ACKNOWLEDGEMENT

I take this chance thank all those who helped in the success of this project. First and foremost is my thanks to Mr. Rono, Kenya Manufacturers Association for the generosity he showed by assisting with important material that helped me a lot in the completion of my report. I cannot forget my thanks to my supervisor, Mr. Walkade for his assistance that saw me through this work.
Table of Contents

1. ECONOMICS OF POWER GENERATION ................................................................. 1
   1.1. INTRODUCTION ............................................................................................... 1
   1.2. ECONOMICS OF POWER GENERATION ......................................................... 1
   1.3.1 COST ANALYSIS .......................................................................................... 1
       1.3.1. INVESTMENT CHARGES, OR FIXED CHARGES ..................................... 2
       1.3.2. ANNUAL OPERATING, OR OPERATIONAL COSTS ................................. 8
   1.4. COST OF ELECTRICAL ENERGY ................................................................... 9
       1.4.1. Fixed costs : ............................................................................................ 10
       1.4.2. Semi-fixed costs : .................................................................................... 10
       1.4.3. Running costs .......................................................................................... 10
   1.5. EXPRESSION FOR COST OF ELECTRICAL ENERGY ................................. 10
       1.5.1. Three-part-form : .................................................................................... 10
       1.5.2. Two-part-form: ........................................................................................ 11
   1.6. IMPORTANCE OF HIGH LOAD FACTOR ....................................................... 12
2. TARIFFS FOR ELECTRICAL ENERGY ................................................................. 13
   2.1. INTRODUCTION: .............................................................................................. 13
   2.2. OBJECTIVE AND REQUIREMENT OF TARIFF ............................................ 13
       2.2.1. Objectives of tariffs .................................................................................. 13
       2.2.2. Requirements of a tariff: .......................................................................... 13
   2.3. TARIFF SETTINGS............................................................................................ 14
2.4. CHARACTERISTICS OF TARIFFS ................................................................. 14
2.5. STAGES IN TARIFF DESIGN .................................................................... 15
2.6. TARIFF STRUCTURE ............................................................................... 15
2.7. GENERAL TARIFF FORM ...................................................................... 16
2.7. VARIOUS TYPES OF TARIFFS: .............................................................. 16
  2.7.1. Flat Demand Rate ........................................................................... 17
  2.7.2. Straight meter rate ......................................................................... 17
  2.7.3. Block Meter Rate ........................................................................... 18
  2.7.4. Hopkinson Demand Rate (Two-part tariff) .................................... 18
  2.7.5. Doherty rate (Three-part tariff) ...................................................... 18
  2.7.6. Wright Demand rate ..................................................................... 19
3. KENYA POWER AND LIGHTING COMPANY TARIFFS ANALYSIS ............ 20
  3.1. KPLC TARIFFS RETAIL TARIFF DEVELOPMENT ......................... 20
    3.1.2. The Policy Objectives of Retail Tariffs .................................... 20
    3.1.3. Desirable Characteristics of Tariffs ........................................... 21
    3.1.4. Stages in the Design of Retail Tariffs ....................................... 21
  3.2. CUSTOMER CATEGORIES .................................................................... 22
    3.2.1. Determinants of Customer Classes ........................................... 22
    3.2.2. Existing Customer Categories ................................................... 23
    3.2.3. New Customer Categories ........................................................ 26
    3.2.4. Considerations for Targeting the Life-Line Tariff .................... 29
  3.3. TARIFF STRUCTURE .......................................................................... 33
    3.3.1. Background on Tariffs and Tariff Structure ............................ 33
    3.3.2. The Composition of the Tariff Structure .................................. 34
    3.3.3. Pass-Through Elements in the Tariff Structure ....................... 35
    3.3.4. Fuel Oil Adjustment Cost (FOCA) ............................................ 37
3.3.5  Foreign Exchange Rate Fluctuations Adjustment (FERFA) .................................................................39

3.4.  SURCHARGE .............................................................................................................................................41

3.5  SCHEDULE OF NON-FUEL TARIFFS FOR ELECTRICAL ENERGY SUPPLIED BY THE COMPANY ...............42

3.5.1.  METHOD DC: .......................................................................................................................................42

3.5.2.  METHOD SC: .......................................................................................................................................42

3.5.3.  METHOD CI1: .......................................................................................................................................42

3.5.4.  METHOD CI2: .......................................................................................................................................43

3.5.5.  METHOD CI3: .......................................................................................................................................43

3.5.6.  METHOD CI4: .......................................................................................................................................43

3.5.7.  METHOD CI5: .......................................................................................................................................43

3.5.8.  METHOD IT: .........................................................................................................................................43

3.5.9.  METHOD SL: .......................................................................................................................................44

CONCLUSION ..................................................................................................................................................46
ABSTRACT.

This is a report written to explain the basic principles of electrical tariff formulation and how they come about. It tries to explain how the cost of generated is transferred to the consumer. Different consumers have different consumption habits and therefore different methods of costing are applied to different cases. This document tries to explore the various methods applied from the classical basis.

Also, there is no point in studying the classical methods and not see how they apply on practical cases. This document tries to show how these methods are exploited by supplying electrical energy supplying company, in this case Kenya Power and Lighting Company to set the various tariffs to various consumers.
1. ECONOMICS OF POWER GENERATION

1.1.1. INTRODUCTION

Power station is required to deliver a large number of consumers to meet their requirements. While designing a power station, efforts should be made to achieve overall economy such that per unit production is as low as possible. This will enable the electric supply company to sell electrical energy at a profit and ensure reliable service. This is the big task that poses challenge to power engineers.

There are several factors that influence the production cost such as cost of land and equipment, depreciation of equipment, interest on capital investment etc.

1.1.2. ECONOMICS OF POWER GENERATION

This is part of determining the per unit (i.e. one kWh) cost of production of electric power. A consumer will use power if it is supplied at a reasonable rate. Therefore, power engineers have to find convenient ways and methods of producing power as cheap as possible so that the consumers are tempted to use electrical methods.

1.3.1. COST ANALYSIS

The cost of power system depends on whether:

a. An entirely new power system has to be set, or

b. An existing system has to be replaced, or

c. An extension has to be provided to an existing system

The cost interalia includes:

1. Capital costs or fixed costs. It includes the following:

   (i.) Initial cost

   (ii.) Interest.

   (iii.) Depreciation and amortization
(iv.) Taxes
(v.) Insurance.

2. Operational costs. It includes the following:

(i.) Fuel cost.
(ii.) Operating labour cost
(iii.) Maintenance cost
(iv.) Supplies.
(v.) Supervision.
(vi.) Operating taxes.

The above mentioned can be discussed as follows:

1.3.1. INVESTMENT CHARGES, OR FIXED CHARGES

1.3.1.1. INITIAL COST:

Some of the several factors on which cost of generating station or a power plant depends on are:

a. Location of the plant
b. Time of construction.
c. Size of units of the equipment
d. Number of generating units.
e. The type of structure to be used.

The initial costs of a power station include the following:

1. Land cost
2. Building cost
3. Equipment cost.
4. Installation cost.

5. Overhead charges which include the transportation cost, store and storekeeping charges, interest during construction e.t.c.

1.3.1.2. **INTEREST.**

This can be defined as the cost of money.

A power station is constructed by investing a huge capital. This money is generally borrowed from banks or other financial institution and the supply company has to pay the annual interest on this amount. Even if the company has spent out the reserve funds the interest must still be allowed for since this amount could have earned interest if deposited in a bank. Therefore while calculating the cost of production of electrical energy, the interest payable on the capital must be included. The rate of interest depends upon the market position and other factors and may vary from 4-8% per annum.

1.3.1.3. **DEPRECIATION AND AMORTIZATION**

Can be defined as the decrease in the value of the power plant and buildings due to constant use.

In actual practice, every power station has a useful life ranging from fifty to sixty years. From the time the power station is installed, its equipment steadily deteriorates due to wear and tear so that there is a gradual reduction in the value of the plant. This reduction in the value of the plant in a year is referred as annual depreciation.

