CHAPTER II

REVIEW OF LITERATURE

The current energy crisis and the awareness generated at the international, national, state and local levels have prompted many researchers to devote their attention to family's energy consumption behaviour. The household sector being one of the major consumers of energy, emphasis has been laid to explore and understand various aspects of household energy consumption. The observations made on energy use are presented under the following heads :

1. The energy crisis scene in India.
2. The energy use pattern in India.
3. Perspective on energy problems.
4. Family level studies conducted on energy in India and abroad.
   - (a) Consumption - expenditure pattern on energy.
   - (b) Knowledge and perception of energy crisis.
   - (c) Stress due to energy crisis.
   - (d) Energy conservation.
   - (e) Alternate technology.

1. The Energy Crisis Scene in India

Although the energy crisis is barely few years old, it has already created considerable dislocation in the economic affairs of the world. India faces prospects of serious energy shortage at least during the next decade. The problem arises from a combination of several factors - unexpected sharp rise in oil prices, increasing demand, limited supply of coal and petroleum products, technological constraints on energy production, transport bottlenecks in distribution and lack of adequate progress in tapping indigenous resources (Chitale and Roy, 1975). The energy crisis has been described as a fuel crisis, an environmental crisis and a management crisis. (Connery and Gilmour, 1974). For the vast majority of the country's population, the cooking energy crisis is already here. Although new sources of energy will help, their development will take time and money. However, they are not going to substitute any of the known sources of energy; they will only supplement other existing sources of energy. Solar energy, hydro-electricity and nuclear power have became increasingly important but still, the world relies on coal, gas and oil for over 80 percent of its energy requirements (Energy Digest Editorial, 1985).

What is meant by 'Energy Crisis' ? The energy crisis has been described as the Arab oil embargo; long lines at gasoline stations and rising prices; fuel oil and natural gas shortage; strip mining and depletion of scarce natural resources. Beyond these are such directly related issues as environmental regulations, capital formation, development of alternate technologies and the very critical problems of world food, environment, nutrition and population. (Lerner,1976).

In India, about sixty percent of the population has an average per capita consumption - expenditure of less than one rupee/day, which means that this low expenditure is hardly likely to purchase anything else besides food. Thus, 60 to 80 percent of the Indian population just does not have the purchasing power to enter the market for commercial energy and therefore, has no option other than surviving on non-commercial energy sources, that is, firewood, dung-cakes and agricultural wastes, as these are available at 'zero' money cost to consumers (Reddy and Prasad, 1980). Thus, this section of the Indian population which exists below and just above the poverty line has not yet crossed the energy gathering stage, even though they might be food producers. In view of this, it is well known that about 48 percent of the total energy consumption comes from non-commercial energy sources.

The oil resources are a depleting asset and at current rates of exploitation, these reserves are likely to be exhausted within fifty years. The current crisis may be explicitly described as the commercial energy crisis as this crisis is largely because of the increasing dependence on oil which has developed over the past twenty-five years. A crisis with respect to a country's energy supplies is a threat to its standard of living because the latter is to a large extent based on its per capita energy consumption. Hence, the new energy crisis is one that is mainly of vital concern to the affluent strata of the population because it threatens their standard of living. (Reddy and Prasad, 1980).

In terms of per capita consumption of oil, India stands at the bottom of the International ladder. Shah (1981) predicts that a disastrous energy crisis is likely to engulf this country very soon. The central fact of our oil situation is our heavy dependence on import. Only one-third of the Indian oil requirement comes from domestic production; two-third comes from imports. It was estimated that, to finance this order of imports of crude oil and petroleum products in 1980-81, foreign exchange worth

Rs. 6,000 crores had to be allocated or ninety percent of total export earnings. All this is a situation in which the per capita energy consumption and income are already miserably low.

The supply of energy has an effect on how people live. Various reasons have been put forth as the cause of this energy crisis by different experts. Despite all the views regarding the energy crisis, Connery and Gilmour (1974) perceived the energy crisis as real and explained it by an objective appraisal of the facts. According to them, the entire crisis can be summed up in three words, 'exponential growth rates'. The population has been growing exponentially. Because energy consumption per person has also grown exponentially, total energy consumption outpaces the nation's capacity to produce sufficient energy from domestic sources.

Various researches have been conducted to determine the opinion of the people regarding energy crisis. Opinion about whether there is an energy crisis was sought from people of United States of America (Farhar, et al., 1980). Survey data showed that as late as 1979, most Americans did not believe that there was an energy crisis. For most of them it was a energy problem.

However, percentage of people believing in the fast approaching energy crisis was on the rise. Morrison and Gladhart (1976) reported that fifty percent families thought the energy crisis was real and not simply a product of oil company maneuvering or foreign oil policies; fifty percent felt it was not an immediate crisis. Belief in the energy problem, however, did not help to decrease energy consumption. Ayotollahi (1980) found that majority of the carowners believed that a real energy problem existed in the United States, though they differed in their views on responsibility for the energy problem. Majority of respondents felt that the petroleum companies are most responsible for the current energy crisis. A relatively strong relationship was found to exist between the belief in a real energy problem and education than with the other major demographic variables. Morrison and Gladhart (1976) reported a strong relationship between the belief in the reality of the energy problem and measures of family's socio-economic status (income and educational attainment).

George and Ogale (1983) surveyed 54 urban households and found that 66.70 percent homemakers belonging to the middle and high income groups believed in energy crisis being a global phenomenon while one-fifth of them disagreed with this. Only one-fourth percent respondents considered energy crisis to be a reality. Fifty-four percent respondents believed that energy crisis was a passing phase. However, 74 percent homemakers believed that the households have an important role to play in easing the energy crisis. They reported that homemakers did not possess adequate knowledge regarding the natural energy reserves of the earth and this formed an obstacle in moulding their beliefs related to earth's energy reserves and man's energy problems. A survey of National Geographic Society members (1981) revealed that majority considered energy situation to be 'serious' while 16 percent felt it to be a 'crisis'. Majority of them (above eighty percent) were switching off more lights and using less energy for heating and transportation purposes. Thus, varying proportion of respondents were found to conserve energy at various points of use. Eighty-eight percent of them felt that conservation was the best alternative to tackle the current energy problem. Kaul (1984) also studied the opinion of 139 urban homemakers regarding the energy problem. She found that majority of homemakers considered the energy problem 'not very serious' though one-third of the sample thought it to be 'serious'. Homemakers showed a tendency to blame technological advancement as contributing to the current crisis rather than hold the domestic sector responsible for the same. Regarding measures to tackle the energy problem, majority of homemakers opted for less effective measures like 'educating the mass' instead of more effective measures like 'rationing of fuel forms' or 'making fuel forms more dear.' Homemakers were concerned about the energy problem for its spiralling prices and increasing scarcity and not for its exhaustion or the future of mankind without energy. George (1982) reported that homemakers associated energy crisis with various factors like rapid rate of population growth, mechanization, careless use of energy and so on.

The energy crisis covers several distinct energy-related problems as mentioned earlier. As for solution to the problems, most experts have given four basic approaches; sharply increased oil and gas imports, greater exploration and production from domestic areas, development of alternate energy sources and energy conservation programmes. Each of these approaches, however, has its problems. If the right decisions are made, both at the micro and macro levels, in relation to energy use, there should be no problems over the long term. We all need to take immediate measures in a planned manner to avoid or postpone the expected serious energy crisis.

2. The Energy Use Pattern in India

The sectors of energy consumption and demand in India may be identified as household, agriculture, industry, transport and others. The domestic sector is one of the major energy consumer in India. Varying figures have been given by different persons. As reported by Pandey (1982), the domestic sector accounts for more than 48 percent of the total energy consumed in India, whereas according to Malhotra (1982), it is about 51 percent. This estimate may be compared with about 30 to 35 percent of the energy being used in the domestic sector in cooler countries such as Germany or Sweden or 18 to 20 percent in the United States or United Kingdom where domestic heating is important. In India, on the other hand, a major portion of domestic energy is used for cooking and lighting through the consumption of non-commercial forms of energy while very little is used for domestic heating, cooling, washing machines or other household purposes. This problem is evident from the fact that the contributions from commercial energy sources such as electricity, coal and petroleum account for only 17 percent of the total domestic energy. It is estimated that the total uses in this sector for cooking, lighting, and heating and cooling account for about 40, 7 and 0.36 percent, respectively (Pandey, 1982). Parikh (1976) reported that 50 percent of energy consumption in India was for domestic cooking and lighting. This consumption would increase with the increase in population. Non-commercial energy sources constituted about 50 percent of India's total energy consumption (Ramchandran and Gururaja, 1977).

There are marked differences in consumption patterns of rural and urban people. Rural people depend predominantly on non-commercial fuels, except that kerosene is extensively used for lighting. Urban dwellers rely more on commercial fuels both for cooking and lighting and dependence on non-commercial sources is declining. With increasing income, people consume less of non-commercial fuels. These are used by many villagers and by urban poor because these fuels are easily available and available without an immediate financial cost (Parikh, 1976).

