Chapter I

INTRODUCTION
"The word energy comes from the Greek word energia which means vigour of expression, activity. The word was coined by philosopher Aristotle from the word elements en (in) + ergon (work). A century or so after Aristotle the term hai energia, expressing the concept "Cosmic forces" entered western through the popular occult writings of group of philosophers centered in Alexandria, Egypt. The psychological meaning of energy, vigour or intensity of action, was introduced in English early in the 19th century by the poet Samuel Taylor coleridge, scientific meanings of which have sprung up over the past 150 years".

1.1. Definitions of energy

Energy is defined as the ability to do work. The term energy was first used by Thomas Yound (1773-1829). Based on chemical, nuclear or locational properties energy is essential to any society because it allows work to be done. Hunting, pastoral, and nomad societies are organized around the gathering of energy in the form of food. Urban and settled agricultural societies are organized around energy in the form of food, coal, oil and electricity. In other words all human societies focus their organization around the provision of energy in one form or another. The distinction between them lies in the types and quantity of energy being exploited. Energy is an essential commodity for all human activities. Odum (1970) has gone so far as to suggest that all commodities be valued in terms of their energy value instead of their cash value.
The term energy has been defined in various ways by various people as follows:

According to Thomas Yound the English Physicist Energy is the ability or capacity to do work;

According to William Blake the renowned poet "Energy is the only life...energy is eternal delight";

According to E.F. Schumatcher there is no substitute for energy and the whole edifice of modern life is built upon it although energy can be bought and sold like any other commodity a basic factor equally with air water and earth;

Energy is a necessity in providing nutritious food, Clean water and a warm place to live - ILO 1976;

Energy is a necessary input into the economic development and employment through which the basic needs are met - ILO 1978;

Per capital requirements for energy necessary to assure a minimum standard of living (subsistence but not growth) have been estimated at 325 kilograms of oil equivalent (Kgoel annually) (Parikh, 1980); and

Energy enters in an economy in three distinct ways, which Slessor simply calls heat, the transformation process and power.

So from the above definitions, the term energy can be summed up as an input, heat, force ability and life.
The term energy presently connotes the "Capacity for doing work". The need for external (to man) sources of energy arose when mankind progressed from a primitive to a civilized state. In the ancient times human needs were limited and all of them could be fulfilled with the exertion of their own body. Whether it was hunting, collecting the food or carrying of loads, a human body was sufficient to perform the required tasks. However the human beings were constantly engaged in a struggle against nature and in this endeavour the first external source of energy which was discovered by them was fire. The fire they got was either from the wood or, later on, from animal tallow, which was used both for heating and lighting. Similarly, in course of time, as agriculture replaced hunting as the main occupation, human body was not considered sufficient for doing mechanical work, animals were used for performing certain tasks.

For thousands of years, these three sources - firewood for heating, animal tallow and other vegetable oils for lighting and draught animal power for other mechanical function fulfilled the energy needs of mankind. Apart from these, there is evidence of the use of wind energy in shipping since ancient times. Later on windmills were used in the medieval period to do certain work of the land. Windmills were also used for the same purpose, which used the hydropower as a source of energy.

All traditional rural societies originally depended on locally available renewable energy sources. Energy was gathered or harvested nearby; none was imported. Traditional societies made use of solar energy, wood and charcoal, plant and animal wastes, and human and domestic animal power for all of their energy needs.
Most energy was used in the household sector (and still is spend) in the preparation of food. Cooking tasks used wood, charcoal or plant wastes. Agricultural, pastoral, fishing, and hunting activities made use of human or animal power. Crops were dried using solar energy and then cleaned, processed and grinned by human muscle in the home.

People traveled on foot, by boat or by animal power. Goods and water were transported on foot or using animals. Communication relied on messengers who traveled on foot.

