Chapter – III

RURAL ENERGY IN INDIA

3.0 INTRODUCTION

Energy is a critical input for economic growth and sustaining development processes. Over one-third of the world's population, largely consisting of the poor in rural areas of developing countries does not have access to electricity. It is estimated that a new power plant would need to be added every two days to meet the increasing global energy demand. This, however, is clearly an unsustainable proposition, and only emphasizes the urgent necessity for developing energy technologies that are environmentally sound, socially acceptable, and economically viable.

Lack of access to affordable energy is an important factor contributing to the relatively poor quality of life in rural areas of developing countries. The potential markets of the rural poor are characterized by a high demand for energy for purposes such as lighting, cooking, space heating in the domestic sector; water lifting and transportation in agriculture; and small and medium enterprises.

3.1 EVOLUTION OF RURAL ENERGY INDIA

3.1.1 Introduction

Biomass energy is the local energy available for meeting the minimum rural needs of cooking. Though the contribution of biomass sources in the overall energy scenario is gradually decreasing, it still contributes over 40% of the energy supply in the country. Sixty-five per cent of the biomass energy in the rural areas is apportioned to fuelwood, 20% to agricultural waste and 15% to cow dung. With the increasing use of commercial sources of energy there has recently been a substantial shift towards commercial sources. As such, the future projections for energy in India do not show a proportionate increase in the fuelwood consumption with the rising population. It is difficult at this stage to predict the shift in the fuel-mix but it is clear that shift is taking place. Also, in view of global energy policy considerations, the final form of energy is more important than the primary form. Therefore, there has been a major thrust on how fuelwood and other sources of energy can be converted into desirable form, thereby making the primary sources of energy of secondary importance. This change is gradual but quite perceptible.

The Government of India has focused attention on governance at the rural level through Panchayats, the body of elected members of the public. The Panchayats have also been assigned certain development tasks as laid down in the Eleventh Schedule of the Constitution of India. Social forestry and farm forestry, along with land improvement, implementation of land reforms, land consolidation and soil conservation, fuel and fodder, and non-conventional energy sources are the responsibility of the Panchayats.

It is necessary to have a look at the energy policy and rural energy planning efforts made in India, as well as the ongoing programmes, to consider how the biomass production can be better managed and regularised through local governance systems.

3.1.2 INDIAN RENEWABLE ENERGY SITUATION

In this section, Indian Renewable situation is examined with respect to its scope, potential, achievements and economics of renewable energy resources. Further this section deals with the Rural energy policy issues with the help of numerical and theoretical experiences

3.1.2.a Renewable Energy Scope

Today most of the world's energy is derived from conventional sources-fossil fuels as coal, oil, and natural gases. Electricity generated from fossil fuels such as coal and crude oil has led to high concentration of harmful gases as carbon-di-oxide, carbon-mono-oxide, sulphur-di-oxide etc in the atmosphere. Also the sources of fossil fuel in the earth are finite and will be depleted in few years. Most recent method to generate electric power is an atomic reactor. All these conventional sources of energy has caused more environmental damage then any other human activity.

Therefore, alternative sources of energy have become more important for the future world. The alternative sources of energy are called Renewable Energy System. A Renewable Energy System converts the energy found in Sunlight, Wind, Falling-water, Sea-waves, Geothermal heat, or Biomass into a form we can use such as heat or electricity. Most of the Renewable energy comes either directly or indirectly from Sun and Wind and can never be exhausted , therefore they called Renewable.

India receives 5000 trillion Kwh of Solar radiation per year. Most part of the country has 300 clear sunny days in a year. So in India alone it is possible to generate 20 MW Solar power per square kilometer area.

Renewable energy sources are environment friendly and reduces chemical , radioactive and thermal pollution. Renewable sources of energy such as Solar energy are economically feasible in small scale applications in remote areas or villages (where there is no electricity) or in large scale applications in areas where the resources are abundant.

The Renewable energy or the non-conventional energy sources are Sun, Wind, Falling-water, Sea-waves, Geothermal energy, method of co-generation etc. It is expected that 60% of all the energy will come from Renewable energy up to year 2070. The world Solar summit, world Solar Decade and the World Bank has recently allocated huge money to the projects dealing with Renewable Energy. World organizations as UNDP, UNISO, UNIDB etc US Department of energy (DOE) and National Renewable Energy Laboratory (NREL) .The European countries are doing lot of research work in Renewable Energy.

The Ministry of Non-Conventional Energy sources (MNES) created in 1992, a Nodal agency of the Government of India, relating to Renewable Energy. The several Renewable Energy sources are Solar Energy, Solar Photovoltaic System, Bio-gas Energy, Biomass

Energy, Wind Energy, Small Hydro Power, Geo Thermal Energy, Ocean Tidal Energy, Co-generation Energy etc

Today India has the World's largest programmes for Renewable Energy. Several Renewable Energy technologies have been developed and deployed in villages and cities of India. A Ministry of Non-Conventional Energy Sources (MNES) created in 1992 for all matters relating to Non-Conventional / Renewable Energy. It undertakes policy making, promotion, coordination of functions, R&D and technology development, intellectual property protection, human resources development and other matters relating to Renewable Energy. Government of India also created Renewable Energy Development Agency Limited (IREDA) to assist and provide financial assistance in the form of subsidy and low interest loan for Renewable Energy projects. India's achievement in the fields of Renewable Energy is very significant as shown in Table: 3.1.

There are 153 Energy Parks in India to educate people about Renewable Energy. India also provided technical guidance and help to many developing countries for construction of Non-Conventional energy equipments. Several Renewable Energy equipments and products as Solar Photovoltaic Systems, Wind Turbine Equipments, Thermal Applications, and Solar Cookers etc. have been exported. India ranks third largest producer in the world of Solar cells and Photovoltaic (PV) modules. In India alone thirteen projects of 940 kw total capacity have so far been installed in different states. A number of R&D projects on Renewable Energy technologies have been implemented at several Research, Scientific and Educational Institutions, National Laboratories, Government and Industrial organizations in India.

Ministry of Renewable Energy of India has taken major initiatives to encourage Private /Foreign Investments to tap energy from Renewable Energy sources. These initiatives include provision of Fiscal and Financial incentives, exemption from Excise duty, Sales tax and concessional customs duty in the imports of items used in Renewable Energy projects.

Table 3.1

The installed capacity (As on 31st March 1999), can be summarized as below (in Units)

Biogas Plants	28.50 lakhs.
Improved Chulhas	300 lakhs.
Solar Heating System	4,50,000 sq.m.
Solar Photovoltaic System	329 mw.
Biomass Power	200 mw.
Wind Power	1025 mw.
Small Hydro Power	183.45 mw.
Solar Photovoltaic Power	1590 kw.
Solar Cookers	4,75,000.
Solar PV Pumps	2868.
Battery Operated Vehicles	217.

*Source: Ministry of Non-conventional Energy Reports - **2000-01***

3.1.2b. Renewable Energy Potential

With a strong industrial base and successful commercialization of technologies in wind, SPV, solar, thermal, small hydel, biogas and improved biomass stoves, India is in a position today to offer "state-of-the-art" technology to other developing countries and play a leading role in the global movement towards sustainable energy development.

India has a large potential for utilization of renewable energy. The scale over which potential can be economically exploited will depend largely on the technologies, financing and the strategies of implementation of renewable energy projects. According to the Ministry of Non-Conventional Energy sources, there exists a potential exploitation of the order of 80,000 MW. Break of this potential is presented in the table 3.2.