Despite the massive development of oil and coal resources, non-commercial energy sources are crucial for India's energy needs. Twenty-eight percent of the total energy consumed in India in 1975-76 came from fire-wood; that year, the country burned 133 million tonnes of firewood. Another 73 million tonnes of dung and 41 million tonnes of agricultural wastes are burnt each year (Agarwal, 1982).

2a. Energy Consumption in Rural Areas

Though the energy consumption in other sectors is increasing at a rapid rate, the increase in population will also increase the need of energy for domestic consumption. The 18th round survey of the National Sample Survey (NSS)conducted between February 1963 and January 1964 covered 4,000 urban households and 21,000 rural households. It was observed that in rural areas, the use of firewood did not depend much on the expenditure level. Also, dung cakes were used by all expenditure classes and in fact, the use of dung cakes increased with the expenditure level. The use of kerosene was more or less constant for the three lowest expenditure classes and a significant increase was found only in the highest expenditure classes. In the urban areas, the consumption of commercial fuels, that is, coke, coal, electricity, gas and kerosene were higher. In addition, firewood consumption decreased with increasing expenditure level. The rural estimates of energy consumption were higher than the urban estimates. As the rural population used non-commercial fuels which were gathered free of costs, they may have the tendency to waste more fuel compared to the urban consumers.

Data collected in the 28th round of the National Sample Survey (1973-74) indicates that both in urban and rural areas, the poorest (spending less than Rs. 21 per month per capita) consume hardly half the energy consumed by the richest (those spending over Rs. 75 per month per capita). In cities, energy consumption patterns are even more skewed; the urban poor consume hardly 40 percent of the energy used by the highest income group. Various surveys conducted by NCAER and NSS have placed the rural per capita consumption around 350 to 400 Kgs (Coal Replacement) and the share of firewood comes to 240 to 265 Kgs. (original units) (Paul, 1981). This indicates that firewood is the single most important source of rural energy requirement.

A study conducted by the Centre for the Application of Science and Technology to Rural Areas (ASTRA, 1980) on rural energy consumption patterns in six villages of Karnataka revealed that commercial energy made only a minor contribution. The bulk of the energy came predominantly from firewood with very small contributions from rice husk and agro-wastes. Men, women and children spent 31 percent, 53 percent, and 16 percent time, respectively, in proportion to total human hours per household per day in collecting firewood. One striking observation was that cowdung cakes were not used as fuel in the villages surveyed but only when firewood was not available within some convenient distance or when agrowastes were scarce, then it was used as a fuel.

Ravindranath et al. (1980) reported the results on energy consumption survey carried out in 1977 in six villages of Karnataka. Firewood accounted for 80 to 90 percent of energy input. Inputs of commercial fuels such as kerosene and electricity were minimal and many of the domestic activities were carried out at low efficiency.

Reddy and Subramaniam (1980) reported on Pura's (Karnataka) energy consumption pattern. Firewood was used to the extent of 96 percent (cooking 82 percent and heating bath water 14 percent) in the domestic sector and four percent in industry. Kerosene was used predominantly for lighting (93 percent) and to a small extent in industry (7 percent). Electricity flowed to agriculture (65 percent), lighting (28 percent) and industry (7 percent). Only four percent of the total firewood requirement of Pura was purchased as a commodity; the remainder was gathered at zero private cost. Large amounts of human energy was spent on firewood gathering (on an average, about 2.6 hours and 4.8 kilometers per day per family to collect about 10 kilograms of firewood). Pura used about 217 tonnes of firewood per year, i.e. about 0.6 tonnes/day for the village or 0.6 tonnes per year per capita.

In villages of Gujarat, firewood was the main fuel and consumption was 10 kilograms per day on an average. The distance travelled to collect firewood varied from one to five kilometers in different villages and spent about four to five hours per day in this activity in village Roli (Nagbrahman and Sambrani, 1983).

In village Dwing, in the high Garhwal Himalayas of Uttar Pradesh, women walk at least 10 kilometers, three out of four days for an average of seven hours per day to bring back about 25 kilograms of wood with each head-load (Agarwal, 1982).

Firewood is also the main energy source followed by dung cake in 110 villages of the Silora Block in Rajasthan. The percentage consumption of firewood was 60.5 percent, dungcake 20.4 percent, vegetable waste

7.6 percent, kerosene 3.5 percent, electricity 3.2 percent and diesel 3.6 percent. Soft coke, LPG, biogas were negligible and wind and solar energy nil. (Malhotra and Chaurasia, 1981).

Gomkale and Shah (1981) observed that the commonly used fuels in Bhavnagar area were firewood, dungcakes and agricultural wastes. Very few had kerosene stoves. Those who had kerosene stoves used the same for the preparation of tea mainly.

Maheswari (1981) estimated that 73 million tonnes of firewood was consumed which works out to be 71 percent of the need of the rural sectors cooking energy and other sources; animal dung used for cooking was to the tune of 75 million tonnes of dry dung cakes which met about 7.3 percent of the fuel requirement of the rural sector; and agricultural waste was estimated to be 50 million tonnes.

Parikh and Parikh (1982) reported that almost half of the total energy needs of the country is fulfilled by the non-commercial fuels having combustion efficiency of only around ten percent. Energy consumed for cooking in the whole country shares 57 percent of the total energy consumed in India. In villages, the total energy consumed for cooking is as high as 95 percent. Cooking fuels in villages include 40 percent dung cakes, 33 percent firewood and 24 percent agricultural waste.

Mathuveerappan (1982) reported that 80 percent of the population in rural areas use firewood and coal. While in urban areas and small cities, 14 percent use kerosene; 21 percent use kerosene, coke and firewood, 25 percent use cooking gas and 40 percent use cooking gas and oil. He further reported that in India about 150 million tonnes of firewood, 52 million tonnes of dried dung and 36 million tonnes of agrowaste are consumed annually for cooking apart from kerosene and LPG.

Gnanam and Mannan (1982) reported that in rural India, about 80 percent of energy requirements were met by renewable energy sources which included firewood, agricultural waste and animal dung. Of the total energy utilisation in the whole country biomass accounted for nearly 43 percent.

Desai (1983) reported data on energy consumption in rural and urban households. The share of commercial energy was only 20 percent in household consumption pattern of rural areas as compared to 40 percent in case of urban households. The demand for fuel wood had grown faster than supply.

Mehta (1983) conducted a rural energy study in the District of Saurashtra and Kutch and found that main fuels used for domestic purposes were firewood, stalks, kerosene and electricity. Small quantities of coal, saw-dust and LPG were also consumed. Large quantity of wood was consumed by artisan category. Marginal and small farmers consumed largest quantities of dung cakes. Out of total wood consumed, 69 percent was gathered. Small families depended entirely on gathered dung cakes and the large farmers used twigs and stalks from their own farmland as fuels.

Sharan (1984) undertook a study which encompassed the domestic, agricultural, industrial and artisan sectors, in 15 villages from three Districts in North Gujarat. The cooking fuel of households consisted of crop residue, wood and small quantity of dung. The crop residues generally used were cotton stalk, rayada, tur stalk and groundnut shell. The use of dung and kerosene did not extend to all villages. They continued to use wood to the extent of about 40 percent of the total fuel.

According to report of Jyoti Consultant Limited (1984), in rural areas of Central and South Gujarat, domestic energy consumption constituted 85.8 percent of total energy consumed. Out of this firewood and twigs constituted 90.9 percent of the total requirements, i.e. 78.3 percent of the total energy consumed in the villages. Use of gobar gas for domestic use had been started recently in some villages but its share was not at all significant.

2b. Energy Consumption in Urban Areas

It is the urban population of the country which is basically enjoying the fruits of economic growth of the country with ever increasing demand and consumption of commercial energy. In a study conducted by National Council of Applied Economic Research (NCAER) (1975), the city of Greater Bombay was chosen as a model of urban India and in-depth study of its energy demands had been carried out. According to this report, non-commercial sources of energy accounted for hardly eight percent of the total energy consumption of Greater Bombay. Industry accounted for about 40 percent of its total commercial energy consumption followed by transport and household sector with 29 percent and 27 percent consumption, respectively. Among the commercial sources, old products played a strategic role contributing over 60 percent of the total energy. With supplies of LPG increasing, demand for kerosene was declining. However, demand for kerosene will still be there even for those families who have switched over to gaseous fuels, as a standby fuel.

The demand for urban household energy is rising, partly due to growing population and partly due to improved income levels which demand higher standard of living. This can be seen from the fact that non-commercial fuels constituted about 40 percent of the total energy consumption of Greater Bombay in 1958 whereas it was only eight percent in 1971.

