CHAPTER 6
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6.1. INTRODUCTION

For the success of socio-economic development of any country, the abundant supply of energy has to be ensured in all sections of the society as it leads to the growth in every sector of the economy. This is called a sustainable development. It is due to the fact that energy has an immense strategic importance to ensure all-round economic development of every country and it is a basic input for almost all the economic and non-economic activities. Energy extends the working hours in a day and also improves the living standards of the people. In fact, one of the indicators of economic growth of a country is the per capita consumption of energy. But, the care has to be taken that, the development that is envisaged is not only sustainable but also acceptable from the environmental point of view.

In the light of the above discussion, the major areas studied are growth of energy scenario in general and renewable energy in India. The study has also estimated the share of energy expenditure in total household expenditure among the sample household for domestic purpose and also analyzed the usage of different energy sources for domestic purpose and expenditure incurred on these energy sources by the sample households, identified the sources of information that are influenced while buying a solar system for domestic purpose and estimated the extent of costs and benefits associated with the usage of solar energy by the sample households for the domestic purpose.

To study the above mentioned areas both secondary and primary data are collected; secondary data is collected from available papers, state and central government energy reports, information is also collected on the facilities available for domestic sector solar energy users and providers. The primary data is collected by canvassing structured interview schedule for exclusively domestic sector solar energy users of two cities namely Dharwad and Bijapur. A total of two hundred households using solar energy for domestic purpose are randomly chosen.

The study is organized into six chapters. The first chapter presents the introduction and research methodology covering the importance of energy for the country. It also provides a glimpse of the research issues, objectives, hypothesis, sources of data, study area, sampling technique, tools for data analysis, importance and
limitations of the study. In the second chapter is reviewed some of the important available literature. In the third chapter trend of energy scenario in India is analyzed in terms of trend in growth rate in installed capacity, energy consumption, potentiality of renewable energy in some of the important states of India is analyzed by executing Compound Annual Growth Rate (CAGR) technique and simple percentage methods. The chapter four deals with the profile of the study area like geographical location of the areas, population structure, professional distribution, transport and communication, industry and agriculture, banking services, electricity, socio-economic background of the respondent households etc are covered. In the chapter five estimated share of energy expenditure in total household expenditure, use of different energy sources for domestic purpose and expenditure incurred on these energy sources with the help of simple average and percentage methods and in the chapter it is also analyzed cost and benefits associated in using solar energy by the households by using Benefic Cost Ratio (BC), Net Present Value (NPV), Internal Rate of Return (IRR) and Pay Back period methods. In the present chapter summary of findings, suggestions are provided and they are as follows;

6.2. ENERGY SCENARIO IN INDIA

6.2.1. Production of Primary Sources of Conventional Energy

There is no uniformity in the growth rate of production of five forms of the primary sources of conventional energy namely coal, lignite, crude petroleum, natural gas, electricity hydro and nuclear during the pre and post-reforms period in India. During the pre-reform period particularly from 1981 to 1886 has been the peak period in terms of the growth rate of production of all the five type of primary sources of conventional energy in India. During the post-reform period production in coal and electricity from hydro and nuclear energy has shown good progress, production of lignite also shown moderate progress. But production in crude petroleum and natural gas is very slow.

6.2.2. Availability of Primary Sources of Conventional Energy

Pre-reform period between 1971 and 1990 has witnessed a good growth rate of availability of the primary sources of conventional energy though with a good amount of fluctuations in the quantity of energy available from different sources, particularly availability of coal and electricity hydro and nuclear was good. During the post-reform period also these primary energy sources have shown very promising picture. It is also
found that growth in the availability of crude petroleum is also very good but production is very slow.

6.2.3. Consumption of Conventional Sources of Energy

There is a continuous increase in the consumption of crude petroleum natural gas and electricity during the fifteen years from 1971 to 1985. Consumption of all the five types of conventional sources of energy in India has fluctuated from period to period during the pre-reform and post-reform period. Comparing the production of five types of conventional sources of energy in India with rate of consumption, most of the time consumption level is higher than the production capacity in India.

