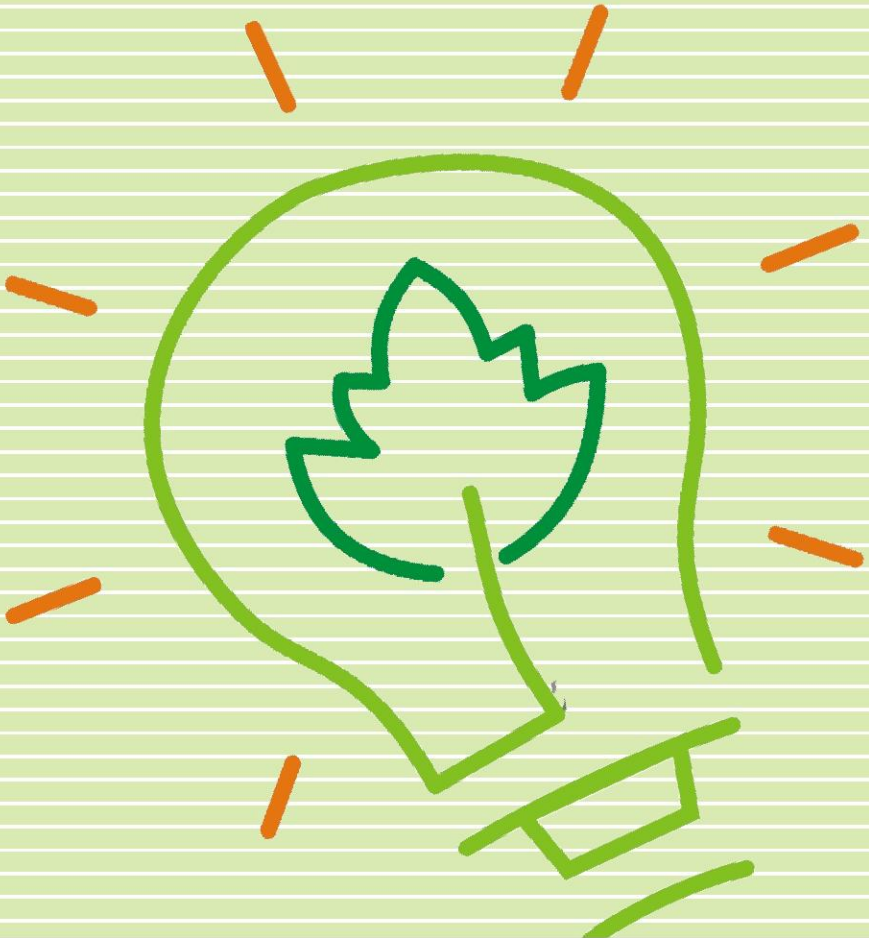
MITIGATION AND ADAPTATION INFORMATION NETWORK FOR SUSTAINABLE COMMUNITIES

RENEWABLE ENERGY IN INDIA - AN OVERVIEW

January 2011



UNEP GRID ARENDAL
Environmental Knowledge for Change

Development Alternatives

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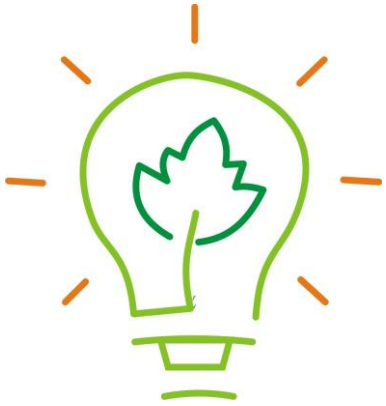

Submitted by:

Development Alternatives

B-32, TARA Crescent, Qutab Institutional Area, New Delhi 110016, INDIA
Tel: + 91 - 11 - 2689 080, 26134103; Fax: + 91 - 11 - 2613 0817
Email: akumar3@devalt.org, nrana@devalt.org

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PROJECT BACKGROUND

Improving lives in a sustainable manner is a vision shared by many around the world. But, despite years of work, the growing knowledge base for sustainable livelihoods has not yielded sufficient improvements in human well-being Existing knowledge is often poorly used or communicated and the same lessons keep being 're-learnt' in different projects. The urgency introduced by the need to adapt to a changing world points to the necessity for a mechanism that empowers communities across the globe to create, share, use and store knowledge to support sustainable livelihoods.

The goal of the Mitigation and Adaptation Information Network (MAIN) is to create a network of expertise, knowledge, and local experiences that result in a 'Virtual Sustainable Livelihood Forum'. This forum will allow the precious lessons from day-to-day and enduring development experiences in one community to be shared, discussed and used in other communities. The network will link communities in different corners of the globe to this forum, where they can share practical experiences on how they are responding to the environmental challenges associated with a rapidly changing world.

1.1 Rationale

To prevent the rapid growth of greenhouse gas emissions, it is important to promote energy efficiency and renewable energy sources. Clean energy addresses energy security, employment and climate change. And yet, very few projects have been able to demonstrate viable and scalable models for provision of energy services to the poor.

Utilization of local energy resources like solar energy, wind power and bio-energy with a simple, locally-appropriate technology is a suitable and cost-effective manner to meet the energy needs in rural areas. There are several village-level efforts in place in India that attempt to address issues of energy, climate change and development.

The Government of India has been supporting various renewable energy programmes especially for rural areas of the country. The Government has also been implementing remote village electrification, village energy security test projects and decentralized biogas based power generation programmes. Although Indian Government's efforts to promote and integrate renewable energy generation (both at policy and practice level) are appreciable but there exist a number of barriers to release the potential for energy efficiency and implementation of decentralized renewable energy solutions.

To scale up renewable energy solutions that enhance access to energy for village communities while mitigating drivers of climate change requires a knowledge base that supports the context-specific implementation of packaged solutions in a large number of villages. The packages should include training, financing, technology and management systems, primarily based on off-grid solutions. But it should be adaptable to the local situation, taking into account the unique environmental, economic and social settings of different village communities.

The Norwegian Society for Conservation of the

Nature together with UNEP Grid Arendal are conducting a study to map these barriers and come up with recommendations on how to overcome them.

Under the overall goal, Development Alternatives with support from UNEP/GRID Arendal and Norwegian Ministry of Environment has been assigned the task of 'Developing a Knowledge Base for Energy Efficiency and Decentralized Renewable Energy in India'. The project will assist village self-governance units, community based organizations and facilitating agencies in identifying and supporting adaptation measures for sustainable livelihoods by building upon their contributions to and interactions with various forms of expert and community knowledge. Adaptation practices will be developed and exchanged from communities to communities.

Models developed, observed, analyzed and documented under the project will be feasible for other developing countries as well, and the project will contribute to creation of the brand **"MAIN village"** that in the future might be recognized in many developing countries.

Thus, the **overall goal** for the project is to build knowledge in the area of decentralized renewable energy by creating a learning platform for the implementation of projects that capitalize upon local skills and resources, with women in key operational roles.

To achieve the goal project envisage following activities:

- Establish a learning platform for projects with regards to MAIN, SCATEC and Eco-villages.
- Provide need-based information on technical, social, organizational and economic aspects of decentralized renewable energy projects.
- Define profile of entrepreneurs (private and community based) for implementing and operations.
- Develop a knowledge base including:
  - Four to six good practice case studies.
  - Replication packages including combinations of technologies, financing options, management systems and organizational formats. These packages will include basic manuals for training.
- Provide linkages to expertise/service providers for CDM certification.
- Profile opportunities for small local business.
- Develop an information network and community of practitioners (to be launched at a Conference in India).

LITERATURE REVIEW

To achieve project's overall goal, the first step of the initiation phase is to conduct a situation analysis delineating the current status of decentralize renewable energy generation in India. A detailed review of the existing literature has been done with the main purpose to identify government policies/ programmes/plans, projects, actors involved in implementing decentralised renewable energy in India. Based on the available secondary information entrepreneurs' profile has also been prepared. The findings of the literature review have been collated in the form of comprehensive report. The report will form the backbone and will help in implementing next steps of the project like developing methodology and tools for information collection and documentation of good practices/ case studies/ technologies/ employment/business opportunities/ expertise/ service providers in the mentioned area. The report will provide the clear understanding about issues pertaining to decentralized energy in India such as polices institutional, financial, technical barriers etc.

2.1 Introduction

Among the various determinants of growth, one of the most important is access to energy. Energy is seen as an effective instrument to bridge the gap between the rich and poor and similarly between the urban and rural. Moreover, access to electricity is very uneven. Even though 85 percent of villages are considered electrified, around 57 percent of the rural households and 12 percent of the urban households i.e. 84 million households (over 44.2 per cent of total) in the country did not have electricity in 2000 as highlighted in Integrated Energy Policy, 2006.

As per the Report by the Expert Committee on 'Integrated Energy Policy -2006', India needs to sustain an 8 to 10 per cent economic growth rate, over the next 25 years, if it is to eradicate poverty and meet its human development goals. To have a sustained growth rate of 8 per cent through 2031-32 ,India needs to increase its primary energy supply by 3 to 4 times (a conservative estimate) and its electricity generation capacity by 5 to 6 times of its 2003-04 levels. The report also suggests that by 2031-32 India's power generation capacity must increase to nearly 8,00,000 MW from the capacity of around 1,60,000 MW (for the base year 2003-04).

Currently, India meets a large part of its energy demand by imported fuel. There is a need to promote renewable energy sources keeping in mind the strategic and environmental reasons. Though energy from renewable sources is not as cheap as those available from conventional sources, it offers benefits in terms of local availability of source, reduced pollution, hygienic conditions and most importantly generation of local employment. Renewable energy solutions can help in solving the issues pertaining to energy generation such as environmental concern, energy security, rural electrification and applications in niche markets where conventional electricity supply is not feasible (Mahesh C Vipradas).

In case of India, all the above mentioned issues are important, however, the most critical issue is that of energy security. India faced 12 per cent peak energy shortages in year 2008-09 with only 44 per cent of rural households **have access to electricity (IREDA, 2009) (Table 1).**

Table 1: The power supply position in the country during 2002-03 to 2008-09

ENERGY(MU)				PEAK(MW)		
Year	Requirement	Availability	% Shortage	Demand	Met	% Shortage
2002-03	5,45,674	4,97,589	8.8	81,492	71,547	12.2
2003-04	5,59,264	5,19,398	7.1	84,574	75,066	11.2
2004-05	5,91,373	5,48,115	7.3	87,906	77,652	11.7
2005-06	6,31,554	5,78,819	8.4	93,255	81,792	12.3
2006-07	6,90,587	6,24,495	9.6	1,00,715	86,818	13.8
2007-08	7,39,345	6,66,007	9.9	1,08,866	90,793	16.6
2008-09	7,74,324	6,89,021	11.0	1,09,809	96,685	12.0

Source: Ministry of Power, 2009

2.2 Status of Renewable Energy Generation in India

It is a well established fact that access to quality, reliable and affordable energy is critical for promoting overall development, economic and social, in any country. The energy situation in rural India is characterized by low quality fuels, low efficiency of use, low reliability of electricity supply and access, leading to lower productivity from the use of land, water and human effort resulting in low quality of life and environmental degradation.

Renewable energy technologies have a good potential in India and considerable progress has been achieved. Renewable energy sources can supplement the present power generation and at the same time address the environmental and energy security issues. The renewable energy technologies are being promoted through various policies and programmes of the Ministry of New and Renewable Energy (MNRE) and achievements so far are result of various promotional policies. However, it has been observed that in the overall power generation scenario, the utilization of renewable energy for electricity generation has remained marginal.

The present installed capacity (as on November 30, 2009) of renewable energy based systems is about 15,225.35 MW whereas the total installed capacity for India is about 1,55,859.23 MW (Ministry of Power, 2009) (Table 2). The Indian wind energy sector has an installed capacity of 10,891.00 MW (as on October 31, 2009) (Figure 1). In terms of wind power installed capacity, India is ranked 5th in the world and his major player in this sector.

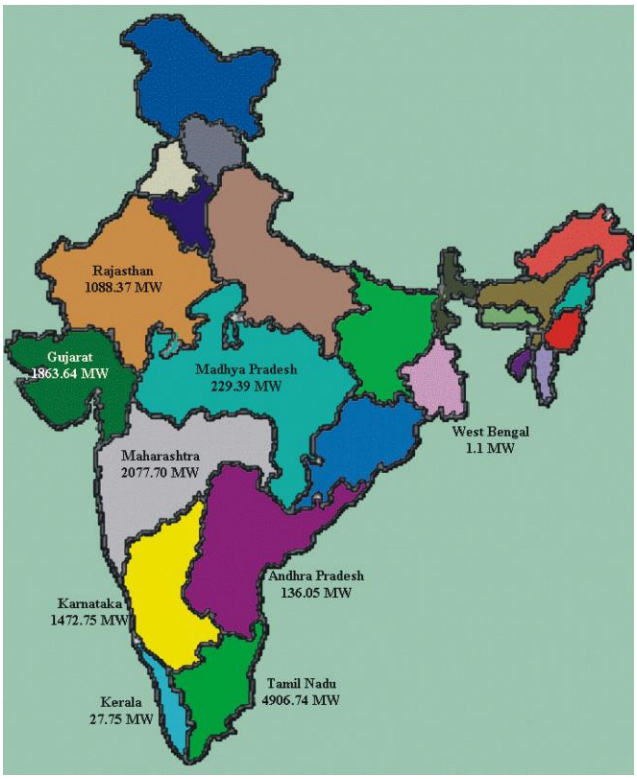
Table 2: Total Installed Capacity for India with respect to fuel (as on 30.11.2009)

Fuel	MW	Percentage
Total Thermal Coal	99,628.48	64.6
Gas	81,605.88	53.3
Oil	16,822.85	10.5
Hydro (Renewable)	1,199.75	0.9
Nuclear	36,885.40	24.7
RES	4,120.00	2.9
Total	15,225.35	7.7

Renewable Energy Sources (RES) include SHP, BG, BP, U&I and Wind Energy.
SHP= Small Hydro Project; BG= Biomass Gasifier ; BP= Biomass Power ; U & I=Urban & Industrial Water Power ;RES=Renewable Sources.

