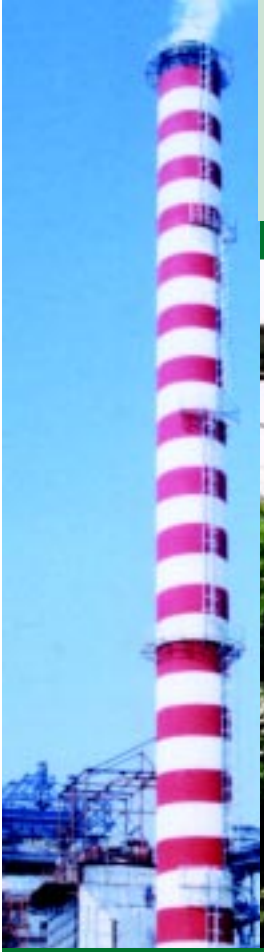

Government of India
Ministry of Non-Conventional Energy Sources

2

Biomass

Dr Manmohan Singh

Prime Minister of India

'Energy is an important input for economic development. Since exhaustible energy sources in the country are limited, there is an urgent need to focus attention on development of renewable energy sources and use of energy efficient technologies. The exploitation and development of various forms of energy and making energy available at affordable rates is one of our major thrust areas.'

Smt. Sonia Gandhi

Chairperson, National Advisory Council

'Today India is one of the few leading countries in the development and utilization of renewable energy. The country is blessed with various sources of non-conventional energy and I hope the efforts of Ministry of Non-Conventional Energy Sources will promote viable technologies that can reach the benefits of such sources to the poorest people in the far-flung regions of the country.'

Renewable Energy in India

Energy is a basic requirement for economic development. Every sector of Indian economy – agriculture, industry, transport, commercial, and domestic – needs inputs of energy. The economic development plans implemented since independence have necessarily required increasing amounts of energy. As a result, consumption of energy in all forms has been steadily rising all over the country.

This growing consumption of energy has also resulted in the country becoming increasingly dependent on fossil fuels such as coal and oil and gas. Rising prices of oil and gas and potential shortages in future lead to concerns about the security of energy supply needed to sustain our economic growth. Increased use of fossil fuels also causes environmental problems both locally and globally.

Against this background, the country urgently needs to develop a sustainable path of energy development. Promotion of energy conservation and increased use of renewable energy sources are the twin planks of a sustainable energy supply.

Fortunately, India is blessed with a variety of renewable energy sources, the main ones being biomass, biogas, the sun, wind, and small hydro power. (Large hydro power is also renewable in nature, but has been utilized all over the world for many decades, and is generally not included in the term 'new and renewable sources of energy'.) Municipal and industrial wastes can also be useful sources of energy, but are basically different forms of biomass.

Advantages of renewable energy are that it is

- perennial
- available locally and does not need elaborate arrangements for transport
- usually modular in nature, i.e. small-scale units and systems can be almost as economical as large-scale ones
- environment-friendly
- well suited for decentralized applications and use in remote areas.

The Ministry of Non-Conventional Energy Sources has been implementing comprehensive programmes for the development and utilization of various renewable energy sources in the country. As a result of efforts made during the past quarter century, a number of technologies and devices have been developed and have become commercially available. These include biogas plants, improved wood stoves, solar water heaters, solar cookers, solar lanterns, street lights, pumps, wind electric generators, water-pumping wind mills, biomass gasifiers, and small hydro-electric generators. Energy technologies for the future such as hydrogen, fuel cells, and bio-fuels are being actively developed.

India is implementing one of the world's largest programmes in renewable energy. The country ranks second in the world in biogas utilization and fifth in wind power and photovoltaic production. Renewable sources already contribute to about 5% of the total power generating capacity in the country. The major renewable energy sources and devices in use in India are listed in Table 1 along with their potential and present status in terms of the number of installations or total capacity.