Along with the growth in energy demand, there have been shifts in the pattern of energy consumption, the major shift being from non-commercial to commercial sources of energy. The factors responsible are many - the desire to improve living standards, rising incomes, lack of storage space, increased availability of electricity and in some cases restrictions imposed by landlords on the use of smoky fuels. Lateral shifts have also been taking place among the commercial sources of energy.

The consumption of commercial energy is closely linked with intensity of industrialization. The consumption of commercial energy in India on a per capita basis is one of the lowest in the world. The per person consumption of commercial energy in the United States is more than fifty times that in India (Parikh, 1976).

Some data on the energy consumption patterns of the Third World Countries of Bangladesh and Kenya were available which is also reported here as they are found to be very much similar to the consumption pattern in India.

Islam (1980) reported on the basis of various surveys that traditional sources of energy contributed the major sources of energy consumed in Bangladesh. According to Bangladesh Energy study, traditional fuels contributed 73 percent of the total fuel consumed. Tyers (1978) and Islam (1979) estimated that traditional sources contributed 93 percent of the total fuel consumption in rural areas.

The total per capita consumption of fuels in Bangladesh in 1977-78 was estimated as 1.47 million KCal/person/years of which commercial fuel consumption was 0.27 million KCal/person/year (18 percent) and traditional fuel consumption was 1.2 million KCal/Person/year (82 percent).

In Kenya, in the urban sector, electricity, gasoline, LPG, kerosene, charcoal, and solar heaters are used for various activities. In the rural sector, firewood, charcoal, cowdung, crop residues and kerosene dominate. The majority of the people in Kenya (87 percent) live in rural areas and are almost entirely dependent on firewood, charcoal and other vegetable materials (Mbeche, 1980).

3. Perspective on Energy Problems

The Indian energy scene presents a formidable problem in analysis. The most significant feature is that non-commercial sources of energy provided nearly half the total energy consumed in the country till 1971. However, with increasing consumption of commercial energy, it is expected that by 1990, the percentage share of non-commercial energy shall be as low as 17 (Table 1).

A review of India's energy resources shows that like other developing countries,Indian energy resources can be classified into three categories. They are commercial, non-commercial and unconventional sources (for future use). The commercial sources consist of oil, coal, natural gas, hydroelectricity and nuclear fuel whereas non-commercial fuel sources include animal dung, firewood and agricultural wastes. As per Table 1, India's percentage demand of coal, oil and electricity has been increasing whereas the demand of firewood, dry dung and agricultural wastes has been decreasing. The increase in oil consumption has naturally affected the economic growth of the country in an adverse manner since most of the oil

Table 1 : Summary of Demand for Fuels (Mtcr)*, India

Fuel	1970-71	1978-79	1983-84	1990-91
1. Coal	51.4 (14%)	85-95 (16-17%)	124-147 (17-19%)	198-238 (18-21%)
2. Oil	97.2 (25%)	173-152 (31-26%)	237-204 (33-26%)	380-308 (35-28%)
3. Electricity	48.7 (13%)	100-128 (18-22%)	167-211 (23-28%)	320-398 (30-36%)
4. Firewood	116.6 (31%)	125 (22%)	124 (17%)	116 (11%)
5. Dry dung	26.9 (7%)	26 (5%)	26 (4%)	21 (2%)
6. Vegetable waste	35.9 (10%)	44 (8%)	44 (6%)	44 (4%)
Total	100%	100%	100%	100%
Per capita energy consumption (In mtcr)	0.67	0.82	0.96	1.44
Percentage of share of energy :				
Commercial	52	64	73	83
Non-commercial	48	36	27	17
Total	100	100	100	100
Percentage share of commercial energy demand :				
Coal	26	24-25	23-26	22-25
Oil	19	48-41	45-36	42-33
Electricity	25	28-34	32-38	36-42
Total	100	100	100	100

Source : (1) Govt. of India, 1974, Report of the Fuel Policy Committee, p.139.
(2) Ramchandran, A., 1974, 'Energy Research and Development in India - Challenges and Perspectives;' Prof. S. Bhagvantham's 60th Commemoration Lecture, Hyderabad, Andhra Pradesh Acad. Science.

*Mtcr = In million tons of coal replacement.

had to be imported. The vast reserves of coal that India has, is certainly going to support the country's economic growth in the coming decades of energy shortfall.

The unconventional energy sources are solar energy, geothermal energy, wind energy, ocean thermal energy, tidal energy, etc. Though some satisfying achievements have been reported by workers, particularly in the field of solar energy technologies, yet solar energy technologies would take another 40 to 50 years to make any significant contribution towards the Indian energy requirements. These new sources of energy will only supplement rather than replace the existing sources.

The future projections on energy problems have been made by various persons on basis of the present consumption rates.

Observations made by Parikh (1976) are as follows :

By 2001 or by 2015 A.D., India's population which was 547 million in 1971 can be expected to double to 1100 million. The requirements of energy for such a large population will depend on the likely growth of income which in turn will depend on the availability of energy. Without energy, therefore, significant progress is not possible. Until the spread of education and family planning stabilises the population of the country, the primary concern will be to feed the increasing population. In India in 1976, the energy consumption per capita per annum was 189 kilograms of coal equivalent and the per capita income per annum was 86 U.S. dollars.

FAO presents a global picture of energy deficit. FAO estimates that 112 million people (96 million rural) live in areas where large numbers are unable to meet minimum firewood needs even through over-cutting. Another 1128 million (1050 million rural) live in deficit areas where minimum needs are currently met, but cutting exceeds forest growth. The projections are ominous; 3000 million people living in areas of acute saarcity or deficit by the year 2000. (Matthai, 1982).

Demand for fuel wood and supply of fuel wood are not balanced. As per FAO (1981) estimates, by the turn of the century, India will be able to grow enough food but will not have enough fuel to cook it (Matthai, 1982).

The National Commission on Agriculture has reckoned the demand for firewood by 2000 A.D. at nearly 375 million cubic metres a year. With the advent of miracle plants such as Kubabul and Isradi Acacia, at least the pressing domestic fuel constraint may be somewhat relieved (Matthai, 1982).

In 1975-76 our oil consumption was of the order of 25 million tonnes. Within five years, the oil consumption went up to 34 million tonnes (1980-81). Thus, our oil consumption has been increasing at the rate of two million tonnes every year. If the domestic production keeps increasing at the indicated rate of one million tonnes per year and if the total consumption continues to increase at the rate of two million tonnes per year, then imports would have to keep increasing at the rate of one million tonnes per annum, i.e. from the current level of about 24 million tonnes, imports may have to increase to around 34 million tonnes by about 1990 A.D. In short, neither now or in the future would we be anywhere near self-sufficiency (Shah, 1981).

The Planning Commissions Working Group on Energy Policy has noted that, if the past trend continues, the consumption of petroleum products in India would reach 93 million tonnes by 2000 A.D., which it rightly suggested, would be unsustainable. It then recommended some oil conservation measures on the basis of which the consumption in 2000 A.D. would be somewhat lower at 69 million tonnes. The basic implication is that the imports of oil would have to be increased from 24 million tonnes in 1980-81 to 44 million tonnes by 2000 A.D. (Shah,1981).

On the basis of the current forecast it is expected that the average growth rate of demand for power during the period 1984-85 to 1989-90 for the country as a whole would be 13.5 percent per annum in terms of peak demand. The pace of household electrification is expected to increase from 18.49 percent in 1980-81 to 35 percent in 1980-90. On the basis of the projected population growth and electricity demand, the per capita consumption in 1989-90 would be 228 kilowatt hour per annum (Central Electricity Authority, 1985).

By the end of 1989-90, coal production is targeted to increase to 226 million tonnes. Consumption of coal is estimated to increase from 139 million tonnes in 1984-85 to 237 million tonnes in 1989-90. The gap of 11 million tonnes between production and likely consumption would be met by imports of coking coal during the seventh plan period (Commerce Research Bureau, 1986). This would involve expenditure of foreign exchange.

The rising prices of fuels will lead to reduced food intake. For an already malnourished population, this would indeed be unfortunate. Cooking energy shortage will not only create serious nutritional problems but may also lead to increased incidence of various diseases. The FAO document, 'Agriculture : Towards 2000 ', points out that the fuelwood production expected to fall short of 40 percent, 'many poor people will not be able to cook their food adequately. This can have serious nutritional and health consequences,' (Agarwal, 1982).

The coal prices were raised for the seventh time after nationalisation of the industry in 1972-73. The price of coal per tonne was Rs. 47.50 in 1974 which increased to Rs. 183 in 1984 and from 8-1-86 it is Rs. 210 per tonne. The coal prices during the last decade have quadrupled. The percentage increase in price is 242.1. (Commerce Research Bureau, 1986).

The price of soft coke mainly used as a domestic fuel, has been kept at the level of Rs. 175 per tonne, which has been kept unchanged since 1982. However, in the case of industrial consumers using soft coke, the price would be Rs. 300 per tonne (Commerce Research Bureau, 1986).

