uncompensated (Marshallian) own price elasticities were high indicating households respond to higher prices through demand management/substitution to other fuels hence fuel stack hypothesis where other factors like fuel stock, household size, other than income determined budget share. The uncompensated cross elasticities for electricity were -0.22, 0.36, 0.35 and 0.77 in the case of fuel wood, kerosene, charcoal and LPG respectively while its own price elasticity was -0.504.

The own-price elasticities for MSP and AGO indicated that fuels was more price elastic compared to the other fuels implying that households were more likely to increase or reduce the share of budget expenditure of these fuels when their price changes. The expenditure elasticities were positive for fuel wood (1.654), kerosene (1.215), charcoal (0.766) and LPG (0.309) suggesting that these fuels are normal goods and an increase in income will generally lead to higher consumption. The highest elasticities (greater than one) are for fuel wood and kerosene implying that an increase in total energy expenditure will lead to more than proportionate increase in the expenditure shares and hence the usage for these two will be pervasive in Kenya. This implied

that when simulating future demand to consider not only income and population growth but distribution. The lowest expenditure elasticities were for LPG (0.31) and charcoal (0.77) implying that an increase in total energy expenditure will lead to less than proportionate increase in the expenditure shares. Note that the expenditure elasticity for electricity was negative (-0.039) indicating that an increase in income would lead to a fall in demand as people shift to more efficient appliances.

Enterprises (Consumers)

For the consumption of each energy type in various enterprises, several models were estimated using expenditure for each fuel type as the dependent variable using ordinary least squares. The regional dummies for fuel wood consumption were statistically significant for the different sectors with an exception of the agricultural sector. The manufacturing and community and social institutions (trade) dummies were positive (negative) implying that fuel wood expenditure in these regions for the sectors were higher (lower) than expenditure in Nairobi, which is the reference region. Fuel wood price was positive (negative) and significant for the agriculture, manufacturing and community and social institutions (trade) implying an increase in the unit price of fuel wood, increases (decreases) the expenditure on fuel wood, which would mean that there is no close substitute for fuel wood in the manufacturing and community and social institutions sectors except for the trade sector. However, as we increase the unit price of kerosene (charcoal), the expenditure on fuel wood decreases for the trade (manufacturing and community and institutions) sector.

The utilization hours were negatively related to fuel wood consumption in the trade sector unlike the other sectors where it is positively and significantly related, which could explain the negative relationship between fuel wood expenditure and fuel wood price in the trade sector. Moreover, days the firm spent without fuel wood (stock out) decreased the fuel wood expenditure in all the sectors as expected. Firm age was positive and significantly related with fuel wood expenditure albeit trade sector where it was insignificant. This not withstanding however, fuel wood distance is positive and significant implying that as we increase the distance of fuel wood source, the expenditure increases.

Under charcoal consumption, charcoal price was positive (negative) and significant for the agriculture, manufacturing and community and social institutions (trade) implying an increase in the unit price of charcoal, increases (decreases) the expenditure on charcoal. In the manufacturing and agriculture sectors, fuel wood price was positively related to charcoal expenditure which could be attributed to the substitutability between the two energy sources in these sectors. As expected, charcoal distance was positive and significant implying that as we increase the distance to charcoal source, the expenditure increases.

For LPG consumption, LPG price was negative (positive) for agriculture and manufacturing (community and social institutions, and trade) sectors, implying an increase in the unit price of LPG, decreases (increases) the expenditure on LPG. The decrease in LPG expenditure accompanying a unit price increase could be attributed to LPG not being a main fuel in these sectors. As noted previously, both charcoal and fuel wood increment in the unit price positively

increases the expenditure. As expected, increasing utilization hour's increases LPG expenditure in all sectors.

In terms of electricity consumption, only labour representing size was positive and significant across all the sectors implying an increase in the size of the enterprise led to an increase in electricity expenditure. Firm age was positive and significant only in the manufacturing sector indicating an increase in firm age led to an increase in electricity expenditure.

As regards motor spirit consumption other than distance to MSP source and days spent without MSP being significant and positive in the electricity and water sector, MSP utilization hours and AGO price was negative and significant.