Table 1

Renewable energy in India at a glance

Source/System	*Estimated potential*	*Cumulative installed capacity / number**
Wind power	45 000 MW	3595 MW
Biomass power	16 000 MW	302.53 MW
Bagasse cogeneration	3500 MW	447.00 MW
Small hydro (up to 25 MW)	15 000 MW	1705.63 MW
Waste to energy		
▪ Municipal solid waste	1700 MW	17 MW
▪ Industrial waste	1000 MW	29.50 MW
Family-size biogas plants	12 million	3.71 million
Improved chulhas	120 million	35.20 million
Solar street lighting systems	–	54 795
Home lighting systems	–	342 607
Solar lanterns	–	560 295
Solar photovoltaic power plants	–	1566 kWp
Solar water heating systems	140 million m^2 of collector area	1 million m^2 of collector area
Box-type solar cookers	–	575 000
Solar photovoltaic pumps	–	6818
Wind pumps	–	1087
Biomass gasifiers	–	66.35 MW

* as on 31 March 2005


राजीव गांधी
एवं विशेष डाक टिकट











National Electricity Policy 2005

The National Electricity Policy aims at achieving the following objectives.

1 Access to Electricity – available for all households in the next five years.
2 Availability of Power – demand to be fully met by 2012. Energy and peaking shortages to be overcome and spinning reserve to be available.
3 Supply of reliable and quality power of specified standards in an efficient manner and at reasonable rates.
4 Per capita availability of electricity to be increased to over 1000 units by 2012.
5 Minimum lifeline consumption of 1 unit/household/day as a merit good by 2012.
6 Financial turnaround and commercial viability of electricity sector.
7 Protection of consumers' interests.

The Electricity Act 2003

The Electricity Act contains the following provisions pertaining to non-conventional energy sources.

Sections 3(1) and 3(2)

Under Sections 3(1) and 3(2), it has been stated that the Central Government shall, from time to time, prepare and publish the National Electricity Policy and Tariff Policy, in consultation with the state governments and authority for development of the power system based on optimal utilization of resources such as coal, natural gas, nuclear substances or material, hydro and renewable sources of energy.

Section 4

Section 4 states that the Central Government shall, after consultation with the state governments, prepare and notify a national policy, permitting stand-alone systems (including those based on renewable sources of energy and other non-conventional sources of energy) for rural areas.

Section 61

Section 61, 61(h) and 61(i) state that the appropriate commission shall, subject to the provision of this Act, specify the terms and conditions for the determination of tariff, and in doing so, shall be guided by the following, namely, the promotion of cogeneration and generation of electricity from renewable sources of energy; and the National Electricity Policy and Tariff Policy.

Section 86(1)

Section 86(1) and 86(1)(e) state that the state commissions shall discharge the following functions, namely, promote cogeneration and generation of electricity from renewable sources of energy by providing, suitable measures for connectivity with the grid and sale of electricity to any person, and also specify, for purchase of electricity from such sources, a percentage of the total consumption of electricity in the area of a distribution license.

Biomass

Introduction

Biomass has been one of the main energy sources for the mankind ever since the dawn of civilization, although its importance dwindled after the expansion in use of oil and coal in the late 19th century. There has been a resurgence of interest in the recent years in biomass energy in many countries considering the benefits it offers. It is renewable, widely available, and carbon-neutral and has the potential to provide significant productive employment in the rural areas. Biomass is also capable of providing firm energy. Estimates have indicated that 15%–50% of the world's primary energy use could come from biomass by the year 2050. Currently, about 11% of the world's primary energy is estimated to be met with biomass.

For India, biomass has always been an important energy source. Although the energy scenario in India today indicates a growing dependence on the conventional forms of energy, about 32% of the total primary energy use in the country is still derived from biomass and more than 70% of the country's population depends upon it for its energy needs.

The Government of India, through its Ministry of Non-Conventional Energy Sources (MNES), has been aware of the potential and role of biomass energy in the Indian context and hence has initiated a number of programmes for promotion of modern technologies for its use in various sectors of the economy to ensure derivation of maximum benefits. Biomass power generation in India is an industry that attracts investments of over Rs 600 crores every year, generating more than 5000 million units of electricity and yearly employment of more than 10 million man-days in the rural areas. The three main technologies being promoted by the MNES for productive utilization of biomass are bagasse-based cogeneration in sugar mills, biomass power generation, and biomass gasification for thermal and electrical applications.