Petrol prices in major cities of Delhi, Bombay, Calcutta and Madras have shown a rising trend. In 1980, the petrol prices were Rs. 4.25 to Rs. 4.43 per litre in the four major cities of India which rose to Rs. 7.01 to Rs. 7.39 per litre in 1985. In 1986, there is a slight increase in price which is Rs. 7.43 to Rs. 7.82 per litre for the four major cities (PTI and UNI, 1986).

The escalating prices of fuel forms and the increasing shortage of non-renewable energy forms have affected almost everyone in varying degrees. The problems that households or families face to support their life-sustaining activities are going to become worse if the present rate of consumption, population growth, price increase and scarcity of resources continue. Hence, it is imperative that the families know the various faces of these ecological issues to foresee and plan energy decisions and others to reduce severity of the problems in the years to come.

4. Family Level Studies conducted on Energy in India, and Abroad

In response to the scarcity and price rise of different energy forms, and importance attached to the household sector in the energy crisis, attention has been diverted towards conducting researches on various aspects of household energy consumption. A large number of studies have been conducted both in India and abroad on energy which have been reviewed under different sections.

4a. Consumption - Expenditure Pattern on Energy

The consumption - expenditure pattern of families on energy is influenced by various factors within and outside the home as the family members are inextricably linked to the environment through energy flows. The energy consumption-expenditure pattern of families and the factors influencing it have been highlighted in this section.

Family characteristics such as family income, stage of family life cycle, size of the family, socio-economic status and family values are especially relevant in understanding family's energy consumption patterns. Family income was found to be the best indirect predictor of residential energy consumption. Richer families used more energy than poorer families (Morrison and Gladhart, 1976; Yao, 1980). Few researches revealed that as family income increased there was an increase in the amount of various sources of energy utilized (Gladhart, 1975; Morrison et al., 1978; Newman and Day, 1974; Yao, 1980). A significant difference was reported between the mean of groups for energy costs and family income by McNew (1979).

Chaturvedi (1983) reported that the percentage of total monthly family income spent on fuels decreased with the increase in income which means people with less monthly family income spend more than the people with a higher monthly family income.

According to George (1983) and Kaul (1984), approximately 10 to 11 percent of the monthly income was spent on fuel consumption. Mean monthly outlay per family on electricity was Rs. 116.71 while it was Rs. 31.77 and Rs. 47 in case of natural gas and LPG. Mean monthly outlay on kerosene and petrol per family was Rs. 21.45 and Rs. 187.22, respectively (Kaul, 1984). As reported by George (1982), the average monthly outlay on energy consumption for the total sample was Rs. 206.18, while for middle and high income groups it was Rs. 149.33 and Rs. 277.25, respectively. In her study conducted in 1983, she found that Rs. 196.72 per month was spent on energy resource consumption.

Almost one-fifth of the United States of America's energy in 1968 was used in the home for heating/cooling homes, heating water, cooking and refrigeration which accounted for 88 percent of a family's domestic energy 'budget'; the balance was used in drying clothes, lighting and operating various appliances (Field, 1973).

The study conducted by NCAER (1975) on energy demands and consumption of Greater Bombay indicated that kerosene was still the preferred fuel source for lower-middle and low income groups, since for them initial investments for enjoying gaseous fuels was out of question. An intensive use of kerosene was found among low income households where more than 90 percent of households derived a major share (75 percent) of their energy requirements from this source. Of the kerosene consumed by households in Greater Bombay in 1972, around 85 percent of it was used by households earning a monthly income of less than Rs. 500. The use of non-commercial sources of energy generally tended to dwindle as the household income increased. Among these, firewood and vegetable wastes were totally absent in middle or higher income group households.

Devadas and Rajagopal (1983) studied the fuel management practices of rural homemakers of Coimbatore District, having a monthly income less than Rs. 300. Ninetysix percent of the families surveyed spent only upto one percent of their income on fuel whereas the remaining spent upto three percent. Firewood, barks, twigs, crop-waste, cotton stock, sugarcane leaves, Baggasse, coconut shells collected from the neighbouring area were the fuels used by all families. Homemaker did the collection of fuel assisted by children also. Babul, tamarind, irul, sal and neem were considered good fuel wood. Kerosene was the only fuel purchased by all families for home lighting purpose. Fifty percent of families spent nearly an hour collecting firewood. The rest walked more than five kilometers spending more than two hours for collecting fuel. The quantity of fuel used per day depended upon factors such as purposes for which the fuel was used, number of family members, meals prepared, items in the menu, quantity of food cooked and type of 'Choola' used. Majority of 75 percent respondents used upto two kilograms of fuel per day mainly for cooking two meals a day.

Natural gas, LPG, electricity, kerosene, coal and petrol were the most common sources of energy used by families in urban Gujarat (Gandotra, 1983; Kaul, 1984; George, 1983; George and Ogale, 1983). Electricity was used by all families for lighting the homes and by some families for operating various types of electrical appliances for comfort in living. Petrol was used for transportation.

The rural domestic energy survey conducted by Chauhan (1983) in Gujarat showed that wood and agricultural waste were used by all families, while cowdung was used by only rabari households and very few used kerosene. Kerosene was used as a supplementary fuel for making tea, etc. Wood and agricultural waste used for cooking was got from their farms while very few purchased them. Nearly 40 percent households gathered fuel for cooking. The mean number of persons involved in the job of procuring fuel was 2.45 and the mean time taken for gathering fuel was 2.06 hours per day.

Chaturvedi (1983) observed that the most commonly used cooking units by urban homemakers were gas stoves, kerosene pump stove, followed by Chulla in which wood and cowdung cakes were burnt, while very few people used wick stove, hot plate or solar cookers.

Families in the child-rearing stages used more residential energy in general than families without children or at the early or later family life cycle stages (Morrison and Gladhart, 1976). Energy consumption in single family dwelling units was related to stage of family life cycle as reported by Giles (1980).

Larger families were found to use more energy than smaller families as a result of greater demand on the available facilities and appliances as reported by Morrison and Gladhart (1976). McNew (1979) found a significant difference between the mean of groups for energy costs and size of the household.

Socio-economic status is another variable which influences households energy consumption as has been reported by Uusitalo (1983); Bailey (1980); and Baker (1979). High socio-economic status is closely related to high energy consumption.

Family values is another important variable influencing energy consumption. All as individuals and as member of families develop some pattern of values which differ from one another. Depending on their value patterns, families make modifications and changes in their consumption style. Values are shaped by the resources available and the perception of how resources should be distributed and used. Values give direction to one's life and one's behaviour. Values, goals and resources are interdependent. With great insight, Cottrell (1955) stated several decades ago that

> '... the preservation of a system of values requires a continuous supply of energy equal to the demands imposed by that system of values. Conversely, ... changes in the amount or form of energy available give rise to conditions likely to result in changes in values, for men who share common values make similar changes in choice when faced with similar changes in consequence of their acts. These changes in choice are influenced not only by the values... but by changed limits as to what is physically possible.
>
> Thus, the possibility of predicting (and directing) change depends as much on knowledge of the physical potentialities in a situation (energy) as it does on a knowledge of the values people hold.' (p.4-5).

Paolucci et al. (1977) stated that family's choice of alternatives depend on the values held by families. Family level studies have been conducted to study eco-consciousness as a family value. Hungerford (1978), Hogan (1976), and Morrison and Gladhart (1976), identified 'eco-consciousness' as a value accompanying household energy conservation behaviours. Those families where both husband and wife valued eco-consciousness were more likely to have adopted practices in the home to conserve energy than families where the level of commitment was lower or where husbands and wives differed in their commitments. George (1983) reported that homemakers' eco-consciousness was directly related to overall extent of commitment to energy conservation goals. Families with husbands having high eco-consciousness were more committed to energy conserving goals.

Personal characteristics such as employment status, age and education of the homemaker are also important determinants of energy consumption.

Families in which homemakers were employed full time or part-time used eight percent and six percent less residential energy, respectively, than those with homemakers not working outside the home (Morrison and Gladhart, 1976).

Age was found to be an influencing factor in energy consumption. Merkley (1981) observed that the effect of aging-related factors which could influence energy consumption patterns, level of past experience with shortage and deprivation was a statistically significant predictor of current energy consumption behaviour. Households headed by older individuals with higher levels of deprivational experience currently appeared to be consuming larger amounts of energy than comparable households headed by individuals with less experience. In addition, households headed by primary income earners with higher levels of exposure to deprivation and shortages in the past appeared to be responding to the energy crisis by reducing proportional energy consumption to a greater degree than equivalent households with less exposure to hardships in the past. McNew (1979) showed a significant difference between the means of groups for energy costs and age of the head of the household. Zimmerman (1981) in his study on household energy consumption determined that age had a direct negative effect on daily travel by adults. Kaul (1984) found a significant negative correlation between the energy consumption behaviour and age of the homamaker. Further, mean difference on energy consumption behaviour was significant for different age groups.

