Chapter - II

RURAL ENERGY CRISIS: AN EMPIRICAL ANALYSIS

2.0 INTRODUCTION

Problems and issues pertaining to energy vary from one type of energy to the other and from one area to the other. Sources of energy are generally classified as commercial and traditional. Under commercial sources of energy such sources, as coal, coke, oil and natural gas and electricity are included, which traditional sources are understood to be consisting of such sources of energy like firewood, twigs and branches, agricultural residue and animal waste. Though, these sources are also strictly speaking commercial in nature as they are also bought and sold in the market if not totally at least partially, in general usage they are considered as traditional sources of energy,

Energy in the Indian rural sector is utilized in agriculture, households, rural handicrafts, transport and other sub-sectors. The rural sectors having a population of about 70%, consumes about 46.1% of the total National energy (20% Commercial & 80% Non-Commercial sources). The bulk of energy is consumed in the domestic sector (70%) followed by agriculture (25%) and others. The per capita energy consumption in the rural sector is 2.70 mil.k.cal/day, whereas it is 7.2 mil.k.cal/day in urban sector. (S. Giriappa:1984).

2.1 PER CAPITA ENERGY CONSUMPTION IN RURAL, AND URBAN AREAS

The energy demand in the households sector in 1982-83, as per information available with the energy supply organization, comprised 11.96 Twh of electricity, 5.19mt. of kerosene, 0.52 units of LPG and 1.73 mt of soft coke. The break up between rural and urban areas, however, is not available.

A comparison of the 18th (1963-64) and 28th (1973-74) Rounds of National Sample Survey (NSS) suggests that the average per capita consumption of energy has not changed significantly during this period. Curiously a conclusion of these surveys is that the per capita consumption in rural areas is higher than in the urban areas. The 28th round gives a
figure of 349.61 kg per year in rural areas and 310.38 kg for urban areas, measured in coal replacement units. (Table.2.1)

The share of commercial and non-commercial energy in the rural areas is 20% and 80% respectively. The corresponding figures for urban areas are 49% and 51%, though not complete, explanation for this rather anomalous finding of higher per capita rural energy consumption lies in the relatively low efficiency of the energy using devices in the rural areas coupled with availability of free fuel which does not encourage economy of use.

From the NSS data (28th Round) There is variation of energy consumption according to Income. The lowest income group consumes hardly half the energy consumed by the highest income group. It would be noticed that according to these figures, the distribution is less skewed in the rural areas as compared with the urban areas. A substantial part of the fuel consumed in the rural areas is collected free of cost.

The level of useful energy consumption in the rural areas is very low, reflecting the pervasive poverty. The rural families depend even today primarily on the traditional fuels. A major portion of which is secured by private effort of individuals at a very low or even zero private cost. The bulk of the fuel requirement in the households sector is for cooking. Animal and human labour largely provide the energy input in agriculture, but energy for irrigation pumping is becoming increasingly significant. On account of depletion of suppliers of firewood, even traditional fuels are getting commercialized and they are rural poor find it difficult to meet their energy needs.

Rural energy demand will increase in parallel with the growing population. If, in addition, their level of living is to improve, the per capita consumption must also go up. Even for higher productivity in agriculture, the energy input has to go up.
Table 2.1

PER CAPITA ENERGY CONSUMPTION IN RURAL AND URBAN AREAS
(1978-79)