Overall, most of the variables in AGO expenditure were significant in the electricity and water sector. For kerosene consumption, kerosene price was positive and significantly related with expenditure indicating that an increase in unit price of kerosene would lead to an increase in expenditure. Kerosene utilization hours were positive and significant implying that an increase in the utilization hours would lead to increase in expenditure which is not surprising given the positive relationship between kerosene price and expenditure.

The price elasticities were different across the enterprises and the fuel types. The transport and communication sector had a negative electricity price elasticity implying that an increase of the price for electricity with 1 % would reduce expenditure on electricity by 49% in this sector.

4.3.2 Energy Supply Trends

Energy Providers

Findings in energy supply trends show that petroleum products are transported from the refinery or Kipevu oil facility via pipeline, railway tankers or road tankers. The pipeline was considered the safest and fastest means of getting the products from Mombasa to the hinterland but does not get the product to its retail outlet. This is done through road tankers which collect fuel from such depots to petrol stations. Road tankers are convenient and faster for short distances and are the only means in areas not served by the pipeline. Stocks kept by oil dealers were in most cases be determined by the financial size of the firm and its storage capacity. Small enterprises would not (even if they are willing) have the financial ability to buy and keep large stocks for the same reasons advanced above. However, as a matter of principle, all dealers indicated they would like to have stocks to last them more than thirty days.

The Energy providers' estimations were done by the type of energy and by specific providers. According to the estimation by type of energy, the model results varied across the sectors. Fuel wood sales were less in other provinces compared to Nairobi, the base region.

Kerosene price was negative (positive) for charcoal and LPG (kerosene) sales. The kerosene results shows non-substitutability for kerosene which supports the earlier results on demand. For both charcoal and LPG, an increase in the price of kerosene, led to decrease in charcoal and LPG sales indicating the people shifting expenditure to kerosene at the expense of the other fuels. Charcoal price was negative and significant implying that a unit increase in charcoal price

decreased the sales which could imply that most charcoal within our sample is provided to the trade sector, whose expenditure was negatively related with the price.

AGO price as positively (negative) for both MSP and AGO (lubricants) implying a unit increase in AGO price increased the sales for both AGO and MSP. Lubricant price is positive for a lubricant which implies non substitutability of the energy type. As expected, fuel wood and solar prices are positive and significant for each implying a unit increase in price increases the sales.

Firm age was positive and significant for kerosene implying a unit increase in age of the firm could increase the sales, which could be attributed to the firm having established loyalty with some customers. With an exception of LPG, labour was found to be positive and significant implying that the sales for petroleum sector increase with increase in labour. Days spent without LPG (MSP) significantly increase (decrease) sales supporting the earlier results.

4.4 Energy Service Quality and Value Added

4.4.1 Willingness to Pay For Improved Services

Households

Households were asked if they are willing to pay to meet the cost of improving the quality, reliability and efficiency of energy products & services in order to ensure zero complaints. On reliability issues, households were questioned if energy is of accepted standards & amount desired. Reliability was measured by frequency, duration, extent of power system disturbances & outages. We note that reduced reliability affects adequacy, security & quality of power supply. Efficiency looked at storage capacity in relation to transmission & generation facilities utilization which affects prices and quality of services.

Majority of households indicated that they were not willing to pay for improved quality of products and energy services. Out of the entire sample, more households were willing to pay more for electricity (13.7%), kerosene (23.5%) and charcoal (18.0%) improved services compared to the other fuel services. 9.8% of households supported paying more for fuel wood. On petroleum related products, 94%, 99% and 99% indicated unwillingness to pay for better LPG, lubricants and other petroleum products.

