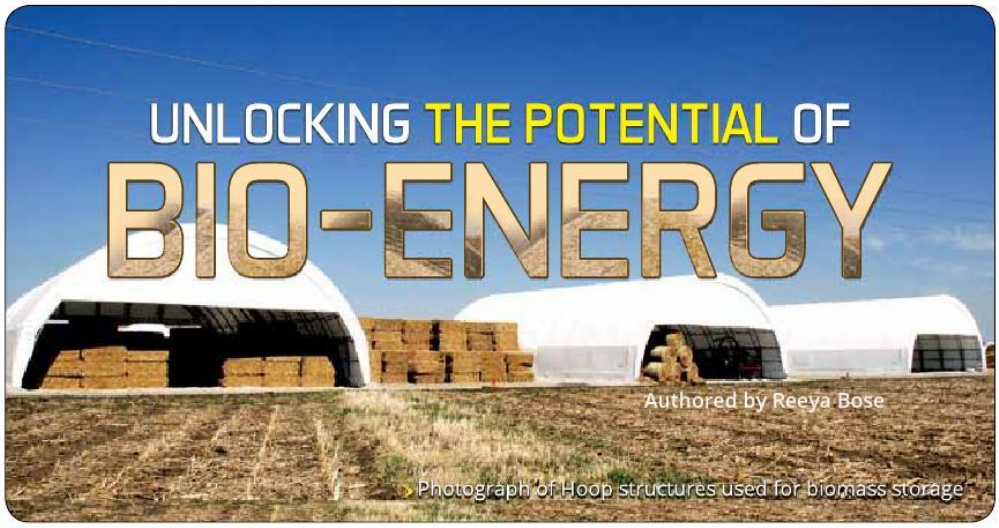

UNLOCKING THE POTENTIAL OF BIO-ENERGY

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Photograph of Hoop structures used for biomass storage

Biomass is the organic matter that has stored energy over time through the process of photosynthesis. It exists in one form as plants and may be transferred through the food chain to animal bodies and their wastes. These can be converted for everyday use through processes such as combustion.

Biomass is the building block or "feedstock" for many other fuels. Many of the biomass fuels used today come in the form of wood products, dried vegetation, crop residues and aquatic plants. It has grown to be among the most commonly used renewable energy sources in the past two decades. This is mainly due to its low cost and indigenous nature. Recent research at Netscribes shows that bio energy accounts for almost 15% of the world's total energy supply and as much as 35% in developing countries, where it is mostly used for cooking and heating.

Types of Biomass

Field and Plantation Biomass

This mostly compromises agricultural crop residues such as cobs, stalks, straw, cane thrashes and edible matter from crops. Apart from plantation debris and livestock waste, this also refers to energy crops like bamboo, prosopis, casuarinas, willow and poplar.

Industrial Biomass

Many industrial processes and manufacturing operations produce residues, waste or co-products that may be used as or converted into biomass fuel. This can be sub-divided into woody and non-woody materials, which include wastes like husk, oil cake, bagasse and molasses.

Forest Biomass

Forest biomass is essentially the by-product of current forest management activities, ongoing protection treatments authorized by governmental agencies or the by-products of permitted forest health treatment. It includes produce like timber, log residues, forest floor debris and animal carcasses.

Urban Waste Biomass

Our cities generate several kinds of waste products daily, including glass, plastic, paper, metals, yard clippings, and wood and construction materials. Household garbage (trash) and some commercial wastes — such as paper and cafeteria food wastes — constitute urban waste biomass. The construction, renovation or demolition of buildings generates wastes that are also used as sources of biomass energy. Additional urban biomass resources include capturing gases produced by the decay of organic materials that have been land-filled, and bio solids generated in the waste water treatment of sewage.

Aquatic Biomass

Aquatic biomass includes microalgae blooms, sea weeds (for example, kelp), fresh water weeds (such as water hyacinth) and dead fish.

Technologies involved in Biomass Energy Production

The use of heat is common in the conversion of biomass into energy. Since the Industrial Revolution, biomass-fired heat has been used to produce steam power. More recently, biomass-generated steam has been used to produce electricity. Burning biomass in conventional boilers can have numerous environmental and air-quality advantages over burning fossil fuels. Recent advances have made it even more efficient and cleaner to use biomass. It can be converted into

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liquid fuels, or "cooked," in a process called gasification to produce combustible gases. This reduces various kinds of emissions from biomass combustion, especially particulates. Here are some technologies utilized widely to convert biomass into useful energy:

Thermal Conversion

Thermal conversion, as the term suggests, utilizes heat as the main component to convert biomass into a more usable form. Combustion, pyrolysis, torrefaction, and gasification are the basic thermal conversion technologies.

