CHAPTER II

NON CONVENTIONAL ENERGY SCHEMES IN
INDIA AND KERALA - AN OVERVIEW

The Industrial Revolution of the 19th century ushered in new technologies. The spurt in inventions in that century was unprecedented in many ways. Some of these inventions involved use of natural resources like coal and oil. The through of exhaustible nature of these resources and the environmental damage from the use of these resources never occurred either to the inventors or the subsequent generations. In the quest to sustain galloping economic activity, the dependence on coal and oil has soared at a phenomenal rate over the years. The burnt fuels result in the release of carbon dioxide and other gases into the atmosphere causing environmental damage. It has become imperative to look at energy technology with a new perspective. There are abundant renewable sources of energy such as wind, sun, water, sea, biomass apart from even daily wastes. These resources are pollution free and hence clean energy apart from being unlimited or inexhaustible.

Energy Sector - Indian Scenario

The electricity intensity of the Indian economy - the percentage growth of electricity consumption that correlates with 1 per cent of economic growth – fell from approximately 3.14 per cent in the 1950’s to 0.97 per cent in the 1990’s\(^1\). In 2007, it was at 0.73 per cent. The main
reason for this reduction is that India’s growth until now was based more
on the service sector (with an electricity intensity of only 0.11 per cent)
than on growth in industrial production (with an electricity intensity of
1.91 per cent)\(^2\). Today, for each 1 per cent of economic growth, India
needs around 0.75 per cent of additional energy\(^3\). The Planning
Commission of India, which co-ordinates Indian long-term policy,
analyses different scenarios. One scenario assessed that this value could
fall to 0.67 per cent between 2021-2022 and 2031-2032\(^4\).

India is facing a formidable challenge to build up its energy
infrastructure fast enough to keep pace with economic and social changes.
Energy requirements have risen sharply in recent years, and this trend is
likely to continue in the foreseeable future. It is driven by India’s strong
economic and population growth as well as by changing lifestyle patterns.
Growth and modernization essentially follow the energy-intensive
Western model of the 19\(^{\text{th}}\) and 20\(^{\text{th}}\) centuries, in which economic growth
correlates with a comparable growth in energy use.

For GDP annual growth of 8 percent, the Planning Commission
estimates that the commercial energy supply would have to increase at the
very least by three to four times by 2031-2032 and the electricity
generation capacity by five to six times over 2003-2004 levels\(^5\). In 2031-
2032, India will require approximately 1,500-2,300 million tones of oil
equivalent (MTOE) to cover its total commercial energy needs\(^6\). The
Indian government by itself does not have enough financial resources to
solve the problem of energy shortages. It must rely on cooperation with
the private sector to meet future energy requirements. This opens up
interesting market opportunities for international companies.
In the study “Powering India: The Road to 2017,” the management consultancy McKinsey calculated that goals specified by the Indian Government have been set too low. The study argues that the peak demand will be 315 and 335 GW by 2017 instead of only 213GW as estimated in 2007 by the Central Electricity Authority (CEA) and 226 GW (assuming 8 percent annual GDP growth) estimated in the Integrated Energy Policy. Accordingly, by 2017, India would require a total installed capacity of 415-440 GW in order to be able to reliably meet this demand. This means that over the next 9 years, the country would have to install more than twice as much capacity as it has been able to install over the last sixty years (159GW). In order to achieve this, the speed with which the new capacities are built must increase fivefold. Such a massive increase requires a fundamental restructuring of the entire power market, which the government has begun through enactment of the Electricity Act.

**Commercial Energy Consumption**

India’s share of the global commercial energy (Commercial energy resources contain all the commercially traded fuels. Although they play a major role in many countries, wood, peat, and animal wastes are not included because no reliable statistics are available) consumption in 2008 was 3.8 percent (433 of 11,295 MTOE), increased from 2.9 per cent over the past ten years, thus making it the fifth largest consumer of commercial energy. By comparison, China holds 19.6 per cent of the population and consumes 17.7 per cent of commercial energy.

The world wide consumption of primary sources of energy by countries are United states 30.4 per cent, China 17.7 per cent, Russia 6.1
Coal is by far the most important energy source for India; it provides more than half the commercial energy supply. Oil, mostly imported, is the second most important source of energy, followed by gas and hydropower. So far, nuclear (atomic) power covers only a small portion of the commercial energy requirements (approximately 1.5 percent). With less than 1 per cent, renewable energy plays a minor role (this does not include hydro > 25 MW), and therefore, it is not even visible in the figure, though its share is projected to increase significantly. The traditional use of biomass (e.g. for cooking) has not been included here as a source of energy. However, the 2001 census points out that approximately 139 million of the total 194 million households in India (72 percent) are using traditional forms of energy such as firewood, crop residue, wood chips, and cow dung cakes for cooking. The majority of these households are in rural areas. Firewood, used by approximately 101 million households, is the main cooking fuel in India.

The Power Market in India and the Role of Renewable Energy

While India has been making progress in different infrastructural areas such as the construction of roads and expansion of the telecommunication system, the power infrastructure has not kept pace with the growing requirements.

India’s power market is confronted with major challenges regarding the quantity as well as the quality of the electricity supply. The base-load capacity will probably need to exceed 400 GW by 2017. In order to match this requirement, India must more than double its total
installed capacity, which as of March 2010 was 159 GW\textsuperscript{10}. Moreover India’s power sector must ensure a stable supply of fuel from indigenous and imported energy sources, provide power to millions of new customers, and provide cheap power for development purposes, all while reducing emissions. On the quality side, the electricity grid shows high voltage fluctuations and power outages in almost all parts of the country on many days for several hours\textsuperscript{11}. According to the “Global Competitiveness report,” in 2009-2010 (weighted average), India ranked 110 among 139 countries in the category “Quality of Electricity Supply”\textsuperscript{12}.

The power deficit reported or 2008-2009 was almost 84 TWh, which is almost 10 per cent of the total requirement; the peak demand deficit was more than 12.7 per cent at over 15 GW\textsuperscript{13}. The electricity undersupply in India is estimated to cost the economy as much as INR 34 (USD 0.68) to INR 112 (USD 2.24) for each missing kilowatt-hour. Thus, the total cost of the power deficit of 85 billion kWh in financial year 2007-2008 amounted to at least INR 2,890 billion (USD 58 billion), or almost 6 per cent of the GDP\textsuperscript{14}. Another report says that there is an approximately 7 percent decrease in the turnovers of Indian companies due to power cuts\textsuperscript{15}. As a consequence, many factories, businesses and private customers have set up their own power generation capacities in the form of captive power plants or diesel generators in order to ensure their power supply. This provides an attractive opportunity for renewable energy solutions; they compete not with power produced relatively cheaply by large coal plants but with much more expensive diesel back-up generators.

Until 1991, The Indian Government monopolized the power market. There were only a few private actors, and the CEA had sole responsibility for giving techno-economic clearance to new plants.
However, the public sector has been unable to cater to the growing demand for power, and in the future, investments requirements in the public sector will far exceed the resources. Current energy policies therefore place an emphasis on the integration of the private sector along the entire value chain: from the generation of power to transmission and distribution.

The Electricity Act, 2003 displaced former energy laws and expanded them comprehensively. The aim of the act was the modernization and liberalization of the energy sector through the implementation of a market model with different buyers and sellers. The main points included making it easier to construct decentralized power plants, especially in rural areas and for captive use by communities, and giving power producer’s free access to the distribution grid to enable wheeling. Producers could also choose to sell power directly to consumers rather than through the financially weak State electricity Boards. Through the electricity Act the different legal frameworks are to be unified at state level to promote foreign direct investment in the country.