6.2.4. Population, GDP and Per Capita Energy Consumption

The growth rate in total and per capita energy consumption was high during pre-reform period in India compared to post-reform period. It is found that during the post-liberalization period, growth in Indian GDP and energy consumption is increasing continuously whereas population growth rate is decreasing. Thus, it can be concluded that energy consumption is having high degree of co-relation with growth of the economy than the population growth. It is because energy has been universally recognized as one of the most important inputs for economic growth and human development. Despite the overall increase in energy demand, per capita energy consumption in India is still very low compared to other developing countries. The per capita consumption in India is 400 KWh per annum.

6.2.5. Installed capacity of Electricity

Thermal, hydro and nuclear are three important sources electricity generation in India. The percentage of growth trend in the installed capacity of electricity has not shown much progress during last forty years in India, but in absolute number electricity generation capacity is increased. However during pre-liberalization period the growth in the generation capacity of electricity is little higher compared to liberalization period. It is also found that self generating industries are making good progress in the installed capacity of electricity in India.

6.2.6. Generation of Electricity

Compared to the pre-reform period the rate of generating electricity by different type of utilities in the post-reform period has been low. Sector wise growth in the
generation of electricity by thermal power sources is highest compared to hydro and nuclear resources. In absolute numbers, current production of power from thermal is 1,08,362.98 MW which is 64.6 percent of total installed capacity, 37,367.40 MW is from hydro that is 24.7 percent of the total power production and nuclear power reactors produce 4,560 MW which is 2.9 percent of total installed base in India.

6.2.7. Consumption of Electricity by Sectors

During last four years (2006-09) domestic consumption of electricity (from utilities) had registered the highest growth rate by commercial sector followed by industry, domestic, agricultural, railways sectors and during the same period the total consumption capacity by all sectors together in India is almost double than the total generation of electricity. Thus, care has to be taken to bridge this big gap.

6.2.8. Share of each State in the Installed Capacity of Electricity

The share of each state in installed capacity of electricity (utilities) in India in 2009 provides some significant trends. Maharashtra’s share in the installed capacity of electricity (utilities) was higher at 9.89 percent compared to Tamil Nadu (7.33 percent) Gujarat (6.27 percent) Andhra Pradesh (6.07 percent), Karnataka (5.32 percent) and so on.

6.2.9. Source wise Installed capacity of Electricity

Source wise, the installed capacity of hydroelectricity accounted for was highest in Andhra Pradesh followed by Karnataka, Maharashtra, Punjab, Tamil Nadu and Madhya Pradesh. The share of thermal power accounted for was highest in Maharashtra, Gujarat, West Bengal, Andhra Pradesh, Tamil Nadu and Uttar Pradesh. And the share of new and renewable energy accounted for was highest by Andhra Pradesh, Karnataka, Maharashtra, Punjab and Tamil Nadu.

6.2.10. Renewable Energy Potentiality

Source wise, the renewable energy potentiality in India during 2009 indicates that Karnataka accounted for maximum of wind power potentiality followed by Gujarat and Andhra Pradesh. Small hydro power potentials in India are limited; within this, the maximum small hydro power potentials are in Maharashtra. The potentials of cogenerations of power from bagasse are higher in Maharashtra and Uttar Pradesh. The generation of energy from waste provides another potential source of renewable energy.
in India; here also Maharashtra state is having high potentiality.

6.2.11. Grid Interactive Renewable Energy

Among the grid interactive renewable energy in India, two-third of potentiality is wind energy followed by small hydro power, biomass power, waste to energy and solar power. Tamil Nadu accounted for maximum of grid interactive renewable energy in India followed by Maharashtra, Karnataka and Gujarat states.