Education is another important variable affecting energy consumption of families as reported by Ayotollahi (1980), Morrison et al. (1978); Uusitalo (1983) and Kaul (1984). A positive correlation existed between energy consumption behaviour of homemakers and their education.

According to Yao (1980), habit formation and or stock adjustmant are other determinant factors of gasoline consumption. Price, social and demographic factors, and per-capita income were the major predictors of residential electricity consumption for all countries. However, their relative importance differed.

Housing is another area that relates directly to energy consumption patterns. Single family homes used more energy than multi-family dwellings. Energy consumption increased as the number of rooms, windows and exterior doors increased. Insulation in ceilings and walls was related to lower energy consumption. Size of the house depended on family's income level. (Morrison and Gladhart, 1976; Hogan, 1978). Energy consumption in all types of dwellings was largely a function of structural attributes and occupants' life-styles which were home centered. Intensive use of the dwelling increased the energy consumption (Giles, 1981). Large size dwellings are associated with high energy consumption (Uusitalo, 1983).

In America, the typical American family spends less time at home, eats out more, uses prepared foods and occupies dwellings that are mechanized. Around 3 million families own a second home; more than 4.5 million families own or rent a recreational vehicle; 80 percent of all households owned one or more cars; all of which contribute significantly to the demand for energy. United States of America is a big energy spender. The use of residential electricity has increased by 129 percent in the last decade. Approximately one-fourth of the nation's fuel is used for transportation. While only six percent of the world's population lives in United States, they consume 33 percent of the world's energy (Montgomery, 1973).

The number of appliances used in the home is another important determinant of household energy use. The number and kinds of major appliances owned by a family were closely related to the family's income level (Morrison and Gladhart, 1976; George, 1983). The increased number of electric appliances and intensity of their use is associated with high energy consumption (McNew, 1980; Uusitalo, 1983). George (1983) found that almost all families expressed the desire to reduce consumption level of energy resource and avoid wastage of energy but at the same time desired to own big household equipment and recreational equipment which would consume large quantities of electricity. She pointed out that families did not pay any heed to ecological implications of their decisions in relation to level of living oriented energy goals, so long as the attainment of those goals contributed to their comfort and standard of living and they could afford to allocate resources for attaining the same.

The consumption pattern of various sources of energy is also influenced by the extent of availability and the relative price of the different fuels. In some cases, preferences for a particular fuel on grounds of cleanliness and convenience also existed. Traditional habits also played a role in energy consumption (NCAER, 1975). Morrison et al. (1978) observed that the middle income households responded more favourably to high cost of fuel. Wilhelm (1982) reported that the relative cost of the fuels used by the household was the only significant motivator for direct energy conservation.

McNew (1980) reported that the greater determinants of energy costs were income, education, sex of household head, size of household, role of respondent, size of living space, air conditioning, certain types of heating equipment and insulation.

<u>Lifestyle factors</u> also play an important part and may even prove to be more efficient explanatory variables than socio-economic or demographic background (Uusitalo, 1983). Lifestyle modifications could promote energy conservation (Giles, 1980). The 'term 'lifestyle' usually refers to various activities and/or situations within households. For example, indoor temperature, energy-saving practices, intensity of use of household appliances and many others. The size of the automobile owned is also a typical lifestyle

variable with great intra and inter country variations (Uusitalo, 1983). The frequency of use and efficiency of the vehicle influences the petrol consumption. The American lifestyle or consumption pattern implies a higher level of per capita energy consumption than India.

Structural factors were found to underlie inter-country differences in energy consumption patterns such as per capita energy consumption, income levels and relative prices, differences in climatic conditions, population density, area and natural resource endowments (Uusitalo, 1983).

Bergman (1983) analysed the relative importance of different structural factors in explaining international differences in energy consumption. The results indicated that a significant part of the observed differences could be explained by structural factors as those mentioned by Uusitalo (1983). Of the remaining differences, a significant share could be explained by differences in the technology used in different countries. The remaining unexplained differences could be interpreted in one of the two ways (1) by the long run price and income elasticities; (2) life-style differences which cannot be explained by income or price differences or other structural factors.

Uusitalo (1983) made a hypothetical model of the environmental impacts of changes in consumption style. Lifestyle was defined as a whole class of activities and preferences depending on people's personal, social and institutional background. The major differences in lifestyle were measured with two indicators : (1) consumption patterns and (2) time allocation pattern. Restaurant and cafe services, pre-prepared, processed foods in particular indicated a modernized way of life while a high budget share for food items like flour and grain (which are needed in the home production of food) indicated a traditional consumption pattern. With respect to time allocation, modernization was indicated by the decreasing share of time spent on housework and the increased amount of time spent in restaurants.

Two further trends in modernization were differentiated: (1) the trend towards career orientation and away from home-production activities and (2) the trend towards a stronger market-efficiency orientation as indicated by purchase of time-saving products amd services. She reported that certain structural changes in society such as urbanization, changes in occupation, structure and women's increased role in the labour force may underlie modernized consumption.

The energy consumption data revealed that about one-third of the energy in America was consumed by the household sector for residential and automobile use (Hogan, 1978). A case study showed that families consume energy directly for central heating and for their cars which alone make up 82 percent of the energy consumed by families.

Berg (1974) reported that residential power needs account for almost one-fifth of America's annual consumption of energy. In 1968, major end uses of residential energy were : space heating 57.5 percent, water heating 14.9 percent and air-conditioning 3.7 percent.

The literature reviewed on consumption-expenditure pattern reveals that a combination of factors affect the energy resource utilization in the household sector. It also reflects the need to know the knowledge possessed and the perception of the people regarding energy crisis which may help in developing positive attitude towards energy conservation. Hence, literature on knowledge and perception of the people regarding energy crisis was reviewed.

4b. Knowledge and Perception of Energy Crisis

Knowledge and perception are important concepts connected with energy use. Knowledge and perception of energy crisis situation will help families to make informed decisions in favour of maintaining a balance between the resource availability and resource use. It may also help the families to readily adapt to the energy crisis situation when faced with it. Few studies on this aspect have been conducted to determine the factors influencing the knowledge and perception of homemakers and whether such knowledge affects their energy conservation behaviours. These are presented in this section.

Newitt (1981) reported that people with more positive attitude to energy conservation or more knowledge of energy conservation techniques tended to consume less energy than those who scored low on these instruments. It was also noticed that those who lived in energy efficient homes had more positive attitude regarding energy conservation and had more knowledge regarding energy conservation techniques.

Chaturvedi (1983) observed that majority of the respondents had either low or just average knowledge regarding fuel management. This included knowledge of homemakers about the effect of fuel on the health and environment, time and energy saving equipment and fuel conservation practices. But they possessed high knowledge with regard to efficiency and cost of cooking units and fuels. Homemakers with higher knowledge about fuel management also had better fuel management practices. People from different income ranges and education levels varied greatly in their fuel management practices.

George and Ogale (1983) observed that homemakers did not have adequate knowledge regarding natural energy reserves of the earth and this formed an obstacle in moulding their beliefs related to earth's energy reserves and man's energy problems. The expressed feelings regarding periodical price rise of energy revealed that it was not sound from the ecological perspective.

Kaul (1984) found that homemaker's age, education, and exposure to mass media affected homemakers' knowledge on energy sources and its related aspects. Furthermore, the energy conservation behaviour was influenced by their perception of need to conserve energy, attitude towards energy conservation and exposure to mass media.

Paolucci et al. 1977 stated that the family's choice of action depends on the family's perception of the situation. Therefore, the concept of perception was included in the present study. It is assumed that there will be variation among individuals on levels of perception as it is dependent on the environmental conditions and personal characteristics of the homemaker.

4c. Stress due to Energy Crisis

Stress is a new concept which is gaining importance in social sciences. The control of stress has assumed practical importance. Stress may have multiple meanings depending on the context in which it is experienced as well as the perspective from which it is studied (Pearlin and Schooler, 1978).

Dr.George Engel defined stress as follows :

> 'A stress may be any influence, whether it arises from internal environment or the external environment, which interfers with the satisfaction of basic needs or which disturbs or threatens to disturb the stable equilibrium', (Langer and Michael, 1963, p.51).

Langer and Michael (1963) state that 'stress' signifies the environmental force pressing on the individual. Strain is defined as a reaction to stress. As the number of environmental stresses increase, the average amount of strain also increases.

People faced with the same apparent stress react so differently, some with extreme strain and others with relatively little strain. When people adapt to stress, adverse after-effects remain which are detectable in behaviour. Observation of urban life leads to the conclusion that despite the unpleasantness of stressful conditions, life goes on. This is because man has the capacity to adapt to or even shrug off the stress. Although man is highly adaptable and can therefore achieve adjustments to extremely undesirable conditions, such adjustments often have indirect effects that are harmful.