Given the long-term energy deficit and the growth trajectory of the Indian economy, the Indian Investment community has responded positively. However, international investors are still hesitant. The largest barrier to more foreign private investment in the energy market is that energy price itself. In many customer sections and regions, they are too low to generate stable and attractive returns. Despite being an impractical drain on resources, the Government has so far failed to adjust prices. The key reason is that cheap or free electricity is an important political token in a country where the majority of the population still lives on a very low income.
Power Consumption

India’s average power consumption per person was 733 KWh in 2009, and the average annual rate of increase since 2003 was 4.4 per cent\(^{18}\). In 2008, a total of 596,943 GWh were consumed in India. The largest consumer was industry with 274,531 GWh (46 per cent) followed by households with 124,562 GWh (21 per cent) and agriculture with 107,835 GWh (18 per cent). In the commercial sector (e.g. offices and shops), 48,047 GWh (8 per cent) was consumed, 11,615 GWh (2 per cent) in rail traffic, and 30,353 GWh (5 percent) in various other sectors\(^{19}\). In India the electricity consumption by industrial sector was 46 per cent, Domestic 21 per cent, Agriculture 18 per cent, Commercial 8 per cent, Traction 2 per cent and Miscellaneous 5 per cent during 2008-09\(^{20}\).

Between 1980 and 2009, energy consumption increased by almost seven times from 85,334 GWh to 596,943 GWh, which corresponding to an average annual growth rate of approximately 7.1 percent. The strongest increase was the consumption by private households, which increased by almost 14 times since 1980 at an average growth rate of 10 percent. The reason behind this increase was the inclusion of several million new households, corresponding to the increase in electrical household appliances such as refrigerators and air conditioners. The agricultural share increased seven-fold at an annual growth rate of 7.6 percent between 1980 and 2008. The reason for a strong growth in the agricultural sector is, first, the inclusion of more rural areas, and second, the provisions of power to farmers at reduced, or even free, rates in many areas. The consequence of this latter practice was the widespread purchase of cheap and inefficient water pumps that continue to run almost uninterrupted. The
slowest growth in power consumption was seen in the industrial sector at 5.9 percent per year, which still corresponds to a five-fold increase\textsuperscript{21}.

The main drivers for the strength in the demand for power are the overall economic growth, the power-intensive manufacturing industry that is growing disproportionately fast, the rapidly rising consumption in households due to the affordability of new electrical appliances, the planned provisions of power to 96,000 currently un-electrified villages, and the provision of power for latent demand, which is currently unfulfilled because of frequent power cuts\textsuperscript{22}.

**Power Generation Capacity**

The total power generation capacity in India in March 2010 was 159 GW. Of this, 64.3 percent was fossil-fuel-fired power plants (coal, gas and diesel), 23.1 percent hydropower, 2.9 percent nuclear power, and 9.7 percent renewable energy\textsuperscript{23}. Renewable energy includes small hydropower plants, biomass gasification, biomass energy, urban and industrial waste energy, solar energy and wind energy.

The composition of the power sector has changed significantly in the last 30 years. The power generation capacity controlled directly by the central government has increased from 12 percent to 32 percent. At the same time, the fraction of generation capacity controlled by the individual states fell from 83 percent to 50 percent. Generation capacity controlled by the private sector more than tripled from 5 percent to 18 percent\textsuperscript{24}. The private sector dominates in power generation from renewable energy sources.
The national electricity policy (NEP) assumes that the per capita electricity consumption will increase to 1,000 kWh by 2012. To cover this demand, the government is planning to add 78,700 MW of capacity during the eleventh five year plan25 (Eleventh Plan) ending March 2012. As of April 2010, 22,552 MW of new installation towards that goal had been achieved. There are further projects under construction with a capacity of 39,822 MW. As per the mid-term plan review, capacity additions of 62,374 MW are likely to be achieved with a high degree of certainty and another 12,000 MW with best efforts26.

The Status of Renewable Energy in India

India has over 17 GW of installed renewable power generating capacity. Installed wind capacity is the largest share over 132 GW, followed by small hydro at 2.8 GW. The remainder is dominated by bio-energy, with solar contributing only 15 MW. The Eleventh plan calls for grid-connected renewable energy to exceed 25 GW by 2012. JNNSM (Jawaharlal Nehru National Solar Mission) targets total capacity of 20 GW grid connected solar power by 2022. Renewable energy technologies are being deployed at industrial facilities to provide supplemental power from the grid, and over 70 per cent of wind installations are used for this purpose. Bio fuels have not yet reached a significant scale in India.

India’s Ministry of New and Renewable Energy (MNRE) supports further deployment of renewable technologies through policy actions, capacity building, and oversight of their wind and solar research institutes. The Indian Renewable Energy development Agency (IREDA) provides financial assistance for renewable projects with funding from Indian
Government and international organizations; they are also responsible for implementing many of the India’s government’s renewable energy incentive policies. There are several additional Indian government bodies with initiatives that extends into renewable energy, and there have been several major policy actions in the last decade that have increased the viability of increased deployment of renewable technologies in India, ranging from electricity sector reform to rural electrification initiatives. Several incentive schemes are available for the various renewable technologies, and these range from investment-oriented depreciation benefits to generation-oriented preferential tariffs. Many states are now establishing Renewable Purchase Obligations (RPOs), which has stimulated development of a tradable Renewable Energy Certificate (REC) program.

**Renewable Energy Share of Electricity**

As of June 2010, India was one of the world leaders in installed renewable energy capacity, with a total capacity of 17,594 MW (utility and non-utility) which represents approximately 10 per cent of India’s total installed electric generating capacity. Of that total, 17,174 MW were grid connected projects, and the remaining 2.4 per cent of installed renewable capacity consisted of off-grid systems.

The wind industry has achieved the greatest success in India with an installed capacity of 12,009 MW at the end of June 2010. India has also installed 2,767 MW of small hydro plants (with sizes of less than 25 MW each), 1,412 MW of grid-connected cogeneration from bagasse, and
901MW of biomass-based power from agro-residues. Waste-to-energy projects have an installed capacity of 72 MW.

India has off-grid renewable power capacities of 238 MW from biomass cogeneration, 125 MW from biogas, 53 MW from waste-to-energy, 3 MW from solar PV plants, and 1 MW from hybrid systems. 

With the recently announced JNNSM, India hopes to develop more of its solar resource potential. As of June 2010, solar PV plants in India have reached a cumulative installed capacity of approximately 15.2MW. This is approximately 0.07 per cent of JNNSM’s 2022 target of 22 GW. As reported by CSP Today, JNNSM’s goal would “make India the producer of almost three-quarters of the world’s total solar energy output.”

By the end of the tenth plan (2007) India achieved a cumulative capacity of 10.161 GW of renewable energy. Additions totalling 15 GW are targeted during the Eleventh Plan to bring the total installed grid-connected renewable generating capacity to over 25 GW. Wind energy is expected to contribute approximately two-thirds of the added capacity in this plan period. If India is able to achieve its renewable energy goals by 2022 (by the end of the Thirteenth Plan), it will reach a total of 74 GW of installed capacity of wind, solar energy, biomass, and small hydropower, with wind and solar expected to account for more than 80 percent of the installed renewable power.

Although the government provides assistance for renewable energy implementation in the form of generation-based incentives (GBI’s), subsidies, subsidized credits, and reduced import duties, the Indian market does not offer investors a framework that is an investor-friendly as in
some developed countries. The main reason is that renewable energy sources are not systematically prioritized over non-renewable sources at a given national budget and a given power demand scenario. While the market certainly offers great opportunities for investors, it also requires adaptation and entrepreneurship to develop solutions that specifically fit the Indian scenario.

Off-grid applications for rural electrification and captive power for industries offer a promising opportunity for renewable energy’s advantages over conventional energy sources: local control of the energy resource and power system and suitability to smaller-scale applications. Renewable energy’s competition is typically either a costly connection to the national grid or diesel generator-based power with its high maintenance and fuel costs. On average, the cost of producing power for a coal plant is about INR 2 (USD 0.03) per kWh, while electricity from a diesel generator plant is approximately INR 10 (USD 0.200) per kWh. To compete effectively with these established technologies, renewable energy technologies require business models adapted to the characteristics of renewable power plants that include plans for efficient marketing, distribution, operation, maintenance, and access to financing.

