

Renewable Energy and Energy Efficiency Status in India

Report compiled by ICLEI South Asia
May 2007

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MESSAGE

ACKNOWLEDGEMENT

ICLEI South Asia is pleased to thank the following people and organizations for providing us with required information and valuable suggestions:

- Dr. Ajay Mathur, Director General, Bureau of Energy Efficiency, Government of India
- Shri Ajit Gupta, Adviser, Ministry of New and Renewable Energy, Government of India
- Dr. A.K Singhal, Director, Ministry of New and Renewable Energy, Government of India
- Mr. Anil Dhussa, Director, Ministry of New and Renewable Energy, Government of India
- Monika Zimmermann, Director, ICLEI- International Training Centre
- Maryke van Staden, Project Officer, ICLEI European Secretariat
- Margarita Maria Parra, Senior Program Officer, ICLEI USA Office
- Paula Gabriela Freitas, Project Officer, ICLEI Latin America & the Caribbean Secretariat
- Bhubaneswar Municipal Corporation Officials
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INTRODUCTION

This report has been prepared within the ‘Local Renewables Model Communities Network Project’ (Local Renewables). The project is supported by German Federal Ministry for Economic Cooperation and Development (BMZ), with technical support from Gesellschaft für Technische Zusammenarbeit (GTZ), Germany. Project partners are the GTZ, Germany and ICLEI - Local Governments for Sustainability (European Secretariat, International Training Center, South Asia Secretariat and ICLEI Cities for Climate Protection Campaign, International Coordination).

The goal of the project ‘Local Renewables’ is to promote the generation and supply of renewable energy and use of energy efficient techniques in communities, with a focus on the roles and responsibilities of local governments as the driving force for innovation and investment. The project will motivate and enable local governments from India and other countries to encourage the inclusion of renewable energy sources in their municipal development strategies and to initiate related activities.

The time frame of the project is three years, from November 2005 to October 2008. Two Indian cities-Bhubaneswar and Nagpur have been selected to participate in the project and become ‘Model Communities’. For more information about the project, refer to the website: www.localrenewables.org

The purpose of this report is to provide an overview of the status of Energy Efficiency (EE) and Renewable Energy (RE) in India. Many facts and data have been obtained from the Ministry of New and Renewable Energy, the Ministry of Power and the Ministry of Petroleum and Natural Gas. Data and observations have been obtained through various contacts with different Indian local governments including the partner cities-Bhubaneswar and Nagpur.

Chapter 1 consists of a brief overview of the major energy sources in India and the present energy status in the country.

Chapter 2 consists of a brief overview of energy efficiency opportunities in energy sector, importance of energy efficiency and plans for achieving the target.

Chapter 3 provides an overview of the current renewable energy status in India, the national institutional framework, financial organizations, policies and incentives in the field of renewable energy in India.

Chapter 4 describes available renewable energy technologies, their potential and financial mechanisms available for promoting these technologies in India.

Chapter 5 describes the various Instruments existing in local governments that can be used for promoting RE and EE and measures available with local governments for reduction of Green House Gases.

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1. ENERGY STATUS IN INDIA

1.1. Overview

Energy is the prime mover of economic growth, and is vital to sustaining a modern economy and society. Future economic growth significantly depends on the long-term availability of energy from sources that are affordable, accessible and secure.

1.1.1. Global Primary¹ Energy Reserves

Coal

The proven global coal reserve was estimated to be 9,84,453 million tones by the end of 2003. The USA has the largest share of the global reserve (25.4%) followed by Russia (15.9), China (11.6%). India was 4th in the list with 8.6%.

Oil

The proven global oil reserve was estimated to be 1147 billion barrels by the end of 2003. Saudi Arabia had the largest share of the reserve with almost 23%.

Gas

The global proven gas reserve was estimated to be 176 trillion cubic meters by the end of 2003. The Russian Federation had the largest share of the reserve with almost 27%.

The global primary energy consumption at the end of 2003 was equivalent to 9741 million tones of oil equivalent (Mtoe). The primary energy consumption for few of the developed and developing countries are shown in figure 1. It may be seen that India's absolute primary energy consumption is only 1/29th of the world, 1/7th of USA, 1/1.6th time of Japan but 1.1, 1.3, 1.5 times that of Canada, France and UK respectively.

Country	Oil	Natural Gas	Coal	Nuclear Energy	Hydro energy	Total
USA	914.3	566.8	573.9	181.9	60.9	2297.8
Canada	96.4	78.7	31.0	16.8	68.6	291
France	94.2	39.4	12.4	99.8	14.8	260.6
Russian Federation	124.7	365.2	111.3	34.0	35.6	670.8
United Kingdom	76.8	85.7	39.1	20.1	1.3	223.2
China	275.2	29.5	799.7	9.8	64	1178.3
India	113.3	27.1	185.3	4.1	15.6	345.3
Japan	248.7	68.9	112.2	52.2	22.8	504.8
Malaysia	23.9	25.6	3.2	-	1.7	54.4
Pakistan	17.0	19.0	2.7	0.4	5.6	44.8
Singapore	34.1	4.8	-	-	-	38.9
Total world	3636.6	2331.9	2578.4	598.8	595.4	9741.1

Figure 1: Primary Energy Consumption by Fuel, 2003 (In Million tonnes oil equivalent)

Source: Bureau of Energy Efficiency

¹ Primary energy sources are those that are found or stored in nature.

Energy distribution between Developed and Developing Countries

Although 80 percent of the world's population lies in the developing countries (a four fold population increase in the past 25 years), their energy consumption amounts to only 40 percent of the world total energy consumption. The high standards of living in the developed countries are attributable to high-energy consumption levels. Also, the rapid population growth in the developing

Countries have kept the per capita energy consumption low compared with that of highly industrialized developed countries. The world average energy consumption per person is equivalent to 2.2 tonnes of coal. In industrialized countries, people use four to five times more than the world average, and nine times more than the average for the developing countries. An American uses 32 times more commercial energy than an Indian.

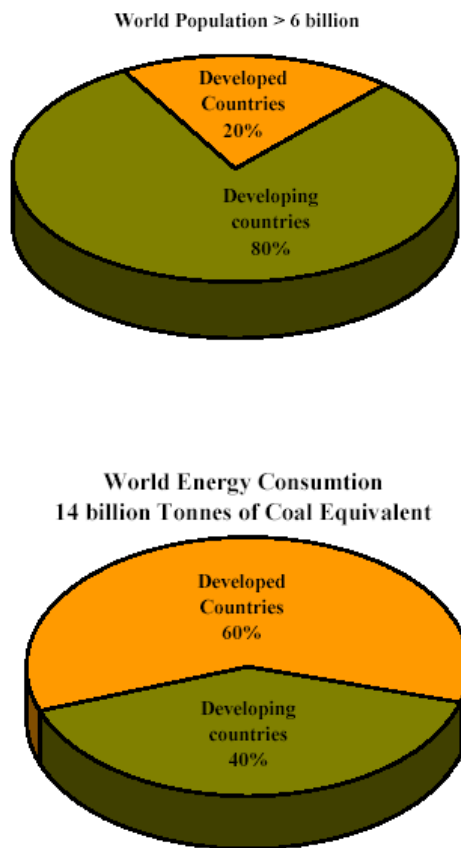


Figure 2 Population and Energy Distributions between Developed and Developing Countries
Source: Bureau of Energy Efficiency

1.1.2. India Energy Status

India faces formidable challenges in meeting its energy needs and in providing adequate energy of desired quality in various forms in a sustainable manner and at competitive prices. India needs to sustain an 8% to 10% economic growth rate, over the next 25 years, if it is to eradicate poverty and meet its human development goals. To deliver a sustained growth rate of 8% through 2031-32 and to meet the lifeline energy needs of all citizens, India needs, at the very least, to increase its primary energy supply by 3 to 4 times and, its electricity generation capacity/supply by 5 to 6 times of their 2003-04 levels. With 2003-04 as the base, India's commercial energy supply would need to grow from 5.2% to 6.1% per annum while its total primary energy supply would need to grow at 4.3% to 5.1% annually. By 2031-32 power generation capacity must increase to nearly 8,00,000 MW from the current capacity of around 1,60,000 MW inclusive of all captive plants. Meeting the energy challenge is of fundamental importance to India's economic growth imperatives and its efforts to raise its level of human development²

² Integrated Energy Policy: Report of the Expert Committee, Government of India, Planning Commission, New Delhi, August 2006

1.2. Major Energy Supply Sources

1.2.1. Coal

India's has huge proven coal reserves, estimated (as of January 2005) at more than 90 billion tons, or about 10% of the world's total. Most of these reserves are relatively high ash bituminous coal and are located in Bihar, West Bengal, and Madhya Pradesh states. At the current level of production and consumption, India's coal reserves would last more than two hundred years. India is currently the third-largest coal-producing country in the world (behind China and the United States), and accounts for about 8.5% of the world's annual coal production. India is also currently the third-largest coal consuming country (behind the China and the United States), and accounts for nearly 9% of the world's total annual coal consumption. More than half of India's energy needs are met by coal, and about 70% of India's electricity generation is now fueled by coal. The annual demand for coal has been steadily increasing over the past decade, and is now nearly 50% higher than it was a decade ago. Even though India is able to satisfy most of its country's coal demand through domestic production, less than 5% of its reserves are coking coal used by the steel industry. As a result, India's steel industry imports coking coal, mainly from Australia and New Zealand, to meet about 25% of its annual needs. A summary of coal production and consumption in India is shown in Figure 3.

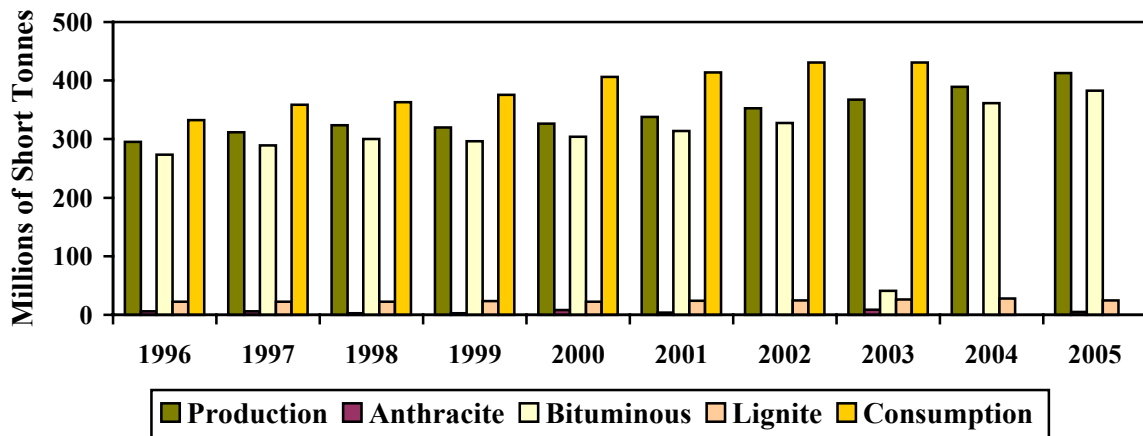


Figure 3 Coal Production & Consumption

Source: TERI Publication

1.2.2. Oil

Oil accounts for about 36 % of India's total energy consumption. India today is one of the top ten oil-guzzling nations in the world and will soon overtake Korea as the third largest consumer of oil in Asia after China and Japan. The country's annual crude oil production is peaked at about 32 million tonnes as against the current peak demand of about 110 million tonnes. In the current scenario, India's oil consumption by end of 2007 is expected to reach 136 million tonnes (MT), of which domestic production will be only 34 MT. India will have to pay an oil bill of roughly \$50 billion, assuming a weighted average price of \$50 per barrel

of crude. In 2003- 04, against total export of \$64 billion, oil imports accounted for \$21 billion. India imports 70% of its crude needs mainly from gulf nations. The majority of India's roughly 5.4 billion barrels in oil reserves are located in the Bombay High, upper Assam, Cambay, Krishna-Godavari. In terms of sector wise petroleum product consumption, transport accounts for 42% followed by domestic and industry with 24% and 24% respectively. India spent more than Rs.1, 10,000 crore on oil imports at the end of 2004³.

³ Bureau of Energy Efficiency

1.2.3. Natural Gas

India's natural gas reserves have been estimated 1075 Billion Cubic meters or about 0.5% of the world total. Most of these reserves lie offshore northwest of Mumbai in the Arabian Sea and onshore in Gujarat state. India does not yet rank in the top 20 of the world's greatest natural gas consumers, but that will soon change. At the present, India producing about 32202 Million cubic Meters of natural Gas annually. Natural gas has experienced the fastest rate of increase of any fuel in India's primary energy supply; demand is growing at about 4.8% per year and is forecast to rise to 1.2 tcf per year by 2010 and 1.6 tcf per year by 2015⁴.

1.2.4. Nuclear energy

India is poorly endowed with Uranium. Available Uranium supply can fuel only 10,000 MW of the Pressurized Heavy Water Reactors (PHWR). Further, India is extracting Uranium from extremely low-grade ores (as low as 0.1% Uranium) compared to ores with up to 12-14% Uranium in certain resources abroad. This makes Indian nuclear fuel 2-3 times costlier than international supplies. The substantial Thorium reserves can be used but that requires that the fertile Thorium be converted to fissile material.

⁴ Ministry of petroleum and Natural gas

1.2.5. Hydro Energy

India's hydel resources are estimated to be 84,000 MW at 60% load factor. The current utility based installed capacity is 32,326 MW and the average annual generation over the last three years (2002-05) was 74 Billion Kilowatt hours (BkWh) giving a load factor of 29%. At such a load factor an installed capacity of 1,50,000 MW including some 15,000 MW of small hydel plants (size <25 MW) may be justified given the available potential hydroelectric energy. The accelerated hydro development plan aims to build 50,000 MW of new capacity by 2025-26.⁵

1.2.6. Electricity

Overall, India's need for power is growing at a prodigious rate, annual electricity generation and consumption in India has increased by about 64% in the past decade, and its projected rate of increase (estimated at as much as 8-10% annually, through the year 2020) for electricity consumption is one of the highest in the world⁶.

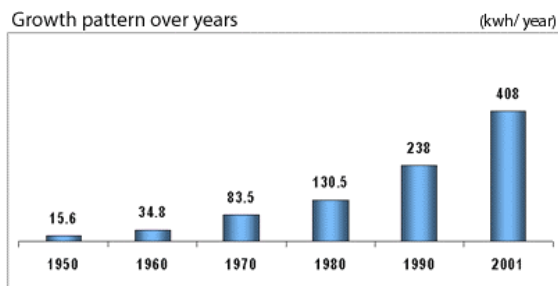
Access to electricity is very uneven in India. Even though 85 percent of villages are considered electrified, around 57 percent of the rural households and 12 percent of the urban households i.e., 84 million households in the country (over

⁵ Integrated Energy Policy: Report of the Expert Committee, Government of India, Planning Commission, New Delhi, August 2006

⁶ <http://www.cslforum.org/india.htm>

44.2 percent of households) did not have electricity in 2000.

The Ministry of Power has set a target of adding a 100,000 MW of generation capacity by 2012⁷. This capacity addition programme includes the 41,110 MW proposed to be added in the 10th Plan (2002-07 five years plan). The capacity addition programme is designed to ensure availability of reliable, quality power, and the creation of an adequate reserve margin.



In 1950 Electricity consumption per capita was 15 kwh
In 2012 it is projected at 932 kwh.

Figure 4: Per Capita Consumption of Electricity in India

Source: Ministry of Power

1.2.7. Renewable Energy

There is a large potential for renewable energy in India, an estimated aggregate of over 100,000 MW. As against the estimated 84776 MWe renewable energy based grid connected power generation potential in the country, so far only about 9372.5 MW installed capacity has been achieved. The renewable energy based power generation capacity presently constitutes 7% of the total installed capacity in the country for power generation from all sources. The country is aiming to achieve up to 10% of additional installed capacity to be set up till 2012 to come from renewable energy sources.

Chapter 4 describes in detail the Renewable Energy status in India.

⁷ Source: Ministry of Power

Summary

Energy is the prime mover of economic growth, and is vital to sustaining a modern economy and society for any country across the world. The global primary energy consumption at the end of 2003 was equivalent to 9741 million tones of oil equivalent (Mtoe).

The developing countries have more than 80 percent of the world's population but their energy consumption amounts to only 40 percent of the world total energy consumption, which shows how the energy consumption is directly related to economic development. An American uses 32 times more commercial energy than an Indian.

The Global Primary Energy Reserves are:

- The proven global coal reserve was estimated to be 9,84,453 million tones by end of 2003. The USA has the largest share of the global reserve (25.4%) followed by Russia (15.9), China (11.6%). India was 4th in the list with 8.6%.
- The global proven oil reserve was estimated to be 1147 billion barrels by the end of 2003.
- The global proven gas reserve was estimated to be 176 trillion cubic meters by the end of 2003.

India faces formidable challenges in meeting its energy needs and in providing adequate energy of desired quality in various forms in a sustainable manner and at competitive prices. India needs to sustain an 8% to 10% economic growth rate, over the next 25 years. In India, the share of fossil fuels in the current primary fuel-mix of the country is dominant as coal, oil and gas together account for around 66 percent.

The India's Primary Energy Reserves are:

- India's has huge proven coal reserves, estimated (as of January 2005) at more than 90 billion tons, or about 10% of the world's total. India is currently the third-largest coal-producing country in the world behind China and the United States.
- Oil accounts for about 36 % of India's total energy consumption. India's proven crude oil reserves are currently estimated at about 756 million metric tonnes, or about 4.5% of the world total. The country's annual crude oil production is peaked at about 32 million tonnes as against the current peak demand of about 110 million ton
- India's natural gas reserves have been estimated 1075 billion Cubic meters or about 0.5% of the world total.

India's need for power is growing at a prodigious rate, annual electricity generation and consumption in India has increased by about 64% in the past decade. At present 65% of electricity is generated through coal. India's hydel resources are estimated to be 84,000 MW at 60% load factor. The current utility based installed capacity is 32,326 MW and the average annual generation over the last three years (2002-05) was a 74 Billion Kilowatt hour (BkWh) giving a load factor of 29%.

Renewable energy based power generation capacity in India presently constitutes 7% of the total installed capacity in the country for power generation from all sources. The country is aiming to achieve up to 10% of additional installed capacity to be set up till 2012 to come from renewable energy sources.

2.1 Overview

India's conventional energy reserves are limited and we must develop all available and economic alternatives. Simultaneously, a major stress must be laid on energy efficiency and conservation, with particular emphasis on efficiency of electricity generation, transmission, distribution and end-use. Clearly, over the next 25 years energy efficiency and conservation are the most important virtual energy supply sources that India possesses.⁸

Difference between Energy Conservation and Energy Efficiency

Energy Conservation and Energy Efficiency are separate, but related concepts. Energy conservation is achieved when growth of energy consumption is reduced, measured in physical terms. Energy Conservation can, therefore, be the result of several processes or developments, such as productivity increase or technological progress. On the other hand Energy efficiency is achieved when energy intensity in a specific product, process or area of production or consumption is reduced without affecting output, consumption or comfort levels. Promotion of energy efficiency will contribute to energy conservation and is therefore an

⁸ Integrated Energy Policy: Report of the Expert Committee, Government of India, Planning Commission, New Delhi, August 2006

integral part of energy conservation promotional policies.

Energy efficiency is often viewed as a resource option like coal, oil or natural gas. It provides additional economic value by preserving the resource base and reducing pollution. For example, replacing traditional light bulbs with Compact Fluorescent Lamps (CFLs) means you will use only 1/4th of the energy to light a room. Pollution levels also reduce by the same amount.⁹

2.2 Institutional Framework

Background

The importance of energy efficiency in the development of India was recognized as early as 1972 in the Fuel Policy Committee Report, and continued in the years that followed. The 1970s saw the growth of the national petroleum conservation programs developed by the Petroleum Conservation Research Association (PCRA), an organization supported by the country's oil companies. The Indian Oil Corporation Ltd. was the leader, and the National Productivity Council (NPC) provided early technical support.

In the 1980s bilateral co-operation such as with the Department for International Development, UK (DFID), German Federal

⁹ Bureau of Energy Efficiency

Ministry for Economic Cooperation and Development (BMZ), and the United States Agency for International Development (USAID) provided technical assistance to India's efforts at promoting and developing energy efficiency training and extension services. The objective was to spread awareness, create institutional capacity and provide energy audit diagnostics services. The Energy and Resources Institute (TERI), the National Productivity Council (NPC), and the Association of Indian Engineering Industries (AIEI), later renamed to the Confederation of Indian Industries (CII), and the Industrial Credit and Investment Corporation of India (ICICI) were some of the earliest domestic agencies that pursued the design and delivery of energy efficiency services way back in 1964, well before the energy crisis, and was responsible for some of the earliest institutional initiatives.

The landmark 1982 Inter-Ministerial Working Group reports on energy conservation –policies and programs recognized the need for bilateral and multilateral support for energy efficiency and recommendations. A few years later (in 1984), the Energy Management Centre in the Ministry of Power was created, followed by the Bureau of Energy Efficiency (BEE).