Combustion

Direct combustion is used in the burning of biomass. In a furnace, biomass burns in a combustion chamber converting the biomass into heat. The heat is then distributed in the form of hot air or water. On the other hand, in a boiler the heat from combustion is converted into steam which is then used to produce electricity, mechanical energy is used for heating and cooling. Co-firing is another method, as part of which the biomass feedstock is heated together with a fossil fuel. The main advantage is the reduced cost and the simultaneous compliance of more stringent emission targets.

Pyrolysis and Torrefaction

These processes are usually carried out under controlled temperatures and restricted oxygen conditions to produce a more energy-dense product. In pyrolysis, the biomass undergoes partial combustion, resulting in liquid fuels along with by-products like char and bio-char. Torrefaction, like pyrolysis, converts the biomass with the application of heat in the absence of oxygen, but at lower temperatures. The final product is an energy-dense solid fuel frequently referred to as bio-coal.

Thermochemical Conversion

Thermochemical technologies are widely used in converting the biomass into useful fuel. The process involves the conversion of the solid biomass into gas, which can be converted into oil. This oil finally produces syngas, which contains carbon and hydrogen and can be used to produce ammonia and lubricants.

Gasification

High temperatures are applied in a controlled environment through partial combustion and chemical reduction to convert biomass into gas. This method is extensively used in the UK, for example, for power generation, household cooking and lighting.

Biochemical Conversion

Biochemical conversion has been in use for long. Recently, fermentation technologies, with the assistance of biological engineering, are leading to breakthrough processes for creating fuels and fertilizer. Anaerobic digestion and fermentation are the key biochemical conversion technologies.

Anaerobic digestion

Anaerobic digestion is the use of microorganisms in an oxygen-free environment to break down organic material. Anaerobic digestion is widely used for the production of methane and carbon-rich biogas from crop residues, food scraps, and manure (human and animal). Solid remnants of the original biomass input are usually left over after the digestion process. This byproduct, or digestate, can be used as fertilizers, for animal bedding and low-grade building products like fiberboard.

Fermentation

Fermentation includes the use of yeasts to convert the biomass into ethanol. At the end of a series of steps, the fermented liquid is distilled to divide the alcohol from the solid materials.

Chemical Conversion

Chemical conversion is also used to transform biomass into other forms of energy. Transesterification is the most popular form of chemical-based conversion. Fatty acids from oils, fats and grease are bonded to alcohol to produce biodiesel, the most common byproduct of this process.

Biomass Energy in India

Biomass has been an important source of energy in India for almost a decade. Recent research at Netscribes shows that 32% of the primary energy use in the country is still biomass-derived, and more than 70% of the country's population depends on it for energy needs. The Ministry of New and Renewable Energy, aware of the potential of biomass energy, has launched several programs to encourage its use in various sectors of the economy. Biomass power generation, which attracts annual investments of over INR 600 crore, generates over 5,000 million units of electricity and provides employment equal to 10 million man-days in rural areas each year. Bagasse-based cogeneration in sugar mills, as well as biomass power generation, is being popularized under government-sponsored programs. About 500 million metric tons of biomass is available per year in the country. The surplus biomass availability is about 120-150 million metric tons per annum, covering agricultural and forestry residues which corresponds to a potential of 18,000MW. Moreover, about 5,000MW of additional power could be generated through bagasse-based cogeneration in the country's 550 sugar mills.

Government incentives and Subsidies

The Government of India is promoting biomass power cogeneration programs since the mid-90s. Research at Netscribes shows that till 2011, 288 biomass power and cogeneration projects had been installed, while around 70 cogeneration projects were in the imple-

mentation stage.

The government has also announced incentives and subsidies for companies manufacturing power through biomass energy plants and launched various programs and plans. Some of the incentives include:

Accelerated Depreciation:

80% depreciation in the first year can be claimed for the equipment required for cogeneration systems. Back pressure and pass-out systems, controlled extraction equipment and extraction-cum-condensing turbine for cogeneration with pressure boilers are some of the machineries for which depreciation can be claimed.

Customs Duty:

Concessional customs and excise duty exemption for machinery and components for initial project set-ups are also provided.

General Sales Tax:

Exemption is available in Gujarat, Maharashtra, Madhya Pradesh, Rajasthan, Pondicherry and Delhi, among others.