For on-grid application of renewable energy, growth depends on grid in fracture improvements and the continued reduction of renewable energy costs. Currently, wind, small hydro, and biomass, are the most cost-competitive renewable options. Solar technologies including concentrated solar power (CSP) and PV are the least competitive but offer the great opportunity for growth because of the high potential. It therefore receives the most financial support in terms of government incentives.
Renewable Energy Application in Industrial Use and Transportation

A large percentage of renewable energy in India is covered under captive generation for industrial use. This is especially true in the wind market where 70 per cent of electricity from wind projects is produced for direct consumption by large industrial facilities to mitigate the effect of frequent shortages of electricity from national grid. Telecommunications companies are also looking toward renewable energy as they search for new solutions to power India’s 250,000 telecom towers. Systems such as solar PV-based hybrid systems provide a less polluting alternative to diesels power, serve as a hedge against increasing diesel fuel prices, help minimize the logistical challenges of transporting and storing diesel fuel at remote tower locations.\(^3^4\)

For the last 2 years, solar cooling has been a buzzword in the industry. While its attraction in a country as sunny and hot as India is obvious, the technology is still under development and is not yet economically viable. There are, however, some demonstration sites such as the Muni Seva Ashram in Gujarat, which uses parabolic Scheffler-type dishes to supply a 100-ton air conditioning system.\(^3^5\)

On the transportation front, there have been initiatives to switch to alternative transportation fuels such as compressed natural gas and electricity. The Reva, developed by the Maini group, is India’s – and one of the world’s – first commercially available electric car. TATA and General Electric are also in the process of developing electric vehicles.

In addition, highly visible pilot projects are deployed to increase public interest in renewable energy technologies. The October 2010 Commonwealth Games in New Delhi are showcasing renewable energy
for transportation and other uses including the utilization of at least 1,000 solar rickshaws, which use PV-powered motors for transporting athletes at the games\textsuperscript{36}. Also, a 1 MW PV plant will provide electricity for one of the stadiums at the games\textsuperscript{37}.

**National Renewable Energy Institutions and Policies**

In 1992, the India government established the world’s first Ministry committed solely to the development of renewable energy sources. The Ministry of Non-Conventional Energy Sources, which has since been renamed the Ministry of New and Renewable Energy. MNRE’s role is to facilitate research, design and development of new and renewable energy that can be deployed in the rural, urban, industrial, and commercial sectors\textsuperscript{38}. MNRE undertakes policymaking, planning, and promotion of renewable energy including financial incentives, creation of industrial capacity, technology research and development, intellectual property rights, human resource development and international relations\textsuperscript{39}.

MNRE’s mission is to reduce India’s dependence on imported oil, thereby improving the country’s energy security supply; to increase clear power’s share of the national energy mix; to increase the existing energy supply with a focus on improving access to clear energy; and to help new and renewable energy technologies to be cost-competitive. The ministry supports both on and off grid power generation from renewable sources including small hydro, wind, solar, biomass and industrial/urban waste. MNRE also has programs focused on rural areas, some of which supply electricity to remote villages and some promote and expand solar energy applications. MNRE has established research, design, and demonstration
projects in new areas such as geothermal, hydrogen energy, and fuel cells\textsuperscript{40}.

\textbf{Electricity Act, 2003}

The Electricity Act, 2003 has been a major step towards liberalizing the power market in India along the value chain, encouraging completion and attracting investment. Under the Act’s, the promotion of cogeneration and electricity generation from renewable sources is identified as consideration in the establishment of tariff regulations, allowing for the Central Electricity Regulatory Commission (CERC) to establish a preferential tariff for renewable energy\textsuperscript{41}. Further, the open access provision allows licensed renewable energy power generators access to transmission lines and distribution systems and only requires that the generators pay a wheeling fee for use of the transmission lines and a fee to the load dispatch centre\textsuperscript{42}.

\textbf{National Electricity Policy, 2005}

National Electricity Policy stipulates the need for increasing the share of electricity from non conventional sources and allows for the State Electricity Regulatory Commission (SERCs) to establish a preferential tariff for electricity generated from renewable sources to enable them to be cost competitive\textsuperscript{43}.

The National Electricity Policy (2005) aims at achieving the following objectives:
a. Access to Electricity-Available for all households in next five years.
b. Availability of Power-Demand to be fully met by 2012.
c. Supply of Reliable and Quality of Power of specified standards in an
efficient manner and at reasonable rates.
d. Per capita availability to electricity to be increased to over 1000 units by
2012.
e. Minimum lifeline consumption of 1 unit/household/day as a merit good by
year 2012.
f. Financial Turnaround and Commercial viability of Electricity Sector.
g. Protection of consumers’ interests.

National Tariff Policy, 2006

The National Tariff Policy, announced in January 2006, mandates
each SERC to specify a RPO with distribution companies in a time-bound
manner. Again, these purchases are to be made through a competitive
bidding process. The objective of this policy is to enable renewable energy
technologies to compete with conventional sources. Section 6.4 of the
National Tariff Policy calls for the relevant Commission, to establish
preferential tariffs with distribution companies for the purchase of
electricity from non-conventional technologies.44

Rural Electrification Programs

Rajeev Gandhi Grameen Vidyutikaran Yojana (RGGVY) was
launched by the central government in 2005 with the goal of extending
electricity to all rural households below poverty line.45 Under this
program, 90 per cent of the capital costs are subsidized by the central government. As of 2009, only 44 per cent of the households have been electrified\textsuperscript{46}. To electrify some of these villages and hamlets, the government has used distributed renewable as well as non-renewable energy sources. During the tenth plan, renewable energy sources were tapped to electrify approximately 5,000 villages and hamlets with the majority of communities being served by solar energy.

**Governance and Institutional Arrangement of Renewable Energy**

The liberalization and reform process initiated in 1991 with the division of the energy ministry into the Ministry of Power (MoP), the Ministry of Coal, and MNRE has led to large-scale changes in the governance structure of the power market. Today along with the traditional central government and state – level actors, there is also an increasingly active private sector at most of the points along the value chain, especially in generation, transmission, and power trading. Private interest remains low in the distribution network.

**DIFFERENT FORMS OF NON CONVENTIONAL ENERGY**

**Wind Power**

India has been a pioneer in the commercial use of wind energy in Asia since 1990’s. In 2009, India has the fifth largest installed wind capacity globally, only behind the United States, China, Germany and Spain. During 2009 India added 1,338 MW of wind capacity for a total
installed capacity of 10,925 MW. This represented a 14 per cent annual growth and contributed 3.5 per cent to the global wind market\textsuperscript{47}. India’s robust domestic market has transformed the Indian wind industry into a significant global player. India’s total wind potential is 48561 MW, with Karnataka, Gujarat, and Andhra Pradesh as the leading States, Kerala’s potential is 1171 MW\textsuperscript{48}. Kerala’s achievement is 27.75MW only.