Mid-1990s saw a renewed interest promoting energy efficiency through technical assistance and training activities aimed at exposing Indian enterprises to management and technological advance in the West. India, the sixth largest and second fastest growing producer of GHG

emissions in the world, was recognized as providing renewed interest in promoting energy efficiency to mitigate the impact of climate change. Energy efficiency programs in India received a further impetus through the line of credit from the World Bank / Global Environment Fund (GEF) to Indian Renewable Development Agency (IREDA) to finance energy efficiency projects and develop the system of delivery through energy service companies (ESCOs). This complemented the other lines of credit provided by ADB (Asian Development Bank) through Indian development financial institutions such as the Industrial Development Bank of India (IDBI) and ICICI Bank to finance energy efficiency as part of the industrial modernization investment. More importantly, the early part of this millennium coincided with the successful passage of the Energy Conservation Act in 2001 with the responsibility for its implementation vested with the BEE.

2.2.1 Petroleum Conservation Research Association (PCRA)

In recognition of the importance of energy conservation, the Indian government created the **Petroleum Conservation Research Association (PCRA)** in 1978. PCRA continues to play an active role in the promotion of petroleum fuel saving strategies and functions as a think tank to the government for proposing policies and strategies on petroleum conservation and environmental protection aimed at reducing excessive dependence on oil.

2.2.2 Bureau of Energy Efficiency (BEE)

Under the provisions of the Energy Conservation Act 2001(Refer section 2.5.1), Bureau of Energy Efficiency has been established with effect from 1st March 2002 by merging erstwhile Energy Management Centre of Ministry of Power.

BEE's mission is to develop programs and strategies on self-regulation and market principles with primary objective to reduce the energy intensity of the Indian economy. Some key activities that BEE is pursuing include the development of energy performance labels for refrigerators, motors, air conditioners, and other mass-produced equipment, certification of energy managers and auditors, assisting industry in the benchmarking of their energy use, and energy audits of prominent government buildings. BEE is also working closely with energy development agencies at the state level in order to deliver energy efficiency services including through public-private partnership.

The BEE has powers to direct the designated consumers to abide by energy consumption norms and to get their energy consumption audited. The BEE is also empowered to mandate that all appliances carry labels indicating their efficiency, that appliance manufacturers abide by efficiency standards set by BEE, and that energy consumption standards set by BEE are met by specified industry or building complexes. The power supply utilities are included in the list of Designated Consumers. At present, the BEE is following a consensus approach and has not started to use its legal / penal powers. It has

also declared that it may start using its legal authority and powers to mandate actions in future. The BEE website suggests that the power distribution utilities should have demand-side management (DSM) cells (to implement the DSM programs). The BEE also offers training support for the DSM cells set up by the utilities. The BEE seems to imply utility-sponsored efficiency programs as a meaning of DSM. The BEE has estimated a potential of 23% savings through energy conservation.

BEE has set up an action plan for achieving 10% saving (nearly 10,000 MW)¹⁰ in the next five years.

2.2.3 Other institutions

Indian industry associations have played an important role in promoting energy efficiency. The Confederation of Indian Industry (CII) and Federation of Indian Chambers of Commerce and Industry (FICCI) are engaged in capacity building through the organization of training programs, workshops, conferences, exhibitions, poster displays, awards, and field visits. The Indian Green Business Center is an example of an institution created by an industry association; CII jointly with the Andhra Pradesh government and with technical support from USAID set it up as a public-private partnership. Its building has acquired the LEED platinum rating, and one of its five working groups is engaged in facilitating

¹⁰ [http://powermin.nic.in/statement to press.htm](http://powermin.nic.in/statement%20to%20press.htm) as on 15 November 2004

energy efficiency improvement across industry through improved capacity utilization, fine tuning, and technology up gradation. Private ESCOs have mobilized and recently set up the Indian Council for Energy Efficiency Business (ICPEEB) to network, provide input to policy makers, support business development, and disseminate information on energy efficiency¹¹.

2.3 Regulatory framework

2.3.1 The Energy Conservation Act, 2001 and its features

Policy Framework - Energy Conservation Act – 2001

With the background of high energy saving potential and its benefits, bridging the gap between demand and supply, reducing environmental emissions through energy saving, and to effectively overcome the barrier, the Government of India has enacted the Energy Conservation Act-2001. The Act provides the much-needed legal framework and institutional arrangement for embarking on an energy efficiency drive.

Under the provisions of the Act, Bureau of Energy Efficiency has been established with effect from 1st March 2002 by merging erstwhile Energy Management Centre of Ministry of Power. The Bureau

would be responsible for implementation of policy programmes and coordination of implementation of energy conservation activities.

Important features of the Energy Conservation Act are:

Standards and Labeling

Standards and Labeling (S & L) has been identified as a key activity for energy efficiency improvement. The S & L program, when in place would ensure that only energy efficient equipment and appliance would be made available to the consumers.

The main provision of EC act on Standards and Labeling are:

- Evolve minimum energy consumption and performance standards for notified equipment and appliances
- Prohibit manufacture, sale and import of such equipment, which does not conform to the standards
- Introduce a mandatory labeling scheme for notified equipment appliances to enable consumers to make informed choices
- Disseminate information on the benefits to consumers

Designated Consumers

- Designated consumers would comply with norms and standards of energy consumption as prescribed by the central government.

¹¹

<http://www.bescom.org/en/news/belp.asp>.

Certification of Energy Managers and Accreditation of Energy Auditing Firms

The main activities in this regard as envisaged in the Act are:

- A cadre of professionally qualified energy managers and auditors with expertise in policy analysis, project management, financing and implementation of energy efficiency projects would be developed through Certification and Accreditation programme. BEE to design training modules, and conduct a National level examination for certification of energy managers and energy auditors.

Energy Conservation Building Codes:

The main provisions of the EC Act on Energy Conservation Building Codes are:

- The BEE would prepare guidelines for Energy Conservation Building Codes (ECBC);
- These would be notified to suit local climate conditions or other compelling factors by the respective states for commercial buildings erected after the rules relating to energy conservation building codes have been notified. In addition, these buildings should have a connected load of 500 kW or contract demand of 600 kVA and above and are intended to be used for commercial purposes;
- Energy audit of specific designated commercial building consumers would also be prescribed.

Central Energy Conservation Fund:

The EC Act provisions in this case are:

- The fund would be set up at the centre to develop the delivery mechanism for large-scale adoption of energy efficiency services such as performance contracting and promotion of energy service companies. The fund is expected to give a thrust to R & D and demonstration in order to boost market penetration of efficient equipment and appliances. It would support the creation of facilities for testing and development and to promote consumer awareness.

Role of Central and State Governments:

The following role of Central and State Government is envisaged in the Act

- Central - to notify rules and regulations under various provisions of the Act, provide initial financial assistance to BEE and EC fund, Coordinate with various State Governments for notification, enforcement, penalties and adjudication.
- State - to amend energy conservation building codes to suit the regional and local climatic condition, to designate state level agency to coordinate, regulate and enforce provisions of the Act and constitute a State Energy Conservation Fund for promotion of energy efficiency.

The main provisions of the EC Act on designated consumers are:

- The government would notify energy intensive industries and other establishments as designated consumers;
- Schedule to the Act provides list of designated consumers which covered basically energy intensive industries, Railways, Port Trust, Transport Sector, Power Stations,
- Transmission & Distribution Companies and Commercial buildings or establishments;
- The designated consumer to get an energy audit conducted by an accredited energy auditor;
- Energy managers with prescribed qualification are required to be appointed or designated by the designated consumers;

2.3.2 Electricity Act in 2003

The Indian Parliament also passed the Electricity Act in 2003¹². It consolidated laws related to generation, transmission, distribution, trade and use of electricity. Among other things, it called for rationalization of electricity tariffs, creation of a competitive environment, and open access in transmission and distribution of electricity. The Act also mandated the creation of regulatory commissions at the central, regional and state levels. As a

12

http://powermin.nic.in/acts_notification/electricity_act2003/preliminary.htm

consequence, the electric utility system is being unbundled, tariffs are being rationalized, and regulatory commissions are playing an active role in enforcement of bill collection and the promotion of DSM programs in some of the larger states. Under orders from the Maharashtra Electricity Regulatory Commission, for instance, utility companies in Maharashtra have initiated a lighting efficiency program in the residential sector¹³, and the Bangalore Electricity Supply Company has initiated a similar program in Karnataka state.

2.4 Potential for saving energy

The importance of energy efficiency and demand side management (DSM) has clearly emerged from the various supply scenarios and is further underlined by rising energy prices. Efficiency can be increased in energy extraction, conversion, transportation, as well as in consumption. Further, the same level of service can be provided by alternate means that require less energy. The major areas where efficiency in energy use can make a substantial impact are mining, electricity generation, electricity transmission, distribution, pumping water, industrial production and processes, transport equipment, mass transport, building design, construction, heating ventilation and air conditioning, lighting and household appliances. It may be noted that a unit of energy saved on production, transport, and

¹³ http://mercindia.org.in/Orders_2005.htm

transmission and distribution losses. Thus a “Megawatt” (a negative Megawatt) produced by reducing energy need saves more than a Megawatt generated.

The target for energy savings in the 10th Plan is 95,000 Million Units which is about 13% of the estimated demand of 7,19,000 Million Units in the terminal year of the 11th Plan. However, there is no specific allocation to meet the energy savings targets¹⁴.

2.4.1 Recommendations of “Integrated Energy Policy-2006” prepared by the Planning Commission, Government of India

To promote energy efficiency and conservation there is a need to create an appropriate set of incentives through pricing and other measures. Public policy can set the pace for such development by offering attractive rewards and imposing biting penalties.

An enabling institutional framework is essential to achieve the objectives listed above. Details of such an institutional framework are listed below:

- The BEE should be made an autonomous statutory body under the Energy Conservation Act and be independent of all the energy ministries. It should be funded by the Central Government. A cess on fuels and electricity (adjusted for the cess on

fuels used for generating electricity) can be justified as a user charge. BEE staffing should be substantially strengthened.

- Existing national energy efficiency organizations like the Petroleum Conservation Research Association (PCRA) should be merged with the BEE. This will ensure that the BEE is responsible for energy efficiency for all sectors and all end-uses.
- Based on the recommendations of the merged autonomous body the government could directly provide funding support to financial institutions for promoting energy efficiency programmes.
- Energy efficiency and conservation programmes and standards should be established and enforced. The BEE should develop such standards for all energy intensive industries and appliances as well as develop modalities for a system of incentives/penalties for compliance/non-compliance. These standards should be at levels equal to or near current international norms.
- Mechanisms for independent monitoring and verification of achieved energy savings and the cost effectiveness of programmes must be established. Evaluation reports should be quantitative and made publicly available. An annual report of the investments and savings made through specific energy efficiency and DSM programmes should be prepared by the BEE and reported to the Parliament. The feedback from the monitoring

¹⁴ Integrated Energy Policy: Report of the Expert Committee, Government of India, Planning Commission, New Delhi, August 2006

exercises should help in modifying programme designs.

- Truthful labeling must be enforced with major financial repercussions if equipment fails to deliver stated efficiencies. In extreme cases, one can resort to black listing errant suppliers at consumer information websites and on government procurement rosters.
- Verification and labeling requires testing laboratories. A programme for setting up such laboratories in public, private and the NGO sectors is needed.
- National Building Codes should be revised to facilitate and encourage energy efficient buildings.
- Improvement in energy efficiency and DSM require actions by a large number of persons and institutions. To mobilize them, the first task is to create awareness of the scope of possibilities and the extent of gains one can make through such measures.
- Promote and facilitate energy service companies (ESCOs) that can identify energy saving options and provide technical support needed or execution to industries and commercial establishments.
- Large scope exists to make buildings energy efficient. Construction materials are energy intensive and the use of appropriate materials and design can save a significant amount of energy not only in construction but also during use by building occupants. Innovative and energy efficient building technologies should be widely publicized through an annual prize. Reducing energy need for heating and cooling by orientation, insulation and using temperature differences in earth or water at some depth could also be significant.

Summary

India's conventional energy reserves are limited and we must develop all available and economic alternatives. Simultaneously, a major stress must be laid on energy efficiency and conservation. The importance of energy efficiency to India's development was recognized as early as 1972. In the 1980s bilateral co-operation such as with the DFID, BMZ, and USAID provided technical assistance to India's efforts at promoting and developing energy efficiency training and extension services. In 1984 the Energy Management Center in the Ministry of Power was created, followed by the Bureau of Energy Efficiency (BEE). India, the sixth largest and second fastest growing producer of GHG emissions in the world, was recognized as providing renewed interest in promoting energy efficiency to mitigate the impact of climate change. EE programme in India was further impetus by World Bank/GEF, ADB, IREDA etc to finance energy efficiency projects.

In recognition of the importance of energy conservation, the Indian government created the Petroleum Conservation Research Association (PCRA) in 1978.

To promote and accelerate the energy efficiency through out the India, Government of India has enacted the Energy Conservation Act- 2001. The Act provides the much-needed legal framework and institutional arrangement for embarking on an energy efficiency drive. Under the provisions of the Act, Bureau of Energy Efficiency has been established with effect from 1st March 2002 by merging erstwhile Energy Management Centre of Ministry of Power.

BEE's mission is to develop programs and strategies on self-regulation and market principles with primary objective to reduce the energy intensity of the Indian economy.

Besides these Indian industry associations (now it is know as CII) have also played an important role in promoting energy efficiency and the Indian Green Business Center is an example of an institution created by an industry association;

Important features of the Energy Conservation Act are:

- Standards and Labeling (S & L) has been identified as a key activity for energy efficiency improvement.
- Designated Consumers
- A cadre of professionally qualified energy managers and auditors would be developed through Certification and Accreditation programme.
- The BEE would prepare guidelines for Energy Conservation Building Codes (ECBC);
- Central Energy Conservation Fund has been set up at the centre to develop the delivery mechanism for
- large-scale adoption of energy efficiency service.

There is a huge potential of Energy saving in all sector in India. The target for energy savings in the 10th Plan is 95,000 Million Units which is about 13% of the estimated demand of 7,19,000 Million Units in the terminal year of the 11th Plan.

3. RENEWABLE ENERGY

3.1 Overview

Over the last three decades, the renewable energy Programme in India has evolved in

three distinctive stages. In the first stage, from about the late '70s to the early '80s, the thrust of the national effort in this field was directed towards capacity building and R&D, largely in national laboratories and educational institutions.

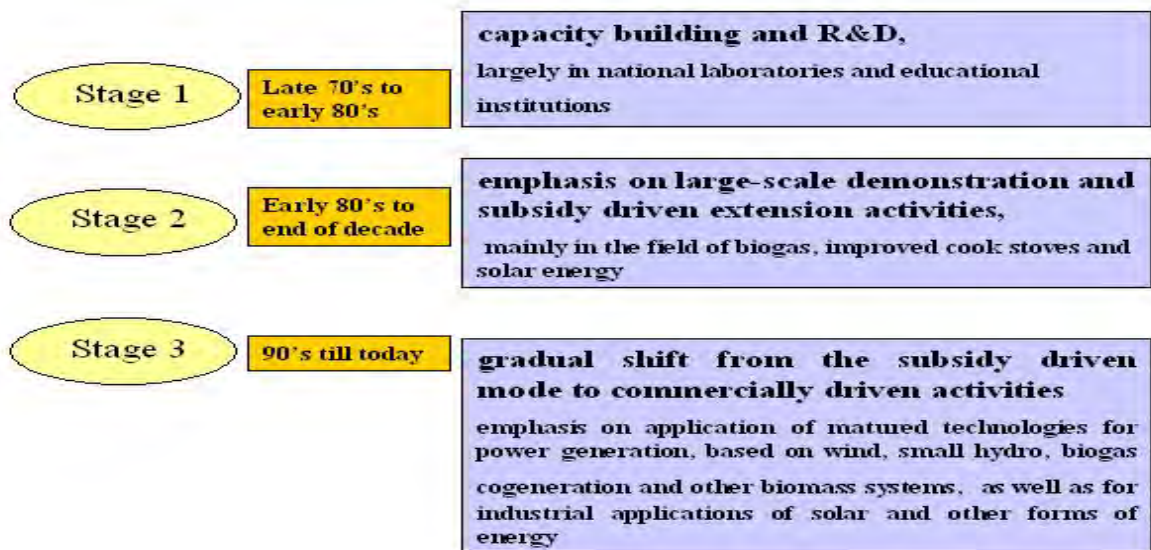


Figure 5: Stages of evolution of Renewable Energy Programme in India

Source: MNRE website

The second stage, from early '80s to the end of the decade, witnessed a major expansion with accent on large-scale demonstration and subsidy driven extension

activities mainly in the field of biogas, improved cook stoves and solar energy. These Programme created awareness and also generated field experience. The

extension Programme, particularly in the areas of biogas and improved woodstoves (chulhas), generated a vast network of institutions and non-government organizations, right down to the level of self-employed workers and organizations at the grassroots levels. In the third and current stage, extending from the beginning of the last decade, the emphasis has been more on application of matured

technologies for power generation, based on wind, small hydro, biogas cogeneration and other biomass systems, as well as for industrial applications of solar and other forms of energy. There is also a gradual shift from the subsidy driven mode to commercially driven activity in the area.

Renewable energy applications have brought about significant changes in the Indian energy scenario. Apart from electricity generation, the application of these technologies has benefited millions of rural folk by meeting their cooking and other energy requirements in an environmentally benign way. The social and economic benefits include reduction in drudgery among rural women and girls engaged in the collection of fuel wood from long distances and cooking in smoky kitchens, minimization of the risks of contracting lung and eye ailments, reduction in deforestation, employment generation at village level and ultimately the improvement in the standard of living and creation of opportunity for economic activities at village level.

There is a large potential for renewable energy in India, an estimated aggregate of over 100,000 MW. As against the estimated 84776 MWe renewable energy based grid connected power generation potential in the country, so far only about 9372.5 MW installed capacity has been achieved. The renewable energy based power generation capacity presently constitutes 7% of the total installed capacity in the country for power generation from all sources. The country is aiming to achieve up to 10% of additional installed capacity to be set up till

2012 to come from renewable energy sources.

3.2 Institutional Framework

3.2.1 Ministry of New and Renewable Energy (MNRE)

Ministry of New and Renewable Energy (MNRE) is the nodal Ministry of the Government of India for all matters relating to new and renewable energy. The Ministry of New and Renewable Energy (MNRE) is the administrative ministry for policies and Programme in this area. The ministry itself is organized into several divisions dealing with a set of technologies and applications.

The extension Programme of the ministry is largely implemented through State Nodal Agencies. All major States have set up energy agencies exclusively for non-conventional energy Programme. These agencies, in turn, mobilize participation of local institutions, non-governmental organizations (NGOs) and village-level organizations for implementation of Programme. Concurrently the R&D Programme is sponsored by the ministry, mainly in educational institutions, national laboratories and to some extent, in industries, in public and private sector.

Functions of the Ministry

- Policy making & planning.
- Development and deployment of Alternate Fuels (Hydrogen, bio & Synthetic) to replace liquid hydrocarbons:

- Development and deployment of Standalone new and renewable energy products and services to provide energy needs of cooking, lighting and motive power.
- Development and deployment of New and renewable energy products and services for urban, industrial and commercial applications, including energy recovery from urban and industrial wastes and effluents and
- MW scale grid interactive electricity system to contribute towards bridging the gap between fossil fuel based electricity generation supply and demand.
- Programme formulation and implementation in Non-conventional energy Sources.
- R&D, technology development and commercialization relating to new and renewable energy.
- Promotion of demonstration, pilot projects and extension programme.
- Encourage creation of industrial and manufacturing capacity.
- Providing fiscal and financial incentives.
- Intellectual property right (IPR) protection.
- International co-operation.
- Promotion of consultancy services.
- Promotion & co-ordination

Subjects allotted to the ministry

Under the Allocation of Business Rules, the following specific items have been assigned to the Ministry:

- Research and development of biogas and Programme relating to biogas units,
- Programme relating to improved chulhas and research and development thereof,
- Indian Renewable Energy Development Agency,
- All matters relating to small/mini/micro hydel projects of and below 25 MW capacity,
- Research and development of other non-conventional/renewable sources of energy, and Programme relating thereto,
- Tidal energy,
- Integrated Rural Energy Programme (IREP),
- Geothermal Energy

3.2.2 State Nodal agencies

For promotion and popularization of Renewable Energy and Energy Conservation in the states of India, state nodal agencies have been set up in different states. These state nodal agencies are working under the Ministry of New and Renewable Energy and they are promoting renewable and energy efficiency in their respective states.

The main objectives of these state nodal agencies are as follows:

- Sponsor, co-ordinate and promote research programmes or projects for prototype (demonstration projects) and pilot investigations in the area of new and renewable sources of energy.
- Provide technical and financial assistance for formulation of programmes, designs and projects meant for extension of renewable energy development in the state.
- Undertake, on its own or in collaboration with other agencies, programmes of research and development, applications and extension as related to various new and renewable energy sources.
- Undertake or sponsor, techno-economic/socio-economic feasibility studies/cost-benefit analysis.
- Formulate and implement a broad-based programme for conservation of energy at all stages, including extraction, conversion, distribution and consumption in all sectors of the economy.
- Study the environmental effects of all energy-related processes.
- Establish an Energy Resources Center that will collect and collate energy and inter-related information.
- Develop and support Documentation Services in area of energy in general and renewable energy in particular.
- Develop Communication and Education projects for wide spread dissemination of energy and environmental issues.

**A list of State Nodal Agencies can be found in annexure II.*

3.2.3 Indian Renewable Energy Development Agency (IREDA)

Indian Renewable Energy Development Agency Ltd. (IREDA) was established in 1987 as Non-Banking Financial Company under the administrative control of the Ministry of Non-Conventional Energy Sources (MNES) to provide term loans for renewable energy projects. Subsequently energy efficiency and energy conservation projects were added to its portfolio.

