Volume 66, Issue 5, 2022

Journal of Scientific Research

of

The Banaras Hindu University

Biomass Energy Resource – Future of Global Power Production

Susmita Mukherjee[1], Camellia Mazumder[2], Aditi Biswas[3], Aratrik Roy[4], Ananya Chatterjee[5], Sonali Paul[6]*

[1] Department of Biotechnology, University of Engineering and Management, Kolkata, susmita.mukherjee@uem.edu.in
[2]Department of Biotechnology, University of Engineering and Management, Kolkata, mazumder.camellia@gmail.com
[3]Department of Biotechnology, University of Engineering and Management, Kolkata, aditibiswas513@gmail.com
[4]Department of Biotechnology, University of Engineering and Management, Kolkata, royaratrik12@gmail.com
[5]Department of Biotechnology, University of Engineering and Management, Kolkata, ananyamanti70@gmail.com
[*6]Department of Biotechnology, University of Engineering and Management, Kolkata, sonali.paul@uem.edu.in

Abstract:**The population of the planet continues to rise rapidly. As a result, the percentage of global energy consumption is growing significantly. Methods of biomass briquettes and BDH (Biomass District Heating) with the biomass energy source has the attributes of fossil fuel while also being able to stored, renewed and transported. While conventional power sources are non-renewable and results in pollution. Thus, countries are setting up biomass power plants for developing an eco-friendly process for power production. This study states the new age technologies for biomass energy production, their economic and environmental benefits along with the capacity of these large plants to provide employment in bulk. The limitations of biomass energy are also stated along with how India, a developing country is coping with the installment of the newest technologies. Thus, replacing the fossil fuels in the upcoming dawns for a better environment.**

Index Terms: **biogas, biomass energy plants, economic drift, geothermal energy, household sewage production, hydro energy, power production, renewable energy, solar energy, wind energy**

I. INTRODUCTION

The Earth's landmass is not enough to hold the rising population of the planet which is now twice as large as it was in 1960, and it is predicted to reach 9 billion by 2050 (Lohri et al, 2017). Energy acts as a vital form of resource globally. It is widely divided into two types – renewable and non-renewable energy. According to recent research in today's world, the non-renewable sources are facing drastic depletion, also causing pollution and global warming (Jowitt, Simon M. (2020). The urgency of using renewable and cleaner sources of energy is more than ever. Switching fossil fuels by biomass-derived energy has had a favorable impact on the economy, ecology, and health (Ishak et al, 2022). Rechargeable energy is known as energy derived from natural resources that can be reused. Examples include hydro energy, solar energy, wind energy. They are nearly imperishable. The best part is that they have minimal harmful impact on the planet's health or the ecosystem. The increase of renewable energy generation provides an option for reducing total greenhouse gas emissions while also adding to socioeconomic and environmental goals (Aguilar et al, 2020).

Biomass energy is one such major form of renewable energy. Research (GhoshUetal, 2021) suggest that in India itself, there is a huge scope of utilizing this energy. In the rural Indian sector, fuel wood accounts for 40% of energy consumption, while crop leftovers and other biomass sources provide for the remaining 28%. 6000 MW generates around 370 million tons of agricultural waste. It is excessive, and it has the potential to save India around 400 million rupees every year. (Because being a fertile land India produces agriculture waste at a rate of around 300 million tons per year). In India, there are agro-wastes available -rice-straw, rice-husk, jute sticks, cotton stalks, wheat stalks, bagasse, molasses, etc. The government is planning to use it for 20% of energy production in the new management systems (Ghosh Uet al, 2021).

This review is designed to compare the various methods associated with sewage and wastewater treatment that have an immense capacity to produce biomass energy and supply the whole state of India. A developing country like India needs to focus on these areas to see biomass source become a vital renewable resource and totally replace fossil fuels for the future generation (Carlos & Khang, 2008). There have been several articles referring to this emerging technology which has been stated to conclude in here how the biomass energy production is a fuel-free energy production, does not harm the ecological balance and produces a lot of employment facilities. The world of science needs to come up with methods to annihilate the restraints from the face of the development for example it is difficult to produce bulk energy from biomass energy sources, is expensive and requires considerable amount of space. This works mentions all the new world technologies and advancement in the biomass energy production involving

biomass briquettes and biomass district heating that provides a study of the above-mentioned conditions and how biomass can be the future of the world alongside generating a huge workload and demand for workers and supply of jobs in this field highly affecting the economy in both micro and macro scales.