Stress is an unavoidable component of each individual's existence. The disturbance of this equilibrium causes a need an associated drive, thereby impelling the organism to attempt to resist moving from the homeostatic state or if he has already moved, to restore the equilibrium. The force disrupting the homeostatic equilibrium is a stresser, the need is a stress and the return to equilibrium is adaptation (Glass and Singer, 1972).

Stress has both physical and emotional causes. Stress comes in part with environmental factors that are sensed but that cannot be stated in medical terms (Darling, 1969, p.656). Different patterns of coping with decision making result in varying amounts of stress (Janis and Mann, 1976, p.658). The level of stress varies with each individual.

Approaches to the Study of Stressful Events :

Mason (1975) has reviewed the evolution of the concept of stress from its early formulations in the works of Cannon and Selye to its present status. He points out that studies of stress have approached the problem in four different ways. The first approach focuses on the stimulus parameters or 'stressors'. This approach is exemplified by the work of Holmes and Rahe (1967) who have attempted to identify the elements that distinguish more stressful from less stressful live events and to develop an 'index' of stressful events (Benswanger, 1982).

The second approach is represented by those who concentrate on the response to stress and examine its emotional and physical manifestations. Examples of this approach are studies of the effects of maternal deprivation, the susceptibility of children to specific illnesses and accidents and types of emotional disturbance that develops as the aftermath of stress.

The third approach focuses on the interaction between stressful events and their subsequent manifestations in mental or physical illness. This approach was formulated initially by Hill (1949) in his classic study of war induced separation and reunion. Hill outlined the dimensions of a family crisis in terms of three parameters. The event itself, the family's coping resources and the family's perception of the event.

The fourth approach conceives of stress from a more dynamic, comprehensive perspective which encompasses a whole spectrum of interacting factors including developmental status, individual coping styles, family dynamics and the social-cultural milieu. This approach has been developed by Lazarus (1971) and Levi (1974).

Wolff (1972) has suggested that the crisis points which occur during the normal course of development influence the perception of and the reaction to stressful events at any given period.

Kyriacou (1981) studied the relationship between social support and coping strategies used by teachers with occupational stress. The coping actions reported by teachers indicated that they appear to cope with stress in 3 ways : (1) by expressing feelings and seeking social support; (2) by taking considered actions to deal with sources of stress and (3) by trying to think of other things. To reduce stress, the type of social support received should match the type of coping strategy adopted by the teacher.

Watts (1983) measured the level of stress and satisfaction present in the relationship of young - adult daughters and their parents. The findings indicated that factors contributing to variance in stress were the daughters' lifestyle values and parents' lifestyle and expectations. Enjoyment from activities done together and pleasure in the daughters' accomplishments were factors contributing to variance in satisfaction. Stress appeared to be associated with boundaries of the family value system and satisfaction was associated with elements of family solidarity and family strengths.

Though some research on stress in family relationships has been done, the area of stress due to energy crisis seemed to be unexplored. In case of the present study it is included as a variable since energy shortages and price rise faced by families do create a stress situation which disturbs the family's smooth functioning as regard to fuel energy management.

4d. Energy Conservation

Throughout the world, the theme 'Conservation for Survival' is gaining importance. Even the most developed countries like the United States of America, United Kingdom and Japan are formulating means to conserve energy. While maintaining austerity in the household sector fuel energy consumption, they are remodelling existing machines for better efficiency, renovating buildings for lesser energy consumption and making people aware of energy crisis and importance of conservation. Farhar et al. (1980) found from their study on 'Public Opinion about Energy' that most Americans were practicing some form of residential energy conservation. Today, however, as most people must be aware, the era of plentiful cheap energy is over. More efficient and economical use of energy must become a part of everyday life with individual contributions bringing personal benefits in terms of lower costs, or at least in reducing the impact of inevitable price rises.

better insulation and controlled ventilation are advocated.

2. The economic solution with emphasis on pricing policy and tariffs. According to the tenets of classical economic theory, as the availability of a resource decreases so should price increase correspondingly, thus those consuming more are penalized and in aggregate, demand will be reduced. On the face of it, two desirable objectives are met, conservation and social equity.

3. The social solution with the emphasis on the use of persuasion, information and social norms to change the consumers' attitudes, knowledge and behaviours in the context of energy. It is assumed that if people come to appreciate the problem and know how to respond, the majority will behave accordingly and make necessary savings.

All three strategies bear upon the consumer through either his house, pocket or attitudes and cognitions, and social relations respectively, but it is only in the context of social solution that social scientists can make a contribution to energy conservation. In view of this, an effective conservation policy must include technical, economic and social factors.

Human Factors in Energy Conservation :

Technical Solution : The extent of the contribution of consumers' behaviours to levels of energy use is wellillustrated by the finding that even in identical houses, similar families show variability in consumption of upto 4 to 1 (Cornish, 1976; Minogue, 1977). High and low consumption must be seen as resulting partially from consumers' preferences and behaviour. Thus, energy conservation is a socio-technical phenomenon and that innovations must be designed and assessed with the understanding of consumers' reactions if it is to be of greater value in the longer term.

The Economic Solution : The heaviest consumers in the domestic sector are the most wealthy and whilst these are the people who should be encouraged to conserve, they show the least inclination to do so. Katona (1963) argues that demand is not purely a function of price but of the individual's ability and willingness to pay.

Consumers seem to adapt to increased prices in a Helsonian sense (Helson, 1958). When petrol prices increased in 1974, there was a dramatic drop in consumption but the reduction was short-lived as documented by Lowe-Watson (1975). Adaptation theory, in this context would predict that to maintain a continued reduction in energy consumption, repeated price increases would be required at regular intervals.

But the most important shortcoming of a purely economic strategy such as pricing is that while it may motivate people to cut back, it fails to tell them how to do so. With minimal levels of knowledge of efficient energy use, people adapt ill-conceived solutions often leading to lower levels of comfort at minimal reductions in cost. To maximise its contribution to conservation of energy, the price mechanism must be seen in the light of socio-economic models which take the knowledge, attitudes and behaviours of consumers into account.

The Social Solution : The psychological contribution centres on the understanding of the energy consumer and on the development of instruments which lead to personal and social change by affecting the attitudes, values and behaviours of individuals.

A number of studies have demonstrated a weak correlation between education level, attitudes to conservation and likelihood of adopting conservation measures, but the relation with income is less clear, while studies show that low income groups are less likely to conserve, there is disagreement on whether high income groups are more inclined to save, although they have the greatest scope for conservation, they may also have little economic incentive to do so. (Ellis and Gaskell, 1978). Studies do not provide very useful information of what kinds of people will or will not conserve energy.

Through greater knowledge the energy literate is in a better position to conserve. Such a person appreciates the general energy problems and is knowledgeable about his domestic energy use. He knows which appliances consume most fuel and where savings can be made. For the energy literate, more options are available with which to respond to changing conditions. Without this energy knowledge, even the strongest motivation to conserve derived from high prices or persuasive appeals cannot be effectively realized (Gaskell and Ellis, 1982).

Researches conducted on Energy Conservation :

Berg (1974), suggested ways of conserving energy which included better insulation, greater use of natural lighting, improved appliance design and more careful selection and maintenance of equipment. The author states that 'one quarter of the total national energy consumption may escape effective use because of leakage at the point of utilization.'

Because energy sources are diminishing more rapidly than new sources are being developed, Fuchs (1974) suggested twelve methods for conserving lighting energy without reducing quality of lighting design.

Home economists can most effectively help the nation's consumers to cope with the rising cost of electricity for home use by giving factual consumer energy education (Butel, 1975). Home heating and cooking require sizeable quantities of energy. Three high energy users among appliances are refrigerators, television and air-conditioners which have, since the energy 'crunch' began, undergone major and minor change in design for energy efficiency.

Christner (1979) identified four categories of variables that may interfere with the achievement of conservation goals, viz., personal variables, structural-cultural variables, situational variables and cognitive variables. Personal variables include comfort needs, ego needs for status and the like while structural-cultural ones cover such hindrances as freedom, self-centered interests, lifestyle, role expectations and so on. Situational variables include the social and physical factors that affect the individual's perception about the need for conservation like the degree of crisis perceived, high prices, behaviour of others and so on. Cognitive variables include the individual's ability to foresee the long-term consequences of energy decisions.

Seligman et al. (1979) showed that attitudes to comfort are among the salient beliefs and are important predictors of levels of consumption, implying that one obstacle to conservation may be beliefs and attitudes about the need to preserve comfort level.

Bailey (1980) conducted a study on socio-economic variables and attitudes of consumers related to energy conservation behaviour. The results showed that attitude operated as an intervening variable between the four socio-economic variables and behaviour. The socio-economic variables exerted a direct influence on both attitudes and behaviour and an indirect effect on behaviour through attitude. When attitude was combined with the four socio-economic variables in the regression on behaviour, attitude contributed to the total variance in behaviour.