The main objectives of IREDA are:

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

- To strive for improvement in customer satisfaction Customer Friendliness, Team work, Productivity, Total Quality & Partnership for Sustainable Development

**A list of other Financial Institutions can be found in annexure III.*

3.3 Policies and Incentives

3.3.1 Policies

The current focus in the Renewable Energy sector is to reduce the costs and to accelerate commercialization of various technologies. The Ministry of Non-conventional Energy Sources (MNRE) initiated this shift in 1992, when it announced a new strategy and action plan to replace subsidy-driven Programme with commercialization. Financial incentives were trimmed and fiscal incentives, such as concessional tax and duties, along with soft loans, were introduced to encourage enterprise. Several renewable energy technologies (RETs) such as wind, solar thermal, solar photovoltaic, and small hydro are now promoted on a commercial scale. Today, India has the largest decentralized solar energy Programme, the second largest biogas and improved stove Programme, and the fifth largest wind power Programme in the world. A substantial manufacturing base has been created in a variety of RETs, placing India in a position not only to export technologies but also offer technical expertise to other countries.

The Prime Minister of India has announced a goal of 10% share for RE or 10,000 MW in the power generation capacity to be added during the period up to 2012.

3.3.2 National Level Policy

New and Renewable Energy Policy Statement 2005

A comprehensive Renewable Energy Policy for all round development of the Renewable sector, encompassing all the key aspects, has been formulated by MNRE. Through this Energy policy statement, it is proposed to send appropriate signals to industry, scientific and technical community, business and investors to indigenously develop new and renewable energy technologies, products & services, at par with international standards, specifications, and performance parameters for deployment in a manner so as to arrive at an optimal fuel-mix that most effectively meets the overall concerns of the country. Although, it is an integral component of a national energy policy the main objectives of this Energy policy statement are:

- Lesser dependence on energy imports through a diverse and sustainable fuel-mix in furtherance of the aim of National Energy Security,
- Sustaining accelerated deployment of renewable energy systems/devices through indigenous design, development and manufacture apart from creating new sources of energy in

furtherance of the aim of Energy Independence.

- Expand cost-effective energy supply for achieving per capita energy consumption level at par with global average through increasing share of new and renewable energy in the fuel mix in furtherance of the aim of Equity.
- Augment energy supply to remote and deficient areas to provide normative consumption levels to all sections of the population across the country through new and renewable energy sources in furtherance of the aim of Accessibility.
- Fuel switching through new and renewable energy system/device deployment in furtherance of the aim of conventional Energy Conservation.

The policy envisages 10% of additional grid power generation capacity to be from RE by 2012. The policy is awaiting approval by the government.

Foreign Investment Policy

- Foreign Investors can enter into a joint venture with an Indian partner for financial and/or technical collaboration and also for setting up of renewable energy based Power Generation Projects.
- Proposals for up to 100% foreign equity participation in a joint venture qualify for automatic approval.
- 100% foreign investment as equity is permissible with the approval of Foreign Investment Promotion Board (FIPB).

- Various Chambers of Commerce and Industry Associations in India can be approached for providing guidance to the Investors in finding appropriate partners.
- Foreign Investors can also set up a liaison office in India.
- Government of India is also encouraging foreign Investors to set up renewable energy based power generation projects on Built- Own and Operate basis.

Industrial Policy

- Ministry of New and Renewable Energy is promoting medium, small, mini and micro enterprises for manufacturing and servicing of various types of renewable energy systems and devices.
- Industrial clearance is not required for setting-up of renewable energy industry.
- No clearance is required from Central Electricity Authority for power generation projects upto Rs. 100 crores (Rs. 1000 million).
- A five-year Tax holiday allowed for renewable energy power generation projects.
- Soft loan is being made available through IREDA for renewable energy equipment manufacturing.
- Facilities for promotion of export-oriented units are available for renewable energy industry.
- Financial support is available to renewable energy industries for taking

up R&D projects in association with technology institutions.

- Power project import allowed.
- Private Sector Companies can set up enterprises to operate as licensee or generating companies.
- Customs duty concession is available for renewable energy parts/equipment, including for machinery required for renovation and modernization of power Plants.
- Excise duty on a number of capital goods and instruments in the renewable energy sector has been reduced /exempted.

3.3.3 Policies by State Governments

A number of states have announced policy packages including wheeling, banking, third party sale and buy back, which have been outlined in table 1.

Some states are providing concessions or exemption in state tax and octroi. These rates vary widely from state to state for different technologies and devices in periodicity. Table1 included policies by state governments:

3.4 Incentives for investing in Renewable Energy Technologies

3.4.1 Fiscal Incentives

The fiscal incentives include direct taxes, exemption or reduction in excise duty, exemption from central sales tax, and

customs duty concessions on the import of material, components and equipment used in RE projects.

The MNRE has issued guidelines to all state governments for creation of an attractive environment for evacuation and purchase, wheeling and banking of electrical power from RE sources. The Ministry has urged that the states should announce general policies for purchase of electrical power from all sources.

3.4.2 Financial Incentives

The MNRE provides financial incentives for various renewable energy programmes. These include interest and capital subsidies. In addition, soft loans are provided through IREDA and also through some of the nationalized banks and other financial institutions for identified technology systems.

Table 1: Policies by state governments

Non conventional energy power policies in states (as on 1.7.2003)							
A-allowed NA-Not allowed							
SI No.	State	Programme	Wheeling 2%	Banking 12 months	TP Sale	Buy-back Rs.2.25 per kWh	Annual Escalation 5%
1	Andhra Pradesh	Wind	A	A	NA	A	A 1994-95
		Cogen/BM	2% for old projects 28.4% + Re 0.5/unit for new projects	2%	NA	A	A 1994-95
		SHP	A	2%, 8-12 M	A not< HTT	A	A 1997-98
		WTE	A	2%, 8-12 M	A not< HTT	A	A 1997-98
2	Chattisgarh	Wind	A	A	A	A	NA
		Biomass	NA	NA	A	A	NA
		WTE	A	A	A	A	NA
3	Gujarat	Wind	4%	6 months	NA	Rs.2.60	5 paise 2002-03
		Biomass	4%	A	A	A	1994-95
		WTE	4%	A	A	A	1994-95
4	Haryana	Wind	A	A	A	A	1994-95
		Cogen/BM	A	A	A	A	1994-95
		SHP	A	A	A	A	1994-95
		WTE	A	A	A	A	1994-95
5	Himachal Pradesh	SHP	A	A with additional charge	NA	Rs. 2.50	NA
6	Karnataka	Wind	6-12%	A 2% on monthly basis	A	Rs.3.10 for new projects	2% on base tariff
		BM	6-12%	A on monthly basis	NA	Rs.2.80	2% on base tariff
		SHP	2-5%	A	A	Rs.2.60	1994-95
7	Kerala	Wind	5%	June-Feb	NA	Rs.2.80	2000-01 for five years
		SHP	A	NA	NA	Rs.2.50	NA

Non conventional energy power policies in states (as on 1.7.2003)

		BM	5%	4 months	NA	Rs.2.80	2000-01 for five years
		WTE	5%	June-Feb	NA	Rs.2.80	2000-01 for five years
8	M.P.	Wind	A	NA	A	A	NA
		Cogen	A	NA	A	A	NA
		SHP	A	NA	A	A	NA
		WTE	A	NA	A	A	NA
9	Maharastra	Wind	A	A	A	A	1994-95
		Cogen	7%	A	A	Rs.3.05 per kWh	@ 2% from the year of commissioning
		SHP	A	A	A	A	1999-2000
		WTE	2-6%	A	A	A	1994-95
10	Orissa	SHP	2-3%	A	A	At mutually agreed rate	NA
11	Punjab	Cogen/BM	A	A	A	Rs.3.01	@3% 2001-02
		SHP	A	A	A	Rs.2.73	1998-99
		WTE	A	A	A	Rs.3.01	3% from 2000-01
12	Rajasthan	SHP	A 10%	A (Calender year basis)	A	Rs. 3.32 in 2003-04	2% from 2003-4 Rs. 3.92 fixed from 2013-14 for 10 years
		Wind	A 10%	A (Calender year basis)	A	Rs. 3.32 in 2003-04	
		Cogen/BM	A	A	A	A	
		WTE	A	A	A	Rs.3.03	2000-01
13	T.N.	Wind	5%	5%	NA	Rs. 2.70	No escalation
		Cogen/BM	2-10%	A 2%	NA	Rs.2.73	2000-01
		SHP	5%	NA	NA	Mutually agreed rate	1995-96
		WTE	NA	A	NA	Rs. 2.70	2000-01
14	Uttranchal	SHP	A	A	A	Mutually agreed rate	
15	U.P.	Wind	12%	A	0.50%	A	1995-96
		Cogen	NA	A 24 months	NA	A	1999-2000
		SHP	A	A	A	A	1995-96
		WTE	A	A	A	A	1995-96
16	W.B.	Wind	A	A 6 months	NA	NA	NA
		SHP	A	A 6 months	NA	NA	NA

(SHP: Small Hydro Power, Wind: wind Power, WTE: Waste to Energy, Cogen: Bagasse Cogeneration)

Source: Renewable Energy in India – Business opportunities: MNRE Feb 2004

Table 2: Status on Govt. Orders issued by Stats Govt. on mandatory use of water heaters/solar

Sl no	State	City	GO issued on mandatory use of SWHS	Byelaws amended by MCs	Notifications issued on rebate in property tax	Notifications issued on rebate in electricity tariff	GO issued on energy efficient solar buildings	GO issued on promotion of solar energy devices (SPV street lights & hoardings)
1	AP	-	3 rd August, 2004	-	-	-	-	3 rd August, 2004
2	Maharashtra	Thane	31 st December, 2002	Date not known	10% rebate announced for existing houses	-	-	1 st September, 2004
		Nagpur		28 th April, 2005	-	-	-	
3	Madhya Pradesh	-	Copy of order not available	-	-	-	-	-
4	Punjab	-	Copy of order not available	-	-	-	-	-
5	Tamilnadu	-	September, 2002	-	-	-	-	-
6	Rajasthan	-	Copy of order not available	-	-	15 paise per unit	-	-
7	Haryana	-	29 th July	-	-	-	29 th July	-
8	Uttar Pradesh	-	1 st August, 2004	-	-	-	-	-
9	Uttaranchal	-	August, 2002	-	-	Flat rebate of Rs.50 in the monthly bills	-	-
10	Chandigarh	-	12 th December, 2001	-	-	-	-	-
11	Dadar & Nagar Haveli	-	Copy of order not available	-	-	-	-	-
12	Karnataka	Bangalore	Status not known	4 th February, 2003	-	25 paise per unit	-	-
13	Gujarat	Rajkot	Status not known	20 th February, 2004	-	-	-	-
14	West Bengal	-	Status not known	-	-	40 paise per unit subject to a maximum of Rs. 80 per month	-	-
15	Himachal Pradesh	-	Copy of order not available	-	-	-	Copy of order not available	-

Source: MNRE

3.5 Incentives for investing in Renewable Energy Technologies

The Ministry of Non-Conventional Energy Sources provides financial incentives, such as interest subsidy and capital subsidy. In addition, soft loans are provided through the Indian Renewable Energy Development Agency (IREDA), a public sector company of the Ministry and also through some of the nationalized Banks and other financial Institutions for identified technologies/systems.

3.5.1 Fiscal Incentives

The fiscal incentives include direct taxes-100% depreciation in the first year of the installation of the project, exemption or reduction in excise duty, exemption from central sales tax, and customs duty concessions on the import of material, components and equipment used in RE projects.

MNRE has issued guidelines to all state governments for creation of an attractive environment for evacuation and purchase, wheeling and banking of electrical power from RE sources. The Ministry has urged that the states should announce general policies for purchase of electrical power from all sources.

3.5.2 Financial Incentives

The Ministry of New and Renewable Energy provides financial incentives for various renewable energy programmes. These include interest and capital subsidies. In addition, soft loans are provided through IREDA and also through some of the nationalized banks and other financial institutions for identified technology systems.

3.5.3 Other Incentives

- Sales Tax benefits will be available to the producer, who owns the project (Resolution of the Govt. Of Gujarat dated 27th January, 1993 is enclosed for guidance)
- The producer will be allowed to use the water for power generation. Royalty on the water used for small hydro projects will be charged at a rate not exceeding 10% of the prevailing electricity tariff for HT consumers.
- Power generation from non-conventional energy sources will be treated like any other industry, and incentives normally available to new industrial units can be availed.
- Concessions given to industrial units in backward areas will be provided, such as exemption from taxes and duties, capital subsidies, etc.
- Infrastructure facilities such as approach roads, water supply, crane, power during construction period, etc. will be provided, on the lines of industrial estates.

Summary

Renewable energy has brought significant changes in Indian energy scenario. There is a large potential for renewable energy in India, an estimated aggregate of over 100,000 MW. As against the estimated 80000 MW renewable energy based grid connected power generation potential in the country. The renewable energy based power generation capacity presently constitutes 5% of the total installed capacity in the country for power generation from all sources. The country is aiming to achieve up to 10% of additional installed capacity to be set up till 2012 to come from renewable energy sources.

Ministry of Non-Conventional Energy Sources (MNES) is the nodal Ministry of the Government of India for all matters relating to new and renewable energy. This is the administrative ministry for policies and Programme in this area. The ministry itself is organized into several divisions dealing with a set of technologies and applications.

For the development and deployment of new and renewable energy in India many Banking and Non-Banking Financial institute come in this sector. Indian Renewable Energy Development Agency Ltd. (IREDA) was established in 1987 as Non-Banking Financial Company under the administrative control of the Ministry of Non-Conventional Energy Sources (MNES) to provide term loans for renewable energy projects.

A comprehensive Renewable Energy Policy for all round development of the Renewable sector, encompassing all the key aspects, has been formulated by MNES. Through this Energy policy statement, it is proposed to send appropriate signals to industry, scientific and technical community, business and investors to indigenously develop new and renewable energy technologies, products & services, at par with international standards, specifications, and performance parameters for deployment in a manner so as to arrive at an optimal fuel-mix that most effectively meets the overall concerns of the country. Besides the National level policy, many states also have announced policy packages including wheeling, banking, third party sale and buy back.

4.1 Overview

Today, India has one of the world's largest programmes for renewable energy. The activities cover all major renewable energy sources of interest to India, such as biogas, biomass, solar energy, wind energy, small hydropower and other emerging technologies. In each of these areas, the Ministry of Non-Conventional Energy Sources has been supporting R&D for technology and manpower development in renewable energy. Present emphasis is on reduction in cost and increase in efficiency. For sustained development of this sector, efforts are being made so that the market and the consumer drive renewable energy to a large extent.

The Ministry is involved in the implementation of the programme for development, demonstration and utilization of various renewable energy based technologies, such as solar thermal, solar photovoltaic, wind power generation and water pumping, biomass combustion/co-generation, small, mini, & micro-hydro power, solar power, utilization of biomass - gasifiers, briquetting, biogas, improved chulha (cook-stove), geothermal for heat applications and power generation/energy recovery from urban, municipal and industrial wastes, and tidal power generation.

The RE technologies have been categorized as following:

- Power generation technologies
- Rural energy technologies
- Solar energy technologies
- Energy from waste
- New technologies

4.2 Power Generation Technologies

In India, there is huge potential for power generation from renewable energy sources, such as, wind, small hydro, biomass and solar energy. Special emphasis has, therefore, been given to the generation of grid-quality power from renewable sources of energy. The Renewable Energy Power sector includes:

- Wind energy
- Small hydro power
- Biomass energy
- Biomass Gasifier
- Solar energy

Figure 6 shows that at present in India, wind power contributes to about 68% of the total power generated by RE technologies. This is followed by small hydropower technology and biomass power technology.

Table 3: Power from Renewable- cumulative achievements as on 31/01/2007

Source/System	Cumulative achievements (MW)
Wind Power	6315
Small hydro Power	1905
Cogeneration Bagasse	602
Waste to Energy	40.95
Bio Power (Agro residues)	510
Total	9372.95

Source: www.mnes.nic.in

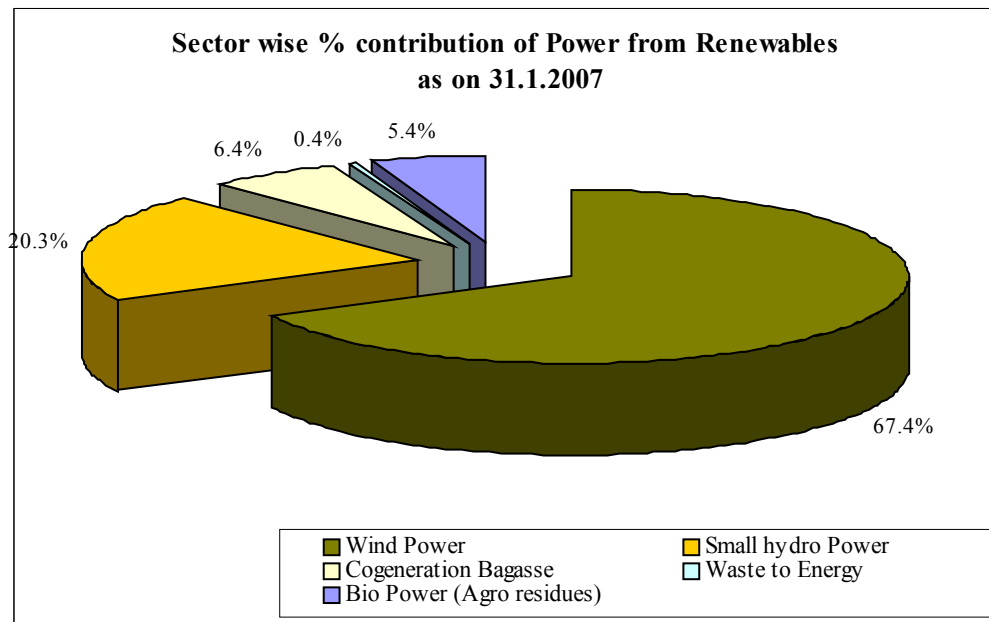


Figure 6: Cumulative achievements of RE power generation technologies in India

Source: www.mnes.nic.in

4.2.1 Wind energy

Overview

- Considerable progress has been made in harnessing the large wind power potential available in the country.
- Supporting this effort is the world's largest wind resource assessment programme.
- New initiatives have been taken in re-assessment and expansion of the wind resource base.
- Center for Wind Energy Technology has been established.
- Large private sector corporations, public sector units and power utilities are being motivated to set up wind power projects.

Potential

India's wind power potential has been assessed at around 45,000 MW assuming 1% land availability for wind farms requiring @12 ha/MW in sites having wind power density in excess of 200W/sq.m. at 50 m hub-height. The potential for grid-interactive wind power would be less (around 15,000 MW) if sites having wind power density in excess of 300 W/ sq.m. at

50 m hub-height are considered in keeping with international practice.

Installed

India is one of the countries with highest total installed wind power capacity. Wind power installed up to 31.12.2006 was 6270.40 MW. During 2006-07 888 MW have been installed up to 31.12.2006 & as per trend it is likely that a total of 1700 MW would be added during the year. India has overtaken Denmark as the fourth largest wind market in the world. Capacity installed in 2005 is 1430 MW.

Figure 7 shows the trend in the growth of installed wind power in India. From 1992 to 1995, there was a steady growth, which started declining from 1995 until the end of the 90s. From year 2000 to date, installation of wind power has seen a fast-paced growth. Especially in the year 2004 and 2005, there has been a huge increase in the installed capacity of wind power in India. A mix of promotional measures has spurred on wind power development in the country.