Source: Central Electricity Authority, 2009

Figure 1: India State Wise Installed Capacity for Wind Power as on 30.09.2009



Source: Centre for Wind Energy Technology

Decentralized Renewable Energy Generation: Most of the rural households face difficulty in linking with the grid and hence to be electrified by decentralized energy generation systems. Even in grid linked villages the quality and availability of power is not very much satisfactory. Decentralized energy generation systems not only can help in meeting the growing energy demand but also can help in supplementing the power generation requirements in electrified and to be electrified areas. Although, the unit cost of decentralized energy generation is on the higher side due to reverse economies of scale and lower capacity factors, higher generating costs of such systems could be somewhat offset on account of lower T&D (transmission and distribution) losses.

Decentralized power generation *(mostly based on renewable energy sources)* meet the local energy needs using locally available resources. Decentralized systems give local communities an opportunity to involve and participate in the process of system establishment. The use of locally available resources forms the core of decentralized energy generation systems. The idea is to reduce the overall cost (capital investment, T&D looses) and the approach also leads to employment generation for local communities.

Table 3 and 4 provide the decentralized power generation from renewable sources for India.

Table 3: Cumulative Achievements as on 31.07.2009

Sl. No.	Sources / Systems	Achievements during 2009-10 (upto 31.07.2009)	Cumulative Achievements
I. Power From Renewables			
A. Grid-interactive renewable power			
1.	Biomass Power (Agro residues)	70.00 MW	773.30 MW
2.	Wind Power	222.00 MW	10464.00 MW
3.	Small Hydro Power (up to 25 MW)	31.00 MW	2461.00 MW
4.	Cogeneration-bagasse	106.00 MW	1155.00 MW
5.	Waste to Energy	-	59.00 MW
6.	Solar Power	-	2.00 MW
	Sub Total (in MW) (A)	**429.00 MW**	**14914.00 MW**
B. Off-grid/Distributed Renewable Power (including Captive/CHP plants)			
7	Biomass Power / Cogeneration.(non-bagasse)	5.00 MW	175.78 MW
8.	Biomass Gasifier	1.56 MWeq.	107.02 MWeq
9.	Waste-to- Energy	MWeq.	34.06 MWeq
10.	Solar PV Power Plants and Street Lights	MWp	5.00 MWp
11.	Aero-Generators/Hybrid Systems	MW	0.89 MW
	Sub Total (B)	**6.56 MWeq**	**322.75 MWeq**
	Total (A + B)	**435.56 MW**	**15,236.75 MW**

Sl. No.	Sources / Systems	Achievements during 2009-10 (upto 31.07.2009)	Cumulative Achievements
II.	**Remote Village Electrification**	Villages/Hamlets	4297 villages + 1156 hamlets
III. Decentralized Energy Systems			
12.	Family Type Biogas Plants	0.03 lakh	41.27 lakh
13.	Home Lighting System	number	4,50,000 number
14.	Solar Lantern	number	7,30,000 number
15.	SPV Pumps		7,148 number
16.	Solar Water Heating – Collector Area	Million sqm.	2.90 Million sqm.
17.	Solar Cookers	number	6.57 lakh
18.	Wind Pumps	number	1347 number
IV. Other Programmes			
19.	Energy Parks	number	511 number
20.	Akshay Urja Shops[1]	number	284 number
MWeq. = Megawatt equivalent; MW = Megawatt; kW = kilowatt; kWp = kilowatt peak; sqm. = square meter ;			

Source: Ministry of New and Renewable Energy, 2009

Table 4: Decentralized power generation from renewable sources

Sl. No.	Particulars	Up to 28.2.09	Last 5 years
1.	Off-grid/ CHP/ distributed renewable power systems	346 MWeq.	275 MWeq.
2.	SPV lighting systems, mostly in rural areas	1.4 million	0.17 million
3.	Remote villages & hamlets provided SPV lighting	5,410 (number)	3,253 (number)
4.	Solar collectors for water heating in urban areas	2.60 million sqm.	1.75 million sqm.
5.	Small biogas plants (2-3 cum/day.), mainly for cooking purpose	4.09 million	0.45 million
MWeq. = Mega Watt Equivalent Sqm. = Square meter Cum/day = cubic meter per day			

Source: Ministry of New and Renewable Energy, 2009

1 Akshay Urja Shops: Meant for providing sale, repair and information of all renewable energy sources and energy saving devices all under one roof. The shops have been established by MNRE at district level.

2.3 Policy Framework for Renewable Energy in India

India has a long history if using renewable sources of energy for electricity generation; for example in early 80's wind energy demonstration projects were initiated in states of Tamil Nadu, Gujarat, and Maharashtra (Mahesh C Vipradas). Development of policy measures, (both financial and institutional) to support the renewable energy technologies followed the initial phase of renewable energy development.

In 1993, Ministry of New and Renewable Energy (MNRE) then Ministry of Non-Conventional Energy Sources (MNES) came out with the policy guidelines for promotion of power generation from renewable energy sources. Some of the salient features of these guideline are - buy back price of Rs. 2.25 per kWh with 5 per cent annual escalation, concessions regarding the banking, wheeling and third party sale and fiscal incentives like allowing 100 per cent accelerated depreciation for renewable energy projects were also given. The MNRE guidelines were valid for a period of 10 years. (Mahesh C Viprada).

Further, the role of renewable energy technologies and stand-alone systems was recognized by the Ministry of Power, GoI in 2003 with the notification of Electricity Act -2003 and National Electricity Policy. Under the Act, the role and responsibilities of State Electricity Regulatory Commissions (SERCs) have been clearly defined and have very crucial role to play in setting tariffs for electricity generated from renewable energy systems. These bodies have also been mandated to set quotes for renewable energy as a percentage of total consumption of electricity in the area of the distribution licensee. Different states adopted the MNRE guidelines to varying degree suiting their local needs and aspirations.

Box 1: Renewable Energy Development in India *facts and figures*

- India is ranked fifth worldwide in total existing wind power capacity and is rapidly expanding many forms of rural renewable such as biogas and solar PV.
- India was among the top five countries for renewable power capacity in 2009, including small hydropower.
- India added nearly 130 MW of hydropower in 2009, for a total of more than 2.5 GW of small hydro, and total domestic hydropower capacity approached 37 GW by early 2010.
- In India, an estimated 20,000 solar hot water systems are installed each year
- India's current five-year plan targets 12.5 GW of added renewables by 2012 (including wind, small hydro, and bio- mass power), and in 2009 the country adopted targets for solar power of 1 GW by 2013 and 20 GW by 2022 (including 1 GW of off-grid solar PV by 2017).
- India is home to some 4 million biogas systems, according to recent figures from the Ministry of New and Renewable Energy.
- In India today there are approximately 7,000 solar-powered irrigation pumps.

National targets for Renewable Energy

- Renewable capacity: 12.5 GW added 2007-2012; 15 per cent share of added power capacity 2002-2022.
- Solar PV and CSP: 1.1 GW by 2013, 10 GW by 2017, 20 GW by 2022.
- Wind power: 9 GW added 2007-2012.
- Small hydro: 1.4 GW added 2007-2012.
- Biomass/cogeneration: 1.7 GW added 2007-2012.
- Waste-to-energy: 0.4 GW added 2007-2012.
- Solar hot water: 15 million m^2 by 2017; 20 million m^2 by 2022.
- Rural lighting systems: 20 million by 2022.

Source: Renewables 2010 Global Status Report

2.3.1 Relevant Provisions under Different Acts/Polices

i. Electricity Act (2003)

The Act has been enacted and came into force from June 15, 2003. The main objective of the Act is to introduce competition, protect consumers' interests and provide power for all. The Act provides for National Electricity Policy, Rural Electrification, open access in transmission, phased open access in distribution, mandatory SERCs, license free generation and distribution, power trading, mandatory metering and stringent penalties for theft of electricity.

It is a comprehensive legislation replacing Electricity Act 1910, Electricity Supply Act 1948 and Electricity Regulatory Commission Act 1998.The Electricity Act, 2003 has been amended two times; the Electricity (Amendment) Act, 2003 and the Electricity (Amendment) Act, 2007. Provisions made under the act related to renewable energy development and promotion are as follows:

- State Electricity Regulatory Commissions (SERCs) to fix certain minimum percentages for purchase of renewable power in the area of each Distribution License.
- National Electricity Policy and National Tariff Policy to take into account renewables: The Central Government shall, from time to time, prepare the National Electricity Policy and tariff policy, in consultation with the State Governments and the Authority for development of the power system based on optimal utilization of resources such as coal, natural gas, nuclear substances or materials, hydro and renewable sources of energy.
- The Central Government shall, after consultation with the State Governments, prepare and notify a national policy, permitting stand alone systems (including those based on renewable sources of energy and non-conventional sources of energy) for rural areas.

ii. National Tariff Policy

Clause 6.4 (1/2)

- 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. It will take some time before non-conventional technologies can compete with conventional sources in terms of cost of electricity. Therefore, procurement by distribution companies shall be done at preferential tariffs determined by the Appropriate Commission.

Clause 6.4 (2/2)

- 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 nonconventional sources, to be followed in cases where such procurement is not through competitive bidding.

iii. The Integrated Energy Policy of India (2006) states that the initial cost of setting up a renewable resources based power plant is high and that there are benefits associated with the use of these resources which at present are not reflected in economic terms. The Integrated Energy Policy gives specific policy suggestions such as giving subsidy for the power produced rather than on the installed capacity, reducing paper work for power project proposals which are located away from the grid and increasing coordination between the various governmental departments.

iv. The National Electricity Policy (NEP) envisages increasing the share of renewable energy sources in the electricity mix by suitable promotional measures such as subsidies. The NEP identifies that in order to promote non-conventional sources of energy power needs to be purchased from such entities at a different rate as compared to conventional ones. The NEP also mandates the State Electricity Regulatory Commissions to set the specific prices. Provisions are also present to set minimum procurement levels of energy from renewable sources.

In case of dispersed renewable sources of energy such as cow dung, poultry litter or biomass the involvement of the community is paramount. Communities are not only the consumers but also play an important role as the supplier of renewable energy sources especially in the case of decentralized energy production. However, the poor lack economic clout and technological know how for running such power plants. The current mindset values technology and capital for power generation, and this is reflected in the poor use of wastes for the generation of power. In the case of energy from waste (agriculture residues, etc.) it is not only capital and technology which is important, but the aggregation of renewable energy source is also essential. Policies need to be framed which provide incentives based on the participation of the marginalized people and the source of fuel.

The Integrated Energy Policy of India (2006) identifies the need to encourage private or community entrepreneurs to set up power plants based on renewable energy by providing land and finance. Although 100% foreign direct investment is allowed in the power sector this will not be of much help in the case of power plants based on renewable sources of energy as they are most successful when local community participation is ensured. Policies have been made viewing the power sector to be partnerships between the public and private sector only. The community is viewed and referred to only as the consumer of power.

v. Power for all by 2012

In order to mitigate the power crises, Ministry of Power (MoP) has launched an ambitious program called "Power for all - by 2012". Utilization of local resources (in a sustainable manner) to strengthen the power generation system of the country forms the core of this programme. The specific objectives to achieve the mission are as follows:

- Sufficient power supply to achieve GDP growth rate of 8%
- Reliable power supply
- Quality power
- Optimum power cost
- Commercial viability of power industry (any kind of)
- Power for all

Strategies to achieve the aforementioned objectives are:

- **Power Generation Strategy** with focus on low cost generation, optimization of capacity utilization, controlling the input cost, optimization of fuel mix, Technology upgradation and utilization of Non Conventional energy sources.
- **Transmission Strategy** with focus on development of National Grid including Interstate connections, Technology upgradation & optimization of transmission cost.
- **Distribution strategy** to achieve Distribution Reforms with focus on System upgradation, loss reduction, theft control, consumer service orientation, quality power supply commercialization, Decentralized distributed generation and supply for rural areas.
- **Regulation Strategy** aimed at protecting Consumer interests and making the sector commercially viable.
- **Financing Strategy** to generate resources for required growth of the power sector
- **Conservation Strategy** to optimise the utilization of electricity with focus on Demand Side management, Load management and Technology upgradation to provide energy efficient equipment / gadgets.
- **Communication Strategy** for political consensus with media support to enhance the genera; public awareness.

vi. Jawaharlal Nehru National Solar Mission - National Action Plan on Climate Change 2008

To deal with the issue of climate change without hampering or altering the development path, the Government of India has formulated the National Action Plan on Climate Change consisting of 8 missions. One of them is the Jawaharlal Nehru National Solar Mission. The National Solar Mission is a major initiative to promote ecologically sustainable growth while addressing India's energy security challenge. The immediate aim of the Mission is to focus on setting up an enabling environment for solar technology penetration in the country both at a centralized and decentralized level. Mission targets are:

- To create an enabling policy framework for the deployment of 20,000 MW of solar power by 2022.
- To ramp up capacity of grid-connected solar power generation to 1000 MW within three years by 2013; an additional 3000 MW by 2017 through the mandatory use of the renewable purchase obligation by utilities backed with a preferential tariff. This capacity can be more than doubled reaching 10,000MW installed power by 2017 or more, based on the enhanced and enabled international finance and technology transfer. The ambitious target for 2022 of 20,000 MW or more, will be dependent on the 'learning' of the first two phases, which if successful, could lead to conditions of grid-competitive solar power. The transition could be appropriately up scaled, based on availability of international finance and technology.
- To create favourable conditions for solar manufacturing capability, particularly solar thermal for indigenous production and market leadership.
- To promote programmes for off grid applications, reaching 1000 MW by 2017 and 2000 MW by 2022.
- To achieve 15 million sqm. solar thermal

collector area by 2017 and 20 million by 2022.