Table 1.1 shows how traditionally, in the absence of large transport and industrial energy requirements, all energy supplies were renewable and locally available.
<table>
<thead>
<tr>
<th>USE</th>
<th>METHOD</th>
<th>ENERGY SOURCE</th>
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<tbody>
<tr>
<td>Cooking, space heating, heating, water</td>
<td>Open fires</td>
<td>Wood, charcoal plant wastes (biomass energy)</td>
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<tr>
<td>Lighting</td>
<td>Special types of wood and resins</td>
<td>Wood</td>
</tr>
<tr>
<td>Agricultural and pastoral activities</td>
<td>Planting, harvesting</td>
<td>Human and animal power (Animate energy)</td>
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<tr>
<td>Food preservation</td>
<td>Smoking</td>
<td>Wood</td>
</tr>
<tr>
<td></td>
<td>Drying, crops and fish</td>
<td>Solar power</td>
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<tr>
<td>Small industries</td>
<td>House building, smelting iron and grafts work</td>
<td>Animate energy Wood Animate energy</td>
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<tr>
<td>Brick &amp; pottery making</td>
<td>Kilns</td>
<td>Wood</td>
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<tr>
<td>Transportation Communication</td>
<td>By foot</td>
<td>Animate energy</td>
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<td></td>
<td>By camel, donkey</td>
<td>Animate energy</td>
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<tr>
<td></td>
<td>By boat</td>
<td>Animate energy</td>
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<tr>
<td></td>
<td>By dhow</td>
<td>Wind power</td>
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</table>
As mankind progressed, the wants increased and their satisfaction required greater capacity to do work which could not be fulfilled by the above mentioned sources. At this time, fossil fuels were found which fulfilled the increased energy needs of mankind mostly for heating purposes. The first fossil fuels to be exploited were surface deposits of asphalt, peat and coal, oil from surface seepage and gas venting from underground reservoir. The invention of steam engine by James Watt in the late eighteenth century was a landmark for mankind in the use of energy. It was for the first time that energy (of coal) was converted into mechanical energy through the steam engine. This marked the beginning of industrial revolution. The internal combustion engine which used petroleum oil (which was previously used for heating and lighting purposes only) as its source of energy greatly facilitated road transportation. Since then the use of petroleum has been constantly increasing and is fulfilling the major energy needs. The total amount of oil in the world is estimated to be about 4 million barrels (600 billion metric tons), half of which is thought to be ultimately recoverable. Some 465 billion barrels of oil already have been consumed. In 1990 proven reserves were roughly 1 trillion barrels (bbs), enough to last only 50 years at the current consumption rate of 20 billion barrels per year.

Further it is estimated that another 800 billion barrels either remain to be discovered or are not recoverable at prices with present technology. However, energy for tomorrow's world, the world energy council report, published in 1993, forecasting energy situation up to 2020 indicates that "energy used (until 2020) will rise and the world will have to rely largely on fossil fuels".
A country's demand for energy is linked with factors such as size of population, degree of urbanisation, dietary patterns and level of technological development. Effective demand however, is related to economic conditions, which influence the availability of the supply, competing demands upon the supply and access to sources of energy. Because the cost of petroleum is already absorbing a significant proportion of the foreign exchange earnings of fourth world economies, Kenya in particular, it is not feasible to consider filling the gap between the demand for biomass and its supply with petroleum based products.

The major demand for energy in developing countries emanates from households for cooking, lighting and space heating. For example, household energy demand accounts for 60 percent of energy consumed in Kenya and over 53 percent of all energy is consumed in rural households.

The contribution of non-commercial energy sources at world level does not exceed 7.7 percent of the total energy consumption. The developing countries as a whole consume only 16 percent of the commercial energy. As a result of poor status in the consumption of commercial energy, the developing countries have to depend to a large extent on the traditional sources of energy, human and animal labour, firewood, crop residues and animal wastes. The non-commercial energy sources are found and utilised mostly in rural areas of third world economies where more than 70 percent of the population live. It is estimated that around two-third of the population of developing countries rely on biomass fuel (wood, dung and fibre residues) for cooking and heating, involving around three billion people (WRI, 1998).
Increased fuel demand and severe shortage leads to over exploitation of forests which may exceed the regeneration capacity of nature. According to FAO study (1981) some 90 million people in rural areas are suffering from acute fuel wood shortages. This scarcity with high demand leads the traditional fuels to commercial markets where cost may approach or exceed the price of food it is to cook. Hence making an African proverb to become true "it costs as much as to heat the pot as to fill it".

The rural poor who cannot afford fuel prices will turn towards inferior substitutes such as cow dung and any vegetative matter available because "it is not what is in the pot but what is under it worries you" (A Chinese saying). Traditional stoves predominant in rural households leads to high radiation losses. Thus reducing the thermal efficiency of the stove. Fuel consumption is therefore, high in these stoves. Because of this inefficiency of the cooking time increases.

