7.1 General

This chapter summarises the major findings and conclusions arrived at in the course of the foregoing discussions. Suggestions are also made for future policy formulations and research.

The present study is an attempt to understand the details of the rural household energy scenario such as the present pattern and the level of energy use, the basic determinates, the mode of obtaining fuels, the potential sources of supply of fuels and the inherent problems faced by the household in meeting their energy requirements. Paradoxically, at the same time, the supply of these sources of energy is becoming scarce and it threatens to grow into a crisis proportion.

The results of this study will be useful for resource use planning for the villages. Therefore, the overall objective of this study is to understand the present patterns of energy use in household sectors and to give policy suggestions for better perspective in future. More specific objectives are:

1. to understand the present pattern of energy use in rural households, with reference to the share of commercial and non-commercial sources;
2. to identify the determinants of energy consumption in rural households;
3. to evaluate the dependence of the households on natural sources of energy;
4. to assess the environmental impact on energy use of the rural households;
and
5. to suggest a rational pattern of energy use and solutions to problems associated with it.
The nature of the study was such that it required primary data. The Tiruchendur taluk in Thoothukudi district of Tamil Nadu State was chosen as the study area. Following multi-stage random sampling technique, a sample size of 375 was taken. Interview schedules designed for the purpose of data collection, were administered to randomly selected sample units. The time reference of the data was 2005 - 2006. Different forms of energy were converted into Mega Joules (MJ) and Giga Joules (GJ) following earlier studies. Different statistical techniques like tabular analysis and multiple regression were applied to analyse the data and the results were interpreted accordingly.

7.2 Findings of the Study

Energy Consumption Pattern of Households

- Out of the total energy used, firewood constitutes 60.12 percent and thus it is the major fuel used in the sample households. Electricity is the next important fuel accounting for 23.36 percent of the sample areas. This proves the first hypothesis that ‘energy use in rural household is predominantly fuel wood based and it is a threat to natural vegetation’.
- The per capita energy consumption of a household is 2858.16 MJ from firewood and 276.76 MJ from electricity respectively. Bio-fuels such as firewood, cow dung and agricultural waste together constitute 96.45 percent of the total used energy.
Out of the total energy consumption, 74.75 percent is used for cooking, 23.95 percent for lighting and other purposes, and transport claims 1.30 percent of the total consumption.

Out of the total kerosene consumption, 77.08 percent is used for cooking purpose and 22.92 percent for lighting. The total electricity consumption is utilised entirely for lighting purposes. Though, kerosene and electricity are alternative fuels for both lighting and cooking, the households prefer kerosene for cooking and electricity for lighting.

Though the bio-fuels are, in general, cheaper than fossil fuels in terms of gross energy, kerosene is preferred in terms of its useful energy. Considering the relative convenience of factors such as smokelessness, less-time consuming easy-to-start-cooking and nature of kerosene, people prefer kerosene over firewood for cooking.

The annual per household and per capita useful energy consumption is 2858.16 MJ and 276.76 MJ respectively. Biofuels such as firewood, cow dung and agricultural waste together constitute 96.45 percent of the total useful energy.

Out of the total energy consumption, the percentage shares of bio-fuels, fossil fuels and electricity are 68.30 percent, 8.34 percent and 23.36 percent respectively. This result proves that bio-fuel is the dominant fuel in the study area.
Cooking is the major end use accounting for 74.75 percent of the gross energy. It is followed by lighting and transportation respectively.

Out of the rural households, the share of non-commercial energy source is more than that of the commercial energy.

**Determinants of Energy Consumption of Households**

The regression model for household energy consumption equations shows the following results:

- The result of the overall model reveals that out of the five significant determinants of energy use, the income of the family and the size of the family are the major determinants. The regression co-efficient is 7.290 and 2.755 respectively.

- The grouping on the size of family group-wise model reveals that, family income, the size of the family and education of the housewife are the major determinants of energy consumption.

- While considering the income group-wise model, the size of the family and the price of energy are the major determinants of energy use.

- The family income and the price of energy are the determinants of energy consumption for the educated housewife category.