Bagasse-based Cogeneration

Technology

In simple terms, cogeneration is the process of using a single fuel to produce more than one form of energy in sequence. Cogeneration of steam and electricity can significantly increase the overall efficiencies of fuel utilization in process industries. A minimum condition for cogeneration is the simultaneous requirement of heat and electricity in a favourable ratio, which is well fulfilled in the sugar industry. The thermodynamics of electricity production necessitates the rejection of a large quantity of heat to a lower temperature sink. In normal electricity generation plants, this heat rejection takes place in condensers where up to 70% of heat in steam is rejected to the atmosphere. In cogeneration mode, however, this heat is not wasted and is instead used to meet process-heating requirement. The overall efficiency of fuel utilization can thus be increased to 60% or even higher in some cases. Capacity of cogeneration projects

can range from a few kilowatts to several megawatts of electricity generation a long with simultaneous production of heat ranging from less than a hundred kW_{th} (kilowatts thermal) to many MW_{th} (megawatts thermal).

Cogeneration in sugar industry

The sugar industry across the world has traditionally used bagasse-based cogeneration for achieving self-sufficiency in steam and electricity as well as economy in operations. In India, almost all sugar mills have been practising some form of cogeneration. This is true even for mills that were set up 70–80 years ago. Technologies are now available for high-temperature/high-pressure steam generation using bagasse as a fuel. These technologies make it possible for sugar mills to operate at higher levels of energy efficiency and generate more electricity than what they require. For example, when steam generation temperature/pressure is increased from 400 °C/32 bar to 485 °C/66 bar, more than 80 kWh (kilowatt-hour)

of additional electricity can be generated from each tonne of cane crushed. The effect of higher pressure and temperature of steam on additional power generation capacity of a typical sugar mill is reflected in Table 1.

Table 1

Impact of steam generation pressure/temperature on power generation capacity in a typical 2500 TCD sugar mill

Steam pressure/ temperature	*Gross electricity generation* (MW)	*In-house consumption* (MW)	*Additional electricity* (MW)
21 bar/300 °C	2.0	2.5	-0.5
33 bar/380 °C	3.5	3.5	0
45 bar/440 °C	6.0	4.0	2.0
64 bar/480 °C	13.5	4.5	9.0
85 bar/510 °C	17.0	6.0	11.0

Note The figures are indicative of the trend only and actual values depend upon the steam consumption in the process, efficiency of turbines/boilers, and many other operation-related factors.

Revenues from sale of surplus electricity can go a long way in improving the viability of sugar mills. It has been estimated that 'optimum cogeneration' can result in an additional net value addition of Rs 70–100 per tonne of cane crushed at current typical electricity sale prices.

The MNES has been promoting bagasse-based cogeneration in sugar mills through policy support and financial incentives/subsidies for over a decade now.

Costs

The capital costs of installed bagasse-based cogeneration projects in sugar mills are known to range between Rs 3 crores/MW and

Rs 4 crores/MW. It has been seen that for a typical sugar mill having an average crushing season of 160 days, investments for additional power generation through cogeneration will turn out to be beneficial in the long term.

Potential

The potential for cogeneration projects is estimated at 3500 MW of additional power generation from the country's existing functional sugar mills.

Achievements

India, today, is perhaps the world leader in the implementation of modern cogeneration projects in sugar mills. The achievements merit attention not only because of the additional grid-connected power generation capacity but also because of the large number of sugar mills, which have implemented these projects. This is noteworthy because of the diverse nature of operating conditions across these mills. An additional power generation capacity of 447 MW has been commissioned in 58 sugar mills as of March 2005. A further capacity addition of about 313 MW in 34 sugar mills is reported to be under implementation. A state-wise distribution of the commissioned and 'under implementation' capacity is given in Table 2.

Technology and equipment

The technology for bagasse-based cogeneration has become fairly well established in the country. The main equipment required for these projects comprise high-pressure bagasse-fired boilers, steam turbines, and grid-inter-phasing system. All these equipment are manufactured indigenously. An extremely competent and experienced group of technical

Table 2

State-wise distribution of commissioned and 'under implementation' cogeneration capacity, as on 31 March 2005

State	*Commissioned*		*Under implementation*	
	Number of projects	*Capacity* (MW)	*Number of projects*	*Capacity* (MW)
Andhra Pradesh	12	73.05	7	55.71
Gujarat	–	–	–	–
Haryana	1	2.00	–	–
Karnataka	10	115.98	9	94.66
Maharashtra	8	32.50	7	69.80
Punjab	2	12.00	–	–
Tamil Nadu	15	138.50	3	28.50
Uttar Pradesh	10	73.00	8	64.30
Total	**58**	**447.03**	**34**	**312.97**

professionals capable of providing comprehensive project and operational services has also been developed in the country to support bagasse-based cogeneration projects.