Many factors influence the depreciation of capital investment but generally fall into five categories:

(a.) Life of the enterprise – In some instances the life of an enterprise may be curtailed, as when the demand of it product vanishes. Cessation of demand may or may not be seen. In this case the capital equipment may be in excellent condition for the purpose it was needed for. If it can be adopted for other uses, it may be readily sold and thereby have a salvage value. If it cannot be adapted to other uses, its only value may be as scrap material with a low salvage value. It has happened
that equipment with no salvage values incurs an expense in removing it from its location.

(b.) Life of the equipment - From the moment ma-made equipments are installed, they steadily deteriorates from corrosion, rot and weathering as well as tear and wear of use.

(c.) Inadequacy of the equipment. - Capital equipment becomes inadequate when its demand exceeds its capacity to produce. In this case anew equipment may be added to aid in carrying out the increased demands, or it may be necessary to replace the existing equipment with new, larger equipment capable of satisfying the increased demand. This latter condition has happened frequently in the history of power generation.

(d.) Obsolescence of equipment - A plant becomes obsolete when it can be replaced by a more modern design which operates at a reduced total annual costs. The reduction of cost may come about from better efficiency in the replacement of the plant or from deterioration of performance of the existing plant. In the former condition, the obsolescence of an existing plant can be determined only by comparing its operating costs and the estimate of total annual cost of the new plant, when such a new plant of improved design becomes available. If the performance of the existing plant is unaffected by use, then for a rapid rate of technological development the plant may possibly become obsolete in a very short time. This possibility of early obsolescence is often one of the chief reasons for assuming shorter lives for projects than the expected physical lives of the equipment involved.

(e.) Requirement of public authority.

Due to depreciation, the plant has to be replaced by a new one after its useful life is over. Therefore a suitable amount must be set aside every year so that by the time the plant retires, the collected amount in terms of depreciation equals the cost of installing a new plant.

It becomes obvious that while determining the cost of production, annual depreciation charges must be included.
1.3.1.1. METHODS OF DETERMINING DEPRECIATION

In accounting practice several methods are available to charge income with amortization of capital funds or, as commonly stated, to allow for depreciation. These are usually designated as:

(I) **Straight line method**

The life of the enterprise or the equipment (whichever is shorter) is estimated. The capital less the salvage value of the equipment is divided by the number of years of life and this amount is deducted from income annually as amortization of capital funds. This method is commonly used due to its simplicity.

(II) **Diminishing value or Percentage method.**

This differs from the straight line method in that, instead of uniform depreciation charges for all years, depreciation charges vary from year to year. This method assumes that the value of the capital equipment decreases at a constant percentage from its value of the previous year; succeeding annual depreciation charges diminishes progressively but never reach zero. Of course, the remaining capital value will reach an estimated salvage value. Included in this method are arbitrary table of percentages that will vary the magnitude of the annual depreciation charges so that they will progressively increase or diminish.

(III) **Sinking fund method.**

This method is based on the conception that the annual uniform deduction from the income for depreciation will, when invested at given interest rate, accumulate to the capital value of the enterprise at the termination of the venture, or the end of life of the equipment as may be the case. For this method, although the annual allowance is uniform it will be appreciably less than that calculated by the straight line method. Though this method does not find frequent application in practical depreciation accounting, it is the fundamental method used in making economy studies. This follows from the basic fact that any sums realized as amortization of the capital funds can (theoretically) be reinvested and yield a return.
(IV) Appraisal method.

At the end of each year an appraisal is made of the value of the capital equipment, the difference in annual appraisals being then taken as the depreciation of the intervening year. This method is costly and impractical for properties of any magnitude and is not often applied.

(V) Unit method.

In this method some factor is taken as a standard and the depreciation measured thereby. Thus the total number of working hours of the equipment or enterprise may be capable of during its entire life is first estimated. Dividing the capital funds by the number of hours will give the amount of capital consumed or depreciated per working hour. Then each year this constant is multiplied by the number of actual working hours to arrive at the magnitude of depreciation for that year. Instead of working hours, the number of units of production may used as the unit of the measuring standard.

1.3.1.4. DISPOSAL OF DEPRECIATION CHARGES.

In the accounting procedure depreciation is deducted from income and allocated to depreciation reserve. Depreciation reserve is merely an account that reflects the decrease in value of capital investment and does not necessarily represent a concrete sum of money set aside and available on call. As these annual sums are taken out of revenue or income, they are recorded in the depreciation reserve but must be disposed off either by retaining them in the enterprise or by reimbursing the source s of capital funds.

These sums are retained the business when invested in capital equipment either by expansion of the plant or by replacement of worn out equipment. This is the actual procedure if the business has any possibility of continuing indefinitely.

Where capital funds have been obtained by bond issues, it is sometimes required to establish sinking funds to guarantee repayment of the principle of the bond at the time of maturity. Thus this part of depreciation charges would be so invested annually. In this procedure a given number of bonds determined by lot are redeemed at face value each year until the entire issue has been retired. The bonds thus repurchased represent the depreciation reserve.
1.3.1.5. **TAXES.**

Taxes levied on an enterprise are many and quite diverse as to the basis used for computing them. The land upon which the plant stands is usually taxed depending on various factors. The tax levied on the value of capital equipment comprising the plant is usually known as property tax. There are numerous other forms of taxes such as social security, unemployment, income excess profits and sales. Some taxes depend entirely upon the magnitude of the capital funds, others on the volume of business and still others on the combination of the two. Taxes that are a function of capital investment only should be included in the investment charges; other taxes should be charged to the operating costs.

1.3.1.6. **INSURANCE.**

Every well-managed company carries some form of insurance against accidents to equipment and personnel. Since the risks involved are diverse in nature, the insurance list is quite long.

It is usually carried out by conventional insurance companies, but if an enterprise is very large and has its properties scattered over considerable region, it may be self insured. This is done by setting aside a reserve fund build up periodically out of earnings. An insurance fund of this type should not be confused with depreciation reserve.

**TOTAL FIXED CHARGES:**

Initial expenditure of funds for capital equipment incurs annual costs that must be met out of income. These annual costs, an enterprise that is not subject to expansion, remain largely constant from year to year, though they are subject to variation in tax and insurance rates. The annual investment costs, or as they are commonly termed the annual fixed costs are usually expressed in terms of percentage of capital. These percentages must be determined individually, as two cases are seldom alike.

For any single company these percentages or fixed charge rates must be predetermined from time to time as the various component cost rate fluctuate or as the possibilities of future changes in these rates present themselves.

The component of fixed-charge rate that represents the cost of money use depends on the proportions of capital funds obtained from bonds and stock issues.
1.3.2. ANNUAL OPERATING, OR OPERATIONAL COSTS.

The operation of power plant incurs expenses that vary with the extent of operation or magnitude of output. However some of these costs remain constant as long as the plant is in active operation or is held in readiness to produce energy. These expenses are generally classified as follows:

1.3.2.1. Fuel.

The largest form of expense in the operation of a plant is the original raw energy in form of fuel. This may be in the form of coal, oil, natural gas, wood scraps or by-products.

Where several of these are available, it will require careful investigation and analysis to determine which is the most advantageous.

The fuel cost varies with the amount of energy produced, the efficiency of the plant, and the unit price of fuel.

1.3.2.2. Operating labor.

Supervision of equipment in power plant is needed since no plant can be made fully automatic. Although some hydraulic and gas-turbines plants are automatic in operation, they still require periodic inspection; operating labour is seldom eliminated as an item of expense. In steps of reducing these costs causes a major advantage to the plant. This is caused by two principle features: (1.) The increased application of automatic equipment and (2.) the increasing capacity of various equipment units.

In a plant with only a few units of equipments the labour cost is likely to remain constant for all range of energy production; a plant containing a larger number of units requires less labor when operating at reduced output for extended period of time. A hydraulic plant or
internal combustion (i-c) engine plant of a capacity equal to steam plant will require less labor by reason of the smaller number of units of equipment that require attention.

1.3.2.3. **Supplies.**

This item usually cover items such as water for make-up and general use, lubricating oils, water treatment chemicals tools and wiping clothes. In general any items that are not included in the category of fuel or maintenance are charged to the supplies accounts.

1.3.2.4. **Maintenance, labor, and materials.**

Any well-managed plant will generally follow a plan of preventive maintenance: inspecting, cleaning, and overhauling apparatus on a regular schedule to forestall the possibility of breakdown during service. This item of expense is made up of two factors: material used in making repair and the labor required to effect it.