Traditional cook-stoves do not have chimneys and hence emit smoke into the Kitchen, particularly in the cooking zone. Added to this, the household and kitchen design features, such as low roofing, poor ventilation and close settlements, aggravate the problem of smoke. Cooking is inconvenient in smoke field kitchens. It creates health problems. Biomass fuels emit 6 major pollutants, viz., particulate matter, carbon monoxide, oxides of nitrogen, formaldehyde, sulphur dioxide and benzopyrene. In addition, hundreds of other simple and also emitted (WHO, 1992). In biomass combustion, exposure to particulate matter is between 17 and 26 mg/hour/m$^3$. It is even higher dung cake. In the case of LPG and Kerosene exposure to particulate matter is 0.4 and 2.4 to 3.6 mg respectively (WHO, 1992). For every kg of wood burnt, 40 mg of Carbon monoxide, 2g of particulate, 1mg of benzopyrene and 200rng of formaldehyde are emitted (Agarwal et.al. 1999).
Inefficient combustion of traditional fuel in linked to respiratory infection, the leading health *hazard* to children in developing countries. It is now widely recognized that among endemic diseases, acute respiratory infection (ARI) is the most pervasive case of chronic deaths per year (Smith 1988, 1993). Response and management strategies to prevent ARI have become a primary focus of national health program.

The heavy reliance of many developing countries like Kenya on non-commercial fuels have grave Governmental consequences. Besides the use of commercial energy in the third world economies is rather minute.

The health effects of the use of non-commercial energy sources have not been a matter of extensive study. Some laboratory experiments have been carried out to access the emissions from non-commercial sources, the findings are as follows:

**Table 1.2: Estimated Emission of Major pollutants from Non-commercial sources (1 Kg per ton of fuel)**

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Firewood</th>
<th>Dry cattle dung</th>
<th>Agricultural waste products</th>
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</thead>
<tbody>
<tr>
<td>Carbon monoxide</td>
<td>1.63</td>
<td>0.69</td>
<td>1.59</td>
</tr>
<tr>
<td>Sulphur dioxide</td>
<td>19.60</td>
<td>8.18</td>
<td>18.75</td>
</tr>
<tr>
<td>Nitrogen oxides</td>
<td>3.90</td>
<td>1.63</td>
<td>3.75</td>
</tr>
<tr>
<td>Organics (including hydro carbons)</td>
<td>23.50</td>
<td>9.81</td>
<td>22.05</td>
</tr>
<tr>
<td>Particulates</td>
<td>31.40</td>
<td>13.09</td>
<td>30.00</td>
</tr>
<tr>
<td>Hydrogen sulphide</td>
<td>1.20</td>
<td>0.45</td>
<td>1.12</td>
</tr>
<tr>
<td>Ammonia</td>
<td>1.20</td>
<td>0.45</td>
<td>-</td>
</tr>
<tr>
<td>Hydrogen chloride</td>
<td>1.20</td>
<td>0.45</td>
<td>1.12</td>
</tr>
</tbody>
</table>

Source: Jyothi Parikh, 1976
Focussing the situation of rural life in the domestic sector there is a scope for dispersion and dilution of the effects which may only show a slow decline in ambient quality. The truth behind this is that women and children who are often close to the source becomes the target of health problem. The effects of these pollutants can be seen on utensils, walls, and clothes and above all on health especially on eyes and lungs. The presence of smoke leads to high incidence of lung and eye disease and other discomforts in general.

On the other hand indirect health effect which could be attributed to the burning of dung is widely prevalent schistosomisis, a disease spread by water contaminated by dung. It is estimated that 200 million people suffer from this waterborne disease in which hookworms residing in the stomach lead to malnutrition and discomfort. (Water conference U.N. 1977)

On account of fast deforestation, dwindling supply of firewood and gradual commercialization of traditional fuel sources, it has become very difficult for the rural folk to secure adequate energy supply at a cost which is affordable by them. Rural people especially women and children are subjected to drudgery of collecting firewood from far off places spending on an average 2 to 3 hours per day or even more. If there is such acute scarcity of energy on one side, there is a huge wastage of available resources due to ignorance and inefficient methods of energy use. In order to chide this enormous misuse of energy, it is necessary to motivate the rural people to shift their choice for more fuel efficient heating and cooking devices and to formulate a proper rural energy policy which gives full credit to rural requirements.
This necessitates an in-depth analysis of energy consumption pattern in the household sector, its relationship with income, development in the rural areas, family size, distribution of land holding type of energy used, source of procurement etc.