Financial incentives

The present levels of interest subsidy offered by the MNES for various categories of bagasse-based cogeneration projects are detailed in Table 3. However, these are subject to change from time to time and the latest information on the scheme of incentives can be obtained from the MNES website <www.mnes.nic.in>.

Sale of electricity

Almost all major sugar-producing states have announced policies in support of cogeneration in sugar mills. Support to these projects by state governments includes purchase of additional electricity at attractive rates through long-term power purchase agreements (PPAs), facilities for wheeling and banking in many states, prompt payments for purchased electricity, etc.

Table 3

Interest subsidy for different categories of bagasse-based cogeneration projects

Category of projects	*Pressure configuration*	*Interest subsidy*
Projects by cooperative/public/ joint sector sugar mills	40 bar and above	3%
	60 bar and above	4%
	80 bar and above	5%
	100 bar and above	6%
Projects in independent power producer mode in cooperative/ public/joint sector sugar mills	60 bar and above	2%
	80 bar and above	3%
	100 bar and above	4%
Projects by private sector sugar mills	60 bar and above	1%
	80 bar and above	2%
	100 bar and above	3%

Case study

A progressive sugar mill in Uttar Pradesh, crushing 11 000 tonnes of cane per day, has deployed state-of-the-art, 87 bar/525 ºC steam configuration to cogenerate over 18 MW of surplus electricity. The technology used is totally indigenous. Biogas generated in its distillery is also used as supplementary fuel. In addition, rice husk and bagasse procured from an adjoining sugar mill are also used to extend the power generation period. The cost of the project was about Rs 50 crores, and interest subsidy was provided by the MNES on the term loan

provided by ICICI. The project is expected to supply over 70 million units of electricity to the state grid every year and provide direct employment to about 70 persons.

Biomass-based Power Generation

Introduction

India produces a huge quantity of biomass material in its agricultural, agro-industrial, and forestry operations. According to some estimates, over 500 million tonnes of agricultural and agro-industrial residue alone is generated every year. This quantity, in terms of heat content, is equivalent to about 175 million tonnes of oil. A portion of these materials is used for fodder and fuel in the rural economy. However, studies have indicated that at least 150–200 million tonnes of this biomass material does not find much productive use, and can be made available for alternative uses at an economical cost. These materials include a variety of husks and straws. This quantity of biomass is sufficient to generate 15 000–25 000 MW of electrical power at typically prevalent plant load factors. In addition, electricity can also

be generated from biomass grown on wastelands, road and rail track-side plantations, etc. The quantum of electricity that can be produced from such biomass has been estimated to be in excess of 70 000 MW. Thus, the total electricity generation potential from biomass could reach a figure of about 100 000 MW.

The technology for generation of electricity from these biomass materials is similar to the conventional coal-based thermal power generation. The biomass is burnt in boilers to generate steam, which drives a turbo alternator for generation of electricity.

Advantages

- These projects can be designed to match the electric loads as biomass can be stored and used according to demand.
- Equipment for these projects is similar to that for coal-based thermal power projects and hence, no new technological developments are required.
- Due to their proximity to the rural areas, these projects are likely to improve quality of electricity supply there.
- A variety of biomass materials can be used in the same plant, providing flexibility of operations.

Technology and equipment

The technology for use of biomass for power generation is fairly well established in the country. The equipment required for these projects comprises mainly of boilers, turbines, and grid inter-phasing systems. Recent innovations include the use of air-cooled condensers to reduce consumptive use of water. All these items of equipment are available indigenously.

Costs

Typical capital costs for biomass power projects range from Rs 3 crores/MW to Rs 4 crores/MW. Costs of generation depend upon the cost of biomass, the plant load factor, and the efficiencies of conversion.