1.3.2.5. **Supervision.**

Supervision usually includes the salary of a station superintendent, chief engineer, chemist, and efficiency engineer. In some classifications, this item also covers any material that these men require.

1.3.2.6. **Operating taxes.**

Operating taxes include those which depend upon the magnitude of output rather than the size of the investment. These are taxes such as income, social security, and unemployment.

1.4. **COST OF ELECTRICAL ENERGY**

The total cost electrical energy can be divided into three main parts namely:

(a.) Fixed costs.

(b.) Semi-Fixed costs.

(c.) Running or operating costs.
1.4.1. **Fixed costs:**

This is the cost which is independent of maximum demand and units generated. The fixed cost is due to annual cost of central organization, interest on capital cost of land, and salaries of high officials. The annual expenditure of the central organization and salaries of high officials is fixed since it has to be met whether the plant has high or low maximum demand or it generate less or more units. Further, the capital investment on the land is fixed and hence the amount of interest is also fixed.

1.4.2. **Semi-fixed costs:**

It is the cost which depends upon maximum demand but is independent of the units generated.

The semi-fixed costs is directly proportional to maximum demand on power station and is on account of annual interest and depreciation on capital investment of building and equipment, taxes and salaries of management and clerical staff. The maximum demand of power station determines the size and cost of installation. The greater the maximum demand on power station, the greater is its size and cost of installation. Further, the taxes and clerical staff depend on the size of the plant and hence upon the maximum demand.

1.4.3. **Running costs**

This is the cost that depends only upon the number of units generated. Running cost is on account of annual cost of fuel, lubricating oil, maintenance, repairs, and salaries of operating staff. Since these charges depend upon the energy output, the running cost is directly proportional to the number of units generated by the station. In other words, if the power station generates more units, will have higher running costs.

1.5. **EXPRESSION FOR COST OF ELECTRICAL ENERGY**

The overall annual cost of electrical energy generated by a power station can be expressed in two forms viz three part form and two part form.

1.5.1. **Three-part-form:**
In this method the overall annual cost of electrical energy generated is divided into three parts viz fixed costs, semi-fixed costs and running costs. i.e.

Total annual cost of energy = Fixed cost + Semi-fixed cost + Running costs

= Constant + Proportional to maximum demand + proportional to kWh generated

= a + b kWh + c kWh

Where

a = annual fixed cost independent of maximum demand energy output.

b = constant which when multiplied by maximum kW demand on the station gives the annual semi-fixed costs.

c = a constant which when multiplied by kWh output per annum gives the annual running costs.

1.5.2. Two-part-form:

It is sometimes convenient to give the annual cost of energy in two parts form. In this case, the annual cost of energy is divided into two parts viz fixed sum per kW of maximum demand plus a running charge per unit of energy. The expression for the annual cost of energy then becomes:

Total annual cost of energy = A Kw + B kWh

Where

A = A constant which when multiplied by a maximum Kw demand on the station gives the annual cost of fixed cost.

B = A constant which when multiplied by the annual kWh generated gives the annual running costs.
It is interesting to see here that two-part form is a simplification of three-part form. A little reflection shows that constant $\hat{A}$ of the three-part form has been merged in fixed sum per kW maximum demand (i.e. constant $A$) in the two-part form.

### 1.6. IMPORTANCE OF HIGH LOAD FACTOR

**Definition:** Load factor - The ratio of average load to the maximum demand during a given period i.e.

\[
\text{Load factor} = \frac{\text{average load}}{\text{Maximum demand}}
\]

If the plant is in operation for $T$ hours,

\[
\text{Load Factor} = \frac{\text{Average load} \times T}{\text{Maximum demand} \times T} = \frac{\text{Units Generated in T hrs}}{\text{Maximum demand} \times T \text{ hrs}}
\]

The load factor plays a vital role in determining the cost of energy. Some important advantages are listed below:

(i.) **Reduces cost per unit generated:** A high load factor reduces the overall cost per unit generated. The higher the load factor, the lower is the generation cost. It because the higher load factor means that for a given maximum demand, the number of units generated is more. This reduces the cost of generation.

(ii.) **Reduces variable load problem:** A high load factor reduces the variable load problems on the power station. A higher load factor means comparatively less variation on the load demand at various times. This avoids the frequent use of regulating devices installed to meet the variable load on the station.
2. **TARIFFS FOR ELECTRICAL ENERGY**

2.1. **INTRODUCTION:**

The cost of generation of electrical energy consists if fixed costs and running costs. Since the electricity generated is to be supplied to consumers, the total cost of generation has to be recovered from the consumers. Tariffs or energy rates are the different methods of charging the consumers for the consumption of electricity. It is desirable to charge consumers according total the maximum demand (kW) and the energy consumed (kWh). The tariff chosen should recover the fixed costs, operation costs and profit incurred in generation of the electrical energy.

2.2. **OBJECTIVE AND REQUIREMENT OF TARIFF**

2.2.1. **Objectives of tariffs**

1. Recovery of capital investment in generating equipment, transmission and distribution system.

2. Recovery of the cost of operation, supplies and maintenance of the equipment.

3. Recovery of cost of material, equipment, billing and collection cost as well as the miscellaneous services.

4. A net return on the total capital investment must be ensured.

2.2.2. **Requirements of a tariff:**

1. It should be easier to understand.

2. It should provide low rates for high consumption.

3. It should be uniform over a large population.

4. It should encourage consumers having high load factors.

5. It should take into account maximum demand charges and energy charges.

6. It should provide the incentive for using power during the off-peak hours.

7. It should provide less charges for power connection than lighting.
8. It should have provision of penalty for low power factors.

9. It should have a provision for higher demand charges for high loads demanded at system peaks.

10. It should apportion equitability the cost of service to the different categories of consumers.

### 2.3. **TARIFF SETTINGS**

Tariff setting is guided by three important policy objectives, namely:

- **Economic Policy Objective:** This requires efficient resource allocation thereby ensuring consumers pay for the costs incurred by the supplier in delivering electricity services.
- **Financial Policy Objective:** This requires that short and long term financial viability of sector utilities be safeguarded.
- **Social Policy Objective:** This requires cost re-allocation to safeguard specific vulnerable consumer groups. The combination of tariffs and subsidies where applicable must be sufficient to cover the full cost of the sub-sector.
- **Other Policy Objectives:** The government requires that a National Uniform Tariff be put in place.

There exists an inherent conflict in the policy objectives guiding tariff design, which in practice is resolved by commencing tariff design with the derivation of cost-reflective tariffs to satisfy the economic policy. These are then adjusted to satisfy financial and social policy objectives. Tariff setting starts with economic policy objectives in order to ensure efficient resource allocation within the economy. The economic tariff is then adjusted to yield the financial tariff which ensures the financial viability of sub-sector utilities. The final adjustments are made to satisfy social policy objectives: For instance the incorporation of cross-subsidies to safeguard the welfare of vulnerable groups, such as rural folk, low income groups or farmers.

### 2.4. **CHARACTERISTICS OF TARIFFS**

Some desirable characteristics for tariffs include the following. Tariffs should be:

- cost reflective in order to promote efficient resource allocation and utilisation
- simple and easily understood by customers
- structured in a way that enhances consumer responsiveness
- publicised in order to enhance transparency in pricing
2.5. **STAGES IN TARRIFF DESIGN**

The process of tariff setting commences with a demand (sales) forecast for the market in question. This is followed by the determination of the mix of generating capacity to meet the forecast demand. The mix of generating capacity is in terms of the technology type i.e. hydro, geothermal, coal, petroleum, nuclear, biomass, wind etc. It is also in terms of the ownership i.e. whether public, private or a mix of both. The third step involves the determination of the sector’s total revenue requirements based on the actual costs of generation and supply likely to be incurred by the sector during the plan period.

The next step is the determination of marginal costs of generation, transmission, distribution and retailing. This also requires determination of the pricing periods and the computation of the ensuing revenue gap. The revenue gap is the difference between the marginal cost revenue and the sector’s revenue requirements. The current tariff policy requires that marginal costing is done on the basis of the Long Run Marginal Cost (LRMC).