The Middle East Conflict of 1973 resulted in sharp increase in the prices of the vital inputs of agriculture, that is energy and fertilizer, thereby adversely affecting the economy of developing and developed nations. The only apparent benefit form this unfortunate conflict has been the creation of awareness, in both developing and developed countries of the value of organic wastes as inexpensive sources of energy and plant nutrients. Sometimes a dark could has a silver lining. So the present man-made energy crisis created by the action of a few countries is a blessing in disguise. It should be considered as an amber light - a warning prior to the real danger (Vandana S;2002)

Table 3.2

Renewable Energy Potential (As on 31st March 1999)

Sl. No	Sources / Technologies	Units	Approx. Potential	Achieved so far
1	Wind Power	MW	45,000	1,267
2	Small Hydro (upto 50 MW)	MW	15,000	1,341
3	Biomass Power	MW	19,500	35
4	Biomass Gasifiers	MW	--	~
5	Biomass Cogeneration	MW	--	273
6	Urban and Industrial Waste	MW	1,700	15.20
7	Solar Photovoltaics	MW	Not Known	65
8	Solar Thermal Applications	MW/Sq.	35	0.55
9	Solar Water Heating Systems	Sqm.	Not Known	5,25,000
10	Solar Cookers	Numbers	Not Known	4,96,000
11	Biogas Plants	Million	12	3.1
12	Improved Biomass Chulha	Million	120	33
13	Wind Pumps	Numbers	Not Known	670
14	Solar PV	Numbers	Not Known	3575

*Source: **MNEs;** December 2000-01*

3.1.2c Economics of Renewable Energy

There are several barriers to the adoption of renewable energy technologies, but opportunities exist to overcome them. The financial limiting greater deployment of renewable technologies. The essential barrier lies in the perceived risk associated with investing in renewable energy technologies, which is generally higher then competing conventional technologies, and the effects of this higher perceived risk on a technology's market:

- Capital markets generally perceive the deployment of emerging technologies as involving more risk than established technologies. The higher the perceived risk, the required rate of return demanded on capital.
- The perceived length and difficulty of the permitting process is an additional determinant of risk.
- The high front-end, or financing requirements of many renewable energy technologies often present additional cost-recovery risks for which capital markets demand a premium.

The following are opportunities to address these financial constraints:

- Low interest loans or loan guarantees might serve to reduce perceived investor risk.
- Tax credits for renewable energy technology production through the early, high risk years a project may provide another mechanism.
- Regulatory cost-recovery mechanisms, which today often favor low-initial-cost, fuel based technologies, can be modified to recognize life-cycle cost as a more appropriate determinant of cost effectiveness.
- Effective redistribution of government spending in research and development that more directly reflects the potential of renewable energy technologies.

Effective valuation of external environmental costs associated with conventional fossil-fuel power generation. In a straight economic accounting based on dollars per kilowatt of power generation, fossil fuel-fired facilities appear to be the option of least cost today. This method of accounting tends to neglect the environmental and social costs involved in producing electrical power by burning fossil fuels or using nuclear power. This form of economic analysis is in a relatively early form of development, yet has made great strides in recent years.

3.1.3 Need for Rural Energy Policy **in India**

India is the second most populous nation in the world and has extreme ecological diversity. 70% of the population in India, close to 700 million, still lives in the rural areas. Meeting their energy requirements in a sustainable manner continues to be a major challenge for the country. All most 75% of the total rural energy consumption is in domestic sector. For meeting their cooking energy requirements, villagers depend predominantly on biomass fuels like wood, animal dung and agricultural residues, often burnt inefficient traditional cook stoves. The main fuel for lighting in the rural households is kerosene and electricity. Irrigation is mainly through electrical and diesel pump sets, while the rural industries and the transport sectors rely primarily on animal power and to some extent on commercial sources of energy like diesel and electricity.

*India adopted short-, **medium-** and long-term energy planning processes in the country.* In the short term, the effort is to maximize returns from the assets already created in the energy sector, improving efficiency in production, transmission and end use; reducing energy intensity of different consuming sectors and initiating steps for meeting fully the basic energy needs of urban and rural households.

In the medium term, progressive substitution of petroleum products by coal, natural gas and electricity, accelerated development of renewable and promotion of R&D efforts on decentralized energy technologies based on renewable resources have been suggested.

In the long term, promotion of energy supply systems based largely on renewables and promotion of technologies of production, transportation and end use of energy, that are environmentally benign and cost effective, have been suggested though fuelwood, agroresidue and cow dung are the main sources of fuel, only **the** use and availability of fuelwood can be planned and quantified. Primary data are available on fuelwood from field surveys, conducted by the National Sample Survey Organization (NSSOX National Council of Applied Economic Research (NCAER) and other research institutions and individuals.

Given the exploitation process of natural resources, this situation is likely to worsen in the years to come. Rural energy systems are further strained by the inability of people to shift to commercial fuels like electricity, LPG and kerosene because of low purchasing powers and limited availability. The subsides on electricity for agriculture and kerosene have also been a cause of concern for energy planners.

To reduce these problems, several efforts have been made both by governmental and non-governmental organizations in the form of national programmes for rural electrification and promoting renewable energy technologies like biogas, improved cookstoves, and solar cookers. However, in spite of the existence of these programmes for nearly tow decades, their impact on the rural energy scenario has been limited. Over the last few years, in line with economic liberalization, there have been efforts towards bringing about commercialization, implemented in the past two decades, in order to formulate a meaningful rural energy planning at national level.

3.2 RURAL ENERGY CONSUMPTION PATTERNS

Rural Energy consumption can be broadly classified into energy for domestic use, for agricultural use, use in Industry sector (small and medium enterprises) and Transport Sector.

3.2.1 Domestic Sector

The household sector accounts for nearly 75% of the energy used. Cooking accounts for almost 90% of the household energy use with the rest taken up by lighting and heating.

Biomass fuels provide 85-90% of the domestic energy and 75% of all rural energy. Among the commercial fuels, only kerosene is prominent being used mostly for lighting.

Given the geographical and ecological diversity in the country, the consumption pattern varies quite considerably as well; for example, the per capita consumption of fuelwood, for instance, ranges from 0.14 kg per day in Haryana to 1.31 kg per day in forest-rich Himachal Pradesh. The fuel-mix also varies from region to region depending on the resource endowments. Fuelwood consumption is high in states (for instance, all the North-Eastern states) where there is considerable foreste over, whereas dung cakes play an important role in states like Punjab and Haryana, which have little biomass cover. Crop residue is used in most areas as a backup fuel when other fuels are in shortage, such as West Bengal and Punjab.

Biomass fuels provide 85%-90% of the domestic energy (table 3.3) (Natarajan 1997). Cooking is the largest energy consuming end use. It accounts for nearly 90% of household energy; lighting and space heating consume the rest. Biomass (wood, animal dung, crop residue) in outdated, inefficient cook-stoves (10 per cent efficiency) is generally used for cooking, while inefficient devices fuelled by kerosene are used for rural lighting.

The Planning Commission estimates the fuelwood requirement at 180 million tonnes in 2001, a substantial increase from the actual consumption of 162 million tonnes in 1996 (Ninth Five-Year Plan: 1997-2002). Kerosene is used mainly for lighting. Considering that only a third of households even in electrified villages have electricity connections, it is estimated that there are 70-80 million households in the country that are not served by grid electricity.