Sale of electricity

Many states have announced policies in support of biomass-based power generation. Support to these projects by the states includes purchase of electricity at attractive rates through long-term PPAs, facilities for wheeling and banking in many states, prompt payments for the electricity purchased, single window clearance facility, etc. Details regarding the current policies can be seen at the MNES website <www.mnes.nic.in>.

Achievements

A power-generation capacity of about 302 MW has been commissioned through 54 projects, as on March 2005. A further capacity addition of about 270 MW through 39 projects is reported to be under implementation. The biomass materials that have been used for power generation in these projects include rice husk, cotton stalk, mustard stalk, *Prosopis juliflora (Vilayati babul)*, poultry litter, bagasse, cane trash, etc. State-wise distribution of the commissioned and 'under implementation' capacity is given in Table 4.

Table 4

State-wise list of commissioned and 'under implementation' biomass power capacity, as on 31 March 2005

State	*Commissioned capacity*		*'Under implementation' capacity*	
	Number of projects	(MW)	*Number of projects*	(MW)
Andhra Pradesh	37	194.2	11	70.25
Chhattisgarh	2	11.0	5	51.00
Gujarat	1	0.5	–	–
Haryana	1	4.0	–	–
Karnataka	5	36.0	11	61.00
Madhya Pradesh	1	1.0	–	–
Maharashtra	1	3.5	1	6.00
Punjab	1	10.0	1	6.00
Rajasthan	1	7.8	4	29.10
Tamil Nadu	4	34.5	6	48.50
Uttar Pradesh	–	–	–	–
Total	**54**	**302.5**	**39**	**271.85**

Financial incentives

During 2003–04, the MNES offered financial support for biomass-based power projects, as detailed in Table 5. These incentives have been

continued for 2004–05 too, although they are subject to change without prior notice. Information on the latest scheme of incentives can be obtained from the MNES website.

Table 5

Financial support by the MNES for biomass-based power projects

Biomass power	*Pressure configuration*	*Interest subsidy*
Direct combustion, cogeneration including captive power projects	1) 60 bar and above 2) 80 bar and above	2% 3%

Financing

Apart from the Indian Renewable Energy Development Agency (IREDA), many financial institutions now provide term loans for biomass-based power projects based on the merits of the projects. Among these financial institutions are the Power Finance Corporation (PFC), many nationalized banks, the IDBI, the ICICI, etc.

Biomass power project in Andhra Pradesh

Case study

A power project in Karnataka utilizes a mix of agricultural wastes such as rice husk, groundnut shell, coconut fronds/waste cotton stalks, bark and roots of trees, cane trash, arecanut shells, etc., as fuel to generate about 20 MW electricity and sell it to the grid. The project has minimized its use of water by resorting to air-cooled condensers. The loans for the project were financed by the PFC and the State Bank of India. The project has generated direct employment opportunities for about 70 persons and indirect employment for over 800 persons.

Biomass Gasification for Thermal and Electrical Applications

What is biomass gasification?

Biomass gasification is thermo-chemical conversion of solid biomass into a combustible gas mixture (producer gas) through a partial combustion route with air supply restricted to less than that theoretically required for full combustion. Typical composition of producer gas is as follows.

Carbon monoxide	-	18%–20%
Hydrogen	-	15%–20%
Methane	-	1%–5%
Carbon dioxide	-	9%–12%
Nitrogen	-	45%–55%
Calorific value	-	1000–1200 kcal/m^3

Why gasify biomass?

- Producer gas can be used as a fuel in place of diesel in suitably designed/adopted internal combustion (IC) engines coupled with generators for electricity generation.

- Producer gas can replace conventional forms of energy such as oil in many heating applications in the industry.
- The gasification process renders use of biomass relatively clean and acceptable in environmental terms.
- Large monetary savings can accrue through even partial substitution of diesel in existing diesel generator (DG) sets.

What type of biomass can be gasified?

Most commonly available gasifiers use wood/woody biomass; some can use rice husk as well. Many other non-woody biomass materials can also be gasified, although gasifiers have to be specially designed to suit these materials and the biomass may have to be compacted in many cases.

How do gasifiers work?

Gasifiers can be of 'updraft' or 'downdraft' types. The working of biomass gasification systems can be explained by considering a typical downdraft gasifier. In this type of gasifier, fuel and air move in a

co-current manner. In updraft gasifiers, on the other hand, fuel and air move in counter-current manner. However, the basic reaction zones remain the same.