The important sources of off-grid/decentralized renewable energy systems in India are biomass plants, water pumping wind mills, street lighting systems, home lighting systems, solar lanterns, power plants, solar photovoltaic pumps, aerogen, hybrid systems, solar cooker, biomass gasifiers, and waste to energy. Maharashtra State led the other states in bio-mass plants followed by Andhra Pradesh. Gujarat led other states in water pumping wind mills. Punjab led other states in solar photovoltaic pumps; other states with good number of solar photovoltaic pumps were Kerala, Tamil Nadu. Maharashtra has taken the lead in aerogun hybrid system of renewable energy devices in 2009. Solar cookers are more used in Gujarat and Madhya Pradesh. Again Tamil Nadu had maximum user of biomass gasifiers; then Uttar Pradesh and Andhra Pradesh.

6.2.13. Green House Gas Emission

Energy Sector accounted for maximum release of CO$_2$ emissions then minerals, industries, metals, chemicals are in the sequence. Emission of CH$_4$ and N$_2$O was highest from agricultural sector. Within the energy sector, electricity generation causes highest CO$_2$ gas emission followed by transport, road transport, and by the residential areas.

6.3. DOMESTIC EXPENDITURE OF THE HOUSEHOLDS

The respondent households in both Dharwad and Bijapur have indicated that percentage of expenditure on food accounted for maximum amount per year. Energy expenditure is second highest and education takes the third largest household expenditure in both the cities covered by the study. In rupees also respondents are spending almost equal amount on food and energy in both the cities. Nearly fifty percentage of income is being spent on household expenditure by the respondents in both cities. The items considered in the domestic expenditure are food, clothing, foot wear, energy, education,
6.4. USAGE OF DIFFERENT ENERGY SOURCES

Electricity is widely used as a source of energy for the various domestic purposes like lighting, washing, fan, air-conditioners, ironing, charging different types of electronic equipments, TV, computers etc. For heating water, solar energy is used to the maximum extent; a very less proportionate solar energy is used for lighting purpose. This reveals that solar energy is mainly used for water heating purpose. The proportionate use of solar energy in Bijapur for water heating purpose is marginally higher than Dharwad city, but this is reverse in the case of using solar lighting system.

6.5. ENERGY EXPENDITURE BY THE HOUSEHOLDS

The respondent households have been spending major part of their energy expenditure on petrol and diesel and followed by expenditure on electricity and then expenditure on gas. Expenditure on other sources of energy is much less compared to these three major sources of energy.

6.6. SOLAR SYSTEM INSTALLATION, COST AND BENEFITS

6.6.1. Type and Duration of Solar System Installation

The average period of using solar system by the household in the two cities is just more than four years. The duration of the solar system being installed by the respondent households indicates that the use of this type of energy is of recent origin. Good potentials exist for the widespread use of this type of energy in the study area. Solar energy for water heating purpose is used by all the sample respondents. However the use of solar energy for lighting purpose is very less in both cities. Other forms of solar energy systems are not used by the respondents.

6.6.2. Sources of Information while Buying Solar System

Friends and relatives have been the source of information for majority of respondent households while buying the solar system. Another major source of information in this context was the sales persons of the suppliers of the solar system. The private company advertisements have also played a role in providing information to the households about the solar systems. The government awareness campaigns too have
provided information about the solar system. The responses indicate that more than one source of information in this context have been used by the households while buying the solar systems.

6.6.3. Reason for Buying Solar System

The cost of other sources of energy particularly the cost of electricity and gas have created an awareness among the energy consumers to go in for solar energy which does not involve any recurring expenditure once the initial investment in the equipment is done. Hence, this awareness has led to the choice of solar system by the respondent households in Dharwad and Bijapur cities. The other reasons to buy solar energy are fluctuations in supply of electric power, availing subsidy facility, government awareness programme, saving electricity for the country, environmental friendly, and suggestion from friends and relatives etc.