<table>
<thead>
<tr>
<th>K.G (Coal replacement units)</th>
<th>Rural</th>
<th>%</th>
<th>Urban</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal</td>
<td>3.68</td>
<td>1.05</td>
<td>17.82</td>
<td>5.74</td>
</tr>
<tr>
<td>Cock</td>
<td>4.37</td>
<td>1.24</td>
<td>21.85</td>
<td>7.03</td>
</tr>
<tr>
<td>Charcoal</td>
<td>0.13</td>
<td>0.04</td>
<td>2.61</td>
<td>0.84</td>
</tr>
<tr>
<td>Electricity</td>
<td>2.17</td>
<td>0.62</td>
<td>18.17</td>
<td>5.86</td>
</tr>
<tr>
<td>Kerosene</td>
<td>59.11</td>
<td>16.93</td>
<td>94.02</td>
<td>30.29</td>
</tr>
<tr>
<td>Firewood</td>
<td>239.11</td>
<td>68.45</td>
<td>141.16</td>
<td>45.48</td>
</tr>
<tr>
<td>Dung cake</td>
<td>29.06</td>
<td>8.31</td>
<td>10.06</td>
<td>3.24</td>
</tr>
<tr>
<td>F&amp;L and others</td>
<td>11.78</td>
<td>3.36</td>
<td>4.69</td>
<td>1.52</td>
</tr>
<tr>
<td>Total</td>
<td>349.61</td>
<td>100.00</td>
<td>310.38</td>
<td>100.00</td>
</tr>
</tbody>
</table>

Source: Papers prepared for the Working Group on energy Policy, 1979
In order to sustain economic growth, the rural infrastructure has also to be strengthened. All of these will mean an ever-increasing demand for energy. How can we meet this demand in such a manner that the costs are within the purchasing power of the people? It is clear in the next two or three decades, the traditional fuels, which will remain as the main sources of energy supply. The major trust has to be towards sustaining and augmenting fuelwood supplies through a vastly expanded programme of social and energy forestry.

Energy crisis attracted wide attention of the public policy makers in 1973 when there was an unusual oil price high and which put lot of strain on the economy of the developing countries. Acute shortage of commercial sources of energy and their bleak future prospects posed a real threat to the entire world. While, there was lot of concern initially about commercial energy crisis, gradually it dawned upon the policy makers and subject experts that the position regarding traditional sources of energy is also not very comfortable and that in fact this is one of the major day-to-day problems of the rural people who form the major portion of the total population. Rural people mainly depend upon the traditional sources of fuel like fuelwood, agricultural waste and animal waste. Domestic sector of the rural area accounts for more than 75% of total consumption. Owing to fast deforestation and dwindling supply of firewood and gradual commercialization of traditional fuel sources of fuel sources, it has become very difficult for the rural people to secure adequate energy supply at a cost, which is affordable by them. Majority of people, are compelled by their economic situation to cover long distances to gather fuelwood for their domestic requirements. It is not uncommon to find women and children spending 2 to 3 hours per day just in collecting fuel wood becoming more and more scarce the hardship and drudgery of collecting fuelwood has increased many times.

If on the one hand there is acute shortage of supply of energy to rural areas on the other hand there huge wastage of available energy due to inefficient energy gadgets used and enormous misuse of energy due to ignorance. In order to chide this huge waste, it is necessary to motivate the rural people to shift their choice for more fuel efficient heating and cooking devices than the devices presently used by them. It is also important to make the rural folk to aware of the dwindling energy sources or energy. It is essential to halt the
indiscriminate feeling of trees; twigs and branches of living trees before it get too late and result in total deforestation.

2.2 STUDIES ON RURAL ENERGY

A major difficulty at rural energy problem is that even today, a clear picture of the pattern of rural energy (supply, demand and consumption etc.) is not available. There are a few macro and micro level studies, which have been carried out during the last 10-12 year in the field of energy.

Literature on energy is of recent origin. Infact, the problems pertaining to commercial sources of energy attracted the attention of the scholars and policy makers only in the early 70’s of this century. The origin of global energy studies may be traced to the year 1952 with Eugene and Scarlott and later on other studies by Patnam and Darmstadt followed. The major theme of these studies related to the energy problems of the highly developed and industrialized countries especially belong to the OECD group of countries, studies pertaining to developing countries surfaced during early sixties.

In 1965, Govt. of India conducted a survey energy sources and brought out a report on energy situation pertaining to India. During mid and late 60’s many studies were brought out in various developing countries of East Africa and South Asia, with main focus on fossil fuel and electricity. Energy requirement of important tertiary and secondary sectors were analysed in these studies. Problems pertaining to rural energy, traditional sources of energy did not surface significantly in any of these studies.