The Government's Programs aimed to promote Biomass initiatives:

National Biomass Gasification Program

The ministry implemented the National Biomass Gasification Program across India. In mid-2005, a new program on biomass energy and co-generation in industry was announced to encourage the wider use of biomass resources. Gasifiers in the range of 5kW-1MW are already manufactured in the country. The new program further provides subsidies for capital investment for gas operating systems linked to operational gasifiers.

National Biomass Cook Stoves Initiative (NBCI)

The NBCI was launched by the ministry in December 2009. The primary aim was to improve the availability of clean and efficient energy in energy-deficient parts of India. Through a pilot project in 2011-12, the government demonstrated the positive, social and economic outcomes of employing biomass cook stoves instead of traditional techniques.

National Bio Energy Mission

The government launched a bio-energy mission to boost power generation from biomass. This mission will offer a policy and reg-

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ulatory environment to facilitate large-scale capital investments in biomass-fired power stations. The mission will also aim at improving energy efficiency in traditional biomass-consuming industries.

Modern Biomass Technology in India

India has a decade's experience with modern biomass technologies for thermal application, motive power and electricity generation. Technology has penetrated various areas like village electrification, captive-power generation and process heat generation. The gasifier technology remains an important aspect in this sector with the large-stage gasifier-based power technologies in the pilot stage.

Government-initiated biomass power programs are now on the grid, connected to megawatt power generation with the help of multiple biomass materials such as rice straw, rice husk, bagasse and wood waste. Enhanced scale of operations of this sector has improved the economics as well as the technology. Improvements in technology have been derived from joint ventures of Indian firms with leading international manufacturers.

Competitiveness of Modern Biomass Electricity

Biomass-based electric power generation technologies have succeeded greatly in niche applications such as supplying electricity in decentralized locations. The large-scale penetration of biomass power technologies are mostly dependent on their delivered cost and reliability and are in direct competition with conventional electricity sources.

In India, the principal competing source for electricity supply is coal-based power. Biomass energy costs are highly variable, depending upon factors such as the source and location. The delivered cost of coal also varies depending upon the extraction and logistics costs. Coal power plants are built with large-scale technology with a standard size of 500MW while the scale of grid-based biomass plants varies from 1MW to 50MW. Along with this, the base price of coal in India is INR 48 per gigajoule (GJ). For biomass, it is INR 72 per GJ. Evidently, the delivered cost of electricity from a 50MW biomass-based power plant is higher compared to coal power plant by 15%. However, in future, this gap is expected to reduce mainly due to improvements in production capabilities of biomass manufacturing and the rising costs of coal.

Bottlenecks faced by the Indian Biomass Industry

Biomass power plants in India are dependent mostly on agricultural waste, which is a dominant problem for the industry. There are several problems in the biomass supply chain. As biomass availability is not certain for the whole year, it becomes a difficult source of energy to be exploited. Biomass from agriculture is available only after the harvesting period, which lasts for two or three months a year. Hence, there is a need to procure and store required quantities of biomass in the stipulated time.

Karnataka, Andhra Pradesh and Maharashtra are the leaders in establishing biomass-fuelled power infrastructure. These states are primarily agriculture-based and have to been able to utilize this growing opportunity. Research shows that only Uttar Pradesh has utilized a large part of its biomass potential among the north Indian states, which is mainly because of its sugarcane industry and co-generation power plants. Interestingly, Punjab and Haryana don't have much installed capacity even though power tariff rates are more than INR 5 per unit, higher than in most states. The defragmented nature of agricultural lands in these areas doesn't allow high mechanization, which results in reduction of efficiency and increase in procurement costs. High transportation costs also pose a problem.

Thus, a robust business model is necessary to motivate local entrepreneurs to take up supplying biomass to processing facilities. Collection centers covering two-three villages can be set up to facilitate decentralization of the biomass supply mechanism. Biomass power plant operators can also explore the possibility of using energy crops as a substitute for crop wastes in case of a crop failure.

Future of Biomass Energy in India

Biomass use is growing exponentially worldwide. The future of biomass energy depends on providing reliable energy services at competitive costs.

In India, this can only take place if biomass energy services can compete in a fair market. The most economical option would be the utilization of waste materials. Potential availability of agro residues and wood processing waste in India can help in the production of 10,000MW power. Biomass waste, however, will be inadequate to support the growing demands for biomass resources. Sustained supply of biomass will require production of energy crops (for example, wood fuel plantations and sugarcane as feedstock for ethanol) and wood plantations for meeting growing non-energy needs. Land supply, enhanced biomass productivity, economic operations of plantations and logistics infrastructure are some of the critical areas which will determine future of biomass in India ■

About the Author

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