Impact of Energy costs on Housing related decisions of elderly householders was studied by McNew (1980). Over 30 percent of the householders retrofitted their dwellings for comfort and four percent to save money on energy. Findings showed that knowledge of energy conservation did not necessarily mean that it was being practised but those who knew more about energy conservation paid more for energy. Changed practices scores indicated that most families will continue to use energy in the amount they can afford.

Ayotollahi (1980) found that majority of the car owners recently practised more conservation in the use of gasoline than before. Those individuals who consumed more gasoline were among higher income levels, more educated and more likely to be in the older age categories.

McKay (1980) observed from her study that the educational needs of homemakers included energy conservation also.

Rich (1980) observed that the trend in the use and effectiveness of conservation measures over time suggested that consumers were willing to adjust fuel use habits in the short and long run but that substantial economic incentive was required to create and sustain a significant response.

Giles (1981) reported that lifestyle modifications could promote energy conservation.

Merkley (1981) reported that households headed by younger individuals, those reared in affluence and lacking a backlog of experiential knowledge to draw upon to help them implement conservation practices were not adapting readily to the current energy crisis. On the other hand, households headed by older individuals, those having faced deprivational experiences in the past, seemed to respond more readily to the need to adapt conservation practices.

McCutcheon (1981) studied the influence of energy conservation education on attitudes and behaviours of selected youths. She observed that the control groups showed feedback combined with information. They reported that the information condition was no different from the control in terms of reported saving measures. Information itself had little impact but feedback, and feedback and information had similar effects in significantly increasing reported saving measures. Thus, energy awareness is essential for feedback to lead to energy conservation.

Wilhelm (1982) reported that a reduction of 1.8 percent in direct household energy consumption was observed between 1977-78 and 1979-80. Nearly three-fourths of households were found to have practised some voluntary simplicity behaviour.

Grasso and Buchman (1982) reported that window shades can help in energy conservation. Thicker, heavier window shades mounted close to the window are most effective in reducing energy flow through windows by conduction. Light, opaque shades are most effective in reducing energy flow by solar radiation. A light opaque shade can reduce energy costs of the window by 60 percent during the cooling season and result in average savings of 100 dollars for the consumer. This same shade during the winter season can reduce energy costs of the window by 34 percent and result in an average savings of 40 dollars. The actual savings are dependent upon location, fuel type and local fuel costs.

Tyler (1983) studied the effect of energy education on low income urban tenants and found that the educational programme was effective in improving personal attitudes and behaviours. More tenants who received individualized or group instruction adopted energy saving behaviours and made retrofit modifications. Though no statistically significant differences were found between the two instructional approaches, still the individualized approach seemed more appropriate to the tenants than the group approach.

Lytle and Chamberlain (1985) analysed the nature of the relationship between energy conservation attitudes and behaviours of adolescents in the use of energy for personal and family-related activities. Energy conservation attitudes and behaviours of adolescents were found to be significantly correlated. Differences in the consistency of attitude and behaviour were found to be significantly associated with sex and employment of adolescents. Males and employed students showed less consistency of attitude and behaviour than females. No significant differences in consistency were found to be associated with other demographic variables tested or with levels of attitudinal qualities measured.

Bhambi and Bhambi (1981) conducted experiments to determine the savings in fuel and money by adopting certain cooking practices. They proved that drying vessels before putting on stove, soaking dals prior to cooking and cooking two to three items at a time in pressure cooker helped in saving fuel and money to quite an extent.

Five grams of LPG per day costing 1.8 paise can be saved by drying the utensils before keeping on fire; 3.5 to 15 grams of LPG per cooking costing 1 to 4.2 paise, depending on the type of dal, can be saved by simply soaking the dals before cooking;and 18 to 34.38 gram of LPG per cooking costing 5 to 9.5 paise can be saved by cooking two dals at a time in a pressure cooker.

Petroleum Conservation and Research Association (PCRA) reports that 15 percent of the 200 crore litres of petrol used in motor vehicles can be saved by adopting good driving habits and on an average, 30 percent of the cooking fuel can be saved by following efficient cooking practices.

One of the ways to conserve energy mentioned during discussion on 'energy and quality of life' at the Twelveth Energy Congress (1983) was to change the food habits of the people so that they drew their protein supply from vegetable foodstuffs rather than from meat (Hindustan Times Correspondent, 1983).

George (1983) reported that families where husbands had less education were more committed to energy conserving goals than those of husbands with high education. Families of old homemakers were more committed to energy conserving goals than those of young or middle-aged homemakers. She also found that as income increased, families tended to be less committed to energy conserving goals. Low income families were actively engaged in conserving energy as far as possible. Some of the constraints to the accomplishment of energy conservation oriented goals identified were attitude, aspiration, lack of eco-consciousness, role expectations and status needs.

George and Ogale (1983) observed that application of energy conservation by the households was independent of homemakers' educational level but influenced by the feelings of homemakers to price rise. The data revealed that the households were exercising conservation in their energy use to some extent with reference to home lighting, comfort in living, use of small appliances, food preparation and refrigeration.

Gandotra (1983) indicated that families need to improve their practices in order to save the energy they use. They were most careful to save fuel on transportation and refrigeration. Reasons which motivated the homemakers to conserve energy were to save money, avoid wastage and reduce cost of operation in the same rank order. Saving national resources was of least concern to them.

Kaul (1984) found that out of 139 homemakers, 9 were not affected by the price increase of fuels and reported that they would conserve only if they were to pay more than what they were paying currently. Almost all respondents were exercising energy conservation in daily living for 'keeping the energy bill down' and 'to save money' but not 'to solve the energy problem' or 'to avoid future energy crisis'. Majority followed conservation practices in relation to home lighting, use of fans, equipment and transport. A positive correlation was found between energy consumption behaviour of homemakers and their willingness to conserve energy.

In view of the above facts, energy conservation is very essential. The goal of striking a balance between people and resources could be achieved by creating a lifestyle based on conservation ethic. Conservation education is the solution to the problem of how to bring about reduction in energy consumption by households.

4e. Alternate Technology

In view of the prevailing energy crisis in the country, now the only workable option is to adopt what is called the soft path, i.e. to conserve energy from oil-based and other non-renewable sources and to shift consumption in favour of renewable sources like solar energy, bio-gas, firewood, tidal power etc.,' said Mr.D.R.Pendse, Economic Adviser to Tatas at the 9th World Congress on the 'Energy Crisis and the Third World', held at London.

The non-commercial renewable sources of energy are once again gaining importance. The search for alternate energy sources, particularly of renewable type which can supplement the commercial energy sources has been receiving wide attention during the recent years. Our late Prime Minister, Mrs. Indira Gandhi outlined the need for utilisation of renewable sources to tackle the problem of energy shortage. She emphasised that 'we must make urgent and all out scientific efforts to promote the development and utilisation of solar and other forms of renewable energy to reduce our dependence on fossil fuels to help safeguard our environment.' She further stressed that 'in the long run, hydel power, solar and bioenergy will be principal forms of energy used in our country' (DNES, 1984). Realising the urgency of the energy crisis, two separate organisations, Department of Non-conventional Energy Sources (DNES) and Commission for Additional Sources of Energy (CASE) were established.

Therefore, researchers have made efforts to develop cheap and alternative technology for the household sector which consumes the major portion of the country's total energy. The two most common technologies are biogas and solar energy which can make significant contribution towards conservation of non-renewable energy sources. Some studies related to the awareness and impact of such technologies are reviewed here :

Biogas Energy : The use of biogas as an additional source of fuel offers an important solution to the present energy crisis, especially in rural areas. It can be used for heating, lighting, cooking and powering generator. Besides this, it offers an environmentally clean technology. Biogas production can be taken up extensively as it can be cheaply produced from cowdung, human excreta, poultry droppings, agricultural wastes, etc.

There is enormous potential to expand the application of biogas technology. There are about 237 million animals in the country which annually produce about 1000 to 1050 million tonnes of animal dung. If this dung can be utilised through biogas plants, we will get 43 percent more manure and also huge amount of energy in the form of gas. Utilising the biogas energy we can save huge amount of commercial energy sources (ABE, 1985).

According to DNES, it is estimated that 150 thousand biogas plants shall result in saving of 600 thousand tonnes of wood equivalent per year and a return of Rs. 500 million per year (Khoshoo, 1985).

Kamalaveni (1962) assessed the value of gobar gas and it was found to be a better fuel than firewood as it saved on time to cook and wash cooking utensils. Moreover, the housewives were protected from the health problems due to smoke.

Regarding its awareness, Chauhan (1985) reported that very few respondents in the Gujarat village surveyed knew about bio-gas generation.

Solar Energy : Solar energy is one of the alternative sources of energy. Utilization of solar energy for cooking is one of the advancements in the application of solar energy. Many designs of solar cookers have been developed as a result of research work carried out by various organizations. Dhesi et al. (1981) stated that solar energy replaces or supplements conventional fuels in supplying the required cooking energy. Mannan (1982) viewed that solar energy can make a substantial contribution in meeting 20 to 60 percent of fuel needs required for cooking. According to Gujarat Energy Development Agency (GEDA), solar cooker saves scafce fuels upto 40 to 50 percent.