Energy crisis was mainly identified with petroleum crisis in the early seventies. While in the early sixties there were fringe references of rural energy sources, it was only in 1970’s this aspect of energy crisis gained significance. However, there were no systematic studies to evaluate rural energy needs prior to 1970’s. While most of the studies address to the problems of commercial source of energy, pricing of energy and such other issues, a few studies directed at examining the pattern of household energy consumption.

In 1976 R. Revelle conducted a study pertaining to rural energy consumption pattern in India. This study was based on secondary source of information and had an aggregative
approach. Makhijani and Poole made an important contribution to the field of rural energy based on primary source of data. These are important studies in the field of rural energy. However, as they have adopted a highly aggregative approach, they do not highlight the inter and intra regional variations in energy consumption. In fact for policy formulation, it is very important to catch the regional as well as seasonal variation of energy consumption pattern. As many studies reveal energy consumption has a positive relationship with the development and income level of a region.

According to study as quoted by TV. Somasekhar in 1975 the per capita energy consumption differential between the United States of America and the rest of the World stood at 8:1 and is predicted to narrow down to a differential of 6.5:1 in 200 AD. The three regions of North America, Europe and USSR accounted for approximately 80% of the world energy consumption while Asia accounted for 14% and other accounted for the balance.

D. E. Earl had made an estimate of energy consumption in developed and developing countries. The per capita energy consumption in kilograms of coal equivalent was of the order 10,817 in the USA, 8,881 in Canada, 5,946 in Sweden and 5,143 in the UK. At the other end of the scale, Earl recoded 259 for Nepal, 274 for India, 291 for Sri Lanka and 304 for Madagascar.

Studies pertaining to household consumption of energy for various end uses like cooking, water heating, lighting, lifting water, space heating or cooling and other purposes like ironing, washing, cleaning and so on need to be studied at length, with relation to the changes in income level, overall development of the area, and availability of alternative sources of energy. Similarly, energy use on agricultural farms, in relation to cropping pattern, holding size and so on need to be studied in detail. In India some attempts were made to study energy problems at macro level. National Council of Applied Economic Research (NCAER) did some of the macro surveys regarding household energy consumption. The NCAER also conducted studies in different regions like Rural Energy Consumption in Northern India, Eastern India, and so on, NCAER also has conducted a detailed survey of consumption of kerosene in India.
The National Sample Survey organisation also carried out consumer expenditure survey (1977-78 and 1983), which provides data on household's energy consumption by income group at all India level and average energy consumption in different states. The survey does not provide State-wise date on energy consumption by income groups. The N.S.S. O data pertain to expenditure on energy by household classified according to average monthly total household expenditure group. However, detailed information about energy consumption by type and by end use by various income class, family size etc., are not available. Besides the above, a few major studies as Energy Survey of India Committee Study 1965, Fuel Policy Committee study (1974), Working Group on Energy Policy Study (1879), and Advisory Board on Energy Study 1985 have undertaken such studies.

2.3 THE PROBLEM OF CRISIS

Energy functions as factors of production, as a process of feedstock and as a consumer good. As an economy develops, its energy demand also tends to increase, and its consumption pattern in terms of energy forms and energy sources also tends to change (Veena; 1988).

Many studies reveals that energy consumption has a positive relationship with the development and income level of traditional fuelwood and dung and agricultural wastes etc. The energy consumption varies from place to place and season to season. The dependency on various fuel sources depends on, and varies according to income level of households and the end use pattern.

Present and future energy needs in developing countries are generally different in urban areas from those in rural areas. In urban areas, the bulk of the energy used is commercial, which is itself largely made of petroleum products. The urban energy crisis is therefore best described as an oil crisis. Where the majority of the population still live, the largest energy consumption is of biomass in the form of fuelwood, animal dung and crop residue. Since the bulk of this energy supply is fuelwood. Which has become increasingly scarce, the rural energy crisis has been called the fuelwood crisis.

The shortage of supply of fuelwood (which is the main form of energy used in rural areas) is the energy crisis facing by the rural areas. These are mainly due to two things:
(i) Due to increase in demand, as result of increasing in population, the forests and other wood sources under severe pressure.

