

India

Renewable Energy Report



APCTT-UNESCAP

**Asian and Pacific Centre for Transfer of Technology
Of the United Nations – Economic and Social
Commission for Asia and the Pacific (ESCAP)**

This report was prepared by Shirish Garud National Expert India Sr. Regional Manager, REEEP, South Asia Secretariat, New Delhi under a consultancy assignment given by the Asian and Pacific Centre for Transfer of Technology (APCTT).



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Abbreviations

AHEC	Alternate Hydropower Energy Centre
APCTT	Asia Pacific Centre for Transfer of Technology
BPL	Below Poverty Line
CASE	Commission for Additional Sources of Energy
CDC	Consultancy Development Centre
CEL	Central Electronics Limited
CERC	Central Electricity Regulatory Commission
CET	Centre for wind Energy technology
CPP	Consultancy Promotion Programme
CSIR	Council of Scientific and Industrial Research
CSIR	Council of Scientific and Industrial Research
CWET	Centre for Wind Energy Technology
DNES	Department for Non-conventional Energy Sources
DSIR	Department of Scientific and Industrial Research
EE	Energy Efficiency
GEDA	Gurajat Energy Development Agency
GoI	Government of India
IIT	Indian Institute of technology
INR	Indian Rupee
IRDPP	Industrial R&D Promotion Programme
IREDA	Indian Renewable Energy Development Agency Limited
IT-eG	Information Technology & e-Governance
ITTP	International Technology Transfer Programme
KVIC	Khadi Village Industries Commission
LEDeGE	Ladkah Ecological Development Group
MEDA	Maharashtra Energy Development Agency
MERC	Maharashtra Electricity Regulatory Commission
MNC	Multi National Companies
MNES	Ministry of Non-Conventional Energy Sources
MNRE	Ministry of New and Renewable Energy
MoP	Ministry of Power

MTOE	Million Tonnes of Oil Equivalent
NAPCC	National Action Plan on Climate Change
NGOs	Non Governmental Agencies
NIF	National Innovation Foundation
NIRE	National Institute for Renewable Energy
NPL	National Physical Laboratory
NRDC	National Research Development Corporation
NRSE	New and Renewable Sources of Energy
PV	Photovoltaic
R & D	Research and Development
RE	Renewable Energy
REC	Renewable Energy Certificates
RETs	Renewable Energy Technologies
RGVY	Rajiv Gandhi Grameen Vidyutikaran Yojna
RPO	Renewable Purchase Obligations
SEC	Solar Energy Centre
SERCs	State Electricity Regulatory Commission
SHP	Small Hydro Power
SNA	State Nodal Agencies
SVO	straight vegetable oils
TDDP	Technology Development and Demonstration Programme
TDIP	Technology Development and Innovation Programme
TDUPW	Technology Development Utilization Programme for Women
TEDA	Tamilnadu Energy developmentAgency
TePP	Technopreneur Promotion Programme
TIFP	Technology Information Facilitation Programme
TMP	Technology Management Programme
TPDU	Technology Promotion, Development and Utilization Programme
VESP	Village Energy Security Programme
SRISTI	Sustainable Technologies and Institutions
GIAN	Gujarat Grassroots Innovations Augmentation Network
ICCIG	International Conference on Creativity and Innovation at Grassroots

Introduction

This comprehensive report covers the status of the renewable energy technologies (RETs) in India. This was prepared for the Asia Pacific Centre for Transfer of Technology (APCTT) under a project which aims to develop network of institutions and organisations working in renewable energy sector and an institutional cooperation mechanism to strengthen the capacities of the countries in the Asia Pacific region to promote the adoption and utilisation of RETs.

The information was collected through comprehensive primary and secondary data search, literature review and direct information collection from experts and stakeholders.

The report is structured as per the requirements of the APCTT. Efforts have been made to make the report as comprehensive as possible. However, considering the development of RETs in India over last few decades, dynamics and spread of its RE markets some information may need further elaborations.

Geography of India

India is a country in South Asia that lies on the Indian plate in the northern portion of the Indo-Australian Plate. India lies between 8° 4' and 37° 6' north latitude and 68° 7' and 97° 25' east longitude. It is the seventh largest country in the world, with a total land area of 3, 287, 263 sq km. It has land frontier of 15, 106.7 km and a coastline of 7, 517 km. India is bound to the southeast by the Arabian Sea, to the southwest by the Bay of Bengal and the Indian Ocean to the south and the great Himalayan mountain range in the north.

India shares its borders with China, Bangladesh, Bhutan, Nepal, Afghanistan, Myanmar and Pakistan.

Demography

India is home to about 1.17 billion population (estimated for July 2009) comprises about one-sixth of the world's population with estimated population growth rate of 1.548%.

Rural population is estimated at 72.2% and urban population at 27.8%. It is important to understand the fact that the developmental needs of the urban and semi-urban or peri-urban areas are vastly different from those of the rural areas and for a large developing country like India renewable can play an effective role in the developmental process.

Urban sector

There are 4378 urban agglomerations and towns in the country, of these, 423 towns have a population of more than 0.1 million. These are 35 urban agglomerations and cities with a population of over 1 millions. The total number of urban households in the country as per 2001 census is 53.7 million.

Shortage of electricity in urban areas has been one of the chronic problems faced by the urban India. In an effort to mitigate the energy problems of cities and to provide alternative energy solutions for industrial and commercial establishments, the MNRE (Ministry of New and Renewable Energy) has focused on the development and applications of the following:

- Solar energy programmes
- Energy recovery from urban wastes and industrial wastes
- Biomass energy and co-generation in industries

Rural sector

It is said that the India lies in its thousands of villages. India has more than 0.5 million villages which comprise the rural sector. As far as the energy sector is considered the rural sector can be categorised broadly in two major categories

a. Remote rural villages.

These are villages/ hamlets in the far flung areas mostly in forests and /or on the forest – fringe areas.

b. Other villages

Out of total 0.5 villages in India about 1, 25,000 villages are yet to be electrified. It is estimated that about 20,000 villages which are in remote areas cannot be connected to grid in near future. MNRE has initiated a special programme called VESP (Village Energy Security Programme) in 2005 for off grid electrification while the MoP (Ministry of Power) initiated a program called as RGGVY (Rajiv Gandhi Grameen Vidyutikaran Yojna)¹ in April 2005 to extend grid to all such villages.

Subsequently, **rural electrification policy was introduced in August 2006. The policy aims at:-**

- 1. Provision of access to electricity to all households by year 2009.**
- 2. Quality and reliable power supply at reasonable rates.**
- 3. Minimum lifeline consumption of 1 unit per household per day as a merit good by year 2012.**

The approach to electrification suggested in the policy includes both extension of grid as normal way of electrification and use of off-grid solutions based on renewable energy and/ or other sources such as diesel based power generation. Most

¹ This translates as Rajiv Gandhi rural electrification scheme

importantly the Ministry also modified the definition of village electrification which now stands as:-

1. The basic infrastructure such as distribution transformer and or distribution lines is made available in the inhabited locality within the revenue boundary of the village including at least one hamlet/Dalit Basti as applicable and
2. Any of the public places like Schools, Panchayat Office, Health Centres, Dispensaries, Community centers etc. avail power supply on demand and
3. The ratings of distribution transformer and LT lines to be provided in the village would be finalized as per the anticipated number of connections decided in consultation with the Panchayat/Zila Parishad/District Administration who will also issue the necessary certificate of village electrification on completion of the works.
4. The number of household electrified should be minimum 10% for villages which are unelectrified, before the village is declared electrified.

It can be observed that the government has initiated various developmental programmes and policies which incorporate renewable energy as an integral part of the development process. This has been a very progressive step in promoting renewable as an effective tool for rural development.

Legislature

India, a union of states, is a Sovereign, Secular, and Democratic Republic with a Parliamentary system of Government. India has 28 states and seven unions. The president is the constitutional head of the Executive of the Union. In the states, the Governor, as the representative of the President, is the head of Executive. The system of government in the states closely resembles that of the Union. Union Territories are administered by the President through as Administrator appointed by him. The parliament of India has two houses- Loksabha and Rajya Sabha.

Economy

Indian economy is the fourth largest economy of the world and also one of the fastest growing economies in the world. The economic growth is fuelling demand for energy. While the Indian economy registered an average growth of 8.8% during the five years ending 2007-08, its growth is slacking today mainly due to the impact of global economic crisis¹.

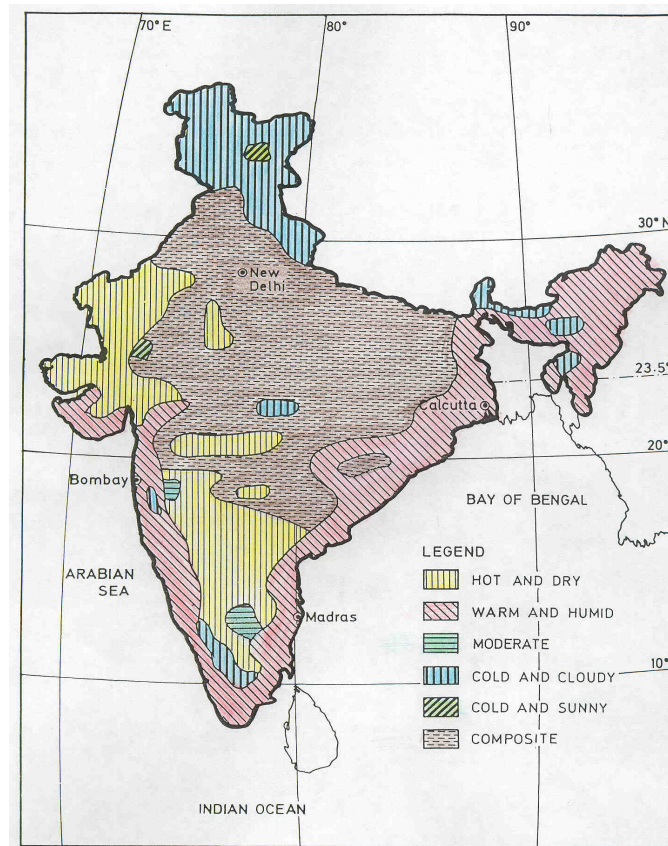
¹ www.ficci.com/indian-economy/indian-economy-nov.pdf accessed on 10th July 2009

Climate

Climatic conditions vary across the India. Climatically it is divided in five climatic zones. These are shown in Figure 1.1 below. These include

- Hot- Dry
- Warm-Humid
- Composite
- Temperate and,
- Cold

The need of energy is very much climate specific so also the potential of some of the renewable energy resources.



Climate	Mean monthly temp (°C)	Relative humidity (%)
Hot and dry	> 30	< 55
Warm and humid	> 30	> 55
Moderate	25 - 30	< 75
Cold and cloudy	< 25	> 55
Cold and sunny	< 25	< 55
Composite	When six months or more do not fall within any of the above categories	

Figure 1.1 Climatic zones in India

CHAPTER 2 Energy supply and demand in India

This chapter provides a brief review of India's energy supply and demand situation including electricity sector.

Primary energy supply and demand: Current situation

In 2008-09 India's primary energy supply was 555 MTOE while trends in primary energy consumption over the past few years are shown in the Figure 2.1 below.

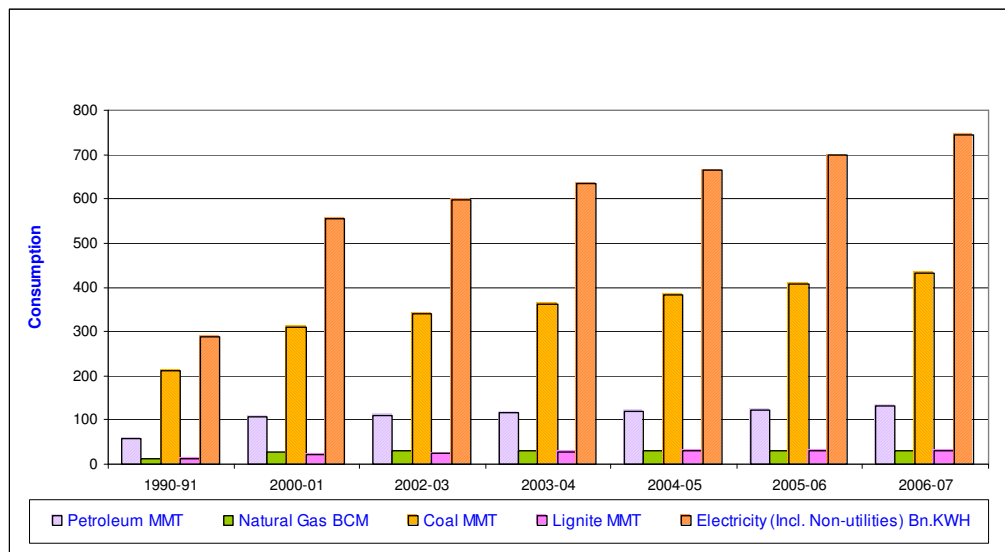


Figure 2.1 Primary energy consumption from 1990-91 to 2006-07

(Source: TEDDY, 2008)

India's energy sector is heavily dependent on coal, petroleum and natural gas. While India has proven reserves of these fossil fuels the country is dependent on the import of fuel. Currently, about 75% of its petroleum demand is met by imports. This is likely to increase in future as the reserves are limited.

Power sector overview

India's installed capacity for electricity generation was 149.4GW as on March 31, 2009 and average per capita consumption of electricity is about 630kWh/ year. Power generation installed capacity by source is shown in Figure 2.2.

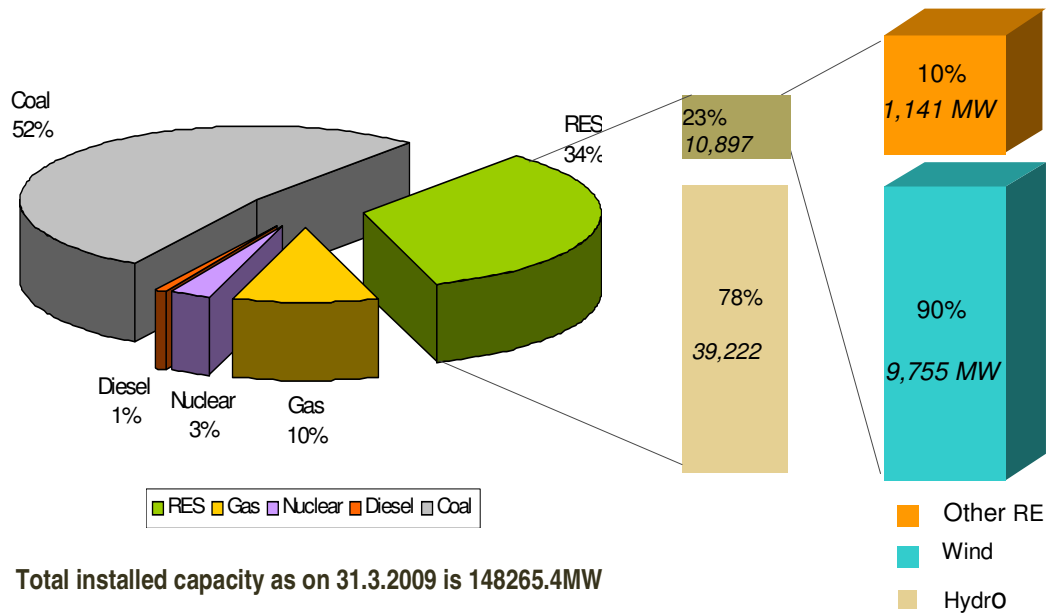


Figure 2.2 Installed generation capacity by resources (MW)

As can be seen, renewable energy without large¹ hydropower constitutes to about 7.7% for the installed capacity and 6% of the total power generation. This does not include off grid electrification plants and thermal devices which save electricity.

Status of electrification

It is estimated that in 2009 about 56% of rural households and 93% of urban households were electrified. 78 million households do not have access to electricity.

Importantly, there is a power shortage of about 11.6% and peak power shortage of about 15% impacting productivity and quality of life of the resident.

Rural electrification

As per 2001 Census, out of about 138million rural households, only about 60.2 million households use electricity as a source of lighting. Still there are about 0.125 million villages to be covered by electricity.

¹ Hydropower plants having installed capacity more than 25MW are termed as large hydro project. These projects have dam for water flow control. Small hydroplants having capacity less than 25MW are covered by MNRE schemes and these are mostly run of the river type.

Rural electrification is a vital programme for socio-economic development of rural areas of India. The objectives of rural electrification programmes are;

- to trigger economic growth and generate employment by providing electricity as an input to rural industries and commercial sector
- to improve the quality of light by providing electricity for lighting and other usage in residential and institutional sector.

A major scheme for rural electricity infrastructure and household electrification named, RGGVY (Rajiv Gandhi Grameen Vidyutikaran Yojana) was launched in 2005. The scheme aims to provide electricity to all villages and habitations, provide access to electricity to all households and give free of charge electricity connection to BPL (below Poverty line) families. Although the focus of RGGVY program is on electrification through grid extension, the possibility of developing local minigrids based on locally available renewable energy resources is also part of the program.

Besides this, the MNRE (Ministry of New and Renewable Energy) has recently launched a program named VESP (Village Energy Security Program) which aims to provide electricity to remote rural areas through locally available renewable energy resources. It is estimated that about 6000 remote villages will be covered under this program. Currently, demonstration projects are being implemented under this scheme.

Future of energy demand and projected supply situation

Estimated growth in the demand for electricity as predicted by the planning commission report on Integrated Energy Policy is shown in Figure 2.3 below.

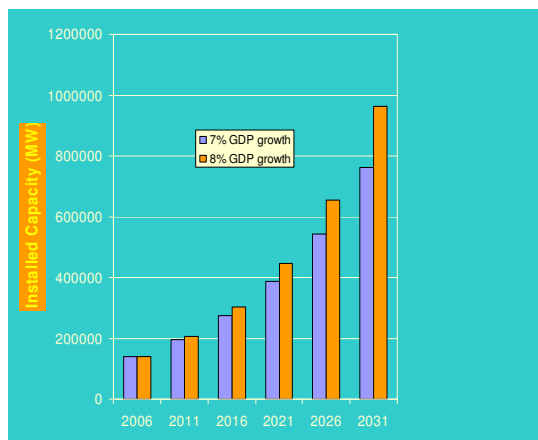


Figure 2.3 Projected requirement of installed capacity of electricity generation in India (2006-2031)

Source: Planning Commission, 2005

Energy sector concerns

It can be summarised that India's major concerns related to energy sector are:

- Energy security at national level and village level
- Access to modern energy for large rural population
- Access to electricity and
- Reduce fuel consumption across all sectors

As we will observe in the next chapters, the Government of India has long before in 1970's identified renewable energy as one of the major energy resource to tackle these issues in faster and environmentally benign way. It's important to see the development of renewable energy sector in India from this perspective as the lessons learned and valuable experience gained can be useful for countries in the region.