- To deploy 20 million solar lighting systems for rural areas by 2022.

vii. Solar photovoltaic (SPV) program

India's Ministry of New and Renewable Energy (MNRE) had recently announced a unified solar photovoltaic (SPV) program to promote the use of decentralized SPV systems for various applications in rural/ urban areas and SPV roof top systems for diesel saving in urban areas.

viii. The Scheme on Aditya Solar Shops

MNRE has been promoting the establishment of Aditya solar shops (showroom-cum-sales and service centers) in major cities of the country by providing some financial assistance. The shops established under this assistance are expected to carry out the following functions:

- Sales of different renewable energy and energy efficient devices;
- Servicing and repair of the devices;
- Dissemination of information on various renewable energy devices and systems

ix. Rural Electrification Policy

Rural Electrification is viewed as the key for accelerating rural development. Provision of electricity is essential to cater for requirements of agriculture and other important activities including small and medium industries, village industries, cold chains, health care, education and information technology. Grid connectivity is the normal way of electrification of villages. Under the Sections 4 & 5 of the Electricity Act, 2003, the Central Government notified the Rural Electrification Policy. The Policy aims at :

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

For villages/habitations, where grid connectivity would not be feasible or not cost effective, off-grid solutions based on stand-alone systems may be taken up for supply of electricity so that every household gets access to electricity. Where neither standalone systems nor grid connectivity is feasible and if only alternative is to use isolated lighting technologies like solar photovoltaic, these may be adopted. However such remote villages may not be designated as electrified till the time appropriate solutions are found to provide electricity in these villages to meet the requirements of the definition of village electrification.

x. Rajiv Gandhi Grameen Vidhyutikaran Yojana (RGGVY)

Ministry of Power has introduced the scheme Rajiv Gandhi Grameen Vidhyutikaran Yojana in April 2005 for achieving the National Common Minimum Programme objective of providing access to electricity to all Rural Households over a period of four Years. Rural Electrification Corporation Ltd. (REC) is the nodal agency for the programme. Under this scheme 90 per cent Capital Subsidy will be provided for rural-electrification infrastructure through:-

- Creation of Rural Electricity Distribution Backbone (REDB) with one 33/11 kV (or 66/11 kV) substation in every block where it does not exist.
- Creation of Village Electricity Infrastructure (VEI) for electrification of all un-electrified

villages/habitations and provision of distribution transformer(s) of appropriate capacity in every village/ habitation.

- Decentralized Distributed Generation (DDG) and Supply System from conventional sources for Villages/ Habitations where grid supply is not cost effective and where Ministry of Non-Conventional Energy Sources would not be providing electricity through their programmer(s).

Balance 10 per cent will be loan assistance on soft terms by REC. The scheme, inter-alia, provides for funding of electrification of all un-electrified Below Poverty Line (BPL) households with 100 per cent capital subsidy.

The scheme aims at electrifying all un-electrified villages over a period of four years and provides access to electricity to all rural households.

As stated by Ministry of Power, a village would be declared as electrified, if:

- Basic infrastructure such as Distribution Transformer and Distribution lines are provided in the inhabited locality as well as the dalit basti hamlet where it exists.
- Electricity is provided to public places like schools, Panchayat office, health centers, dispensaries, community centers etc.
- The number of households electrified should be at least 10% of the total number of households in the village.

The Integrated Energy Policy promotes decentralized generation of power as way to provide electricity in areas which have not been reached by the state utility services or which are being underserved. The DG plants in villages where grid extension is not proposed are covered under Rajiv Gandhi Gram Vidyut Yojana's subsidy program. In grid connected areas DG plants can benefit from the incentives provided by MNRE. Whereas, urban and municipal wastes have a potential of 2880 MW, the energy potential from industrial waste (dairy, distillery, press mud, tannery, paper and pulp and food processing industry) is 1287 MW *(Mr.A.K.Dhussa, Director, MNRE*). Almost all the power projects based on wastes are DG in nature as transport of wastes over long distances is both economically non-viable and technologically unfeasible.

So far, under the RGGVY scheme, Ministry of Power has sanctioned 568 projects for 540 districts to electrify 118,533 villages and to provide free electricity connections to 24.6 million BPL rural households. As on 31st August 2009, 64,331 villages have been electrified and 6.9 million free electricity connections have been released to BPL households. It is targeted to complete all the sanctioned projects before March 2012.

xi. Programme on Energy Recovery from Urban Wastes

MNRE implemented a Programme on Energy Recovery from Urban Wastes during the year 2009-10 at a total outlay of INR 50 million.

The main objectives of the proposed Programme on Energy Recovery from Municipal Solid Waste are as follows:

- To promote setting up of biomethanation based projects for recovery of energy from other urban wastes such as sewage gas, cattle dung, vegetable market, slaughterhouse wastes and agricultural wastes / residues;
- To create conducive conditions and

environment, with fiscal and financial regime, to develop, demonstrate and disseminate utilisation urban wastes for recovery of energy.

xii. National Biogas and Manure Management programme (NBMMP)

The programme was started in 1981-82 as the National Project on Biogas Development and key objectives of the programme are as follows:

- To provide fuel for cooking purposes and organic manure to rural households through family type biogas plants
- To mitigate drudgery of rural women, reduce pressure on forests and accentuate social benefits
- To improve sanitation in villages by linking sanitary toilets with biogas plants

Components:

- Indigenously developed models of biogas plants are promoted.
- States have designated nodal departments and nodal agencies for implementation. Besides, Khadi and Village Industries Commission, Mumbai; National Dairy Development Board, Anand (Gujarat), and national and regional level non-governmental organisations are involved in implementation.
- Project provides for different types of financial incentives including central subsidy to users, turn key job fee to entrepreneurs, service charges to State Nodal Departments / Agencies and support for training and publicity.
- Various kinds of training programmes are supported. Biogas Development and Training Centres, functioning in nine major States, provide technical and training back up to State Nodal Departments and Nodal Agencies.
- Commercial and co-operative banks provide loan for setting up of biogas plants under Agriculturally Priority Area. National Bank for Agriculture and Rural Development (NABARD) is providing the facility of automatic refinancing to banks.

Table 5: Models of biogas plants Approved for promotion

Model	Approved capacity (cubic metres gas production per day)
Floating Drum Type Biogas Plant - KVIC Model	1 to 10
KVIC Model with ferro cement digester and / or fiber glass reinforced plastic (FRP) gas holders	1 to 10
Deenbandhu Model	1 to 6
Deenbandhu in-situ model with ferro-cement	1 to 6
Pre-fabricated RCC fixed dome model	2 and 3
Bag digester made of rubberized nylon fabric - Flxi model	1 to 6

Table 6: Financial Incentives being given during the year 2007-2008 under NBMMP

Category	Approved capacity (cubic metres gas production per day)
North Eastern Region States and Sikkim(except plain areas of Assam)	INR 11,700/- (It is the same for 2-6 cu.m plants)
For plain area of Assam	INR 9,000/- (It is the same for 2-6 cu.m plants)
Jammu & Kashmir, Himachal Pradesh, Uttaranchal (excluding terai region), Nilgiris of Tamilnadu; Sadar Kursoongnd and Kalimpong, Sub-divisions of Darjeeling district (West Bengal), Sunderbans, Andaman & Nicobar Islands.	INR 4,500/- (INR 3,500/- for 2-6 cu.m. plants)
Scheduled Caste, Scheduled Tribes, desert districts, small and marginal farmers, land-less labourers, terai regions of Uttaranchal, Western Ghats and other notified hilly areas	INR 3,500/- (INR 2,800/- for 2-6 cu.m. plants)
All Others	Rs.2,700/-

Table 7: Central Financial Assistance (CFA) provided under various renewable energy schemes / programmes

Sl. No.	Programmes/Sector	Subsidy
1.	**Family Type biogas plants**	
	North –Eastern Region States including Sikkim (except plain areas of Assam)	INR 11,700 for 1 cubic m.
	Plain areas of Assam	INR 9,000 for 1 cubic m.
	J&K, Himachal Pradesh, Uttaranchal (excluding terai region), Nilgiris of Tamil Nadu, Sadar Kursoong and Kalimkpong sub-divisions of Darjeeling, Sunderbans, Andman &Nicobar Islands	INR 4,500 (limited to INR.3,500/- for 1 cum. fixed dome type plant)
	Scheduled Caste, Scheduled Tribe desert districts, small and marginal farmers, landless laborers, terai region of Uttaranchal, Western Ghats and other notified hilly areas.	INR 3,500 (limited to INR 2,800/- for 1 cum. fixed dome type plant)
	All Others	INR 2,700 (limited to Rs. 2,100/- for 1 cum. fixed dome type plant)

Sl. No.	Programmes/Sector	Subsidy
2	**Biomass gasifiers**	
i.	Biomass Gasifiers for rural areas	INR 1.50 lakh/100 kWe - for thermal and electro-mechanical applications (with dual fuel engine) INR 15.00 lakh/100 kWe - for power generation upto 1MW (with 100% producer gas engine) 20% higher subsidy for Special Category States & Islands
ii.	Biomass gasifier for industrial applications	INR 2.00 lakh/300 kWe for thermal applications INR 2.50 lakh/100 kWe with dual fuel engine INR 10.00 lakh/100 kWe with 100% producer gas engine INR 15.00 lakh/100 kWe with 100% producer gas engine in institutions
3	**Industrial Waste-to-Energy projects**	INR 50.00 lakh to INR 1.00 crore/ MWe, depending on technology. (20% higher subsidy for Special Category States)
4	**Solar Photovoltaic (SPV)**	
	SPV lanterns	INR 2,400 for NE and special areas; nil for other
	SPV home lighting systems.	INR 4500 to 8,600 for NE and special areas, and INR 2500 to 4,800 for general areas, depending on model
	SPV street lighting systems	INR 17,300 for NE and special areas INR 9,600 for general areas
	SPV standalone power plant of capacity > 1 kWp	INR 2,25,000/kWp for NE and special areas INR 1,25,00/kWp for general areas
	SPV standalone power plant of capacity > 10 kWp	INR 2,70,000/kWp for NE and special areas INR 1,50,000/kWp for general areas
5	**Solar Photovoltaic (SPV) applications in Urban Areas:**	
	SPV streetlight control systems	25% of cost subject to a max. of Rs. 5000/-
	SPV street/public garden lights (74/75 Wp modules)	50% of cost subject to a max. of INR 10,000/- & INR 12,000/- for 11 W and 18 W CFL respectively

Sl. No.	Programmes/Sector	Subsidy
	SPV illuminated hoardings (with maximum 1kWp SPV module)	50% cost subject to a max. of INR 15,000/100 Wp module
	SPV road studs	50% of cost subject to a maximum INR 1000/-
	SPV blinkers (minimum 37 Wp module)	50% of cost subject to a maximum INR 7,500/-
	SPV traffic signals (minimum 500 Wp module)	50% of cost subject to a maximum INR 2.5 lakh
	SPV power packs (maximum 1 kWp module	50% of cost subject to a maximum INR 1.00 lakh per kWp
6	**SPV water pumping systems**	INR 30/Wp of SPV array used, subject to a maximum of INR 50,000 per system.
7	**Solar Thermal systems/ devices**	**Box type cookers:** Incentive to SNA: - INR 200 per cooker of ISI brand - INR 100 per cooker of non-ISI brand - Upto INR 1.50lakh for publicity / workshops etc. - support to manufacturers : reimbursement of 50% fees for obtaining BIS approval. **Solar Water Heating systems:** - Subsidized Loan at the rate of 2% to domestic users, 3% to institutions and 5% to community users plus INR 100/square meter of collector area as incentive to motivator. - Capital subsidy at the rate of INR 825/1100 per sqm. to commercial establishments/ institutions **Solar Air Heating/ Steam Generating Systems:** Capital subsidy at the rate of 35-50% of the cost subject to certain ceilings. **Dish / community type solar cookers:** 50% of cost limited to INR 2,500 for dish type cookers and INR 25,000 for Scheffler/community type cooker.

Sl. No.	Programmes/Sector	Subsidy
8	**Akshay Urja Shops**	Subsidized loan at the rate of 7% upto INR 10 lakh and performance based grant & incentive up to INR 10,000 per month.
9	**Remote Village Electrification**	90% of the costs of electricity generation systems subject to pre-specified maximum and the following ceilings: - INR 18,000 per household for distributed generation systems, and - INR 11,250 per household for SPV home-lighting systems.

2.3.2 Specialized Centers / Institutes

Solar Energy Centre: The Solar Energy Centre (SEC), established in 1982, is a dedicated unit of the Ministry of New and Renewable Energy, Government of India for development of solar energy technologies and to promote its applications through product development.

Centre for Wind Energy Technology (C-WET): A Centre for Wind Energy Technology (C-WET), an autonomous organisation under the administrative control of this Ministry, has been established in Chennai, Tamil Nadu and serves as the technical focal point for wind power development.

The Sardar Swaran Singh National Institute of Renewable Energy (SSS-NIRE): The Sardar Swaran Singh National Institute of Renewable Energy (SSS-NIRE) is being established as an autonomous institution in district Kapurthala, Punjab. NIRE will serve as the technical focal point for development of bio-energy, including bio-fuels, and synthetic fuels.

Alternate Hydro Energy Centre, IITR- Alternate Hydro Energy Centre (AHEC) was established in Indian Institute of Technology, Roorkee, now, with initial sponsorship of Ministry of Non-Conventional Energy Sources in the year 1982. The mandate of the center is to promote power generation through the development of Small Hydropower projects in hilly as well as plain areas & development of decentralized integrated energy systems in conjunction with other renewable energy sources e.g. biomass, solar, wind etc.