WTP differed from national, rural and urban areas and also by income levels. Household living in the urban areas and those with higher incomes had higher WTP. For instance, at the national level households are willing to pay for 121.52 KW/h per month for improved (or have zero complaints raised on) quality, reliability and efficiency of electricity products and services while urban and rural areas are WTP 132.42 KW/h per month and 88.84 KW/h per month respectively. For the lower income household (those who earn less than Ksh.8,249 per month) are willing to pay Kshs. 35.45 KW/h per month for improved electricity products and services with a threshold willingness to pay of 6.41 KW/h per month. Middle income households (those who earn between Kshs. 8,250 and 11,499 per month) are willing to pay 64.33 KW/h per month for improved electricity products and services with a threshold willingness to pay of 10.11 KW/h per month. Higher income households (those who earn above Kshs. 15000 per month) are willing to pay for

161.33 KW/h per month for improved electricity products and services with a threshold willingness to pay for 14.9 KW/h per month.

The analysis revealed that affordability was the main reason why majority were not willing/ able to pay for improved energy services for example kerosene, electricity and charcoal were viewed to have high cost. Lack of information deterred households from willing to pay for improved LPG products and services, while petrol and lubricants, were viewed to be dangerous, unsafe and of poor quality.

WTP varies from across energy type, by sector and technology. Some households/firms are willing to pay for improved renewable energy technologies. The key determinants influencing WTP include total expenditure (which was a proxy for income), region, age, education level and whether rural or urban.

Enterprises

The bigger proportions of firms were unwilling to pay additional money for improved energy services. Electricity was singled out as the energy source for the majority of the business community though they were unwilling to pay for improved services. On average, few agriculture enterprises were willing to pay extra amount for the improved services compared to enterprises in the trade, community and social institutions sector.

4.4.2 Consumer Satisfaction Index (CSI)

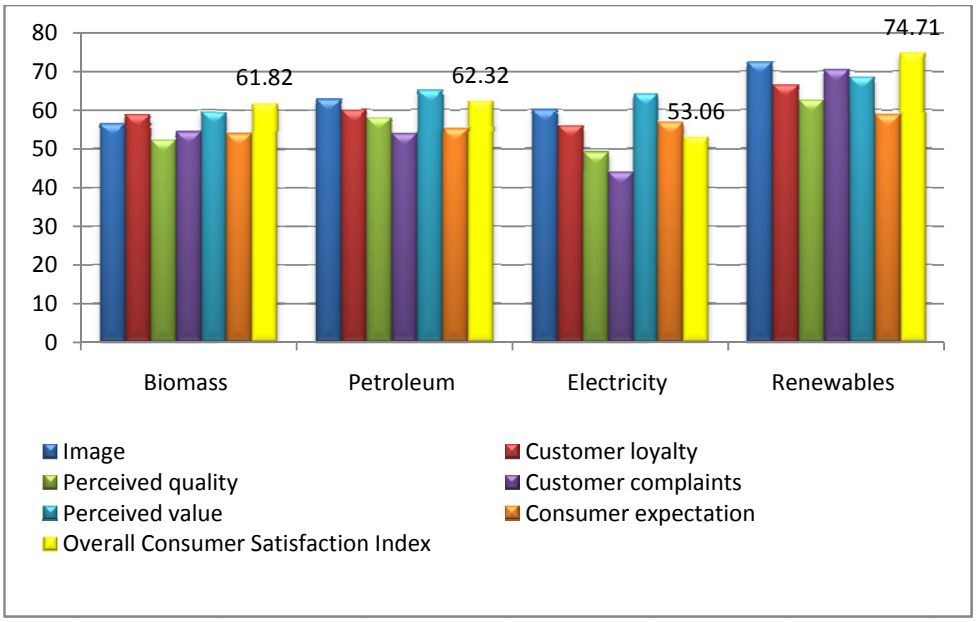
Consumer satisfaction survey was done for petroleum products,, electricity and renewable energy providers. The analysis was based on six key variables as outlined in the methodology. These were customer expectation, perceived quality, perceived value, image, loyalty and handling of customer complains. The causality model indicated that all variables had a significant impact on consumer satisfaction. However, the most important factor on consumer satisfaction is perceived quality (0.507) which depends on customer expectation. Customer expectation and perceived value had less impact, (0.045 and 0.167) on customer satisfaction. The study finds that complaint was a very important factor in the biomass sector.