Table 3.3

Energy Consumption in Rural Households: 1995-96

Energy fuel	**Quantity (thousand tonnes)**	**Share (%) (useful kcal)**	**Quantity (thousand tonnes)**	**Share (%) (useful kcal)**
Coal/soft coke	1,143	1.92	429	0.38
Kerosene	414	2.55*	1,103	4.44*
Dung cake	66,755	22.51	86,732	17.00
Firewood	—	—	—	—
Logs	20,109	11.95	57,956	32.49
Twigs	58,742	35.62	73,418	29.11
Crop waste	29,529	17.41	34,955	13.35
Others	—	1.03	—	—
Total	—	100.00	—	100.00

* *in thousand kilolitres*

Source:* *Natrajan I. *1997. Biomass energy: key issues* ***and priority needs. Paris: Organization for Economic Cooperation and Development.***

These homes are totally dependent on kerosene for lighting. An unreliable power supply, even to electrified homes, compels villagers to use kerosene lamps. According to the 50th round of the National Sample Survey (NSSO 1996), about 62% of rural households uses kerosene primarily for lighting (table 3.4). Only two per cent of rural households in India uses kerosene as the primary cooking fuel. The total kerosene consumption in India during 2000/01 was estimated at around 11.5 million tonnes out of which about 60% was for the rural areas. In spite of significant increases in the supply of commercial energy, the consumption of commercial fuels such as LPG is still negligible in the rural areas with only 1.3% of households using it for cooking (TERI 1998a).

TERI has found that grid-based rural electrification programmes in India are largely unaffordable and unreliable with an estimated cost of 12 500-30 000 dollars per village; this translates into 65-165 dollars per household per year, depending on the distance from the existing grid. With over 80 000 Indian villages still awaiting electrification, renewable energy technologies, such as solar lanterns, solar home lighting systems, solar water heaters, etc. can provide options that are more environmentally friendly, economically viable, and socially acceptable.

3.2.2 The Agriculture Sector

The agriculture sector is the second largest energy-consuming sector in rural India. In the agricultural sector, animate energy (human and draught power) accounts for more than one-third of the total energy consumed. Inanimate energy inputs are mainly in irrigation through diesel and electrical pump sets. There are an estimated 10 million electric and 6 million diesel pump sets in the country. Diesel for tractors used in tilling, harvesting, etc. is the other important energy source.

Table 3.4

Primary source of energy for lighting in Rural Households (%): 1988/89, 1993/94 and 2000/2001

	Kerosene			Electricity		
State /Year	**1988/89**	**1993/94**	**2000/2001**	**1988/89**	**1993/94**	**2000/2001**
Andhra Pradesh	59.07	50.5	41.6	38.20	**49.2**	52.6 '
Assam	84.70	84.6	78.3	9.10	**14.9**	21.3
Bihar	92.20	92.8	88.4	4.40	6.4	9.3
Gujarat	42.20	31.8	26.4	49.40	**67.5**	74.3
Haryana	41.60	23.5	19.1	57.20	74.6	82.4
Karnataka	60.10	44.9 -	31.6	35.80	54.5	66.3
Kerala	55.90	43.4	32.2	42.20	56.5	60.2
Madhya Pradesh	62.30	54.1	40.3	29.80	**44.9**	65.0
Maharashtra	50.70	41.1	33.4	45.90	**58.6**	60.3
Orissa	85.80	84.9	79.4	10.90	**14.6**	17.2
Punjab	23.80	11.0	10.2	71.40	87.3	90.3
Rajasthan	74.60	58.0	40.0	22.20	41.0	55.4
Tamil Nadu	53.20	45.7	38.3	43.20	54.0	58.3
Uttar Pradesh	89.10	81.0	74.2	9.30	17.7	22.1
West Bengal	91.10	88.2	85.3	5.80	11.2	19.8
All-India	**69.20**	**62.4**	**60.0**	**27.04**	**37.1**	**48.3**

Sources: National Sample Survey Organization.2001. Sarvekshana XX(4): S213 and S2S7. New Delhi: Department of Statistics, Ministry of Planning and Programme Implementation, Government of India.

Three activities in the sector account for most of the energy used: land preparation, harvesting and irrigation (water lifting and transportation). Irrigation is the most important end-use of energy. Animate energy (human and draught power) caters to over one-third of the total energy consumed (table 3.5). An estimated 15 million electric and 6 million diesel pumps are currently in operation in the agriculture sector of the country. Diesel oil and electricity are the major sources of energy for irrigation with the estimated demand for each being 8 MMT and 127 TWh, respectively in 2001/2002. The share of oil and electricity in the final energy consumption of the agricultural sector has increased steadily over the years (Figure 3.5). The sector accounts for 30% of the overall demand for electric power, mostly for water lifting, which is provided by the erratic grid power supply interspersed by human and animal power. An erratic and insufficient power supply reduces the efficiency of the electric pumps also affecting agricultural yield.

The country's population is slated to reach 1.4 billion by 2030, but with the restricted land area available for cultivation, agricultural production needs to grow, too. This can be achieved only by using innovative methods such as biotechnology, bio-fertilizers, bio-intensive pest control methods, and micro-irrigation. Villages would benefit greatly from a dependence on non-conventional modes of energy generation (renewable and energy efficient technologies).

3.2.3 The Industry and Commercial Sector

While small industries and commercial establishments (hotels, restaurants, shops, etc.) in rural areas (and in urban areas)consume significant quantities of biomass energy, reliable statistics are not available on the extent of consumption. Available evidence suggests a high level of fuelwood consumption and a growing demand. Most of these establishments are in the informal sector, would depend on diffused sources for fuelwood, and would have no proper records. Nonetheless, one estimate puts the figure of total fuelwood consumed in this sector at 6 million tonnes per annum

Table 3.5.

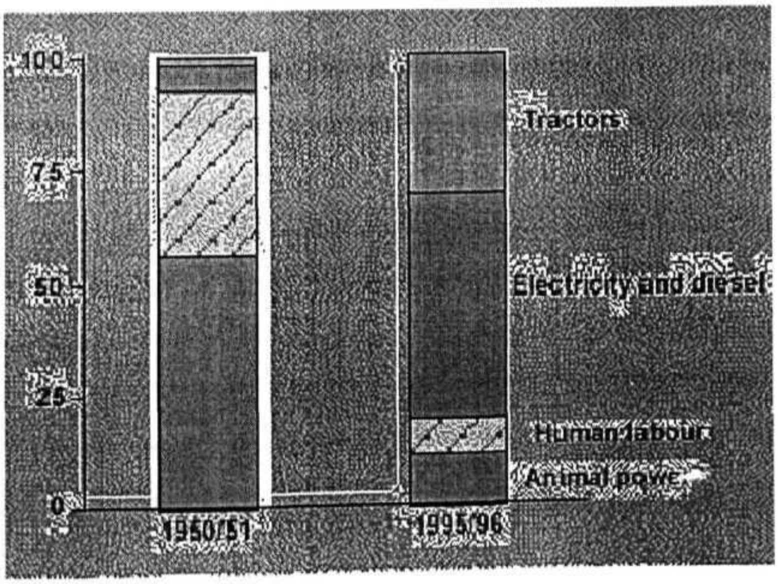
Contribution of various energy sources to farm power: 1991/92

Sources of **farm** power	Number (million)	Total (GW)	**Total** (%)
Human	-		
Male	149.20	8.95	7.32
Female	50.80	2.54	2.08
Draught animals	84.00	31.50	25.76
Tractors	1.30	29.10	23.80
Power tillers	0.09	0.54	0.44
Diesel engines	4.60	17.16	14.04
Electric motors	8.30	30.96	25.32
Combines	0.04	1.51	1.24

Source: ***TERI.*** *1995.*

Fig: 3.5

Changes in relative share of different source of energy in **agriculture** over **time**



.The small-scale industry in India is characterized by gross inefficiency, which leads, in turn, to the consumption of large amounts of energy and adverse effects on the environment caused by high levels of pollutants generated at the source. The overall consumption of energy is low when compared to the rest of the energy requirement in the rural sector. The small enterprises sector is an important engine of the economy, stimulating the development of technical skills and providing employment to the local population. Rural industries such as small-scale foundries and brick kilns are energy-intensive and use fuel wood to fulfill their energy requirements. Cottage enterprises resort to grid electricity where it is available, though its use is restricted due to poor connectivity.