The final two steps involve the allocation of the total revenue requirement among customer classes on the basis of the marginal costs and price sensitivity; and the subsequent determination of retail tariffs. The determination of the retail tariffs is an iterative procedure in which the retail tariff is subjected to sensitivity analysis in which the impacts of the tariff on the final electricity bill is assessed for competitiveness vis-à-vis alternative sources of electricity e.g. self generation. The impact of the bill is also assessed for competitiveness vis-à-vis alternative sources of energy for similar uses e.g. gas and kerosene for lighting and cooking.

2.6. **TARRIFF STRUCTURE**

The structure of the tariff is designed to facilitate the recovery of the costs imposed on the system by consumers. These are the capacity related costs, energy related costs and consumer related costs, respectively.

**Capacity related** costs are generation and usage related costs. They are costs which are incurred as a result of a change in the level of peak demand on the system, and hence include costs of future additions of generation, transmission and distribution capacity as well as fixed operations and maintenance.
Energy related costs are design-demand related costs. They are costs which are incurred in the supply of an extra kWh of energy whenever it occurs, hence are dominated by expenditure on fuel and variable operations and maintenance.

Consumer related costs are also known as customer-related costs. They are costs incurred on behalf of each consumer regardless of their electricity consumption and include metering, billing and revenue collection.

Capacity and consumer related costs are typically recovered in a fixed monthly charge, while energy related costs are usually recovered in a per unit energy charge.

### 2.7 GENERAL TARIFF FORM

A large number of tariffs have been proposed from time to time and are in use. They are all derived from the following equation:

\[ z = ax + by + c \]

Where, \( z \) = Total amount of the bill for the period considered,

\( x \) = Maximum demand in Kw,

\( y \) = Energy consumed in kWh during the period considered,

\( a \) = Rate per kW of maximum demand,

\( b \) = Energy rate per kWh, and

\( c \) = constant amount charged to the consumer during each period.

This charge is Independent of demand or total energy because a consumer that remains Connected to the line incurs expenses even if he does not energy.

### 2.7. VARIOUS TYPES OF TARIFFS:

1. Flat demand rate
2. Block meter rate
3. Straight meter rate
4. Hopkinson demand rate (Two-part tariff)
5. Doherty rate (Three-part tariff)
6. Wright demand rate

**2.7.1. Flat Demand Rate**

The flat demand rate is expressed as follows:

\[ Z = ax \]

i.e., the bill depends only on the maximum demand irrespective of the amount of energy consumed. It is based on the customer's installation of energy consuming devices which is usually denoted by so many KW per month or per year. It is probably one of the early systems of charging energy rates. It was based upon the total number of lamps installed and a fixed number of hours of use per year. Hence the rate could be expressed as price per lamp or unit of installed capacity.

Now-a-days the use of this tariff is restricted to signal systems, street-lighting e.t.c., where the numbers of hours are fixed and the energy consumption can be easily predicted. It is very common to supplies of irrigation tube wells, since the number of hours for which the tube well feeders are switched on are fixed. The charges are made according to horsepower of the motor installed.

In this form of tariff the unit of energy cost decreases progressively with an increased energy usage since total cost remains constant.

By the use of this form of tariff the cost of the metering equipment and meter reading are eliminated and so the account cost are minimum.

**2.7.2. Straight meter rate.**

Straight meter rate can be expressed as follows:

\[ z = b.y \]

This is the simplest form of tariff. Here the charge per unit is constant. The charge depend on the energy used. This tariff is sometimes used for residential and commercial consumers.

Advantage: Simplicity

Disadvantages: 1. The consumer using no energy will not pay any amount although he has incurred some expenses to the power station.
2. This method does not encourage the use of electricity unless the tariff rate is very low.

### 2.7.3. Block Meter Rate

In order to remove the inconsistency of straight meter rate, the block meter rate charges the consumers on a sliding scale. The term “block” indicates that a certain specified price per unit is charged for all or any part of such units. The reduced prices per unit are charged for all or any part of succeeding block of units, each such reduced price per unit applying only to a particular block or portion thereof.

The block meter rate accomplishes the same purpose of decreasing unit energy charges with increasing consumption as the step meter rate without its defect. Its main defect is that it lacks a measure of customers demand.

This tariff is mainly used for residential and commercial customers. A reverse form of this tariff is used to restrict the energy consumption. In this reverse form the unit energy charge increases with increase in energy consumption.

### 2.7.4. Hopkinson Demand Rate (Two-part tariff)

This method charges the consumer according to his maximum demand and energy consumption. This can be expressed as follows:

$$Z = a + by$$

This method requires two meters to record the maximum demand and energy consumption of the consumer.

This form of tariff is generally used for industrial customers.

### 2.7.5. Doherty rate (Three-part tariff)

When the Hopkinson demand rate is modified by the addition of a customer charge, it becomes a three charge rate or Doherty rate. It was first introduced by Henry L. Doherty at the beginning of the twentieth century. It consists of a customer or meter charge, plus a demand charge plus any energy charge. This may be expressed as follows:

$$Y = ax + by + c$$

Many people consider that theoretically this is the ideal type of rate. As it requires two meters, it is better suited for industrial than for residential customers.
The Doherty rate is sometimes modified by specifying the minimum demand and the minimum energy consumption that must be paid for, if they are less than the minimum value specified. In this manner the customer charge is incorporated with demand and energy component.

2.7.6. Wright Demand rate

This tariff was introduced by Arthur Wright (of England) in 1896. This rate intensifies the inducement by lowering both the demand and the energy charge for a reduction in maximum demand or in other words an improvement in load factor. This rate is usually specified for industrial consumers who have some measure of control over their maximum demands.

The rate is modified by stating a minimum charge which must be paid if the energy of the billing period falls below the amount by such charge. For allowing fair returns some adjustments in the rate reforms are provided. Some of them are:

(i) Higher demand charges in summer (due to longer days in summer).
(ii) Fuel adjustment to provide a rate change when fuel prices deviate from the standard.
(iii) Wage adjustment
(iv) Tax adjustment
(v) Power factor adjustment
(vi) Discount to be given to the customers for prompt payment of the bills.

Ref:


5.
3. KENYA POWER AND LIGHTING COMPANY TARRIFFS ANALYSIS

3.1. KPLC TARRIFFS RETAIL TARIFF DEVELOPMENT

Tariff control in K.P.L.C is wholly controlled by the regulation from an overseeing board that undertakes regulation of tariffs in Kenya, E.R.B(Energy Regulating Board) much of information in this chapter relates to the board.

3.1.2. The Policy Objectives of Retail Tariffs

1) The retail tariffs are designed to satisfy three policy objectives namely: Economic, financial, and social. Additional objectives may be included as discussed hereunder;

   a.) The Economic Policy objective of the retail tariffs is to achieve efficient resource allocation within the economy with consumers only paying for the costs prudently incurred by the utilities

   b.) The Financial Policy Objective aims to ensure short and long-term financial viability of sector utilities

   c.) The Social Policy objective is to re-allocate costs amongst consumers with a view to safeguarding specific vulnerable consumer groups. This may require subsidies; however, the sum tariffs and Subsidies must be sufficient to cover the full cost of the sub-sector.

   d.) Other Policy Objectives of retail tariffs are often a variation of the social policy objectives and may include regional equity as envisaged under the National Uniform Tariff policy.

2) Taken together there are inherent contradictions in the policy objectives guiding tariff design e.g. Subsidies may distort efficient allocation of scarce resources within the economy. To resolve the inherent conflicts tariff design often commences
with the derivation of cost-reflective tariffs to satisfy the economic policy objectives in order to ensure optimal resource allocation within the economy. The strict economic tariffs are then adjusted to satisfy financial and social policy objectives respectively.