Petroleum products providers' customer satisfaction was mostly influenced by perceived quality (0.425) followed by image and perceived value. Loyalty depended upon customer satisfaction (0.218) and image (0.096). All variables had a significant impact on consumer satisfaction for electricity providers. However, the most important factor on consumer satisfaction was perceived quality (0.499). Customer expectation and perceived value have less impact (-0.028 and 0.139), on customer satisfaction.

In biomass, all latent variables had average scores ranging from 52% to 62%, with the level of consumer satisfaction being comparatively higher than of the other factors (see Figure 4.1). Perceived value and customer loyalty had the highest and second highest average implying that the focus on the short term strategy should be on quality of products and services as well as fees and prices. Over the medium and long term, the focus strategy would be on the perceived quality in relation to the technical quality of the network, customer service and personal advice offered,

quality of the services used, range of services and products offered, reliability and accuracy of the products and services provided, and clarity and transparency of the information provided.

Figure 4.1: Consumer Satisfaction Index: Summary of latent key variables



Source: National Energy Survey, 2009

In the case of petroleum, the score ranged from 54% to 65%, with perceived value being comparatively higher than the other variables implying that the focus on the short term strategy should be on quality of products and services as well as fees and prices. Like in the electricity sector, the focus strategy would be on how customer complaints are handled over the medium and long term.

With regard to electricity, the latent variables had average scores ranging from 43% to 64%, with the level of customer complaints being comparatively lower than the other factors. Perceived value and image had the highest average implying that the focus on the short term strategy should be on quality of products and services as well as fees and prices, and trustworthiness, stability of the firm innovativeness and social contribution to the society, respectively. Over the medium and long term, the focus strategy would be on how customer complaints are handled.

With regard to renewable energy, all latent variables had average scores ranging from 59% to 75%, with the level of customer expectations being comparatively lower than the other variables. Image had the highest average implying that the focus on the short term strategy should be on trustworthiness, stability of the firm innovativeness and social contribution to the society. Over the medium and long term, the focus of strategy would be on customer expectations.

Overall, the study found that renewable energy sub sector had the highest customer satisfaction of 74.71 percent followed by petroleum at 62.32 percent while the electricity sector had the lowest customer satisfaction of 53.06 percent and biomass 61.82.

4.4.3 Energy Efficiency and Conservation Measures

Efficient energy use, sometimes called energy efficiency is using less energy to provide the same level of service. On the other hand, energy conservation is achieved through efficient energy use in which case energy use is decreased while achieving a similar outcome or by reduced consumption of energy and related services. Efficiency and conservation measures are important for any given nation. In the study, efficiency and conservation measures used were similar across all consumer categories for the different fuel types. These included use of energy saving devices like fluorescent bulbs, rational saving methods including switching off devices when not in use, forgoing some activities like ironing, using alternatives like use of other fuels to cook and light which are cheaper, Use of quality light and cooking devices which are efficient and good maintenance of appliances.

Energy as used by households and enterprises may make a large difference if enough measures are employed towards efficiency and conservation. While 26% of electricity users did not apply any efficient or conservation methods in its use, 28% utilized energy saving appliances and devices to save energy. 50% of fuel wood users did not apply any efficiency measures as opposed to 27% of charcoal users who did not use any efficiency measures.

From the study findings, the estimated national energy saving for all forms and sources of energy was Kshs. 24.20 billion; this translates to 7,604,374 giga joules when the study was carried out in May/June 2009. The highest savings were recorded in the households sector where more than Kshs. 22.14 billion was saved. Other sectors with major energy savings were also recorded in manufacturing, agriculture, trade and community and social institutions in that order.The highest efficiency and conservation savings in terms fuel usage was in MSP and AGO were about Kshs. 11 billion (or 3,505,519 giga joules) was saved. Major energy savings were also noted in LPG and Fuel wood. The savings in the electricity sub sector was Kshs. 2.243 billion (or 709,917 giga joules).

Discussion Synthesis and Summary

This study presents work that has been undertaken by KIPPRA in the comprehensive study and analysis on energy consumption patterns in Kenya. The study utilized a combination of survey and non survey techniques to collect data, estimate energy consumption patterns and willingness to pay for energy services, develop a consumer satisfaction index and estimates energy efficiency and conservations savings for the energy sector in Kenya.