(ii) Due to relative increase in income or purchasing power, the increased consumption fuelwood, which is considered more efficient than crop wastes and other biomass fuels in rural areas.

Thus, with the increase in demand for food to satisfy the increasing in population, more forest areas are being brought under cultivation, thus worsening the fuelwood availability in the rural areas. The depleting sources of fuelwood on one side, and increasing demand on the other, are leading to the energy crisis in the rural areas.

This is so-called fuelwood crisis, which is mainly the result of ruinous exploitation and complete deforestation, did not occur suddenly. It proceeded continuously and unobserved over the course of time. In the beginning, small clearings emerged on the outskirts of settlements, small patches, which then grew. Finally, joining together: wood supply came to an end in the surrounding settlements and eventually even in whole region, which had previously had a surplus of fuelwood. The fuelwood crisis or more broadly, the biomass was mainly caused by the following:

- Rapid growth of the rural population, and the resultant increased consumption fuelwood, or mass;
- Poverty of the rural population and the consequent lack of purchasing power to pay for and alternative fuel;
- Underestimation of the crisis and the over estimation of the means of containing it and
- Lack of or insufficient reforestation and/or aforestation.

These above all factors have resulted in a vicious cycle of resource depletion in rural areas in developing countries. This can be shown in Table 2.2.
Table 2.2
INCOME AND ENERGY CONSUMPTION IN RURAL AND URBAN AREAS
(1978-79)

<table>
<thead>
<tr>
<th>Expenditure class</th>
<th>Index of total per capita energy consumption in</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rs. Per month per capita</td>
<td>Rural</td>
</tr>
<tr>
<td>All expenditure classes together</td>
<td>100</td>
</tr>
<tr>
<td>0-21</td>
<td>66</td>
</tr>
<tr>
<td>21-28</td>
<td>80</td>
</tr>
<tr>
<td>28-43</td>
<td>90</td>
</tr>
<tr>
<td>43-75</td>
<td>100</td>
</tr>
<tr>
<td>Above 75</td>
<td>138</td>
</tr>
</tbody>
</table>

As the declining wood yield of the forests could no longer meet the fuelwood requirements of the rapidly growing rural population, instead of planting new trees, the population began to cut them down without reforesting. This uncontrolled overexploitation caused extreme soil erosion and related impacts, thereby exacerbating the dramatic shortage of fuelwood, which has totally disappeared in some areas. With the increased shortage of fuelwood, which had till then been regarded as common property, the population searched for alternative found was to burn animal excrement dung cakes - and woody crop residues, such as cotton stalks, corn stalks and cored corn cobs. The increased burning of dung displaced its use as an organic soil conditioner or fertilizer and thereby downgraded soil fertility. Lower soil fertility brought about lower agricultural yields i.e reducing in food and fodder production with its ensuring consequences; a food crisis and a decrease in dung production.

In an attempt to compensate for the low yield achieved per unit of arable land, farmland was simply enlarged. As arable land could not be enlarged indefinitely, this expansion was at the expense of the forests woodlands, initially in the valleys and eventually on the mountain slopes. What followed was a dramatic contraction of forest land, resulting in increased soil erosion, so that even more forests and arable land were destroyed. The effects were, among other things, a shortage of biomass and food and an ecological crisis.

The decreasing agricultural yield also led to a reduction in the land used for fodder cropping and to decline in agricultural byproducts, so that altogether there was less fodder for the livestock. Livestock consequently produced less dung, which was needed both substitute for increasingly scarce fuelwood as an organic fertility, so that the drive intensified to create more farm land to compensate for the decreasing agricultural yield per unit. Equally less milk and meat were produced, so that the food shortage become increasingly acute.

These many vicious cycles (fuelwood crisis - leads to ecological crisis - which lends to food crisis), began with the apparently harmless shortage of fuelwood, but eventually spread to affect all rural activities. They highlight how serious the rural energy crisis and its consequences are: they threaten not only economic growth, but also the survival of the rural population in developing countries.
If the energy source to be substituted has no market price, as is often the case, for example with fuelwood and/or dung, the economic feasibility calculation can only be made on the basis of shadow prices or opportunity costs of the substituted energy sources, which are difficult to ascertain and verge, so that the outcome of the calculation in such cases is best with uncertainties.