- The size of the family and the price of energy are the determinants of energy consumption in farm based households. The results of the group-wise models on the price of energy reveal that the family income, the price
of energy and the education of the housewife are the major determinants of energy consumption.

➢ In the Tiruchendur taluk the main source of energy is non-commercial, which is 68.31 percent but the commercial source of energy is only 31.69 percent. In non-commercial energy, firewood is an important source of energy abundantly available, and collected by the people without cost.

➢ The non-availability of modern energy systems like cooking gas stove, electric stove and solar system is another factor. This shows that the second hypothesis that ‘apart from income, the lifestyle of rural families and non-availability of modern energy sources (cooking gas, electricity, solar energy devices) are also the causes of change in the present pattern of energy use’ holds true.

➢ The mean value of non-commercial energy is higher (23,017 MJ) than commercial energy (1,291.22). This may be due to the fact that in rural areas the non-commercial energy sources like firewood and agricultural waste are more abundantly available than in the rural areas.

➢ The per capita income is significantly and positively related to the variables: income class (0.124), education of housewife (0.103), positively related to size of family (0.031), cost of energy (0.013) and negatively correlated with farm family (-0.026). The results show that correlations among the selected variables are as expected on a priori grounds.
Energy use and its Impact on Environment

➤ Women and children constitute 62.85 percent and 26.32 percent of fuel collection.

➤ On an average, the small size family spends the maximum quantity of labour on fuel collection. The mandays spent per household per year for fuel gathering of the small size family is 41.72. The large size family spends less labour for fuel gathering in the rural households and it works out to 6.63 mandays.

➤ The rate of increases in income is in direct proportion to the rate of decrease in mandays spent on fuel gathering.

➤ When the education of the housewife increases, the labour spent per household for gathering fuel decreases at an increasing rate. Fuel gathering per household per year decreases from 21.59 mandays to 1.74 mandays.

➤ When the occupational level increases, it leads to a decrease in the collection of firewood. As a corollary to this, it must be noted that when occupational level increases, the duration per household spent on fuel gathering declines from 14.78 mandays to 4.77 mandays.

➤ The natural resources contribute 67.58 percent of the total energy. The natural resources like firewood contribute 59.49 percent, agricultural waste 6.97 percent and cow dung 1.13 percent.
The main problem in fuel collection is that the entry into the private farms is illegal. Private farmland owners do not permit freely all the households to gather fuel, since they feel that it would be suicidal for their crops.

Rainy days, drunkard husbands (who sell the gathered fuel), lack of space to store the fuels and the strict control against gathering in the village common lands planted with trees under the government afforestation schemes are the major difficulties faced in fuel collection.

As far as calorific value is concerned commercial energy sources exceed non-commercial energy sources.

The toxic pollutants discharged by non-commercial energy sources are carbon monoxide, sulphur dioxide, nitrogen oxide, organics, particulates, hydrogen sulphide, ammonia and hydrogen chloride. The maximum emission level in particulates is 31.40 in kg. per tonne of firewood and 30 in kg. per tonne of agricultural waste. Hydrogen sulphide, ammonia and hydrogen chloride are the minimum emission level pollutants i.e. 1.20 in kg. per tonne of firewood and 1.12 in kg. per tonne of agricultural waste respectively.

Presence of bio-fuels is an important cause for bronchitis and chest infection, and to a moderate extent TB and eye irritation. However, the fuel index is significant for all respiratory diseases. This shows that the third hypothesis that ‘there are also problems of pollution and future scarcity of
fuel wood; biogas and solar energy appear to be a limited option to solve the problem’ holds true.

➢ An average of 44.46 lakh kg of trees has been destroyed by the public per year in the Tiruchendur taluk. It is also found that to increase the subsidy amount and efficient use of energy will reduce the impact on environment that is, by destroying the trees. This supports the fourth hypothesis that ‘a change in energy use pattern is beneficial to protect rural environment and it requires policy support to build awareness and infrastructure facilities’.

7.3 Recommendations

The following proposals and energy planning recommendations are proposed for an effective, efficient and productive energy use pattern in the immediate future.