CHAPTER 3 Regulatory and policy initiatives for renewable energy sector in India

Background

Recognizing the importance of the renewable sources of energy, CASE (Commission for Additional Sources of Energy) was set up, under Department of Science and Technology, Ministry of Human Development, Government of India, in 1981 with the objective to develop, and demonstrate renewable energy technologies. Subsequently, in 1982, the Department for Non-conventional Energy Sources (DNES) was created in the Ministry of Power, which was later upgraded to the Ministry of Non-Conventional Energy Sources in 1992. In the early 80's the focus was on research and demonstration of renewable energy technologies in India. Different programmes in renewable energy technology were initiated by the DNES promoting renewable energy technologies through financial support (subsidy). Since then the sector has undergone many phases of development such as the 'classical' development cycle with initial stage of technology development and demonstration, followed by the policy and financial incentives for market creation. On the financing front, in order to overcome the barrier of high initial cost and high financing risk perception of the renewable energy technologies; IREDA (Indian Renewable Energy Development Agency Limited) was established in March 1987 as a public sector enterprise to finance renewable energy projects. IREDA provides loan for renewable energy projects at lower than market interest rates.

In 1993 the Ministry prepared 'Guidelines for procurement of power from Renewable energy sources' which guided various state utilities regarding purchase price for power from renewable energy sources. In addition to the price, the guidelines were provided for other issues like interconnection, wheeling of power etc. These guidelines were adopted at different scales by different state utilities in India.

Energy sector reforms started in the 1990's with formation of Central and State Regulatory Commissions and unbundling and privatisation of government- controlled utilities.

In June 2003 the Electricity Act 2003 was notified. This act has specific provision for power generation through renewable energy. It mandated the state level regulatory commissions to specify quota for procurement of power from renewable sources of energy. The act has accelerated the development of RE sector in India.

Although India does not have a renewable energy policy various other energy and power sector policies have defined role of

renewable and have specific provisions which are instrumental in accelerating the development of the sector. A brief overview of such policies and Acts is covered in the following sections.

Electricity Act 2003

The Electricity Act 2003, mandates the state regulatory commissions to specify a percentage, of total power consumed, to be purchased from renewable energy sources through the section 86(1)(e) which defines functions of State Regulatory Commissions as *'to promote co-generation and generation of electricity through renewable sources of energy by providing suitable measures for connectivity with the grid and sale of electricity to any persons, and also specify, for purchase of electricity from such sources, a percentage of the total consumption of electricity in the area of a distribution licensee'*.

As per the provisions (section 3(1)) of the Electricity Act 2003, the Ministry of Power, Government of India also notified the National Tariff Policy on January 6, 2006. Some of the important provisions with regard to non-conventional energy generation are given below.

National Tariff Policy

National tariff policy has important provision of renewable energy quota for utilities. The same is quoted below

Section 6.4

Pursuant to provisions of section 86(1) (e) of the Act, the Appropriate Commission shall fix a minimum percentage for purchase of energy from such sources taking into account availability of such resources in the region and its impact on retail tariffs. Such percentage for purchase of energy should be made applicable for the tariffs to be determined by the SERCs latest by April 1, 2006.

Such procurement by Distribution Licensees for future requirements shall be done, as far as possible, through competitive bidding process under Section 63 of the Act within suppliers offering energy from same type of non-conventional sources. In the long-term, these technologies would need to compete with other sources in terms of full costs.

The Central Commission should lay down guidelines within three months for pricing non-firm power, especially from non-conventional sources, to be followed in cases where such procurement is not through competitive bidding.

Renewable Electricity Purchase Obligations Implementation of Section 86 (1) (e) of the Electricity Act 2003 and Section 6.4 (1) of the National tariff Policy are underway. Different states are in the process of issuing tariff orders for renewable energy based electricity generation and specifying quota/share for power

from renewable energy in accordance with the provisions of the “Electricity Act 2003”.

The present status of issuing tariff orders and specifying quotas for renewable energy procurement in some of the major Indian states is summarized in Annexure-I. The quota obligations are excluding the generation from hydro projects above 25MW.

National Electricity Policy¹

Announced in 2005 in compliance of Section 6 of the Electricity Act 2003, the National Electricity Policy aims to achieve following objectives

- Access to Electricity - Available for all households in next five years
- Availability of Power - Demand to be fully met by 2012. Energy and peaking shortages to be overcome and adequate spinning reserve to be available.
- Supply of Reliable and Quality Power of specified standards in an efficient manner and at reasonable rates.
- Per capita availability of electricity to be increased to over 1000 units by 2012.
- Minimum lifeline consumption of 1 unit/household/day as a merit good by year 2012.
- Financial Turnaround and Commercial Viability of Electricity Sector.
- Protection of consumers’ interests

National Electricity Policy has accelerated the village electrification programs mentioned earlier.

Semiconductor policy

Recently announced semiconductor policy offered substantial incentives for the semiconductor industries including solar photovoltaic industries. This has attracted about 18 projects in solar PV sector having investment potential of Rs 135 billions.

Generation based incentives for solar and wind energy

In January 2008, the ministry announced generation based incentives for solar power projects and scheme for supporting solar power projects totalling to 50MW capacity. The incentives were first of its kind for grid connected solar power projects. Solar photovoltaic projects were offered incentive of up to Rs 12/ kWh for 10 years and solar thermal power projects were offered incentive of up to Rs10 / kWh for projects

¹ National Electricity Policy, CEA, available at http://www.cea.nic.in/planning/national_Electricity_policy.htm accessed on June 14, 2009

commissioned before December 2009. This policy generated lot of interest in industry. Subsequently, some states like Gujarat, Rajasthan, Punjab etc also came out with their own incentive schemes for solar projects.

This was followed by generation based incentive of 0.5 Rs./kWh for wind projects which do not claim accelerated depreciation was announced in 2008. These are available for total 50MW capacity projects on first come first served basis.

National Action Plan on Climate Change

Announced in 2008, the NAPCC (National Action Plan on Climate Change) was announced in 2008. It aims to tackle the problem of climate change by initiating eight focussed missions namely:

- National Solar Mission
- National Mission on Sustainable Habitat
- National Mission on Enhanced Energy efficiency
- National Mission on Himalayan Ecosystem
- National Mission for a “Green India”
- National Mission for Sustainable Agriculture
- National Mission on Strategic Knowledge for Climate Change.

National Mission on Solar Energy focuses on increasing use of solar energy for large scale electricity production, distributed electricity production and solar energy industries development. The formal mission will be announced soon in November 2009.

The impact of these policies is visible if one looks at the development of grid connected renewable energy electricity projects in India. Figure 3.1 below shows the development of the grid connected RE in India.

REC scheme

As can be seen that (refer Annexure I) the RPO quota varies from as high as 10% for Tamilnadu to nil in many cases. This is mainly due to the different level of development and limited availability of resources in the states. This is one of the issues which can be tackled by introducing renewable energy certificates (REC) and the Central Electricity Regulatory Commission (CERC) has recently come out with the notification for implementing REC scheme from April 2010.

Initial work on development of REC scheme was carried out by TERI under a project funded by British High Commission. The Maharashtra Electricity Regulatory Commission (MERC) was one of the partners in the project along with the University of Warwick, UK. Building on that research CERC has now come up with notification for implementation of REC scheme across the country. The REC scheme aims to decouple the electricity pricing and environment and other benefits of the renewable

energy based electricity production. The electricity will be sold at the average purchase price of the distribution company while renewable energy certificates will be issued to the generating company which it can trade with distribution companies across the country. One REC will be issued for each MWh of electricity sold. The distribution companies can fulfil their RPO obligation by producing adequate number of the RECs as required. This will enable the states like Delhi or Goa which has limited RE resources to have RPOs at par with the other states and distribution companies in these states can meet their RPO obligations using RECs purchased by them. Thus major barrier for development of RE in India, i. e. uneven distribution of the RE resources is expected to be addressed.

RE related policy chronology

A brief chronology of major RE related initiatives is covered below.

Electricity generation and distribution

Year 1993 – 2003

The Ministry of Non Conventional Energy Sources issued guidelines for purchase of power from renewables sources of energy by Indian state utilities. The then Ministry of Non-Conventional Energy Sources (MNES)¹, in 1993 prepared policy guidelines for promotion of power generation from renewable energy sources. Some of the salient features of this policy guideline are - buy back price of Rs. 2.25 per kWh with 5% annual escalation, with 1993 as base year, concessions regarding the banking, wheeling and third party sale and fiscal incentives like allowing 100% accelerated depreciation for renewable energy projects were also given. The MNES guidelines were valid for a period of 10 years.

Other initiatives for promotion of renewables

Year 1982 – till date

The ministry had prepared different programmes for promotion of renewable energy technologies for power generation as well as other energy applications. These technology specific programmes included capital grants, interest grants, tax incentives, duty exemption. The capital grants for the power generation have been discontinued, however, grants for other applications like biomass gasifier etc. are still continuing. The discontinuation of the capital grant was mainly to promote the commercial viability of renewable energy power generation projects.

¹ The Ministry was renamed as “ Ministry of New and Renewable Energy” (MNRE) recently

Table 3.1 RE based electricity quotas in different states

S. No.	State	Quota/Renewable Purchase Obligation	Time Period
1	Assam	Minimum 5% of its total consumption	2008-12
		Minimum 10% of its total consumption	2012
		Minimum 15% of total consumption	2015
2	Andhara Pradesh	Minimum 5% of total energy consumption (of this 1/2% is to be reserved for wind)	2005-06, 2006-07 & 2007-08
3	Bihar	-	-
4	Chattisgarh	Minimum 10 % of Total Energy consumption (5% from Biomass based plants, 3% from small hydel plants, 2% from Solar(PV&Thermal), wind, bagasse based cogeneration and others)	-
5	Delhi	-	-
6	Goa	-	-
7	Gujarat	Minimum 1% of total energy consumption	2006-07
		Minimum 1% of total energy consumption	2007-08
		Minimum 2% of total energy consumption	2008-09
8	Himachal Pradesh	Minimum 20% of total energy consumption	2007-10
7	Haryana	Upto 3% of total energy consumption	2007-08
		Upto 5% of total energy consumption	2008-09
		Upto 10% of total energy consumption	2009-10 & thereafter
8	Jharkand	-	-
9	Karnataka	Minimum 5% and maximum of 10% of total energy consumption	-
		Minimum 10 % of Total Energy consumption	2008-09
10	Kerala	Minimum 5% of total energy consumption (of this 2% from SHP, 2% from wind and 1% from all other NCE sources)	2006-09
11	Madhya Pradesh	Minimum 0.5% of total energy consumption including third party sales from wind energy	2004-07
		Minimum 10 % of total energy consumption	2007-12
12	Maharashtra	Minimum 3% of total energy consumption	2006-07
		Minimum 4% of total energy consumption	2007-08
		Minimum 5% of total energy consumption	2008-09
		Minimum 6% of total energy consumption	2009-10
		450 MU	2005-06
14	Punjab	Minimum 1% of total energy consumption	2007-08
		Minimum 1% of total energy consumption	2008-09
		Minimum 2% of total energy consumption	2009-10
		Minimum 3% of total energy consumption	2010-11
		Minimum 4% of total energy consumption	2011-12
15	Rajasthan	Minimum 4.88% of total energy consumption	2007-08
		Minimum 6.25% of total energy consumption	2008-09
		Minimum 7.45% of total energy consumption	2009-10
		Minimum 8.50% of total energy consumption	2010-11

S. No.	State	Quota/Renewable Purchase Obligation	Time Period
		Minimum 9.50% of total energy consumption	2011-12
16	Tamil Nadu	Minimum 10% of total energy consumption	2006-09
		Minimum 13% of total energy consumption	2009-10
		Minimum 14% of total energy consumption	2010-2011
17	Uttarakhand	Minimum 5% of total energy consumption	2007-08
		Minimum 5% of total energy consumption	2008-09
		Minimum 8% of total energy consumption	2009-10
		Minimum 9% of total energy consumption	2010-11
		Minimum 10% of total energy consumption	2011-12
18	Uttar Pradesh	5% of total energy consumption	-
		7.5% of total energy consumption	
19	West Bengal	Minimum:	
		WBSEB: 1.9% of total energy consumption	2006-07
		CESC Ltd.: 1.02% of total energy consumption	
		The Durgapur Projects Ltd.: 0.72% of total energy consumption	
		DPSC Ltd.: 0.43% of total energy consumption	
		WBSEB: 3.8% of total energy consumption	2007-08
		CESC Ltd.: 2.03% of total energy consumption	
		The Durgapur Projects Ltd.: 1.4% of total energy consumption	
		DPSC Ltd.: 0.95% of total energy consumption	
		WBSEDC Ltd: 4.8% of total energy consumption	2008-09
		CESC Ltd. 4.0% of total energy consumption	
		DPL: 2.5% of total energy consumption	
		DPSC Ltd: 2.0% of total energy consumption	
		DVC: 2.0% of total energy consumption	
		WBSEDC Ltd: 6.8% of total energy consumption	2009-10
		CESC Ltd. 6.0% of total energy consumption	
		DPL: 4.0% of total energy consumption	
		DPSC Ltd: 4.0% of total energy consumption	
		DVC: 4.0% of total energy consumption	
		WBSEDC Ltd: 8.3% of total energy consumption	2010-11
		CESC Ltd. 8.0% of total energy consumption	
		DPL: 7.0% of total energy consumption	
		DPSC Ltd: 7.0% of total energy consumption	
		DVC: 7.0% of total energy consumption	
		WBSEDC Ltd: 10.0% of total energy consumption	2011-12
		CESC Ltd. 10.0% of total energy consumption	
		DPL: 10.0% of total energy consumption	
		DPSC Ltd: 10.0% of total energy consumption	
		DVC: 10.0% of total energy consumption	

CHAPTER 4 Renewable energy sector development in India

India's concerns about social justice, and equitable development and of late growing concerns about energy security and need to address the issue of climate change has led to the development of a strong renewable energy sector in India. Today, India is one of the leading countries in this sector and a shining and unique example of what a developing country can do to adopt renewable energy resources not only in the everyday life of the poorest of poor but also developing renewable energy sources to fuel the economic growth and industrial development.

A brief overview of this development covering institutional arrangements is covered in this chapter.

Institutional development

Realising the importance of energy to fuel the growth of Indian economy and also realising the important implications it has on the quality of life, soon after the oil shock of 1973, the Government of India established the CASE (Commission for Additional Sources of Energy) under the Department of Science and Technology with mandate to promote R & D activities and develop and demonstrate RET (renewable energy technologies) and oversee the deployment of RETs into various sectors. It was upgraded to the DNES (Department of Non-conventional Energy Sources) in 1982. During the decade of 1982-1992 DNES focussed on promoting RETs and establishing demonstration projects through subsidy schemes.

On the financing front, in order to overcome the barrier of high initial cost and high financing risk perception of the renewable energy technologies; IREDA (Indian Renewable Energy Development Agency Limited) was established in March 1987 as a public sector enterprise to finance renewable energy projects. IREDA provides loan for renewable energy projects at lower than market interest rates.

DNES also established state level nodal agencies in several states to implement renewable energy and energy efficiency projects.

In 1992, DNES was converted into full fledged Ministry named as MNES (Ministry of Non-conventional energy Sources). In 2006, MNES was renamed as MNRE (Ministry of New and Renewable Energy Sources). Ministry also established three major R & D centres dedicated to renewable energy sectors namely:

- SEC- Solar Energy Centre to carry out research, development testing and certification of solar energy products ;
- CET- Centre for wind Energy technology and

- AHEC- Alternate Hydropower Energy Centre for development of hydro power projects and technologies and
- NIRE (National Institute for Renewable Energy) which will focus on the bioenergy development

Since then the sector has undergone many phases of development such as the 'classical' development cycle with initial stage of technology development and demonstration, followed by the policy and financial incentives for market creation.

The overall administrative structure is shown in Figure. 4.1 (a) and (b).

Institutional structure

The Central government structure including ministries, departments and public sector related to the energy and renewable energy sector is depicted in the Figure 4.1 (a). Where as the overall institutional structure working in renewable energy sector is shown in the Figure 4.1 (b).