3.2.4 Transport Sector

The rural infrastructure in India in terms of metal led roads, access to markets, etc. is generally poor, with the majority of the people using non-motorized transport. However, the level of transport infrastructure, which depends on the level of prosperity of agriculture, is highly non-uniform across the country. Statistics on the energy consumption pattern in the rural transport sector are not generally available.

3.3 RURAL ENERGY SUPPLY AND DEMAND

The broad trends in supply and demand of various fuels including fuelwood, animal residues, crop residues and commercial fuels are outlined below.

3.3.1 Fuelwood

The average consumption of fuelwood at present is around 200 million tonnes per annum, with estimates ranging between 100 and 300 million tonnes. The per capita or per family consumption of fuelwood varies considerably across different regions and agro-climatic zones depending on the resource endowments and accessibility. Also most of the fuelwood consumed in the rural areas is collected in the form of twigs and branches, mainly by women and children, and not purchased.

On the supply side, it is estimated that the annual sustainable yield from different land sources is about 86 million tonnes -- 36 million tonnes from forests and the rest from other lands such as plantations, revenue lands, wastelands, etc.. Thus there is a wide gap between the demand and the sustainable supply. Of the total supply, forests contribute just about 32% of the total fuelwood while the rest comes from a variety of other sources.

Given the trend, the demand for fuelwood by the turn of the century is expected to top 300 million tonnes. At the present rate of supply, this will clearly result in further degradation of the biomass resource base, and containing this demand would be a major concern.

3.3.2 Animal residues

Animal waste in the form of dung cakes is an important fuel in the regions which are agriculturally prosperous but where the fuelwood supply is poor. The total current consumption of dung as fuel is about 100 million tonnes per annum. On the other hand, the total supply is about 200 million tonnes. However, most of the dung produced is used as manure in the fields, and diversion of its use for fuel has a large opportunity cost.

3.3.3 Crop residues

Crop residue is the least preferred of the biomass fuels because, being in loose form, the rate of combustion is high and difficult to control. As a consequence, it is also an inefficient fuel. However, this acts as a back-up fuel wherever there are scarcities of fuelwood, and is gaining prominence as the fuelwood availability is becoming difficult. It is estimated that about 100 million tonnes of non-fodder crop residue is produced and consumed as fuel in different parts of the country.

3.3.4 Commercial fuels

Kerosene and electricity are the other important fuels in the domestic sector, while diesel and electricity are prominent in agriculture. Presently about 10 million tonnes of kerosene and 8 billion units of electricity are consumed in the rural areas, and the demand is expected to go up to 12 million tonnes and 13 billion units respectively, by year 2006. Also, kerosene use for cooking will grow faster than kerosene for lighting, which is expected to be taken care of by electricity.

In the agricultural sector electricity demand is expected to grow sharply in the next two decades along with diesel, assuming that large-scale mechanisation would take place.

3.4 RURAL ENERGY DEVELOPMENT IN INDIA

Rural Development purse has never figured in the stated Energy Policy. Rural electrification is mainly perceived in the context of energy requirements to meet the irrigation needs of agriculture as part of the overall food security policy. Therefore, Rural Electrification PRIORITY was to provide assistance for transmitting energy to agricultural pump sets to increase the productivity of land. Household electrification came as a secondary or incidental issue. The whole definition of rural energy in the past was to provide one connection to a village which was primarily used to electrify agricultural pump sets. The Government of India changed the definition of village electrification recently to state that a village is considered as electrified if it provides electricity/power to all the habitations in the village. They consider the village as electrified if al least 10 to 20% of the inhabitants in the villages are provided with energy for lighting.

Consequently, the emphasis is not on energy and its use for rural development, but availability of electricity for certain segment of households, in the villages and hamlets.

The main issue is how do we bring rural development and bridge the gap between the power requirements for rural development and the energy policies of the government.

The Rural Electric Supply Technology (REST) mission launched by the Government of India hopes to make power available for the rural households but even the stated policy objectives do not cover the strategies to provide energy to the poorest of poor households in the rural areas. If we need to achieve sustainability in rural development with emphasis on livelihoods and the means of enhancing the economic well being of the poor households, it is necessary that affordable access to energy is provided to these households. The primary need is an integrated development strategy to use energy to improve health, education, nutrition and economic activities of the rural households. As such gender issues need to be addressed with adequate focus in the context of energy use. It is difficult to bring any meaningful integration between energy and rural development unless we take a integrated approach to development and energy end use.

The major programmes/schemes undertaken in these areas are as follows and are open for implementation in all States/UTs.

3.4.1 Rural Energy Programmes

- National Programme on Improved Chullas
- National Project on Biogas Development
- Community, Institutional and Night Soil based biogas plants programme.
- Rural Energy entrepreneurship and Institutional Development (REEID)
- Women and Renewable Energy Development (WRED)
- Biomass Production, conversion & utilisation programme
- Biomass gasification programme.
- Animal Energy Programme
- Integrated Rural Energy Programme.

3.4.2 National Programme on Biogas Development (NPBD), Community, Institutional &Night-Soil based Biogas Plants **(CBP/IBP/NBP)** Programme and **Research** and Development on Biogas.

Biogas is a clean, unplugging, smoke and soot-free fuel, containing inflammable methane gas. It is produced from cattle dung, human waste and other organic matter in a biogas plant, through a process called "anaerobic digestion". The Indian biogas system mainly comprises of collection and processing of cattle dung, production and delivery of biogas and handling & application of digested slurry in agricultural fields. The State-wise estimated potential and achievement up to 2000-01 is presented in Table No. 3.6.

The biogas programme was started by the government of India in 1981-82 and comprised:

- National Project on Biogas Development (NPBD) for setting up of family type biogas plants
- Community, Institutional and Night Soil based Biogas Plants (CBP/IBP/NBP) Programme
- Research and Development on Biogas Production and Utilization Technology.

3.4.2.1 National Project on Biogas Development (NPBD)

It was started in 1981-82 with the objectives of:

- Providing fuel to rural households for cooking purposes
- Organic manure for application in agricultural fields
- Mitigating the drudgery of rural women
- Recycling human waste by linking toilets with biogas plants, thereby improving sanitation
- To provide easy and safe cooking gas for the rural families.
- To prevent pollution and forest degradation
- To protect the health of women and children by creating a Smoke-free kitchen.
- To help rural women devote this saving in time to more Productive pursuits
- To create additional employment by setting up of biogas **plants. In the ultimate** analysis, **to** create a clean, healthy and enterprising village.