➢ Literacy programme, especially for women, should be organized to create awareness about energy efficiency in energy end-use. If literacy rate is improved among the family members, they can easily understand the modern energy programmes.

➢ A special programme for improving the construction of kitchen has to be included in the existing household energy programmes.

➢ Awareness of kitchen hygiene, ventilation and maintenance of store should be brought to the person responsible for cooking through audio–video visual media.
There is also a need to provide investment support or subsidies to investment in renewable energy sources.

The government should find means of ensuring sufficient supply of petroleum fuels to take care of domestic consumption. This is a vital step and a means by which economic growth could be achieved in this region and the country at large. Anything short of this will only put additional pressure on the already heavily depleted sources of wood.

There is a need to develop strategies of alternate energy supply (e.g. biogas, kerosene, smokeless chullas, briquettes and fuel efficient stoves) for rural people to avoid total dependence on forest for firewood. Such alternative measures would help to protect and sustain forest ecosystem.

The government is advised to set up plantations of the best species of wood. A typical example is the Anogeissus leicarpus, commonly called ‘mark’.

The priority within wood energy conservation programme should be the supply of convenient, healthy and attractive household stoves at affordable prices, so as to reach the maximum number of wood energy users.

Infrastructure should be developed further in areas where wood is already a traded item and where potential exists for supply enhancement to meet the existing and growing demand.

Effort to produce improved stoves that reduce pollutant emissions needs to be encouraged, considering the large number of women and children that would benefit from this.
The households should avoid the reheating of food to save not only energy but also the nutritional value of food.

Women should be involved in planning of household energy issues as a means of getting a more realistic scenario of the end-users of household energy.

Stove users, producers, disseminators, developers and evaluators should all be involved in any stove development and dissemination project and each group should have its own set of objectives, priorities and measures of success.

**7.4 Conclusions**

At the outset, it should be stated that the empirical investigation into the energy scenario of the villages of Tiruchendur taluk in Thoothukudi district has helped to confirm the hypotheses framed for this research work.

The study reveals that in the villages of Tiruchendur taluk, bio-fuels are the dominant fuels satisfying a large part of the energy requirements. In the villages of Tiruchendur taluk crop residues, rather than firewood are the chief fuel. In the absence of forest access in the villages, households depend on farm lands and home gardens for firewood.

Customs and habits constitute an important social institution, which have a tremendous impact on the taste and behaviour of individuals. This is quite true as
far as the attitude of the household and the general consumption behaviour towards non-commercial energy sources are concerned.

As non-commercial energy sources are available in plenty and they are always within the easy reach of households any breakdown in the supply of electricity, kerosene or liquified petroleum gas can never destabilize the normal functioning of household.

The conclusion reached is that energy consumption can be reduced using improved heating and cooking ovens with greater efficiency. Among the rural households, people belonging to very high income brackets still cling to non-commercial energy sources despite their obvious disadvantages because their every day need for heat energy to prepare feed for animals and food for men and women in their employ is always on the increase.

Thus well-targeted and locally relevant interventions that include financial support measures (through income generation and/or micro-credit), where appropriate, will to some extent allow change in the face of continuing high levels of poverty. It should be recognised however that in rural areas where wood and other biomass are cash free, cleaner fuels are seen as expensive. This, together with the unreliability of supply due to insufficient distribution infrastructure and markets in rural areas is a major factor, meaning that for the rural poor - even if up-front costs are reduced and there is a willingness to pay - barriers to accessing cleaner fuels remain.
7.5 Areas of Further Research

The impact of fuel shortage on the health of the households is an important aspect requiring attention. So a study on the trade-off between leisure and fuel gathering is a potent area for further research.

Formation of energy clubs among housewives for energy efficiency and energy conservation may be studied and it will be a potent area for future research.

Another area that can be considered for further research which will be useful in designing future technologies is the study of the economic viability of each renewable energy technology.

An analysis of the operation of fuel markets and the relationship between the prices of marketed bio-fuels and fossil fuels will be a potent area for future research. This will be useful for framing future fuel subsidies and action policies.

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