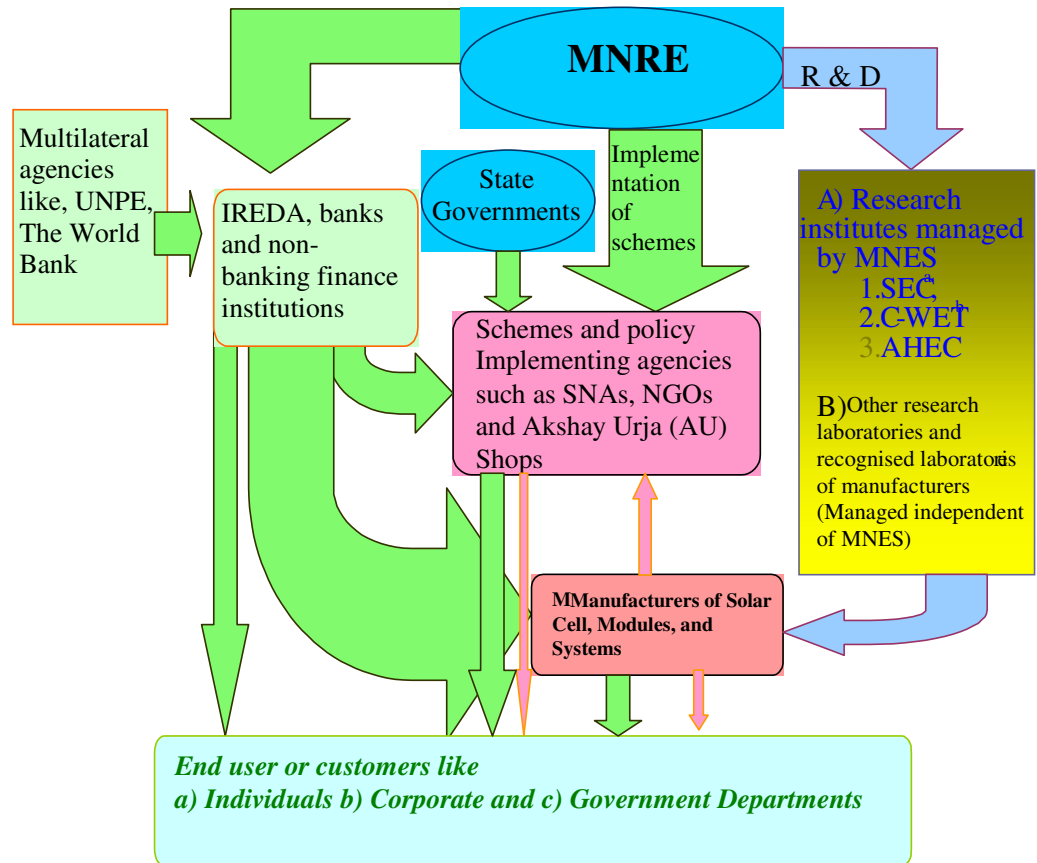
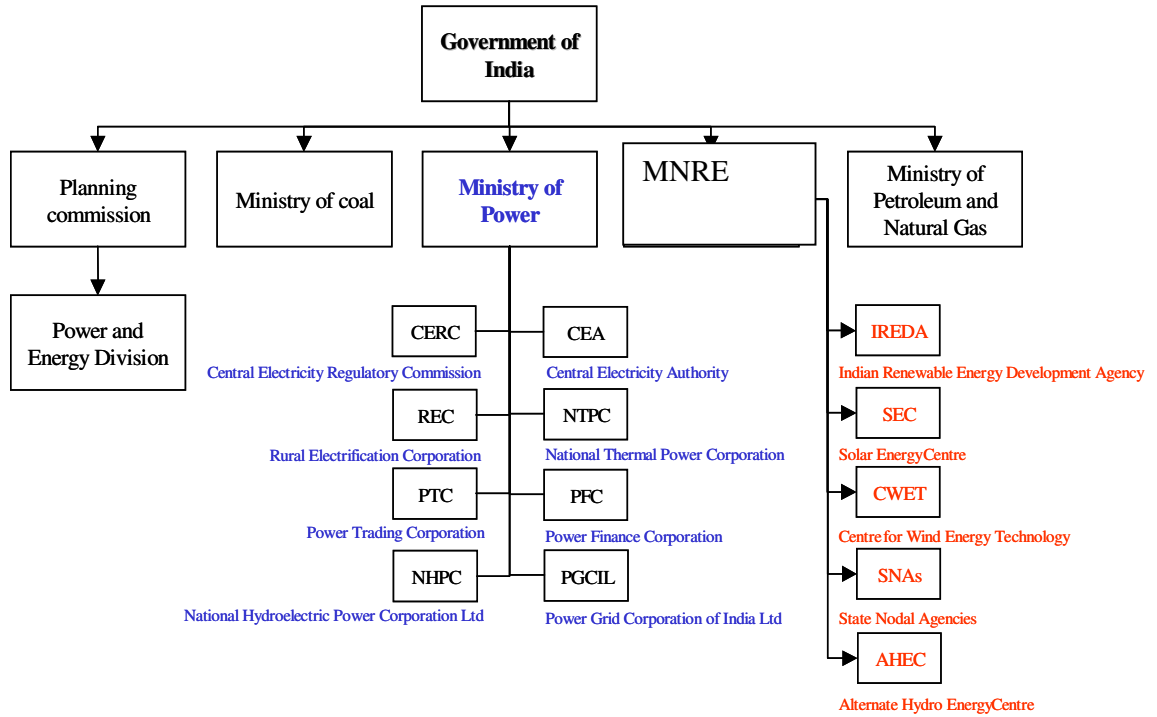


Figure 4.1 (a) and (b). Overall administrative structure of (a) Energy related Ministries and institutions and (b) RE sector

As explained earlier MNRE is the apex ministry for RE sector. It has been instrumental in promoting RE sector primarily through a) subsidy programmes through its nodal agencies in the states b) providing support to R & D activities through its exclusive R&D institutes c) providing soft (low interest loans) to users and industries throughs IREDA.

Some of the major institutions which are influencing the growth of the RE sector are discussed below.

IREDA¹

Indian Renewable Energy Development agency (IREDA) was established in 1987 to provide finance for the budding RE and energy efficiency (EE) sector. This was a major move to remove the barrier of financing. RE projects are capital intensive and don't attract enough finance from the conventional banking or non banking financial institutes easily till the technologies are established and proven in the field. IREDA was created to remove this barrier. Since inception it has provided concessional finance to the tune of INR 104 billion to about 1900 RE industries and projects. Typically IREDA provides long term -10 years- loan with two year moratorium period. Loan interest rates and eligibility criteria vary from scheme to scheme. More information about IREDAs current loan schemes is available at its web site www.iredaltd.com.

The main objectives of IREDA are:

- To operate a revolving fund for development and deployment of New and Renewable Sources of Energy (NRSE).
- To give financial support to specific projects and schemes for generating electricity and/or/energy through new and renewable sources and conserving energy through energy efficiency.
- To bring down the cost of Renewable power.
- To assist in upgradation of technologies in the country through New and Renewable Sources of Energy (NRSE).
- To develop criteria/systems/concepts for financing projects based on New & Renewable Sources of Energy and Energy Efficiency/Conservation.
- To strive for improvement in customer satisfaction

State Nodal Agencies

State nodal agencies (SNA) are established in almost all states and union territories to implement MNRE and state government programs in RE and EE sectors. List of state nodal agencies is enclosed in Annexure –I. Some nodal agencies like GEDA, TEDA, MEDA have even established demonstration projects like wind power plants to promote the sector. They played key role in accelerating the development of RE sector at

¹ www.iredaltd.com

state level. Apart from MNRE they also get funds from the state governments to implement RE programmes in the respective states.

Akshay Urja Shops

In late 1990's MNRE started establishing Special shops to provide sale and service support to the users of RE devices under a promotional scheme called as 'Akshay Urja Shops'. MNRE provided part of initial investments and loan up to INR 0.5 million for establishing these shops. These shops provided sales and service support to the customers and clients in their areas. Initially the shops were established through SNAs and NGOs. However, now the scheme has been extended to private entrepreneurs who can avail special low interest loan to establish shops. So far more than shops have been established across the country. This scheme was effective in creating sales and service network at district and block level especially in remote areas where providing servicing was not only expensive but logistically difficult to the manufacturers. Under the scheme training is also provided to local youths including ladies to develop their skills as technicians.

Non Governmental Agencies

Non Governmental Agencies (NGOs) have also played an important role in developing RE sector in India. While there are many NGOs which have been working in this sectors activities of some of them are listed in Annexure II. NGOs like barefoot engineers from Tilonia GERES, LEDeGE , PEN network are some of the active NGOs which are either implementing the RE projects or promoting RE through awareness creation and capacity building.

Electricity Regulatory Commissions

Apart from the above Central Electricity Regulatory Commission (CERC) and State Electricity Regulatory Commissions (SERC) are the independent regulatory authorities established as part of the opening up of the electricity sector reforms. These commissions are responsible for the smooth functioning of the electricity sector per say at the Central and State level. Their main functions with respect to RE sector include deciding RE quotas for RPO obligations and RE electricity tariffs. List of the SERCs is provided in the Annexure III.

CHAPTER 5 Current status of renewable energies in India: Resource potential and achievements

An overview of the renewable energy sector including resource potential and achievements is presented in this chapter.

India has fairly good potential of various renewable energy resources. However, major among them are:

- Solar
- Wind
- Bioenergy
- Hydro
- Geothermal
- Ocean energy

Renewable energy potential in India is given below in Table 5.1.

Table 5.1 RE potential in India

Sources/Systems	Estimated potential (MW)
Power from Renewable	
Grid-interactive renewable power	
Wind Power	48,561
Small Hydro Power (up to 25 MW)	15,000
Cogeneration-bagasse	5,000
Total (in MW)	84,776
Decentralized Energy Systems	
Family Type Biogas Plant	12 million
Solar Photovoltaic Programme	20 MW/Sq.km.
Solar water Heating Systems	140 million sq.m. collector area
Other Energy resources	
Geothermal	
50 MWe potential in Puga valley of Ladakh. There are about 340 hot springs in India which can be potential source for geothermal energy	
Ocean energy	
OETC (ocean thermal energy conversion)- 180 000 MW	
Wave energy- 40 000 MW	
Tidal energy- 8000 MW	

Overall achievements in deployment of renewable energy devices both for grid connected power generation and distributed generation / off grid applications along with other applications are also covered table 5.2

Table 5.2 Achievement in deployment of RE technologies in India

NEW & RENEWABLE ENERGY – Cumulative achievements as on 31.01.2009			
No.	Sources / Systems	Achievements during 2008-09 (up to 31.01.2009)	Cumulative Achievements
I. Power From Renewables			
A. Grid-interactive renewable power			
1.	Biomass Power (Agro residues)	77.50 MW	683.30 MW
2.	Wind Power	998.85 MW	9755.85 MW
3.	Small Hydro Power (up to 25 MW)	163.83 MW	2344.67 MW
4.	Cogeneration-bagasse	232.90 MW	1033.73 MW
5.	Waste to Energy	3.66 MW	58.91 MW
6.	Solar Power		2.12 MW
	Sub Total (in MW) (A)	1,476.74 MW	13,878.58 MW
B. Off-grid/Distributed Renewable Power (including Captive/CHP plants)			
7.	Biomass Power / Cogen.(non-bagasse)	60.92 MW	150.92 MW
8.	Biomass Gasifier	8.98 MWeq.	160.31 MWeq
9.	Waste-to- Energy	4.36 MWeq.	31.06 MWeq
10.	Solar PV Power Plants and Street Lights	0.07 MWp	3.00 MWp
11.	Aero-Generators/Hybrid Systems	0.09MW	0.89 MW
	Sub Total (B)	74.42 MWeq	346.18 MWeq
	Total (A + B)	1551.46 MW	14,224.76 MW
II.	Remote Village Electrification	300/NIL Villages/Hamlets	4254 villages + 1156 hamlets
III. Decentralized Energy Systems			
12.	Family Type Biogas Plants	66000	4.09 millions
13.	Home Lighting System	31,754 nos.	4,34,692 nos.
14.	Solar Lantern	27,360 nos.	6,97,419 nos.
15.	SPV Pumps		7,148 nos.
16.	Solar Water Heating - Collector Area	0.03 Mln. sq.m.	2.60 Mln. sq.m.
17.	Solar Cookers		6.37 lakh
18.	Wind Pumps	80 nos.	1347 nos.
IV. Other Programmes			
19.	Energy Parks	26 nos.	504 nos.
20.	Akshay Urja Shops	15 nos.	289 nos.
MWeq. = Megawatt equivalent; MW = Megawatt; kW = kilowatt; kWp = kilowatt peak; sq. m. = square meter			

Solar energy

Solar energy is one of the most abundantly available renewable energy in India.

Solar energy potential

India is blessed with abundant solar energy with more than 300 sunny days and 4 to 7 kWh of solar energy per square meter of land area. Assuming solar system efficiency of 7%, annual average electricity generation capacity ranges from 80 to 100 million kWh per square kilometre per year for Solar PV technologies. Estimated potential for Solar PV is 20MW/ sq. km. Solar energy resource potential across the India is shown in Figure 5.1 below.

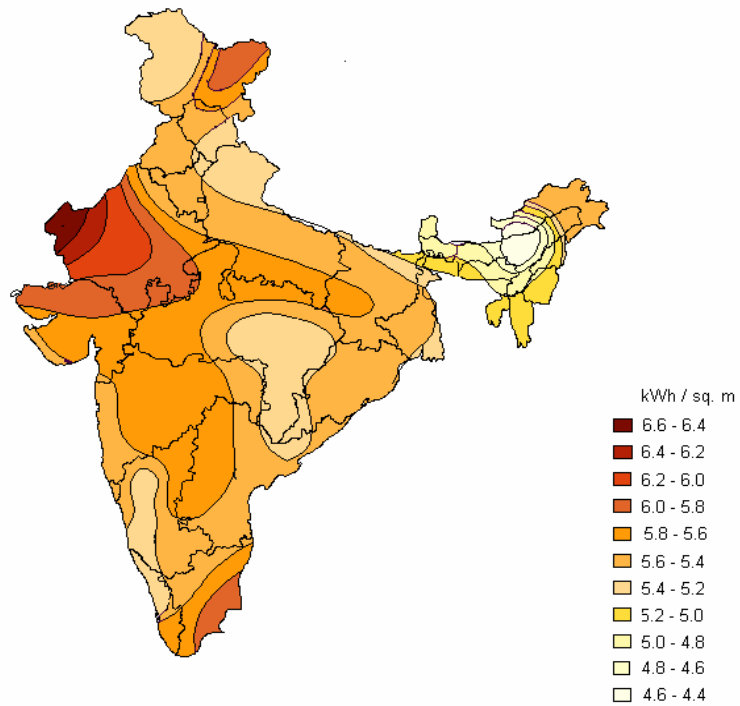


Figure 5.1 Solar energy potential in India

Solar energy is utilised by in two major routs solar thermal and solar photovoltaic. Following section covers the current status of these two technologies in India.

Solar thermal technologies

Various types for solar thermal systems and devices have been developed and manufactured in India. These include:

- Solar flat plate collectors , vacuum tube solar collectors and water heating systems
- Solar dryers
- Solar stills
- Solar cookers

- Scheffler cooker based steam cooking systems
- Dish based solar steam systems for industrial applications

Solar collectors and water heating systems

Figure 5.2 shows typical solar water heating systems installed for hotel. Currently, two types of collector are used in India – Flat plate collectors with copper tube absorber and vacuum tube collectors. Currently about 12.6 million sq m are of collectors are installed. One of the worlds largest solar water heating system of 120 000 lit per day capacity having 1326 m² of collector area and supplying water for industrial boiler was installed at M/s Godavari Fertilizers and Chemicals, Kakinada, Andhra Pradesh in 1997. The system is still in working condition. This was installed using flat plate collectors' manufactured using indigenously developed NALSUN selective coating.



Figure 5.2 Solar water heating system for hotel (capacity 20000 lit /day)

5.3 shows the progress of solar water heating systems installed during last few years. Solar water heating systems are being promoted through interest subsidy scheme implemented through IREDA, nationalised banks and private sector and cooperative banks. The interest rates offered for loans to purchase of systems depend on the type of the user and vary

between 2% for individual users to 7% for industrial/ profit making organisation. The scheme for year 2008-9 and 2009-10 is called as “Accelerated development and deployment of solar water heating systems in domestic, industrial and commercial sectors”. Details of the scheme are available at http://www.mnre.gov.in/Solar-water-heaters/revised-SWHS-2008-09_2009-10.pdf

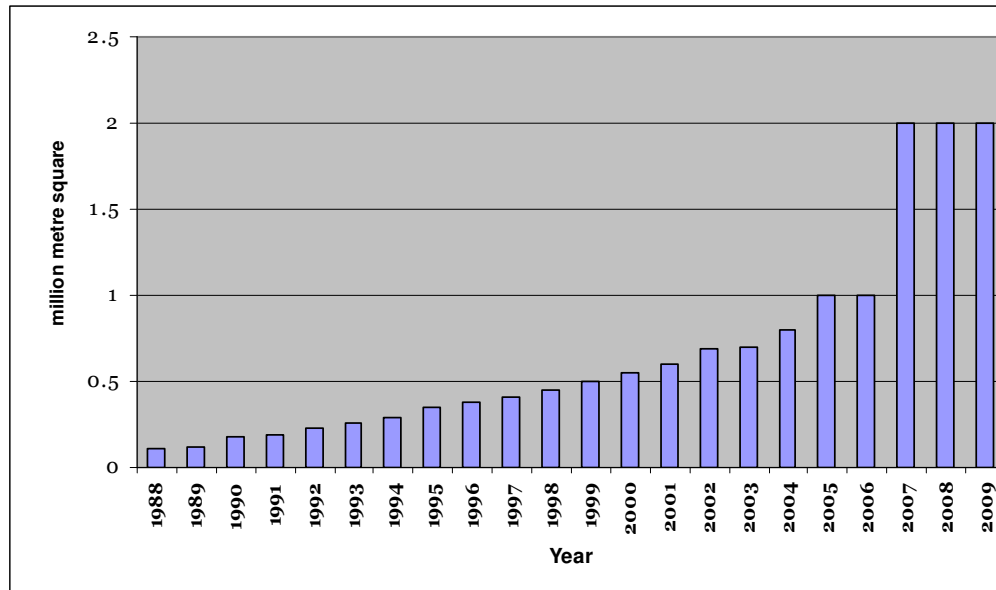


Figure 5.3 Solar water heating systems installed in India (1998-2009)

Some salient features of the solar water heating system promotional schemes are

1. Interest subsidy to the users through banks. The difference between commercial lending rate and subsidised interest rate is compensated by the central government
2. Accelerated depreciation allowed to eligible consumers
3. Some states like Karnataka are giving rebate to the residential sector users on conventional electricity consumed for households having solar water heating system. While some other states like Maharashtra charge cess on electricity

Solar PV systems

India has developed large variety of solar PV systems and products to meet variety of requirements. These include;

- Solar street lights
- Solar pumping systems
- Solar lanterns
- S solar home lighting systems
- Small off grid stand alone SPV power plants
- Solar grid connected power plants

These devices have played an important role in rural areas to provide access to energy.

Figure 5.4 shows the annual installed capacities of various devices in MW.

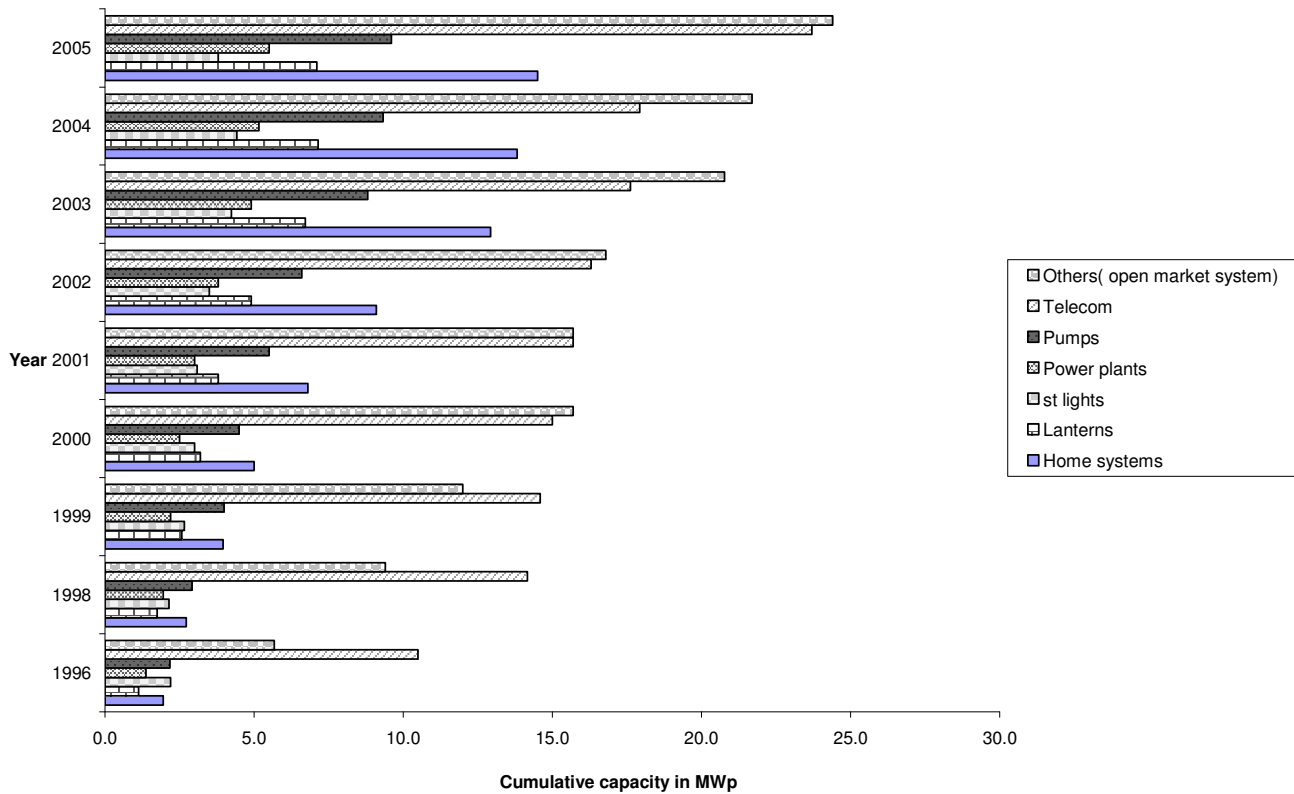


Figure 5.4 Solar Photovoltaic installations in MW in India (1996-2005)

Wind energy development

Currently, India ranks fifth in the list of countries using wind power for electricity generation with installed capacity of little over 12000MW.