A comprehensive study of rural energy should however include the analysis of energy consumption in various sectors like agriculture, transport, rural industries, rural commercial and social establishments and so on. Further an analysis of animated energy is also equally vital. However, in the present study, the researcher has restricted the scope to analysis of energy consumption pattern in the rural household sector only which accounts for the bulk of the rural energy consumption.

1.2 Energy as a concept:

Energy as a concept was invented to account for the fact that when heat or work are put into or taken out of a system, and that system ends up on a different state, some property of the system has to account for the difference. That property is called the "energy concept". To Thermodynamists it is initial energy content (Ei) with a final energy content Ef.

When any work is done, energy is converted from one form to another. Our bodies convert the chemical energy stored in food to mechanical energy (when walking, for example) and heat energy. A charcoal stove converts the stored chemical energy in wood to heat and radiant energy. A light bulb converts electrical energy to radiant and heat energy.
It is usually easier to convert "higher" forms of energy than it is to convert lower forms of energy to higher forms of energy. For example, it is quite easy to covert electrical energy into heat energy (using resistors), but much more difficult to convert heat energy into electrical energy.

1.3 Energy: A Critical Commodity:

Energy is a critical commodity. It functions as a factor of production, as a process feedstock and as a consumer good. The availability of energy determines the shape of the life style of individuals and that of the total economy. The evidence all over the world has shown a positive association between per capita income and per capita consumption of energy. In fact the per capital consumption of energy is now regarded as one of the most important indices of economic development.

Economic development is also seen to have been accompanied by substitution of one form of energy by another. As an economy develops, its demand for energy tends to increase and its consumption pattern in terms of energy forms and energy sources also tends to change. But the stock of known viable sources of energy supply, particularly of commercial fuels are limited and to a large extent non-renewable. Further, the commercial exploitation of energy sources involves large investment and long gestation period. This and other considerations emphasis the need for taking along run-view on demand and supply of energy.

The developing countries of Asia, Africa and Latin America, where 71% of the world population lives, consume only about half as much commercial energy annually as the United States of America alone, which contains only 5.5% of the world's population
and less than what is consumed in western Europe, which has 9% of the world population. In 1975, the commercial energy consumed by the developing countries accounted for only 17.5% of global energy consumption.

The disparity in energy consumption is even more striking when considered in per capita terms. In 1975 the per capita commercial energy consumption of the developing countries was 0.5 tones of coal equivalent (tee), while in the developed world it was 5.9 toe.

Levels of economic development, standards of living, and access to energy service are distributed distinctly unevenly around the world. Disparities are evident even at high levels of regional aggregation. Disparities in energy availability mirror the economic disparities among regions. The richest 20% of world’s population use 55% of final and primary energy, while the poorest 20% use only 5%. In 1990, per capita use of final energy varied by a factor of 18 between South Asia (SAS) and North America (NAM) - from 0.3 toe per capita to 5.3 toe per capita, respectively. Of all energy carriers, the disparities are largest for electricity. The richest 20% use 75% of all electricity, while the poorest 20% use less than 3%(Hall and Rosillo-Calle, 1991; IEA, 1993; World Bank, 1993, 1994; UN, 1993b, 1993c).

Global primary energy demand has grown more slowly than GDP. Primary energy growth averaged slightly above 1% per year between 1990 and 1995, about half the growth of global GDP. Thus, global energy intensities continue to improve, except in some transitional economies.
Nearly all the additional primary energy demand growth has been for commercial energy forms, though there was variation across energy sources. Petroleum continues to be the world's primary energy source, followed by coal and natural gas. Global demand for coal stabilized between 1990 and 1995. Gas, renewable and nuclear energy, on the other hand, expanded their shares between 1991 and 1996 (BP, 1997; EIA, 1998a, 1998b).