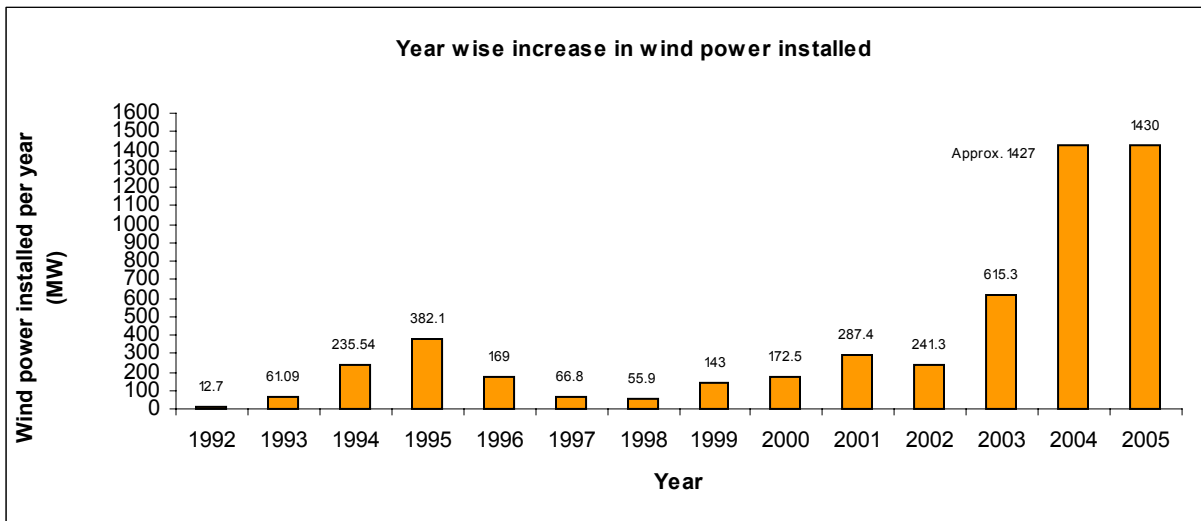


Figure 7: Trend of increase in installed wind power in India

Data Source: MNRE

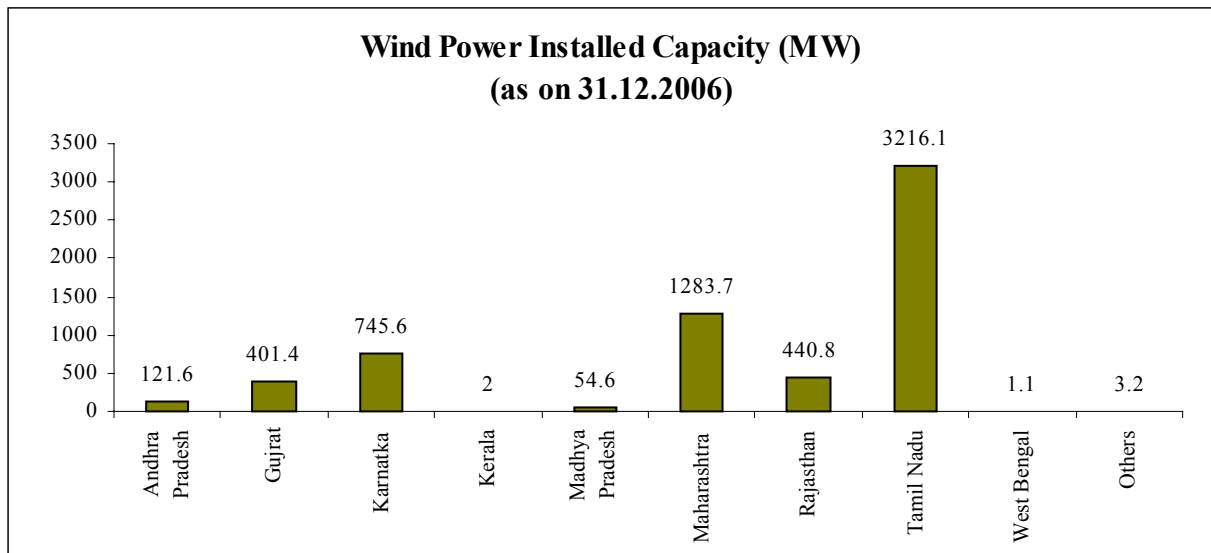


Figure 8: State wise wind power installed Capacity

Source: MNRE Annual Report (2006-2007)

4.2.2 Small wind energy and hybrid systems

Small wind energy systems, namely water pumping windmills, aero generators and wind-solar hybrid systems can also be used for harnessing wind power potential, in addition to the large capacity wind turbines. These systems have been found to be very useful for meeting water pumping and small power requirements in decentralized mode in rural and remote windy areas of the country, which are un-electrified or have intermittent electric supply. The Ministry has been implementing a Programme on “Small Wind Energy & Hybrid Systems” for promoting these systems in the country through the State nodal agencies.

Incentives

The Government has introduced a package of incentives, which includes fiscal concessions such as 80% accelerated depreciation, tax holiday for power generation projects, concessional customs and excise duty, liberalized foreign investment procedures, etc. SERCs of Andhra Pradesh, Madhya Pradesh, Karnataka and Maharashtra have so far announced preferential tariffs for wind power. Maharashtra Electricity Regulatory Commission (MERC), Andhra Pradesh Electricity Regulatory Commission (APEREC), Karnataka Electricity Regulatory Commission (KERC), Madhya Pradesh Electricity Regulatory Commission (MPERC) and Orissa Electricity Regulatory Commission (OERC) have directed that each distribution licensee shall purchase a

minimum quantum of electricity annually from renewable sources expressed as a percentage of its total consumption. Rajasthan Govt. has recently modified their policy for Non-conventional Energy projects including for wind energy.

Financial Assistance for Demonstration Projects

Land Based Demonstration Projects: 60% of the cost of wind turbine equipment, maintenance spares, and erection commissioning, subject to eligibility and ceiling of Rs. 3.5 crore/MW for determination of CFA. However the ceiling in respect of all the Special Category States and Islands (excluding those that are Union Territories) would be Rs. 4 crore / MW.

Wind Hybrid Demonstration Projects: For wind hybrid projects, cost of wind turbine and control equipment, including spares and erection/commissioning subject to a ceiling of Rs.70 lakhs per 100 KW, would be provided. In addition, up to 90% of the cost of laying new, or upgrading/extension of existing lines for decentralized electrification in remote and inaccessible area such as Islands, remote and difficult areas would be provided. The State Governments would meet the cost of DG set(s) or its up-gradation and other local works.

4.2.3 Small hydro power

Overview

Ministry of Non-Conventional Energy Sources is assigned the business of small hydro power (SHP) up to 25 MW station capacities. The Ministry's aim is that out of the total grid interactive power generation capacity that is being installed, 2% should come from small hydro. The SHP Programme is essentially private investment driven. Electricity generation from small hydro is becoming increasingly competitive with preferential tariffs and some other concessions. The challenge is to improve reliability, quality and costs. There is need to lower the cost of equipment, increase its reliability and set up projects in areas that give the maximum advantage in terms of capacity utilization.

Potential

Of the estimated potential of 15,000 MWe of small hydro in the country, 4,400 sites with an aggregate capacity of 10,500 MW have been identified.

Installed

The cumulative installed capacity of grid interactive small hydropower projects up to 31.3.2006 is 1826 MW. During 2006-07, 79 MW have been installed up to 31.12.2006 and as per trends it is likely that a total of 120 MW would be added during the year. With this, the capacity addition during the 10th plan is likely to be 510 MW. Apart from this, projects aggregating 394 MW are under implementation. State wise installed capacity and that under implementation as on 31.12.2006 is given in Figure 9.

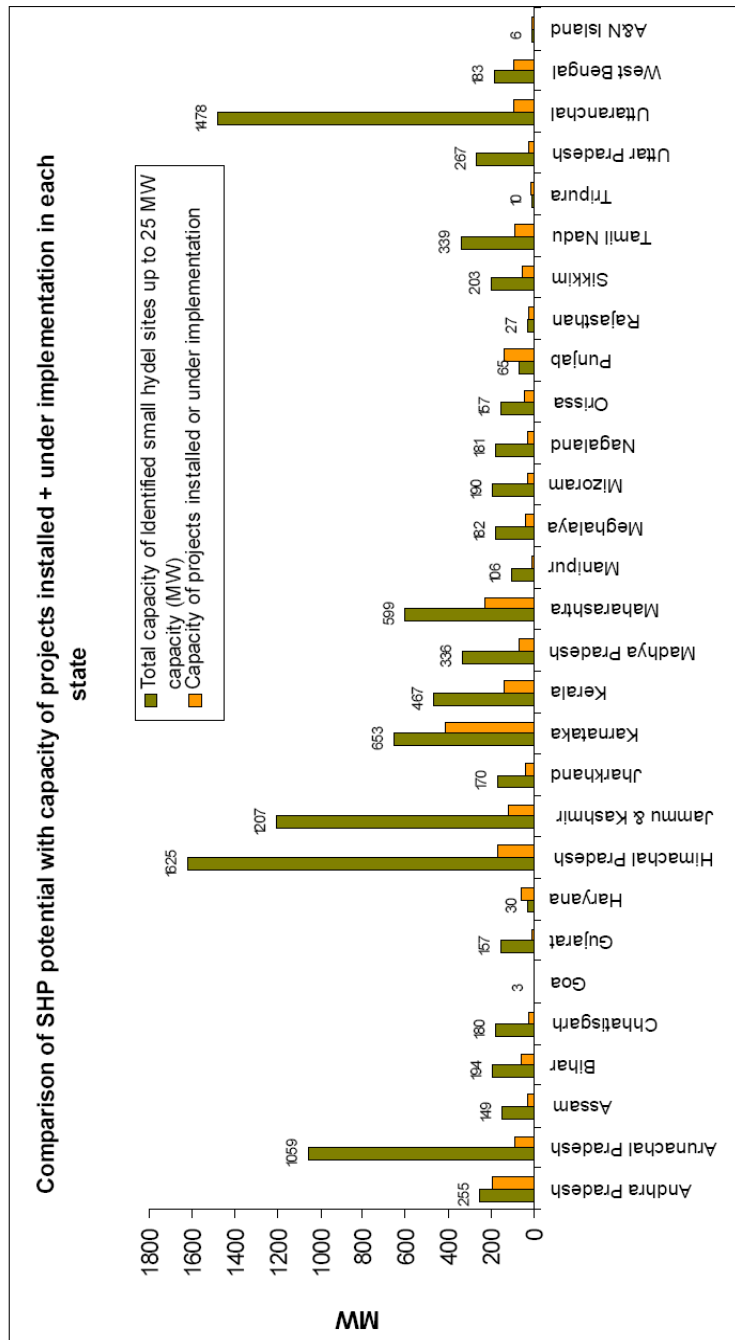


Figure 9: Comparison of identified SHP potential with capacity of projects installed

Source: MNRE Annual Report 2005-06

Incentives

A series of steps have been taken to promote development of SHP in a planned manner and improve reliability & quality of the projects. By giving various physical and financial incentives, investments have been attracted in commercial SHP projects apart from subsidizing State Governments to set up small hydro systems. Concurrently, efforts are being made to renovate and modernize old SHP projects and complete languishing projects.

The Ministry is providing financial support to the States for identification of new potential sites and preparation of a perspective plan for the State for development of small hydro. This activity is important for making a long-term strategy for systematic development of SHP projects. The Ministry provides a financial support up to Rs.30 lakh per State for the overall estimation of its SHP potential, identification of new potential SHP sites and for the preparation of a Perspective Plan.

The Ministry continued its various schemes to support SHP development both in the public as well as private sector. Apart from support to new SHP projects, Central Financial Assistance is also provided for the renovation and modernization of existing SHP projects and languishing projects in the Government sector. The Ministry also provides financial support for the development and up gradation of watermills for mechanical as well as electricity generation. A special incentive package has been developed for the

promotion of the SHP programme in the North-Eastern States, Sikkim, J&K, Himachal Pradesh and Uttaranchal. The schemes under SHP programme were reviewed to rationalize the same and align it with other renewable energy based grid power programme of the Ministry. It is proposed that parameters such as cost of project, cost of electricity generation, capacity utilization factor of a project should be the guiding factors to grant CFA for grid interactive power projects. Emphasis is being given on quality of the project by adopting technical standards and reducing cost per MW of the projects. For private sector, subsidy is released to the Financial Institution (FI), after successful commissioning and commencement of commercial generation from the project. The subsidy is given to the FI for the purpose of offsetting it against the term loan provided to the developer.

Most capacity addition is now being achieved through private investment. State Nodal Agencies provide assistance for obtaining necessary clearances, in allotment of land and potential sites. 16 States have policies in place for private sector participation. SERCs are now determining preferential tariffs for renewable electricity. The 16 States have offered sites with an aggregate potential of over 2500 MW to the private sector. So far, private sector SHP projects with an aggregate capacity of about 400 MW have been set up mainly in Andhra Pradesh, Karnataka, Himachal Pradesh, Punjab, Uttaranchal and Maharashtra. A number of FIs are extending term loans to the SHP projects. The Ministry is supporting 133

SHP Projects in the Government sector aggregating to 260 MW capacities in 22 States/ UTs. So far, a total of 64 projects aggregating to a capacity of 72 MW have been commissioned and the other projects are at various stages of execution.

Renovation & Modernization of old SHP projects and support for languishing projects A scheme to provide financial support for Renovation/ Modernisation of Small Hydro Power Stations is also under operation. The main aim of the scheme is to extend the useful life of projects. Ministry has so far supported 14 existing SHP

projects for their renovation and modernization in the States of Assam, Himachal Pradesh, J&K, Nagaland, Sikkim, Uttaranchal and West Bengal. In addition, an “in principal” approval has been accorded for undertaking R&M works on 4 SHP projects in Jammu & Kashmir. In order to provide financial support for completion of languishing SHP government projects taken up in the Government sector, a scheme was introduced. Haftal, Sanjak, Marpachoo, Igo-Marcellong and Bhaderwah projects in J&K have been supported under this scheme.



Figure 10: Aleo Small Hydro (3MW) Power Project in Himachal Pradesh
Source: MNRE website

4.2.4 Biomass and cogeneration

Overview

- Currently, biomass contributes about 14 percent of the total energy supply worldwide and 38 per cent of this
- energy is consumed in developing countries, predominantly in the rural and traditional sectors of the economy.
- The various applications of biomass energy include:
- Thermal or heat.

- Mechanical water pumping for irrigation.
- Power generation (stand-alone or grid-connected) including village electrification and industrial applications.
- India is the largest producer of cane sugar and the Ministry is implementing the world's largest co-generation Programme in the sugar mills.
- Biomass power generation from surplus agricultural residues is also being actively promoted.

Potential

The current availability of biomass in India is estimated at about 120-150 million MT/annum covering agricultural and forestry residues corresponding to a potential of 16,000 MW. This apart, 5000 MW can be installed through Bagasse cogeneration. Plantations on wastelands also provide significant opportunity - about 62,000 MW for grid-interactive power and

another 15,000 MW for off-grid applications.

Installed

As a result of support from various stakeholders, a momentum has been generated for installation of biomass power/co-generation projects in various potential States. The cumulative installed capacity of grid interactive & Bagasse cogeneration power projects up to 31.12.2006 was 912 MW. During 2006-07, 190 MW has been installed up to 31.12.2006 as per state wise break up given in the table below.

Table 4: State -wise Grid interactive Biomass Power Installed Capacity

State	Cumulative Installed Capacity (MW)
Andhra Pradesh	301.25
Chhattisgarh	88.50
Gujarat	0.50
Haryana	6.00
Karnataka	254.28
Maharashtra	62.00
Punjab	28.00
Rajasthan	23.30
Tamil Nadu	215.50
Uttar Pradesh	121.50

Source: MNRE Annual report (2006-07)

As per trends it is likely that a total of 220 MW would add during the year. With this,

the capacity addition during the 10th plan would be 750 MW.

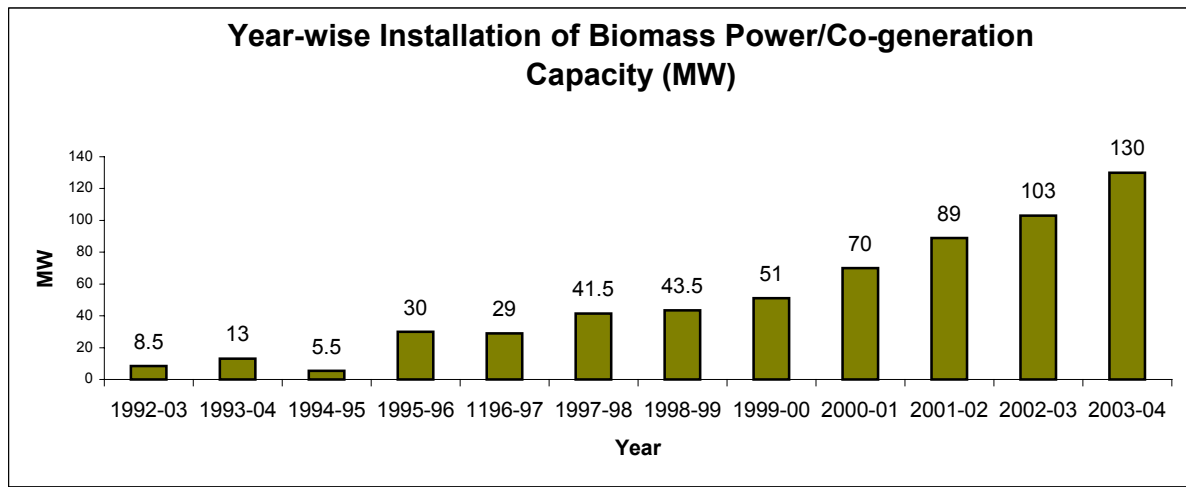


Figure 11: Growth in installation of Biomass Power/Co generation Capacity

Source: MNRE Annual report 2003-04

Incentives

Fiscal incentives such as accelerated depreciation, concessional import duty, tax holiday for 10 years etc. are being continued till the same are considered necessary. Biomass power projects can now avail the benefit of concessional custom duty and excise duty exemption on the provision of certification by this Ministry, which was introduced in September 2005. Electricity Regulatory Commissions of Andhra Pradesh, Karnataka, Uttar Pradesh and Maharashtra have announced preferential tariffs for biomass power.

The Programme is being implemented with the active involvement of the State Nodal Agencies, State Governments, State Electricity Boards, and Financial

Institutions. The nodal agencies are responsible for development of proposals from their respective States, monitoring of the progress of implementation and for providing post-installation feedback to MNES. A major achievement of the Ministry's promotional activities has been the confidence generated among the financial institutions in this sector. A number of major financial institutions such as IREDA, IDBI, IDFC, PFC and nationalized banks are being involved in project implementation.

4.2.5 Biomass Gasifiers

Overview

Biomass gasification is the thermo-chemical conversion of solid materials into a gaseous fuel known as producer gas. The gas has low calorific value (1000-1200 kcal/Nm³), but it can be burnt efficiently with a good degree of control without emission of smoke. It can be used for replacing diesel oil in engines for mechanical and electrical applications or for replacing other forms of conventional energy in heating applications. The gasification route of conversion of biomass to useful energy has many advantages as compared to the other routes. These include easy adaptability to conventional internal combustion engines, higher conversion efficiencies in small capacity range, low per unit cost, etc. The Ministry has been supporting development of biomass gasification technology for almost two decades and as a result of these efforts, India today ranks among the technology leaders in the world. Biomass gasification systems from 5 kW to 1000 kW unit capacity suitable for using a variety of biomass have been developed indigenously, primarily as a result of the developmental support provided by the Ministry over several years.

In the area of small-scale biomass gasification, significant technology development work has made India a world leader.

- Biomass Gasifiers capable of producing power from a few KW up to 1 MW

capacity have been successfully developed indigenously.

- Indigenously developed small biomass gasifiers have successfully undergone stringent testing abroad.
- Biomass Gasifiers are now being exported not only to developing countries of Asia and Latin America, but also to Europe and USA.
- A large number of installations for providing power to small-scale industries and for electrification of a village or group of villages have been undertaken.
- The Biomass Gasifier Programme has been recasted to bring about better quality and cost effectiveness.
- The programme on biomass briquetting and biomass production is being reviewed and a new programme on power production linked to energy plantations on wastelands is proposed to be developed.

Potential

Potential from available Biomass is 16000 MW.

Installed

Biomass gasifier systems for electrical applications aggregating 1.66 MW have been commissioned in Tamil Nadu, Karnataka, West Bengal, Jharkhand, Arunachal Pradesh, Nagaland and Manipur as on 31.12.2005. Four biomass gasifier each of 100 kWe capacities has been set up in villages Tora, Ukhrul Distt. and Songatal, Chorachandpur Distt. in Manipur for meeting the electricity needs.

Financial incentives

The Ministry provides subsidy of Rs.15 lakh per 100 kWe on prorata basis provided for 100% producer gas engine with biomass gasifier systems for meeting electricity needs in electrified villages as well as for grid connected biomass gasifier power. The balance cost is to be met by the user agency/ entrepreneur. 20% higher CFA is provided for such project in all special

category states and Islands. CFA is also provided for preparation of Detailed Project Reports (DPRs), organization of seminars, business meets, workshops, training programme, etc. CFA of Rs.1.50 lakh per 100 kWe is provided for biomass gasifier coupled with dual fuel engine for electrical applications and water pumping. For details on the financial incentives refer annexure IV.



Figure 12: A 7.5 MW Biomass based power project under implementation in Pudukkottai District of Tamil Nadu

Source: www.mnes.nic.in

4.2.6 Solar Energy: Solar thermal power

Overview

- A 140 MW Integrated Solar Combined Cycle (ISCC) Power Project is being given final shape for setting up at Mathania near Jodhpur in Rajasthan.
- Techno-economic clearance of CEA has been obtained and appraisal by World Bank/KfW who would provide US \$ 49 million grant assistance and US \$ 150 million loan assistance respectively, has been completed.
- Government of India has accorded approval of the project as a centrally assisted project to be implemented by Rajasthan Renewable Energy Corporation Limited (RRECL), Jaipur.
- An Agreement has been signed on 29th October 2001 between KfW, Germany and Department of Economic Affairs, Ministry of Finance for composite loan amount of DM 250 million for the project.
- The Mathania ISCC Project will be the first of its kind, and among the largest such projects in the world.

Potential

Solar Thermal Power Generation - 35 MW per Sq. Km

4.2.7 Solar Energy: Solar Photovoltaic

Overview

There are about **300 clear sunny days** in a year in most parts of India. This is equal to over **5,000 trillion kWh/year**, which is far more than the total energy consumption of the country in a year Potential.