Table 2.1

Status of Wind Power in India 2010-11

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>States</th>
<th>Estimated Potential (MW)</th>
<th>Cumulative Capacity up to Jan 2011 (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Andhra Pradesh</td>
<td>8968</td>
<td>180.90</td>
</tr>
<tr>
<td>2</td>
<td>Gujarat</td>
<td>10645</td>
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<tr>
<td>3</td>
<td>Karnataka</td>
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<td>4</td>
<td>Kerala</td>
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<td>Madhya Pradesh</td>
<td>1019</td>
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<tr>
<td>6</td>
<td>Maharashtra</td>
<td>4584</td>
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<td>7</td>
<td>Rajasthan</td>
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<td>Others</td>
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<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>48561</strong></td>
<td><strong>13183.58</strong></td>
</tr>
</tbody>
</table>

*Source: MNRE Annual report 2010-11*
Solar Power

Solar is an important, although currently underutilized, energy resource in India with the potential to offer an improved power supply (especially in remote areas) and increase the security of India’s energy supply. The Indian Energy Portal estimates that around 12.5 per cent of India’s land mass, or 413,000 km$^2$, could be used for harnessing solar energy.$^{49}$

Although India already has a strong solar cell production industry, until now, there has not been a high demand for them in the domestic market. In order to achieve the goals, MNRE seeks to create an attractive environment for investors, including incentives such as fee-in tariffs.$^{50,51}$

Solar Water Heating (SWH)

SWH’s have widespread potential in India including in the residential, commercial and industrial sectors. MNRE has estimated the total SWH potential to be approximately 140 million m$^2$ of collector area, and as of June 2010, installations have just reached over 3.5 million m$^2$ of collector area. The targets for 2012 and 2022 are to reach collector area of five million m$^2$ and 20 million m$^2$, respectively. Government support for SWH deployment is available as capital and interest subsidies. The Indian government is also supporting market development and awareness building through capacity building and outreach activities.
Global Solar Water Heating Capacity

In 2009, the worldwide existing cumulative solar hot water and heating capacity increased by 21 per cent to reach an estimated 180,000 thermal MW (figure excludes unglazed swimming pool heating)\textsuperscript{52}. In 2008, approximately 70.5 per cent of existing global SWH capacity (149,000 thermal MW) was in China, followed by European Union (EU) (12.3 per cent), Turkey (5.0 per cent), Japan (2.8 per cent), and Israel (1.7 percent). The Indian share was 1.2 per cent.

Solar Water Heating in India

MNRE estimates that a 100-litre SWH, was an appropriate size for domestic use, could save 1,500 kWh of electricity per year. At an energy cost of INR 5 (USD 0.10) per kWh, the savings are INR 7,500 (USD150). MNRE also estimates that each 1,000 SWHs with 100-litre capacity deployed can save 1 MW of peak power demand\textsuperscript{53}.

As of 1989, the total collector area of installed SWH in India was approximately 119,000m\textsuperscript{2}\textsuperscript{54}. Between 1995 and 2008, the annual growth rate in SWH installations was 16.8 per cent\textsuperscript{55}. At the end of 2002, India’s total installed collector area was 680,000 m\textsuperscript{2}, and this reached 2.7 million m\textsuperscript{2} by the end of 2008\textsuperscript{56}. By the end of 2009, the total installed collector area had reached approximately 3.4 million m\textsuperscript{2} \textsuperscript{57}. Approximately 0.5 million m\textsuperscript{2} of this value is from sales between April and December 2009\textsuperscript{58}. At the end of June 2010, India’s cumulative SWH installations had reached over 3.5 million m\textsuperscript{2} of collector area\textsuperscript{59} less than 0.025 per cent of the estimated techno-economic potential of approximately 140 million m\textsuperscript{2}. 

62
of SWH collector area. India’s current installations work out approximately 3 m² of collector area per 1,000 people\textsuperscript{60}.

Present installations are concentrated (65 per cent) in two states—Karnataka and Maharashtra— and more than 95 per cent of households in India with SWH are located in urban areas. A 2010 SWH market assessment estimates that 85 per cent of installed SWH are functioning\textsuperscript{61}.

The SWH installations in India are distributed across the following market-segments: households (residential sector) in both urban and rural areas, commercial and institutional buildings (e.g., hotels, hospitals, hostels and religious complexes), and industries.

**Households**

In households, hot water is required for bathing, cleaning utensils, washing clothes, cooking, and preparation of cattle feed. The majority of households in the country use traditional biomass fuels for most purposes, including heating water.

The main use of household SWH is for bathing. The demand of hot water varies significantly across different regions, from 4 months per year in warmer regions to 9 months in colder regions\textsuperscript{62}. The highest requirement of hot water in rural households is in the colder region of the country, mostly in the Himalayan States. However, most households with SWH are in the non-rural and warmer areas. Only 5 per cent of households with SWH are located in rural areas, and those are mostly in high-income rural households in parts of states including Himachal Pradesh and Kerala. The barriers to increased use of SWH systems in rural areas have been
identified as: a. High initial cost of the system; b. Long payback period as the fuel replaced is low-cost biomass fuel and c. Absence of SWH supply chain.

**Commercial and Institutional Buildings**

In hotels, there is a year-round demand for hot water. The number of hotels with SWH systems installed has increased as a means to reduce the use of expensive petroleum fuels and electricity. Use of SWH for supplying hot water in institutional buildings such as hospitals and hostels has lagged behind the technology adoption observed in the hotel industry.

**Solar Drier:**

In India, small cabinet driers for drying fruits and vegetables have been developed by the CAZRI, Jodhpur; IIT, Kanpur and IIT, Delhi; and Annamalai University. Forced convection type driers were developed in past by Indian Agricultural Research Institute (IARI), New Delhi; National Physical Laboratory (NPL), New Delhi and National Industrial Development Corporation (NIDC), New Delhi. NIDC in 1976 developed a pilot plant with 500kg drying capacity per day\(^63\).
TTK – LIG a leading manufacture of condoms from latex rubber has shown the way in adapting this novel technology with the help of planters Energy Network.

In TTK LIG latex rubber is dried in tumble driers using electrical heating. In the first pilot project in Chennai, 55 sq meter solar thermal collectors were connected to two tumble driers, leading to saving of 10 units of electrical energy per hour. The drying time of the latex rubber is also reduced leading to increase in productivity. Based on this success the company has installed a large unit with solar collector area of 113 Sq. m at Puducherry. The company is expected to save around 150 units of electricity per day. Around 45,000 units of electricity will be saved per year assuming around 300 sunny days in a year with a pay back period of about two years.

**Small Hydro**

The estimated potential for small hydro in India of 15,000 MW\textsuperscript{64} suggests that it can make a significant contribution to India’s power supply, especially in remote areas where alternative supply solutions face many challenges. For this reasons, the further development of small hydro is one of the focal areas of MNRE, who wants to concentrate on reducing the capital costs and enhancing the reliability, plant load factors, and average plant lifetimes. The Indian government aims to develop half of the identified potential in the next 10 years and is supporting small-hydro deployment through capital subsidies and preferential tariffs. As of March 2010, a total of 2,735 MW of grid-connected small hydropower has been
installed, contributing about 16.2 per cent to India’s total grid interactive renewable power.

Bio Energy

Historically, traditional biomass has been a major source of household energy in India. Today, the total energy supply in India is composed of approximately 40 per cent non-commercial energy sources such as wood and cow dung. Rural households in India predominantly use wood and cow dung as fuel for cooking and water heating due to lack of electricity. Modern biomass energy is derived from organic material and can be used in a variety of conversion processes to yield power, heat/steam, and fuel. In India, the use is focused on waste materials such as municipal, agricultural or forest residues. Biomass is generally divided into three categories: biogas, solid biomass, and liquid bio fuels.

Bio Gas

Biogas is obtained via an anaerobic process of digesting organic material such as animal waste, crop residues, and waste from industrial and domestic activities to produce the combustible gas methane. In India, most biogas plants primarily use cattle manure and operate at a household level to meet cooking and lighting needs in rural areas throughout the country.
Table 2.2

Status of Family Type Biogas Plants in India  2010-11

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>States</th>
<th>Estimated Potential Plants in No.</th>
<th>Cumulative achievement up to 31-3-2010 Plants in No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Andhra Pradesh</td>
<td>1065000</td>
<td>457938</td>
</tr>
<tr>
<td>2</td>
<td>Arunachal Pradesh</td>
<td>7500</td>
<td>2645</td>
</tr>
<tr>
<td>3</td>
<td>Gujarat</td>
<td>554000</td>
<td>411950</td>
</tr>
<tr>
<td>4</td>
<td>Karnataka</td>
<td>680000</td>
<td>418759</td>
</tr>
<tr>
<td>5</td>
<td>Kerala</td>
<td>150000</td>
<td>126463</td>
</tr>
<tr>
<td>6</td>
<td>Madhya Pradesh</td>
<td>1491000</td>
<td>295580</td>
</tr>
<tr>
<td>7</td>
<td>Maharashtra</td>
<td>897000</td>
<td>750527</td>
</tr>
<tr>
<td>8</td>
<td>Manipur</td>
<td>38000</td>
<td>2159</td>
</tr>
<tr>
<td>9</td>
<td>Orissa</td>
<td>605000</td>
<td>239818</td>
</tr>
<tr>
<td>10</td>
<td>Rajasthan</td>
<td>915000</td>
<td>67348</td>
</tr>
<tr>
<td>11</td>
<td>Sikkim</td>
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<td>6338</td>
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<td>12</td>
<td>Tamil Nadu</td>
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</tr>
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<td>Tripura</td>
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<td>Uthar Pradesh</td>
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<td>15</td>
<td>West Bengal</td>
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<tr>
<td>16</td>
<td>Others</td>
<td>4393500</td>
<td>514054</td>
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<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>12339300</strong></td>
<td><strong>4253561</strong></td>
</tr>
</tbody>
</table>

*Source: MNRE Annual report 2010-11*
Solid Biomass

Solid biomass includes agricultural and forest residues as well as organic household and industrial wastes for direct combustion or gasification to provide electricity or combined electricity and heat.