Within the developing countries, there is yet another world where the rural population lives. Here again, the rural population, which accounts for nearly 70% of the population of these countries consumes less than 15% of the commercial energy consumed by their countries. This is possible because non-commercial energy, i.e., fuel wood, agricultural waste and dung, meets a large proportion of rural energy requirements. In addition animate energy also make a significant contribution. In view of the increasing rural population in the developing world, continued energy supply from these sources can no longer be taken for granted.

Among commercial energy sources, oil plays a major role. Oil is an energy source suitable for the decentralized demand arising in developing countries, as no complex infrastructure is required to provide oil, and its Versatility makes it suitable for a variety of purposes and types of equipment's.

The oil consumption of developing countries is also minimal, being 0.135 tons per person as against 1.750 tons in developed countries. Since in rise the price of oil in 1973, availability of this important element, so necessary for development, can no longer be counted upon.
It is therefore pertinent that the energy consumption pattern in the household sector in rural areas be perused.

1.4 Integrated Emergy Planning:

The objective of energy planning assessment is to facilitate the achievement of short term and long term economic and social development goals. Success in achieving these goals requires that energy resources of the proper type and magnitude be available to sustain the evolution of various sectors of society, and that cost-effective energy use pathways from resources and intermediate conversion to final demand be achieved.

All too often the development of an integrated energy planning process - one which can specify needs and establish timely programmes. The general requirements can be made more specific. First, development objectives embody economic and demographic futures with which energy constraints and requirements must be associated. These include sector-specific growth in output, energy intensities, and fuel mix. Changes in income distribution will also affect consumption patterns through technology and fuel choices.

1.5 Energy and Economic Activity:

Energy is an important input in economic activity. All economic activities can be broadly sub-divided into two categories - consumption and production. While energy is a crucial input in the process of production, it is an important item of the consumption menu. Use of more energy not only facilitates life but also helps mankind to fight the vagaries of nature, and thereby make life worth to live. The examples of this are use of coolers, fans, bulbs and so on. Above all the cooking of
food which is the basic human need cannot be done without energy. In the production process use of energy is indispensable, in the processing of raw materials and their fabrication into final goods, cannot be carried out without using energy. Like other factors of production, energy is also a factor of production and it possesses the attributes of complementary and substitutability.

Energy is imperative for economic and social development. It is a basic input required to attain, sustain economic growth and to provide basic of life. Energy consumption and economic development have a positive relationship between them. Nations with higher levels of Gross National Product (GNP) per capita, tend to consume more commercial energy per capita. Developing economies like Kenya need more and more energy as a prime mover of their economies. Without heating, refrigeration, lighting, and mechanical power, development would be inconceivable. These and other energy services literally fuel the engine of economic living standards.

Building a sector capable of delivering energy services is itself one of the most complex and expensive aspects of National Development. Both industrial and residential demand have outstripped growth. This has led developing world to face several structural problems that exacerbate already inadequate energy supplies.

Given the limitations of expanding the energy sources, aggressive investment in energy efficiency, which extracts more services from the same energy input, is an important tool for developing countries.
Adopting new technologies is not the sole means of improving energy efficiency. It has been shown in Kenya that housekeeping measures such as shutting down machinery not in use can deliver energy savings of up to 10 percent.

1.6 Role of Energy to Economic Development

Energy has become a strategic factor in the process of economic development. A comprehensive global energy analysis indicates a strong positive relation between aggregate economic performance and total commercial energy consumption. Whenever the rate of growth of energy sector continues to be far greater than of the growth in population, society transforms itself from a subsistence economy into a developed one with a higher standard of living. Thus energy is a basic element of human civilization and indispensable input of economic development.

Generally, per capita energy consumption in the household sector is taken as an index of living standard of the people. For example in some of the Kenyan villages people are expending more energy to procure fuel wood.

An indicator of a society's level of development is the quantity and quality of the energy it consumes. This is made clear by the wide disparity in per capita energy consumption in industrialized and developing countries, i.e. USA consumes more energy annually than Africa, Latin America, India and China put together. Adequate supply of energy at a reasonable cost is a key factor in the economic development of a country. The global energy crisis has clearly shown that dependence on imported forms of energy should be reduced to the minimum, and
fossil fuels which are limited, will be generated from other forms of energy, such as hydro, solar and bio-energy which are particularly promising in most developing countries. As energy is a critical parameter in the economic development of a country, energy availability in a region means the ability to produce shelter, clothing, communication, health care, education, transportation, leisure and so forth.