Wind power potential and installations in India

India has a total wind power potential of 48,561 MW¹ for power generation. There are 216 sites identified as the wind farmable sites under the Ministry of New and Renewable Energy Wind power development program and the data for 91 other sites are being collected by Centre for Wind Energy Technology (CWET). Apart from these many wind power developer are also collecting the wind data by installing their own wind masts. With this the

¹ Assuming 1% of land availability for wind farms requiring @12 ha/MW in sites having wind power density in excess of 200 W/sq.m. at 50 m hub-height

wind resource map of India is developing and hence the installation of wind energy generators.

The wind power capacity addition in India during the year 2008 was 1800 MW [1]¹. With this India ranked 3rd in the total capacity addition during the year 2008 and 5th in terms of total installed capacity. State wise wind power potential and installed capacity in India up to 31st March 2009 is given in table 5.3.

Table 5.3 State-wise wind potential and installed capacity as on March 31, 2009

State	Gross Potential (MW)	Total Capacity (MW) till
		31.03.09
Andhra Pradesh	8968	122.5
Gujarat	10,645	1566.5
Karnataka	11,531	1327.4
Kerala	1171	27.0
Madhya Pradesh	1019	212.8
Maharashtra	4584	1938.9
Orissa	255	-
Rajasthan	4858	738.4
West Bengal		1.1
Tamil Nadu	5530	4304.5
Others		3.2
Total (All India)	48,561	10242.3

Source: Indian Wind Energy Association (www.inwea.org)

During last few years on an average 1800MW capacity projects are being installed on annual basis. Figure 5.5 shows the cumulative installed capacity in over the year.

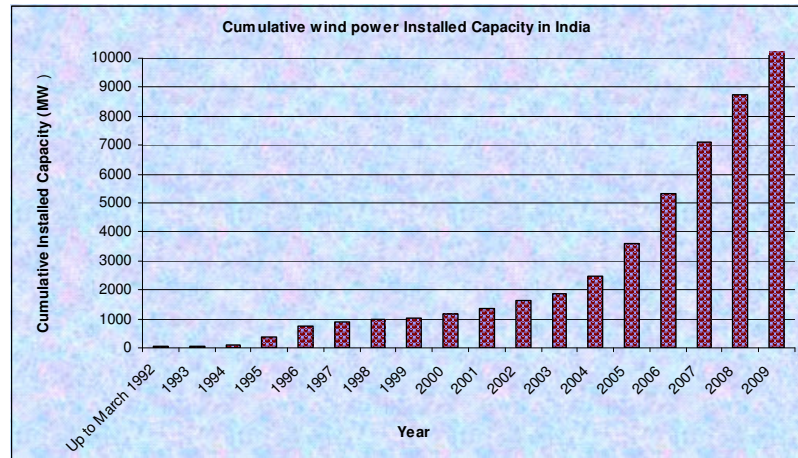


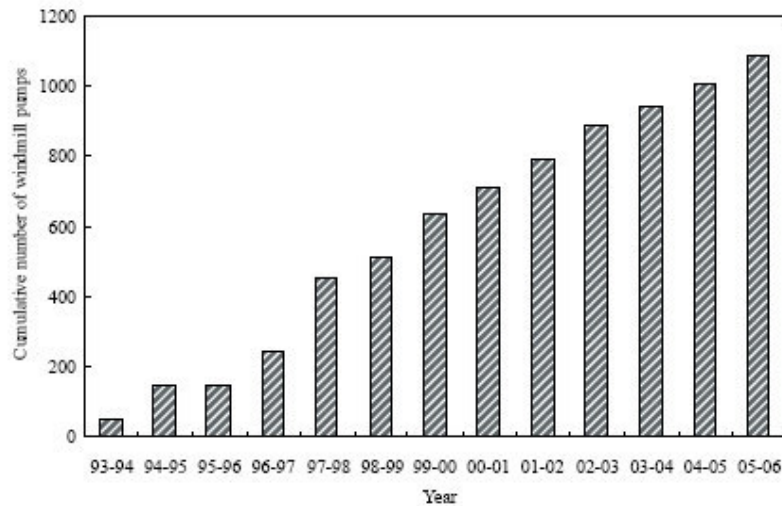
Figure 5.5 Wind power projects cumulative installed capacity in MW in India (1992-2009)

¹ Total installed capacity as on 31st March 2009 is 10242.3 MW (www.inwea.org)

It may be noted that the growth rate started increasing after 2003 primarily due to the favourable policy environment created by the Electricity Act 2003.

Other wind energy applications

Apart from large wind farms MNRE has promoted solar wind machines, wind mill pumping systems and solar PV wind hybrid systems for distributed power generation. Few Indian manufacturers like BHEL have developed these systems indigenously. Total installed capacity for these various devices is shown in figure 5.6



Source: Annual Reports of the MNRE, Govt. of India

Figure 5.6 Wind mill pumping systems cumulative installed capacity in MW in India (1993-2006)

Bioenergy

Bioenergy is energy derived from organic matters, commonly known as biomass and biomass derived fuels such as bio-diesel and straight vegetable oils. Bioenergy applications include

- Power generation by direct combustion of biomass
- Biomass gasification for power generation and meeting thermal energy needs in industries and institutions for cooking and process heating applications.
- Use of processed biomass through efficient cook stoves and heating devices for cooking and space heating
- Biofuels to replace conventional diesel and kerosene for power generation and lighting applications.

Biomass

Biomass is renewable organic matter derived from trees, plants, crops or human, animal, municipal and industrial wastes. Biomass can be classified in two main types woody and non-woody. Woody biomass is essentially derived forests, plantations and forestry residues. Non-woody biomass comprises agricultural and agro-industrial residual wastes. Biomass is indigenous resource, which is either readily available from forests or agricultural related activities or can be grown through plantation.

About 870 million tonnes of agricultural waste and agro-residue resources are generated every year in the country. These bioresources have competitive uses as fuel, fodder, industrial raw material, fertilizers and non commercial fuel. It is estimated that about 590 million tonnes of these can be used for energy generation through advanced technologies such as gasifier. Of this, about 350 million tonnes is on account of sugarcane bagasse most of which can be used in sugar mills for power generation through cogeneration mode. India has potential for about 1500MW capacity through bagasse based cogeneration.

Biogas generation

Biogas can be generated through animal dung and night soil. India having large population of cattle and poultry has tremendous potential for biogas production. India has world's second largest number of biogas installations. The biogas digester technology was developed indigenously by Khadi and Village Industries Commission and other institutions. Currently, over 4 million biogas plants are installed in the country. Recent developments include prefabricated biogas plants using plastics.¹

Biofuels

Biofuels are fuels having properties similar to petroleum fuels like diesel and hence can be used as replacement for diesel. Primarily, these are produced from vegetable oils. Some times some vegetable oils are used directly as fuel in IC engines and are known as SVO (straight vegetable oils). Apart from these, biodiesel production using vegetable oils using esterification process is being researched. Considering the impact of large scale biodiesel production on food production and availability of oils for cooking and consumption as part of food chain, GoI is encouraging use of only non edible oils for this purpose. Oil bearing seeds of plants like Jatropha and Pongamia are being investigated for this purpose. The government had announced its biofuel policy some months back but currently it has been withdrawn. New policy is expected soon. Large organisations

¹

like Railways are experimenting with blending of 5 % to 10% bio-diesel with diesel for locomotive applications.

It is estimated that India has potential for 16000MW (excluding bagasse power generation) of power generation from biomass of which currently installed capacity is about 630MW.

Cogeneration using bagasse

Cogeneration in sugar factories using sugarcane waste- bagasse- is being promoted on large scale in India. India is the second largest manufacturer of sugar in the world and has potential of generating 5000MW of electricity using bagasse.

Improved cook stoves

Large number of Indian households both in rural and urban areas uses biomass as fuel for cooking. Conventional cook stoves are inefficient (less than 10% efficiency) and produce smoke and poisonous gases like CO. This has been a major cause for indoor pollution in households. The Indian government promoted improved cook stoves to a) improve the fuel efficiency of the cook stoves and b) to reduce or in some cases eliminate the indoor pollution. Variety of improved cook stoves were developed to meet specific cultural needs and cooking practices / cooking needs. Few of these cookstoves are shown in figure below. Improved cookstoves were promoted by MNRE through its various schemes jointly with other organisations like KVIC. The government is planning to reintroduce a large program for improved cook stoves in India very soon.

Small Hydro power systems

Small hydro is defined as hydropower plants below 25 MW capacity in India. Estimated potential for small hydropower is about 15000MW in India. Currently installed capacity is about 2350 MW.

India has strong base of manufacturers, designers and power companies promoting small hydropower plants. There are about 21 companies registered with MNRE which manufacture various small hydro power plant equipments. State-wise potential and installed capacity is shown in Table 5.4

Table 5.4 State wise potential and installed capacity of SHP in India as on 31st March 2009

S. No	Name of State	Identified	Total Identified	Projects Installed		Projects under Implementation	
		Number of Sites	Capacity (MW)	Nos.	Capacity (MW)	Nos.	Capacity (MW)
1	Andhra Pradesh	489	552.3	59	180.8	12	21.5
2	Arunachal Pradesh	566	1333	81	61.32	43	25.94
3	Assam	60	213.8	4	27.1	4	15
4	Bihar	94	213.8	12	54.6	4	3.4
5	Chhatisgarh	164	706.6	5	18.05	1	1
6	Goa	9	9.10	1	0.050	-	-
7	Gujarat	292	197	2	7.000	2	5.6
8	Haryana	33	110.1	5	62.700	1	6
9	Himachal Pradesh	547	2268	79	230.915	9	26.75
10	Jammu & Kashmir	246	1412	32	111.830	5	5.91
11	Jharkhand	103	208.95	6	4.05	8	34.85
12	Karnataka	128	643.16	83	563.45	14	85.25
13	Kerala	247	708.10	19	133.87	2	3.2
14	Madhya Pradesh	99	400.58	10	71.16	4	19.9
15	Maharashtra	253	762.58	29	211.325	5	31.2
16	Manipur	113	109.10	8	5.45	3	2.75
17	Meghalaya	102	229.81	4	31.030	3	1.7
18	Mizoram	75	166.94	18	24.470	1	8.5
19	Nagaland	99	196.98	10	28.670	4	4.2
20	Orissa	222	295.5	8	44.3	6	23.93
21	Punjab	234	390	29	123.900	2	18.75
22	Rajasthan	67	63.17	10	23.850	-	-
23	Sikkim	91	265.5	16	47.110	2	5.2
24	Tamil Nadu	176	499.3	15	90.050	4	13
25	Tripura	13	46.86	3	16.010	-	-
26	Uttar Pradesh	220	292.2	9	25.100	-	-
27	Uttaranchal	458	1609.25	93	127.92	33	40.35
28	West Bengal	203	393.79	23	98.400	16	79.25
29	A&N Island	12	7.91	1	5.25	-	-
	TOTAL	5,415	14,305.47	674	2429.77	188	483.2

Source: www.mnre.gov.in

CHAPTER 6 Renewable energy technology research and development in India

This chapter covers the exhaustive review of the research and development activities and achievements in RE in India. While RE related research and development is by and large coordinated by the MNRE, RE related research activities are part of the overall scientific research and development agenda and hence it is essential to have an understanding of the overall arrangement of the R & D activities in India.

There are about five major types of research and development institutions in India which can be classified as:

1. National Laboratories
2. Laboratories established under universities educational institutions like IITs, and colleges
3. Private sector promoted research and development laboratories including laboratories established by MNCs (Multi National Companies)

While, the Department of Science under the Ministry of Science and Technology is the central body established for coordination and development of R & D activities in India, MNRE has been funding various R & D projects through its own R & D schemes. Additionally, MNRE has also established three independent institutes namely- SEC, C-WET and NIRE and one centre AHEC for R & D and deployment of pilot projects. A brief profile of these institutes is given below.

C-WET

Centre for Wind Energy Technology (C-WET) is an autonomous wind energy research and certification organisation under the administrative control of MNRE established in Chennai, Tamil Nadu. (www.cwet.tn.nic.in)

C-WET has established a Wind Turbine Test Station with technical and partial financial support by Danida, Government of Denmark, at Kayathar, in Thoothukud; District Tamil Nadu, as an integral part of the centre. It is envisioned that C-WET will serve as a technical focal point of excellence to foster the development of wind energy in India.

C-WET provides services in:

- Wind Resource Assessment
- Certification of wind turbines

- Wind turbine testing services
- Training and capacity building including consultancy services for wind farm development
- Research in wind turbine development

Solar Energy centre

Solar Energy Centre (SEC) was established in 1982 for development solar energy technologies and applications. The centre has been supporting R & D activities. A partial list of the R&D projects supported by SEC is given below

- Development of a transient test procedure for characterizing solar flat plate collectors (IIT Bombay)
- Development of test standards for thermal performance of solar cookers (IIT, Delhi)
- Status report on renewable energy operated desalination system (TERI, Delhi)
- Application of Finite-time thermodynamic and second law assessment of solar thermal power generation (IIT, Delhi)
- Development of evaluation of SPV power packs and farm equipment (IARI, Delhi)
- Establishment of spectral response measurement system (IACS, Calcutta)
- Design and cost optimisation techniques for solar hybrid absorption refrigeration plants using second law analysis & exergo economics (IIT, Delhi)
- Development of a mechanical load test system for PV modules (NPL, Delhi)
- Round-robin testing of flat plate solar collectors and box type solar cookers in India. (IIT, Delhi)
- Development of design, guidelines and preparation of handbook on energy conscious architecture (IIT, Mumbai).
- Energy plantation for production of biomass for power generation (Phase-1) (NBRI, Lucknow).

Alternate Hydro Energy Centre¹

Alternate Hydro Energy Centre (AHEC) was established at The Indian Institute of Technology Roorkee, Uttarakhand (then Roorkee University) in 1982. The mandate of the centre is to Promote small hydropower projects and hydropower technologies in hilly areas. The centre has been doing active work in this area. Recently, the centre has established small hydro power plant real time simulator which can simulate the performance of small hydropower plant under various operating conditions. This simulator is useful for training of

¹ <http://ahec.org.in/>

hydropower plant operators. The centre has developed two design of water mills for power generation.

Apart from the R & D centre established by MNRE, research laboratories established under CSIR (Council of Scientific and Industrial Research) are also active in R & D in RE sector. A brief overview is given below.

Department of Scientific and Industrial Research

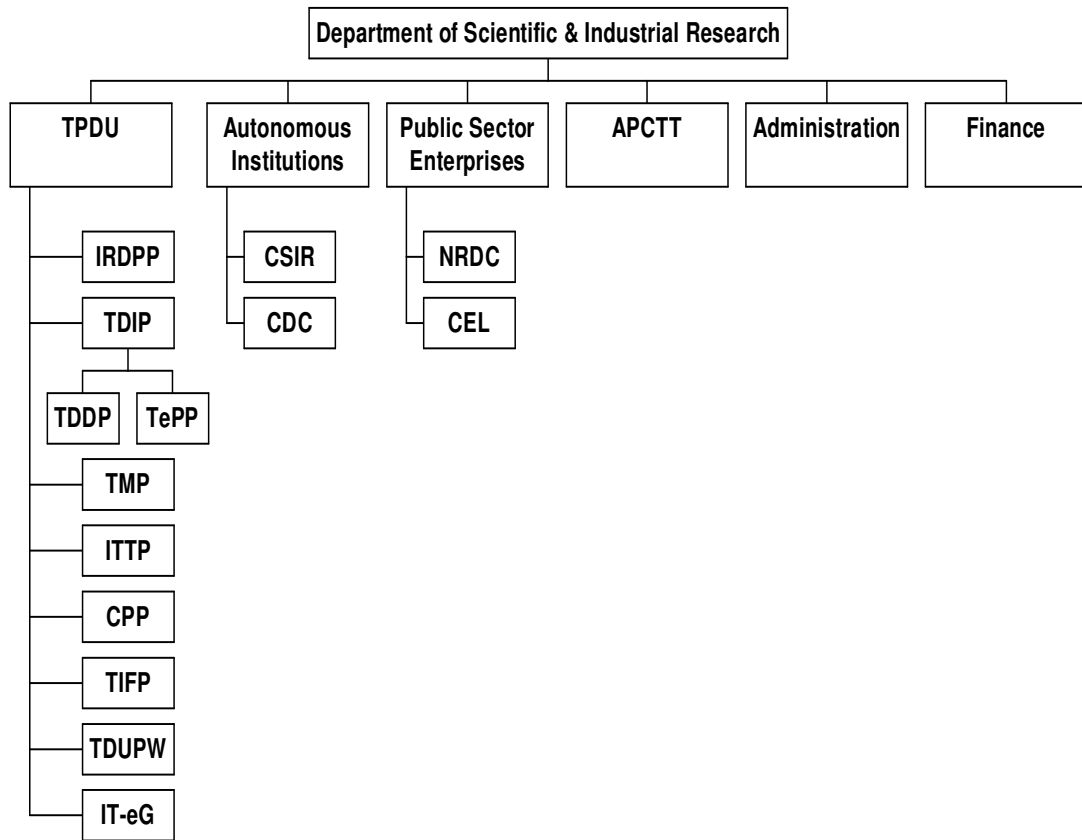
The Department of Scientific and Industrial Research (DSIR) is a part of the Ministry of Science and Technology, which was announced through a Presidential Notification, dated January 4, 1985 (74/2/1/8 Cab.) contained in the 164th Amendment of the Government of India (Allocation of Business) Rules, 1961. The Department of Scientific and Industrial Research (DSIR) has a mandate to carry out the activities relating to indigenous technology promotion, development, utilization and transfer. It also overlooks the Council of Scientific & Industrial Research (CSIR), Indian largest research and development organization. DSIR has many R & D related institutes and programs under it. The overall organisation structure is given in Figure 6.1

Council of Scientific and Industrial Research (CSIR)

Established in 1942, CSIR is an autonomous body and India's largest Research and Development (R&D) organization, with 39 laboratories and 50 field stations or extension centers spread across the nation.