Indian Renewable Energy Development Agency (IREDA): Indian Renewable Energy Development Agency Limited was established on 11th March, 1987 as a Public limited Government Company under the Companies Act, 1956 and it promotes, develops and extends financial assistance for Renewable Energy and Energy Efficiency/ Conservation Projects. IREDA has been notified as a "Public Financial Institution" under section 4 'A' of the Companies Act, 1956 and registered as Non-Banking Financial Company (NFBC) with Reserve Bank of India (RBI).

The Sardar Swaran Singh National Institute of Renewable Energy (SSS-NIRE): The Sardar Swaran Singh National Institute of Renewable Energy (SSS-NIRE) is being established as an autonomous institution in district Kapurthala, Punjab, (Adhikhui Village (12 Kms. From Jallandhar), Jallandhar- Kapurthala Road, Punjab.) NIRE will serve as the technical focal point for development of bio-energy, including bio-fuels, and synthetic fuels.

State Nodal Agencies for New and Renewable Energy: MNRE is mandated to promote the use of renewable energy in India. MNRE for carrying out its mandate has established nodal agencies in each of the state and Union Territory. These nodal agencies of MNRE maintain district wise records of available renewable resources for energy generation purposes, renewable projects/programmes operating within the state. The nodal agencies also serve as disbursal desk for subsides provided by MNRE *(list is provided in Annexure- III)*.

2.4 Decentralized RE projects in India - Brief Description

2.4.1 Ministry of New and Renewable Energy Projects under different Programmes/ Schemes[2]

Distributed/decentralized renewable power projects using wind energy, biomass energy, hydro power and hybrid systems are being established in the country to meet the energy requirements of isolated communities and areas which are not likely to be electrified in near future.

i. Decentralized Small Hydro Power projects

The rural energy scenario in India is characterized by inadequate, poor and unreliable supply of energy services. Realizing the fact that mini hydropower projects can provide a solution for the energy problem in rural, remote and hilly areas where extension of grid system is comparatively uneconomical, promoting mini hydro projects is one of the objectives of the small hydro Power programme in India. A number of mini/micro hydro projects have been set up in remote and isolated areas, mainly in Himalayan region. While these projects are developed by various state agencies responsible for renewable energy, the projects are normally maintained with local community participation. A number of tea garden owners have also set up such micro hydro projects to meet their captive requirement of power.

Water wheels have traditionally been used in the Himalayan regions for rice hulling, milling of grain and other mechanical applications. These water mills are normally of very old design and work at very low efficiencies. It has been estimated that there are more than 1.5 lakh potential water mill sites in the Himalayan regions of India. With the R&D efforts, new and improved designs of water mills have been developed for mechanical as well as electricity generation of 3-5 kW. These designs were tested at AHEC, IIT Roorkee and have been replicated by 6-7 small scale manufacturers. Local organizations such as the Water Mill Associations, cooperative societies, registered NGOs, local bodies, and State Nodal Agencies are being encouraged to install watermills in their areas. A number of NGOs are now propagating water mills for electricity generation to meet small scale electrical requirements of villages. The state of Uttaranchal has taken a lead in setting up electricity generation watermills and over 500 such watermills were installed in remote and isolated areas of the state. A mass movement with community participation to install electricity generating watermills is now underway in Uttaranchal.

ii. Small Wind Energy and Hybrid Systems

The Ministry continued to support setting up of small wind energy systems, namely water pumping windmills, aerogenerators and wind-

2 Source: Compiled from Annual Reports : Ministry of New and Renewable Energy, Government of India

solar hybrid systems in rural, semi urban and urban areas having annual average wind speed of about 15 km/hr (4.17 m/s) or above, at 20 m height. The programme was implemented through State Nodal Agencies mainly in the States/UTs of Andaman and Nicobar Island, Goa, Haryana, Karnataka, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Punjab, Sikkim, Tripura and West Bengal.

Under the programme 80 water-pumping windmills including the gear type were installed during the year, taking the total to 1462. Water pumping windmills are used for drinking water supply and micro-irrigation The State wise details of wind mills installed are given in Table 8.

Table 8: State-wise details of windmills installed

Sl. No.	States/UTs	Installed
1	Andaman & Nicobar	2
2	Andhra Pradesh	6
3	Assam	3
4	Bihar	46
5	Chhattisgarh	1
6	Gujarat	879
7	Karnataka	28
8	Kerala	79
9	Maharashtra	26
10	Rajasthan	222
11	Tamil Nadu	56
	Total	1346

An aggregate capacity of about 850 kW of the aerogenerators/hybrid systems has been installed under the programme, including about 91 kW systems during the year. The state-wise details of the aerogenerators/ hybrid systems installed are given in Table 9. The projects were developed in "Project Mode" for users such as Tribal Hostels, Primary Health Care Centers, Nursing homes Police Communication Centers, Anganvadis, Literacy Centers, and Panchayati Raj Institutions etc. Provision for providing subsidy under the programme for individual user was excluded.

Table 9: The state-wise details of the aerogenerators/ hybrid systems installed (kw)

Sl. No.	States/UTs	Installed
1	Andhra Pradesh	16.00
2	Assam	6.00
3	Goa	68.80
4	Gujarat	10.00
5	Haryana	10.00
6	Karnataka	39.15
7	Kerala	8.00
8	Maharashtra	566.90
9	Manipur	30.00
10	Maghalaya	5.00
11	Puducherry	5.00
12	Rajasthan	4.00
13	Sikkim	15.50
14	Tamil Nadu	24.50
15	Tripura	2.00
16	West Bengal	38.00
	Total	848.85

The wind-solar hybrid systems in the unit capacity range of 1-10 kW to meet the small power requirement for domestic, institutional as well as community applications. A hybrid system of 5 KW capacity set up in the Office of Meghalaya Renewable Energy Development Agency, Shillong[3] is providing electricity for lighting, fans and computers in the office. Hybrid systems for providing street lighting were set up in the State of Karnataka.

iii. National Biogas and Manure Management Programme

Biogas is generated by anaerobic decomposition of various types of organic materials such as cattle dung and agro/ forestry and sanitary wastes in biogas-fertilizer plants (BGFPs). The annual estimated biogas generation potential based on available cattle dung is about 17,340 million m^3. Under the programme during the 11th plan it is envisaged to install 2 million m^3 biogas generation capacity in the country. These biogas plants would also produce bio-fertilizer equivalent to 164 million kg of urea per annum. Over one lakh number of family type biogas plants were set up in the country during the year.

a. Demonstration of Integrated Technology Package on Biogas-Fertilizer Plants

During the year, the Ministry took up a new initiative to demonstrate an Integrated Technology-package in entrepreneurial mode on medium size (200-1000 cu.m./day) BGFP for generation, purification/ enrichment, bottling and piped distribution of Top biogas. Installation of such plants aims at meeting stationary and motive power, cooling, refrigeration and electricity needs in addition to cooking and heating requirements. There

[3] Uttarakhand State was earlier known as Uttaranchal

exists a potential of installation of 1-6 lakh medium size biogas-fertilizer plants in various villages of the country. Under the demonstration phase, the Ministry is providing a central financial assistance of 50 percent of the cost (excluding cost of land) for a limited number of such projects for implementation following an entrepreneurial mode.

b. Electricity & Energy Services provided by 50 kW Biomass Gasifier in Distt. Araria, Bihar

Decentralized Energy Systems India Pvt. Ltd. (DESI Power), Bihar has set up biomass gasifier based Employment and Power Partnership for electricity supply, energy services and job creation in rural areas of district Araria, Bihar to promote socio-economic development of villages through the provision of electricity and energy services. The 50kW biomass gasifier and balance of systems are provided by Netpro Renewable Energy (India) Pvt. Ltd. Baharbari Oudyogic Vikas Swavalambi Sahkari Samity Ltd. (BOYS), a local cooperative which owns and operate the plant. All the villagers are members and beneficiaries. They have set up micro-enterprises and other energy services such as Mini Rice Mill7.5 kW; Aatta Chakki7.5 kW; Chura Mill3.5 kW; Battery Charging Station2.0 kW; Mini Work Shop10.0 kW, Irrigation Pumps (6 in numbers)21.0 kW; Briquetting Machine8.5 kW; two Fish Ponds; and Organic farming. DESI Power has imparted capacity building and trained trainers among beneficiaries to operate the micro enterprises. The sources of funds for the four projects are equity from a local society, DESI Power and a German social-investor apart from subsidy from MNRE with commercial loan from ICICI Bank / IFMR Trust.

c. Rice Husk based Gasifier Technology provides Electricity to households in District West Champaran, Bihar

Samta Samriddhi Foundation, uses rice husk based gasifier technology to produce electricity using 32 kWe (40kVA) producer gas engines that deliver electricity as a "pay-for-use" service to households at village Tamkuha, Dhanaha Block; village Madhubani, Rupahi Blocks; Bhitaha, Distt. West Champaran, Bihar. Samta Samriddhi Foundation has partnered with Ganesh Engineering Works, Buxar to successfully produce highly cost effective down-draft gasifiers in which the rice husk undergoes "bio-mass gasification" (controlled incomplete combustion) to produce a combustible mixture of gases (mainly producer gas) that runs a CNG engine to drive an alternator and produce power. The gasifiers cost are 30% cheaper than similar gasifiers. Samta Samriddhi Foundation provides power to clusters of 500-700 households in rural areas within a radius of 1.5 kms at an affordable price for 5-8 hours everyday. The charges are no more than two third of the savings in price of Kerosene usage. Only CFL or LED lighting is allowed. In the daytime power is provided to local enterprises as well as a mini rice mill of 500 kg/hr capacity. The rice mills setup by Samta Samriddhi Foundation mill the paddy free of cost. They produce 50-60% of the plant's husk requirement in just about 6 hours of operation per day and hence reduce dependence on outside sources for husk.

Monthly charges of electricity are collected in advance and are facilitated by a *Gram Urja Samiti* in each village.

iv. Solar Photovoltaic

The Indian SPV programme for decentralized applications of photovoltaic technology areas is one of the leading programmes in the world.

A total of 16,769 solar street lights, 863 solar lanterns and 3.12 MWp aggregate capacity of stand-alone power plants were allocated to various states and UTs during the year. During the year, the implementing agencies reported installation of 50,904 solar home lighting systems, 7,391 street lighting systems, 41,397 solar lanterns, 56 solar pumps and 300 kWp capacity of solar power plants.

v. Village Energy Security Test Projects

The Village Energy Security Test Projects (VESP) aim at meeting the total energy requirements, such as cooking, lighting and motive power of villages, with full participation of the local communities, including women. The energy production systems could comprise improved *chulhas;* biogas plants based on dung / oil cakes or leafy biomass; biomass gasifiers coupled with 100% producer gas engines; and, biofuel based engines run on 100% Straight Vegetable Oils (SVO) for lighting and biofuel based pump sets for meeting the motive power requirements. Energy plantations are an integral part of these projects.

37 projects have so far been commissioned, of which, 13 test projects have been commissioned during the year (2008-2009). During the same year, 17 new test projects have been sanctioned. Details of the projects are given in Table 10.

Table 10: State-wise breakup of Village Energy Security Test Projects sanctioned and commissioned

Sl. No.	Name of State	Implementing Agency	Number of test projects under implementation	Number of commissioned projects
1	Assam	State Forest Department	14	-
2	Chhattisgarh	State Forest Department/ CREDA and NGO	15	6
3	Gujarat	NGO	2	2
4	Madhya Pradesh	State Forest Department	10	6
5	Maharashtra	NGO	10	3
6	Orissa	State Forest Department and NGO	15	11
7	Tamil Nadu	State Forest Department	4	4
8	Uttarakhand[4]	Uttarakhand Biofuel Board	4	4
9	West Bengal	State Forest Department/WBREDA	7	1
		Total	81	37

Source: Ministry of New and Renewable Energy, 2009

4 Uttarakhand State was earlier known as Uttaranchal

a. Saradi Test Project in Dehradun District of Uttarakhand

Saradi, situated on a hilltop, at an altitude of 1200 meters above mean sea level, is a remote, tribal-dominated and forest fringe village with 106 households at a distance of about 70 Kms. from Dehradun. Saradi test project was completed in all respects and dedicated to the villagers in November 2008. Two gasifiers, each of 10 kW capacity have been installed and commissioned on 25th May 2008 and 7th November 2008 respectively. The project was implemented by Uttarakhand Biofuel Board (Forest Department, Government of Uttarakhand). The biomass gasifiers meet the daily requirement of domestic lighting in the households, community hall/school lighting, street lighting and other entertainment activities. Each household has been provided with two light points and one power point for domestic lighting and entertainment. One oil expeller installed in the project, is being operated on 10 HP motor for extraction of oil from Jatropha seeds. In addition, the villagers also make full use of oil expeller to extract oil from mustard. The oil extracted from Jatropha seeds is being used by the villagers as raw material to operate their diesel engine pump sets directly for irrigation purpose. With the availability of electricity in the village, the quality of life of the villagers has improved drastically and villagers are happy as they have installed television sets in their houses for entertainment and children are able to study at night in a proper light. The fear of wild animals has reduced, as 10 streetlights have been installed in the village, which provide adequate illumination during night. The villagers have decided to use the power generated for many other applications, such as, flour mill, chaff/fodder cutter machines and water pumps. The Village Electrification Committee (VEC) has undertaken plantation of Jatropha in 7 hectares land, which would provide biomass for running the gasifiers and oil seeds for running the oil expeller. Biogas plants have also been installed in the village for meeting their cooking requirements.

2.4.2 Some other Projects

i. Solar Applications

a. Village electrification using solar power

Development Alternatives (DA) have facilitated the work of village electrification with the support of ScaTech. Two different technologies and distribution models have been adopted in the two villages viz. Rampura and Gopalpura.