Economic development consists in large part of harnessing, increasing amounts of energy for productive purposes. This can occur by either tapping increased amounts of energy resources or by making more efficient use of available energy resources through use of appropriate tools and machine or conservation techniques.

The relationship between energy and economic development is a dynamic one, in which the amount, type, and speed of economic growth are mutually dependent on variables of the quantity, kind and price of the energy available. The physicist definition of energy is the "ability to do work". However, different sources of energy have different capabilities of doing work. Historically energy has played a vital role in the development of all societies. The forms of energy used have changed from purely manpower to steam engine and currently to fission reactions from nuclear sources.
As shown in the above table (1.3), the relationship between energy and Gross National Product (GNP) holds both cross-sectionally and historically: The higher a nation's income or output, the higher in general, its level of energy consumption; as its GNP rises over time, so does its energy consumption is close, even if not proportional, conformity. In addition to the method of Darmstadter et. al., one approach is based on micro-economic demand theory in which emphasis is put on the response of

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<tbody>
<tr>
<td>1</td>
<td>Tanzania</td>
<td>90</td>
<td>453</td>
</tr>
<tr>
<td>2</td>
<td>Nepal</td>
<td>190</td>
<td>320</td>
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<td>270</td>
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<td>4</td>
<td>India</td>
<td>300</td>
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<td>Nigeria</td>
<td>300</td>
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<td>Philippines</td>
<td>850</td>
<td>528</td>
</tr>
<tr>
<td>7</td>
<td>Ecuador</td>
<td>1200</td>
<td>731</td>
</tr>
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<td>8</td>
<td>Malaysia</td>
<td>3140</td>
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Oxford University Press, Delhi.
energy consumption to relative price, per capita income, industrial production, and other economic factors, as demonstrated by Glakpe. The evolution of civilization in terms of the invention of tools and weaponry, the development of agriculture and husbandry and the acquisition of other aids to living is just another facet of how much, in what form and in which way man has used energy.

While the trend is of the conditional convergence across countries, the pattern of energy intensity improvements in different countries reflect their different situations and development histories. Economic development is accumulative process, that in different countries, incorporates different consumption lifestyles, different settlement patterns and transport requirements, different industrial structures and different take off dates into industrialization.

The ultimate purpose of economic development is an improvement in the standard of living of the people by raising the economic activity of the country. This can be measured by Gross National Product of a country and should be a head of Population growth, so that per capita income rises. Economic development in its true sense is "the process whereby the real per capita income of a country increases over a long period of time—stress is laid on along period of time—because what is significant from the standpoint of development is a sustained increase in real income.

The supply of adequate energy resources is a sine qua non for ensuring a continuous growth of the economy.
Energy has a vital role to play. This can be called the Infrastructure aspect of energy’s role in economic development. A development process cannot be ensured in any country unless adequate infrastructure is strengthened.

The function of infrastructure is to release the latest productivity in the factors of production, singly and in coordination, and bring about not only increase in the output of individual factors and units of production but also a mutually additive effect through coordination in inputs, outputs, space and time and thus maximize the overall rate of economic growth.

Energy sector is an important constituent of the infrastructure of an economy. Since energy constitutes an essential element of the productive activity in all the sectors in an economy viz-manufacturing, transportation, agriculture, commerce and household, an adequate development of energy sector is a natural stimulant for the development of all other infrastructural sectors of the economy. Energy is required for operating pump sets, high yielding variety seeds, a certain degree of mechanization, fertilizer and pesticides, provision for storage extension services, credit marketing, price support and transport facilitates all required for increasing agricultural production and making it available for both rural and urban consumption and for industrial production.

In the industrial sector energy's role is also pervading and it is basic to the operations of plant and machinery, investment of heavy equipment, material processing, lighting and so on. Energy is the basic resource for rail, road, water, or air transportation. Therefore, to talk of development without adequate
development of energy sector is of no avail. Energy's role in economic development can be considered from two angles. Firstly how increasing energy consumption contributes to economic growth and secondly how energy shortages work as brakes on the economic development.

Since energy is the most dynamic resource in the process of development it is regarded as a causeway to growth. It makes investments to be productive, technology to advance, scale economies to take place and labour efficiency to improve.