Economic factors are important, therefore, but should not override the long-term social and environmental value of disseminating renewable energy technologies. Where the concern is to satisfy the basis needs of the poorest section of the population, humanitarian criteria should replace economic ones. To ensure, however, that scarce capital is put to effective use, priority should be given to systems that constitute an improvement on traditional technologies. For example, if updated 'three-stone stoves' have been used, the population should be provided with better, more efficient stoves.

Where possible, a strategy for improving and securing energy supply should not be based on energy imports, but rather on self-sufficiency in energy. This self-reliance should not be confined to energy resources alone, but should also include the requisite technology and technology and technological infrastructure for the conversion and utilization of these energy resources. This means that, wherever possible, a renewable energy strategy for developing countries should avoid replacing or substituting the current heavy dependence on petroleum imports with a dependence on imports of capital intensive and highly sophisticated technical equipment.

2.4 ALTERNATIVES OF ENERGY CONSUMPTION IN RURAL AREAS

The Non-Commercial fuel is obtained from agro-waste, animal waste, firewood etc. Though non-commercial sources available at almost zero or negligible cost. Non-commercial fuels are in the nature of inferior goods; and tend to be substituted by commercial fuels as income level increases. Since non-commercial fuels are available at zero or negligible cost, it constitutes an important source of energy for poorer sections of the populations, especially in the rural areas. This is because a large majority of the rural population does not have enough purchasing power; they survive on non-commercial energy sources like firewood, dung-cake and agricultural wastes. Thus in rural areas,
With development, increase in incomes of the households, and an increase in population, the demand for energy increases almost exponentially. Energy consumption domestic or household sector depends mainly on increase in income and increase in family size. The household energy source consists mainly of fuelwood, crop residues, animal dung and twigs and branches on the one hand and coal, kerosene, electricity and LPG on the other. Most of these sources of energy act as substitutes for one another, at one point or the other.

The alternatives to fuelwood may be commercial, non-commercial or other potential fuels. Commercial fuels like oil that is petrol, diesel, kerosene, coal & coal products like briquettes, LPG, natural gas, propane, butane, electricity - hydro, thermal nuclear. The Non-commercial fuels can be divided into agricultural wastes, animal wastes, bio-gas, forest products, and shrubs, and the Potential sources of fuel (non-conventional) can be divided into solar-direct, solar electricity, fuel cells and solar cookers, wind energy, tidal energy, and geothermal energy.

Of the above listed alternatives, the viable and preferred sources of fuel for the rural household consumption are (the Non-commercial and Potential sources of fuel.

2.4.1 Commercial Sources of Energy

The commercial sources of fuels are not only non-renewable and almost near exhaustion. They form the foundation of the industrial structure, and most important, they have very high environmental costs attached to their usage and future development.

The most common usage of electricity at present is for lighting purposes. Cooking by electricity is rare in the rural areas, and even in the urban areas, it is very expensive to use electricity for cooking purposes. Also, cooking by electricity is rare in developing countries, and wherever it occurs, it is usually among the richer members of the region. Where it is adopted for cooling, it tends to replace or displaced gas or kerosene rather than

wood is the basic cooking fuel, and where it is scarce, dung and agricultural wastes are adopted.
fuelwood, and its direct impact on fuelwood demand in the reasonable near future is likely to be relatively minor.

In fact the major shift to kerosene is theoretically possible, does not imply that it is either feasible or desirable distribution systems completely precludes a significant shift to commercial fuels by rural consumers in the majority of the third world countries. The relative costs of cooking with different fuels might be expected to have an impact on the choice mix between the fuels by the customers.

2.4.2 Non-Commercial Sources of Energy

The alternatives of Non-commercial sources of energy are mainly four; i.e Improved Stoves, Agricultural Wastes, Animal Wastes, and Biogas.