Rampura : This off- grid PV system is a self sufficient system. It feeds power to the household loads from its own created local grid for the particular design area and, AC power can be fed to a cluster of houses from multiple points. The major advantage of this system is that various other sources of non-conventional energy can be tapped and connected to this local grid. For example, if the load goes up in future then a gasifier or any other generator can be hooked to the system to meet the enhanced demand. The DC power generated from solar array is converted into AC power with the high efficiency PCU. This power is pumped into local own created grid. The grid supply is fed to local villager's house to run various appliances. The same grid is connected to bidirectional Inverter which charges the battery bank through power generated from solar array. The batteries are essential for storing energy produced by PV array, for running the load during nights or cloudy weather.

In the day time when the PV array will be producing energy, the PV energy will be used to fulfill the power demand and the extra energy is used to charge battery through bidirectional inverter. In night or cloudy weather when sunlight is not available, the power required to operate the load is delivered from the battery bank. The bidirectional inverter feed battery power in to local grid. During peak load time, if power demand is greater than PV energy produced, then extra power comes from the charged batteries. The battery autonomy is for 3 days.

Gopalpura: There are 100 Nos. of thin film modules connected in series and parallel. The output from the array junction box is connected to a Power Conditioning Unit (PCU), which gives AC and DC outputs of desired current and voltage. It supplies AC at 230 volts and has number of outlets for charging the 12 Volt batteries, solar lanterns and mobile phones. 10 Nos. 12 Volt batteries and 15 Nos. 12 Volt lanterns can be charged simultaneously. There are 8 Nos. of 12 Volt and 75 Ah batteries connected in series.

b. World's Largest Solar Steam Cooking System at Tirumala, Andhra Pradesh

The world's largest solar steam cooking system has been installed by the Tirumala Tirupathi Devasthanam (TTD) at Tirumala in Andhra Pradesh. The system has a capacity to prepare food for15,000 people/day and employs automatic tracking solar dish concentrators, which convert water into high pressure steam. The steam thus generated is being used for cooking purposes in the kitchen of TTD. It has been hooked up with the existing boiler working on diesel so as to make the system reliable under all climatic conditions.

The system has been designed to generate over 4000 kgs of steam/day at 180 degree centigrade and 10 kg/sqcm which is sufficient to cook two meals for around 15,000 persons. It is modular in nature and consists of 106 automatic tracked parabolic concentrators arranged in series and parallel combination, each of 9.2 sq meter reflector area. Each unit of concentrators is connected to a central steam pipeline going to the kitchen. The system is made of indigenous components and the reflectors are of acrylic mirrors having reflectivity over 75%. Its installation was completed during September 2002 and was inaugurated on 11th October 2002. The system is expected to save around 1,18,000 litres of diesel per year, valued at Rs. 2.3 million. The total cost of the system is about Rs. 110 million, which includes back up boiler, utensils and annual maintenance contract for five years. The system has been installed by M/s Gadhia Solar Energy Systems, Valsad under a demonstration scheme of MNES with 50% financial support. Balance of the cost has been borne by the TTD trust. A total of 6 such systems have been installed in the country. This technology could be very useful at places where rice is the staple food and cooking is done on a very large scale.

c. Roof-Top SPV Systems Catch- Up

A rooftop grid-interactive SPV power system can meet the partial load during peak demand of a building and supply grid-quality power to the utility when

power is not required on holidays. A typical grid interactive system comprises SPV modules, which supply electrical power to the load through a high quality inverter. The inverter converts the direct current (DC) generated by SPV to grid-quality alternating current (AC). When the SPV system produces more power than is needed in the load area, the excess power can be sold to the utility.

During 2001-02 five projects with an aggregate capacity of 275 kWp were commissioned. This brings the total rooftop systems installed up to February 2002 to nine. In addition two rooftop systems are under installation. Among the projects commissioned during the year are those at the Vidyut Saudha Building in Hyderabad and at the Bikalp Shakti Bhavan in Kolkata. The West Bengal Renewable Energy Development Agency (WBREDA) has set up the Kolkata project, which has a capacity of 25 kWp. WBREDA has entered into an Energy Adjustment Agreement with the West Bengal State Electricity Board, under which the WBREDA would pay net energy charges. A bi-directional import-export energy meter keeps a record of the net energy consumption by the WBREDA and the electricity charges are based on net energy consumption at Bikalp Shakti Bhawan.

ii. Biomass Applications

a. Biogasifier based power generation for irrigation in Bundelkhand

A 10 Kw biogasifier has been established by Development Alternatives in village Radhapur in the central Indian region of Bundelkhand. The power produced from the biogasifier is used for operating the irrigation pumps.

b. Co-generation - Bagasse based Cogeneration System

A 17 MW co-generation power project set up by M/s Kakatiya Cement Sugar & Industries Ltd., in 2002 at Peruvancha village, Kallur Mandal, Khammam District, Andhra Pradesh. The project is the first of its kind for a sugar mill. A high pressure boiler of 87 ata./515 deg C has been installed, which ensures high energy efficiency & better utilization of bagassee resulting in more steam and hence more electricity. The project envisages generation of power to meet captive sugar plant requirements, cement plant requirements and export of about 10.85 MW of surplus power during season and 14.70 MW during off-season, to the State grid. The project uses bagasse generated from the crushing operations of the sugar mill during season, and stored bagasse, cane trash and coal during off-season. The project was completed in a record period of 18 months. It achieved a PLF of around 90% in the very first year. The cost of the co-generation project was Rs. 501.7 million. The technology used was indigenous, except for the turbo-generator, which was imported. The project has generated direct employment opportunities to about 100 persons and has also contributed to economic development of the area.

c. Biomass Energy for Rural India Project (BERI)

Biomass Energy for Rural India (BERI) project, sponsored by GEF-UNDP, ICEF, Government of India and Karnataka state government, is being implemented to demonstrate the local

objective of decentralized renewable energy production technology to augment the rural energy needs in a sustainable way.

The project aims at developing and implementing a bio-energy technology package to reduce Green House Gas (GHG) emissions and to promote a sustainable and participatory approach in meeting rural energy needs. The project is being implemented in a cluster of about 24 villages of Tumkur district in Karnataka State of India. The project goals will be achieved through

- Demonstration of technical feasibility and financial viability of bio-energy technologies on a significant scale;
- Building capacity and development of appropriate mechanisms for implementation, management and monitoring of the project;
- Developing financial, institutional and market strategies to overcome the identified barriers for large scale replication of the bio-energy package for decentralized applications; and,
- Dissemination of the bio-energy technology and information package on a large scale.

The project is being implemented in a cluster of twenty-four villages in nine village Panchayats covering 5 talukas (blocks) in Tumkur district of Karnataka State in India.

d. Agro-Waste and Industrial Waste Utilizing Gasifier

The 8 MW Biomass based Power Project with export of 7.20 MW of surplus power after meeting 0.80 MW for inhouse auxiliary consumption has been set up at Patancheru in Medak District of Andhra Pradesh. The project utilizes a variety of agricultural wastes and industrial wastes for generation of power, such as sugar cane trash, coffee shells, *toor dal* stalks, corn cobs, ground nut shells, poultry manure, jowar husk, waste crops, juliflora, eucalyptus, cotton talks, saw dust, wood husk, rice husk and bagasse. The project was commissioned in February 2002. A PLF of 90% has been achieved in the first full year of commercial operation. The technology used is totally indigenous. The company has tied up with M/s AP Forest Development Corporation Limited for developing fast growing clone eucalyptus plantations in about 500 acres of barren land for fuel supply to the plant. The Plant has generated direct employment to over 110 persons, and has also contributed to the economic development of the region.

iii. Biogas applications

a. Biogas powered women based enterprises

Development Alternatives with support from United States Agency for International Development (USAID), started an initiative known as *"Gaushala"* (cow shelter) model. The main objective of the *"Gaushala"* model is to develop and establish community based enterprises with active participation of rural women while simultaneously empowering them.A Gaushala (cowshed for scrap cows) is being operated by women. The women are organized in Self Help Groups. The number of cows is around 70. The dung collected is utilized for generation of power by way of biogas production. The biodigester is of fixed dome type. The generator for power

production has a capacity of 7.5 Kwh. Based on this power women run various enterprises such as milk chilling plant, spice grinding, oil expeller and flour mill. The profits generated are distributed among the Self Help Groups (SHGs).

iv. Small Hydro Power

a. Demonstration of decentralized PICO HYDRO power plant as an eco-friendly technology to meet the energy needs of small communities in hilly areas of Karnataka

A power plant on decentralized PICO Hydro power was setup by Technology Informatics Design Endeavour *(TIDE) in the State of Karnataka with the basic aim to provide reliable electricity to target group in remote hilly areas of Karnataka. Project (1999 2001) was funded by Indo Norwegian Environmental Programme.* Pico Hydro projects are hydroelectric projects with power generation capacity of up to 10kW.They generate power by converting energy in water flowing down a gradient into electrical energy. To generate electricity, water from a natural stream flowing down a gradient is tapped at a convenient higher elevation, passed through a water conducting system and then let into a turbine installed at a lower elevation. The turbine drives an electrical generator producing electricity.

The capacity of generation depends on two main parameters:

- The head available- the vertical difference in elevation between the point of tapping of water and point of installation of turbine.
- The discharge - the water flow rate through the turbine .

After flowing through the turbine the water is lead back into the same water source. Thus, except for a small stretch of the natural stream the water flow in the stream is undisturbed. Pico hydro projects also do not involve any storage of water.

Salient Features of the project

- The project addresses three categories of target group viz. Residents of large plantations ; a group of small planters / agriculturists and population living in hamlets
- Setting up 7 demonstration village hydros totaling to a generating capacity of 26 kW.
- Building local capacity to operate, maintain and manage the projects including setting up systems for tariff fixation, tariff collection, demand management through community participation.

2.5 Profile of Entrepreneurs

i. DESI Power Pvt. Ltd.

DESI Power is a non-profit collaboration of TARA with DASAG India, dedicated to promoting renewable energy. It sets up Independent Rural Power Producers (IRPPs) at the rural level with local communities and entrepreneurs. DESI Power provides around 25% of the financing in the form of equity. The local partner provides 25% and the remaining 50% is provided by the market from "green" funding sources willing to accept below market return rates, or from regular commercial sources. The profitability and return on investment primarily depends on the precise terms under which the investment capital is obtained.

The first DESI Power station was set up at Orchha, Madhya Pradesh (India) in April 1996, as a joint venture between FREND a Swiss non-profit organisation that promotes renewable energy and TARA. Together they provided roughly 50% of the equity capital, which was 25 pre cent of the total investment. The rest of capital was fulfilled as a loan by the Small Industries Development Back of India (SIDBI) and as a subsidy from the MNRE.

TARA is also a primary client of this power plant, purchasing the electricity to run operation and innovation in its technology village, TARAGram, run under a Power Purchase agreement (PPA) with DESI Power. The manufacturing facilities at TARAGram[5] employ over one hundred people. They consist of a large handmade paper recycling unit, several enterprises producing micro concrete roofing tiles, mud-blocks and other cost effective building materials, a charcoal briquetting unit, and a paper products unit. Additional production units are being continually added.

DESI Power Pvt Ltd, under an agreement signed on July 23, 1999 between the Governments of India and Netherlands, became the first power utility in India to get financing under the UN Climate Change Convention (UNFCCC). The Dutch Ministry of Development Co-operation will provide investment capital in the form of a grant to DESI Power for it to set up six independent Rural Power Producers around the country.

ii. Barefoot College

Solar power was first used in 1986 on a large scale, to completely energise the 80,000 square foot Barefoot College campus at Tilonia, Rajasthan. The College campus now is totally self-sufficient with a 40 kilowatt solar energy unit meeting all its energy needs.

The College by training rural unemployed youth as well as semi-literate and literate rural women, as barefoot solar engineers, from different part of the country, have since 1986, installed solar home lighting systems in their villages. They also fabricate and produce solar lanterns. More than 200 kilowatt solar energy is being generated across the country thorough systems and lanterns.

Barefoot solar engineers have installed SPV home lighting systems and fabricated produced solar lanterns across 10 states of India. The results include:

- Solar electrifying 300 adult education centres.
- Solar electrifying 870 schools across the country.
- 3530 solar lanterns manufactured at the College.
- 28 remote and inaccessible villages in Ladakh have 40 Kws of solar panels that provide three hours of light in the bleakest winter to 1530 families.
- In Leh and Kargil districts, solar energy initiatives have saved a total of 97,000 litres of kerosene.
- 392 rural youth including women trained as barefoot solar engineers with absolutely no aid from urban professionals.
- 350 villages and hamlets (clusters) have been covered where a total number of 12000 households have been solar electrified.

5 Technology and Action for Rural Advancement (TARA) is a unique social enterprise based in India. Its objectives are to improve the well being of people and their communities. Its mode of operation is commercial.

- 195,000 litres of kerosene saved, by replacing generators and oil lanterns with solar power.
- All solar panels have been installed, maintained and repaired by the village people without the assistance of any paper qualified engineer.

iii. Nimbkar Agricultural Research Institute (NARI), Uttaranchal

NARI is an NGO and non-profit research and development institute. It was established in 1968 by Mr. B.V. Nimbkar who remained its first President till 1990. Since then Dr. Nandini Nimbkar is the Permanent President.

It is registered under the Societies Registration Act XII of 1860 and the Bombay Public Trust Act of 1950. It is situated in the rural town of Phaltan in Maharashtra state. Phaltan is about 100 km from Pune and 300 km south-east of Mumbai. For the detailed map and location of the Institute please see it in Google Earth.

The Institute undertakes research and development in agriculture, renewable energy, animal husbandry and sustainable development.