Table: 3.6 N P B D (State-wise coverage of Estimated Potential up to 2000-01

Sl. No.	State / UT	Number of Plants		Percentage
		Est. Potential	Plants Installed	
1	Andhra Pradesh	1065600	308519	29
2	Arunachal Pradesh	7500	1142	15
3	Assam	307700	48059	16
4	Bihar	939900	119110	13
5	Goa	8000	3283	41
6	Gujarat	554000	343686	62
7	Haryana	300000	42120	14
8	Himachal Pradesh	125300	43354	35
9	Jammu & Kashmir	128500	1932	2
10	Karnataka	680000	306845	45
11	Kerala	150500	72339	48
12	Madhya Pradesh	1491200	192951	13
13	Maharashtra	897000	662120	74
14	Manipur	38700	1939	5
15	Meghalaya	24000	1859	8
16	Mizoram	2500	2376	95
17	Nagaland	6700	1477	22
18	Orissa	605500	171761	28
19	Punjab	411600	62708	15
20	Rajasthan	915300	66026	7
21	Sikkim	7300	2971	41
22	Tamil Nadu	615800	198838	32
23	Tripura	28500	1438	5
24	Uttar Pradesh	2021000	358311	18
25	West Bengal	695000	187266	27
26	A & N Islands	2200	137	6
27	Chandigarh	1400	97	7
28	Dadra & Nagar Haveli	2000	169	8
29	Delhi	12900	675	5
30	Pondichery	4300	539	13
	Total	**12049900**	**3204047**	**27**

Cumulative achievement

The total potential of 12 million biogas plants exists in the country.

The achievements so far indicate:

- 3.20 million rural families have benefited, indicating coverage of 27% of the total potential of biogas.
- About 3486 nightsoil-based and institutional biogas plants have been set up.
- Research and Development projects have been taken up to develop new designs and improve operational efficiency of the biogas plants. These plants have helped in saving 42 lakh tonnes of fuelwood and in producing 430 lakh tonnes of manure equivalent to 9.5 lakh tonnes of urea per year. In addition an estimated 5.5 million person-days of employment has been generated in rural areas.

Financial **Assistance**

The NPBD provides for Central Finance Incentives as detailed below:

(i) *Central Subsidy:* A fixed a mount is offered as Central subsidy depending upon the category of beneficiaries and the rural areas. The detail of Central subsidy are given in the below table: 3.7

(ii) *Turnkey Job Fee:* The rate of turnkey job fee was increased from Rs. 500 to Rs. 700 per plant during 20001-02 with a view to attracting more entrepreneurs, corporate bodies and NGOs. However, for the North Eastern Region States (excluding the plain areas of plain areas of Assam). Sikkim, Jammu and Kashmir, Himachal Pradesh, other notified hilly areas and Andaman and Nicobas Islands the turnkey jog fee is Rs. 800/-per plant.

(iii) *Household Toilet-linked Plants:* An additional Central subsidy of Rs. 500/- per plant is given for linking the cattle dung-based plant with a sanitary toilet, wherever feasible.

(iv) *Incentive **for** Saving Diesel:* Up to a maximum, of Rs. 2,500/- per plant is provided for a kit to modify a diesel engine to work as dual fuel engine and for one or two plastic or rubber balloons for transportation of gas.

(v) ***Toilet-linked** Plants in Schools:* A sum of 10,000/- or 70% of the total cost of a small capacity biogas plant tow toilets and a water storage tank is given for demonstration purpose to schools, especially girls schools in rural areas.

(vi) *Service Charge and Staff Support:* The rates of service charge are linked with a given target range allocated to states and agencies, expect in the North Eastern Region States, Sikkim and Jammu and Kashmir. Where full financial support is given for the staff sanctioned for the state headquarters and selected districts.

(vii) *Biogas Extension Centres (BECs):* A non-recurring grant of Rs. 10,000/- and a recurring grant of Rs. 20,000/- per year is given to **a** BEC fro systematically organizing user's courses in villages.

(viii) ***Training** Course:* Financial assistance is given for organizing different kinds of training courses as mentioned below Table: 3.8

Table 3.7

CBP/IBP/NBP Programme (Patterns of Central Financial Assistance)

(a) Central Subsidy

(ii) For Community and Institutional Biogas Plants

Plant Capacity (cu. m. of gas production per day)	Community Biogas Plant	Institutional Biogas Plants Goshatas / Pinjrapotes, Charitable Organizations / Government Institutions, Co-operaive Societies, Trusts or other Institutions tied to such bodies		Private and Profit making Institutions and others	
		for NE Region	Other States	for NE Region	Other States
Category	I	II (A)	II (B)	II (C)	II(D)
15	44000	85000	22000	70000	15000
20	44000	110000	22000	90000	15000
25	70000	135000	55000	112000	35000
35	70000	200000	55000	165000	35000
45	150000		95000		64000
60	170000		115000		76000
85	200000		140000		94000

Table 3.7

CBP/IBP/NBP Programme (Patterns of Central Financial Assistance) **(contd...)**

(ii) For Night – Night soil based Biogas Plants

(Amounts in Rupees)

Plant Capacity (cu.m.of gas production per day)	NE States		Other States	
	Institution	Community *	Institution	Community**
10 – 15	90,000	2.50,000	70,000	1,45,000
20 – 25	2,00,000	4,60,000	1,50,000	2,25,000
35	-	-	2,10,000	4,50,000
45	-	-	2,70,000	6,25,000

* CFA includes assistance for toilet sets, a dual fuel engine and a machine room.
** CFA includes assistance for a dual fuel engine and a machine room.

(b) Project Contingency

A project contingency amount is given for CBPs, IBPs and NBPs of upto 25 cubic metre capacity is 10% of the CFA with free operation and maintenance warranty for two years. In the case of NBPs of 35 to 60 cubic metres capacity, the amount of project contingency is 20% of the CFA with the provision of free operation and maintenance warranty for a minimum period of 20 years.

Table 3.8

National Project on Biogas Development (NPBD) - Training course

Course	**Duration**	**No. of Trainees per Course**	**CFA per Course**
Users	1 day	50-60	Rs. 1,000
Staff	2-3 days	10-15	**Rs. 5,000**
Refresher / Construction-cum-Maintenance	16 days	10	Rs. 19,000
Turnkey Workers	21 days	10	Rs. 38,500

(ix) Communication and Publicity: Assistance is given for communication and publicity work linked with target ranges to **State nodal departments and** agencies as mentioned below Table 3.9.

Table 3.9

National Project on Biogas Development (NPBD) - Communication and Publicity

Target Range	**Assistance**
Up to 1,000	Rs. 1.00 Lakh
1,001-10,000	Rs. 2.50 Lakh
More than 10,000	Rs. 5.00 Lakh

(x) *Biogas Development and Training Centres:* A sum of Rs. 10.00 lakh is **given to each Centre to meet the expenses of staff, contingency and training** courses.

3.4.2.2 Community and Institutional Biogas Plants Programme

It was initiated in 1982-83 with the scheme of setting up of night soil based plants in community toilet complexes being added in 1993-94. It was started with the objective of recycling the large quantity of cattle dung available in the villages for the benefit of the weaker sections of society as well. A total of 3,487 plants including 600 Night soil-based biogas plants (NBPs), had been installed upto 2000-01. The State -wise number for community, Institutional and Night soil-based biogas plants set up is given in A3. 3.4.2

The biogas generated is generally used to fuel requirements of motive power and electricity, in addition to meeting the cooking needs of the rural populace. Through the programme,

- Indigenously developed models of biogas plants, namely floating drum type and fixed dome Deenbandhu are being popularized.
- Central financial assistance, including Central subsidy, turn-key job fee, service charges or staff support, training and publicity support, etc are being provided.

Central Financial Incentives

Central financial assistance (CFA) is provided in fixed amounts which vary according to the type and the size of the plants and the category of institutions and areas (Table 3.7). During 2001-02, the pattern of CFA was rationalized in order to provide a higher CFA for biogas plants linked with community toilet complexes. The highest amount of CFA, which works out to about 90% of the estimated cost of the biogas plant, is given to the States in the North Eastern region. In addition, a project contingency amounts at the rate of 10% of the CFA is given to State nodal departments and agencies for providing technical and training support, including determining the feasibility, arranging trained masons, supervising construction work, etc. The amount of project contingency is higher, i.e 20% of the CFA for 35, 45 and 60 cubic metres capacity NBP, with the condition of providing free operation and maintenance warranty for a minimum period of 20 years.