Although CSIR is mainly funded by the Ministry of Science and Technology, it operates as an autonomous body registered under the Registration of Societies Act of 1860.

Organizational and Functional Structure of DSIR



APCTT	Asian and Pacific Centre for Transfer of Technology
CDC	Consultancy Development Centre
CEL	Central Electronics Limited
CPP	Consultancy Promotion Programme
CSIR	Council of Scientific and Industrial Research
IRDPP	Industrial R&D Promotion Programme
IT-eG	Information Technology & e-Governance
ITTP	International Technology Transfer Programme
NRDC	National Research Development Corporation
TDDP	Technology Development and Demonstration Programme
TDIP	Technology Development and Innovation Programme
TDUPW	Technology Development Utilization Programme for Women
TePP	Technopreneur Promotion Programme
TIFP	Technology Information Facilitation Programme
TMP	Technology Management Programme
TPDU	Technology Promotion, Development and Utilization Programme

Figure 6.1 DSIR organisational and functional structure

National Innovation Foundation (NIF) of India

The Department of Science and Technology help establish the National Innovation Foundation (NIF) of India, on Feb 28th 2000, with the main goal of providing institutional support in scouting, spawning, sustaining and scaling up grassroots green innovations and helping their transition to self supporting activities.

The foundation has a governing council chaired by Dr. R. A. Mashelkar, Former Director General CSIR and President Global Research Alliance. Professor Anil K. Gupta, President SRISTI and Professor Indian Institute of Management Ahmedabad, is the Executive Vice Chairperson of NIF.

Other initiatives

For the last seventeen years the Honeybee Network and Society for Research and Initiatives for Sustainable Technologies and Institutions (SRISTI) have been scouting innovations by farmers, artisans, women, etc. at the grassroots level.

Gujarat Grassroots Innovations Augmentation Network (GIAN) scales up innovations, from the Honey Bee database of innovations, through value additions in innovations to sustain creativity and ethics of experimentation. GIAN was conceived at the International Conference on Creativity and Innovation at Grassroots (ICCIG), jointly organized by IIM Ahmedabad and SRISTI.

The Honey Bee database of 10,000 innovations, collected and documented by SRISTI, would be part of the National Register of Innovations to be managed and supported by NIF.

Technology Development Board¹

For the development and application of indigenous technology in a dynamic economic environment, the Government of India enabled the placing of proceeds of the Research and Development Cess on the import of technology into a fund called the Fund for Technology Development and Application. To administer the Fund, the Government also constituted a Technology Development Board on 1st September, 1996, under the provisions of the Technology Development Board Act, 1995.

Research and development in RE sector

Research and development of renewable energy technologies started way back around 1950 when National Physical Laboratory, one of the premier research institutes in India, started work on development of solar cookers and solar water

¹ <http://www.tdb.gov.in/WebContent.aspx?id=7&type=homemore>

heating systems in India. Today more than 25 public research institutes and private research laboratories are working actively in India.

Some of the major research and development successes are

1. Development and commercialisation of solar selective coating in 1986 by National Aerospace Research Laboratory, Bangalore.
2. Development of gasifiers by TERI (The Energy and Resources Institute), Indian Institute of Sciences, Bangalore and private sector company M/s Ankur Industries Limited, Baroda
3. Development and commercialisation of solar box cookers and solar collectors by various public and private sector companies
4. Development and commercialisation of solar steam cooking systems based on solar dish concept by M/s Gadhia Solar Pvt Ltd, Valsad
5. Development of solar dish steam generation system by Indian Institute of Technology Bombay and M/s Clique Technologies Pvt Ltd., Mumbai
6. Development of higher capacity wind turbines by M/s Suzlon Energy Ltd
7. Development of wind pumping systems by M/s BHEL Ltd
8. Development of solar pond technology by TERI
9. Development of biogas systems by Khadi and Village Industries Corporation.
10. Development of vacuum tube collectors
11. Development of improved cookstoves

Major R & D institutions and their contributions

Table 6.1 Major R & D achievements

Name	Type of institute	Technology developed
National Aero space Laboratories, Bangalore	Research laboratory	Solar selective coating technology (NALSUN), small wind machines, vertical axis wind machine
Indian Institute of Sciences, Bangalore	Research Institute	Gasifier technology for thermal and power generation applications
Indian Institute of Technology Bombay, Mumbai	Educational Institute	Solar concentrator collectors, solar cooling systems
Indian Sciences Academy, Kolkatta	Research Institute	Amorphous solar PV moduels
The Energy and Resources Institute (TERI)	Research Institute	Gasifier, Solar pond, Solar cooling (under development), Solar pond, solar desalination system
Khadi Village Industries Corporation	Rural industries development corporation	Biogas plants (fixed dome type)
M/s Gadhia Solar Technologies	Manufacturer	Solar steam cooking systems
Clique Solar	Manufacturer	Arun Solar dish collectors for industrial process heat applications
Indian Institute of Technology	Educational institute	Concentrating solar dish collectors

Chennai		
GERES	NGO	Solar green houses
PEN (Planter's Energy Network)	NGO	Solar air heating systems
Network, Coimbatore		

One of the initiatives which need mention is solar energy initiative by DST.

Solar Energy Research Initiative by DST¹

A pan IIT coordinated programme on Solar Energy Research has been initiated to synergise strengths of IITs in the area of Solar Energy Research both thermal as well as photovoltaic. The programme would also attempt to demonstrate hybrid solar-agro energy systems for distributed energy generation to establish viability of the system to meet rural energy needs. A prototype solar thermal stand alone power plant will be mobilised under public- private- partnership mode which would encourage indigenous research and ingenuity in integration of sub-systems and exploration of various R&D pathways and multiple technology alternatives. A task force has been set up to guide DST's efforts in the area of Solar Energy Research.

Case studies on successful technologies

Solar distillation system for extraction of essential oils for aromatic plant materials²

RRL-Bhubaneswar has designed and developed the solar still of the distillation system, which is of green house type capable of accumulating heat energy through appropriate mirror arrangements.

Development of solar powered R.O. unit

Two solar powered R.O. units of 8 l/hr and 15 l/h capacity were designed and fabricated on behalf of Rajiv Gandhi National Drinking Water Mission (RGNDWM). One unit was installed at Science Park, Jaipur for publicizing and promoting the concept while the second unit was installed for conducting field trials in Bahadurvas village of Jhunjunu District, Rajasthan. Both the units are operating with the help of two solar photovoltaic (PV) panels.

¹ <http://www.dst.gov.in/scientific-programme/t-d-solar-energy.htm>

² http://www.dst.gov.in/about_us/11th-plan/rep-csir.pdf

Scheffler Solar cooker

Scheffler solar cookers were designed by German scientist Dr Scheffler. These cooker designs were modified and adapted by few manufacturers in India notably by M/s Gadhia Solar Pvt Ltd, Valsad. Scheffler cooking systems consist of a large 9 m² are mirror mounted on stand structure which has mechanical clock based tracking system. The innovative concept is the focus remains constant as mirror tracks the sun. As shown in Figure 6.2, the mirrors focuses solar radiation on the secondary mirror fixed at the bottom of the pot which reflects the radiation on the bottom of the pot. This cooker offers following advantages

- Cooking inside the kitchen is possible
- High temperature can be generated thus steaming, frying etc is possible.
- It can cook food for 10-15 persons at a time and hence is suitable for community cooking

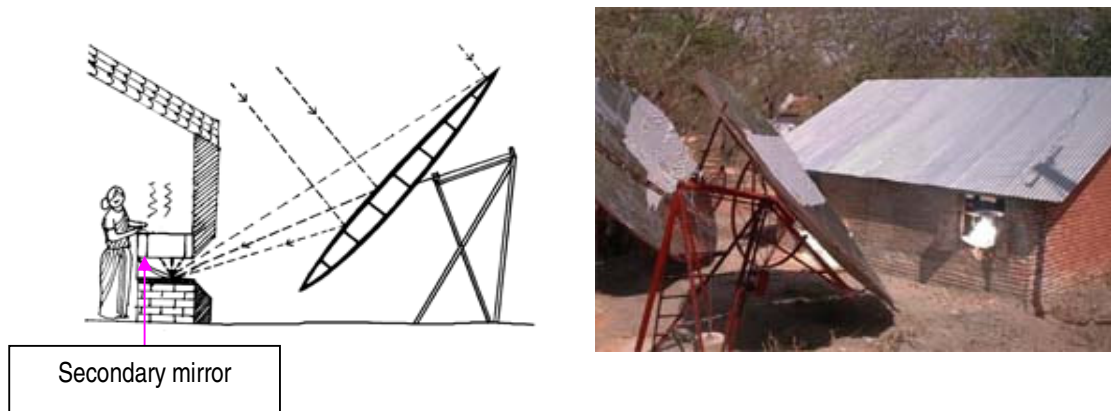


Figure 6.2 Scheffler cooker for inside cooking

Biomass gasifiers

Biomass gasifiers were developed by TERI, IISc and other organisations for various thermal and power applications. Wide range of applications is covered which include:

1. Thermal applications in industry like sweet making, silk reeling, aluminium smelting, rubber processing
2. Community cooking

Solar selective coating

Selective coating is used to improve the solar radiation collection efficiency in solar thermal collectors. These coatings are commonly used in solar collectors. Materials Science Division of National Aerospace Laboratories, a CSIR laboratory based in Bangaluru developed this coating using simple low cost indigenous method in 1990s. Brief information about the same is attached in Annexure IV. Today most of the manufacturers are using this technology.

CHAPTER 7 Development of RE industries and markets in India

Renewable energy industries development started in early 1980's with the establishment of manufacturing facilities in public sector companies like BHEL and CEL (Central Electronics Ltd). While BHEL invested in solar thermal, solar photovoltaic and wind energy systems development and manufacturing, CEL invested in solar photovoltaic modules and systems designing and manufacturing. M/s Jyoti Industries Baroda was one of the first major private sector companies who started manufacturing solar flat plate collectors and solar water heating systems in India. M/s Renewable Energy Systems Ltd, Hyderabad was one of the first major private sector companies in solar photovoltaic systems manufacturing while M/s NEPC India Ltd, Chennai was first major private sector company in wind turbine manufacturing.

Today there are about 150 odd industries having manufacturing activities in various renewable energy sectors.

Manufacturing base

Solar energy

Solar thermal and Photovoltaic industries are perhaps largest in numbers among the RE industries in India. An exhaustive list of the manufacturers is enclosed in Annexure IV.

Solar thermal industries

Majority of solar thermal industries are in flat plate collector manufacturing, vacuum tube collectors, solar cooker and solar steam generation systems. A comprehensive list of solar thermal system manufacturing units is given in Annexure-IV.

Solar Photovoltaic industries

India is slowly emerging as a major centre for solar photovoltaic systems. It has more than 8 solar cell manufacturing units, about 28 solar modules manufacturing units and many system integrators. These are listed in the Annexure IV.

Wind energy

India has world class wind manufacturing facilities including one of the world's leading manufacturers M/s Suzlon Energy Limited. There are about 7 leading manufacturers of wind machines in India. Most of them are either joint venture companies or subsidiaries of leading European/ US wind energy equipment manufacturing companies. Details of different capacities wind machines manufactured by these are given in Table 7.1 below.

Table 7.1 Manufacturer wise wind machine specifications

Name of Manufacturers	Capacity (kW)	Rotor Dia (m)	Hub Height (m)	Generator
Suzlon Energy Limited	600	52	75	Asynchronous
	1250	64	74	Asynchronous
	1250	66	75	Asynchronous
	1500	82	78	Asynchronous
	2100	88	80	Asynchronous
Enercon India Limited	800	48	50/57/75	Synchronous
	800	53	73/75	Synchronous
RRB Energy	600	47	50	Asynchronous
	500	47	50	Asynchronous
Vestas Wind Technology India Pvt. Ltd.	750	48.2	45/50/55	Asynchronous
	1650	82	70/ 78/80	Asynchronous
Pioneer Wincon Private Ltd.	250	29	50	Asynchronous
Regen Powertech Pvt Ltd	1500	77	85	Asynchronous
Siva Windturbine India Pvt. Ltd.	250	30	50	Asynchronous
Southern Wind Farms Ltd	250	29.8	45	Asynchronous

Source: www.windpowerindia.com

Bioenergy

Numbers of manufacturers and project developers are have established themselves n the bioenergy sector. These include large scale companies and small, medium and micro scale industries. An exhaustive list of bioenergy industries is enclosed in Annexure IV.

Small hydro

Small hydro sector has industries mainly in two categories a) manufacturing industries like turbine and controller manufacturers and b) contractors which offer engineering, procurement and commissioning (EPC) services. A list of approved manufacturers and contractors is enclosed in Annexure IV.

Quality assurance

Quality and reliability of products is vital for the successful adaptation of new technologies and especially for renewable energy technologies since they are capital intensive and are viable when used for longer periods. Understanding this, the Ministry has paid special attention to develop and adopt Indian standards which are at par with international standards. Initially, the development started with ministry drafting guidelines for manufacturing and testing and over the periods these guidelines were modified and adapted by the Bureau of Indian Standards in phased manners which are responsible to develop Indian standards. Currently testing and performance standards are available for all major renewable energy products

like solar collectors, solar photovoltaic modules, cells and systems, wind turbines etc.
An exhaustive list of BIS standards on RE systems and devices is enclosed in Annexure V.

Wind turbine technology status in India

Wind turbine technology is well developed and most of the wind energy generators now being installed are of MW scale. Wind turbines offered in India range from 250 kW to 2MW capacity. Since India is having low wind regimes, with highest wind power density of about 450W/m², and the offshore use of wind turbines has you to begin the high capacity wind turbine are not being offered in India. In the previous years the wind turbines ranging from 225 kW to 1.65 MW, from various manufacturers, having the type certificates from Centre for Wind Energy Technology, Chennai were available for the installation in India. Those manufacturers include the major wind turbine manufacturers of MW scale such as Bharat Heavy Electricals Limited (BHEL) (800 kW), Enercon India Limited (600 kW), GE wind energy India (1500 kW), NEG Micon Pvt, Ltd. (1500 kW and 1650 kW), Pioneer Asia wind Turbines (850 KW), Suzlon Energy Limited (1000 kW, 1250 kW) Vestas RRB,(500 KW) etc. Currently there are eight manufacturers in India with the type test certification of Centre for wind energy technology, and some are under the process of type test certification. A list of wind turbines currently having type test certification with their specification is given in table 7.2.

Table 7.2 Manufacturer wise approved wind machine models

Name of Manufacturers	Capacity (kW)	Rotor Dia (m)	Hub Height (m)	Generator
Suzlon Energy Limited	600	52	75	Asynchronous
	1250	64	74	Asynchronous
	1250	66	75	Asynchronous
	1500	82	78	Asynchronous
Enercon India Limited	2100	88	80	Asynchronous
	800	48	50/57/75	Synchronous
RRB Energy	800	53	73/75	Synchronous
	600	47	50	Asynchronous
Vestas Wind Technology India Pvt. Ltd.	500	47	50	Asynchronous
	750	48.2	45/50/55	Asynchronous
	1650	82	70/ 78/80	Asynchronous

Name of Manufacturers	Capacity (kW)	Rotor Dia (m)	Hub Height (m)	Generator
Pioneer Wincon Private Ltd.	250	29	50	Asynchronous
Regen Powertech Pvt Ltd	1500	77	85	Asynchronous
Siva Windturbine India Pvt. Ltd.	250	30	50	Asynchronous
Southern Wind Farms Ltd	250	29.8	45	Asynchronous

Source: www.windpowerindia.com

Apart from these the Global wind Power of India has got the licence from Dutch wind pioneer Henk Lagerway to manufacture a direct drive 2 MW wind turbine named GWP-2000-KW, Inox wind limited (Part of India's Inox group and company limited) received licence to manufacture 2 MW doubly fed induction wind turbine from AMSC wind tech (a subsidiary of American Superconductor Corp) and plan to manufacture this from 2010 and sale globally. Also the Ghodawat Industries (India) Pvt. Ltd. got license from AMSC to manufacture its 1.65 MW turbine design and this wind turbine is under process of type test certification by CWET.

[Global Wind Power \(GWP\)](#) of India plans to erect a new direct-drive 2-MW prototype within the next few months in the Netherlands. The turbine, named GWP-82 - 2000-kW, has been developed by Dutch wind pioneer Henk Lagerway and his design team and incorporates — among other features — a "passive air-cooled" fully enclosed PM generator.

CHAPTER 8 Projected trends and initiatives in international cooperation

The Ministry of New and Renewable Energy Sources had prepared its plan for the 11th plan. As per this plan the targeted power generation capacity addition based on renewable energy sources, excluding small hydro is 14200 MW. In addition, about 14185MW of large hydropower generation capacity is planned to be added by 2012. The details of these capacity additions are given in Table 7.1.

Table 8.1 RE capacity addition targets for 11th plan period

Technology	11 th Five Year Plan target capacity (MW) (2007-2012)
Hydro	15585 (1400 small hydro)
Wind	10500
SPV	50
Solid Biomass excl. CHP	900
Biomass CHP	1200

In addition to the projections till 2012, the Report of The Working Group on New and Renewable Energy for the 11th Five year Plan also made some long term projections, till 2020 for some of the major technologies like hydro, wind and biomass for power generation. According to these projections, the total installed capacity based on hydro would reach 80700MW. In case of wind the project the total installed capacity would be about 39000MW and the biomass based power generation capacity would reach 7073 MW.

Solar mission proposed under recently announced NAPCC (National Action plan for Climate Change) envisages solar power generation capacity of 20000MW by 2030.

International cooperation initiatives in technology and RE

Promotion of international cooperation with both developed countries (commonly known as north countries) and developing countries (commonly known as south countries) has been one of the focus areas of the GoI. These initiatives can be classified as:

- International trade and commerce development
- S&T cooperation
- Cooperation on common international issues

For the purpose of this report we will be focussing on some of initiatives taken by GoI in international cooperation in RE sector.

While Ministry of External Affairs is primarily responsible for international cooperation activities respective ministries have departments of international cooperation to coordinate the activities.