Sugarcane leaves gasifier

Large amount of agricultural residues like sugarcane leaves, Bajra residues, wheat residues, etc. are burnt in the fields. Besides creating air pollution there is a tremendous loss of energy. NARI has therefore developed a biomass gasifier for loose agricultural residues.

Attributes of NARI gasifier:

- Thermal gasifier of 800 kW capacity
- It is a multifuel gasifier. Can run on sugarcane leaves, Bajra (pearl millet) husk, safflower residues, sweet sorghum stalks and bagasse, sugarcane bagasse, etc.
- About 20-24% of the fuel is converted into char, which is a value added item
- Zero waste water system. Hot gas cleaning.
- PLC controlled unit. Only two operators per shift are required.
- The cost of the present unit is ~ Rs. 15,00,000/-
- Flame from gasifier used for preparing Madhura syrup

Solar powered ethanol distillation plant

A solar powered ethanol distillation plant was set up in the Institute campus. It was capable of distilling 50 l/day of 94% (v/v) ethanol from MADHURA sweet sorghum hybrid developed at NARI. The solar collector area was 38 sq. m. About 70% of the energy for distillation came from solar energy.

Yearly production of food, fuel and fodder from 1 ha of 'Madhura':

- 60-80 tons of stripped stalks
- 21-28 tonnes of bagasse
- 2000-3000 liters of ethanol (95% v/v)
- 2-4 tons of good quality grain

Ethanol can be used as a substitute for kerosene for household lighting and cooking energy needs. Besides it can be mixed with diesel and petrol to help reduce the pollution and also foreign exchange outflow in importing petroleum products. At NARI suitable stoves and lanterns have been developed to run on low concentration (50% and above) of ethanol/water mixtures.

Solar detoxification of distillery waste

Distillery waste which is black in color, very obnoxious smell wise and has high chemical oxygen demand (COD) has been cleaned using chemicals and solar energy.

A pilot plant was set up and ran for 2 years at

NARI campus. It could clean 200 liters of diluted distillery waste in two days. The chemical used could be recycled and the waste water had 90% transmittance and hence was fit for discharge in waterways. Initial and preliminary experiments with the pulp paper effluent yielded excellent results.

iv. Technology Informatics Design Endeavour (TIDE)

TIDE is an organization devoted to sustainable development through technological interventions. It is a registered not-for-profit society set up in 1993 and registered under the Societies Registration Act. The competence of TIDE is largely in the area of biomass combustion and fermentation technologies and power generation from small and pico hydro. Most of the renewable energy products developed are for thermal energy applications.

Project: Demonstration of decentralized PICO HYDRO power plant as an eco-friendly technology to meet the energy needs of small communities in hilly areas of Karnataka. Pico Hydro projects are hydroelectric projects with power generation capacity of up to 10kW.They generate power by converting energy in water flowing down a gradient into electrical energy.

Funded By: Indo Norwegian Environmental Programme in Karnataka (INEP) (1999 - 2001)

The main objective of the projects is to provide reliable electricity to target group in remote hilly areas of Karnataka by:

- Setting up 7 demonstration village hydros totaling to a generating capacity of 26 kW.
- Building local capacity to operate, maintain and manage the projects including setting up systems for tariff fixation, tariff collection, demand management through community participation.

The project addresses three categories of target group viz.

- Residents of large plantations
- A group of small planters / agriculturists
- Populace living in hamlets

Advantages of Pico Hydro Technology

- Uninterrupted and reliable electrical power
- User controlled power generation
- Can provide electricity to all typical domestic appliances. Power packs up to 1 kW (1000W) can be used of non-motive loads such as lighting, Television, Audio, Computer, water heating etc. Larger power packs can be used for motive loads such as refrigerators, mixer grinder, wet grinders etc. also.
- No recurring fuel costs-requires only water running down a slope for its operation
- Very little maintenance costs as the rotating parts are fully balanced and are not exposed to high temperatures unlike internal combustion engine based power packs.

v. Scatec Solar

A Norwegian Company, Scatec Solar, through its initiative electrified two villages, namely, Rampura and Gopalpura, in the Jhansi district of India by solar energy early 2009. The uniqueness of this initiative is that the whole system of power generation and distribution is solely managed by the community through a Village Energy

Committee (VEC). Scatec Solar engaged Development Alternatives, for village mobilization and capacity building. A Gurgaon based electronics company, DD Solar 23 India Pvt. Ltd, provided the engineering know-how and execution of project on a turn-key basis.

Two different technologies and distribution models have been adopted in the two villages. Rampura plant uses crystalline silicon solar plants, where as amorphous silicon thin film modules have been used in Gopalpura. The plant capacity in Rampura and Gopalpura is 8.7 and 9 kWp, respectively. Similarly, two different distribution models have been tested in the villages. Rampura supplies power to individual homes through a mini-grid of 0.75 km long, whereas Gopalpura has energy services in the form of charging hub for charging mobile batteries, lanterns and mobile phones. Both the villages have approximately 70 houses.

CONCLUSION

The present installed capacity of renewable energy (as on 30.11.2009) based electricity systems is about 15,225.35 MW whereas the total installed capacity (renewable and non- renewable sources) in India is about 1,55,859.23 MW (MoP, 2009). To name a few the key drivers for renewable energy in India are ample number of sites for wind, hydro and solar energy production, Government incentives, and increasing sources of finance.

Efforts made by the Indian Government in last decade or so are appreciable, however, there are some of the limitations and barriers that have been faced for promoting renewable energy based electricity generation such as pricing of power, poor replicability of successful models, market barriers. Issue of handholding is a major issue is case of decentralized energy generation systems.

Although, the policies are in place and are to a large extent are being adhered to, there are opportunities which need to be explored. Policies within the energy sector and those with others need to be streamlined. Utilization of waste provides benefits which to date have not been priced by the market. Policies relating to agriculture subsidies and industry also affect it.

The following are the more specific recommendations made by the policy experts:

- Access to quality power for poor needs to be promoted and thus there is clear need to differentiate between different technologies available to produce power.
- Decentralization of power generation needs to be promoted, thus providing energy security and reducing transmission and distribution losses.
- Focus on enterprise development in case of decentralized energy generation so leading to value addition in local economy and project sustainability in the long run.
- Promotion of public-private partnerships
- Local energy services will not only reduce T&D losses but they also ensure power to the communities who participate in its production. The locations where power is produced and where it is consumed are usually not the same. Neither the National Electricity Policy nor the Integrated Energy Policy has specific guidelines for supplying a particular share of the power produced to the local community even though the locals may suffer the most. The National Electricity Policy states that most of the states have been reporting a loss in transmission and distribution (T&D) of about 40%. Community participation has been identified as a means of reducing T&D losses. Yet, T&D losses are not covered in the sections dealing with conservation of energy. The issue of T&D losses can be dealt with if the electricity produced is for local consumption as the need for transmission will be reduced. Giving the people a stake in power generation will automatically address the issue of T&D losses due to indifference of the community. Local energy services will not only reduce T&D losses but they also ensure power to the communities who participate in its production.
- Providing subsidies to industries for combusting diesel in generators is counterproductive keeping in view India's policy of promoting low carbon power generation.
- Policies from different sectors need to be

streamlined so that the policy from one sector does not work against that of another.

- Though partnerships have been identified as the key to meet the energy needs of the country, non inclusion of the community remains to be a stumbling block and needs to be addressed urgently.

Current focus on rural electrification is unlikely to resolve the energy access problem, due to the low penetration of electricity in the energy mix of the poor. Although energy market reform, promotion of renewable technologies and correct pricing are important, these alone are unlikely to succeed in changing the current status, as acceptance of this policy prescription is rather low. Instead, a bottom-up, holistic, long-term approach is suggested that links energy access with economic development, and relies on selective market intervention, local resources and local governance.

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Annexure I

Table: Installed capacity (MW) of states as on 30.11.2009

Sl. No.	States	Hydro	Thermal				Nuclear	R.E.S	Total
			Coal	Gas	Diesel	Total			
1	Chandigarh	46.74	27.09	15.32	0.0	42.41	4.84	0.0	93.99
2	Delhi	581.62	2346.96	808.01	0.0	3154.97	47.08	0.0	3783.67
3	Haryana	1327.68	2535.49	103.70	3.92	2643.11	76.16	74.70	4121.65
4	Himachal Pradesh	1539.94	118.30	61.88	0.13	180.31	14.08	240.19	1975.24
5	Jammu & Kashmir	1480.53	263.70	304.14	8.94	576.78	68.00	129.33	2254.64
6	Punjab	2962.89	3208.19	263.92	0.0	3472.11	151.04	271.47	6857.51
7	Rajasthan	1454.80	4024.48	665.03	0.0	4689.51	469	902.95	7516.26
8	Uttar Pradesh	1597.42	6563.84	549.97	0.0	7113.81	203.72	487.98	9402.93
9	Uttarakhand	1919.18	261.26	69.35	0.0	330.61	16.28	132.97	2399.04
10	Chattisgarh	120.0	4083.00	0.0	0.0	4083.0	47.52	184.95	4435.47
11	Gujarat	772.0	6678.89	3894.49	17.48	10590.86	559.32	1642.41	13564.59
12	Madhya Pradesh	3223.6	4282.1	257.18	0	4539.28	273.24	287.81	8323.99
13	Maharashtra	3331.84	10703.05	3715.93	0.0	14418.98	690.14	2417.96	20858.92
14	Goa	0.0	277.03	48.00	0.0	325.03	25.80	30.05	380.88
15	Dadra and Nagar Haveli	0.0	22.04	27.10	0.0	49.17	8.46	0.0	57.60
16	Andhra Pradesh	3617.53	6259.88	2347.40	36.80	8644.08	214.28	687.71	13163.60
17	Karnataka	3599.80	3902.67	220.00	234.42	4357.09	195.36	2208.14	10360.39
18	Kerala	1781.50	765.38	533.58	256.44	1555.40	78.10	138.78	3553.78
19	Tamil Nadu	2108.20	5519.81	1026.30	411.66	6957.77	478.50	4846.11	14390.58
20	Puducherry	0.0	207.01	32.50	0.00	239.51	16.28	0.02	255.81
21	Damodar Vally Corporation	193.26	3313.10	90.00	0.0	3403.10	0.0	0.0	3596.36
22	Bihar	129.43	1661.70	0.0	0.0	1661.70	0.0	50.60	1845.73
23	Jharkhand	200.93	1737.88	0.0	0.0	1737.88	0.0	4.05	1942.86
24	Orissa	2188.93	1828.10	0.0	0.0	1828.10	0.0	64.30	4081.33
25	Sikkim	75.27	68.10	0.0	5.0	73.10	0.0	47.11	195.48
26	West Bengal	1116.30	6756.34	100.0	12.20	6868.54	0.0	164.85	8149.69
27	Arunachal Pradesh	97.57	0.0	21.05	15.88	36.93	0.0	67.34	201.84
28	Assam	429.7	60.00	441.32	20.69	522.01	0.0	27.11	978.84
29	Manipur	80.98	0.0	25.96	4.41	71.37	0.0	5.45	157.80
30	Meghalya	230.58	0.0	25.96	2.05	28.01	0.0	31.03	289.62
31	Mizoram	34.31	0.0	16.28	51.86	68.14	0.0	24.47	126.92
32	Nagaland	53.32	0.0	19.19	2.00	21.19	0.0	20.67	103.10
33	Tripura	62.37	0.0	160.84	4.85	165.69	0.0	16.01	244.07
34	Andaman & Nicobar Islands	0.0	0.0	60.05	60.05	0.0	0.0	5.35	65.40
35	Lakshadweep	0.0	0.0	9.97	9.97	0.0	0.0	0.76	10.73

Note: R.E.S = Renewable Energy Sources

Source: Central Electricity Authority

Annexure II

List of Aditya Solar Shops

ANDHRA PRADESH

1. Sri R. Surya Prakash,
   M/s. Suryaprakash Aditya Solar Shop
   D. No. 4-4-382, Girls High School Road,
   Bhoktapur Adilabad Dt,.
   Tel. No. 9440061641, 9390911340

2. Shri A. Chendrasekhar,
   M/s. Kiran Aditya Solar Shop,
   D. No. 19-20, Beside Buggareddy Gardens NH. 7,
   SHADNAGAR (PO), Mahaboobnagar Dt.
   Mob. 9392611009, 9392633007

3. Sri R. Balasubramanyam,
   M/s. Balu Aditya Solar Shop,
   Shop No. 102,Simhapuri Cloth market,
   Srirangarajapuram, Stone housepet,
   Nellore Dt., Tel. No. 2303385, 9849160084

4. Smt. N. Neeraja,
   M/s. Neeraj Aditya Solar Shop,
   173, New Balaji Colony, Tirupathi,
   Chittor District
   Tel. No. 0877-2241838, Mob. No. 9849277585

5. Sri M.N.V. Vara Prasad,
   M/s. Venus Aditya Solar Shop,
   GNT Road, Powerpet, Eluru 534 002.
   Tel. No. 253023

6. Sri V. Raja Rao,
   M/s. SEVA Aditya Solar Shop,
   D.No.11-24-36, M.V. Colony, Road No. 2,
   Deshiapet Road, Warangal - 506002
   Tel. No. 0870-2426554, Mob. No. 9849622384

7. Sri Syed Zaheed,
   M/s. Zaheed's Aditya Solar Shop, Shop No. 15 &
   16, First Floor, Sabarigirija Complex,
   Opp. RTC Bus Stand ,Ongole- 523 001
   Prakasam District
   Tel. No. 08592-561156, Mob. No. 9346258206

8. Sri T. Kishore Kumar,
   Aditya Solar Shop,
   Shanthi Lodge Complex,
   Station Road, Khammam - 507001.
   Tel. No. 08742-552052
   Mob No. 9399323257