3.4.2.3 Research and Development on Biogas

The trust areas of the biogas research and development activities are mentioned below: *Research and development on biogas* is taken-up in the identified thrust areas, such as:

- Studies in the field of microbiology, biochemistry and engineering for increasing the yield of biogas especially at low and high temperatures;
- Development of cost-effective designs of biogas plants;
- Development of designs and methodologies for utilization of biomass, other than cattle dung for biogas production;
- Reducing the cost of biogas plants by using alternative building materials and construction methodology; and
- Diversified use of digested slurry for value-added products.

3.4.3 National Programme on Improved Chulhas (NPIC)

The National Programme on Improved Chulha programme was started by Ministry of Non Conventional Energy Sources, Govt. of India, in 1984 as a demonstration programme. The demonstration programme became a national programme in 1985 due to its overwhelming popularity. It was initiated in 1986-87 with the following objectives:

- Fuel wood conservation;
- Eliminate / reduction of smoke;
- Reduction in drudgery of women and children from cooking in smoky kitechen and collection of fuel wood;
- Environmental upgradation and check on deforestation; and
- Employment generation in rural areas.

Fuel burning efficiency of an improved chulha is 20-50% whereas fuel burning efficiency of traditional chulha is only 5-10%. The chimney system and efficient burning in an improved chulha causes less smoke and harmful gases like carbon monoxide are released less in the kitchen. The multipot seats in an improved chulha reduce cooking time and make time available for other productive activities. Reduction of smoke means cleaner cooking operation and lesser blacking of the utensils. The National Programme on Improved Chulhas (New Models of Fixed-type Improved Chulhas developed during 2001-02) is shown in Table No: 3.10.

Achievement

The 3.39 over 7.00 Lakh Improved chulhas have been installed during the period of April to December 2001. The State-wise and Agency-wise achievement vis-à-vis the targets are given in Table No. 3.11.

Benefits

An improved chulhas saves on an average about 375 kg of bio-fuel and 3 litres of kerosene per year under field conditions. Accordingly, the achievement of the target of 17.55 lakh of improved chulhas set for 2001-02 would result in a saving of about 6.58 lakhs tones of bio-fuels and 53 lakh litres of kerosene per year. Besides, an improved chulhas results in a saving of 45 minutes to one hour per family which would otherwise be spent on collecting and processing the fuel material, cleaning of utensils and cooking. The improved chulhas also helps in making the environment inside the kitchen smoke-free, thereby reducing the incidences of eye and lung diseases amongst women and children. The NPIC is also generating employment in the rural areas for women at the rate of 0.3 person day per chulha.

Table No: 3.10.

National Programme on Improved Chulhas (New Models of Fixed-type Improved Chulhas developed during 2001-02)

TBU	**Model Name**	**Type of Model**	**Type of Fuel**	**Thermal Efficiency (in %)**	**Estimated cost per Chulha (Rs)**
Indore	Jyoti	Simple-pot chulha made cement and tone power	Wood, agro-residues and dung-care	**21**	170
Indore	Ahilya	Simple-pot chulha made of clay and cement	Wood, agro-residues and dung-care	**20**	260
Katyani	Modified Kalyani coal chulha	Single pot bricks and lime	Coal	**42**	134
Sotan	High Attitude Metal Stove	3-pot Iron and steel	Wood	**21**	700
Gukwahati	Modified Sukhad	2-pot pottery liner brick and cement	Wood and Agri-residues	**25**	190
Gukwahati	Modified Aafavati	2-pot pottery liner brick and cement	Wood and Agri-residues	**25**	210

3.4.4 Rural Energy Entrepreneurship and Institutional Development (REEID)

The Rural Energy Entrepreneurship and Institutional Development, which was initiated in 2000-01, was continued with the following objectives:

- To promote local - level entrepreneurship in the rural energy sector;
- To strengthen the Entrepreneurship Development Centres in different states for providing training, management skills, support for project formulation, maintenance services and export management and consultancy.
- To organize entrepreneurship Awareness Camps in the teaching and technical institutions;
- To organize Entrepreneurship Development Programmes to promote rural energy micro-enterprises for manufacturing, marketing, servicing and exporting rural energy systems;
- To develop and promote linkages among rural energy entrepreneurs, renewable energy industries, financing institutions including IREDA and State nodal departments and nodal agencies;
- To involve non-governmental organizations in promoting, facilitating and establishing rural energy enterprises; and
- To develop and disseminate entrepreneurship manuals, guides, etc.

Table: 3.11:NationaI Project on Improved Chulhas (State-wise achievement 2001-02)

Sl. No	State/UT/Agency	Annual Target		April to December 2001	
		No. of Villages	No. of Chulhas	Target No. of Chulhas	Achievement No. of Chulhas
1	Andhra Pradesh	800	175000	87500	34824
2	Assam	300	12500	6250	32
3	Bihar	80	6000	3000	2178
4	Chattisgarh	150	15000	7500	-
5	Gujarat	490	105000	52500	48928
6	Goa	20	4000	2000	1510
7	Haryana	300	60000	30000	28482
8	Himachal Pradesh	6	1000	500	510
9	Jammu & Kashmir	100	30000	15000	-
10	Jharkand	100	16000	8000	-
11	Karnataka	300	60000	30000	32179
12	Kerala	200	40000	20000	20443
13	Madhya Pradesh	10	1500	750	-
14	Maharashtra	540	86000	43000	16071
15	Manipur	100	5000	2500	1231
16	Meghalaya	100	5000	2500	-
17	Mizoram	150	5000	2500	-
18	Nagaland	150	5000	2500	1660
19	Orissa	700	200000	100000	138636
20	Punjab	250	35000	17500	-
21	Rajasthan	150	30000	15000	6234
22	Sikkim	100	5000	2500	4096
23	Tamil Nadu	300	60000	30000	45312
24	Tripura	200	18000	9000	4157
25	Uttar Pradesh	800	150000	75000	52384
26	Uttaranchal	40	2000	1000	154
27	West Bengal	1300	325000	162500	191086
28	A & N Islands	8	1200	600	841
29	Dadra&Nagar Haveli	5	500	250	-
30	Delhi	12	2000	1000	-
31	Lakshwadeep	2	300	150	-
32	Pondichery	15	4000	2000	1435
33	KVIC Mumbai	1970	260000	130000	65517
34	Aiwc, New Delhi	220	25000	12500	2448
35	Thiruvanantapuram	50	5000	2500	-
	Total	10018	1755000	877500	700348

Central Financial Assistance (CFA)

CFA is given for the organization of one-day Entrepreneurship Awareness Camps **at the** rates of Rs. 10,000 per camp and Entrepreneurship Development Programme at the rate of Rs. 0.50 lakh to Rs. 1.00 lakh per programme for a duration of about 4 **to** 5 weeks. Also, core organizational support up to Rs. 10.00 lakh s non-recurring grant and Rs. 5.00 lakh per year as recurring grant is given to R&D, teaching and management institutions. A grant of Rs. 1.00 lakh is given for establishing a Rural energy Entrepreneurs and consumers facilitation counter. Besides, REEID provides for partial financial support to entrepreneurs for acquiring technology, getting quality certification from the Bureau of Indian Standards (BIS), preparing bankable projects, etc. Provision has also been made for organizing market surveys, studies on financial and socio-economic analysis of renewable energy systems, preparation and distribution of good practices manuals for fostering entrepreneurship among the rural youth.