The literature review highlighted studies undertaken on fuel choice decisions at household level, demand for energy in various productive sectors and policy significance of such investigations. Further, a complete energy demand model was estimated. The study presented key drivers of energy choice which for majority of the energy type include income of household head, employment level, price of energy, education level, total energy expenditure and location by region among other factors. With regard to global energy demand, the study finds mixed results. In the case of the total country model; household size, kerosene total expenditure, kerosene price, fuel wood price, charcoal price, LPG price, female, education level, are some of the key

determinants of kerosene budget share. As the household size increases, the budget share on kerosene declines. This could be explained by the fact that as the household size increases, the household switches to other fuel types such as charcoal, fuel wood and even LPG to meet increased demand for energy for example in food preparation. From the results, households in urban areas are likely to demand more kerosene than those in rural areas. This is expected since rural households have at their disposal other types of fuels such as fuel wood and charcoal. From the analysis, one can conclude that the share of budget for LPG in Kenya is mainly driven by household size, total expenditure on LPG, kerosene prices, fuel wood price and its own price. As the price of LPG increases, the budget share also increases. Also as the price of charcoal increases, the budget share on LPG increases.

In the transport fuels, the study has established that the budget share for MSP is mainly driven by employment both formal and informal, its own price which is positively related with the budget share, i.e. as its own price increases, the budget share allocated to MSP increases as well. Automotive Gas Oil is widely consumed in the transport and is the most consumed fuel in Kenya among petroleum products sources of energy. The main factors driving consumption of lubricants include its own price which is positively related to its budget share, total expenditure on lubricants, AGO price which is inversely related meaning that as the price of AGO increases the budget share declines. However it's positively related with price of MSP. Most of the variables that are significant for the overall country model are also statistically significant for rural and urban household demand models.

From the global demand model, budget share for charcoal is driven by various factors ranging from socioeconomic, prices, education level and location of households among other factors. Demand for charcoal is inversely related to its own price. That is, as the price increases, less of it is demanded. As the price of kerosene increases, demand for charcoal increases as well. Other important factors in the demand for charcoal include, household size, price of LPG and primary education which is inversely related to demand. With regard to rural and urban locations, households in urban areas are more likely to use charcoal than those in rural areas. This could be supported by the probit model results presented earlier that rural households are more likely to use fuel wood than the urban households. Charcoal is for richer households in the rural areas and in urban areas, it's used both by the poor and the middle income households.

The model results also indicate that the demand for MSP and AGO is more price elastic compared to the other fuels. With an exception of fuel wood and LPG, the Hicksian own price elasticities are smaller in magnitude compared to the Marshallian elasticities. For some cross price elasticities, while Marshallian estimates are negative, Hicksian estimates are positive. The expenditure elasticities are positive for fuel wood, kerosene, charcoal and LPG suggesting that these fuels are normal goods and an increase in income will generally lead to higher consumption. The highest elasticities (greater than one) are for fuel wood and kerosene implying that an increase in total energy expenditure will lead to more than proportionate increase in the expenditure shares. The lowest expenditure elasticities are for LPG and charcoal implying that an increase in total energy expenditure will lead to less than proportionate increase in the expenditure shares.

In the enterprises, consumption of energy varies depending on type of sector and the fuel consumed. The study adopted the European Commission Consumer Satisfaction Index (ECSI) model for the energy services and calculated the consumer satisfaction index using the model. The estimated index varied across the different energy service providers which included biomass, electricity, petroleum and renewable energy services. The customer satisfaction index was the highest for the renewable energy providers compared the other energy service providers, which is not surprising since only perceived quality had a significant impact on the customer satisfaction. Note that perceived quality was the most important factor for consumer satisfaction in all energy sub sectors.

The performance indices of the factors liable to affect consumer satisfaction varied across the various energy providers which imply that policy regarding the consumer satisfaction index should be sector specific. The indices were generally quite low ranging below 50% with an exception of perceived quality under electricity and renewable energy providers. From the CSI analysis, the study concludes that image, loyalty, customer expectations, perceived value, perceived quality and complaints very important and key to consumer satisfaction.