Fuel is loaded into the reactor from the top. As the fuel moves down, it is subjected to drying and pyrolysis. Air is injected into the reactor in the oxidation zone, and through the partial combustion of pyrolysis products and solid biomass, the temperature rises to 1100 °C. This helps in breaking down heavier hydrocarbons and tars. As these products move downwards, they enter the reduction zone where producer gas is formed by the action of carbon dioxide and water vapour on red-hot charcoal. The hot and dirty gas is passed through a system of coolers, cleaners, and filters before it is sent to engines.

What can be done with the producer gas?

The clean producer gas can be used for electrical power generation, either through dual-fuel IC engines (where diesel oil is replaced to an extent of 60%–80%), or through 100% gas-fired spark ignition engines. The producer gas can also be used for heating applications to replace conventional forms of energy in many applications. Such heating applications may include small boilers, furnaces, hot air generators, dryers, etc.

Typical capacities

Biomass gasifier-based systems are being made in capacities ranging from a few kilowatts to a megawatt of electricity equivalent. For heating applications, the current upper limit on the unit size is equivalent to 200–300 kg/h of oil consumption.

Costs

The typical costs of biomass gasifier-based electricity generation systems range from Rs 4 crores/MW_e to Rs 4.5 crores/MW_e. The cost of power generation depends on cost of biomass, plant load factor, etc., and is estimated to be between Rs 2.50/kWh and Rs 3.50/kWh. For thermal applications, the capital costs are estimated to be about Rs 0.5–0.7 crores for each 1 million kcal capacity.

Technology and equipment

There are about a dozen known manufacturers in the country for gasification systems. A list of these can be obtained from the respective state nodal agencies for renewable energy development.

Achievements

The biomass gasifier-based thermal and electricity generation applications are at a 'take off' stage in the country. The MNES has so far provided partial financial support for installation of about 1900 biomass gasification systems in the country. Many systems have also been installed without support by the MNES, reflecting the improving commercial viability of the technology, especially in niche applications. A few megawatt-scale projects have also been planned by independent power producers, and are likely to come on line in the coming years.

Financial incentives

The MNES offers financial support for biomass gasifier projects as listed in Table 6 below. These are subject to change without prior notice. Information on the latest scheme of incentives can be obtained from the MNES website.

Table 6

Financial support by the MNES for biomass gasifier projects

Type of application	*Capital subsidy*
Thermal applications, including cooking (up to 3 MW_{th} [megawatt thermal])	Rs 1.25 lakhs/300 kW_{th} (kilowatt thermal) on *pro-rata* basis or in multiples thereof
Electrical application, including pumping and captive power, with provision for surplus power to grid (up to 1 MW_e)	Rs 1.50 lakhs/100 kW_e for electrical applications, including pumping and captive power on *pro-rata* basis, or in multiples thereof, preferably with provisions of surplus power to grid
Electricity generation with 100% producer gas-based engines, up to 100 projects	Rs 15 lakhs/100 kW_e on *pro-rata* basis or in multiples thereof, or Rs 10 lakhs/100 kW for engines alone

Case studies

1 Ceramics is an industry sector where biomass gasifiers have been very successfully used. The production of ceramic ware requires that raw items be baked for a pre-specified period at a temperature of 900–1300 °C. Typically, this is carried out in tunnel kilns, which operate almost continuously for 365 days a year. Oil or other suitable fuels are fired into the kilns to raise temperature. Typically, kerosene, diesel or LPG are used as fuels. These can be replaced by producer gas generated in biomass gasification systems. The typical oil consumption of ceramic factories is 2000–3000 litres/day. After installation of biomass gasifiers, oil consumption could be reduced to less than 30%, resulting in huge money savings to the users. It is estimated that ceramic industry consumes 0.3–0.5 million tonnes of oil per year. Seventy per cent savings on this figure would imply savings of 0.20–0.35 million tonnes of oil. About 100 ceramic factories out of the estimated 500 are reported to have switched over to biomass gasifiers.