Liquid Bio fuels

Liquid bio fuels, namely ethanol and biodiesel are used to substitute petroleum derived transportation fuels. India’s bio fuel strategy is focused on using non food sources for the production of bio fuels: sugar molasses and non edible oils seeds as well as second generation bio fuels in the near future.

India’s commercial production of biodiesel is very small and what is produced is mostly sold for experimental projects and to the unorganized rural sector. The existing biodiesel producers in India are using non edible oilseeds, non edible oil waste, animal fat and used cooking oil as feedstock\textsuperscript{68}. According to the Biodiesel Association of India, biodiesel production in the country during 2009-10 was approximately 80,000 tones, sold entirely to commercial establishments using diesel generators.

The word ‘energy’ means ‘work’, ‘power’ or ‘force’. The best way to define energy would be as “the measure or the ability of a device or system to do work”. Energy is the key input for sustainable development of the country. It cannot be created or destroyed. It can only change from one of its forms such as heat, light, mechanical, chemical or electrical to another. There can be no two views about the importance of energy for economic development. The prosperity of any country depends on the
extent to which different sources of energy are exploited and India is no exception. Large quantities of energy and better quality of energy are equally necessary for rising living standards in the face of a rising population and for providing energy for economic development.

NON CONVENTIONAL ENERGY – KERALA SCENARIO

Kerala is a narrow stretch of land located in the south west tip of the Indian Peninsula with tall mountain ranges on the east and Arabian Sea on the West. It is the most densely populated state in India with a density of population of about 749 per sq. km. The state presents the picture of very large extended township contrary to the usual pattern of densely populated cities and towns and sparsely populated rural areas and remote village formations elsewhere in the country.

The conventional sources of energy in Kerala are fuel wood, petroleum products and electricity. Till recently Kerala has been depending solely on hydro-power for electricity, availability of which is limited due to lack of technically favourable sites and unfavourable ecological impacts. Nuclear power and fossil fuel-fired thermal stations are the other conventional sources. Owing to widespread popular opposition, because of high population density and fragile ecology, nuclear stations could not be installed in Kerala. The other alternative was fossil-fuelled thermal stations like Brahmapuram or Kayamkulam, which is also not capable of providing all our energy needs.

It is widely accepted that fossil fuels are limited, that its price will go on increasing, that they do not offer a long term solution, that they
contribute to global warming and therefore alternative sources are to be identified.

The uncertainties of mansoon and the growing demand for energy have resulted in a significant energy deficit which is growing year by year.

In order to achieve sustainable development it is imperative that the basic philosophy of sustainability is percolated down to the local level. Therefore, initiatives at the local and national levels have to go hand in hand and with equal thrusts.

In order to cater the ever-increasing demand of power, Government of Kerala has decided to give encouragement to power generation from Non-conventional Energy Sources. It is proposed to generate energy from municipal waste, agro waste, industrial waste, and sewage and other biomass, small-hydel units, solar photo voltaic, wind, tide, wave, geothermal etc. These technologies are environment friendly. The use of Municipal Solid Waste for power generation, besides generating power, will eliminate the problem of pollution and disposal of urban waste. Private investment will be attracted in all these sectors. Kerala is blessed with abundant renewable sources that could be utilized in multipleforms to provide adequate energy and essential modern amenities to people of Kerala. Most of these are also significant as potential sources to support and strengthen the existing power grid or to reduce our dependence on the fast depleting fossil fuels.

There is significant potential in the state to meet the basic energy requirements of the rural people in an economically efficient manner through the non conventional sources of energy, which is available everywhere, in view of the environmental impacts, high cost and transmission losses of the lar
From conventional power projects. The major Non Conventional Energy Sources relevant to Kerala are Solar Energy and Bio Energy.

In Kerala both government as well as private sector agencies is functioning in the field of implementation. In this study an attempt is made to study the agencies in two broad categories as agencies involved in bio energy and agencies involved in solar energy.

In Kerala the national project on biogas is implemented through ANERT- state nodal agency; Department of Agriculture- state nodal department; KVIC, BIOTECH –MNRE approved NGO zila panchayath, grama panchayaths and other independent agencies.

In Kerala there are Institutions in the Organised and Unorganised Sector for the development of non conventional energy source. In the Organised sectors ANERT is the Governmental organisation and BIOTECH is another notable Agency in the orgnised sector, and in addition there are Trainers who implement projects of their own in the Unorganised sector.

Agency for Non Conventional Energy and Rural Technology (ANERT)

Agency for Non conventional Energy and Rural Technology (ANERT) is an autonomous organization established during 1986 under Societies Act by the Government of Kerala, now functioning under power department; with its Head quarters at Thiruvananthapuram.
The objective of the Agency is to gather and disseminate useful knowledge in various fields of Non Conventional Energy, Energy Conservation and Rural Technology; conduct studies, demonstrate, implement and support implementations of schemes and projects in these fields and thereby deal with the problems arising out of the rapid depletion of conventional energy sources; update the technologies used in rural areas as well as introduce appropriate new technologies with an aim to reduce drudgery, increase production and improve quality of life. The Agency is better known by its acronym “ANERT” and has become a synonym for Renewal Sources of Energy and Energy Conservation in the State.

ANERT is guided by an Executive Committee chaired by the Chairman, Secretary Power Department and a Governing Body chaired by the Minister for Electricity, Government of Kerala to provide guidelines for ANERT’s activities in various energy related areas. ANERT is headed by a Director appointed by the Government. It is also the Nodal Agency for the Ministry of New and Renewable Energy Sources (MNRE), Government of India, to carry out the Central Programmes in Kerala.

**ACTIVITIES OF ANERT**

For the past 24 years, ANERT has been contributing significantly to the development and exploitation of New and Renewable Energy sources of the State. So far, ANERT has established a power generating capacity of 3 MW of Solar photovoltaic panels which have negated 4.2 million units of electricity; conserved 70.9 million units conventional electricity through its energy conservation programme by sparing a generation capacity of 33.2 MW; supplied solar hot water equivalent to hot water heated by 32.5 million units of electricity; generated 0.85
million units of electricity through its biomass gasification and biogas programmes and conserved 0.18 million tonnes of fire wood through its improved Chulha programme. All the above activities significantly contribute on mitigating climate change.

The different programs being implemented by ANERT are as follows:

1. Rural Village Electrification Programme (RVEP)
2. Solar Photovoltaic Programme (SPV)
4. Rural Technology
5. Solar cities and solar grid interactive programme
6. Wind Energy Programme and Small wind hybrid programme
7. Renewable Energy demonstration park
8. Total energy security mission, now being a flagship project of Govt. of Kerala
9. Micro Hydel Programme
10. Solar Thermal Energy Programme (STEP)
11. Programme on Improved Chullha (PIC)
12. Energy Conservation Programme
13. Research and Development
14. Rajiv Gandhi Akshya Urja Programme, Exhibition and awareness programme
15. RE Programme on Local self government institution
16. Other programmes

1. **Rural Village Electrification Programme**: During 2001-02, ANERT initiated a new project to electrify all the remote SC/ST colonies in the
forest area, which are away from the conventional electricity lines. In the first phase, this project has already brought light to about 6000 families of 129 colonies all over Kerala. 100 street lighting systems have also been installed in these villages. In the first phase, eleven Stand-alone Solar Photovoltaic Power Plants with an installed capacity of 40.04 KW have been established. In the second phase, 173 remote colonies are selected and completed the installations. To ensure local participation, Beneficiary Committees have been created with all beneficiaries as members under the local Panchayat President. Solar TV, Solar pumping systems and solar stills have also been provided to a few colonies to meet their additional demands.