Major international cooperation initiatives in RE can be summarised as below

- Promotion and Exchange of research activities
 - The DST has signed S & T promotion agreements with countries in Europe and other parts of the world to promote joint research activities. RE sector is one of the sectors identified in most of these agreements. Further information is available on the website of DST – www.dst.nic.in.
 - Promotion of trade through trade promotion visits, exhibitions and joint missions. These are mostly coordinated by MEA and trade promotion organisations such as CII, FICCI, industry associations etc.
 - Financial assistance to the governments of the LDC countries through MEA schemes. In recent years MEA has included RE as priority sector in these schemes.
 - Technology exchange through organisations like APCTT, TIFAC, TDB etc.

Apart from the above initiatives which are common across all sectors MNRE has been promoting international cooperation through a special division named International Cooperation Division which is mandated to promote international cooperation in RE sector. This division has undertaken various international cooperation initiatives such as

International cooperation under APP (Asia Pacific Partnership) under which it has sanctioned joint research projects.

International Hydrogen Energy Partnership (IHEP)

MNRE has also endorsed international agencies such as ARENA, IEA to promote international cooperation.

Solar Park Initiative by Clinton Foundation-TERI

Clinton Climate Initiative promoted by the William J Clinton Foundation, USA and TERI have jointly taken up an initiative to assist the Governments (state and central) in developing an integrated solar power plant facility appropriately named as ‘Solar Park’. Solar Park is essentially a specially developed area where solar power plant project developers can establish large scale power plants and / or manufacturing facilities for solar power projects. Typically a solar park will have capacity to

establish about 3-5 GW capacity power plants. This concept offers following advantages

- Economies of scale to bring down cost of the project by at least 10-15%
- Pre approved facilities
- Integrated facilities / infrastructure such as transmission lines, water lines, gas pipe line, road and other infrastructure
- Assured market for project promoters
- Avoid legal battles over land allocation and rehabilitation of villagers
- Special economic package for projects
- Faster development of the projects

All this is expected to 1) bring down the cost by 30-40 % as compared to current costs 2) develop manufacturing hub in India 3) faster development of solar power projects in India.

Currently, the work is in progress to identify land in the states of Gujarat and Rajasthan. First park will be created and negotiations underway to establish the first facilities by mid 2010.

An extensive account of the development of RE sector in India is covered in this report. India is a growing economy and at the same time it faces huge challenge of lifting about half of its over a billion population above the poverty line by providing access to modern energy. RE sector development which started with the social objective of providing access to energy is now on the verge of revolutionising the energy sector with large scale deployment of RE based grid connected power projects. With an estimated potential of above 80000 MW of power generation from various RE resources, India still has a lot to achieve. The lessons learned from more than four decades of RE sector development in India can be summarised as below

1. The experience shows that integration of RE technologies in a developing country can achieve two major objectives
 - Providing access to energy in remote areas. RE technologies being decentralised and modular (for example Solar PV) are easy to implement and can offer energy solutions which can bring major change in the life style of the beneficiaries.
 - Acting as nucleus to societal transformation and economic upliftment.
2. Sustained government support for technical development and financial support in terms of capital subsidy is essential to start the RE development in developing countries.
3. Establishment of an independent dedicated financial institution IREDA to support RE projects in early stages of RE sector development has been one of the major initiatives. This is type of institution which is mandated with financing RE sector is crucial in bringing private sector development in the sector.
4. It is important to encourage local capacity building and develop home grown technologies to meet the local demand. Development of appropriate low cost technologies goes a long way in harmonising the development of the sector.
5. Right and timely policy initiatives with consistent policies are essential for sustained growth.

Annexure I

Details of State Nodal Agencies

STATE NODAL AGENCIES

Sl. No.	Name and Address	Telephone / Fax	E-mail / Website
1.	Vice Chairman & Managing Director Non-Conventional Energy Development Corporation of Andhra Pradesh (NEDCAP) Ltd. 5-8-207/2 Pishah Complex, Nampally Hyderabad – 500 001.	Tel: 040-23201172 (O), Fax: 040-23201666	nedcap@ap.nic.in
2.	Director, Arunachal Pradesh Energy Development Agency Urja Bhawan Tadar Tang Marg, Post Box No. 141 Itanagar-791111	Tel: 0360-211160 / 216937 (O), Fax: 0360-214426	http://www.apedagency.com
3.	Director Assam Energy Development Agency (under Science and Technology Deptt. Govt. of Assam) Bigyan Bhawan, Near IDBI Building G S Road, Guwahati-781005	Tele:0361-2464619, 2464621, Fax No.0361-2464617	aeda@india.com http://www.assamrenewable.org
4.	Director Bihar Renewable Energy Development Agency 1st Floor, Sone Bhawan, Virchand Patel Marg, Patna – 800 001	Tel: 0612-2233572, 2220493 (R); Fax: 0612-2228734	dir_breda@sancharnet.in
5.	Principal Secretary Energy and Chief Executive Officer Chhattisgarh State Renewable Energy Development Agency (CREDA) Mantralaya, DKS Bhawan Raipur (Chhattisgarh) Director Chhattisgarh State Renewable Energy Development Agency MIG/A-20/1 Sector 1, Shankar Nagar, Raipur	Tel : 0771-2221308, 5080308 (F) 2221163 Tel:0771-2426446; 5022050 (R); 5066770 (Fax)	vivekdhand@cg.nic.in creda@epatra.com / credacg@rediffmail.com / credacg@yahoo.com http://www.credacg.com
6.	Member Secretary Goa Energy Development Agency DST&E Building, 1st Floor, Saligo Plateau Opp. Seminary, Saligao, Bardez Goa – 403511	Tel. 271194	
7.	Director Gujarat Energy Development Agency (GEDA) 4th Floor, Block No.11 & 12 Udyog bhawan, Sector-11. Gandhi Nagar-382017 Gujarat	Tel. 079-23247086/89; Fax: 23247090	info@geda.org.in http://www.geda.org.in
8.	Director, Haryana Renewal Energy Development Agency (HAREDA) SCO 48, Sector 26 Chandigarh – 160 019	Tel: 0172-2791917, 2790918, 2790911(O), 2794185 (R), Fax: 0172-2790928	hareda@chd.nic.in http://www.hareda.gov.in

9.	Chief Executive, HIMURJA, SDA Complex, Kasumpti, Shimla-171009	Tele:0177- ,2620365 (O) 2620371 (R) Fax: 0177-2620365	himurja@hp.nic.in http://himurja.nic.in
10.	Director General Maharashtra Energy Development Agency (MEDA) S.No. 191/A, Phase1, 2nd Floor, MHADA Commercial Complex Opp. Tridal Nagar, Yerawada Pune – 411 006.	Tel: 020- 26614393, 26614403, 26615322 Fax: 020-26615032	meda@vsnl.com mahaurjamumbai@yahoo.com dg.meda@nic.in http://www.mahaurja.com
11.	Chief Executive Punjab Energy Development Agency SCO 134-136, Sector 34-A Chandigarh – 160 036	Tel: 0172- 2663392; EPBX 2663328/266338 2, Fax: 0172- 2646384	peda@glide.net.in mpsingh66@yahoo.com peda_spa@yahoo.co.in
12.	Chairman & Managing Director, Rajasthan Renewable Energy Corporation Limited E-166, Yudhister Marg, 'C' Scheme Jaipur – 302 001	Tel: 0141- 2225898 / 2228198 (O), Fax: 0141- 2226028	rrec_jai@yahoo.co.in gsomanl@datainfosys.net http://www.rajenergy.com
13.	Chairman & Managing Director Tamil Nadu Energy Development Agency (TEDA) EVK Sampath Building, Chennai – 600 006	Tel: 044- 28224832 Fax: 044-28236592	teda@md4.vsnl.net.in
14.	Chairman and Director Non-conventional Energy Development Agency (NEDA), U.P. Vibhuti Khand, Gomti Nagar Lucknow – 226 010	Tel: 0522- 2720652 (O); Fax: 0522- 2720779, 2720829	nedaup@dataone.in http://neda.up.nic.in
15.	Director Uttarakhand Renewable Energy (UREDA) Development Agency Energy Park Campus Industrial Area, Patel Nagar, Dehradun-248001	Tele :0135- 2710560 ; Fax No. 0135- 2521553	aruntygi@yahoo.com http://www.uttara.in/ureda/intro.html
16.	Indian Renewable Energy Development Agency Limited (A Government of India Enterprise) Corporate Office 3rd Floor, August Kranti Bhawan, Bhikaiji Cama Place, New Delhi – 110 066.	Tel: +91 11 26717400 - 26717413 Fax: +91 11 26717416	cmd@ireda.in http://www.ireda.in/default.asp
17.	Director Agency for Non-Conventional Energy and Rural Technology (ANERT), PATTOM P.O. PB No.1094, KESAVADASAPURAM Thiruvananthapuram-695 004	Telefax:0471- 2440121; 2440122, 2440124 (Fax) 2449854	anert@vsnl.com http://education.vsnl.com
18.	Managing Director, MP Urja Vikas Nigam Ltd., Urja Bhawan, Main Road NO.2 Shivaji Nagar, Bhopal –462016	Tele: 0755- 2556245; 2553595 Fax: 0755-2556245	mpuvn@sancharnet.in http://www.mprenewable.org

Annexure II

Details of Selected NGOs

NGOs

Sl. No.	Name and Address	Telephone / Fax	E-mail / Website
1.	Ladakh Ecological Development Group, Karzoo, Leh, Ladakh – 194101 Jammu & Kashmir, INDIA.	Phone: (91)(1982) 253221	ledegleh@gmail.com http://www.ledeg.org/
2.	Groupe Energies Renouvelables, Environnement et Solidarités (GERES) GERES India c/o Rinzin Namgyal (Danzom) Behind Indian airlines office Leh Leh, 194101 Leh District, J&K INDIA	Tel : 0091 1982 251 586	v.stauffer@geres.eu india@geres.eu http://india.geres.eu/index.php
3.	Social Work Research Centre (SWRC) Barefoot Engineers Tilonia District Ajmer 305 816 Rajasthan	Tel: 01463-42016, 01463-88203, 01463- 88204 Fax: 01463-88206	bunker@del2.vsnl.net.in barefoot@sancharnet.in www.barefootcollege.org
4	Appropriate Rural Technology Institute 2nd Floor Manini Apartments Dhayarigaon Pune 411041 Maharashtra	Tel: 91-20-24390348 Fax: 91-20-24390348	arti_pune@vsnl.net
5	Ashoka Trust for Research in Ecology and Environment 659, 5th A Main Road Hebbal Bangalore 560 024 Karnataka	Tel: 91-80-23530069 Fax: 91-80-23530070	seemap@atree.org siddappa@atree.org
6	Asian Institute of Rural Development 7/A Ratnavilasa Road Basavagadi Bangalore 560004 Karnataka INDIA	Tel: 91-80-26574091 Fax:	asiancarebg@vsnl.net
7	Ramakrishna Mission Ashrama Narendrapur, Kolkata 700 103 West Bengal INDIA	Tel: 91-33-2477 2201/2/3 Fax:91-33-2477 2070	rkmlpndp@cal.vsnl.net.in www.rkmcnarendrapur.org
8	Aurore CSR Office - Auroshilpam Auroville Tamil Nadu 605 101 India	Tel: 91 413 2622749 / 2622277 Fax: +91 413 2622057	aurore@auroville.org.in http://www.auroville.com/aurore

9	Madhya Pradesh Gramin Vikas Madal (MPGVM), PO Box 02 Balaghat 481001 Madhya Pradesh, India	Tel: + 91 7632 48354 Fax: 91 755 560642	mpgvm@rediffmail.com
10	Development Alternatives, 111/ 9-Z, Kishan Garh, Vasant Kunj, New Delhi- 110070 INDIA	Tel: 91 (11) 2613-4103, 2689-0380 Fax: 91 (11) 2613-0817	tara@devalt.org http://www.devalt.org
11	Technology Informatics Design Endeavour (TIDE) No. 19, 9th Cross, 6th Main, Malleswaram, Bangalore 560 003. Karnataka INDIA	Tel: 91-80-23315656 91-80-23462032 Fax: 91-80-3344555	tide@vsnl.com http://www.tide-india.org/
12	Nimbkar Agricultural Research Institute (NARI) Phaltan-Lonand Road, Tambmal, P.O.Box 44, Phaltan - 415523, Maharashtra, India	Tel: 91-2166-220945 91-2166-222396 Fax: 91-2166-225246	Nariphaltan@nariphaltan.org nariphaltan@gmail.com http://www.nariphaltan.org/nari/
13	Navreet Energy Research & Information (NERI), 799/28, Bharat Colony, Rohtak Uttar Pradesh INDIA	Tel: Fax:	
14	Assam Science Society Lamb Road PB No 74 Latasil Guwahati 781001 Assam INDIA	Tel: 2544208 Fax: 0091-361- 2603304	mailus@assamsciencysociety.org http://www.assamsciencysociety.org
15	BAIF Development Research Foundation, Dr. Manibhai Desai Nagar, Warje, Pune 411 058 Maharashtra INDIA	Tel: 91 - 20 - 25231661 Fax: 91 - 20 - 25231662	baif@vsnl.com http://www.baif.org.in
16	BAIF Development Research Foundation, "SURBHI", E-7/65, Lala Lajpat Rai, Society, Arera Colony, Bhopal – 462 013 Madhya Pradesh		

Annexure III

Details of State Electricity Regulatory Commissions

STATE ELECTRICITY REGULATORY COMMISSIONS

Sl. No.	Name and Address	Telephone / Fax	E-mail / Website
1.	Chairman Central Electricity Regulatory Commission 3 rd & 4 th Floor, Chandernagore Building, 36, Janpath, New Delhi- 110001	Ph: 91-11-23353503 Fax: 91-11-23753923	chairman@cercind.gov.in http://www.cercind.gov.in/index.html
2.	Rajasthan Electricity Regulatory Commission Shed No. 5, Vidhyut Bhawan, Vidhyut Marg, Jyoti Nagar, Jaipur 302 005	Phone: 2741181, 2741016 Fax: 2741018 Nodal Officer: Tarun Mathur, Deputy Secretary (141-2740067)	recjpr@yahoo.co.in http://www.erc.gov.in/index1.htm
3.	Gujarat Electricity Regulatory Commission (GERC) 1st Floor, Neptune Tower Opposite Nehru Bridge Ashram Road Ahmedabad - 380 009 Gujarat - India	Phone: 91 - 79 - 26580350, 26580359, 91 - 79 - 26584684 Fax: 91 - 79 - 26584542	chairman@gercin.org gerc@gercin.org http://www.gercin.org/index.php
4.	Assam Electricity Regulatory Commission ASEB Campus, Dwarandhar, G.S. Road, Sixth Mile, Guwahati-781022	Phone: 0361-2234442/2234472 Fax: 0361-2234432	aerc_ghy@hotmail.com http://aerc.nic.in/
5.	Andhra Pradesh Electricity Regulatory Commission D.No.11-4-660, 4th&5th Floor, Singareni Bhavan, Red Hills, Khairatabad, Hyderabad – 500 004	EPABX TEL. NOs. 2339-7381/7399/7556/7656/0970/0971/1973, 23378646 FAX NOs. 2339-7378/7489	chmn@aperc.gov.in http://www.aperc.gov.in/
6.	Bihar Electricity Regulatory Commission Ground Floor, Vidyut Bhawan-II B.S.E.B. Campus, Jawahar Lal Nehru Marg (Bailey Road), Patna - 800021 Bihar (India)	Phone : 091-612-6526749, 2504489, 2504488 Fax : 0612-2504488	chairman@berc.co.in bercpat@berc.co.in http://berc.co.in/pages/welcome-to-berc.S3InfoSystem
7.	Chhattisgarh State Electricity Regulatory Commission Civil Lines, G.E Road, Raipur (CG.) Pin-492001	Phone : 91-771-4073555, Fax : 4073553	cserc.cm.cg@nic.in cserc.sec.cg@nic.in http://www.cserc.gov.in/
8.	Delhi Electricity Regulatory Commission Viniyamak Bhawan, C- Block, Shivalik, Malviya Nagar, New Delhi, INDIA	TeleFax.: 91-11-26673608	secyderc@nic.in http://www.derc.gov.in/
9.	Himachal Pradesh Electricity Regulatory Commission Keonthal Commercial Complex, Khalini Shimla-171 002 Himachal Pradesh India	Phone : + 91 - 177 - 2627262 / 2627263 Fax. : + 91 - 177 - 2627162	hperc@rediff.com http://www.hperc.org/index.html

10.	Haryana Electricity Regulatory Commission Bays 33-36, Sector 4,Panchkula-134112 Haryana,INDIA	Phone: +91(172) 2572997, 2582531 Fax:+91(172)257 2359 EPABX: 2563052 , 2572298 , 2582532	herc@chd.nic.in http://herc.nic.in/
11.	J&K State Electricity Regulatory Commission PDC Complex, Ashok Nagar Satwari, Jammu	Telephone : 0191-2457899 Fax : 0191 -2454420	http://www.jkserc.nic.in/
12.	Jharkhand State Electricity Regulatory Commission 2nd Floor, Rajendra Jawan Bhawan-cum-Sainik Bazar, Main Road 34001	Ph. : 0651-2330838, 2330923, 2330763, 2330761, 2330926	chairman@jserc.org jserc@sancharnet.in http://jserc.org/
13.	Karnataka Electricity Regulatory Commission 6th & 7th Floor, Mahalaxmi Chambers, # 9/2, M.G.Road, Bangalore - 560 001	Ph: +91-080-25320213, 25320214, Fax:25320338	kerc@vsnl.com http://www.kerc.org/english.html
14.	Kerala State Electricity Regulatory Commission K.P.F.C.Bhavanam C.V.Raman Pillai Road Vellayambalam Thiruvananthapuram 695 010		kserc@erckerala.org http://www.erckerala.org
15.	Madhya Pradesh Electricity Regulatory Commission "Metro Plaza", 3rd & 4th Floor, E-5 Arera Colony, Bittan Market, Bhopal – 462 016	EPABX 0755-2430183, 2463585	http://www.mperc.org/
16.	Maharashtra Electricity Regulatory Commission World Trade Centre,Center No.1,13th Floor,Cuffe Parade, Colaba, Mumbai-400005	Telephone : 091-22-22163964/65/69 Fax : 091-22-22163976	rajavp@mercindia.org.in mercindia@mercindia.org.in http://www.mercindia.org.in/
17.	Meghalaya State Electricity Regulatory Commission 1st Floor [Front Block Left Wing] New Administrative Building Lower Lachumiere, Shillong-793001 East Khasi Hills District, Meghalaya	91-364-2500142 91-364-2500069 91-364-2500062 (Fax)	mmserc@gmail.com secy.mserc-meg@nic.in http://www.mserc.gov.in/home.html
18.	Punjab Electricity Regulatory Commission SCO: 220-221, Sector: 34-A, Chandigarh	PABX: (0172) 2645164 - 65 - 66 FAX: (0172) 2664758, 2645163, 2602435	percchd8@hotmail.com http://www.pserc.nic.in/
19.	Orissa Electricity Regulatory Commission Bidyut Niyamak Bhavan, Unit-VIII, Bhubaneswar - 751 012	Ph.:+91-674-2396117, 2393097, 2391580, 2393606 . Fax.:+91-674-2393306, 2395781	bksahoo@orienc.org orienc@rediffmail.com info@orienc.org http://www.orienc.org/index.asp