2 An independent power producer has set up the single largest capacity, fixed-bed biomass gasifier-based electricity generation system of 1 MW in grid-connected mode. The project is located near Coimbatore in Tamil Nadu and uses coconut shells or other types of wood for electricity generation. The system uses two gasifiers of 750 kg/h biomass gasification capacity each and five engines of 250 kW nominal capacity each. The engines are suitable for 100% producer gas operation. Air-cooled radiators have been used in the installation to reduce use of water. This 100% producer gas engines are operating successfully. The project has utilized indigenously developed state-of-the-art technology with fully automatic controls and auxiliary systems.

3 Odanthurai is a remote village of Block Karamadai in Coimbatore, Tamil Nadu, having 135 houses with 540 inhabitants. The electricity supply system of Odanthurai was most unreliable due to its topographical and isolated location. To provide a reliable drinking water supply system and provide lighting facilities for community uses, the District Rural Development Agency, Coimbatore, installed a 9-kW_e biomass gasifier project coupled with 100% producer gas engines. The system selected was most appropriate for operation by local persons. The project cost was Rs 5.90 lakhs. The biomass

requirement of 100% producer gas engine system is about 1.5–1.6 kg/kWh. If the installed system operates for 12 hours, biomass requirement would be about 150 kg per day. Thus, annually, there would be a requirement of about 60 tonnes of biomass. As Odanthurai has a large number of coconut trees and plenty of other biomass, the supply of the required quantity is not a problem. Every unit of electricity generated is likely to cost about Rs 2.42. It is expected that revenue generation from water supply and illumination will more than compensate the power generation cost.

Rajiv Gandhi Akshay Urja Diwas

On 20 August 2004 – the 60th Birth Anniversary of our Late Prime Minister Mr Rajiv Gandhi – the Ministry organized the Rajiv Gandhi Akshay Urja Diwas. Initiated by the Hon'ble Minister of State (Non-Conventional Energy Sources), Mr V Muttemwar, the occasion saw the release of a commemorative stamp by the Hon'ble Prime Minister, Dr Manmohan Singh, at a function attended by Smt. Sonia Gandhi, Chairperson, United Progressive Alliance (UPA), Members of the Union Cabinet, Members of Parliament, Chief Ministers, Foreign Dignitaries, Administrators, Scientists, and students among others.

The day was also appropriate to advocate renewable energy, since Mr Rajiv Gandhi was a keen enthusiast of scientific advances that would enable India to leap into the 21st century. Thus, a human chain of nearly 12 000 school children was formed in the National Capital to promote a renewable future. In the rest of the country too, functions such as rallies and human chains were organized. In addition, competitions such as essay writing, painting, quizzes, and debates were held, all of which covered different aspects of renewable energy – from biogas to biomass to solar, hydro, and wind power. The essence of these public activities was to generate mass awareness and disseminate information about the advances made in renewable energy technologies, and with the ultimate objective of achieving '***Akshay urja se desh vikas – Gaon gaon bijlee, ghar ghar prakash***'. The success of the Rajiv Gandhi Akshay Urja Diwas has encouraged the Ministry to make it an annual affair, to be celebrated on 20 August every year.

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Disclaimer
Every effort has been made to provide correct information in this booklet. However, the Ministry of Non-Conventional Energy Sources (MNES) does not assume any responsibility for the accuracy of the facts and figures mentioned here, nor for any consequences arising out of use of any information contained in this publication.

Shri Vilas Muttemwar

Minister of State (Independent Charge)
Non-Conventional Energy Sources, Government of India
New Delhi – 110 003

'The promotion of renewable energy sources in the country requires widespread publicity and greater awareness of the potential of these energy sources and the products available. The Ministry of Non-Conventional Energy Sources is expanding several of its programmes so that these sources can contribute to sustainable development of the nation. The Ministry will work towards reducing the costs of renewable energy products and making them easily available to the people. The motto of the Ministry is "Akshay urja se desh vikas" and the ultimate goal is "Gaon gaon bijli, ghar ghar prakash".'

2 Biomass

Booklets in this Series

1. Biogas
2. Biomass
3. Solar Heat
4. Solar Electricity
5. Energy Recovery from Wastes
6. Wind Energy
7. Small Hydro Power
8. Hydrogen Energy
9. Solar Energy Centre
10. Centre for Wind Energy Technology
11. Indian Renewable Energy Development Agency Ltd
12. Information and Public Awareness

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