3.4.5 Women and Renewable Energy Development

The 'Women and Renewable Energy Development' (WRED) programme was started to train and empower women in the promotion, marketing, utilization and management of renewable energy system and devices. In all, 125 Sales and Servicing Outlets and 150 Renewable Energy Women Self-Help Groups have been sanctioned. The scheme was started in 2000-01 with the following objectives:

- Establishment of renewable energy sales and servicing outlets managed by women at the local level;
- Organization of women self-help groups to arrange construction and maintenance servicing of improved chulhas, biogas plants, solar lanterns, solar cookers, etc. besides undertaking energy plantations in waste lands for fuel wood production and organizing annual maintenance contracts for renewable energy systems, etc.;
- Imparting of training in the construction, operation, repair and maintenance of various kinds of renewable energy systems relevant for women;

- Reorganization of entrepreneurship and research capabilities among women through awards and certificates of merit;

Central Financial Assistance

The Scheme provides for CFA to the tune of Rs. 20,000/- for establishing a renewable energy sales and servicing outlet (KliSSO) in rural areas managed by a women self-help group or a women entrepreneur. Besides a grant of Rs. 10.000/- is given to serve as a revolving fund to self-help groups for arranging maintenance servicing of renewable energy devices and systems. For training of women in renewable energy technologies, courses are organized in villages through educational institutions and grass root NGOs. The duration of the Orientation and Training Course (OTC) is about five days and a CFA of Rs. 15,000/- per course is given.

3.4.6 Integrated Rural Energy Programme

The IREP aims at developing planning and institutional capabilities to formulate and implement micro level energy plans and projects for promoting the most cost-effective mix of energy options for use in rural areas. The objectives of the programme are to

- Provide for minimum domestic energy needs
- Provide the most cost effective mix of energy sources for meeting the requirements of sustainable agriculture and rural development with due environmental considerations
- Ensure people's participation in the planning and implementation of IREP plans and projects through various micro-level institutions
- Develop and strengthen mechanisms and co-ordination arrangements for linking micro-level planning for rural energy with state and national level for energy and economic development.

The centre and state provide financial, technical and training support for the IREP programme, which is being implemented in 724 blocks in the country against the 860 blocks sanctioned during 2001-02. With this about 16% of the total number of the Blocks in the country have been covered under IREP. State-wise cumulative number of blocks sanctioned for the preparation and the implementation of IREP plants and projects information is given in the Table No.3.12

3.5 IMPACT OF RURAL ENERGY

In this section, the impact of Rural Energy on Society & Environment, Natural Resource base, Women & children and Global impacts are explained with reference to the rural energy fuel.

3.5.1 On Society and Environment

As is evident, the energy demand, especially that of biomass fuels is going to increase substantially which could only raise the gap between the demand and the sustainable supply. This would have a deteriorating effect on the resource endowment apart from other manifestations which are briefly discussed here.

3.5.2 On Natural Resource base

It is an established fact that forests and other public lands in India, given the pressures of high population growth rate, are in various stages of degradation severely affecting their carrying capacity. One of the major casualties of this situation is fuelwood which is becoming scarce in several parts of the country. Though no direct correlation between deforestation and rural energy use has been established -- demand for agricultural land, and industrial and commercial requirements are considered the principal causes -- there is evidence that where the land is already degraded, fuelwood extraction could exacerbate the process. With domestic households as well as rural industries using increasing quantities of fuelwood, this situation could only worsen in the future.

Table: 3.12

Integrated Rural Energy Programme
State-wise Cumulative Number of Blocks **Sanctioned– 2001-02**

Sl.No.	State / UT	Number of Blocks
1	Andhra Pradesh	32
2	Arunachal Pradesh	10
3	Assam	21
4	Bihar	48
5	Chhitisgar	22
6	Goa	5
7	Gujarat	25
8	Haryana	38
9	Himachal Pradesh	45
10	Jammu & Kashmir	28
11	Jarkhand	8
12	Karnataka	42
13	Kerala	44
14	Madhya Pradesh	63
15	Maharashtra	37
16	Manipur	15
17	Meghalaya	18
18	Mizoram	11
19	Nagaland	25
20	Orissa	45
21	Punjab	40
22	Rajasthan	38
23	Sikkim	4
24	Tamil Nadu	21
25	Tripura	6
26	Uttar Pradesh	94
27	Uttaranchal	21
28	West Bengal	34
29	A & N Islands	5
30	Chandigarh	1
31	Dadra & Nagar Haveli	1
32	Dao & Daman	1
33	Delhi	5
34	Lakshadeep	1
35	Pondichery	6
	Total	860

3.5.3 On Women and Children

As mentioned earlier, fuel collection in rural areas is mostly done by women, except in some cases of head loading, which puts a heavy burden on them. This is particularly so in the hilly areas where women also have to participate in all other productive activities. As fuelwood becomes scarce, women are forced to spend more time and walk long distances to collect fuelwood. This extra burden affects the quality of life substantially as it cuts into the time and attention women could pay to their children's education and health, and other household activities. Several micro level studies conducted in different ecological settings, indicate that distances up to 10 km are covered in the process expending 5 to 6 hours per day.

Pollution due to biomass burning is a major factor that affects the quality of life in a major way. Burning of biomass in inefficient cookstoves is one of the major causes of chest and lung related health problems among rural women and children. This problem would be particularly severe in a scarcity situation where households may be forced to switch to inferior fuels such as fuelwood fron. shrubs, roots and weeds, and crop residue in loose form.

3.5.4 Global Impacts

Biomass energy consumption, apart from local environmental effects, also has serious impact on climate change due to emissions of greenhouse gases. The process of degradation and depletion of forests — which results in loss of natural sinks that could absorb carbon emissions ~ and biomass burning, have been identified as significant contributing factors to the greenhouse effect. In India it is estimated that of the 68.3 million tonnes of carbon released annually due to biomass burning, fuelwood accounts for 82.3%. Thus, it is important to take this potential contribution into account in the issue of sustainable biomass use.

3.6 INTEGRATING RURAL ENERGY WITH RURAL DEVELOPMENT

The other imperative is to integrate rural energy with other development factors such as health, education, infrastructure and financing. As we saw, electrification does not automatically yield economic development and rural people will not automatically adopt woodfuel forestry. This section will explore how the requirement for integrated development may be met and what the institutional implications are. However, in order to discern how government and non-government institutions could better integrate the various elements required for rural energy development, first we must see what institutions are currently at work

3.6.1 Institutional arrangements for rural energy planning

In India, predominantly an agrarian economy, the government has sought to increase rural people's cash and therefore their ability to make the transition to modern fuels by intervening in setting the procurement price for cereals. Hence when the government raises prices, food and goods consumers subsidise rural energy development. As part of its Integrated Rural Energy Programme, India has also developed technical back-up units at the state and district level for devices such as biogas plants, improved woodstoves and solar cookers. A national training centre has been set up in Delhi and regional training and R&D centres are already set up in a substantial portion of districts. (Ramani et al (1993).

5.6.2 Institutional coordination

As has been stated time and again, energy does not cause rural development but it can act as a catalyst when other development factors are already present. Thus, to be most effective, certain forms of energy, for example grid-based electricity, should only be introduced into rural areas after or along with a series of other development inputs or infrastructural components. While centralised co-ordination of the planning effort is still necessary at the national level, this should focus primarily on seeking consensus on policy decisions, establishing common guidelines for planning at the decentralised level and mobilising the necessary human resources and finance. Much of the planning effort, in particular the aspects of energy needs identification, resource assessment and technology choice, should be decentralised to the level of local government and other local agencies.