2. Solar Photovoltaic Programme: Under this programme, ANERT distributes solar PV devices like solar lantern (64000), solar home lighting systems (7900), solar street light systems (712), solar TV power pack (150), Solar water pumping systems (deep and shallow well) (250), solar fencing energizers (10), solar vaccine refrigerators (10), solar fishermen pack (925), SPV demo kits for schools (350), PV insect light traps (4), PV rubber tappers light (120), PV modules of 35, 70 and 90W (7500). Though only a few devices have MNRE subsidy, all devices are distributed to public with a subsidy component utilizing ANERT funds.

3. Biogas Programme: Another important programme of ANERT is the Biogas programme for Night soil, Institutional and Community purposes. This programme is aimed to recover energy from waste; scientific disposal of waste; and conversion of waste into fertilizer after energy extraction; to improve sanitation, to protect environments; and also to generate employment opportunities. Biogas programmes are implemented by ANERT with financial assistance from MNRE and with active
participation of beneficiaries. ANERT has installed 102 large size biogas plants since its inception with central financial support. An average of 10 lakh m$^3$ biogas is being generated every year. These plants are installed at medical colleges, district medical hospitals, private and charitable institutions with 15 to 70 m$^3$ capacity for thermal applications and electricity generation. Of the 102 plants, 73 use night soil, 24 use canteen waste and 5 use animal waste as feed material. 5 plants generate electricity, each using a 10 KW dual fuel engine. Other plants use biogas for heating applications.

4. **Biomass Gasification**: Solid wastes such as coconut shell, husk, coir pith, rice husk, firewood, coffee husk, and other industrial wastes can be converted into producer gas by gasification route. This producer gas can be used for heating and generating electricity. During this year, ANERT has installed 2.5 lakhs kCal capacity coconut shell based gasifier at Thiruvampady, Calicut for drying copra with MNRE assistance and beneficiary share. ANERT had also installed a Briquetting machine to briquette coir pith into useful fuel without any additives, which can be used for cooking food, boiling water, and generating electricity. So far, ANERT has installed only 3 biomass gasifiers in the State with MNRE assistance. The Kerala Ceramic, Kundara at Kollam District recently installed a High efficiency Biomass direct combustion system to save SKO/Diesel to generate hot air for the factory use with 90 per cent financial support from ANERT. Now the factory is saving an approximate amount of Rs 5 lakhs per month being the cost of diesel.

5. **Grid Connected Solar Photovoltaic Power Plant**: The MNRE has sanctioned a 25 kW (p) Grid Interactive Solar PV Power plant on the rooftop of the KSEB Vydhuthi Bhavan Complex Pattom,
Thiruvananthapuram. ANERT has installed the first 25 kW Grid Interactive Solar PV Power plant of the State during March 2001 at Vydhuthi Bhavan, Kerala State Electricity Board.

6. Wind Energy Programme: ANERT in association with MNRE had conducted a detailed study of the wind potential of Kerala and this is estimated to be about 605 MW. Even though Kerala is blessed with such a high wind potential, the State could not utilize it fully for its effective harness and utilization. ANERT had prepared a detailed Project Report for establishing a Wind farm of 2 MW capacities as a demonstration project at Ramakkalmedu in Idukki District and submitted to MNRE for its approval. 20Mw wind energy generators have been installed in Kerala (Idukki, Palakkad district) with active private participation. It is expected that another 30 MW would be installed during the end of this year.

Apart this, ANERT has installed 137 wind water pumps in various parts of Kerala. Of the total 21 sites for which wind data was collected, presently 5 wind monitoring stations are recording wind data. The remaining stations have been closed or shifted after their useful service life.

7. State Level Energy Education Park: The MNRE has sanctioned a State Level Energy Park for Kerala with a financial assistance of Rs 90.02 lakhs. ANERT also contributed by providing land and Rs 40 lakhs towards development of land and building. The park is established at the existing Children’s Park in Ernakulam. The park is ready to provide awareness among the public about the use of Renewable Energy sources. This will give an opportunity for the children to see and learn all NRSE devices in operation. Apart these devices, working models and hands-on
experimental operational systems to teach the principle behind these technologies are displayed.

8. National Biomass Resource Assessment Programme: ANERT has been conducting detailed study for assessing the surplus biomass available for power generation under a National programme sponsored by MNRE. So far ANERT has completed studies at 8 taluk and the estimated power potential is about 33.5 MW. Private power producers have already shown their interests in establishing biomass based power plants in the state with their own investment.

9. Micro-hydel Programme: The state of Kerala has a large untapped potential for Small Hydro Power generation. ANERT has identified this as a thrust area of activity for the coming years and has initiated activities to mobilize potential developers of SHP in the State. Orientation training for selected Local Self Government Institutions, who are the possible developers stand alone SHP projects in remote rural areas, was conducted. A detailed training on technical aspects of SHP development was also organised to equip ANERT Engineers by Alternate Hydro Energy Centre, IIT Roorkee. The target for power generation from SHP sector in 11th plan period is 107 MW. Two microhydel plants of 10kw each have been completed by ANERT at Wynad district.

10. Solar Thermal Programme: Solar Thermal Energy Programme of ANERT is aimed at supplementing thermal energy requirements at various temperatures for different applications like cooking, water heating, industrial process heating, crop drying, space heating and water desalination by harnessing solar energy and converting it into heat using various solar thermal devices and systems. ANERT has installed 1,24,000
Lpd solar water heating systems in hospitals. So far, ANERT has installed 27626m³ collector area in Kerala. With these installations, the power conserved is equivalent to 0.84MW of conventional electricity generation capacity. Government of India is not providing any financial assistance for Solar Water Heater Programmes and hence ANERT also proposed to discontinue the practice of providing subsidy to these programs in the State, which have otherwise become commercially attractive. The present programmes undertaken are schemes to provide solar cooker for which central financial assistance is available. Apart this, ANERT has distributed 940 solar cookers, 15 solar crop driers, 3 industrial crop driers, 80 solar stills, 3 SK -14 cookers, 90 m³ of swimming pool heaters and has carried out revitalization of 10 old industrial systems.

11. Programme on Improved Chulha: Government of India has celebrated the year 2001 as women’s empowerment year. During that year, MNRE has decided to make 10000 villages “Smoke free” by the promotion of improved chulhas all over India. MNRE have allotted a target of 200 villages to ANERT for saturation of all households with smokeless chulhas. However, ANERT has selected 350 villages as “smoke free villages” and this programme is being implemented on whole village approach. ANERT has installed 817352 improved chulhas in Kerala till now including community chulhas for schools and anganwadies. MNRE has recognized ANERT chulha as a long life model. More than 140 training programs are being conducted every year to users, masons, potters, master craftsmen, NGOs and SEWs. ANERT received National award for three times for the best performance and its functionality.
12. **Energy Conservation Programme**: ANERT had conducted a study to compare locally available CFL with Electronic ballast with the CFLs with Electronic Ballast distributed by ANERT with respect to their performance. Various parameters such as Operating Voltage Range, Power Consumption, Power factor, Output Voltage Waveform, Harmonics, Circuit efficiency, Operating Frequency and Light output were considered for comparison. The study brought out the superiority of ANERT systems over locally available ones with respect to the tested parameters. ANERT systems are found to be better whether the commonly used figure of merit pay back period or ‘lumen hour per rupee’ was used for comparison. ANERT has distributed with subsidy 120000 electronic chokes, 470000 CFL with electronic ballast, 150000 pressure cookers and 180000 high efficiency kerosene stoves towards energy conservation.