- The daily average solar energy incident over India varies from **4-7 kWh/m²**, depending upon location
- SPV systems have found applications in households, agriculture, telecommunications, defence, and railways among others. In the last two decades, the cost of PV has gone down significantly, increasing affordability for dispersed rural applications
- MNRE is implementing two major schemes for the deployment of stand-alone PV systems in the country:

Lighting systems, stand-alone power plants and other specialised systems, implemented mainly through SNAs/departments/corporations, 'Aditya' solar shops operated by Manufacturers' Associations and NGOs, Water-pumping systems for agriculture and related uses, implemented through IREDA and SNAs

Potential

Solar Photovoltaic Power Generation - 20 MW per Sq. Km



Figure 13: SPV water pumping system in Punjab

Source: MNRE website

Installed

Under the MNRE, SPV Programme Grid Interactive Power Plants in units of 25 kWp up to a maximum capacity of 100 kWp are being set up. So far, 34 such power plants aggregating to 2.8 MWp total capacity have been commissioned in different parts of the country, and 6 more projects of aggregate capacity of 400 kWp are under installation. (MNRE Annual report 2004-05)

Financing Mechanism

Under SPV Programme, CFA in the form of grants-in-aid and subsidies is being provided to beneficiaries (SNAs and SEBs) for resource assessment, feasibility studies, research and development and to design, install and operate Solar Photovoltaic Power Plants in grid interactive mode.

Central Financial Assistance of 2/3rds of the project cost, subject to a maximum of Rs.1.2 crore for a 100 kWp system is being provided. For Special Category States i.e. North Eastern States including Sikkim, Jammu & Kashmir, Himachal Pradesh, Uttaranchal and unelectrified island regions the CFA is up to 90% of the project cost with maximum of Rs.1.62 crore per 100 kWp. (MNRE Annual report 2004-05).

4.3 Rural Energy Technologies

4.3.1 Biogas

Overview

Biogas is an alternate source of fuel derived mainly from organic wastes available abundantly in various forms. The technology, based primarily on cow dung, has been promoted in the country for more than three decades. Standardized models of biogas plants suitable both for individual households as well as for institutions or communities are available. Over the years, a large pool of skilled manpower has been developed for taking up construction and maintenance of the plants.

The Ministry of New and Renewable Energy Sources has been promoting family type biogas plants since 1981-82. The models being promoted under the programme include:

- Floating gasholder type, popularly called “Indian or KVIC (Khadi and Village Industries Commission) Model”.
- Fixed dome type, commonly known as “Deenbandhu Model”.
- Bag type portable digester made of rubberised nylon fabric.

In addition, low cost fixed dome models made of alternate construction materials, like the pre-fabricated ferro-cement or reinforced cement and in-situ built ferro-cement, are also being promoted.

Potential and installed

A cumulative total of over 37.75 lakh plants have been set up in the country against a theoretical potential of about 120 lakh plants. State-wise potential and cumulative achievement are given in figure 19. The target for 2005-06 has been enhanced from 25,000 plants to 66,000 plants at Revised Estimate 2005-06 stage. A total of 33,700 plants have been set up until December 2005.

Financial incentives

The Ministry provides Central Financial Assistance (CFA) for construction and maintenance of biogas plants, training & awareness creation, technical centers, and service charges or salary support to implementing agencies. During 2004-05, the financial assistance for construction of biogas plants has been enhanced for a few categories of beneficiaries mainly to accommodate the increase in cost of construction. The central subsidy offered to different categories of beneficiaries/areas for construction of biogas plants during the year 2004-05 has been given in Annexure IV.

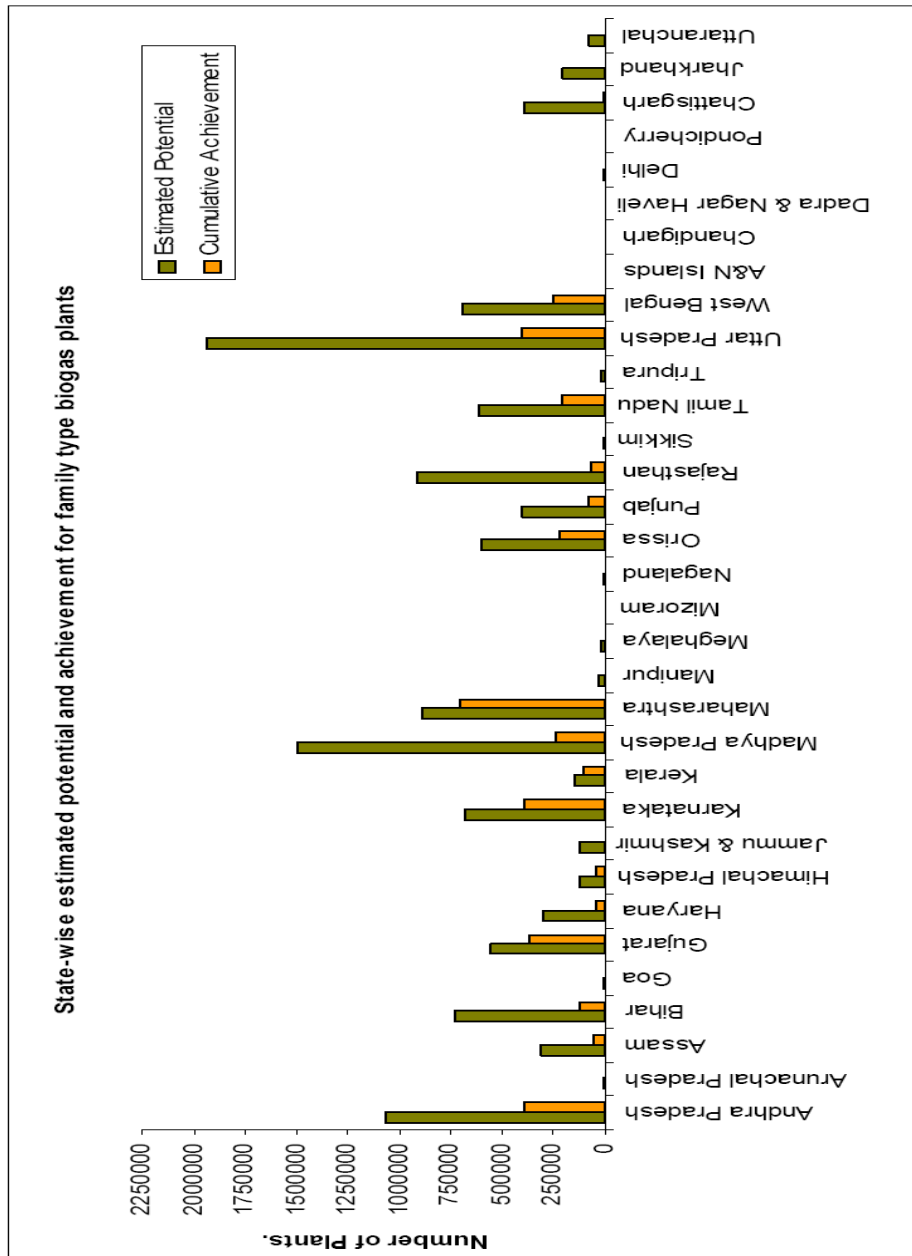


Figure 14: State-wise estimated potential and achievement for family type biogas plants

Source: MNRE Annual report (2005-06)

4.4 Solar Energy Technologies

India has a high level of solar radiation, and receives solar energy equivalent to more than 5,000 trillion kWh per year, which is far more than its total annual consumption. The daily global radiation is around 5kWh per sq.m per day with the sunshine ranging between 2300 and 3200 hours per year. Though the energy density is low and the availability is not continuous, it has now become possible to harness this abundantly available energy very reliably for many purposes, by converting it to usable heat or through direct generation of electricity.

4.4.1 Solar Thermal

Solar energy can be utilized for various applications such as cooking, water heating, drying, desalination and space heating.

Solar water heating systems

Solar water heaters are generally viable in areas where hot water requirement is there for at least six months in a year. A domestic solar water heater of 100 liters per day capacity has the potential to save electricity upto 1500 kWh/ annum and pay back its cost in 3-4 years through conservation of electricity. Solar water heating systems (SWHS) have been effectively commercialized in India. Their technical feasibility and economic viability has been established. It is now recognized that reliable products exist that can save

substantial amounts of electricity or other conventional fuels, can be used to support peak load reduction and reduces the emission of carbon dioxide, a major GHG. The initial skepticism about the utility, effectiveness and maintenance of SWHS has given way to product acceptance by a wide cross-section of users. Depending on the site, type of use and the structure of electricity tariff or fuel prices, the payback period of the solar thermal energy devices vary from 2 to 6 years.

Domestic and commercial applications of SWH:

Domestic solar water heating systems can substitute or supplement electrical geysers in bathrooms and kitchens for heating water. The solar water heating system is modular in nature and the capacity of the system can be designed to accommodate the consumer's requirement for hot water. Generally, a 4 member family consumes on an average 100 litres of hot water a day at 60 degree Celsius (°C). Hot water of 100 litre capacity at 60°C can approximately be delivered by a single collector system of 2 sq.m area. The solar water heating systems are generally provided with auxiliary backup in the insulated hot storage tank for the rainy and heavily overcast cloudy days.

Commercial Application:

The commercial applications of solar water heating systems include the hotel and dairy industries, educational institutions, hospitals, etc. - for catering, hot water for bathing and washing purposes. Generally,

conventional electrical geysers / furnace oil / coal fired boilers / wood based boilers are the main sources of supply of hot water in these industries. The solar water heating systems are also used in the process industries where the boiler supplies low pressure steam. Solar water heating systems are generally used as an excellent energy conservation and energy efficiency equipment by supplying hot water at 80°C to boiler at pre-heater stage.

Installed

Around 2.0-lakh sq. m. collector area has been installed so far during the current year, taking cumulative installations to around 1.5 million sq. m. A target of 4-lakh sq.m. Collector area has been set for 2005-06, which is likely to be achieved in view of the low interest rates now available from various banks and other financial institutions and also the efforts being made by the Ministry to provide support through other promotional measures.

Incentives for Solar Water Heating Systems

The Ministry has been pursuing with State Governments the proposal for making solar assisted water heating mandatory in certain categories of buildings through amendments in the building bye-laws. To encourage local governments to notify the mandatory provision for solar water heating systems, Central financial assistance of Rs. 5 lakh to municipalities and Rs. 10 lakh to municipal corporations is provided for training, study tours, awareness creation, demonstration, preparation of brochures /

manuals and creating infrastructure for implementing the mandatory provision.

Solar water heaters are fast catching up in urban centers such as Bangalore, Pune, Hyderabad and Mysore. The MNES programme of soft loans and other incentives and the emphasis on quality standards has created a favorable environment and a significant infrastructure for the manufacture, installation, financing and servicing of solar water heating systems. The low pay back period for urban households is an added attraction. The result is that a number of builders and colony developers are now offering houses and apartment blocks fitted with solar water heating systems.

To promote large-scale use of solar water heating systems in the country, a scheme for accelerated deployment of solar water heating systems was launched during the year 2005 for installation of 1.2 million sq. m. of collector area during the next two years. Under this scheme, subsidized soft loans have been made available to users through IREDA covering a large network of banks/ Financial Institutions (FIs), including private, public and co-operative banks. These loans are available at an interest rate of 2% to domestic users, 3% to institutions and 5% to commercial users to be repaid in a maximum period of five years. IREDA is administering the interest subsidy to FIs/Banks. Incentives are also being provided to motivators who bring business to Banks/ FIs. The motivators who could be unemployed youth may also work for other than domestic systems.

Nine banks, namely, Union Bank of India, Canara Bank, Bank of Maharashtra, Andhra Bank, Punjab and Sind Bank, Syndicate Bank, Vijaya Bank, Dena Bank and Punjab National Bank; three Non Banking Financial Institutions; and five Scheduled Co-operative banks that have registered with IREDA, so far have started providing loans. More Banks /FIs are likely to join the scheme.

Uttaranchal has decided to provide Rs.50/- per month as rebate in the electricity tariff to users of solar water heaters. Three other States, Rajasthan, Karnataka and West Bengal are providing such incentives. Thane Municipal Corporation has also announced a rebate of 10% in Property Tax to users of Solar Water Heaters.

Magarpatta City, a large housing and office complex coming up on the outskirts of Pune that would eventually comprise about 10,000 dwelling units, is installing solar water heating systems for the complex. When completed in 2008, the township will probably have the biggest concentration of solar water heaters in any residential complex in India.

The Ministry has been working with the Ministry of Urban Development to get the building bylaws in municipalities across the country amended to facilitate installation of solar water heaters. A model regulation / building bylaw for making installation of solar assisted water heating systems mandatory in various categories of new buildings had been circulated to all States and Union Territories for incorporation in building bye-laws. Andhra

Pradesh, Maharashtra, Tamilnadu, Rajasthan, Haryana, Uttar Pradesh, Uttaranchal, Punjab, Dadra & Nagar Haveli and Chandigarh have already issued necessary advice to their local bodies. The Municipal Corporations of Bangalore, Rajkot, Pune, Nagpur and Thane have made the necessary amendment to their building bylaws. Based on the amendments made by the Thane Municipal Corporation, 10 commercial buildings have already incorporated solar – assisted water heating systems in their building plans. To encourage local bodies, the Ministry provides a one-time financial assistance to those who make the necessary modifications of their building bylaws for promotion of solar water heaters.

Solar Air Heating / Steam Generating Systems

Solar air heating technology can effectively be used for drying and curing of agricultural products, space heating for comfort, regeneration of dehumidifying agents, seasoning of timber, curing of industrial products, tanning of leather and many more industrial and agro processing activities. It can act as a partial energy delivery (PED) or a full energy delivery (FED) unit. The PED units require a back up energy system. Depending on the drying process, required temperature, microclimate and site conditions, the technology has the potential of saving considerable conventional energy in a variety of industrial establishments.

Solar flat plate collector (FPC) based air heating systems can be used for drying

applications in agricultural and agro-industries such as tea leaves/coffee beans, fruits, spices, cereals, mushroom, papad, vegetables, fish, seafood, etc. Also for industrial uses in leather, textiles, chemicals, rubber, paper, pharmaceuticals etc. help in reducing fuel consumption and air pollution in addition to improving the quality of the end-product.

Installed

About 10,000 sq. m. collector areas for solar drying have been installed in about 50 industries so far in the country. 1 sq.m. Solar air heating system can save equivalent of 40 liters of diesel per year or 800 liters of diesel over a 20-year lifecycle. The payback period of the system is generally 5 to 6 years, without subsidy support.

Solar concentrator steam-generating systems deployed in large numbers at Tirumala, Andhra Pradesh generate around 4 MT/day of steam is sufficient to cook two meals for 15,000 people. The system saves an equivalent of one lakh liters of diesel per year. The second largest deployment of these systems is at Mount Abu, Rajasthan for preparing meals for 10,000 people. The third system commissioned at a hospital in Mount Abu generates 1.2 MT/day of steam for use for sterilization, laundry etc. apart from cooking purposes in the hospital kitchen. A total of 12 such systems of different capacities have been installed in the country so far.

Solar cookers

The heat from the sun can be effectively used for cooking, through the use of a solar cooker. This has the potential to save significant amounts of conventional fuel, although solar cooking does not always completely replace the need for other fuels. On clear sunny days, it is possible to cook both noon and evening meals in a solar cooker. Different types of solar cookers have been developed. These include a box cooker, a dish cooker, a cardboard cooker, and large community cooker for indoor cooking and solar steam cooking system for mass cooking.

Installed

During the year 2004-05, about 25,000 box solar cookers and dish type solar cookers were sold making a total of 5,80,000 cookers sold in the country. Cooking demonstrations, competitions, publicity and awareness promotion activities were carried out in various states.

One solar steam cooking system consisting of 20 dishes of 12.6-m² areas each has been installed at Global Hospital & Research Centre, Mount Abu during the year. The system produces 1200 Kg. of steam, which is used for the purpose of cooking, sterilization and laundry purposes. A solar steam cooking system for cooking food for around 5000 people per day is under installation at Sringeri Math in Karnataka. Three solar steam-cooking systems for 500 people each are under installation in Gujarat.



Figure 15: A Solar Energy System at Global Hospital, Mount Abu

Source: MNRE Report 2005-06

Incentives

The details of the financial assistance being provided by the Ministry are given in Annexure IV.

4.4.2 Photovoltaic Systems

Solar photovoltaic (PV) systems convert sunlight into electricity. The electricity thus produced can directly be used or can be stored in a battery. The technology has a desirable set of attributes that make it suitable for a variety of applications based on decentralized power generation.

A PV power pack of 1kWp capacity can generate 1100 to 1400 units of electricity per year depending on the site of installation. In the country, over more than two decades, a good industrial base for the

production of single and polycrystalline silicon solar cells and a large number of PV systems have been developed.

In view of the demand in the international PV market, mainly from Germany, the Indian PV industry was able to secure orders for export of PV modules. The Indian PV industry has been growing at an average growth rate of about 25%. However, the sudden surge in global demand resulted in shortage of silicon wafers resulting in enhanced silicon wafer prices.

A Task Force on Silicon Supply for the Indian PV Industry submitted its report in July 2005. The major recommendations of the Task Force include (i) bulk procurement of Silicon wafers by industry, (ii) expansion of domestic manufacture of

Silicon wafers, (iii) R&D to significantly reduce consumption of Silicon material in manufacture of solar cell modules, (iv) Examine feasibility of setting up a 2000 TPA poly Silicon plant in India and (v) prepare a Road Map for development of PV technology in India. Follow up actions have been initiated on the major recommendations of the Task Force.

With a view to accelerate growth of PV technology development in the country, a Group of Experts has been set up in November 2005 to prepare a Photovoltaic Technology Road Map for India. The Group is expected to submit their report during 2006-07.

Potential

The solar radiation falling over India is about 5,000 trillion kWh / year. There are about 300 clear sunny days in a year in

most parts of the country. The daily average insolation incident over India is about 5.5 kWh / sq. meter over a horizontal surface.

Installed

Significant progress has been made in deployment of small capacity stand-alone PV systems in the country. By 31st December 2005 PV systems of about 245 MW aggregate capacity (about 13,00,000 systems), including export of about 160 MW have been in use for various applications.

Under the PV program, about 10 lakh systems have been installed. This includes 5.6 lakh solar lanterns, 3.42 lakhs solar home lighting systems, 54,000 street lighting systems, 7,002 water pumping systems and of about 4.75 MWp aggregate capacity of stand alone and grid interactive power plants/packs.

Solar street lighting systems

An SLS (solar street lighting system) is an outdoor lighting unit used to illuminate a street or an open area usually in villages. A CFL is fixed inside a luminaire, which is mounted on a pole. The PV module is placed at the top of the pole, and a battery is placed in a box at the base. The module is mounted facing the south, so that it receives solar radiation throughout the day, without any shadow falling on it. A typical SLS consists of a PV module of 74-kWp capacity, a flooded lead-acid battery of 12 V, 75 AH capacity, and a CFL of 11-W rating. This system is designed to operate from dusk to dawn. The CFL automatically lights up when the surroundings become dark. The cost of an SLS is about Rs 19 000.



Source: Akshaya Urja, July-August 2006, Volume 2 Issue 4 (MNRE publication)

PV water pumping

Photovoltaic pumping systems provide an excellent alternative to fuel burning generators or hand pumps. They provide water precisely when it is needed the most, when the sun shines the brightest! Solar pumps are simple to install and maintain. The smallest systems can be installed by one person in a few hours, with no experience or special equipment required.

Advantages of using PV-powered pumps include:

- Low maintenance.
- Ease of installation.
- Reliability.
- Scalability.

A PV Water Pumping System consist of a DC / AC surface mounted / submersible / floating motor pump set, electronics if any, interconnect cables, a On-Off switch and a

PV array mounted on a suitable structure with a provision of tracking.

Incentives

Financial assistance (central subsidy) is available for purchase of various solar PV systems to certain eligible categories of users.

Incentives for SPV water pumping

MNES has been implementing a Programme on solar photovoltaic water pumping systems since 1993-94. Majority of the pumps fitted with a 2HP motor are powered with 1800 Wp PV array which can deliver about 1,40,000 liters of water/day from a total head of 10 meters. The solar pumps are also being used to meet the drinking water requirements of the people and livestock in several villages and hamlets.

During 2005-2006, implementation of the Programme was continued through the State Nodal Agencies and IREDA. Subsidy is provided under the scheme @ Rs.30/- per watt of SPV array used, subject to a maximum of Rs.50,000/- per system. In addition, a scheme for providing interest subsidy to IREDA to compensate for the difference between its normal lending rate and subsidized interest rate of 5% per annum (for users) and 2.5% per annum (for financial intermediaries/manufacturers) was continued. During 2005-06, 222 installations have been installed. A total of 7002 solar PV water pumping systems have been installed since the inception of the programme. The Ministry continued a scheme to provide support for setting up manufacturing facilities for production of silicon material/wafers, solar cells and integrated solar cell modules. Under the scheme, Ministry would provide interest subsidy to IREDA to extend soft loan to industry at 5% annual interest rate. No new project was sanctioned in this period. Financial incentives for other SPV systems have been given in Annexure IV.

4.4.3 Solar Buildings

Overview

Solar buildings are constructed based on the techniques of solar passive design with a view to provide comfortable living and working conditions, both in winter and in summer. Such energy efficient buildings with an additional cost of 5 to 10% towards passive design features can save significant amount of conventional energy (30 to 40%) that is used for lighting, cooling or heating.

Incentives

In order to reduce/conserves the consumption of conventional energy through saving of electricity and fossil fuels in buildings, industrial and commercial establishments, the Ministry has been providing assistance for the preparation of DPRs and construction of demonstration solar buildings in the government and semi-government sector; and, also for awareness promotion and technical documentation activities. These activities will continue to be supported and expanded under the Scheme with a higher level of financial assistance, namely, upto 50% for DPRs and 10% for construction of demonstration buildings with certain ceilings. DPRs will be supported for private institutional buildings also.