6.6.4. Investment on Solar System

The average investment on solar water system by the respondent households in Bijapur is higher compared to that of in Dharwad. However the average investment in solar lighting system is higher in Dharwad than in Bijapur. The respondent solar system users in Dharwad have used both own and borrowed sources of finance for investment in water heating but this borrowing from the financial institution is very less. However, respondent users of solar energy in Bijapur have used only own sources for the investment in solar system for both water heating and lighting.

6.6.5. Cost and Benefits of Using Solar System

Mainly two varieties of solar system are used by the respondent households that are solar water heater and solar lighting systems in both the study areas. It is found that life spans of the solar water heater are ten, fifteen, twenty, twenty five years in Dharwad, but in Bijapur twenty five years life span solar water systems are not found. Whereas solar lighting systems having ten and fifteen year’s life span are found in Dharwad but in Bijapur, only ten years life span solar lighting systems are found. Through net present value, benefit cost ratio, internal rate of return and pay back period it is found that solar energy systems having more life span is more economically benefitted than the solar systems having lesser life span. It is also found that users of solar water heater in Bijapur are more economically benefitted than respondent households of Dharwad. However, users of solar lighting systems in Dharwad are more benefitted than the users of Bijapur.
respondents. Most of the users of solar energy systems had felt that by using solar energy it saves the time and a few of the respondents also felt that it is good for health and environment as well.

6.7. SOURCES INFLUENCED WHILE BUYING SOLAR SYSTEM

The friends and relatives have been the source of information for majority of respondent households while buying the solar system. Another major source of information in this context were the sales persons of the suppliers of the solar system, private company advertisements have also played a role in providing information to the households about the solar systems. Government awareness campaigns too have provided information about the solar system. The responses indicate that more than one source of information in this context have been used by the households while buying the solar systems.

6.8. SUGGESTIONS

➢ To bridge the gap between the production and consumption level of conventional sources of energies like coal, lignite, natural gas, crude petroleum, hydro and nuclear electricity in India; it is advised to increase in the production capacity and use all available capacity of these energy resources.

➢ Despite the overall increase in energy demand, per capita energy consumption in India is still very low compared to other developed countries. Therefore Government of India has to make necessary efforts to increase in the per capita availability of energy in India, by increasing the production capacity and by using more renewable energy resources. Thus, it is the time ensure minimum per capita availability of energy by the government.

➢ Electricity is one of the main inputs for any economic and domestic activities of any country. Thus, the sufficient electricity to all sections of the society in India has to be made available. This can be made possible, not only by using conventional sources of energy but also by increasing the use of wind, solar photovoltaic energy and other renewable energy sources.

➢ Government of India, while allotting electricity and funds for the energy projects to the different states, it is suitable to consider the socio-economic progress, availability of per capita energy, size of the population, all ready availed benefits,
growth in the different sectors like industries, agriculture etc of the states has to be considered.

- All states in India have to make more efforts to encourage the use of renewable energy in their respective state. For example recently the Government of Karnataka has adopted a new policy that is every new house constructed should have solar energy system to avail electricity connection.

- To enhance the use of renewable energy in India, Government of India can set the target to each state in the proportion use of renewable and non-renewable energy, depending upon the availability of these resources in the state.

- More serious action has to be taken on the companies emitting green house gas after prescribed level. Like, canceling the license, more fines and penalties etc should be levied on the companies emitting more green house gas.

- The solar energy systems having more life span are more economically benefited. Therefore it is advised to produce solar systems having more life span by the producers of the solar energy systems. It is also suggested that lower life solar energy systems should be able to give more economic benefits to the users, so that solar systems having less cost can be purchased by lower sections of the society.

- It is found during the study that solar energy systems mainly used by the households residing in the own house. Because of the difficulty in mobility of the solar energy systems like solar water heater, solar lighting systems etc. are not used by the household living in the rented house. Thus, producers of solar energy systems should make it more mobile, so that people residing in rental house can also avail the benefits from solar energy and it is also beneficial to the companies producing solar energy systems by having more target customers.