Gada (1982) studied the impact of solar technology on the beneficiaries of the subsidised scheme. The subsidised price was the main attraction for majority (95 percent) while novelty of the device was the second attraction (42 percent). Monetary saving in fuel cost was about 10 to 50 percent as reported by 25 percent of the beneficiaries. They exhibited neutral attitude towards solar technology for domestic use. Though homemakers were satisfied with the solar cooker, its acceptability was low. Homemakers lacked adequate knowledge about its best use. The findings revealed that solar cooker is yet to make an impact in households of the beneficiaries to effect a remarkable reduction in the consumption of non-renewable energy forms.

Combs and Madden (1983) conducted a statewide survey to determine (1) the perceived compatibility of solar system to values, felt needs and past experiences of households; (2) how perception of compatibility relate to the adoption of solar heating systems for the home; and (3) how various segments of the population differ in their evaluation of the compatibility of solar systems. The findings showed that people tend to find solar systems more compatible in meeting broad societal needs than their individual housing needs. A relationship between perception of compatibility of solar systems to the adoption of these systems was strongly indicated. Certain segments of the population, those who are younger, highly educated, work in managerial or professional positions, and live in a household of three or more members, found solar systems more compatible than others.

Devadas and Rajagopal (1983) reported in their study of fuel management practices of rural homemakers of Coimbatore district, that none of the families were aware of the availability of solar devices for cooking. Though fifty percent of homemakers showed enthusiasm in knowing about the solar cookers, all of them were doubtful about the performance of the device. Only five percent were ready to use the solar cooking device for cooking.

Sharma and Singh (1984) reported that the knowledge of farm women in villages of Hissar District, Haryana, regarding solar cooker was of medium level. Forty-two percent women had developed favourable attitude towards solar cooker, followed by unfavourable (23 percent), while eighteen percent had neutral attitude for solar cooker. One-fourth rural women expressed that it could be used without difficulty and the same percent said it was difficult to use. Sixteen percent women expressed their inability to use it.

Chauhan (1985) reported that majority of respondents in a Gujarat village were aware about the solar cookers as solar cookers were distributed in the village and demonstrations were given to the whole village.

Combs (1985) conducted a state wide survey of home builders to discover their perception of the acceptability of current solar and earth-sheltered housing designs. Analysis indicated that many perceived it difficult to obtain designs that consumers find attractive, that are acceptable within existing neighbourhoods, that consumers find psychologically easy to live in, and that consistently work. Home builders who find it less difficult to obtain acceptable designs were more favourable towards the construction of solar and earth-sheltered housing.

Though satisfying achievements have been reported by workers in the field of solar energy technology, yet it would take another 40 to 50 years to make any significant contribution.

New Efficient Stoves : Various research studies are being conducted to develop efficient stove designs and compare their efficiencies in order to optimise the use of different energy forms.

The annual consumption of firewood for cooking purposes in this country amounts to 150 million tonnes. In rural India, firewood forms 93 percent of total domestic consumption of energy. Improving the efficiency of chulahs would thus mean a drastic reduction in firewood consumption with great benefits. These are prevention of deforestation and land fertility, saving wood, lessening fuel gathering time, diversion of time and effort to more fruitful and productive activities, reduction of smoke and pollution problems and consequently lessening of health hazards (Jayaraman, 1984).

Sandberger (1985) pointed out that families in Gujarat villages had no perception of the increasing scarcity of wood fuel. The landless families did not buy wood but it was gathered from jungles.

The ordinary 'chulahs' used in rural areas are extremely inefficient, having a use efficiency of 5 to 7 percent which can be increased to 10 to 15 percent by improving the designs (Pandey, 1982).

Presently, as many as 112 million homes in our country use traditional chulahs with very low efficiency (2 to 10 percent) resulting in enormous wastage of wood. Realising that wood cook stoves are and would continue to be the basic mode of cooking in rural areas especially, efficient models of wood burning stoves have been developed to reduce wood consumption. Central Power Research Institute (CPRI) have brought out one or two wood stove designs yielding higher efficiencies and also operational procedures, with slight modifications to existing stoves whereby improved efficiencies could be obtained. One of them is the 'Priagni Wood Stove.' It gives a well-directed flame, almost smokeless in operation, records an efficiency of over 30 percent, consumption of firewood is less by 25 percent and portable (Sankarasubramanian, 1985).

Smokeless 'chulah' is another modification of the ordinary 'chulah' with high efficiency. A lot of work is being done on smokeless chulah for the past few years. Different designs have been developed, their efficiencies tested; and awareness and acceptability determined. At present there are 29 different models of the chulah, 17 of them are fixed models and 12 are portable.

The main purpose of the smokeless chulah programme are to reduce deforestation by saving fuelwood because of the expected higher efficiency of the new stove, to reduce the inconveniences of smoke and to create better environment. The perceived advantage of the chulah was that it saved time (Sandbergen, 1985).

During the year 1984-85, Haryana introduced the improved chulahs in 566 villages out of which 200 have been made completely smokeless and are known as 'smokeless villages'. The total number of improved chulahs constructed during the same period was 7,424 (Mahapatra, 1985).

Very few homemakers in the village of Gujarat knew about smokeless 'Chulah' as reported by Chauhan (1985), although the programmes of installing smokeless chulahs have been implemented in many villages of Gujarat.

Research studies have been conducted to compare the common open 'chulah' with available smokeless 'chulahs' by cooking selected items such as rice, dals and vegetables. A saving of about twenty percent of time and fourteen percent of fuel could be effected by the smokeless 'chulahs' over the open 'chulahs' (Devadas and Kamalanathan, 1983).

In another study, a smokeless 'chulah' designed for the rural households was introduced in 24 families. It was found that the use of smokeless 'chulah' resulted in a saving of twelve percent each of fuel and time which could be diverted to other activities (Devadas and Kamalanathan, 1983).

The Gandhi Niketan Ashram at T.Kallupatti, the Gandhigram Institute at Gandhigram and Home Science Wing of Rural Extension Training Centre propagated the 'Magan smokeless chulah' in rural areas as a part of community development programme. An element of subsidy was also given so that people on large extent will be able to take up the scheme. But it did not have much impact as it should; perhaps the villagers did not want to adopt the new technology or perhaps the propaganda and publicity was not enough or perhaps the womenfolk were not properly educated about the advantages of smokeless chulahs. (Perumal, 1983).

Propagation of smokeless 'chulahs' is spreading all over the country like a wild fire. During 1984-85, 7.82 lakh chulahs were constructed or installed against a target of 4 lakh only, thereby resulting in the savings of more than 6 lakh tonnes of fuelwood valued at Rs. 24 crores (Dayal, 1985).

Veni (1985) compared the thermal efficiency of different types of biogas burners. The results showed that there was no significant difference between the Mecker burner and biogas burner in terms of their thermal efficiency. Both the burners did not have a high thermal efficiency and as such both the burners are not helpful in effective utilisation of gas.

As a result of the effort to develop more efficient fuel consuming equipment, the Nutan Wick Stove which consumes 30 percent less kerosene than normal stoves was designed(PCRA).

If households switch over to these improved stoves and chulahs, there would be remarkable conservation of fuel wood and kerosene which are becoming scarce.

Direct solar technology will play only a marginal role in the foreseeable future due to unpredictable weather conditions. The possibility of achieving energy self-sufficiency would either be through recycling of animal, plant and human waste and by fuel wood plantation through the social forestry programmes. Furthermore, efforts will have to be continuously made to conserve our energy resources for sustainable development. The country can no longer rely on any single source for bulk of its energy needs. At least seven types of energy, biomass, solar, coal, petroleum, natural gas, hydro and nuclear will power the country, none of these supplying more than 20 percent of the nation's need. (Khoshoo, 1986).

Only a few studies on alternate technology appropriate for domestic purposes have been reviewed. Immense research and development programmes are going on to exploit new alternate technology for all sectors which will contribute towards decreasing consumption of non-renewable sources of energy. The Government is also making efforts to popularise biogas and solar cookers through the subsidised schemes. The increasing shortage of scarce renewable energy forms could be combatted to a certain extent through the adoption of renewable forms of energy, especially by the households. For this, educating the public, specifically the home-makers, regarding the energy crisis and the alternate technology becomes imperative.

From an overview of the literature reviewed, it is clear that energy resources of the earth are finite and must not be consumed leaving little or nothing for the posterity. We must take to a lifestyle that will not make the energy resources disappear. We must think of new ways to use these efficiently and through recycling. Home Economists can play a critical role in helping families to make informed decisions - to look at options and assess both long and short term costs of adopting a energy conservation behaviour.

To assist families to take appropriate energy-related decisions during energy crisis situations , it is essential to know the energy consuming/management behaviour of families. Hence, the need for the present investigation was considered imperative.