4.5 Energy from Waste

4.5.1 Energy Recovery from Urban Waste

The enormous increase in the quantum and diversity of waste materials generated by human activity has led to an increasing awareness, world-wide, about an urgent need to adopt efficient, scientific and safe methods for the treatment, processing and disposal of wastes. The technologies for recovery of energy from wastes not only reduce the quantity but also improve the quality of waste to meet the required pollution control standards, besides generating a substantial quantity of energy.

Potential of energy recovery from Urban Waste

According to a recent estimate, about 42 million tonnes of solid waste (1.15 lakh tonnes per day) and 6000 million cubic meters of liquid waste are generated every

year in urban areas. This translates into a potential for generation of over 1700 MW of power. The estimated potential of energy recovery from Municipal Solid Waste (MSW) over the next 12 years is given in Table 5.

Table 5: Estimates of Solid Wastes and Potential for Power

Period	Projected MSW generation (TPD)	Potential for power generation (MW)
2007	148000	2550
2012	215000	3650
2017	304000	5200

Source: www.mnes.nic.in

All technology options available for MSW to energy are being supported. The major benefits of recovery of energy from MSW are to bring about reduction in the quantity of waste by 60 to 90%; reduction in the demand for land for landfill sites; and, net reduction in environmental pollution, besides generation of substantial quantity of energy.

Recent Developments in Municipal Solid Waste Management

The following recent developments regarding municipal solid waste management and energy recovery from urban wastes are expected to facilitate promotion and installation of such projects:

- Notification of Municipal Solid Wastes (Management and Handling) Rules - 2000 necessitates all Class-I cities to provide proper treatment and disposal facilities for MSW;

- Twelfth Finance Commission has recommended that at least 50% of the grants provided to States for the Bulbs should be utilized to support the cost of collection, segregation and transportation. Segregated wastes require relatively simpler and less expensive equipment and devices for conversion into energy, and initiative being taken under National Urban Renewal Mission are expected to give a major boost to the efforts for improving waste management in 60 large cities.

4.5.2 Recovery of Energy/Power Generation from Industrial and Commercial Wastes and Effluents

It has been estimated that there is a potential for recovery of about 1000 MW of energy from industrial wastes. The estimated potential for recovery of energy/generation of power from industrial solid and liquid wastes is expected to

increase to about 1300 MW by 2007, 1600 MW by 2012 and 2000 MW by 2017. Several initiatives have been taken on various aspects including R&D, pilot plants/ demonstration, dissemination, promotion and commercialization through the UNDP/GEF-assisted project on Development of High Rate Biomethanation and the National Programme on energy recovery from urban and industrial wastes. Projects aggregating 27 MW have been installed in distilleries, pulp and paper mills, and slaughterhouses, tanneries and starch industries.

Installed

The cumulative installed capacity of waste to energy projects in the country is around 60 MW (till 31.3.2007).

Incentives

Financial **incentives** being provided for eligible waste-to-energy projects under National Programme on Energy Recovery from Urban & Industrial Wastes are given below: -

Commercial Projects:

Commercial projects for MSW in fast track mode Projects based on high rate Biomethanation technology. Financial assistance of Rs. 2.0 crore / MW will be provided for projects based on power generation from MSW through high rate biomethanation technology.

Demonstration Projects:

Financial assistance of up to 50% of capital cost of the project limited to Rs. 3.00 crore

per MW for innovative demonstration projects for generation of power from Municipal Solid Wastes and for selected Industrial Wastes.

Power generation at Sewage Treatment Plants (Steps)

Financial assistance @ 40% of the project cost subject to a maximum of Rs 2.0 crore/MW shall be provided for projects for generation of power from biogas being produced at Sewage Treatment Plants. Project cost will include the cost of engine-genset, H₂S removal plant and other related equipment.

Power generation from other urban wastes

Financial assistance @ 50% of project cost subject to upper limit of Rs. 3.0 crore / MW shall be provided for setting up projects based on biomethanation technology for power generation from cattle dung, vegetable market and slaughterhouse wastes generated in the urban areas. For cattle dung based projects, eligible project capacity would be 250 kW and above. In case of projects for generation of only biogas for thermal application, the FA will be limited to Rs. 1.0 crore / MWeq (i.e. biogas production of 12000 cu.m / day).

Other Incentives

Incentives to Urban Local Bodies, Municipal Corporations and State Nodal Agencies

State Nodal Agencies: An incentive of 1% of the MNRE' Financial assistance with an upper limit of incentives @ Rs. 5.00 lakh per MWe is payable to State Nodal Agencies for promotion, coordination and monitoring of projects. However, this incentive will be reduced to 50% in case of generation of power from fuel or fuel from waste.

Financial Institutions: A service charge of 2% of the actual subsidy channeled through the FI to the promoter or other FIs, subject to maximum of Rs. 2.00 lakh per project.

Preparation of Detailed Project Report: 50% of the cost preparation of DPR or Techno-economic Feasibility Reports, subject to a maximum of Rs. 2.00 lakh per report to Urban Local Bodies only.

Financial Assistance for Resource Assessment Studies:

Financial assistance may also be provided towards the full cost of carrying out studies for assessment of resources for setting up waste-to-energy projects, if considered necessary.

Financial Assistance for Promotional Activities:

Financial assistance can also be provided for organization of Training Courses, Business Meetings, National Workshops and Seminars, creation of awareness and publicity. Requests received from Urban Local Bodies, Industries Associations, Central or State Govt. Departments or

Agencies, Corporate Bodies, State or National level financial and other institutions for technical or financial assistance for such activities may be considered under this Programme.

Support from the State Governments

Some State Governments, namely Uttar Pradesh, Madhya Pradesh, Tamilnadu, Andhra Pradesh, Rajasthan, Maharashtra, Haryana & Karnataka have announced policy guidelines measures pertaining to allotment of land, supply of garbage and facilities for evacuation, sale and purchase of power to encourage setting up of waste-to-energy Projects.

4.6 New Technologies

- Hydrogen Energy and Fuel Cells
- Geothermal Energy
- Tidal Energy
- Alternative Fuels for Surface Transportation
- Biofuel

4.6.1 Hydrogen Energy and Fuel Cells

In recent years hydrogen has been receiving worldwide attention as a clean and efficient energy carrier with a potential to replace liquid fossil fuels. Significant progress has been reported by several countries, including India, in the development of hydrogen energy as an energy carrier and an alternative to fossil fuels. Serious concerns relating to energy security, depleting fossil fuel reserves, GHG

emissions and air quality are driving this global transformation effort towards a hydrogen-based economy. Hydrogen has a high energy content. When burnt, it produces only water as a by-product and is, therefore, environmentally benign. At present, hydrogen is available as a by-product from several chemical processes, plants or industries.

Hydrogen can be used for a wide range of applications including power generation and vehicular transport. Hydrogen can be used either directly in IC engines or through fuel cells for production of motive power and electricity. A fuel cell is an electrochemical device that converts energy into electricity and heat without combustion. Fuel cell systems generally operate on pure hydrogen and air to produce electricity with water and heat as the only by-products. Fuel cells are modular in construction and their efficiency is independent of size.

Fuel cells are emerging as a clean and fuel-efficient technology for stationary and portable applications. Fuel cells can be potentially used in residential, industrial, transport and agricultural sectors and also in remote areas for reliable power supply. Fuel cell power systems can be used as uninterruptible power supply (UPS) systems, replacing batteries and diesel generators. Low operating temperature (up to 100°C) fuel cells are better suited for transport and small power generation applications. Medium and high temperature (up to 1000°C) fuel cells are preferred for power generation/ combined heat and power applications.

The Ministry has been supporting a range of projects on research, development and demonstration of hydrogen and fuel cell technologies including production, storage and utilization of hydrogen as a fuel. Several research, scientific and educational institutions, laboratories, universities, industries etc. are involved in implementing the projects. During 2004-05 emphasis of the research has been on further improvements in renewable energy-based hydrogen production techniques, its storage methods and materials used for storage and utilization of hydrogen energy as a fuel. The focus of the research on fuel cell technology has been on improvements in the fuel cell related materials, sub-systems and systems. Sixteen R&D projects on different aspects of hydrogen energy and six projects on fuel cell technology were under implementation during the year.

4.6.2 Geothermal Energy

Geothermal energy can be harnessed for power generation, space heating and other thermal applications. Preliminary data of resource assessment has been generated for 340 hot springs in the country. Magneto telluric investigations for assessing the suitability of sites and other studies have been taken up at a few sites through National Geophysical Research Institute (NGRI), Hyderabad. NGRI has been conducting magneto-telluric (MT) studies in Satluj-Spiti, Beas and Parbati valley in Himachal Pradesh, Badrinath-Tapovan in Uttaranchal and Surajkund in Jharkhand. A total of 36 stations were set up in Badrinath-Tapovan region to collect the data, which is being analyzed through

computer modeling and quantitative interpretation. Currently, harnessing geothermal energy is not regarded as being commercially viable in India.

4.6.3 Tidal Energy

Power generation through tidal energy has been found to be a technically viable option when considering the sea as a resource. In India, Gulf of Kutchh and Gulf of Cambay in Gujarat and delta of Ganga in Sunderbans, 24 Parganas district, West Bengal are potential sites for generating tidal power. The Ministry sponsored a detailed project report and environmental impact assessment study for setting up of a 3.6 MW capacity tidal power plant at Durgaduani Creek, in Sunderbans area of West Bengal. The West Bengal Renewable Energy Development Agency has taken steps to obtain environmental clearance and other statutory clearances for the project. However, tidal energy is not commercially viable at this juncture and its technology also needs to be imported.

4.6.4 Alternative Fuels for Surface Transportation

The Ministry of Non-Conventional Energy Sources has implemented a scheme for the development of electric vehicles (EVs) under the Alternative Fuels for Surface Transportation Programme. The programme aimed at developing and deploying battery-operated vehicles (BOVs). One of the major limitations of the existing EVs, which use lead-acid batteries, is the limited driving range of the vehicle per charge of the battery. Therefore, efforts

are being made by the Ministry to develop and deploy newer types of rechargeable batteries, which have higher energy and power densities, besides lasting longer cycle life with higher depth of discharge and lower costs through R&D activities.

Lithium Ion batteries are an important development in the area of advanced battery technology. Under a project for electro-chemical studies of high quality cathode materials for lithium batteries sponsored to Centre for Materials for Electronics Technology (C-MET), Pune has successfully developed prototype lithium-ion cells using lithium manganese oxide, lithium cobalt oxide and lithium nickel oxide cathode materials with the help of industry. Efforts will be made to use these prototype lithium-ion cells in battery-operated vehicles with the help of industry.

4.6.5 Biofuel

Petroleum resources are finite and, therefore, the search for an alternative is continuing around the world. Moreover gases emitted by petrol and diesel driven vehicles have an adverse effect on the environment and on human health. There is universal acceptance of the need to reduce such emissions. In India, domestic supply of crude oil meets only about 22% of the demand and the rest is being met from imported crude. Biofuel has been considered as one of the most preferred alternative fuel for petrol and diesel, particularly in the transport sector. Most biofuels are fuels generated from biomass, which are renewable energy sources (some

synthetic fuels). There are different routes to use biomass as energy source such as directly burning it, controlled combustion to generate producer gas, anaerobic digestion to generate methane and fermentation process to produce alcohol. Oil extraction from the oilseed plants, transesterification of oil with alcohol to produce biodiesel is another way of using biomass as a fuel. While all above processes/methods generate biofuels, internationally alcohol and biodiesel have been named as bio-fuels. Brazil, USA, Canada, Australia, and China are some of the countries using ethanol in transport sector.

The Ministry of Non-Conventional Energy Sources has initiated a comprehensive programme on biofuels for surface transportation since 2002 to develop the technology for converting vegetable oils, mainly non-edible oils, to biofuels and promotes the use of these biofuels in automotive sector after taking care of different aspects of the conventional diesel/petrol engines. The Ministry has also taken up a scheme on Biofuel Pilot Demonstration Project in rural areas for implementation initially in one village in each State, namely, Menasina Adya, Kallugudda in Chikkamagalur district, Sipri and Sahariya (cluster) in Lalitpur district, Basghari in Mandla district and Gadrdih in Bokaro district in the States of Karnataka, Uttar Pradesh, Madhya Pradesh and Jharkhand respectively with an objective to provide energy through non-edible vegetable oilseeds for rural people in far-flung areas for lighting, agricultural operations and other community based

stationary applications such as drinking water, etc.

A number of developmental activities are being taken up in the country for development and production of biofuels, which include 5% compulsory blends of ethanol in petrol in 9 States and trials for 10% & above ethanol blends. While in European Union (EU) countries and the USA, edible vegetable oils are being used to produce biodiesel. India is endowed with a number of non-edible vegetable oil producing trees and shrubs, which can be used for the production of biodiesel for use in diesel engines.

The Ministry has sponsored an R&D project at the Indian Institute of Technology (IIT) Delhi entitled "Production of Bio-diesel from non-edible oils and field trials of diesel car with bio-diesel operation". This R&D project aims at formulation and development of process conditions for producing bio-diesel from non-edible oils especially *Pongamia pinnata* (Karanja) oil-seeds through transesterification process using methanol and ethanol, selection of appropriate bio-diesel for long term operation, studies on shelf-life of bio-diesel on storage, determination of physico-chemical properties of neat diesel oil, bio-diesel and the blended fuel as per ASTM (American Society for Testing and Materials) specifications, utilisation of the biodiesel developed in the lab to evaluate the performance and emission studies on typical diesel-powered car engines to generate baseline data. IIT has extracted Karanja oil from the kernels by mechanical as well as soxhlet extraction at lab scale. Bio-diesel has been produced in the

laboratory through transesterification process using methanol (1 litre and 6 liters batch capacities). Engine tests were being carried out using karanja oil methyl ester (KOME). The physico-chemical properties

of the karanja oil have also been determined and some of the properties of bio-diesel fuels have been evaluated according to ASTM standards at IOC R&D Centre, Faridabad.

Summary

Today, India has one of the world's largest programmes for renewable energy. The activities cover all major renewable energy sources of interest to India, such as biogas, biomass, solar energy, wind energy, small hydropower and other emerging technologies. In each of these areas, the Ministry of Non-Conventional Energy Sources has been supporting R&D for technology and manpower development in renewable energy. Present emphasis is on reduction in cost and increase in efficiency. For sustained development of this sector, efforts are being made so that the market and the consumer drive renewable energy to a large extent. In India there is huge potential for power generation through renewable such as wind, solar, biomass, hydro etc. At present wind power contributes to 65.15% of the total power generated by RE technologies.

India's wind power potential has been assessed at around 45,000 MW assuming 3% land availability for wind farms. India is one of the countries with highest total installed wind power capacity. Wind power installed up to 31.03.2006 is 5340.60 MW. Ministry of Non-Conventional Energy Sources is assigned the business of small hydro power (SHP) up to 25 MW station capacities. The Ministry's aim is that out of the total grid interactive power generation capacity that is being installed, 2% should come from small hydro. Of the estimated potential of 15,000 MW of small hydro in the country, 4,404 sites with an aggregate capacity of 10,477 MW have been identified. At the end of the 9th Plan the total installed capacity of SHP projects up to 25 MW station capacities was 1438.89 MW. As India is the largest producer of cane sugar so the Ministry is implementing the biomass/cogeneration programme. The current availability of biomass in India is estimated at about 120-150 million MT/annum covering agricultural and forestry residues corresponding to a potential of 16,000 MW. A power generation capacity of 867 MW has been commissioned, and 858 MW capacities are under implementation (MNES report 2005-06). Many applications in households, agriculture, telecommunications, defense, and railways etc. Solar Photovoltaic Power Generation - 20 MW per Sq. Km. At present 2.8 MWp total capacity have been commissioned in different parts of the country, and 6 more projects of aggregate capacity of 400 kWp are under installation. Solar energy can be utilized for various applications such as cooking, water heating, drying, desalination and space heating.

In rural areas, Biogas is an alternate source of fuel derived mainly from organic wastes available abundantly in various forms. A cumulative total of over 37.75 lakh plants have been set up in the country against a theoretical potential of about 120 lakh plants. A total of 33,700 Plants have been setup until December 2005.

Energy recovery from the waste is one of the good options to meet the required pollution control standards, besides generating a substantial quantity of energy. The technologies for recovery of energy from wastes not only reduce the quantity but also provide energy so this is like win-win situation. A recent estimate, about 42 million tonnes of solid waste (1.15 lakh tonnes per day) and 6000 million cubic meters of liquid waste are generated every year in urban areas. This translates into a potential for generation of over 1700 MW of power. The cumulative installed capacity of waste to energy projects in the country was around 46.50 MW (till 31.12.2004). Besides the above renewable energy we have some other also like Geothermal, Tidal, Biofuel etc.

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5. RENEWABLE ENERGY AND ENERGY EFFICIENCY AT LOCAL GOVERNMENT LEVEL

5.1 Local governments - drivers for renewable energy implementation

According to the Census of 2001, and data published by the Ministry of Urban Development, India had a population of 1027 million, as on 1st March 2001. About 285 million people (27.8% of the total population) live in urban areas. While the population in rural areas grew by 17.9% during the decade between 1991 and 2001, that in urban areas grew by as much as 31.2%, indicating a migration from rural to urban areas (besides normal population growth). There are a total of 4378 urban agglomerations and towns in the country (the census data shows 5161 towns). Of these, 423 towns and cities have a population or more than 0.1 million. There are 35 urban agglomerations and cities with a population of over 1 million. The total number of urban households in the country is 53.7 million.

These urban areas are heavily dependant on fossil fuels for the maintenance of essential public services, for powering homes, transport systems, infrastructure, industry and commerce. The environmental and social impacts of the consumption of fossil fuels that includes air pollution, global warming, waste disposal problems; land degradation and the depletion of natural resources are increasingly becoming a cause of concern. The drawbacks of

depending on fossil fuels have become increasingly apparent, in terms of physical, financial and social well-being. Due to instability of energy supply imports and increasing energy prices, local governments in India are finding it increasingly difficult to provide services to the growing population.

Indian cities have thus begun to realise the importance of renewable energy sources and energy efficient technologies as an effective and sustainable solution to the above-mentioned problems. The required technologies are mature and available, targets and policies exist at National level. However, their effective implementation at local level is limited. To achieve the national targets and policy goals, it is required to instigate actions also at city level. There is a need to set the framework for this to function – by setting clear targets and formulating city level policies for improving the energy efficiency of the urban services and generating energy through renewable energy sources. With their executive power, Local Governments can implement sustainable energy at an appropriate level. They can thus liberate peripheral and developing economic regions from their dependence upon national investment decisions in energy. Providing access to energy services in this

decentralized manner can not only improve the economy of these regions, but also give control to the people of each region over their own energy use and needs. Existing instruments for Local Governments to promote RE/EE

The following are the instruments already existing with the Indian Local Governments that can be used for promoting RE and EE in their communities:

- Legal instruments
- Fiscal and financial incentives
- Persuasive actions (e.g. awareness programmes)
- Demonstration projects

5.1.1 Legal instruments:

Local governments can use legal instruments for promoting RE and EE by amending existing bylaws or by making new laws that have the specific aim to promote RE and EE. The Ministry of New and Renewable Energy has been working with the Ministry of Urban Development to get the building bylaws in municipalities across the country amended to facilitate installation of solar water heaters. A model regulation / building bylaw for making the installation of solar assisted water heating systems mandatory in various categories of new buildings had been circulated to all States and Union Territories for incorporation in building bylaws. Andhra Pradesh, Maharashtra, Tamilnadu, Rajasthan, Haryana, Uttar Pradesh, Uttaranchal, Punjab, Dadar & Nagar Haveli and Chandigarh have already issued

necessary advice to their local bodies in this regard. The Municipal Corporations of Bangalore, Rajkot, Pune, Nagpur and Thane have made the necessary amendment to their building bylaws.

In addition, the Bureau of Energy Efficiency, of the Government of India, has prepared the 'Energy Conservation Building Code 2006'. The purpose of this code is to provide minimum requirements for the energy-efficient design and construction of building. These codes have not been made mandatory yet but efforts in this direction are in progress. The authority of approving building plans in a city usually lies with the Corporations. These codes provide an opportunity for the local governments to use them as criteria for approval of new buildings.