3.1.3. **Desirable Characteristics of Tariffs**

The desirable characteristics of tariffs include:

- a.) cost reflectivity in order to promote efficient resource allocation and utilization
- b.) simplicity so as to be easily understood by customers
- c.) a structure that enhances consumer responsiveness
- d.) publicity in order to enhance transparency in pricing
- e.) long-term orientation and stability in order to facilitate planning by consumers based on the published tariffs
- f.) administrative feasibility

3.1.4. **Stages in the Design of Retail Tariffs**

1) Tariff design is a systematic process which involves the following steps:

   a.) Demand forecasting for the bulk and retail markets

   b.) Generation planning to meet the forecasted demand: This involves long range planning of the mix of generating capacity in terms of technology, and preferred developer: whether Public or Private Sector.

   c.) Determination of revenue requirements based on forecasts of costs likely to be incurred for generation, transmission, distribution and supply
d.) Determination of marginal costs of generation, transmission, distribution and retailing; based on pricing periods.

e.) Allocation of total revenue requirement among customer classes on the basis of the marginal costs and price sensitivity.

f.) Computation of initial retail tariff proposals

g.) Sensitivity analysis of the proposed retail tariffs in order to fine-tune the proposed retail tariffs.

h.) Public exposure of the proposed tariffs, leading to public debate and hearing.

i.) Determination of the final retail tariffs

The first and second steps in the tariff design process outlined above i.e. demand forecasting and long range generation planning are currently undertaken by a committee comprising ERB, the Ministry of Energy, and representatives of key utilities in the electric power sub-sector. Actual retail tariff design, review and adjustment which incorporates the outcome of the foregoing processes, commences at the third stage and is the statutory preserve of ERB as provided for in the Act. It follows the systematic process described above, which is discussed in detail in the remaining sections of this document.

### 3.2. CUSTOMER CATEGORIES

#### 3.2.1. Determinants of Customer Classes

1.) In establishing the customer classes due consideration shall be given to the determinants of customer classes, which include among other factors:

a.) **Voltage levels**: The cost of providing service varies by voltage levels.
b.) **Metering arrangements:** Different customer types need different metering equipment with the aim of achieving cost-effectiveness in the type of equipment chosen.

c.) **Load pattern characteristics:** Customers impose different loads on the system; for instance industrial consumers may impose short intense loads (spikes) on the system thereby warranting a separate tariff which takes these characteristics into account.

d.) **Bypass:** Uneconomic bypass should be prevented by being cognizant of customers’ sensitivity to prices. Highly price sensitive customers may opt for non-optimal sources such as self-generation, which are inefficient for the economy.

e.) **Optional levels of service quality:** The option of interruptible services shall be available to customers who may choose to use the service.

f.) **Eligibility for subsidies:** Government policy in respect of such issues as lifeline tariffs, rural electrification and the national uniform tariff shall be observed.

---

**3.2.2. Existing Customer Categories**

1) The existing customer categories, which are presented in the following table, have been in place since August 1999. Categories C4 and C5 were introduced in the May 2000 tariff review, but there are no Consumers in category C4 and only one in C5, hence raising the question of the appropriateness of this move.

2) The domestic tariff (Code A0) includes four energy blocks, with successively higher charges for energy consumed in each block. The existing structure of the domestic tariff is an increasing block tariff in which the customers consuming bigger blocks of energy pay more. The rationale for using increasing block tariff is to enforce prudent use of electricity amongst customers consuming large quantities of electricity.
3) The lowest block in the domestic tariff is the Life-Line Tariff (LLT) block, which is capped at 50 kWh per month. The subsidy provided in this block is poorly targeted with every domestic consumer benefitting from it contrary to the objective of benefiting only vulnerable members of the society. This shall be reviewed with the aim of prudentially targeting only vulnerable consumers.

4) The key weakness of the LLT as currently practiced is the fact that all domestic customers benefit indiscriminately: the first fifty kWh is subsidized for all domestic customers, thereby beating the purpose of the subsidy. The proposal in the Retail Tariffs Review Policy is for the subsidy to be targeted strictly at customers consuming only up to 50 kWh per month. If the consumption exceeds this threshold the consumer becomes ineligible for the subsidy and all the units consumed will be charged at the higher applicable tariff.

5) The uppermost block provides for consumption not exceeding 7,000 kWh per month, however, some domestic customers routinely exceed this. There is an average of forty or so customers who regularly exceed the 7,000 kWh thresholds by a significant margin, consuming an average of 10,000 kWh per customer per month.

6) This raises questions as to the appropriateness of this limit and whether or not it should be adjusted upwards; or alternatively whether the affected consumers should be moved to the appropriate commercial or industrial tariffs. The Board proposes to adjust this limit upwards.

7) Small commercial/industrial and medium irrigation customers are metered at Low Voltage and do not have demand meters or time of use metering. It is recognized that irrigation customers are particularly amenable to time of use metering and should therefore be put on time of use metering.

8) Commercial/Industrial categories are differentiated by voltage, energy usage; and by metering including demand meters and time-of-use metering. This is considered appropriate, but the number of categories at is eight considered too many and is therefore not justifiable.
9) KPLC employees obtain electricity services at subsidized tariffs; while KPLC installations receive it free. It is considered inappropriate to subsidize KPLC employees' electricity consumption in the manner in which it is currently practiced as it gives them no incentives to use the service efficiently and opens it to abuse. The Board adheres to the principle that efficient use of electric power should be practiced by all consumers including KPLC’s employees and installations.
## Table 1: Existing Customer Categories

<table>
<thead>
<tr>
<th>CODE</th>
<th>TYPE</th>
<th>VOLTAGE</th>
<th>Energy Limit (kWh/month)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A0</td>
<td>Domestic</td>
<td>240/415V</td>
<td>0-50</td>
</tr>
<tr>
<td></td>
<td></td>
<td>240/415V</td>
<td>51-300</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>301-3000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3001-7000</td>
</tr>
<tr>
<td>A1</td>
<td>Small Commercial/Industrial</td>
<td>240/415V</td>
<td>&lt;7,000</td>
</tr>
<tr>
<td>B0</td>
<td>Medium Irrigation</td>
<td>240/415V</td>
<td>7,000 - 100,000</td>
</tr>
<tr>
<td>B1</td>
<td>Medium Commercial/Industrial</td>
<td>240/415V</td>
<td>7,000 - 100,000</td>
</tr>
<tr>
<td>B2</td>
<td>Medium Commercial/Industrial</td>
<td>11kV</td>
<td>7,000 - 100,000</td>
</tr>
<tr>
<td>B3</td>
<td>Medium Commercial/Industrial</td>
<td>66/132kV</td>
<td>7,000 - 100,000</td>
</tr>
<tr>
<td>C1</td>
<td>Large Commercial/Industrial</td>
<td>415V</td>
<td>100,001 - 5,000,000</td>
</tr>
<tr>
<td>C2</td>
<td>Large Commercial/Industrial</td>
<td>11kV</td>
<td>100,001 - 5,000,000</td>
</tr>
<tr>
<td>C3</td>
<td>Large Commercial/Industrial</td>
<td>66/132kV</td>
<td>100,001 - 5,000,000</td>
</tr>
<tr>
<td>C4</td>
<td>Large Commercial/Industrial</td>
<td>66/132kV</td>
<td>5,000,001 - 7,500,000</td>
</tr>
<tr>
<td>C5</td>
<td>Large Commercial/Industrial</td>
<td>66/132kV</td>
<td>&gt;7,500,000</td>
</tr>
<tr>
<td>D0</td>
<td>Interruptible off-peak</td>
<td>240V</td>
<td>&lt;7,000</td>
</tr>
<tr>
<td>E</td>
<td>Street lighting</td>
<td>240V</td>
<td>No limit</td>
</tr>
<tr>
<td>F5</td>
<td>KPLC Employees</td>
<td>240/415V</td>
<td></td>
</tr>
<tr>
<td>F8</td>
<td>KPLC installations</td>
<td>240/415V</td>
<td></td>
</tr>
<tr>
<td>F9</td>
<td>KPLC installations</td>
<td>240/415V</td>
<td></td>
</tr>
</tbody>
</table>

### 3.2.3. New Customer Categories

1) The Board shall make changes to the existing customer categories as explained in the following paragraphs:

2) In line with government social policy on providing this basic service to vulnerable members of the Society the lifeline tariff shall be retained and capped at 50 kWh per month. However, this service will only be available to consumers who do not exceed the 50 kWh per month.
3) To improve the targeting of this benefit and ensure it only benefits the intended target group, any consumption in excess of 50 kWh per month shall attract normal charges on all units including the first fifty. The Board shall require KPLC to put in place appropriate mechanisms to implement this process.