9. Sri Shesham Hari Babu
   Akshya Aditya Solar Shop,
   Donka Road, III Line, P. Venkatachalam
   Complex Upstairs, D.No. 7-11-119,
   Arudnelpet, Guntur District
   Mob No. 9394799134

10. Sri P. Suresh,
    M/s. Suresh Aditya Solar shop,
    Opp. Dr. Gajapathi, Raju Hospital, Phool Bagh
    Raod , Vizianagaram Distt
    Tel No. 08922-232571
    Mob. No. 9849124659

11. Sri G. Muneendra,
    M/s. Srimuneendra Aditya Solar Shop,
    VUDA Shop No. 16,
    Opp. EENADU Seethamammadara,
    Visakhapatnam -13
    Tel. No. 2553156 (O) 2703331(R)
    Mob No. 9885028252

12. Sri V. Swarna Kiran,
    Sri Krishna Aditya Solar Shop.
    Near ZP Kalyana, Mandapam, Shanthi, Sowdha
    Apartments, Kakinada, East Godavari District

13. Aditya Solar Shop
    5-8-207/2 Pisgah Complex
    Hotel Yatrik Compound, Nampally,
    Hyderabad - 500 001
    Tel. : (3202391/ 3203692
    Fax : (040) 3201666

14. Sri Ballam Srinivasa Rao,
M/s. Sromovasa Aditya Solar shop
H.No. 40-7-12 A, Datta's Lord
House, Jammichettu Street, Magalrajpuram,
Vijayawada 520 010 Krishna District
Tel. No.5545558, Mob No. 98663855558

15. Sri P. Ram Reddy,
M/s. Krishna Veni Aditya Solar Shop,
H. No. 2-2-12, Bare Imam, Besides Srinivasa
Oil Mills, Medak.
Tel. No. 944080516

16. Smt. G. Manjula
M/s. Manjula Aditya Solar Shop,
6-2-306, Opp Women College Hostel Tower,
Kanteswar Road, Subashnagar
Nizamabad 503 002.
Tel. No. 9440268488

17. Sri T. Mallikarjuna Reddy,
M/s. Devi Aditya Solar Shop,
Near DCMS, Kamalanagar, Ananthapur
Mob No. 9440412476

18. Sri M. Arunkanth,
Sri Sai Aditya Solar Energy
Shop No. 29, Suryalok Complex, Near Poojitha
Apartments, Hyderabad Road, Nalgonda
Mob No. 9885006818

ARUNACHAL PRADESH

1. Siang Aditya Solar Shop,
(Sh. Marjom Loya),
Cosy Park, Nehru Chowk,
P.O. Along, Distt West Siang (A.P.)
Tel. No. 03783-223214/222751

2. Molo Aditya Solar Shop,
(Shri Yika Molo), Anini, P.O. Anini, Distt Upper
Dibang, Valley (A.P.)
Tel. No. 03801 222306

3. Linggi Aditya Solar Shop,
(Shri Budhi Linggi),
Roing, P.O. Roing, Distt. Lower Dibang
Valley (A.P).

4. Khodelum Aditya Solar Shop,
(Shri Khodelum Tayang),
Tezu, P.O. Tezu Distt. Lohit (A.P)

5. Nilling Aditya Solar Shop,
(Shri Taken Nilling),
Daporijo, P.O. Daporijo,
Distt. Upper Subansiri (A.P.)

6. Natung Aditya Solar shop,
(Shri Mama Natung),
Seppa, P.O. Seppa, Distt East Kameng (A.P.

ASSAM

Aditya Solar Shop,
Arindom Shopping Complex
'Orion Tower', Ist Floor
Christianbasti, G.S. Road,
Guwahati-781005
Tel: (0361) 621006,Fax: (0361) 548475

BIHAR

1. Aditya Solar Shop
Shop No. 12 & 13, Ground Floor
Maurya Tower, Maurya Lok Complex, Dak
Bunglow Road, Patna

CHHATISGARH

1. Aditya Solar shop,
(Shri U.P. Ojha), M/s. Cosmo Products,
Chhattisgarh Energy Education Park, VIP Road,
Raipur (CG)
Tel. 0771-5052927, 094252 10113

DELHI

Aditya Solar Shop
Shivaji Stadium, Bus Terminus,
Connaught Place,
New Delhi-110 001.

GUJARAT

1. Aditya Solar Shop,
Swamina Gadhada no Khadi Bhandar,
Pritam Nagar no Pahelo dhal,
Ellise Bridge, Ashram Road,
Ahmedabad, Tel. 0796579280

2. Aditya Solar shop,
Gram Shilp Khadi Bhawan,
Vidya Nagar Main Road,
Nr. Rastriya Shala,
Rajkot.,Tel. 0281-466141

3. Aditya Solar Shop,
P.B. No. 37,
Near S.R.P. Camp,
Godhara 389001.
Tel. 0267242327, 41782, Fax. 02672- 4237

4. Aditya Solar Shop
Sharma Complex
College Road
Rajpipla, Narmada District

5. Aditya Solar Shop
Devnad Complex Panwadi
Bhavnagar

6. Aditya Solar Shop
80 Ft Road, Near Desalbhagt Vav
Nr. Ghanshyam Nagar
Surendra Nagar

7. Aditya Solar Shop
17, Digvijay Plot, New Road
Talav ni pal, Jamnagar

HARYANA

1. Addl. Deputy Commissioner-cum-Chairman,
Aditya Solar Shop
Vikas Bhawan,
Gurgaon
Tel : 0124-2339658

2. Addl. Deputy Commissioner-cum-Chairman,
Aditya
Solar Shop,
Old DRDA Complex, Opp. Telephone
Exchange,Sector 15, Faridabad
Tel: 0129-2266261

3. Addl. Deputy Commissioner-cum-Chairman,
Aditya Solar Shop
Mini Secretariat Complex, Hissar
Tel. 01662-226384

4 Addl. Deputy Commissioner-cum-Chairman,
Aditya Solar Shop
Mini Secretariat Complex, Panchkula,
Tel. 0172-2582337

5. Shri Ajay Kumar,
Village & PO-Nasibpur (Near Housing Board),
Tel: 01282-260282

6. Ms. Sunita Yadav,
Shakti Nagar, Rewari
Tel: 01274-260935

7. Shri Yash Pal Dhanda,
7-D.C. Market, Karnal

8. Shri Om Parkash,
Aditya Solar Shop,
Behind Jat School, Nehru Garden Colony, Kaithal
Tel: 09416383570

9. Om Aditya Solar Shop,
Gandhi Ashram Rania Gate, Sirsa

10. Shri Ved Pal,
Pal Electronics,
Palika Bazar, Jlnd

HIMACHAL PRADESH

1. Aditya Solar Shop,
Urja Bhavan, Kasumpti,
8-A SDA Complex, Shimla - 171009.
Tel. (0177) 222635, Fax (0177) 221783

JAMMU & KASHMIR

1. Aditya Solar Shop
Ladakh Ecological Development Group
Leh 194101, Ladakh
Tel: 01982- 53221, Fax 01982-52284

JHARKHAND

Aditya Solar Shop,
190/C, Road No. 3,
Ashok Nagar, Ranchi 834002

KARNATAKA

1. Aditya Solar Shop,
(Dr. B. Shivalingaiah, Managing Director, KREDL),
No. 19, Maj. Gen. A.D. Loganadhan, INA Cross,
Queens Road, Bangalore 560052
Tel. 22208109, 22282221, 22207851, Fax. 22257399

KERALA

1. Aditya Solar Shop
Door No.Xl, I/2319,
Opposite North Square,
Paramara Road,
Near Town Hall, Cochin, Kerala
Tel : (0484) 395528, Fax : (0484) 532862

2. Aditya Solar Shop
Kesavadasapuram
Ullur Road (N.H.)
Thiruvananthapuram - 695 004
Tel : (0471) 440121, Fax : (0471) 449458

3. Aditya Solar Shop,
Room No. 24,
Athulya Shopping Complex,
Near Indira Gandhi Hostel,
Panur Road, Thallassery 670103,
Kannur District, Kerala.

MADHYA PRADESH

1. Aditya Solar Shop,
Urja Bhavan, Main Road No.2,
Shivaji Nagar, Bhopal 461016
Tel : (0755) 2553595 / 2556566
Fax:(0755) 2553122

MAHARASHTRA

1. Shivam Aditya Solar Shop,
Mohite Complex Swatantra Chowk,
Near C.B.S. Jalgaon 425001
Tel. No. 98231-60886, 2223373

2. D & D. Aditya Solar Shop,
Mangalay Gurucul, Nandi Stop,
Ausa Road, Latur.
Tel. No. 02382-226126-94220-71896

3. Ashirwad Complex,
Amaravati Road, Yawatmal
Tel. No. 07232 239939

4. Sauryajoti Aditya Solar Shop,
336, High School Road,
Opp. Bank of Baroda,

5. Aditya Associate Aditya Solar Shopee,
S-1, Ganpat Complex,
2020 Rajarampuri, 8th Lane Near Janani Hospital,
Kolhapur 416006.
Tel. No. 0231-5685623

6. Runchandi Traders Aditya Solar Shop,
MAHARANA Behind Court Samrth Nagar,
Osmanabad 413501
Tel. 02472-223229.

7. Aditya Solar Shop
Shop No.23, Sahakar Vaibhav Building, Jafagate,
Nava Mondha,
Aurangabad, Maharashtra
Tel : (02432) 345744

MANIPUR

1. Aditya Solar Sho,
(MANIREDA),
Keshampat, Opp. to State Central Library, Imphal
West District, Imphal 795001.
Tel. 0385- 2413975, Fax: 0385- 2222187

MIZORAM

1. Aditya Solar Shop (MIREDA),
(Er. Vanialruata, Director),
Mizoram Renewable Energy Development Agency (MIREDA),
A-88, Tuikual 'S' Temple Square, Omega
Travels Building, Aizawl 796001, Mizoram,
Tel. 95389 2312527

NAGALAND

1. Aditya Solar Shop
   Strides Electricals & Electronics
   Taxi Stand, Kohima 797001
   0370-2219499

2. Aditya Solar Shop
   Society for Energy & Environment
   (Er. M. Aier)
   P.O. Box 23, Circular Road
   Dimapur-797112, Tel. 0370-240968

ORISSA

1. Aditya Solar Shop
   Shop No. 21, Shubham Market
   Opposite Ram Mandir Bhubaneswar-751001
   Tel. (0674) 516724, Fax: (0674) 504899

2. Aditya Solar Shop
   New Bus Stand Commercial Market Comlex,
   Berhampur, Ganjam, Orissa

PONDICHERRY

Aditya Solar Shop
Pondicherry Agro Service and Industries
Corporation Limited (PASIC),
No. 247, Thiruvalluvar Salai, Pillaithottam ,
Pondicherry-605 005
Tel: 0413 2241702, Fax : 0413 - 2241702

PUNJAB

1. Aditya Solar Shop
   (PEDA),
   Nehru Garden, ,Jallandhar,
   (Distt. Jallandhar)
   Tel: (0181) 2400588

2. Aditya Solar Shop,
   (PEDA),
   National Rural Development Society, Plahi, Near
   Phagwaraq, Distt. Kapurthala.
   Tel. 01824-260733, 260607

RAJASTHAN

1. Aditya Solar Shop
   C.G.R. 1, Nehru Place,
   Tonk Road, Jaipur, Rajasthan
   Tel: (0141) 382759, Fax: (0141) 380928

2. Aditya Solar Shop
   Shantivan Ashram of Brahmakumaris
   Abu Road, Rajasthan
   Tel : (02974) 28298

SIKKIM

1. Aditya Solar shop,
   (State Trading Corporation, Sikkim
   STCS Building, Deorali, Gangtok,
   Tel./Fax (03592) 281953

TAMIL NADU

1. Aditya Neema Solar Shop
(Mr. Rajendran, Director),
No. 36, Walaja Road, Chennai-600 008
Tel: (044) 28555713 / 8513034
Tel. Fax : (044) 8555716

2. Mr. K. Suthahar,
Suras Aditya Solar Shop,
No. 111 B-Sivalingam Complex,
Bethaniapuram, Bye Pass Road,Madurai 625 016
Tel. 0452-238440, 2423960, Mob.No. 9443032421

3. Mr. N. Joseph Proprietor,
Aditya Solar shop,
No. 15, Gurusamy Pillai Lane,
North car Street, Dindigul 624 4001
Tel. 0451-2423960,Fax.0451-242974
Mob.No. 9442029670

TRIPURA

1. Aditya Solar Shop
(TREDA)
UK Academy Mini Stadium
Agartala, Distt. West Tripura
(0381) 2225900(O) /2326139

2. Aditya Solar Sop,
(TREDA)
Udaipur
Tel. (03821) 222137 (O)

UTTAR PRADESH

1. Aditya Solar Shop
Suresh Plaza Market ,
First Floor, Agra
Tel : (0562) 2155937

2. Aditya Solar Shop
Upica Handloom House,
Sarvodaya Nagar, Kanpur
Tel : (0542) 2234007

3. Aditya Solar Shop
Shop No. 6, Janpath Market
Lucknow, (U.P.)
Tel: 0522-2617073

4. Aditya Solar Shop
S-19/19, Varuna Bridge Road
Nadeshwar, Near Taj Gangej
Varanasi Tel : (0542) 2345063

5. Aditya Solar Shop
Surya Complex,
Shop No. S-2-3, Civil Lines,
Mahatma Gandhi Marg, Allahabad.
Tel : (0532) 2422437

6. Aditya Solar Shop
State Bank Building, Near Kotwali
Ballia, Tel : 05428 225430

7. Aditya Solar Shop,
Mittal Electronics Systems,
543/1, Foolbagh Colony,
S.K. Road, Meerut

8. Aditya Solar Shop,
N. Priya Store, Nagar Nigam Bhawan, Townhall,
Gorkhpur

9. Aditya Solar Shop.
Kumar Electronics, Civil Lines,
Devriya

10.Aditya Solar Shop,
Deshmesh Electornics, Sabji Mandi, Tater Bajar,
Sidharth Nagar