20.	Tamil Nadu Electricity Regulatory Commission No 19A, Rukmini Lakshmi pathy Salai, Egmore, Chennai - 600 008	Phone : 044-28411376,28411378,28411379 Fax : 044-28411377	tnercmail@gmail.com http://tnerc.tn.nic.in/
21.	Tripura Electricity Regulatory Commission Agartala, Tripura-799001	Telephone No: 0381-2326372 (O), 9436123782 0381-2351573 (R)	ssctercom@yahoo.com http://tripura.nic.in/terc
22.	Uttarakhand Electricity Regulatory Commission Institution of Engineers (I) Building, 1st Floor, Near ISBT, Majra, Dehradun (Uttarakhand)	Phone: 91-135-2641119 Telefax : 91-135-2641314	uttaranchalerc@rediffmail.com uerc@indiatimes.com secretaryuerc@indiatimes.com http://www.uerc.in/
23.	UPERC, IInd Floor, Kisan Mandi Bhawan, Gomti Nagar, Vibhuti Khand, Lucknow-226010	Phone: +91-522-2720426, Fax: +91-522-2720423	arun@uperc.org secretary@uperc.org http://www.uperc.org/
24.	The West Bengal Electricity Regulatory Commission Poura Bhavan (3 rd Floor) Block-FD , 415-A,Bidhannagar Kolkata – 700106	Ph NO: 2359-2189,2359-3397 FAX:(033)2359-3397	wberc@cal3.vsnl.net.in http://www.wberc.net/

Annexure IV

Details of RE consultants and equipment manufacturers

CONSULTANTS/ CONSULTANCY ORGANIZATIONS INVOLVED IN WASTE TO ENERGY PROJECTS

Sl. No.	Name and Address	Telephone / Fax	E-mail
1.	M/s CRISIL Limited 961-962, Solitaire Corporate Park Andheri –Ghatkopar link Road Andheri East Mumbai – 400 093	022–5644 1857, 5644 1801-09 / 022 – 5644 1830	vdeodhar@crisil.com
2.	M/s MECON Limited Management Advisory Services Division Ranchi – 834 002. Jharkhand	0651–2481 017, 2480 216 / 0651-2482 189	te@mecon.co.in
3.	M/s TAPSI Engineering Company A-57/4, Okhla Industrial Area Phase-II New Delhi – 110 020	2638 5323/28/29/38 / 2638 5333	energo@del3.vsnl.net.in
4.	M/s MITCON Consultancy Services Ltd. Kubera Chambers Shivaji Nagar, Pune 411 005	020-2553 3309, 2553 4322 / 020-2533206	urjit_mumb@yahoo.com
5.	M/s Ernest & Young Environment & Sustainability Services Ernest & Young Tower B-26, Qutab Institutional Area New Delhi – 110 016	2661 1004-09, 2685 2034 / 2661 1012-13	dipankar.ghosh@in.eyi.com
6.	M/s ERM India Private Limited 2 nd Floor, 3, Palam Marg, Vasant Vihar, New Delhi – 110 057	2615 4549 to 53 / 2615 4548	subrata.bose@erm.com
7.	M/s MWH India Private Limited 133, Udyog Bhavan Sonawala Road,Goregaon (East) Mumbai – 400 063	022-2686 7165, 26861963, Extn.115 / 022- 2686 7133	sharad.s.bhagwat@mwhglobal.com
8.	M/s Wilbur Smith Associates, Environmental Planning & Management 374, 2 nd Floor Sri Krishna Rukmuni Complex Judges Colony, R. T. Nagar Bangalore – 560 032	080-2354 9646, 47 / 080 – 2354 9644	giridhar.ba@wilbursmithpl.com
9.	M/s Industrial & Technical Consultancy Organisation of Tamil Nadu Ltd. 50-A, Greams Road, Chennai- 600 006	Fax: 044-2829 3512	
10.	M/s Fichtner Consulting Engineers (India) Pvt. Ltd. Plot No.11, 1 st Floor, Sector –24 (Turbhe) Sion - Panvel Expressway, Vashi New Mumbai – 400705	022-2763 3037 / 022- 2761 1414	finmumb@vsnl.com

LIST OF BIOMASS GASIFIER MANUFACTURERS IN INDIA

Sl. No.	Name and Address	Telephone / Fax	E-mail
1.	Dr. B.C. Jain, Managing Director M/s. Ankur Scientific Energy Technologies Pvt. Ltd. Near Old Sama Jakat Naka Vadodara-390 008	0265-2793098 / 0265-2794042	ascent@ankurscientific.com info@ankurscientific.com
2.	Mr. B.V. Ravi Kumar, Director M/s. Cosmo Powertech Pvt. Ltd. Devpuri, Near Jain Public School Dhamtari Road, Raipur - 492015	0771-5011262 / 0771-5010190	cosmo_powertech@yahoo.co.in
3.	Mr. J. Mukherjee, Director, M/s. Grain Processing Industries (I) Pvt. Ltd. 29, Strand Road, Calcutta-700001	033-2431639, 2101252 / 033-2204508, 2103368	
4.	Prof. P J Paul, Chief Programme Executives, ABETS Dept of Aerospace Engineering Indian Institute of Science Bangalore-560 012	080-23600536, 22932338 / 080-23601692	paul@cgpl.iisc.ernet.in
5.	Mr. K. Ramachandra M/s. Netpro Renewable Energy (India) Ltd. 139/B, 10 th Main, Rajamahal Vilas Extension Bangalore-560080	080-3613585, 3613457 / 080-3611584 Res.: 3232640	netpro1@vsnl.com
6.	Mr. Sudhir Chandra M/s. Chanderpur Works Yamuna Nagar – 135 001, Haryana	01732-250546, 250964, 251866 / 01732-279852 New Delhi (Tel.): 26317811	sudhiryn@sancharnet.in
7.	Mr. Naval Kishore Agarwal M/s Infinite Energy Private Limited 149-A, Baba House, 1st Floor Kilokari, Opp. Maharani Bagh New Delhi- 110014	65273819, 65191937 / 26903696 (M)+91-9212084933	ifnfiniteenergy@vsnl.net
8.	Shri H.R. Jaiswal, Managing Director Rishipooja Energy & Engineering Company M.G. College Road Gorakhpur – 273 001 (UP)	0551-340 612, 339475	
9.	Shri K.J. Haris, Managing Director Southern Carbons (P) Ltd. VI/590 B, Development Area, Edayar Binanipuram P.O. Aluva Cochin 683502, Kerala	0484-2540158 / 2532685 / 2543739 (M) 09447120502	southerncarb@gmail.com
10.	Dr.S.V. Makadia Radhe Renewable Energy Development Associate D-110 Rajdoot Industrial Estate 4, Umakant Pandit Udyog Nagar Near Mavdi Plot Rajkot – 360 004 (Gujarat)	91-981 372567 (O) 571932 / 91-281 372557	radheengineering@radhegroup.com
11.	Shri Ashok Mourya M/s Agro-power Gasification Plant Pvt. Ltd. B37/181, B1, Birdopur Varanasi-221010 (UP)	9415221537 (M) 0542-2364285	
12.	Shri Ashok Poddar M/s Ganesh Engineering Works Poddar House, Jyoti Chowk, Buxer – 802101 Bihar	06183-224571 (M) 9431420171 / 06183-227503	

LIST OF EQUIPMENT MANUFACTURERS OF SMALL HYDRO TURBINES

Sl. No.	Name and Address	Telephone / Fax	E-mail
1.	General Manager (Hydro) M/s Bharat Heavy Electricals Ltd. BHEL House Asiad, Siri Fort New Delhi-100 049	011 –26001010 / 011-26001172, 2649356	km@bhel.in
2.	Managing Director M/s Boving Fouress (P) Ltd. Plot No. 7, KIADB Industrial Area, Hoskate Bangalore-562114	080 – 27971641, 2791646 / 080 - 27971455, 28395176	foursbov@vsnl.com ; info@bovingfouress.com
3.	Managing Director M/s VA Tech. Escher Wyss Flovel Ltd. 49/5 , Mathura Road Vill. Prithla, Tehsil Palwal Dist. Faridabad-121 102 (Haryana)	01275-262161, 262162, 262163 / 01275 - 262055	contact@vatewf.com
4.	Managing Director M/s Jyoti Ltd., Nanubhai Amin Marg Industrial Area P.O., Chemical Industries Vadodara - 390 003	0265–2281522, 2282047 / 0265- 2350538, 2381871	hyd.jyoti@sm3.sril.in
5.	The Managing Director M/s Steel Industrials Kerala Ltd. Silk Nagar, Athani P.O. Thrissur – 680 771 (Kerala)	0487–2201421, 2201423 / 0487 - 2201331, 2201753	silk@md3.vsnl.net.in
6.	Vice President (Power) M/s Kirloskar Bros. Ltd. 'YAMUNA', Sr.No. 98/3-7 Baner, Pune – 411 045	020–27214598, 27214599 / 020 - 27214514	kblin@kbl.co.in
7.	Managing Director M/s. HPP Energy (India) Pvt. Ltd. G 21, Sector - 63 NOIDA – 201 301	0120 – 4699100 / 0120 - 4699199	info@hppenenergy.com
8.	President M/s Alstom India Ltd. IHDP Building Plot # 7, Sector 127 Noida – 201 301	0120 – 4731100 / 0120 – 4731777	
9.	M/s ABB Limited Khanija Bhawan 49, Race Course Road, 2nd floor East Wing, Bangalore – 560001	080 – 22949150, 22949154 / 080 - 22949148	
10.	Managing Director Voith Hydro Pvt. Ltd. A – 20 & 21, Sector 59 Noida – 201 301	0120 – 3074242 / 0120 - 3074243	info@vs-india.com
11.	Managing Director M/s. Flovel Mecamidi Energy Pvt. Ltd 14/3, Mathura Road, Faridabad – 121 003	0129 - 4090600, 4090602 / 0129 - 4090650	contact@flovel.in
12.	M/s Prakruti Hydro Labs # 768 (1st Floor), 14th Cross, 33rd Main, J.P. Nagar, 1st Phase Bangalore – 560 078	080 – 26656191 / 080 - 26860077	
13.	M/s. Indusree Pvt. Ltd.,	011 – 26284551 /	indusree@bol.net.in

Sl. No.	Name and Address	Telephone / Fax	E-mail
	317 Hemkunt Chambers, 89, Nehru Place, New Delhi-110 019	011 - 26220621	sbahydro@vsnl.net
14.	Vice President M/s Ushvin Hydro System (P) Ltd., 443, Udyog Vihar, Phase – III, Gurgaon – 122 016	0124 – 3010883 – 92 / 0124 – 3010895, 3010896	ushmil@rediffmail.com
15.	M/s DRG Jalshakti Engg Pvt. Ltd. Electronic City, 28 Salt Lake (near City Center) Kolkata – 700 064	033 – 23343188 / 033 - 23372924	contact@jalshakti.com
16.	M/s. Gita Flow Pumps India Pvt. Ltd. Gita Compound Paper Mill Road Saharanpur – 247 001	0132 - 2724084, 2725009 / 0132 - 2730139	gitaflo@hotmail.com
17.	M/s. PentaFlo Hydro Engineers L – 25, LGF, Kalkaji New Delhi-110 019	011 – 41600460 / 011 - 41602360	contact@pentaFlo.com pentaFlo@airtelmail.in
18.	Everest Energy Pvt. Ltd. # 75, Dinnur Main Road HMT Layout, RT Nagar Bangalore-560 032	080-51244844 / 080-51244845	anil@everest_energy.com
19.	M/s. Plus Power System B-25/6, Rajapuri, Uttamnagar New Delhi	011-25562175	
20.	M/s Standard Electronics Instruments Corporation 142, Malviya Nagar, Chowk, Railway Road, Ganeshpur, Roorkee dist. Haridwar (Uttarakhand)	01332 - 274327	
21.	Managing Director M/s. Vinci Aqua Systems (P) Ltd. 158, Avarampalayam Road Peelamedu Post Coimbatore – 641 004	0422 – 6453180, 2560485	vincipumps@yahoo.co.in

**SOLAR PASSIVE ARCHITECTURE
INDICATIVE LIST OF EXPERTS AND ARCHITECTS**

Sl. No.	Name and Address	Telephone / Fax	E-mail
1.	Prof. C.L.Gupta Solar Energy Unit Sri Aurobindo Ashram Podicherry 605002		solagni@auroville.org.in
2.	Prof. Arvind Krishan Centre for Advanced Studies in Architecture School of Planning & Architecture 4, Block B Indraprastha Estate New Delhi-110002	011-26107250, 26167060	krishan@del2.vsnl.net.in
3.	Ms. Milli Mazumdar Tata Energy Research Institute Darbari Seth Block India Habitat Centre, Lodi Road New Delhi – 110 003	011-24682100, 1	milim@teri.res.in
4.	Prof. J.K. Nayak Energy System Engineering Deptt. Indian Institute of Technology Bombay-400076		
5.	Sh. B. V. Doshi Vastushipa Foundation for Research in Environmental Design Sangath, Thaltej Road Ahmedabad- 380054		sangath@vsnl.com
6.	Sabu Francis & Associates A-104, Shiv Chamber Sector 11, CBD-Belapur Navi Mumbai MAHARASHTRA		chief@archsfa.com
7.	Mr Patel Nimish and Zaveri Parul Abhikram 15 Laxmi Nivas Society Paldi Ahmedabad 380007		
8.	Mr. Harish Ganeriwala Glaze Architecture Pvt. Ltd. 591, Block O New Alipore Kolkata – 700 053	24005255	glazeonline@gmail.com
9.	Ms Anand Mann & Siddhartha Wig The Elements SCF 59, 1st Floor, Sector 6 Panchkula 134101	0172-2580094	
10.	Dr. Vinod Gupta Space Design Consultants G 4, Masjid Moth, GT 2 New Delhi-110048	40573213 Ext. 31, 40573264 / 40573265	http://www.space-design.com
11.	Mr Ashok B Lall B-25 Chirag Enclave New Delhi 110017 Also at 2B Ramkishore Road Civil Lines, Delhi 110054		
12.	Mr Manmohan Dayal D-3/3552 Vasant Kunj		

	New Delhi 110030		
13.	Mr Sanjay Prakash R-1/ 301 Hauz Khas Enclave New Delhi 110 016	011-5165 5696, 2656 9934	sanjay_prakash@vsnl.com
14.	Mr. Anurag Roy Roy and Partners D* /8184, Vasant Kunj New Delhi – 110 070		anuragroy@vsnl.com
15.	Mr Upendra Kachru C-47, Pamposh Enclave New Delhi 110048	011-26411741	tams.soc@gmail.com
16.	Mr. Pankaj Jain M/s Jain & Associates S-13/21, DLF-111 Gurgaon	0124-4605318, 2352829	

SPV LIGHTING MANUFACTURERS LIST

Sl. No.	Name and Address	Telephone / Fax	E-mail
1.	Mr. V. Sambaiah GM - QAD MIC Electronics Limited A-4/II Electronic Complex Kushaiguda Hyderabad – 500062 Andhra Pradesh	040-27122222, Fax : 040- 27133333, (M)09000011388	vs@mic.co.in
2.	Mr. K.K. Roy Director Kalisons Telvent Pvt. Ltd. T-4, IIIrd Floor, Plot No.19 Sec-10, Central Market, Dwarka New Delhi	011-25071355, 011-28083515 Fax : 011- 25071355, 011-28083515 09810127459, 09999778971,	info@kalisonstelvent.com kkroysolar@gmail.com
3.	Mr. Shiv Kumar Seth (Business Development Manager) Power Technologies Corporation, S-158, Greater Kailash – II, New Delhi – 48	Tele fax : 011- 41637585 9310827105	Shiv.seth@sanartigroup.com
4.	Mr. C.G.Patel Managing Director M/s Topsun energy Ltd. B-101,GIDC Electronic Zone, Sector-25 Gandhinagar – 382028, Gujarat	079-23288804 / 079-23288805	info@topsunenergy.com
5.	Mr. H.Narasimhaiah, C.E.O. M/s Rashmi Industries 60 & 61 Begur Road Hongasandra Village Bangaluru – 560068 Karnataka	080-25734115, 4114 Fax: 080- 25732309	rashmisolar@gmail.com
6.	Mr. S.A Sudarshan Vice President & Business Head M/s WIPRO Eco Energy S.B. Towers (5th Floor) 88 M.G. Road Bangalore – 560001, Karnataka	080-41994000, 080-41994004 Fax : 91-80- 41994010 09900582662	Sudarshan.ananth@wipro.com
7.	Mr. Ashok Ramakrishna, General Manager – Business development (RIL Solar Group) Mr. Gurjit Bharara Business Head – North (RIL Solar Group) M/s Reliance Industries Ltd. Relinace Corporate Park Gate House Thane - Belapur Road Ghansoli Navi Mumbai -400701, Maharashtra	022-29770000, 022-44770726, 022-44710084 Fax : 022-44710084, 022-40658447 (M) 09811048677, 09958593885	ashok.ramakrishna@ril.com Gurjit.bharara@ril.com
8.	Mr.Sanjeev Phadnis (Manager-Technical) M/s Jain Irrigation Systems Ltd. Jain Energy Park Jain Valley Shirsoli Road P.O.Box 20 Jalgaon-425001	0257-2360033 0257-2260044 Fax: 0257-2261144 0257-2261155	Solar@jains.com Phadnis.sanjeev@jains.com

MANUFACTURERS OF WIND TURBINES

Sl. No.	Name and Address	Telephone / Fax
1.	M/s Enercon (India) Ltd. "Enercon Tower" A-9, Veera Industrial Estate Veera Desai Road Andheri (West) Mumbai – 400 053	022-6692 4848 / 022-6704 0473
2.	M/s Global Wind Power Limited 301, Satellite Silver 3 rd Floor Andheri Kurla Road Marol, Andheri (East) Mumbai – 400 059	022-3991 8500 / 022-3991 8521
3.	M/s Leitner Shriram Manufacturing Ltd No. 5, T V Street Off. Spurtank Road Chetpet Chennai – 600 031	044-2792 6000 / 044-2792 4944
4.	M/s Pioneer Wincon Private Ltd. 30/1A, Harrington Chambers 2 nd Floor, "B" Block Abdul Razaq 1 st Street Saidapet Chennai – 600 015	044-2431 4790 / 044-24314789
5.	M/s Regen Powertech Pvt. Ltd. No. 28/11, College Road Chennai – 600 006	044-3028 0200 / 044-3028 0199
6.	M/s RRB Energy Limited No.17, Vembuliamman Koil Street K K Nagar (West) Chennai – 600 078	044-2364 1111 / 044 2364 2222
7.	M/s Siva Windturbine India Pvt. Ltd. 12A, Kandampalayam Perundurai Erode – (DIS) Pin : 638 052	04294 – 220017 / 04294 - 220137
8.	M/s Southern Wind Farms Limited No.15, Soundarapandian Salai Ashok Nagar Chennai – 600 083	044-3918 2600 / 044-3918 2636
9.	M/s Suzlon Energy Ltd. 5 th Floor Godrej Millennium 9, Koregaon Park Road Pune – 400 001	020-4012 2000 / 020-4012 2100
10.	M/s Vestas Wind Technology India Private Limited 298, Old Mahabalipuram Road Sholinganallur Chennai – 600 119	044-2450 5100 / 044-2450 5101
11.	M/s Winwind Power Energy Private Limited Sterling Tower 327, Anna Salai Teynampet Chennai – 600 006	044-2431 3001 / 044-2435 6564
12.	M/s Elecon Engineering Company Ltd.	02692-227077 / 02692-236457