4. In addition to the life-line tariff, the domestic category shall have two other categories defined on the basis of the load imposed on the system; which are 3-7kVA and over 7kVA respectively. These loads correspond to monthly energy consumptions of 0-3,000kWh/month; and consumption between 3,000 and 15,000 kWh respectively.

5.) The eight medium and large commercial/industrial categories (B1, B2, B3, C1, C2, C3, C4, C5) shall be reduced to five based on the voltage level of service:

   i. 230 V/400 V
   ii. 11 kV
   iii. 33/40 kV
   iv. 66 kV
   v. 132 kV

6) The rationale for this consolidation emanates from the cost differences:

   a. Cost differences for commercial/industrial customers arise from the voltage level of service not the rate of energy usage.

   b. Variations in cost of service due to different patterns of use during the day are captured more effectively by time of use (ToU) metering rather than through separate categories.

7) Irrigation customers shall be moved to the commercial/industrial class with time of use (ToU) metering. The rationale for this being the fact that irrigation is particularly suited to off-peak operation. Irrigation customers shall therefore be encouraged to irrigate during off-peak hours.

8) It is recognized that the existing D0 interruptible tariff gives domestic and small commercial/industrial customers a form of time of use tariff without a time of use meter, albeit with a second meter. This will remain in place.
present form.

9) A new optional Time-of-Use tariff; T0 specific to domestic and small commercial/industrial customers shall be introduced. Customers on this tariff shall have the choice of two metering systems: Either a single time-of-use meter or two meters (peak vs. off-peak meters respectively). The time of use meter allows customers the freedom to respond to the time of use price signal thereby giving greater control over their use patterns.

10) The tariff category E0 applicable to public and local authorities for supplies of electrical energy for street lighting shall be retained in its current format.

11) The special tariff (F5) for KPLC employees shall be eliminated and all KPLC employees put on normal domestic tariffs. However, if KPLC wishes to preserve the benefit to its employees it shall award them a fixed amount in their salaries.

12) The rationale for this is to provide the right signals to KPLC employees in order to give them incentives to use electricity prudently. Further this in keeping with S121 (2) of the Electric Power Act, 1997.

13) The special tariff categories F8 and F9, through which free power is provided to company installations, shall be eliminated. In their place power to KPLC installations shall be provided at commercial/industrial tariffs.

14) The rationale for this is to make the managers of company installations accountable for electricity consumption at the facilities with a view to improving the overall operational efficiency of the company.

15) The new customer categories which will come into effect in the first tariff control period in which this policy takes effect, are presented in the following table:
### Considerations for Targeting the Life-Line Tariff

1. The social policy objective is one of the key policy objectives guiding tariff design. Its aim is to re-allocate costs with a view to safeguarding clearly identified vulnerable consumer groups; such as poor urban households, rural households, specific industries or institutions.

2. The cost re-allocation may call for subsidies in various forms. In consonance with the government’s policy of National Uniform Tariffs consumers from all regions of the country pay the same tariff, hence the lower cost Consumers subsidizes the higher cost ones.

3. Government policy also requires that vulnerable households enjoy a Lifeline Tariff (LLT) designed to restrict their expenditure on electricity for basic needs within their income bracket. Therefore, for purposes of establishing the Life Line Tariff it is...
necessary to ascertain:
   a. The characteristics of vulnerable households;
   b. allowable expenditure on electricity by vulnerable households for basic needs

4. A household’s vulnerability is viewed in the context of the standard of living or welfare and therefore relates to poverty. Vulnerable groups are thus identified as those with a low standard of living. Such households are largely found within the low income segments of the society.

5. The standard of living is a measure of the ability of a person to obtain basic needs on food and non-food requirements including clothing, shelter, and health services. The standard of living is determined by a person’s level of consumption which is a function of permanent or long run income. A suitable metric for household consumption is household expenditure.

6. The incidence of poverty in Kenya has been studied by the Central Bureau of Statistics and a summary on which this Policy Framework relies appears in Chapter 15 of Economic Survey 2000. According to this source, a household member is considered absolutely poor if he or she cannot afford a recommended minimum expenditure on food plus a minimum allowance for non-food items.

7. The minimum food requirement is determined on the basis of a recommended minimum nutritional requirement of 2250 calories of food energy per day per adult equivalent. This is derived on the basis of a defined food basket of goods. The minimum non-food requirement is derived from the band of population around

8. The absolute poor are found among the lowest ranks of the low income group, and the absolute poverty line encompasses both food and non-food basic requirements and is the arithmetic sum of the food poverty line and a minimum mean value of non-food requirements.

9. The urban absolute poverty line in the year 2003 was KSh. 3,884.68 per month per adult equivalent. For a reference urban household with a size of five persons and a household adult equivalent size of 3.58, this is consistent with a household expenditure of KSh 13,751.75 per month; which puts the reference urban household on the poverty line.
10. The Central Bureau of Statistics (CBS) defines the low income group as comprising a household with an income or expenditure of KSh 10,000.00 or less per month (1997 prices). To be able to afford the same basket of goods in the year 2003, such an urban household requires KSh. 14,670.00 per month.

11. Thus urban households with the characteristics of the reference household and which have an expenditure of KSh. 14,670.00 per month are poor and therefore vulnerable as their income generally falls within the poverty line.

12. On the basis of the mean consumption, a profile of the reference household may be developed to give some indication about the plausibility of the assumptions under-pinning the analysis in the absence of empirical data.

13. A key service for which households use electricity is the provision of light. The quantity of electricity required to produce basic lighting services is small, however, the improvement in the household’s quality of life engendered by adopting electric light is substantial. In the absence of electricity; lighting services for low income households are mainly provided by kerosene lamps. Consider household using two kerosene lamps providing an amount of light comparable to that provided by two 40W bulbs. A litre of kerosene .

14. Consider household using two kerosene lamps providing an amount of light comparable to that of two 40 watts bulbs. A litre of kerosene contains 39.6 MJ of energy. (1kWh = 3.6 MJ) and a kerosene lamp with a typical efficiency of 30% produces 3.3 kWh of light energy.

15. If all of the 24kWh of electricity consumed by the reference urban household per month is for lighting, the kerosene Equivalent is seven litres worth about KSh. 350.00, which works out at 14.59 KSh/kWh for kerosene.

16. Thus the household pays only KSh 151 for 24kWh of electricity [equivalent to an End-User-Tariff of 6.28 KSh/kWh] yet they would be willing to pay up to KSh 350 [equivalent to 14.59 KSh/kWh] for an alternative (kerosene) source of lighting services. Such households enjoy this substantial benefit (consumer surplus) as life-line consumers because of a cross-subsidy. Genuine vulnerable households may thus pay up to an End-User-Tariff of 14.59 KSh/kWh at which point their subsidy benefit is wiped out.
17. The marginal (incremental) cost of producing and supplying a unit of electricity to domestic consumers consuming up to 3,000 kW per month has been estimated by NERA (2002) at 28.67 KSh/kWh. Lifeline tariff and REP consumers fall within this bracket.

18. In prudentially targeting the Life-Line Tariff, the Board shall consider minimizing its impact on the consumers from whom the facility is being withdrawn and on KPLC’s revenue base; and choose a course of action which disturbs the status quo the least and gives a "win-win" outcome.
3.3. **TARIFF STRUCTURE**

3.3.1. **Background on Tariffs and Tariff Structure**

1) The sessional Paper No. 4 on Energy requires electricity tariffs to be cost reflective in order to give signals for efficient resource use by consumers. It is envisaged that cost reflective tariffs also convey the right signals upstream to the generators in order to facilitate efficient resource utilization by electricity utilities and the economy.

2) The electricity tariffs are based on the Long Run Marginal Cost (LRMC) principles and reflect the cost of supplying a unit of electric power to consumers. Generation tariffs, which comprise a significant input into the retail tariff, incorporate environmental costs and hence serve to internalize environmental costs to the generators and ultimately to the consumers.

3) Planning for new generation capacity, which is carried out under the Least Cost Power Development Plan (LCPDP), incorporates environmental costs; and where these are material the ranking of a generation project which is otherwise attractive, is adversely affected so that its coming on stream may be delayed substantially. However, when it eventually does come on stream, the generation tariff will necessarily be significantly higher than it would be without environmental costs.