Since energy is unique in this way, substitutes for energy are not easily available. According to this point of view, if the development process is to be hastened the "causeway" needs to be widened so that higher level of economic activity can be sustained. Similarly, if the causeway gets clogged other, economic activity will have to be curtailed.

1.7 Statement of the Problem.

In the household sector in rural areas, Energy consumption pattern varies from place to place and in some cases even from season to season as compared to the urban sector which ranks second in energy used in household sector. The percentage of energy derived from traditional fuels varies between 1 percent for Taiwan to over 80 percent for countries like Nigeria and Bangladesh (Smil, 1979). On account of fast deforestation, dwindling supply of firewood and gradual commercialization of traditional fuel sources it has become very difficult for the rural
folk to secure adequate energy supply at a cost which is affordable by them. Rural people especially women and children are subjected to drudgery for collecting fuel wood from far off places spending on an average 2 to 3 hours per day or even more. If there is such acute scarcity of energy on one side, there is a huge wastage of available resources due to ignorance and inefficient methods of energy use.

Factors like fuel availability, income, fuel substitutability, climate and household composition do influence the energy consumption pattern in the household sector of rural areas. In order to chide enormous misuse of energy and reduce inefficient combustion of it, it is vital to motivate the rural people to shift their choice for more fuel efficient heating and cooking device and to formulate a proper rural energy policy which gives full credit to the rural requirements. This is because traditional fuels (wood fuel, crop residues, dung, sisal and similar substances) are linked to respiratory infections, the leading health hazard to children in developing countries (Smith 1993).

This necessitates an in-depth analysis of energy consumption pattern, its relationship with income level, development of rural areas, family size, distribution of land holdings, type of energy used, sources of procurement and so on. This study is an attempt to understand and examine the energy consumption pattern in the household sector in rural Kenya. The study is based on the information gathered at grass-root level as well as secondary data and observation of day-to-day domestic requirements of energy.

The current study envisages a sectional study of energy use in three villages of rural Kenya with a focus on type of energy used and their consumption pattern.
1.8 Rationale of the Study

The study at hand was carried out with the purpose of making a detailed analysis of energy consumption pattern in household sector of rural Kenya. However, it may also give some indications of the implications for rural energy budgets of different rural development programmes, the nature of macro relationship between income and energy in villages, and the prospects of energy research and development plans.

By multiplying such studies and scaling up by carefully chosen estimation procedures, a more reliable picture of national rural energy in household sector may be obtained. It may also make away for a comparable information system of rural energy in third world generally focussing on similarities and differences. Consequently, the distortion in the rational allocation of international financial and technical assistance in the area of energy in household sector, as international statistics are selective so far as the coverage of non-commercial fuels are concerned may be removed by a better comprehension of rural energy consumption pattern in household sector. It is also postulated that such studies may also lead to a more pragmatic approach to the choice of technology and alternative energy sources. Hence by taking the above factors into consideration it was vital to carry out the present study.

This study is directed at assessing the energy consumption pattern in three selected villages in the household sector of rural Kenya. A comprehensive study of rural energy should however include the analysis of energy consumption in various other sectors like agriculture, transport, rural industries, rural
commercial and social establishments and so on. Further an analysis of animated energy is equally important. However in the present study, the researcher restricted the scope to analysis of energy consumption pattern in rural household sector only which accounts for the bulk of rural energy consumption.

1.9 Objectives of the Study

The study has the following objectives:

1. to assess energy consumption pattern in rural household sector in the study area

2. to understand the food habits and cooking practices of the sample households in the study area.

3. to analyse the inter and intra village variations in energy consumption in the study area.

4. to suggest appropriate rural energy policy so as to mitigate the household energy problems in the study area

In spite of technological advancement, rural folk may experience various socio-economic and religious constraints in adopting new technology or changing their conventional and traditional way of living. Hence these factors do emerge from micro level studies and in turn help in formulating realistic policies. The above objectives are helpful in devising a rural energy policy in a developing countries like Kenya.
1.10 Scope of the Study-

Rural Energy generally comprises energy consumption by domestic sector, transport, agriculture, industries and various types of establishments. However, out of all these, it is the domestic sector that accounts for more than 90 percent of rural energy consumption in Kenya. Hence, this sector forms the main theme of the current study.