- The study shows that solar energy is more beneficial to the areas having more number of sunny days. Therefore the technology in the solar energy systems should be developed in such way that they are equally useful to the areas having lesser number sunny days.

- For strategies of a massive CO₂ reduction there is a need for combined use of solar thermal and photovoltaic system. A significant reduction in the cost of PV system is necessary. For large scale use in the power sector production processes must be developed for efficient thin layer modules requiring less energy than the presently
prevailing crystalline silicon technology. PV components should be integrated into existing structures of buildings thus reducing or avoiding the need for investment in components such as supporting structures or foundations.

- Providing subsidies for building up large scale production lines for PV components is an option to enhance the dissemination of solar energy systems. For a shorter time scale, major worldwide demonstration programmes for remote applications and for feeding solar electricity into the public grid by means of decentralized and large scale central systems seem more appropriate to improve the understanding of PV systems thus stimulating the demand for building large scale PV factories.

- Solar electricity is more viable for small villages with low load requirement. A conscious effort must be made to develop and apply appropriate technology at the rural level.

- In the context of building up awareness among the urban areas about the benefits of solar energy the role of Government awareness campaign about the solar energy is very important. Hence the government agencies need to streamline their awareness campaigns in this direction.

- Financial institutions like banks should come forth with more liberal credit policies towards providing finance for the prospective users in their effort to install solar systems for domestic use.

- The high capital cost of a solar energy system needs to be addressed. The solution to this context lies in maximum utilization of all solar energy collected for optimum economics.

- It is found that solar energy systems used by the households are fixed panels, but in order to increase efficiency and use of solar energy, it is advised use tracking solar panels. Tracking solar panel follows the path of the sun during the day to maximize the solar radiation that the solar panels receive. A single axis tracker tracks the sun east to west and a two-axis tracker tracks the daily east to west movement of the sun.

- In order to optimize solar energy people can use adjustable solar panels. An adjustable solar panel can be changed two or more times during the year to account for the lower angle of the sun in winter as the earth orbits the sun causing seasonal
change. A good rule of thumb is latitude +15 degrees in the winter and latitude -15 degrees in the summer.

- In order to make solar production easier and more affordable for the commercial purpose, the public and private sectors can have collaborative projects. They can make joint efforts in marketing the solar energy, educating the potential buyers etc.

- The study shows that solar energy technology is relatively new. Most of the people do not understand exactly how it works or the principles behind it and the benefits from the solar energy. The best way to rectify this is to educate people and make sure they have all the facts and information they need to make what was new and uncomfortable seem familiar and exciting. With the increasing popularity of the internet and the expanding availability of computer technology, a lot of information on solar and renewable energy is available online, but people have to know its there and desire to find it first.

- In order to popularize and attract more investors on solar energy systems for homes and business, the government sponsored rebates and incentives will be more useful. This type of incentive programs help to offset the high initial cost of solar equipment and bring the costs of solar energy down to comparable levels with some other energy sources.

- Some time sun is too hot, this may damage solar panel, so it is advised have flow control system to solar water heating system. Flow control systems reduce the amount of water which is heated at once: two sensors attached to the solar panel measure the heat of the water in the panel. Once the water in the panel is hot enough, it is moved out of the solar panel, and the pump either shuts off, or heats up a fresh batch of water.

- During the survey it is observed that solar energy systems over a period of time build-up with dirt and debris on the panel, this may reduce sun light absorption efficiency. Thus, it is suggested that users of solar energy should clean and wipe down the solar panels regularly.

- It is also observed during the survey that shading and shadows on solar panels. Thus, when deciding on a location for solar panels, make sure no shadows will fall on the solar panel array during peak sunlight hours. Not only will shading of the solar panels significantly reduce their output, but also could cause damage.

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