2.4.2.1 Improved Stoves

Regarding non-commercial sources of alternative to fuelwood, most important and presently more feasible is introduction of improved stove, using fuelwood or twings and branches. It not only conserve the fuelwood, it also makes the cooking activity easier because of more efficient use of the fuel source then compared to the traditional stoves. It has been observed that on an average about 5% of fuelwood can be saved in the bigger cook stoves and about 10% in smaller ones (Tyagi and Bhat; 1985). But one major problem with the large scale adoption of the improved cook stoves is the cost involved, which needs periodical repairs or rebuilding, as most of the stoves are made mud, bricks and other locally available materials. Their relative non-flexibility ana larger labour time act as other constraints.

In order to encourage the women in the rural areas to use efficient improved chullhas / stoves in place of traditional stoves - thereby minimizing drudgery and health hazards. A centrally sponsored project on demonstration in Improved chullhas was implemented in the country from February 1984. Under the scheme, trainees are trained by master trainers in the art of constructing the improved chullhas. These trainees, on completion of their training are expected to construct chullhas for the beneficiaries in the villages ultimately making the entire village a 'Smokeless village'. The Government of India
provides funds for this scheme at the rate of Rs. 10,000 per training course and subsidy of Rs. 50 per chullhas which are constructed outside the training classes.

2.4.2.2 Agricultural Wastes

The use of agricultural waste is dependent on agricultural production and its availability is seasonal. Apart from this, there are many other uses for the agricultural wastes, like it is an excellent fodder for the farm; animals, house making and some wastes are also used as fertilizers. Thus the use of agricultural wastes can best be limited to vocational use and fuel time dependence on it has a household fuel is neither possible nor feasible.

2.4.2.3 Animal Wastes

Animal wastes like cow dung is used on a large scale in the rural areas of India. It is also used to some extent in the poorer sections of urban areas also. Cow dung is not only a source of energy, it is also natural fertilizer. Cow dung cakes, though are a popular source of fuel in many areas, it is not an efficient fuel. The drawback of using cow dung cakes, as fuel is that its use deprives the farmer of a valuable natural fertilizer.

2.4.2.4 Bio-Gas

A device for utilizing the methane gas generated by the decomposition of organic matter like cow dung and the agricultural waste which are available in abundance in the countryside. The oil crisis of 1973 aroused keen interest about the potential of bio-gas as an alternative source of energy in the rural areas. Thus a biogas plants converts animal dung to produce both fuel and manure where as dung can be used either as manure or as dung cake for fuel.

The best alternative may be the usage of cow dung for the generation of biogas or gobar gas. This can be viable alternative for fuelwood in the rural areas, specially, as it usage as a source of fuel does not mean it cannot be used as a fertilizer. In fact, the by-product dung - out of the biogas plant is said to be better fertilizer source for the fields. The use of bio-gas can check the rate of deforestation, but the impact of promotion of bio-gas may increase the size of livestock population which in turn, needs more fodder is mainly
derived from tree-leaves, branches cut form nearby trees or from local forests and other miscellaneous trees. Thus, even with the promotion and use of biogas, some amount of deforestation takes place. But bio-gas technology is a major alternative because it not only provides crop manure of a higher nutrient content, but also a very convenient fuel source, which can be used for cooking, heating and lighting purposes.

A bio-gas project being taken up must explore variables like the number of family members, size of land-holdings, livestock population, daily dung production, daily fuel wood consumption, the amount of dung used to produce bio-gas, consumption of kitchen fuel, if any, like kerosene.

Through it is a clean, efficient fuel, and it can be used for cooking lighting and gives manure for the fields, its high initial cost inspite of the subsidy given by the government, and its continuous operating costs make it unacceptable and in accessible to most of the rural households.

2.4.3 Potential Sources of Energy

These are still under development and as of now, not an economic prospect. But their development is underway, as they are all renewable sources of fuel and are by and large, non-polluting. Thus there will not be any adverse affect by their development and usage, but they are yet to be brought under usage on commercial scale. The energy from sun, sea tides and wind is considered as very useful source. Even these sources have make the people realize the importance of non-commercial and potential sources of energy, and its optimal utilization for meeting the growing needs of the people of the world in general and developing countries in particular.