Lastly, the study has shown that Kenya has huge potential in energy efficiency and conservation were over Kshs. 24.204 billion can be saved. The household/ residential sectors have the greatest potential while automotive gas and motor spirit premium have the highest potential in terms of savings by fuel.

5 Conclusions and Recommendations

Conclusion and recommendations are given for biomass, electricity, petroleum products consumption, in addition to customer satisfaction index.

5.1 Biomass

There is need to encourage users to shift to modern energy sources by encouraging marketers as well as providing incentives to increase production and use and creating an enabling environment to achieve low and affordable prices for fuels, appliances and equipment, gadgets and apparatus among the majority of the citizens. Since fuel wood has been the main fuel in the rural areas, there is need to encourage and enforce adoption of wood saving cookers, outside the traditional three stones. This should continually be done in the medium term to protect the environment.

There is need to encourage and enhance energy saving and efficiency methods in charcoal production and use in areas in which they have not permeated to protect the environment from degradation

There is need for contineius and deliberate measures to provide economic instruments to regulate biomass production and use to as to achieve sustainability of supply and protect the environment following Kyoto protocol and Copenhagen resolutions among other environmental protection conventions.

5.2 Electricity

Under electricity sub sector, costs should be reduced and electricity tariff setting harmonized to minimise costs transfer to low income households with regard to fuel and exchange rate adjustment costs which have remained high due to over reliance of thermal electricity generation. Note that increasing funding and resources in the electricity sector to increase clean electricity generation from wind energy will not only put more electricity to the national grid, but also ensure improved access and reduction in cost of power as well as protect the environment from carbon dioxide emissions.

There is need to ensure that universal access to electricity in the rural areas for majority of citizens is adhered to so as to increase access.

5.3 Petroleum

For Kerosene, due to health problems associated with smoke from use of Kerosene, there is need for the government to increase the penetration of other alternative fuels such as biogas and LPG by making them available and cheaper to the users.

Under LPG, In order to increase usage and penetration of LPG in the country, there is need to provide more fiscal incentives both to the users and suppliers and particularly for the appliances such as cookers which are currently expensive and other peripherals that discourages prospective users.

There is need to enforce regulation on gas regulators to harmonise its access as outlined in the proposed LPG regulations by the energy regulatory Commission (ERC).

There is need to provide more fiscal incentives both to the users and suppliers and particularly for the appliances such as cookers which are currently expensive and other peripherals that discourages prospective users, In order to increase usage and penetration of LPG in the country

MSP and AGO

The government should increase the reserve stock point (for MSP & AGO) strategically located in certain agronomical zones both in the high productive zones as well as in the ASALs were much irrigation is taking place.

Lastly for MSP and AGO, There is need to enhance policy implementation with regard to petroleum products price by ensuring friendly regulations to ensure that prices reflects consumer satisfactions.

5.4 Renewable energy

There is need to put in place deliberate measures to improve penetration of renewable technologies by providing fiscal incentives as well as credit facilities for both consumers and providers of energy in this sub sector. The renewable technologies (solar, wind, biogas) are the fuels for rural Kenya since they are stand alone. Moreover, self regulations in the renewable

energy sub sector e.g. in solar and other forms of energy to ensure quality supply of products, should be promoted.

5.5 Consumer satisfaction index

The energy regulation commission needs to enhance consumer satisfaction in the energy sector by ensuring that the welfare and aspirations of energy consumers are met by the energy providers and particularly in electricity and petroleum sub sectors. There is need to continue ensuring that quality products are supplied across all energy services. To ensure efficiency in service delivery and therefore value for money for citizens, there is need for periodic survey to ascertain the levels of consumer satisfaction on the various energy products and providers of services.

5.6 Overall Energy Sector

From the foregoing, availability of adequate and reliable performance data is a challenge across the entire sector exacerbating the regulatory challenge and enhancing information asymmetry between policy makers, regulators, providers and consumers. Therefore the government

Invest in and secure the development of good quality data and information to the stakeholders in the energy sector focusing on critical decision influencing parameters namely; the cost of service, quality and availability of service.

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