13. **Research and Development**: ANERT is the only Nodal Agency in India which has as an exclusive division for carrying out R&D in the area of Renewable Energy sources and technologies. ANERT is recognized by DSIR, Government of India as an R&D Institution. As part of establishing the facilities, ANERT has established modern state of the art laboratories to carry out performance analysis of devices like solar lanterns, solar home lighting systems, solar street lights, SPV demo kits, SPV modules, CFL ballast, CF tubes, electronic choke, electronic fan regulator with an outlay of about Rs 150 lakhs. This facility can also be used by other institutions, R&D agencies, Panchayats and private manufacturers for a test fee. Scientists of ANERT have published more than 50 articles in International and National Journals and Conferences. More than 15 M.Tech and 45
B.Tech projects have been carried out by students of various engineering colleges in ANERT.

Some of the important outcome of the R&D activities includes:

a. SPV Battery Charger for Rubber Tapper’s Light
b. Computer controlled test rig for testing the performance of a CFL electronic adaptor
c. A high efficiency pulse charger for battery for use in many ANERT devices
d. An SPV demonstration kit for distribution to schools to propagate various applications of solar photovoltaics
e. A digital, compact, hand held PV solarimeter using solar cell to measure the instantaneous solar global radiation.
f. An efficient solar still for enhanced yield of potable water
g. A Data acquisition system for remote SPV power plants
h. An SPV light trap for insects
i. Testing and certification of Solar PV, solar thermal and energy conserving devices
j. Conducting of instrumented Energy Audits in Industries
k. Turn-key execution of NRSE projects

14. Promotional Activities: Every year ANERT conducts more than 10 business meets with financial assistance from MNRE and IREDA to promote business and to develop industries based on non conventional energy. At present, there are more than 9 industries manufacturing PV and energy conservation devices in Kerala. Training programs are arranged by ANERT for making service facilities available to public throughout Kerala. Recently ANERT has completed 4 training programs in this area exclusively for women. ANERT has a mobile demonstration van and an
electric vehicle to spread the use of NRSE. ANERT participates every year in more than 698 exhibitions by displacing devices in stalls.

15. **Interaction with Other Institutions**: ANERT has been maintaining a close relationship with National Research Institutions like TERI, CUSAT, CPRI, ERTL, Anna University, IITs and IISc- Bangalore. ANERT has been jointly conducting research projects with CPRI on the Development of Biomass based gasifier coupled with Stirling Engine and Development of thin films for PV applications using electrodeless bath deposition techniques with CIUSAT. Two GEF projects briefs using anaerobic digestion and gasification based technologies are being prepared with the help from TERI for financial support. Anna University is helping ANERT to conduct trials on the coir pith briquetting machine with the help from three more industries.

16. **Other Facilities Available**: It includes:

a. VSAT facility for Internet browsing and e-mail communications
b. Net work of more than 40 computes
c. Library with more than 3000 books, International and National journal, videos, maps and charts, photos relating to Renewable Energy
d. Data bank of more than 10000 technical articles on NRSE in computer ready format for R&D purposes
e. A website for information dissemination
f. E-mail communication system
g. Seminar and conference facilities with all modern audio visual presentation systems
h. Facilities for undertaking consultancy works in all areas of Renewable Energy
BIOTECH

BIOTECH was started in 1994 though the idea was conceived much earlier during the eighties. It focuses attention on research, development, production of Renewable Energy, especially Bio Energy Programmes with the active co-operation of other government and non governmental organizations especially local bodies.

It has received several awards including Ashden (International Green Oscar) Award 2007. The Ashden Award is an award for projects with outstanding achievements in the field of sustainable energy in the UK as well as in the developing countries. The award takes place once a year.

In consideration of the stupendous efforts made by BIOTECH to propagate energy conservation devices and energy generation programmes through non conventional Energy Sources and waste management system, Kerala State Energy Management Centre, honoured them four times with the “Energy Conservation Award” as the best NGO for the years 1999, 2002, 2003 and 2007. More than 15 inventions have been added to the credit of BIOTECH related with waste to energy programmes. BIOTECH has developed different models of waste treatment plants suitable for use under different geographical conditions.

BIOTECH do implement projects suitable to treat bio waste at the domestic level and public institutions like Hospitals, Hostels, Convents and Slaughter Houses. BIOTECH also provides eligible subsidy for waste to energy projects.

It implements programmes throughout the State in association with Local bodies. It renders consultancy services for the preparation of
projects, feasibility study, site visit, project implementation, awareness programme, exhibitions, seminars and symposium and for demonstrations related with waste treatment. There are opportunities for the unemployed especially youths for getting training and jobs under the programme of BIOTECH. Different awareness programmes conducted by BIOTECH includes:

**ENERGY CLUBS:**

BIOTECH organises Energy Clubs in both rural and urban areas, with the association of local NGOs, who are actively involved in the development programmes. They provide proper training and renders awareness among the members of the club. Under this programme they had organised 26 Energy Clubs in various places, which were actively functioning now.

**VIDEO DOCUMENTARIES:**

Realising the importance of video messages to produce spontaneous reactions and understanding among the public, BIOTECH initiated and produced video documentaries on subjects related to Non conventional energy programmes and energy conservation programmes. These programmes are broadcasted through various TV Channels.

**MUSEUM:**

To create awareness about non conventional energy programmes and conservation of energy to the general public, BIOTECH has started a permanent museum at the head office premises. The number of energy saving devices and non conventional energy equipments has been exhibited in the museum.
EXHIBITIONS:

They are participating on various exhibitions at regional, national and international levels. There programmes includes exhibitions of different energy saving devices and bio gas plants in public places, schools and colleges.

WOMEN EDUCATION PROGRAMMES:

Women are the real users of cooking fuels. If they are properly educated and an awareness is created among them for the beneficial use of biogas, energy saving devices etc., there will be considerable reduction in the consumption of fuel. BIOTECH is taking more effort in this field with the cooperation of residents associations and social service clubs.

ROAD SHOW:

They are organising a permanent road show van, which helps to demonstrates the use of non conventional energy in public places. This system is very effective in creating awareness about bio gas plants in the general public.

RESEARCH AND DEVELOPMENTAL ACTIVITIES:

For the proper development and for providing better service to the beneficiaries, BIOTECH is conducting regular Research and Development programmes on Bio Energy and Waste Management.

BIOTECH – Bio-Energy Plants for Clean Environment

1. **Domestic Waste Management**: The Research and Development Wing of BIOTECH developed nine different models of Domestic Waste Treatment
Plants catering to the taste and demands of beneficiaries. All the bio degradable waste and organic waste water generated in every house can be hygienically treated at source for producing cooking gas – an alternate source of conventional fuel.

2. **Institutional Waste Management**: Waste of food materials and other bio degradable waste produced in Convents, Hostels, Hospitals, Hotels and Other industrial organizations can be treated in an eco-friendly way by hygienic Waste disposal method and production of cooking gas in a very large scale.

3. **Night Soil Biogas Programme**: Night Soil from public institutions like Hostels, Convents and Hospitals can be treated for the production of biogas as a sustainable source of energy. These plants are capable for treating food waste also. This technology is highly cost effective and the construction of Septic Tank can be totally avoided.

4. **Eco-friendly Toilets**: Bio Waste and Night Soil produced in every household can be subjected to hygienic treatment for production of cooking gas. These eco-friendly Toilets are most convenient waste disposal system for people living in coastal area, marshy land and high water table areas.

5. **Electricity from Bio Waste**: Easily degradable bio waste, waste water and blood generated in public markets, slaughter houses and such other public institutions can be treated hygienically using bio mechanization technology at source for production of electricity. BIOTCH launched Kerala’s first ever bio waste treatment electricity generation projects.

6. **Integrated Waste Management (BIOTECH Model)**: With the intention of containing the menace of bio waste and the problem of health and hygienic it brings, BIOTECH developed an Integrated Waste Management System combing five different technologies in a project. The specialty of
the of the projects is that it will help to treat wastes of various types like fast decomposing, slow decomposing, non-degradable, blood and waste water.