Solar Energy of the potential sources of energy, solar energy is the most important. Though solar energy, is the most basic source of energy, its harnessing and use in the requires of recent origin. Solar energy used for lighting, drying, heating, and other uses from the earliest times, harvesting it and using the same even when sun is the source of energy, which is of interest here. The solar energy received by earth in a second is 10-17 joules. Which is equivalent to more than electricity generated in a month all over India, or
eight days of sunshine is equal to the total availability source of energy in the world put together for a period of about one year.

Basically there are three ways of catching sun’s rays used either for heating or for generating electricity:

a) By keeping of Solar Panel on the roof of house or building and storing as much as possible or converting these rays into electricity current.

b) Keeping water in insulated tubes is a good medium where is a lot of sunshine.

c) By Photovoltaic cells, where the cells generate energy because of chemical reaction, triggered on by the sunrays falling on the cell, filled with chemicals.

Other potential use of solar energy in households is by solar cookers. The solar cookers works on the reflector principle, where the sunrays are made to fall on one or a few mirrors and than they heat up the cookers and cook the dishes kept inside the cooker.

Solar water heaters are mainly of two types thermosyphon systems and forced -flow systems.

Another use of solar energy is by solar battery. The battery is operated with semiconductor crystals, which are quite similar to those use in transistors, wither of germanium or silicon. An electric current is generated when sunlight strikes such a crystal. Solar power can be an ideal alternative to other commercial and non-commercial sources of energy because of its inexhaustive nature and also because there is a no shortage of the source in a tropical country like India.

**Wind Power**, Wind power, which can be developed as an alternative to fuelwood. Apart from generating electricity by wind miles, it can be used for various small uses like crop drying, irrigation, etc. This can be useful and free of pollution as long as wind of a particular velocity is available.

**Tidal Energy** or the sea tides are another source of energy, which is derived from tides, thus it can be called as Lunar Energy. But it is in an initial stage of development to provide available alternative to fuelwood.
2.5 CONCLUSION

In the rural parts of India, more than 75% of rural households depend on traditional sources of energy. Their income level is very low and lack of purchasing capacity, majority of households do not afford to buy fuel for their day-to-day use. Vast unemployment and acute poverty forces the rural poor to go on hunting for fuel. Small children of the age of 8 years and above also go to the forests or nearby grazing land, fallow land, and waste land in search of fuel. Men, Women and children, on an average daily spend about 3 hrs in fuel gathering and they walk about 4 to 5 kilometers in search of fuelwood.

Though, rural energy consumption pattern very much depends upon the socio-economic position of the villages and the households as the villages do not differ much in items of their socio-economic pattern, energy consumption pattern also do not very much among the villages. However, the quality consumed varies among the differentially developed villages and among different income and landholding class.

The following are the major observations of this chapter:

- An increase in per capita income leads to an increase in the quantity of energy demand.
- Income increase, significantly influences the consumption pattern as:
  - People shift their demand from inferior type of fuel to superior type of fuel.
  - If, there is no shift in demand or shift is negligible along with an increase in Income, larger quantity of inferior type of energy consumed. (Energy Ladder: P.V.Prathibha - 2002)
- The end use pattern undergoes a change and the demand for energy for heating water increases.
- The rural people are not only using the traditional and very inefficient sources of energy, but also the cooking gadgets are out-moded and are very inefficient. There is considerable amount of energy loss due to inefficient cooking gadgets.
The depleting sources of fuelwood on one side, and increasing the demand on the other side are leading to the energy crisis in the rural areas. This crisis causes fuelwood crisis to ecological crisis, which leads to food crisis.

In order to reduce the rural energy crisis, there is need for formulating a comprehensive and integrated rural energy policy. To meet the rural energy problem, it is important to exploit, the locally available sources of energy. Simultaneously the technology in non-conventional energy systems should be constantly updated through intensive research and development efforts. It is equally important to educate and train the rural people in such devices through demonstrations.

The alternatives to fuelwood may be commercial, non-commercial, potential and other sources. The non-commercial and potential are viable and preferred sources of fuel for the rural household energy consumption. The next chapter considers the most viable source (Bio-gas) of energy considering the various socio, economic and other factors.