3) The system operator dispatches of generation plant on a strict economic merit order unless there are compelling reasons to do otherwise. The Board shall be informed of such reasons in writing by the system operator at the earliest opportunity and in any case no later than fourteen days from the date thereof.
The Composition of the Tariff Structure

1) The applicable tariff structures shall be formulated with due regard to the:
   a. Billing determinants
   b. Degree of tariff unbinding i.e. Separation of generation, transmission, distribution and retailing charges

2) Kenya Power and Lighting Company is responsible for transmission, distribution and supply or retailing of electrical energy in Kenya. The retail tariffs it charges are therefore bundled and incorporate the combined cost of the different functional component

2) The Board is cognizant of the fact that unbundling the tariff has the advantage of showing the cost make-up of the different functional components, which would therefore expose the relative efficiencies of the different services thereby facilitating an assessment of the cost-effectiveness of the services rendered.

4) The Board is also cognizant of the fact that unbundled tariffs may not be understood by all consumer and hence may detract from desirable transparency and simplicity in the tariff; without adding value to the customer. The retail electricity tariffs shall therefore remain bundled during the review period following the adoption of the Retail Tariffs Review Policy Framework.

4) The Board, however, undertakes to study this issue further and consult more widely with a view to compiling information that will facilitate future decision making on the optimal degree of tariff unbundling given the existing market structure.

6) In addition, the Board may require KPLC to undertake activities aimed at increasing the degree of transparency in the tariff setting, enforcement and compliance process. Already the Grid Code requires KPLC to ring fence the transmission function forthwith.

7) The tariff structure shall follow the utility’s underlying marginal cost structure in order to: provide customers with efficient price signals keep the utility’s revenues in line with its costs.

8) The tariff structure shall comprise:
   a.) fixed charge
   b.) energy charge
c.) capacity charge

10) Marginal customer related costs shall be recovered in a fixed monthly charge, which shall vary by customer category.

11) Marginal distribution facilities costs shall be recovered in a fixed monthly charge based on the customer's contract capacity. This shall be reset at the highest metered demand level if actual demand exceeds the contract level.

12) Time differentiated marginal generation, transmission and demand related distribution costs shall be recovered on a time-differentiated per kilo-Watt-hour basis with Time-of-Use metering. For customers without time of use metering it shall be on non-time differentiated per kilo-Watt-hour basis.

### 3.3.3. Pass-Through Elements in the Tariff Structure

1) Regulated companies face significant costs that are both uncertain and largely outside their control, and are therefore exposed to a considerable amount of risk relating to the fluctuations in these costs.

2) As a general principle, risk should be passed onto those best suited to bear it. With regard to the electricity industry players i.e. Generators, KPLC and the consumers, each player has a different capacity to bear specific risks.

3) There are two pass-through terms in the existing tariff structure: fuel oil adjustment cost (FOCA) and the foreign exchange rate fluctuations adjustment (FERFA).

4) The FOCA clauses in the PPAs between KPLC and each of the generators operating fuel oil thermal plants provide for the treatment of the respective fuel cost above.

5) There are two basic forms of fuel price adjustment clauses either of which may be used; with the difference being in the incentives faced by the generator in obtaining the lowest possible fuel.
6) The price paid by the generator to the fuel provider is passed through in full to the utility so that the utility or its customers or both parties bear all the price risk for the fuel. The fuel related payments made by the utility to the generator are based on a given market index for the fuel price, so that the fuel price risk is shared between the utility and the generator.

7) Historically, fuel price adjustments in the electricity industry are of the full pass through type where the risk is fully borne by the utility and the consumer. This is the case with the Kenyan ESI today.

8) The straight pass through without restraint gives no incentive to the generator to obtain the best price available. Therefore in the tariff control period immediately following the implementation of this policy the Board shall investigate the possibility of progressively shifting into the arrangement involving some risk sharing between the utility and consumers on the one hand; and the generators on the other, in the context of the fuel oil market in Kenya with a view to managing the oil price risk. The instruments for this purpose may include various hedging mechanisms.

9) The Board recognizes that consumers face considerable volatility in the Monthly electricity bills, which makes it difficult for them to plan meaningfully for their consumption. Nevertheless, it is important that the monthly bill should accurately reflect the cost of owner generation and supply in order to give them incentives to use it efficiently.
3.3.4. **Fuel Oil Adjustment Cost (FOCA)**

1) The FOCA in Kenya cents/kWh applicable to the given billing period under consideration is given by the following expression:

\[
\text{FOCA} = \frac{1}{1-L} \left[ \sum \frac{C_i G_i S_i - e_b}{G} \right] \times 100
\]

- **Ci**: Actual price in KSh/Kg paid by KPLC or the operator of the fuel oil thermal plant i.
- **Gi**: Total units in kWh generated by the fuel oil thermal plant i.
- **Si**: Specific fuel consumption in kg/kWh generated by the fuel oil thermal plant i.
- **G**: Total of all units in kWh purchased by KPLC during the billing period under consideration.
- **eb**: Base fuel cost in KSh/kWh purchased from operators of fuel oil thermal plants. The base fuel cost in use is the product of the unit fuel cost in KSh/kWh and the proportion of the fuel oil thermal generation in the generation mix, which has been assumed at a constant 20%; resulting in \([4.15 \times 20\%] = 0.83\).
- **L**: Allowed losses in transmission and distribution = 0.15
2) The foregoing structure of the FOCA will be retained in the tariff control period following the adoption of this policy with no amendments.

3) Specific fuel consumption based on manufacturers’ specifications for the existing petro-thermal power plants are shown in Table 4.

4) The fuel charges are based on a "deemed fuel quantity" based on net electrical output of the plant and the guaranteed heat rate. The deemed fuel quantity takes into account the fuel heating value and allows for the fact that there may be more than one fuel supplier and therefore a mix of fuel qualities. There may therefore be over or under recovery of the fuel charges.

5) An annual review shall be undertaken to assess the over or under-recovery of fuel oil adjustment costs for each fuel oil thermal plant.

6) KPLC shall be required to channel any over-recovered funds into a separate account the amounts of which shall be released to the consumer on a one-off basis-half yearly. Computation of the amounts involved shall be on the basis of the kWh consumption of each customer.
Table 4: Approved Specific Fuel Consumption \( \text{SI} \) for Existing Petro-Thermal Power Plants

<table>
<thead>
<tr>
<th>PLANT</th>
<th>( \text{SI} ) (kg/kWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Kipevu Diesel Plant II (TPC)</td>
<td>0.219</td>
</tr>
<tr>
<td>2 Kipevu Diesel Plant I (KenGen)</td>
<td>0.210</td>
</tr>
<tr>
<td>3 Kipevu Gas Turbine (KenGen)</td>
<td>0.300</td>
</tr>
<tr>
<td>4 Kipevu Steam Plant (KenGen)</td>
<td>0.335</td>
</tr>
<tr>
<td>5 Nairobi South Gas Turbine - Fiat (KenGen)</td>
<td>0.410</td>
</tr>
<tr>
<td>6 Nairobi South Diesel Plant 1 Nigata (Iberafrica)</td>
<td>0.229</td>
</tr>
<tr>
<td>6 Nairobi South Diesel Plant 1 Wartsila (Iberafrica)</td>
<td>0.223</td>
</tr>
<tr>
<td>7 Garissa Diesel (REP-KenGen)</td>
<td>0.200</td>
</tr>
<tr>
<td>8 Lamu Diesel (REP-KenGen)</td>
<td>0.290</td>
</tr>
<tr>
<td>9 Lodwar Diesel (REP-KPLC)</td>
<td>0.290</td>
</tr>
<tr>
<td>10 Mandera Diesel (REP-KPLC)</td>
<td>0.290</td>
</tr>
<tr>
<td>11 Marsabit Diesel (REP-KPLC)</td>
<td>0.290</td>
</tr>
<tr>
<td>12 Wajir Diesel (REP-KPLC)</td>
<td>0.290</td>
</tr>
<tr>
<td>13 Moyale Diesel (REP-KPLC)</td>
<td>0.290</td>
</tr>
</tbody>
</table>

### 3.3.5 Foreign Exchange Rate Fluctuations Adjustment (FERFA).

1) Foreign exchange rate fluctuations are largely outside the control of the utilities and can constitute a significant proportion of the costs they face, given the capital intensive nature of the industry and the heavy reliance on Foreign currency denominated investments; hence the need for the adjustments. These pass on this risk to the consumers and KPLC thereby keeping the price signals to the consumers at efficient levels.