Sl. No.	Name and Address	Telephone / Fax
	Post Box No. 6 Anand Sojitra Road Vallabh Vidyanagar Gujarat – 388 120	
13.	M/s India Windpower Ltd 14, Radhekishan Bungalows Nr. Bodakdev Fire Station Nr. Furniturewala Showroom Bodakdev Ahmedabad – 380 054	079-6605 1466 / 079-4003 2946
14.	M/s Kenersys India Private Limited Industry House Survey No. 49 Mundhwa Pune – 411 036	020-4106 1901 / 020-4106 1999
	M/s Elecon Engineering Company Ltd. 5 th Floor Godrej Millennium 9, Koregaon Park Raod Pune – 411 001	020-4012 2000 / 020-4012 2100

Dealers of Solar Water Heaters in Delhi

Sl. No.	Name and Address	Telephone / Fax	E-mail
1.	M/s ANU SOLAR POWER PVT LTD. Mr. Sumith Kumar Nahar Singh Complex Near Bajaj Service Dundahera, Kapashera Gurgaon - 122 016 Mr. Shashank Kumar Choudhary Shop No. 2, WZ-912 Ring Road, Naraina New Delhi - 110 028 Mr. Dilip Patra Dharam Veer Market Near Kartik Kunj Apartment D-13, Sector - 44 Noida - 201 301	0124 - 3290843 / 09810719261 09968374670 09899424681	
2.	Mr. Vicky Vadhera Electric India Control Device E-206 , East of Kailash New Delhi - 110065	9810879087	
3.	Mr. Sanjeev Jaitley Surbi Enterprises 138, D.D.A. Flats Near Satyam Cinema Near Ranjeet Nagar New Delhi - 110008.	9811659311	
4.	Mr. Kurian Thomas M/s. Aviv Energy Systems Pvt. Ltd 8/243, Chattarpur Pahari New Delhi - 110 074	011-26303560 Mobile: 98184- 49970	kurian_54@yahoo.co.in
5.	Mr. Krishnan Kumar M/s Shree Parvarhi Metals Pvt. Ltd A-140, Shankar Garden, Vikas Puri New Delhi- 110018	9811973344, Ph. : 41582033 (O), 9312261353 & 9828280404 (M) Fax: 25508286	spm@ndf.vsnl.net.in
6.	Mr. Khaleel Junedi Hitech Solar Pvt. Ltd Nizamudin New Delhi	9873748458, 9911694069 (M)	
7.	M/s Solanand Solar Systems, Haryana 459,A/33, Onkar Nagar, Trinagar, Delhi		
8.	Mr. Manmohan Singh Millennium Energy Systems Pvt Ltd # 901-A, GD-ITL, Twin Towers # B-08, Netaji Subhash Palace Ring Road, Pitampura DELHI 110 034	Cell : 98183 73221 Tel : 011 27353445 Fax : 011 27353445	millennium_es@rediffmail.com
9.	Mr. Ajay Chachra Alpha Interiors Pvt Ltd # 106-A, Allied House Inderlok DELHI 110 035	Cell : 98116 11004 Tel : 011 55646699 Fax : 011	ajaycha@vsnl.com

Sl. No.	Name and Address	Telephone / Fax	E-mail
		23658597	
10.	Mr. Anil Bhat ntegro Engineers Pvt Ltd # S-6, Okhla Industrial Area Phase II NEW DELHI 110 020	Cell : 98111 13212 Tel : 011 26388540, 541 Fax : 011 41733202	integro@vsnl.net
11.	Mr.Suresh Paruthi Mr. Vinod Sobti Venus Oilfield Services P Ltd # D-25, Saket NEW DELHI 110 017	Cell : 98104 70009 Fax : 011 26864153	vsobti@yahoo.com
12.	Col.R.C.Madan Star International # 906, B-8, GD-ITL Towers Netaji Subash Palace NEW DELHI 110 034	Cell : 99103 98760 Tel : 011 27351075 Fax : 011 27351075	star_india@rediffmail.com
13.	Mr Sushil Daga Prime Power Agencies # E-2/204, Alaknanda Market 2nd Floor, Near Post Office NEW DELHI 110 019	Cell : 93502 07076 Tel : 011 32568071 Fax : 011 26028833	prime_power@vsnl.net
14.	Mr. Gulshan Kapur Advance Electronic Systems # 40, DSIDC Complex Okhla Industrial Area, Phase – I NEW DELHI 110 020	Cell : 98102 62388 Tel : 011 26812802 Fax : 011 41660248	kapuraes@airtelbroadband.in
15.	Mr. Aditya Nath General Commerce Ltd # 100-A, Bangla Sahib Marg NEW DELHI 110 001	Cell : 98111 03465 Tel : 011 23362163 Fax : 011 23746555	gclsolar@gmail.com
16.	M/s. System Appliances Co. 408/5A/1, Lane No.22 Nai Basti, Anand Parbat New Delhi-110005	011-28761267 Mob. 9312221083, 9811086669	
17.	M/s. Kallison Televent Pvt. Ltd. T-4, 3rd floor, Plot. No.19 Sec. 10 , Central Market Sec. 10 , Central Market Dwarka, New Delhi-110075	Tel : 011- 25071355, Tel/fax 011- 28083515 Mob. 9312237293, 9210034598	
18.	Neutrol Engineers 201, Aditya Building No. 7 Commercial Complex, Preet Vihar New Delhi-110092	Tel : 011- 22503010, 22510621, 22412149 Fax : 011- 22503010	

List of known Manufacturers/suppliers/institutions involved in Installation of flat plate collector based Solar Driers/Air Heating Systems/ Solar Steam Generating Systems

Sl. No.	Name and Address	Telephone / Fax	E-mail
1.	M/S Planters Energy Network (PEN) No. 5, Powerhouse Street N.R.T. Nagar Theni-625531, Tamilnadu	Phone: 04546-255272/ 255271 Telefax: 04546-255271	pen01@sify.com , & mdu_pen@sancharnet.in
2.	M/S NRG Technologies 989/6, GIDC Estate, Makarpura, Vadodara-390010	Telefax: 0265-2642094	nrgtechnologists@yahoo.com
3.	M/S Kotak Urja Pvt.Ltd. No. 378, 10th Cross, 4th Phase Peenya Industrial Estate, Bangalore -560 058	Tel. (080) 23560456-7; Fax : 23562233	kotakurja@vsnl.com
4.	Director Sardar Patel Renewable Energy Research Institute, Post Box No. 2, Vallabh Vidyanagar-388120, Gujarat	Ph.: 02692-231332/ 35011, Fax: 02692-37982	director@spreri.org
5.	M/S ATR Solar , #1,RMR Complex, 2nd Floor, SS Colony, North Gate, (opp. Devaki Scans) Madurai-625010	Tel: 0452-3025400 Mobile: 9344453444, 9843265400.	atrsolar@gmail.com
6.	M/S STEELHACKS INDUSTRIES , 525-526, G.I.D.C., Vithal Udyognagar 388121, Dist. Anand. Gujarat. (INDIA)	Tel: 02692 236156,235518 Fax : 2692 236534	info@unisolar.com , unisol26@gmail.com
7.	M/s. Gadhia Solar Energy Systems (P) Ltd. Plot No.86, OLD GIDC Gundlav, Valsad – 396 035, Gujarat	Telefax 02632- 236703	gadhiasolar@yahoo.co.in & gadhia_ad1@sancharnet.in
8.	Project Co-ordinator Solar Steam Cooking System Brahamakumari Ashram Mount Abu Rajasthan	Tel: 02974-237049 (direct)/ 238788 (general), Fax: 02974 -238951 & 238952	bkgolo@sancharnet.in / golobhai@gmx.net
9.	M/s Solar Alternatives St. Mary's Church Compound Phulwari Sharif, Patna-801505	Tel. 0612-254487 / Fax 227903	solarpatna@yahoo.com sjphulco@dte.vsnl.net.in
10.	M/s Sharada Inventions 94/1, MIDC Satpur Nashik-422007	Tel : 0253- 2352444/2353844 / Fax : 0253-2353853	sharadainv@satyam.net.in
11.	M/s Thermax Limited Sai Chambers 15, Mumbai-Pune Road Wakadewadi Pune-411003	Tel. 020-25511010, 25511141 / Fax: 020-25511042, 25511976	
12.	Unison Technologies Pvt. Ltd No.6, 1st Floor, Kodava Samaja Building 1st Main. Vasanthnagar Bangalore-560052	Tel : 080- 22355238/30909193 / Fax: 080- 22289294	unison@vsnl.com
13.	M/s Clique Development Pvt. Ltd. 134 A/B, First Floor, Government Industrial	Tel. : 022-28609011 / Fax: 022- 28609734	sbk@cliquetechnologies.com

Sl. No.	Name and Address	Telephone / Fax	E-mail
	Estate, Charkop, Kandivali (West) Mumbai- 400 067		

List of Box Type Solar Cookers manufacturers

Sl. No.	Name and Address	Telephone / Fax	E-mail
1.	M/S Universal Engineers Enterprises Garg Bhavan, Prince Road Gandhi Nagar, Moradabad (U.P.)	0591-2493619 (Telefax) : 0591-2499768	
2.	M/s Rural Engineering School Rojmal, Tal.: Gadhada (SN) District Bhavnagar-364750, Gujarat	Tel : 02847 294127 Fax: 02847 253535	ruralschool@rediffmail.com
3.	Khadi Gramodhyog Prayog Samiti Gandhi Ashram, Ahmedabad-380 027	Telefax: 079-27552469 Mobile : 9825484275, 9879784255	
4.	Sayala Taluka Khadi Gramodyog Seva Mandal, Motiram Building , Below SBS Service Branch, Phulchhab Chowk, Rajkot 360 001	Ph.: 0281-2477226 Mobile : 09825074591	aylatalukakhadigs.mandal@yahoo.co.in
5.	M/S J. N Enterprises, F-12, Navin Shahdara, Delhi	Mobile : 2350859119	
6.	M/s. Vishvakarma Solar Energy Co. G.T. Road , Phillour Distt.Jalandhar, Punjab	01826-22523 01826-22217	
7.	M/s Fair Fabricators 142, Tilak Nagar , Near Post Office, Indore - 452 018	Telefax: 0731-2491488 Mobile : 9425316707	fairfabricators@hotmail.com
8.	M/s Rohtas Electronics, 15/268-B, Civil lines, Kanpur - 208001	Ph. : 0512-2305564 Telefax : 0512-2305390	rohitas@vsnl.net
9.	M/s Rural Engineering School , Rojmal, Tal.: Gadhada (SN) District Bhavnagar-364750, Gujarat	Tel : 02847 294127 Fax: 02847 253535	ruralschool@rediffmail.com
10.	M/S Usha Engineering Works 40-A,Trunk Road, Madanur-635804 Vellore District, Tamilnadu	Ph.: 04174-73613	solltechnew@yahoo.co.in
11.	M/S Geetanjali Solar Enterprises P/14, Kasba Industrial Estate Phase-I, E.M. Bye Pass PO East Kolkata Township Kolkata-700107	033-24420773/24424027 (Fax) 033-24420773	gse@cal.vsnl.net.in

EVACUATED TUBE COLLECTOR BASED SOLAR WATER HEATING SYSTEMS

List of Eligible Manufacturers / Suppliers

Sl. No.	Name and Address	Telephone / Fax	E-mail
1.	M/s Borosil Glass Works Limited, Khanna Construction House, 44, Dr. R. G. Thadani Marg, Worli, Mumbai – 400 018	Tel : 022-2493 0362, 2493 0366, 24930370 Fax : 022-2495 0561, 2492 0718	borosil@borosil.com
2.	M/s Photon Energy Systems Ltd. 775-K, Road No. 45, Jubilee Hills Hyderabad – 500033	Tel : 040- 23331337/8/9, Fax : 040- 23331340 Mobile : 9246333624	varma@photonsolar.com thermal@photonsolar.com
3.	BGS Energy Pvt. Ltd. 1-11-303, Gr. Floor, Bhagwanthpur, ICICI Bank Lane, Begumpet, Hyderabad-500016 (AP)	Tel: 040-27762919	info@bgsenergy.in
4.	M/s. Access Solar Ltd., S-5, Phase II, T.I.E. Balanagar, Hyderabad – 500 037 (AP)	Tel: 040-23076010, Fax: 040-23076271	info@accesssolar.net
5.	M/s. Solari Techno Ventures India Pvt. Ltd., 1-2-47/100/36, Subhodaya Nagar Colony, Behind MNR PG College, Beside Adithya Nagar, Hydernagar, Kukatpally, Hyderabad – 500 072 (AP)	Tel: 09246501142, 09441185373 Fax: 040 – 23514571	
6.	M/s Qbarons Natural Energy system Door No: 45-48-13, Flat No.201, Venkata Chalapathi Residency, Jagannadhapuram, VISAKHAPATNAM – 530016 (AP)	Tel: 891- 6644669/6460544, Fax: 891-3065866	info@qbarons.com
7.	M/s Sri Sundaram Solar Solutions 8-2-70 Harshvardhna Colony Old Bowenpally, Secunderabad – 11 (AP)	Tel:- +91 40- 64517469 ,Fax:- +91-40-27500619	sssolars@yahoo.com
8.	M/s Arsh Electronics (P) ltd. 224, Surya Niketan, Vikas Marg Extn Delhi – 110 092	Tel: 011-22374859, Fax: 011-22379973	arsh_electronics@vsnl.com
9.	M/s Bhambri Enterprises 794, Joshi Road, Karol Bagh, New Delhi	Tel: 011- 23541114/55388606 /9811759494	bhambri123@rediffmail.com
10.	M/s. Ados Electronics Pvt.Ltd. C 202, Sagar Sadan, 113, I.P. Extension, Delhi-110 092	Tel: 011-22230734, 9811194519, 986817996	adosmail@rediffmail.com
11.	M/s. Shriram Green Tech 5th Floor, Akashdeep Bldg. 26A Barakhamba Road New Delhi – 110 001	Tel: 011-23312267, Fax: 011-23313494	shriramgreentech@dcmr.com
12.	M/s. Prachi International Pvt. Ltd., A-14, 1st Floor, Wazirpur Indl. Area,]Delhi – 110 052	Tel: 011-27375577, 27375599, Fax: 011-27371030	knightqn@del2.vsnl.net.in

Annexure V

List of BIS standards

Wind Turbine Generators

For wind turbine generators the IEC standards have been accepted. List of these standards are as follows

S No.	Title	International Standards / IEC Code	Indian Standard Document (Document NO.)*
1.	Electro technical Vocabulary – Part 415: Wind Turbine Generator Systems	IEC 60050-415 :1999	ETD 42 (5985)
2.	Wind turbines- Part1: Wind turbines safety and design	IEC-61400 -1	NA
3.	Wind turbines – Part 2: Design requirements for small wind turbines	IEC 61400-2 :2006	ETD 42 (5986)
4.	Wind turbines – Part 13: Measurement of mechanical loads	IEC 61400-13 :2001	ETD 42 (5987)
5.	Wind turbines – Part 21: Measurement and assessment of power quality characteristics of grid connected wind turbines	IEC 61400-21 :2001	ETD 42 (5988)
6.	Wind turbines – Part 24: Lighting protection	IEC 61400-24:2002	ETD 42 (5989)
7.	Wind turbine certification	IEC 61400-22 (Revision expected to be published by 2010)	NA
8.	Wind turbine generator systems- Part 23: Full scale structural testing of rotor blades	IEC 61400-23 :2001	NA
9.	Wind Turbines- Part25-1: Communications for monitoring and control of wind power plants- Overall descriptions of principles and models	IEC 61400-25-1: 2006	NA
10.	Wind Turbines- Part25-1: Communications for monitoring and control of wind power plants- conformance testing	IEC 61400-25-5: 2006	NA

***Accepted but not published yet. Data taken from the BIS document for the comments of stakeholders of Wind power systems for their views on accepting the IEC codes for Indian conditions.**

Small Hydropower

SNo	Equipment	Standard
1	Turbines and generator (rotating electrical machines)	IEC 60034 – 1: 1983 IEC 61366-1: 1998 IEC 61116-1992 IS: 4722-2001 IS 12800 (part 3) 1991
2	Field Acceptance Test for Hydraulic performance of turbine	IEC 60041: 1991
3	Governing system for hydraulic turbines	IEC 60308
4	Transformers	IS 3156 – 1992 IS 2705 – 1992 IS 2026 - 1983
5	Inlet valves for hydro power stations & systems	IS 7326 - 1902

Source: Ministry of New and Renewable Energy: www.mnre.gov.in

Solar Power

Standard for solar modules

S No	Title	Standard
1	Photovoltaic devices: Part 1. Measurement of PV current and voltage characteristics	IS-12762 (Pt.1): 1989
2	Photovoltaic devices: Part 2: Requirement for reference Solar Cells	IS 12762 (Pt.2): 1989
3	Procedures for temperature and irradiance corrections to measure I-V characteristics of crystalline silicon PV devices.	IS-12763: 1989
4	Solar photovoltaic energy systems - Terminology	IS-12834: 1989
5	Guide for General Description of Photovoltaic (PV) Power Generating System	14153: 1994
6	Characteristic parameters of stand alone photovoltaic (PV) systems	IS 14244: 1995
7	Qualification test procedures for crystalline silicon photovoltaic modules	IS 14286: 1995

Above mentioned standards are identical to the corresponding IEC/TC-82 standards. Indian standards for other items like batteries, inverters, service conditions for PV systems in India, safety guidelines for grid connected PV systems mounted on buildings etc. are under consideration.

Solar Thermal

BIS Standards for solar thermal collectors and vocabulary are listed below

S No	Title	Standard
1	Solar Flat plate Collector	IS-12933(Pt.1-3 & 5): 1993 revised in 2003
2	Solar energy-Thermal applications-Vocabulary	IS 12934: 1990 under revision

Source: www.mnre.gov.in