Table 6: Rajkot Municipal Corporation's Initiative

Case description: Rajkot, India Case Relevance: example of legal instrument – Regulation / Bylaws for installation of solar assisted water heating system
<p>Rajkot Municipal Corporation has adopted the following Regulation/Bylaws for the installation of solar assisted water heating systems in functional buildings.</p> <p>The following provisions are formatted for inclusion in the building bylaws of RUDA:</p> <ol style="list-style-type: none">1. No new building in the following categories in which there is a system or installation to supplying hot water shall be built unless the system or the installation also has an auxiliary solar assisted water heating system:<ol style="list-style-type: none">a) Hospital & Nursing Homesb) Hotels, Lodges and Guest housesc) Hostels of Schools, Colleges, Training centersd) Barracks of armed forces, paramilitary forces and policee) Individual residential buildings having more than 150 sq.mt plinth areaf) Functional buildings of Railways Station and Airports like waiting rooms, retiring rooms, rest rooms, and inspection bungalows and catering units.g) Community centers, banquet halls, 'Barat Ghars', 'Kalyan Mandaps' and buildings for similar use.2. Installation of Solar Water Heating Systems New Building Clearance of Plan for the construction of new buildings of the aforesaid categories shall only be given if they have a provision in the building design itself for an insulated pipeline from the rooftop in the building to various distribution points where hot water is required. The building must have a provision for continuous water supply to solar water heating system. The building should also have open space on the rooftop, which receives direct sunlight. The load bearing capacity of the roof should at least be 50 kg per square meter. All new building of above said categories must complete installation of solar water heating system before obtaining necessary license to commence their business.<ol style="list-style-type: none">a) Existing Buildings: Installation of Solar Assisted Water Heating System in the existing building shall be made mandatory at the time to change of use to above said category provided there is a system or installation for supplying hot water.3. Capacity The capacity of solar water heating system to be installed on the building of different categories shall be decided in consultation with the local bodies. The recommended minimum capacity shall not be less than 25 liters per day for each bathroom and kitchen subject to the condition that maximum of 50% of the total roof area is provided with the system.4. Specification Installation of Solar Assisted water heating system shall confirm to BIS (Bureau of India Standards) specification IS: 12933. The Solar collector used in the system shall have the BIS certification mark.5. Auxiliary System Wherever hot water requirement is continuous, auxiliary, heating arrangement either with electric elements or oils of adequate capacity can be provided. <p style="text-align: center;"><i>(Source: Rajkot Municipal Corporation)</i></p>

Table 7: Barcelona City Council's Initiative

Case description: Barcelona, Spain

Case Relevance: example of legal instrument- Solar Thermal Ordinance

The city council of Barcelona, to stimulate the knowledge and management between the activities of the city that have environmental impact, charged to Barcelona Regional the development of a Plan for Energy Improvement in Barcelona. The goals of Barcelona City Council's Plan for Energy Improvement in Barcelona (2002-2010) are to increase the use of renewable energy (especially solar energy), reduce the use of non-renewable energy sources and lower the emissions produced by energy consumption in order to meet Barcelona City Council's international protection commitments. This integrated plan includes a quantification of the energy used and emissions produced in the city and provide scope for municipal action to promote an environmentally sustainable city, reducing air pollution and the consumption of fossil fuels in the process. As part of its plan a Solar Thermal Ordinance has been introduced. The aim of the ordinance is to regulate, through local legislation, the implementation of low-temperature systems for collecting and using active solar energy for the production of hot water for buildings. New buildings and buildings undergoing major refurbishment are required to use solar energy to supply 60% of their running hot water requirements. Since its enforcement licenses for the installation of a total of 14,028 square meters of solar panels have been requested with annual savings of 11,222 Megawatt hours and a corresponding reduction in eCO₂ emissions of 1,973 tonnes per year.

The strategies named promotion policies and demonstration projects have been present in the city for several years, with different examples such as the installation of solar systems in schools, sports centers (solar thermal installation in the Olympics Swimming Pool) or in some other public buildings (solar photovoltaic installation in the Town Hall building).

Concerning legal instruments, Barcelona is the first European city to have a Solar thermal ordinance. According to this bylaw all new buildings and buildings undergoing major refurbishment are obligated to use solar energy to supply 60% of their running hot water requirements. This solar ordinance was approved by the Barcelona City Council in July 1999 and entered into force in August 2000. This new policy has brought, 1 sq.m. /1000 inhabitants (in 2000) to 13 sq.m/1000 inhabitants [as of march 2004, the licenses requested for the installation of solar panels made up a total of: 19543 sq.m of solar panels (before: 1650 sq.m)]. We are happy to see these results and specially to see that more than 20 Spanish cities are now "replicating" this initiative taking Barcelona as a model.

The Barcelona Energy Improvement Plan (PMEB), a 10-year plan adopted in 2002, and the Barcelona Energy Agency, are two major management instruments that ensure the commitment of the City to further promote these energy measures in a planned and structured manner. The Barcelona Energy Improvement Plan proposes a series of measures and 55 projects for local action up to the year 2010, these being centered on energy savings and in the use of renewable energies.

The municipal action promoting a sustainable energy city also works towards the integration of sustainable energy measures in urban developments, an example of this integration are the sustainable energy measures in the Forum Barcelona 2004 area. The major Sustainable Energy measures in the Forum 2004 area are the following:

- Urban solar FV power station (10.700 sum, 1,3 Medic)
- District heating & cooling system, and
- Energy efficient buildings

(Source: <http://www.managenergy.net/download/nr166.pdf>)

Table 8: Freiburg City Initiative

Case description: Freiburg, Germany Case Relevance: example of legal instrument – Energy Policy
<p>Freiburg is a city of 205,000 people that was founded 900 years ago in the wine-growing area of southwest Germany. Freiburg has acquired a leading position in solar energy research and application and is renowned as a center of expertise.</p> <p>Freiburg's energy policy has three pillars: energy conservation, the use of new technologies such as combined heat and power, and the use of renewable energy sources such as solar. The aim is to meet new demand, move away from fossil fuels that have to be imported, and realize an ecologically-oriented energy supply. Behind this, there lies an important goal, namely to create sustainable regional development for the area as a whole. In 1996, this was strengthened by a city resolution taken to reduce Freiburg's CO₂ emissions to 25% below the 1992 level by 2010. This calls for initiatives in the areas of transport, waste and industrial production, as well as energy and buildings. The average Freiburg citizen produces 11 tonnes of CO₂ a year, three quarters of which comes from the city's use of energy.</p> <p>The City of Freiburg supports solar energy with a wide range of policy measures:</p> <ul style="list-style-type: none"> • Own solar projects by the City or related corporations • Subsidies for solar projects, pilot and demonstration projects, including involvement of and support by the local utility. • Letting of roof surfaces to solar power plant operators • Subsidy programs by the City or related corporations • Favorable property conditions to attract innovative businesses, linking development to specific requirements for clean energy provision • Pro-active research and economic development support • Coordination of numerous initiatives and new cooperation models • Public relations campaigns for solar energy and for Freiburg as a center of expertise <p>There is a support program for home insulation and energy efficiency retrofits. All new houses build on city land must meet a new low-energy design standard that uses two thirds of the legally permitted limit (which in Germany is already low). The houses cost about 3% more to build, but their energy costs and CO₂ emissions fall by 30%.</p> <p style="text-align: center;"><i>(Source: http://www.solarregion.freiburg.de/solarregion/freiburg_solar_city.php)</i></p>

5.1.2 Fiscal and financial incentives:

To promote the RE/EE at local level Local Governments can also adopt the strategy of providing incentives. These incentives can be financial or fiscal in nature. For example, Thane Municipal Corporation has


introduced an incentive through a 10% reduction in property tax those owners that install solar water heating systems.

5.1.3 Persuasive and information instruments:

To accelerate development and deployment of RE/EE Programmes in communities, Local Governments can organize awareness-raising and training programmes. To raise awareness about Solar Water Heating systems, Thane Municipal Corporation is conducting workshops for housing societies, builders, developers and architects. The workshops

have received a very enthusiastic response. A positive development is that banks have come forward with interest-free loans. Non-governmental organizations, colleges and schools have also joined the initiative. They are holding regular meetings with housing societies and distributing pamphlets. The Cities of Bhubaneswar and Nagpur have established resource centers on renewable energy and energy efficiency to create a focal point for such activities in the city and generate awareness amongst citizens.

Table 9: Bhubaneswar and Nagpur Municipal Corporation's initiatives

Case description: Bhubaneswar and Nagpur in India	
Case Relevance: example of persuasive and information instrument- Establishment of Renewable energy and energy efficiency resource centers	
<p>The cities of Bhubaneswar and Nagpur are participating in the 'Local Renewables Model Communities Network' project as 'Model' cities.</p> <p>Within this project, 'Renewable Energy and Energy Efficiency Resource Centers' have been planned and established in Bhubaneswar and Nagpur. The purpose behind the Resource Centers is to establish a focal point of all RE/EE related activities in the city. They have developed a comprehensive database of information and physical exhibition of models related to RE and EE. These centers act as a platform where all requirements of a potential consumer (of RE/EE technologies and measures) are fulfilled directly or are directed to the relevant resources such as manufacturers, banks and consultants. The centers organize awareness-raising events like workshops, seminars, study visits, etc addressing different target groups like schools children, college students, municipal engineers, and building professionals. The resource centers are equipped with computers with an Internet connection to browse information from the web. The information material at the Resource Centers includes various reports, journals, training materials, VCDs, etc.</p> <p style="text-align: right;"><i>(Source: ICLEI)</i></p>	

5.1.4 Demonstration projects:

Some local governments have implemented pilot projects to demonstrate renewable

energy and energy efficiency options that work in the local climate, geography and general context. Table number 5, 6 and 7 describe such initiatives.

Table 10: Thane City's initiatives

Case description: Thane Municipal Corporation in India
Case Relevance: example of a combination of legal, fiscal, persuasive instruments and demonstration projects
<p>Thane city is acquiring a brand new image - an environmentally friendly makeover. Large-scale use of solar energy, which was considered a somewhat far-fetched concept, has brought real benefits and results in cost and energy savings. It is being applied to heat water, power traffic lights and advertising boards. Leading this unique experiment is the Thane Municipal Corporation. Two months ago, the corporation made it mandatory for all new buildings in the city to install solar water heating systems. This began nearly a year ago (2006) when they introduced solar panels at the Raja Gandhi Medical College. The system can heat 19,050 liters of water everyday. The electricity bill dropped by a remarkable Rs 9 Lakh (0.9 million). Buoyed by the success, the technology was soon adopted in other hospitals run by the corporation. "We showed that solar water heating can be commercially viable through this project," says Thane Municipal Commissioner Mr. Sanjay Sethi, the prime motivator behind the clean energy and energy conservation drive.</p> <p>Now the corporation is encouraging existing housing societies to install solar water heating systems. A 10% cut in property tax is being offered to those who adopt the measure. The cost varies with the size of the building — anything up to Rs 15 Lakh (1.5 million). However, Sethi says one can recover the cost in three years and the energy savings beyond that are dramatic. Those people who have installed it are very satisfied and support the move.</p> <p>To raise awareness, the corporation is also conducting workshops for housing societies, builders, developers and architects. Mr. Sethi says the workshops have received a very enthusiastic response. Even banks have come forward with interest-free loans. Non-governmental organizations, colleges and schools too have joined the initiative. They are holding regular meetings with housing societies and distributing pamphlets.</p> <p>While the corporation's solar water-heating project is ground-breaking, it has also adopted several energy conservation initiatives, which can be emulated in other cities. They are testing a project where advertising boards can be lit, powered by solar energy. This could clearly be of interest in neighbouring Mumbai, where lights on boards had to be switched off in the evenings this summer because of power shortage.</p> <p>The corporation has also adopted an elaborate system for street lighting, which automatically switches streetlights on and off. This is based on programmed information indicating how much light and traffic an area has at any given time of the night and how much lighting the area will need. The result in savings was Rs 6 crore (60 million) since the project was initiated two years ago. They are also working on a Union government-funded project to save energy in water pumping. There are plans to install solar panels to operate the city's 36 traffic signals as well.</p> <p>Mr. Sethi says his move has not only brought down electricity consumption, but also cut down on emissions of greenhouse gases like carbon dioxide. Even the Ministry of New and Renewable Energy Sources has lauded the efforts and circulated the Thane model as one to be followed by other cities. Thane has a limited number of local solar water heater manufacturers and given the expected demand, many entrepreneurs are now planning to set up shop in the city. At one point, Thane was seen as Mumbai's lesser cousin. However, these new initiatives have proven that the Big Brother can also learn a lesson or two. As do Delhi and other cities.</p> <p><i>(Source: http://www.outlookindia.com/mad.asp?fodname=20050801&fname=Making&sid=1)</i></p>

Table 11: Bhubaneswar Municipal Corporation's Building Energy Efficiency Project

Case description: Bhubaneswar Municipal Corporation, India
Case Relevance: Example of demonstration project- Building Energy Efficiency
<p>Energy consumed by buildings is one of the areas where there is a tremendous potential to not only reduce demand, but also to achieve reduction in Greenhouse Gas (GHG) emissions - by planning for energy efficiency. Looking at the potential of building energy efficiency Bhubaneswar Municipal Corporation recommended ICLEI to carry out Pilot Project on saving energy in their Building under Cities for Climate Protection (CCP) campaign.</p> <p>Under the scope of the project on "Building Energy Efficiency", a two-month pilot project was taken up with installation of 50 KVA (kilovolt amperes) power savers during May 2005. The pre-project monitoring was done for a month to establish present energy consumption and another one month monitoring was done after installation of power saver on 2 June 2005.</p> <p>The pre-project monitoring showed 291 kWh average daily energy consumption during 4 to 31 May 2005.</p> <p>The seven weeks of post-project monitoring showed a daily average consumption of 251.26 kWh, which was about 13.65 % i.e. 40 kWh less than the pre-project daily average energy consumption.</p> <p>During the seven weeks after installation of power saver corporation had saved 1947.26 units of electricity amounting to Rs 8,762 (@ Rs 4.5 per unit). However, the installed power savers were expected to reduce energy consumption by 20%. These power savers also act as a protection devise thus saving a lot on maintenance and increasing the life of electrical equipment installed in the building.</p> <p style="text-align: center;"><i>(Source: ICLEI)</i></p>

Table 12: Guntur Municipal Corporation's Energy Efficient Street Lighting Project

<p>Case description: Guntur Municipal Corporation (GMC), India</p> <p>Case Relevance: Example of demonstration project - Energy Efficient Street Lighting through Power Savers</p>
<p>This pilot project was supported by ICLEI under an agreement with GMC, which provided that once the results of the pilot project were substantiated GMC would implement its recommendations across the entire city phase-by-phase. The "Energy Efficient Street Lighting System", a two-month pilot project with a capacity of 35 KVA and using Servo Max power saver instruments, was initiated on 4 March 2003. The locations for the pilot project in Guntur included Hindu College, Ponnur Road, Shankar Vilas, and Krishna Picture Palace.</p> <p>Servo Max power saver instruments were specially designed for the four specified locations and, in particular, to suit each unique lighting load. The pilot project was designed to last two months, thereby providing two weeks for readings without Power Saver (i.e. weeks 1 and 8) and six weeks for readings with Power Saver (i.e. weeks 2 through 7), for a total period of eight weeks of observation.</p> <p>The data gathered during the two-month period under the pilot project suggests that there is a definite energy savings associated with the implementation of Power Saver technology. The annual energy savings from Power Saver in the four test locations was estimated to be Rs. 82 431.</p> <p style="text-align: right;"><i>(Source: ICLEI)</i></p>

5.2 Measures available with cities

for reduction of greenhouse gases

Below is a sector-by-sector list of opportunities available for cities to reduce energy consumption and greenhouse gas emissions in their community and in the corporations' own facilities and operations (municipal sphere). These opportunities vary as per conditions prevailing and local applicability in the city.

5.2.1 Local government's operations

Given the responsibilities and powers of Indian local governments, at Municipal Corporation level, streetlights and water supply are the major area of intervention for reduction of energy consumption. With a share of more than 50%, streetlights contribute a major share of electricity consumption in the Municipal Corporation sector. The streetlight and water supply sectors together share more than 85% of total carbon emission at Municipal Corporation level, and both the sectors have excellent potential for reducing electricity consumption and thus the

electrical charges by employing renewable energy and energy efficiency technology and measures.

Buildings

- Regular building energy audits to monitor use, and identify problem areas
- Comprehensive municipal retrofit of existing buildings, parks, stadiums, markets, e.g. lighting, insulation, HVAC (heating, ventilation and air conditioning) systems.
- Lighting efficiency improvements (low energy bulbs, movement sensors to switch light on when needed).
- Energy efficiency standards for renovations and new construction of municipal buildings.
- Rooftop gardens, greening of building surroundings for cooling.
- Use rooftop space for energy generation through PV and solar thermal systems.
- Building-specific fuels switch from electricity to natural gas.
- Implement co-generation or heat recovery.
- Procurement policies that specify energy efficiency standards in all purchasing and bid specs for office equipment, motors, lighting, appliances, etc.
- Energy conservation - reducing use of unnecessary electrical equipment, and inform staff of options to conserve energy.

Street Lighting

- Replace existing lighting with energy-efficient and low-wattage lamps and ballast.

- Reduce energy use through reducing hours of operation and/or number of lights.
- Solar photovoltaic (PV) powered street and emergency lighting.
- Switch traffic signals, exit signs from incandescent bulbs to Light Emitting Diodes (LEDs).

Procurement

- Modify purchasing policies to specify energy efficiency standards in all purchasing and bid specs for office and heavy equipment, motors, lighting, appliances, etc.
- Purchase “green power” and specify renewable energy content for local government operations- Consider joint procurement consortia with other municipalities to do bulk purchasing and bring down the price of products.

Vehicle

- Improve scheduling and route efficiency. Change procurement policy to specify high fuel efficiency for each vehicle class. Improve maintenance regime for increased efficiency, e.g. regularly check tire pressure. Encourage use of bicycles and walking for short trips. Change to biofuel, or other fuels that have a lower CO2 impact.

Water

- Comprehensive energy audit of Municipal water pumping.
- Energy-efficient retrofit of facilities, especially pumping processes.
- Energy-efficient specifications for new construction of sewage and waste water system.
- Process changes to improve energy-efficiency of treatment of drinking water, wastewater and sewage.
- Change energy source from electricity to natural gas or photovoltaic for existing operations.

Waste

- Increase office recycling, e.g. paper, cardboard, cans, glass bottles, toner cartridges
- Recover food waste in cafeterias and kitchens of local government buildings for composting or other use (bio-energy).
- Waste prevention in day-to-day operations — print only when really needed, double sided copying, reduced paper requirements, etc.
- Purchasing preferences for recycled materials.
- Compost park, street, and other landscaping debris for re-use by Parks and Recreation.

5.2.2 At community level

Buildings

- Use of energy efficient techniques during design and construction of buildings. Example: Passive solar

design, optimum orientation, suitable insulation for buildings to minimize HVAC needs.

- Energy efficient retrofit in existing building stock at time of sale.
- Use of energy efficiency devices, such as low-flow showerheads, compact fluorescent bulbs, lighting occupancy sensors, etc.
- Greening, rooftop gardens, and tree planting program to maximize shading of buildings.
- Cooperative or aggregate purchase or buyer program for lighting, efficient equipment.

Industrial Sector

- Energy efficiency requirements for new industrial permits
- Implement energy conservation programs in the industries.
- Lower business fees or waiving permits for energy efficiency improvements and fuel switching (including use of solar energy), heat recovery/co-generation systems.
- Provide energy services to industry, e.g. audits, assessments to recommend process changes, other energy efficiency improvements.

Transportation Sector

- Implement policy shifting funding away from roads and highways to alternative transit
- Increase use of alternative transit - public transit, van- or car pooling, cycling, walking.
- Funding for facility, system and/or infrastructure improvements.

- Dedicated lanes for transit/HOV vehicles.
- Work with transit authority to reduce public transit fares.
- Establish solar PV or other electric vehicle charging station.
- Establish or facilitate road tolls to decrease motor vehicle use.

Waste Sector

- Establishment of centers for reusing salvageable goods.
- Home composting education program.
- Compost bin distribution.
- Collection of residential and commercial recyclable waste.
- Community recycling drop-off sites.
- Landfill methane collection program

Summary

To mitigate the energy problems of cities and to provide alternative energy solutions for industrial and commercial establishments, it is very important to focus on the development and application of renewable energy technologies and energy efficient systems and measures. A combination of the right technology and correct human behaviour is needed.

Local governments are effective in promoting the generation of energy from renewable resources. With their executive power they can implement sustainable energy at a locally appropriate level, and also encourage the local community to switch to renewables.

Indian local governments have the following existing instruments that can be used for promoting RE and EE at the local level:

- Legal
- Fiscal and Financial incentives.
- Persuasive (Organizing Awareness Programme etc).
- Demonstration projects

At Municipal Corporation level there are many measures available for reducing energy consumption and improving their quality and reliability of power supply. At Municipal Corporation level, streetlights and water supply are the major area of intervention for reduction of Energy consumption. Some of the opportunities available are in buildings, street lighting, water pumping, and waste at corporate level while at community level buildings, industrial, transportation etc.