The study covers both traditional and commercial sources of energy. It covers a period of twelve months i.e., December 1998 to December 1999 for understanding seasonal variation in household energy consumption pattern in the study area.

1.11 Methodology

In this study data were obtained from primary as well as secondary sources. The primary data were gathered through field survey by administering a schedule of questions, by adopting a simple random technique. Secondary sources of data were used for gathering information from various government offices i.e., ministry of energy, and environment and other background material.

A structured schedule was used to cover the following aspects:

(i). General information i.e., name, age, religion, occupation of the household, family size, sources of income, educational level;

(ii). Agricultural data like land holdings, cropping pattern, number of trees planted etc;

(iii). Housing condition, size of kitchen, attached or separated, owned or rented, size etc;
(iv). Energy consumption by household sector, energy gadgets used, mode of obtaining energy etc;

(v) Livestock population, and information on dung, purpose was used and so on was also gathered.

Information about monthly variation (of energy consumption) was also obtained in order to assess the impact of seasonal variation on household rural energy consumption.

The selection was made keeping in view of the following factors.

1.11.1. Sample selection

Three villages were selected from Kisii District for investigation purposes.

I. Relative levels of developments of the villages
II. Accessibility of the villages and
III. Fuel resource availability.

Thus, three villages—keeping the above factors in mind, were selected purposively. The village named Riondonga was selected as a developed village in terms of educational level, employment opportunities, diversified economic activities, amenities and services etc. The second village was Birongo and it was a medium village in terms of development. The third village was Bochari. It is located far away from the main road, at distance of seven kilometers. It is very poor in terms of development.

Being unbiased in sample selection SO respondents were randomly selected in each village totaling to 240 respondents.
Thus the three villages were purposively selected for this viz. Riondonga, Birongo and Bochari for investigation.

While selecting these households the main consideration was that they should represent all occupation and landholding categories and income classes and family size. Data relating to monthly energy consumption, price, source, type, total expenditure etc were collected from these households.

1.11.2 Interview schedule

A provisional questionnaire was prepared on the basis of reference to the literature on the subject and previous studies whose published reports are available and discussion with experts on various aspects of energy. A pilot survey covering 20 households in each village was undertaken to test the relevance and reliability of the items in the questionnaire. On the basis of the outcome of the Pilot survey appropriate changes were made in the questionnaire which was then finalised. (A copy of the questionnaire is given in the annexure). The researcher addressed questions to the heads of the sample households in their own regional language and duly recorded their answers.

1.11.3 Analysis and interpretation

After assembling the data the researcher made a critical examination of the same and subjected them to content wise analysis. The data were then logically organised and tabulated for the purpose of analysis and interpretation. The following appropriate statistical methods such as percentages, ratios, frequency distribution and statistical significance test were used in analysing the data.
1.12 Special Features

Like any study based on field data, this study also supplements information based on field data with personal observations and participation. The reported quantity of fuel, i.e., twigs and branches, agricultural by-products used as fuel like maize cobs, maize stalks etc., were measured by the researcher. This measured quantity of fuel was given to the households with a request to use only given the fuel during the next 24 hours. Next day the balance of fuel was duly measured to derive the actual quantum of fuel consumed per day. The head loads of fuel were also measured. Measuring of head-load of fuel was essential as the fuel of weight of head-load differs from person to person depending upon, age and sex of the person. Thus, a child collects lesser quantity of fuel than an adult and so on. Similarly, the quantity of head load also varies depending upon the purpose of which fuel is collected.

1.13 Limitations of the Study

The study at hand is not free from limitations. The first limitation is that, it is confined to the household sector of rural areas only without talcing other sectors i.e., agriculture, industry and transport into consideration. It can also be noted that the findings drawn out of this study cannot be generalized. As there are inherent shortcomings in the survey, effort was made to minimize their effect on the survey's result.
1.14 Plan of the thesis

The thesis is presented into Seven chapters. The First chapter presents a brief introduction, objectives, statement of the problem, rational of the study, scope and coverage and limitations of the study. The Second chapter deals with a review and appraisal of related literature. The energy/scenario in Kenya is highlighted in the Third chapter. The Fourth chapter focuses on the profile of the study area. Chapter Five highlights the socio-economic profile of the sample households. The Sixth chapter deals with analysis and discussion. The Seventh chapter presents the summary, findings and conclusions.
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