11. Aditya Solar Shop,
Upkar Photovoltaic Implement,
156-158, First Floor, Durga Tower, A-13, RDC,
Rajnagar, Gaziabad

UTTARANCHAL

1. Aditya Solar Shop
   (Diretor, UREDA)
   Sanjay Bazar, 355
   Kishan Nagar, Dehradun. (U.P.)
   Tel : (0135) 2758246 / 2751080

2. Kailash Aditya Shop,
   (Diretor, UREDA)
   (Sh. Kailash Chandra Joshi),]
   Joshi Electronics, Near Raja Hotel
   Takana Road, Pithoragarh
   Tel. 05964-227388

3. Mingwal Aditya Solar Shop,
   (Sh. Chandra Shekhar Singh Mingwal),
   Mingwal Electgronics Near Petrol Pump
   Goeshwar, Chamoli
   Tel: 01372-253711

4. Spark Aditya Solar shop,
   (Sh. Rajendra Singh Rawat),
   Spark Traders, Aditya Solar Shop,
   Opp. Samrat Hotel, Badrinath Marg, Srinagar, Pauri Garhwal
   Tel. 01368-251495, 09412079786

5. Navdeep Aditya Solar shop,
   (Sh. Deepak Sharma),
   25, Sarvan Nath Market, Kankhal, Haridwar ,
   Tel.: 01334-242444

WEST BENGAL

1. Aditya Solar Shop,
   Sewak Road, 2nd Mile,
   WBSB Complex, Siliguri,
   District Darjeeling (W.B.)
   Tel: (0353) 548342

2. Aditya Solar Shop
   Alipore (Opposite Zoo)
   Kolkata - 700 027
   Tel : (033) 4790406

3. Aditya Solar Shop
   Ramakrishna Mission Ashrama
   Narendrapur - 743 508
   South 24 Parganas (W.B.)
   Tel: (033) 4770975
   Fax: (033) 4772070

4. Aditya Solar Shop
   Nachan Road, Distt. Burdwan
   Durgapur-4, West Bengal
   Tel : 0343-570244

Annexure III

List of State Nodal Agencies for New and Renewable Energy

1. Andhra Pradesh
The Vice Chairman & Managing Director
Non-Conventional Energy Development
Corporation of Andhra Pradesh
(NEDCAP) Ltd.
5-8-207/2 Pisgah Complex
Nampally
Hyderabad 500 001.
Tel: 040-23201172 (O), Fax: 040-23201666

2. Arunachal Pradesh
The Director,
Arunachal Pradesh Energy Development Agncy
Urja Bhawan Tadar Tang Marg,
Post Box No. 141
Itanagar-791111
Tel: 0360-211160 / 216937 (O), Fax: 0360-214426

3. Assam
The Director
Assam Energy Development Agency
And Assam Science, Technology & Environment
Council,
Co-Operative City Bank Building, U.N.B. Road,
Silpukhuri
Guwahati 781 003.
Tel: 0361-2662232,2664415 Fax: 0361-2668475

4. Bihar
The Director
Bihar Renewable Energy Development Agency
1st Floor, Sone Bhawan,
Virchand Patel Marg,
Patna 800 001.
Tel: 0612-2233572 ; Fax: 0612-2228734

5. Chhattisgarh
The Director
Chhattisgarh State Renewable Energy
Development Agency
MIG/A-20/1 Sector 1, Shankar Nagar,
Raipur
Tel:0771-2426446; Fax : 5066770

6. Delhi
The Executive Officer
EE & REM Centre
Delhi Transco Ltd.
2nd floor, SLDC Building, Minto Road
New Delhi-110002
Tel. : 011-23234994, Fax: 23231886

7. Goa
The Director
Goa Energy Development Agency
DST&E Building, 1st Floor, Saligo Plateau
Opp. Seminary, Saligao, Bardez
Goa 403511
Tel. 0832-271194

8 Gujarat
The Director,
Gujarat Energy Development Agency (GEDA)
4th Floor, Block No. 11 & 12
Udyog Bhawan, Sector 11
Ghandhi Nagar - 382017
Tel : 079-23247086, 89, 90
Fax : 079-23247097

9. Haryana
The Director,
Haryana Renewal Energy Development Agency
(HAREDA)
SCO 48, Sector 26
Chandigarh 160 019
Tel: 0172- 2791917 ,2790918, 2790911,
Fax: 0172-2790928

10. Himachal Pradesh
The Director,
HIMURJA, SDA Complex,
Kasumpti, Shimla-171009.
Tel: 0177-,2620365 Fax: 0177-2620365.

11. Jammu & Kashmir
The Chief Executive Officer,
Jammu & Kashmir Energy Development Agency (JAKEDA)
12 BC Road,
Jammu-180001
Tel: 0191 - 546495, Fax :2546495

The Chief Executive Officer,
Jammu & Kashmir Energy Development Agency (JAKEDA)
Dharrilla, Raj Bagh
Srinagar
Telefax: 0194-2479791

12. Jharkhand
The Director
Jharkhand Renewable Energy Development Agency
328 B, Road No.4
Ashok Nagar
Ranchi 834 002.
Tel: 0651-2246970 Fax : 0651-2240665

13. Karnataka
The Managing Director
Karnataka Renewable Energy Development Agency Ltd.
1 9, Maj. Gen. A. D. Loganadan,
INA Cross, Queen's Road,
Bangalore- 560 052
Tel:080-22282220(O), Fax :080-22257399.

14. Kerala
The Director
Agency for Non-Conventional Energy and Rural Technology (ANERT),
PATTOM P.O.
PB No.1094, KESAVADASAPURAM
Thiruvananthapuram-695 004.
Tel:0471-2440121; 2440122, 2440124 Fax : 2449853

15. Madhya Pradesh
The Managing Director,
MP Urja Vikas Nigam Ltd.,
Urja Bhawan, Main Road NO.2
Shivaji Nagar, Bhopal 462016
Tel: 0755-2556245; 2553595 Fax: 0755-2556245

16. Maharashtra
The 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: 020-26615354, Fax: 020-26615031

17. Manipur
The Director
Manipur Renewable Energy Development Agency (MANIREDA)
Department of Science, Technology
Minuthong Hafiz Hatta,
Imphal-795001
Tel: 385-441086; Fax: 91-385-224930

18. Meghalaya
The Director
Meghalaya Non-conventional & Rural Energy Development Agency
Lower Lachaumiere, Opp. P&T Dispensary, Near BSF Camp (Mawpat)
Shillong 793 012
Telefax: 0364-2537343

19. Mizoram
The Director
Zoram Energy Development Agency

H/No.A/4, Muol Veng, CHALTLANG,
Aizawl, Mizoram 796007
Tel: 0389-2350664; 2350665
Fax: 323185

20. Nagaland
The Project Director
Nagaland Renewable Energy Development Agency
(NREDA)
NRSE Cell Rural Development Department
Nagaland Secretariat
Kohima, Nagaland
Telefax 0370-241408

21. Orissa
The Chief Executive Officer,
Orissa Renewable Energy Development Agency
S-59, Mancheswar Industrial Estate
Bhubaneswar 751 010
Tel: 0674-2580660 (O),
Fax :2586368

22. Punjab
The Chief Executive
Punjab Energy Development Agency
Plot No. 1-2, Sector 33-DChandigarh 160 036
Tel: 0172-663392; 663328, 663382,
Fax: 0172-2646384, 2662865

23. Rajasthan
The Chairman & Managing Director,
Rajasthan Renewable Energy Corporation Limited
E-166, Yudhister Marg, 'C' Scheme
Jaipur 302 001
Tel: 0141-2225898 / 2228198 , Fax: 0141-2226028

24. SIikkim
The Director
Sikkim Renewable Energy Development Agency,
Department of New and Renewable Energy Sources
Government of Sikkim
Tashiling Secretariat, Annexi- I,
Gangtok 737 101
Tel: 03592- 22659, Fax: 03592-22245

25. Tamil Nadu
The Chairman & Managing Director
Tamilnadu Energy Development Agency (TEDA)
EVK Sampath Building,
Maaligal, 5th Floor
Chennai 600 006
Tel: 044-28224832 Fax: 044-28236592,28222971

26. Tripura
The Chief Executive Officer
Tripura Renewable Energy Development Agency
Vigyan Bhawan, 2nd Floor,
Pandit Nehru Complex
West Tripura , Agartala 799 006
Tel: 0381-225421 (O), Fax. 0381-225900

27. Uttar Pradesh
The Director
Non-conventional Energy Development Agency
(NEDA), U.P.
Vibhuti Khand, Gomti Nagar
Lucknow 226 010
Tel: 0522-2720652; Fax: 0522-2720779,2720829

28. Uttarakhand
The Director
Uttarakhand Renewable Energy (UREDA)
Development Agency
Energy Park Campus
Industrial Area, Patel Nagar,
Dehradun-248001
Tel :0135-2521387, 2521386 Fax : 0135-2521553

29. West Bengal
The Director
West Bengal Renewable Energy Development Agency
Bikalap Shakti Bhawan, Plot- J-1/10, EP & GP

Block,Salt Lake
Electronics Complex, Sector- V, Kolkata- 700091
Tel.033-3575038, 3575348 (O), Fax 3575037, 3575347

30. Andaman & Nicobar Islands
The Superintending Engineer
Electricity Department,
Govt. of Andaman & Nicobar Islands,
Port Blair 744 101
Tel. 03192-232404, Fax. : 233365

31. Chandigarh
The Director (Science & Technology)
Chandigarh Administration
Additional Town Hall Building
2nd Floor, Sector-17 C, Chandigarh
Tel: 0172-2745502,2744235 ; Fax :2740005

32. Dadra & Nagar Haveli
The Development and Planning Officer
Administration of Dadra & Nagar Haveli
Silvassa.
Tel. 0260-642070

33. Lakshadweep
The Executive Engineer
Electricity Department
Lakshadweep Administration
Kavaratti 682555
Tel. 04896-262363, Fax. 262936

34. Pondicherry
The Project Director
Renewable Energy Agency of Pondicherry
No. 10, Second Main Road
Elango Nagar
Pondicherry 605 011
Tel. 0413-2244219

35. Leh-Ladakh

Source: Ministry of New and Renewable Energy, 2009

Annexure IV

List of Figures

List of Boxes

List of Abbreviations /Acronyms

AC	Alternate Current
Ah	Ampere per hour
AHEC	Alternate Hydro Energy Centre
ASSOCHAM	Associated Chambers of Commerce and Industry of India
ata./deg C	Atmosphere per degree Celsius
BG	Biomass Gasifier
BGFPs	Biogas-fertilizer Plants
BIS	Bureau of Indian Standards
BP	Biomass Power
BPL	Below Poverty Line
CFA	Central Financial Assistance
CFL	Compact Fluorescent Lamp
CHP	combined heat and power
CII	Confederation of Indian Industry
CREDA	Chhattisgarh State Renewable Energy Development Agency
crore	A unit in the Indian numbering system equal to ten million (10,000,000 or 107)
cubic m. / cu.m	cubic metre
DC	Direct Current
DDG	Decentralized Distributed Generation
DG	Distributed Generation
FICCI	Federation of Indian Chambers of Commerce and Industry
GDP	Gross Domestic Product
GEF	Global Environment Facility
HP	Horse Power
ICEF	India-Canada Environment Facility
IREDA	Indian Renewable Energy Development Agency Limited
ISI	Indian Standards Institution or ISI mark. Given by BIS and means the product conforms

to respective national product standard the customer has to accept the same.

kg	Kilogram
kg/sqcm	Kilogram per centimeter square
km/hr	Kilometer per hour
Kms	Kilometers
KVIC	Khadi and Village Industries Commission
kwh	kilowatt hour
kWp	kilowatt peak
l/day	Liters per day
lakh	A unit in the Indian numbering system equal to one hundred thousand (100,000 or 105)
m/s	Meter per second
MNES	Ministry of Non-Conventional Energy Sources
MNRE	Ministry of New and Renewable Energy
MoP	Ministry of Power
MU	Million Units (equivalent to gigawatt hour)
MW	Megawatt
MWeq	Megawatt equivalent
MWp	Megawatt peak
NABARD	National Bank for Agriculture and Rural Development
NARI	Nimbkar Agricultural Research Institute
NBMMP	National Biogas and Manure Management programme
NE	North-East
NGO	Non- Governmental Organizations
PLF	Plant load factor
RCC	Reinforced Cement Concrete
REC	Rural Electrification Corporation
RES	Renewable Energy Sources
RGGVY	Rajiv Gandhi Grameen Vidhyutikaran Yojana
Rs	Rupees (Indian Rupee)

SERCs	State Electricity Regulatory Commissions
SHGs	Self Help Groups
SHP	Small Hydro Project
SPV	Solar Photovoltaic
sqm	square meter
T&D	Transmission and Distribution
U&I	Urban & Industrial Water Power
UNDP	United Nations Development Programme
UTs	Union Territories
v/v	volume in volume
VEC	Village Electrification Committee
VESP	Village Energy Security Test Projects
WBREDA	West Bengal Renewable Energy Development Agency
Wp	Wattpeak

UNEP/GRID-Arendal
Postbox 183
N-4802, Arendal
Norway
Tel: +47 4764 4555
Fax: +47 3703 5050
Email:Anne.solgaard@grida.no
Web: www.grid.no

Development Alternatives
B-32 TARA Crescent
Qutab Institutional Area
New Delhi – 110016 (INDIA)
Tel : +91-11-26134103
Fax : 011-26130817
Email: akumar3@devalt.org
Website: www.devalt.org