2) KPLC is therefore covered for variations in exchange rates by an adjustment: Foreign Exchange Rate Fluctuations Adjustment (FERFA) for its own foreign exchange payments, as well as payments to KenGen and the IPPs.
3) The FERFA formula shall be maintained in its existing format

4) The current FERFA formula:

\[
\text{FERFA} = \frac{1}{1 - L} \left( \frac{zF + Y}{Gt} \right)
\]

Where:

- \( G_t \): Total of all units in kWh purchased by KPLC during the billing period \( t \).
- \( Z_t \): Percent change in the CBK mean exchange rate on the last business day of the calendar month immediately preceding the billing period \( t \) from the base rate.
- \( Y \): Sum of foreign currency related costs invoiced by KenGen to KPLC for the billing period \( t \).
- \( F \): Sum of foreign currency related costs incurred by KPLC including payments to IPPs during the billing period \( t \).
- \( L \): Allowed losses in transmission and distribution = 0.15
7) The Board recognizes that the FERFA formula does not cover variations in cross-exchange rates for costs denominated in currencies other than the US dollar. However, since most of the loans and all IPP payments are US dollar denomination this approach is deemed the most practical. It is considered prudent for KPLC to absorb the cross-currency fluctuations risk, however, during the initial review period the Board shall investigate the possibility of using a basket of currencies representative of the varying currencies faced by KPLC with a view to managing the foreign exchange risk inherent in the business.

3.4. SURCHARGE

1 KPLC has been allowed to continue to impose the power factor correction surcharge on customers operating at power factor levels below 0.90. The rationale for imposing the surcharge is to enforce energy efficient consumption practices by the consumers.

2 KPLC has also been allowed to continue to impose a surcharge on electricity consumers who have installed welding machines at their premises. This is in recognition of the disturbance caused to the system by the use of welding equipment thereby calling for increased investments on the system in order to minimize the negative impact on other consumers.

3 The surcharge in either case i.e. Power factor surcharge or welding surcharge, has been approved by Electricity Regulatory Board.
The Tariffs to be applied by the Company for the supplies of electrical energy from the Interconnected System and also from the Off-Grid Systems, in each Billing Period shall be as detailed below:

### 3.5.1. METHOD DC:

Applicable to Domestic Consumers metered by the Company at 240 or 415 volts and whose consumption does not exceed 15,000 Units per Billing Period.

a) A Fixed Charge of KSh 120.00*
b) Energy charges of:
   i) KSh 2.00 per Unit for 0 - 50 Units consumed;
   ii) KSh 8.10 per Unit for 51-1,500 Units consumed;
   iii) KSh 18.57 per Unit for Units consumed above 1,500.

* If Method DC is used in conjunction with Method IT at the same supply terminals, then the combined Fixed Charge for both Methods of Charge shall be KSh 240.00.

### 3.5.2. METHOD SC:

Applicable to non-domestic Small Commercial Consumers metered by the Company at 240 or 415 volts and whose consumption does not exceed 15,000 Units per Billing Period.

a) A Fixed Charge of KSh 120.00*
b) Energy charge of KSh 8.96 per Unit for all Units consumed.

* If Method SC is used in conjunction with Method IT at the same supply terminals, then the combined Fixed Charge for both Methods of Charge shall be KSh 240.00.

### 3.5.3. METHOD CI1:

Applicable to Commercial and Industrial Consumers for supplies provided and metered by the Company at 415 volts three phase four-wire and whose consumption exceeds 15,000 Units per Billing Period.

a) A Fixed Charge of KSh 800.00
b) Energy charge of KSh 5.75 per Unit consumed.
3.5.4. METHOD CI2:
Applicable to Commercial and Industrial Consumers for supplies provided and metered by the Company at 11,000 volts, per Billing Period.

a) A Fixed Charge of KSh 2,500.00.

b) Energy charge of KSh 4.73 per Unit consumed.

c) Demand charge of KSh 400 per kVA.

3.5.5. METHOD CI3:
Applicable to Commercial and Industrial Consumers for supplies provided and metered by the Company at 33,000 volts, per Billing Period.

a) A Fixed Charge of KSh 2,900.00

b) Energy charge of KSh 4.49 per Unit consumed.

c) Demand charge of KSh 200.00 per kVA

3.5.6. METHOD CI4:
Applicable to Commercial and Industrial Consumers for supplies provided and metered by the Company at 66,000 volts, per Billing Period.

a) A Fixed Charge of KSh 4,200.00

b) Energy charge of KSh 4.25 per Unit consumed.

c) Demand charge of KSh 170.00 per kVA

3.5.7. METHOD CI5:
Applicable to Commercial and Industrial Consumers for supplies provided and metered by the Company at 132,000 volts, per Billing Period.

a) A Fixed Charge of KSh 11,000.00

b) Energy charge of KSh 4.10 per Unit consumed.

c) Demand charge of KSh 170.00 per kVA

3.5.8. METHOD IT:
Interruptible off-peak supplies of electrical energy to ordinary consumers metered by the Company whose consumption does not exceed 15,000 Units per Billing Period.

a) A Fixed Charge of KSh 120.00*

b) Energy charge of KSh 4.85 per Unit consumed.
* If Method IT is used in conjunction with Method DC or SC at the same supply terminals, then the combined Fixed Charge for both Methods of Charge shall be KSh 240.00.

Notes:

Note 1 The electrical energy which shall be supplied and charged under this method of charge shall be available at all times other than during peak periods which shall be such periods of high demand as may occur during each day not exceeding sixteen hours in the aggregate and during which the supply of electrical energy may be restricted, the time or times of such restriction and the duration thereof being controlled by the Company at its sole discretion.

Note 2 This tariff is only available for installations so arranged to the company's satisfaction, that they cannot be operated on any other tariff and also where there is no duplication of the off-peak circuits by other electrical circuits unrestricted as to time of use so enabling the supply on another method of charge to be used for a similar function.

Note 3 The Company shall provide and maintain apparatus up to a maximum capacity of 15 amperes, single phase, to control the period of availability of the supply and shall take all reasonable steps to ensure the reliability thereof, but shall not be responsible for any loss, damage or injury which may result from any mal-operation of this control equipment.

3.5.9. METHOD SL:

Applicable to public and local authorities metered by the Company at 240 or 415 volts for supplies of electrical energy to public lamps (Street Lighting).

a) A Fixed Charge of KSh 120.00.
b) Energy charge of KSh 7.50 per Unit consumed
Supplies under this Method of Charge shall be available for a minimum period of 11 hours per night for public lamps and for no other purpose.

The attention of public and local authorities taking supplies on this tariff is drawn to the fact that where public lamps are fitted on the Company's poles, all maintenance of the lamps, switch wire and associated equipment must be carried out by the Company, and shall be charged for on the basis of net costs of materials, labour and transport plus 25

**Note:** Every Consumer shall pay to the Company in addition to the charges specified in this Part of this Schedule of Tariffs a Fixed Charge at a rate not exceeding KSh 50.00 per kVA per Billing Period of nameplate kVA continuous rating in respect of all electric welding plant, as adjusted by any power factor equipment in use.

Reference:

2. [www.ERB.go.ke](http://www.ERB.go.ke)
3. Daily Nation, Friday, July 11, 2008
4. CONCLUSION

With assistance from various people and comprehensive research, the study of how tariffs are developed from the classical details to how they are applied generating and transmitting companies. The various types of tariffs, costing of electricity was researched and studied at length.

In this case, the application at hand was the electricity transmitting and distributing company in Kenya by the name Kenya Power And Lighting Company Ltd. With the various material from the company’s regulating board internet, and those from summit organized by the company, I was able to very clearly show the relationship between the classical principles of tariff formulation, from literature materials and those being used by the supplying company at that time.

With that, I can confidently say that the project was able to meet its objective to do an in-depth study of tariffs and by establishing a vivid relationship of the classical models of tariffs with those being used by supplying company.
APPINDEX.