BIOTECH has built more than 15,000 biogas plants of which the big majority seems to run well.

**Kerala State Agricultural department**

The Kerala State Agricultural Department is engaged in the implementation of biogas plants in the grass root level as state nodal Department. Installation of biogas plant on turn key basis is approach followed by them. Implementing agency is required to work out feasibility report giving estimates of plant capacity, finances needed resource inputs and identification and availability of locally available materials both in plant.

The agricultural department has the advantages of utilizing the services of the panchayath/agriculture extension officers and village level workers for promotion of biogas through their functional linkage at district, block, panchayat and village level. But this facility is not available to the other implementing agencies having set up only up to the district level.

**Khadi and Village Industries Commission**

KVIC has a few supervisors/technicians at the state level earmarked for all non-conventional energy programmes. They now train the people after that training they are designated as Trainers. Now they
carryout non conventional energy development programmes by they themselves.

Non Governmental Organisations in Kerala

The following are the Non Governmental Organisations in Kerala engaged in the development and use of non conventional sources:

1. Mithradam

It is an institution registered under societies Act and started functioning from 1995, located at Chunangamveli village, 16 km from Kochi International Airport. Along with different other charitable activities, they are also promoting implementation of various solar energy projects like, solar photovoltaic power plant, solar home lightning systems, solar street lamps, solar water pumping systems, solar water heaters, solar tunnel dryer etc.

Mithradham, together with local government administration undertakes projects for installation of home lighting systems especially for economically backward families without connection to the public electricity supply network. This is helpful for students who have to study under polluting oil lamps. The project engages technical personnel in P-V from the centre.

2. Jyothy Biogas and Rural Social Service Centre Chemboor:

This was organized in the year 1999 with the aim of generating biogas in rural and urban areas by construction of biogas plants. They are popularizing biogas plants along with their other major social services.
3. **Energy Conservation Society**

   Energy Conservation Society (ECS) is a non governmental organization functioning in Kerala. They are involved in promoting conservation of energy environment and sustainable development. They are only popularizing the message.

**Major Private Agencies in Kerala**

a. **V-GUARD Industries Limited**

   V-Guard Solar Water Heaters! a truly International quality product manufactured at use the highly efficient Evacuated Tube Collector system enabling optimal utilization of solar energy. The PUF insulated stainless steel storage tank prevents heat loss. V-Guard Solar Water Heaters dramatically cut electricity bills, help conserve energy and are environment friendly. They are available in 100 Lpd, 125 Lpd, 200 Lpd, 300 Lpd, 500 Lpd and 1000 Lpd for domestic use, and are easy to install and last a lifetime.

   V-GUARD ETC solar water heaters are also manufactured for industrial applications that is for pool heating, large hotels, large hospitals and factories and are available in 2000 Lpd, 3000 Lpd, 4000 Lpd and 5000 Lpd and also according to the requirements.

   They are using solar water heaters with International ETC (Evacuated Tube Collector) technology, which is efficient in absorption and utilization of solar energy with minimal heat loss. Approved by MNRE, Solar Water Heaters are eco-friendly and non-polluting as they do not consume electricity or fuel to heat water.
b. **Hykon India Private Limited**

Hykon India Private Ltd is a part of a Multi-Crore Hycon group of companies engaged in the design, production, and implementation and after sales services of products like inverter, UPS, servo stabilizer, solar water heater, solar lighting systems for around 17 years. They are playing a major role in the implementation of solar products in Kerala with its Head Office at Thrissur.

c. **Kraft Work Solar Private Limited**

Kraft work solar was established in 1993 for the manufacture of solar water heaters. They are the pioneer of solar water heating technology in Kerala with over a decade of experience in manufacturing and erecting solar water heaters with their office at Cochin.

d. **Flare Up**

Flare up is mainly deals with solar water heaters, located at Cochin. They are involved in the design, installation & maintenance of state-of-the-art, environmentally clean, efficient, economical and easy to maintain small to large capacity solar water heaters for domestic, commercial and industrial purposes.

e. **Tata BP Solar**

Tata BP solar a major player in the market, has a dealer network throughout the country and also conduct awareness programmes for grass root level organizations to influence the markets in their respective areas.

f. **ABR Solar Agencies**

It is a private agency involved in the implementation of all kinds of solar products, such as solar lanterns and solar home lighting system,
solar street lighting system, solar water heaters etc. There area of operation is including in entire districts in Kerala state as well as neighbouring states of Karnataka and Tamilnadu. They are approved suppliers of products to ANERT and many other national and international companies, organizations individuals, institutions etc.

g. Other Related Institutions

**Total Energy Mission:** The major thrust in energy sector for the eleventh five-year plan is to achieve Total Energy Security for the State. Accordingly the flagship project, Total Energy Security Mission was launched. The Programme aims at converging various initiatives of local governments with those of agencies promoting rural electrification and non conventional energy in the state and with the new initiatives in rural electrification and in energy sector launched as a part of the Common Minimum Programme by the Government of India.

The status of household electrification in Kerala is surprisingly poor and Kerala ranks 11th in the 2001 census below Gujarat, Karnataka and Tamil Nadu.

The percentage of unelectrification houses among the BPL families varies from 24% to 50 per cent. As much as 70 per cent of the ST colonies are still un-electrified.

**Energy Management Centre**

The Energy Management Centre (EMC) in Kerala established in 1996, under Department of Power, Government of Kerala as an R & D Centre is now becoming the state designated agency to enforce Energy Conservation Act, 2001 in Kerala. With the prime objective of attaining
energy efficiency in all sectors of economy, EMC is formulating and implementing energy management programmes and projects. It is promoting SHP (Small Hydro Projects) developments in the state. The UNIDO opened its first Regional Centre for SHP in EMC for catering to the needs of the state and also for the South Asian Countries. The first off grid SHP was implemented in Mankulam Panchayat. This Panchayat is the only local body in Kerala, which generates, transmits and distributes electricity to the people.

Kerala government is mulling to put its Secretariat under the solar energy fold. State government has authorized KINFRA - its infrastructure-building organ - to set up a park for making products from non-conventional energy. About Rs 15 crore has been earmarked in the state Budget for the next financial year for this backward integration.

The State is considering bringing the stadium adjacent to the state Secretariat too within the solar energy ambit. Although often identified a costly option for power generation, SPV (Solar Photovoltaic) Programme is found convenient for far flung villages, where the existing grid cannot be extended. While in the remote areas and North-east, MNES allows up to 90 per cent subsidy, in central areas this is only 50 per cent. The state's non-conventional energy promotion outfit ANERT had prepared the detailed site surveys and DPRs for the rural electrification through SPV programme.
Integrated Rural Energy Programme IREP

The Integrated Rural Energy programme (IREP) in Kerala is being implemented with MNRE assistance with an objective of promoting various activities in the rural areas for ensuring energy security by enhanced utilization of renewable energy sources.

One of the major activities under this programme is the implementation of MNRE assisted/sponsored programmes like SPV water pumping, Rural/Cluster of village electrification, Solar cooker, Wind mills, Renewable Energy Park, Waste to energy projects etc. Subsidy from ANERT @ 40 per cent of MNRE’s financial assistance is also envisaged for these programmes.

As part of the Integrated Rural Energy Programme (IREP) of the Government of India, 28 of the 152 rural development blocks in Kerala has been selected as IREP blocks. ANERT has an office consisting of a Project Officer, Project Engineer and supporting staff in each of these blocks. Thus there are 2 offices in each of the 14 districts of Kerala.

The present trend shows that the state cannot pull on further without developing other modes of energy projects such as biogas, solar, wind, waves etc. along with nuclear and coal energy. Only by bettering the power position, the state can attract industrialists to start new industries and augment the power capacities of existing industries. The development of our state can be hastened only through adequate, industrial and economic growth, which can be achieved only with a stable and reliable power supply.
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