6. Annexes

Annexure – I

Abbreviations

	Abbreviations
ADB	Asian Development Bank
AIEI	Association of Indian Engineering Industries
APERC	Andhra Pradesh Electricity Regulatory Commission
ASTM	American Society for Testing and Materials
BEE	Bureau of Energy Efficiency
BkWh	Billion Kilowatt hours
BM	Biomass
BMZ	German Federal Ministry for Economic Cooperation and Development
BOV	Battery-Operated Vehicles
CASE	Commission for Additional Sources of Energy
CEA	Center Electricity Authority
CFA	Central Financial Assistance
CFL	Compact Florescent Lamp
CII	Confederation of Indian Industries
C-MET	Centre for Materials for Electronics Technology
Cogen	Cogeneration
DDA	Delhi Development Authority
DPR	Detailed Project Report
DSM	Demand-side management
EE	Energy Efficiency
EEPS	Energy efficiency portfolio standards
ESCOs	Energy Service Companies
FED	Full Energy Delivery
FICCI	Federation of Indian Chambers of Commerce and Industry
FIPB	Foreign Investment Promotion Board
FIs	Financial Institutions
GBC	Green Business center
GEF	Global Environment Fund
GHG	Green House Gas
GMC	Guntur Municipal Corporation's

GO	Govt. Orders
GTZ	Gesellschaft für Technische Zusammenarbeit
HVAC	Heating, Ventilation and Air Conditioning
ICICI	Industrial Credit and Investment Corporation of India
ICPEEB	Indian Council for Energy Efficiency Business
IDBI	Industrial Development Bank of India
IIT	Indian Institute of Technology
IREDA	Indian Renewable Development Agency
IREP	Integrated Rural Energy Programme
ISCC	Integrated Solar Combined Cycle
KERC	Karnataka Electricity Regulatory Commission
KVA	Kilovolt amperes
KVIC	Khadi and Village Industries Commission
LED	Light Emitting Diodes
LEED	Leadership in Energy and Environmental Design
MCs	Municipal Corporation
MERC	Maharashtra Electricity Regulatory Commission
MKWh	Million Kilowatt hour
MMT	Million metric tones
MNES	Ministry of Non-Conventional Energy Sources
MPERC	Madhya Pradesh Electricity Regulatory Commission
MSW	Municipal Solid Waste
MT	Magneto-Telluric
Mtoe	Million tones of oil equivalent
MW	Mega Watt
NGO	Non-governmental organizations
NGRI	National Geophysical Research Institute
NPC	National Productivity Council
NRSE	New and Renewable Sources of Energy
OERC	Orissa Electricity Regulatory Commission
PCRA	Petroleum Conservation Research Association
PED	Partial Energy Delivery
PHWR	Pressurized Heavy Water Reactors
R&D	Research & development
RD&D	Research, development and demonstration

RE	Renewable Energy
RETs	Renewable Energy Technologies
RRECL	Rajasthan Renewable Energy Corporation Limited
SEBs	State Electricity Board
SERC	State Electricity Regulatory Commission
SHP	Small Hydro Power
SLS	Solar Street Light
SMEs	Small and medium enterprises
SNAs	State Nodal Agencies
SPV	Solar Photovoltaic
SWHS	Solar water heating systems
Tcf	Trillion Cubic Feet
TERI	The Energy and Resources Institute
UPS	Uninterruptible Power Supply
USAID	United States Agency for International Development
WET	Wind Energy Technology
WTE	Waste To Energy

Annexure II

Table 13: List of State Nodal Agencies

<p>ANDHRA PRADESH Non-conventional Energy Development Corporation Of Andhra Pradesh Ltd (NEDCAP),5-8-207/2, PISGAH Complex, Namapalli, Hyderabad- 500 001 Tel : 040-2320 2391-3692,Fax : 040-2320 1666,Email : nedcap@ap.nic.in</p>	<p>ARUNACHAL PRADESH Arunachal Pradesh Energy Development Agency Post box No.141, Itanagar - 791 111 Tel : 0360-211160 Fax : 0360-214426</p>
<p>A & N ISLANDS Department of Non-conventional Energy Sources Prothrapur, Port Blair-744101 Tel : 03192-32404, 32685 Fax : 03192-33365</p>	
<p>ASSAM North East Renewable Energy Sources Pvt. Ltd. Anuradha Complex, Guwahati-781 021 Tel : 0361-550292 Fax : 0361-550989</p>	<p>BIHAR Bihar Renewable Energy Development Agency Shikarpur House, Dr.T.N.Banerjee Road, Chajubagh, Patna-800 001 Tel : 0612-2332572 Fax : 0612-223983</p>
<p>CHANDIGARH Department of Science & Technology Chandigarh Administration, Additional Town Hall Building, Sector-17C, Chandigarh-160001</p>	<p>CHHATTISGARH Government of Chhattisgarh, CREDA DKS Bhawan, G Road, Raipur-492 001, Chhattisgarh State Tel/Fax : 0771-221207, 222206/08</p>
<p>DELHI Delhi Energy Development Agency 37, Tughlakabad Institutional Area Near Batra Hospital, New Delhi-110 067</p>	<p>GOA Rural Development Agency Dr. KuchadRail's Building 2nd Floor, Dr. Malacca Road Panaji</p>
<p>GUJARAT Gujarat Energy Development Agency (GEDA) Suraj Plaza, Part-II, 2nd floor, Sayaji Gunj, Vadodra-390 005 Tel : 0265-363123,Fax : 0265-363120</p>	<p>HARYANA Haryana State Energy Development Agency (HAREDA), SCO 48, Sector 26, Chandigarh-160 019,Tel : 0172-778911,778917,88918,778928 Fax : 0172-778928,Email : hareda@chd.nic.in</p>
<p>HIMACHAL PRADESH HIMURJA H.P.Govt.Energy Dev. Agency Urja Bhawan, SDA Block No.8-A, Kasumpti, Shimla - 171 009 Tel : 0177-221430, Fax : 0177-221783</p>	<p>JAMMU & KASHMIR Jammu & Kashmir Energy Development Agency Govt. of Jammu & Kashmir Jammu</p>
<p>JHARKHAND Government of Jharkhad HEC Project building Dhruva, Ranchi-834 001 Tel : 0651-403240 Fax : 0651-403255</p>	<p>KARNATAKA Karnataka Renewable Energy Development Ltd. (KREDL),No.1 Coffee Board Building, Dr. B.R.Ambedkar Veedhi Bangalore-560 001 Tel : 080-22282220/2221,Fax : 080-22257399</p>

	Email : kredl@bir.vsnl.net.in
KERALA Agency for Non-conventional Energy and Rural Technology (ANERT) Post Box No. 1094, Kesavadasapuram, Thiruvananthapuram-695 004 Tel : 0471-49854, 440121, 440122 Fax : 0471-449854	LAKSHADWEEP Department of Electricity Lakshadweep Administration Union territory of Lakshdweep Kavarati-673 555 Tel : 04896-62127 Fax : 04896-62936, 62140
MADHYAPRADESH Madhya Pradesh Urja Nigam Ltd. Urja Bhawan, B-Block, Main Road No.2, Shivaji Nagar, Bhopal-462 016 Tel : 0755-2556245, 2553595 Fax : 0755-2553 5584	MAHARASHTRA Maharashtra Energy Development Agency (MEDA),MHADA Commercial Complex, 2nd Floor, Opp. Tridal Nagar, Yerawada, Pune-411006,Tel : 020-668 3633/3634 Fax : 020-668 3631,Email : meda@vsnl.com
MEGHALAYA Meghalaya Non-conventional & Rural Energy Development Agency Lower Lachumiere Opp. P&T Dispensary Shillong-793 001	MIZORAM Power Department Govt. Of Mizoram Aizwal-796001
PUNJAB Punjab Energy development Agency (PEDA) SCO 54-56, Sector 17-C Chandigarh-160036	RAJASTHAN Rajasthan Renewable Energy Corporation Ltd. (RRECL),(Formerly REDA & RSPCL) E-166, Yudhisthir Marg, C-Scheme, Jaipur-302 004,Tel : 0141-384055, 384077 Fax : 0141-381528
NAGALAND Govt. of Nagaland Power and Science and Technology Department Kohima-797 001	ORISSA Orissa Renewable Energy Development Agency (OREDA) S-3/59, Mancheswar Industrial Estate, Bhubaneswar-751 010,Tel : 0674-580660, 580558,Fax : 0674-580368

Source: www.mnes.nic.in

Annexure III

Table 14: List of Financial Institutes

Industrial Credit & Investment Corporation of India Ltd., ICICI Building, 163, Backbay Reclamation, Churchgate, Mumbai - 400 020 Fax 022-2046582
Industrial Finance Corporation of India, Bank of Baroda Building, 16, Sansad Marg, New Delhi - 110 001. Tel. 3320425, Fax 3323143
Power Finance Corporation, Chandralok Building, Janpath, New Delhi - 110 001. Tel. 4361851, 4361562 Rural Electrification Corporation Core 4, Scope Complex, 7, Lodi Road, New Delhi-110 003
Industrial Development Bank of India, IDBI Tower, Caffe Parade, Mumbai-400005 Fax 022-2182562
Infrastructure Leasing and Finance Services Ltd., Mahindra Towers, 4 th Floor, Dr. G.M. Bhosale Marg, Worli, Mumbai - 400 018. Tel. 4935127, 4964353, Fax 493 0080

Source: www.mnes.nic.in

Annexure IV: Financial Incentives

Incentives for Biomass Power Generation

Table 15: Fiscal incentives for Biomass Power Generation

Item	Description
Accelerated Depreciation	<ul style="list-style-type: none"> ▪ 80% depreciation in the first year can be claimed for the following equipment required for co-generation systems: ▪ Back pressure, pass-out, controlled extraction, extraction-cum-condensing turbine for co-generation with pressure boilers ▪ Vapor absorption refrigeration systems ▪ Organic rankine cycle power systems ▪ Low inlet pressures small steam turbines
Income Tax Holiday	<ul style="list-style-type: none"> ▪ Five year tax holiday with 30% exemption in the next 5 years for power generation projects with PPAs
Customs Duty	<ul style="list-style-type: none"> ▪ Duty leviable for NRSE power projects of less than 50 MW capacity (under Project Import Category) is 20% ad valorem.
General Sales Tax	<ul style="list-style-type: none"> ▪ Exemption is available in certain States

Source: <http://www.mnes.nic.in/frame.htm?publications.htm>

Financial incentives- Pattern of financial assistance/incentives for setting up of Biomass Power / Cogeneration projects

Table 16: Interest Subsidy for Bagasse / Biomass Cogeneration Projects

Bagasse Co-generation (Commercial Projects)			
	Schemes	Pressure Configuration	Interest Subsidy
1.	Projects by Cooperative/Public/ Joint Sector Sugar Mills	40 bar & above	3%
		60 bar & above	4%
		80 bar & above	5%
2.	Projects in IPP Mode in Cooperative/Public Sector Sugar Mills	60 bar & above	2%
		80 bar & above	3%
3.	Projects by Private Sector Sugar Mills	60 bar & above	2%
		80 bar & above	3%
Biomass Co-generation			
4.	Commercial Projects	60 bar & above	2%
		80 bar & above	3%
For Bagasse Cogeneration by Cooperative/Public Sector Sugar mills, the floor rates of interest shall not be lower than 8%, otherwise 10% for general category of projects			

Source: <http://www.mnes.nic.in/frame.htm?publications.htm>

Table 17: Interest Subsidy for Biomass Power Projects (Commercial Projects)

Biomass Power			
	Schemes	Pressure Configuration	Interest Subsidy
1.	Commercial Projects (Direct Combustion, including captive power)	60 bar & above	2%
		80 bar & above	3%
2.	Commercial Projects (Atmospheric Gasification including captive power)	--	2%
3.	MW-Scale projects with 100% Producer Gas Engines	Capital Subsidy of Rs.1.00 Cr./MW	
4.	Advanced Biomass Gasification	Capital Subsidy of Rs.1.00 Cr./MW	

Source: <http://www.mnes.nic.in/frame.htm?publications.htm>

Biomass Power projects in North-Eastern States & Sikkim, additional interest subsidy @2% will be provided subject to floor rates of interest shall not lower than 8%, otherwise 10% for general category of projects.

District-wise Resource Assessment Studies

Financial assistance @ Rs.75,000.00 – Rs.1,00,000.00 per district depending on size of the district.

Promotional Incentives

Table 18: Promotional incentives for Biomass Power / Cogeneration projects

Business Meets, Seminar, Training etc.	Rs.1.00-Rs.3.00 lakh/event
State Nodal Agencies	Rs.0.50 lakh/MW; max. Rs.5.00 lakh/project
Consultancy Firms	Rs.1.00 lakh/MW; max. Rs.5.00 lakh/project

Source: <http://www.mnes.nic.in/frame.htm?publications.htm>

Table 19: Financial Assistance Provision under Biomass Gasifier Programme

Financial Assistance provision under Biomass Gasifier Programme During 2004-05	
Type Of Application	Capital Subsidy
(a) Biomass Gasifier for Thermal and Electrical Applications	
i) Thermal Application including cooking (upto 3 MWth)	i) Rs. 1.25 lakh/300 KWh for thermal application on pro-rata basis , or in multiplies thereof
ii) Electrical application , including pumping and capative power, with provision for surplus power to grid (upro 1 MW)	ii) Rs. 1.50 lakh/100 KW for electrical application, including pumping and capative power on pro rata basis or in multiplies therof with provision of surpluspower to grid
(b) Use of 100 % Producer Gas Engines couples with biomass Gasifier for power production	
<p>CFA of Rs. 15 lakh per 100 KW , on pro rata basis is providede on the gas engine and Gasifier system. CFA of Rs.10 lakh per 100 kW on pro-rata basis is provided for the projects involving gas enegine alone. Balance cost of the projects is to be met by the user agency . 20% higher CFA is provided for such projects in all the special category states and islands</p>	
(C) Conversion of existing power plants in North –East Region / Islands to Biomass Gasifier for power production	
<p>The programme aims at conversion of existing D.G sets to dual – fuel mode of operation in conjunction with biomass gasifier in the special Category States and Islands. This will reduce the dependance on diesel for power generation in such remote areas. A total CFA of Rs. 10.00 lakh per 100 KW Project for the gasifier system and for the conversion of D.G set to dual –fuel mode of operation is provided, on pro-rata basis , or in multiple therof</p>	
(d) Promotional Activities: Support is provided for Preparation of Detailed Project Reports, Organization of Business Meets/ Seminars, Workshop, Orientation / Training Programme	

Source: MNRE Annual Report(2005-06)

Table 20: Central Financial Assistance under National Biogas Programme

Central Financial Assistance Under National Biogas Programme for 2004-05				
Turn –Key Job Fee	Turn Key job fee at the rate of Rs.8.00 per biogas plants is payable in North Region States, (Excluding plain areas of Assam ,Sikkim , Jammu & Kashmir , Himachal Pradesh , uttranchal Hilly districts and Islands. Turn Key Job fee at the rate of Rs. 7.00 per biogas plants is payable in other states and areas			
Household toilet Naked biogas plants	Additional subsidy at the rate of Rs. 5.00 per plant is given for the linking cattle dung based biogas plants with sanitary toilets.			
Incentives for savings diesel by using biogas in dual fuel engines	Incentives is available for the purchase of a kit to modify diesel engine into dual engine . Financial support would also be given for the purchase of plastic or rubber balloons / container for storage and transportation of biogas from the site of the plant to site of the engine, subject to a maximum of Rs. 2500 per plant.			
Service Charges/ staff support	Service Charges are paid at the following rates to the State Governments/ Implementing agencies, except North –Eastern States , Sikkim & Jammu & Kashmir. The rates are linked with a given target angle allocated to the states and agencies.			
	Target Range	Amount of Services Charges		
	100-300	Rs. 0.5 lakh + Rs. 300/- per plant in excess of 200 plants		
	3001-7000	Rs. 8.90 lakh + Rs. 100/- per plant in excess of 3000 Plants		
	Above 7001	Rs. 14.90 lakh+Rs. 100/-per plant in excess of 7,000 Plant		
	For the North – Eastern States, Jammu & Kashmir, 100 % Central grant for the sanctioned staff is available for the implementation of Programme.			
Training Courses	Financial Support is given for organizing different type of training courses as mentioned below:			
	Course	Duration	No. of trainees/courses	CFA /Course
	User	One Day	50-60	Rs. 1000
	Staff	2-3 Days	10-15	Rs. 5000
	Refresher	16 Days	10	Rs. 19000
	Turn –Key Workers	21 Days	10	Rs. 38,500

Central Financial Assistance Under National Biogas Programme for 2004-05

Biogas Development Traning Centres (BDTCs)	Financial support will be provided to Biogass Development and training Centres (BDTCs) towards staff, TA/DA consumables and contingency and for conducting different training different programmes as per allocated targets.								
Communication And publicity	Financial support is provided for the communication and publicity purposes on lump-sum basis linked with the target ranges allocated to States/Agencies as per details is given below								
	<table border="0" style="width: 100%;"> <tr> <td style="text-align: left;">Target ranges (no.of plants)</td> <td style="text-align: right;">Support for communication & Publicity</td> </tr> <tr> <td style="text-align: left;">Up to 1,000</td> <td style="text-align: right;">Rs. 1.00 lakh</td> </tr> <tr> <td style="text-align: left;">1001 – 10,000</td> <td style="text-align: right;">Rs. 2.50 lakh</td> </tr> <tr> <td style="text-align: left;">More than 10,000</td> <td style="text-align: right;">Rs. 5.00 lakh</td> </tr> </table>	Target ranges (no.of plants)	Support for communication & Publicity	Up to 1,000	Rs. 1.00 lakh	1001 – 10,000	Rs. 2.50 lakh	More than 10,000	Rs. 5.00 lakh
Target ranges (no.of plants)	Support for communication & Publicity								
Up to 1,000	Rs. 1.00 lakh								
1001 – 10,000	Rs. 2.50 lakh								
More than 10,000	Rs. 5.00 lakh								
Support for repair of old Non Functional plants	Financial support limited to 50 % of the rate of Central subsidy , as applicable for different categories of beneficiaries and areas , is available for repair of plants that have been used for a period of at least five years and thereafter developed structural defects								

Source: MNRE Annual Report (2004-05)

Table 21: Financial Support Under Solar Cooker Programme

Financial Support Under Solar Cooker Programme			
A. Promotional Scheme			
I) Incentives to State Nodal Agencies (SNAs) and associated promoters for the production activities / services charges, etc			
Type of solar cooker sold	Incentives/ cooker to SNAs If the sale is made by SNAs	Incentives /cooker if the Sale made by associated	
		SNAs	Associated Promoters
ISI marked box solar cooker	Rs.200	Rs. 100	Rs.100
Non ISI box solar cookers but Approved	Rs.100	Rs. 50	Rs. 50
ii) Support to repeat NGOs/ universities / institutions/ Regional Test Centres etc.			
Up to a maximum of Rs. 1.50 lakh, towards organization of promotional activities like publicity, cooking demonstrations/ competitions, seminars/workshop, evaluation studies , development of improved models , etc on solar cookers based on specific proposals received from them in the prescribed format			
(This support is also extended to SNAs for organizing workshop/seminars/business meets on solar cookers)			
iii) Support to manufacturer for taking BIS approval			
Reimbursement of BIS fee (including application and marketing fee and test charges), directly by MNES (MNRE) on 100 % basis during 1 st year and on 50 % basis during further years of 10 th plan (subject to modification, if any), on submission of approval certificate and copies of necessary bills /receipt issued by BIS.			
B) Demonstration Scheme on Installation of Concentrating Solar Cookers			
Type of Solar Cooker	Support to Users	Service charges to SNAs for Implementation & monitoring	
Dish Solar Cookers (Minimum diameters 1.4 m)	50 % of total cost, limited to Rs. 2500/- per cooker	Rs. 250 per cooker	
Community solar cooker For indoor cooking (minimum Aperture areas 7 sq.m)	50% of eligible capital cost limited to Rs. 22,5000/- per cooker	Rs. 2500 per cooker	
Solar Steam Cooking System	50% of eligible capital cost, as agreed upon by the ministry Capacity,	1-2 % of MNES support depending on the system	

Source: MNRE Annual Report 2004-05

Pattern of Financial Assistance for SPV systems

Table 22: Pattern of Financial Assistance for SPV systems

SPV System	CFA for GENERAL AREAS 50% of the cost subject to a maximum of	CFA for NE & SPECIAL AREAS 90% of the cost subject to a maximum of	Service Charge
Solar Lanterns (10 W module, 7 W CFL)	Nil	Rs. 2,400	Rs. 100
Solar Home System Model 1 (18 W Module, 1 light)	Rs.2500	Rs.4500	Rs.200
Solar Home System Model 2 (37 W Module, 2 lights)	Rs.4800	Rs.8660	Rs.200
Solar Home System Model 3 (37 W Module, 1 light, 1 fan)	Rs.4800	Rs.8660	Rs.200
Solar Home System Model 4 (74 W Module, 2 lights, 1 fan)	Rs.4800	Rs.8660	Rs.200
Solar Home System Model 5 (74 W Module, 4 lights)	Rs.4800	Rs.8660	Rs.200
Street Lighting System (74 W Module, 1-2 lamps)	Rs.9600	Rs.17300	-
Stand Alone Power Plant of capacity more than 1 kWp	Rs. 1,25,000 / kWp	Rs. 2.25,000 / kWp	Rs. 10,000
Stand Alone Power Plants of capacity more than 10 kWp with Distribution Line	Rs.1,50,000 /kW	Rs.2,70,000 / kW	Rs.10,000

Source: <http://www.mnes.nic.in/frame.htm?publications.htm>

Eligible Categories of Beneficiaries For Central Subsidy

Table 23: Eligible categories of Beneficiaries for Central Subsidy for SPV systems

SPV System	Eligible Category of Beneficiaries
Solar Lanterns	All households in unelectrified villages of special category states
Solar Home Systems	All Categories of individual beneficiaries & non profit institutions / organizations. (Except for beneficiaries from remote un-electrified census villages) No individual would be given more than one system
Street Lighting Systems	All categories of non – commercial institutions / organizations, State Nodal Agencies, Electricity Boards, Panchayats, Zilla Parishads and DRDAs. (Except for beneficiaries from remote un-electrified census villages and urban municipalities)
SPV Power Plants / Other Systems	All categories of non- commercial institutions / organizations, State Nodal Agencies, Electricity Boards, Panchayats, Zilla Parishads and DRDAs.(Except for beneficiaries from remote un-electrified census villages and urban municipalities)

Source: <http://www.mnes.nic>.

Annexure V

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