An important task of the agency entrusted with rural energy planning co-ordination at the national level would be to establish links between the planning for decentralised renewable energy systems and that for centralised energy systems. Specific attention should be given to rural electrification, to ensure that the plans and programmes of the electricity utilities are consistent with those for the diffusion of decentralised renewable energy systems.

In order to achieve this integration of energy and other factors in development it is essential that there be greater horizontal communication between all agencies involved in rural development. Presently, the lack of information exchange and horizontal co-operation, particularly between government agencies, inhibits the implementation of well-integrated programmes in many countries.

Many other rural development activities, or inputs, such as agriculture, transport, water supply, education and the provision of health care, all have their energy needs. The energy role of agriculture, both as a producer and consumer, must be integrated into both energy and agricultural plans. Bioenergy resulting from the energy conversion of residues and from purpose-grown energy plantations is a major source of rural fuel. However, it is very seldom that these ministries or departments co-ordinate or co-operate with the ministry of energy, or one another, to arrive at the most rational and integrated solution to their energy needs. It is possible that decentralisation of the rural energy planning process may help to achieve this. However, it is an important aspect that still needs to be addressed at the central government planning level, if optimal use of a country's development resources is to be achieved.

5.6.3 Decentralization and integration

The principles of decentralization and integration should be the starting point in all areas of rural energy development effort.

Sustainable forestry: Participatory management of natural forests and woodlands and by extension agro-forestry, is probably the most significant outcome of the new thinking. However, recommendations for action should take into account the existing human, financial and institutional resource constraints in developing countries. While joint forest management might seem like an easy and politically popular winner, there are many barriers to successful implementation. For participating communities they include the willingness:

- to co-operate with each other,
- to invest their labour and cash resources, and
- to organise for and learn new management skills.

Government, on the other hand, must be prepared to weaken greatly its own jurisdiction and authority over basic national resources. It thus requires from government:

- a strong commitment to more equitable land tenure or access to land and land-based resources,
- increased local accountability and community powers,
- openness to and policy support for the emergence of non-governmental organisations and private entrepreneurs, and
- willingness to explore many technical and administrative innovations, including the redistribution of tax revenues from the state to local communities.

In addition to the above obvious benefits, pilot projects have shown that the training of rural people is often needed in techniques of sustainable production, elementary management and, at later stages, marketing skills.

Better data: It is becoming clear that decentralisation of rural energy planning and its integration with other aspects of development has a number of advantages, particularly in assisting planners to formulate strategies and projects that more closely meet the needs of local communities. However, apart from the changes in attitude required, there are some further constraints that have to be dealt with in order for it to be effectively implemented.

One of the most important of these is lack of information. As a first step, a more comprehensive and reliable rural energy information system needs to be developed in many countries at all planning levels. In addition, it needs regular updating. It should include assessments of rural energy needs on an area basis, patterns and trends in traditional and commercial energy consumption, and economic, social and environmental indicators of rural development. Under conventional approaches substantial financial and human resource commitments would have to be made for the surveys necessary to capture the data, and for establishing information systems that could be accessed by the various agencies involved in rural energy development.

A further important lack of information is the one felt by rural people themselves. Although they know a great deal about traditional energy supplies and end-use options, very few of know about the potential of new technologies and modern fuels, making it difficult for them to contribute meaningfully to much of the planning process.

Better training: A further factor that constrains the effectiveness of decentralised planning is the lack of sufficiently skilled people to carry it out. While collecting data through schools could form the basis for improving these skills, it is necessary, in addition, to introduce higher level training of planners. Such efforts have already begun in China, where university-level courses in rural energy planning have been initiated. The Chinese have shown willingness to share this experience with other countries, and this could provide the starting point for a plan of action to improve rural energy planning skills in developing countries.

Local agencies need to be provided with adequate human resources and skills to develop and implement decentralised rural energy plans and programmes. Explicit policies and strategies are needed to ensure the involvement of rural communities, interested non-governmental organisations and the private sector in the planning and programming process. Particular attention should be paid to the role of women in these processes. In building these skills, it is important to move away from the still common approach of having foreign experts move into energy planning departments to produce national rural energy master plans. Technical assistance of this type does nothing to help build national capacity and often only results in the demoralisation of nationals employed in these planning departments. It would surely be more effective for such technical assistance to be structured so as to be short-term to provide instead a mentoring of nationals responsible for the planning. In addition, where skills are lacking in a country, by linking with universities and other training institutions, and using both their faculty staff and students to assist in the planning process, the longer term sustainability of national energy planning capacity could be greatly enhanced.

Rural Credit: A crucial aspect of rural development integration must be the widening of credit facilities to include the financing of energy technologies. The provision of affordable financial services for rural people has long been a prime component of rural development strategics. Originally the approach focused on concessional loans to farmers. More recently, however, it has been replaced by much wider financing for rural activities, thus reducing the lending transaction costs. In addition, the integration of rural financial markets with general financial markets has resulted in the mobilizing of savings as the major capital resource for rural people, rather than the previous reliance on concessional donor or government funds.

A number of barriers at the multilateral, bilateral, national government and village level serve to distort capital markets away from energy technologies. Capital needs to be mobilized to form an investment pool able to be leveraged to provide improved small-scale energy supplies on a large scale. A new approach to risk and return is needed, in which public sector capital becomes subject to more commercial discipline than in the past and private sector capital accepts possibly longer lead times to realize its returns. With such help from the public and private sectors, the savings poor people themselves can make as they substitute more efficient energy forms for inefficient, expensive traditional ones can potentially help develop and disseminate the technologies that would significantly improve their welfare and livelihoods.

3.7 CONCLUSION

In most developing countries, the largest contribution to the establishment of the national energy infrastructure comes from governments, either through national funds themselves or through international loans. Donor inputs normally contribute significantly in the pre-investment phases, critically influencing the design of the projects and programmes. It is clear that many opportunities for co-operation exist in the rural energy sector, and it is also apparent that communications gaps are all too common.

- Amongst donors and other external development agencies, sector or project work and recommended solutions may be driven by agendas established *a priori* by a particular aid or development agency, without much cross-fertilization and exchange of experience.
- Between donors and governments, there is still not sufficient recognition of the fact that any drive for radical policy change and new approaches can only succeed with a genuine meeting of the minds. Short of that, pro forma compliance, with what are often seen by recipient governments as externally imposed conditions, breeds only frustration on all sides.
- Between governments and the people, conflicts arise when it is perceived that the former have lost touch with the needs of the common people. This is especially so with the rural population with their traditional ways of life.

In all the above cases, if governments were better equipped with well-defined development agendas, most of these communication problems would be avoided. However, other agencies or organisations can play a role in improving communication.

Another vital area for greater co-ordination and co-operation is in the stimulation of research and development for the rural energy sector. The quality of energy services proposed for rural areas often falls far short of those provided in urban areas. There is a clear need for research and development effort on technologies suitable for rural energy supply and use, and there are a couple of specific areas that could be addressed in the short term.

Bringing electricity to all households should also be given high priority. This would require far more research and development on two fronts. First, energy-efficient, decentralised and reliable small-scale power sources need to be developed that can deliver a level of energy service equivalent to that enjoyed by those connected to the grid. These systems should also be designed to operate in conditions of skills scarcity. Second, research and development is required to reduce the costs of grid-based electrification. Some possible avenues were noted. It is apparent that there is still significant potential for greater reductions in cost, without loss of amenity.

Finding the resources for this research and development is in itself a challenge. Support from international aid agencies may be desirable in some instances, while co-operative programmes, mounted and funded by strategic groupings of developing countries, might be better in others. Collaboration with industrialized countries should be considered in all instances.