II. RENEWABLE ENERGY RESOURCE

Renewable energy sources include the sun, wind, water, the Earth's heat, and plants, which are constantly renewed by nature. Renewable energy is energy generated from naturally renewing but flow-limited sources; renewable resources are essentially infinite in length but limited in energy accessible per unit of time. Renewable energy systems convert fossil fuels into useable forms of energy, often electricity, but sometimes heat, chemicals, or mechanical energy (Kanu, 2021). Renewable energy is abundant, and technologies are constantly developing.

According to the latest research work (Pal K et al,2017), renewable power can be used in a diverse number of applications. Renewable energy sources and innovations have the potential to address impoverished nations' long-standing challenging issues. Renewable energy sources are becoming increasingly important if we are to make the necessary reforms to mitigate global warming's effects. Few of these impactful renewable energy sources that have been already commercialized in India and outside are as follows:

A. Solar Energy

The Sun generates solar energy. Sunlight is a non-depleting renewable energy source that is non-polluting. Every hour, enough sunshine energy reaches the planet to supply the whole world's energy requirement for a year. In present world, we require electricity 24 hours a day, seven days a week. This Solar Energy is created for use in industrial, commercial, and household applications. The main benefit of solar energy over other common power generators is the ability to convert sunlight into solar energy using the smallest photovoltaic (PV) solar cells (Yadav & Sircar, 2020). It readily takes in the photon energy from direct sunshine. As a result, it is incredibly efficient and does not pollute the environment. Because of the diminishing supply of renewable energy resources, the last 10 years have become more crucial for the per-watt cost of solar energy devices. It is undoubtedly expected to become more affordable in the next years, as technology improves in terms of both cost and applicability. Every day, the planet receives sunshine from above (1366W approx.) The supply of energy is limitless and free to use.

The main advantage of solar electricity over other traditional electricity producers is that sunlight can be turned directly into solar electricity using smaller photovoltaic (PV) cells. A major advantage of solar energy over other traditional energy producers is that sunlight may be effectively transformed into solar power using small photovoltaic (PV) solar cells. The Bhadla Solar Park, the world's largest solar power facility, is in Bhadla hamlet in Rajasthan's Jodhpur district. The fully functioning power plant, which spans 14,000 acres and has a capacity of 2,250MW, has been installed. Rajasthan's current solar power use accounts for 10% of the state's overall electricity consumption.

B. Wind Energy

For centuries, humans have used windmills to harness the wind's energy (Zhang et al, 2020; Rolington, 2010). Modern times uses wind turbines, which operate differently from windmills, are much more advanced technology. Wind turbine technology appears straightforward: the wind spins turbine blades around a central hub, which is coupled to a shaft, which powers a generator, which generates energy. Wind energy is one of the most enticing sustainable power source improvements because of its great efficiency and minimal pollution. After hydro power, wind energy is the most abundant renewable energy source. It is sensible, yet it is discontinuous. Even though the utilization of wind stretches back a few millennia, the cutting-edge wind vitality sector began amid the oil crisis of the 1970s. Wind turbines are mostly built on land these days, but some are built offshore, usually in wind farms. Because wind vitality is intermittent, it must be supported by other sources of energy. Wind vitality, overall, can be beneficial. It has not, however, achieved complete matrix equivalence with fossil types of energy. Turbines, on the other hand, are extremely complex power devices that absorb wind energy using novel blade designs or airfoils. Modern mechanical drive systems, in conjunction with sophisticated generators, transform the energy into electricity. Wind energy has been the fastest growing source since 90s, expanding at a pace of more than 25% per year on average. It is a trend fueled mostly by tremendous advancements in wind technology.

California has by far the most installed wind turbines. Numerous wind turbines are also being constructed across the Great Plains, from Montana east to Minnesota and south through Texas, to capitalize on the region's tremendous wind potential. Technical assistance, including wind resource evaluation and site identification, is furnished by the National Institute of Wind Energy in Chennai.

Inter-state transmission rates and losses have been eliminated for wind and solar projects scheduled to be completed by March 20, 2022, in order to encourage inter-state wind power sales. Guidelines for Tariff-Based Competitive Bidding Process for Procurement of Power from Grid Connected Wind Power Projects were issued with the goal of providing a framework for procurement of wind power through a transparent bidding process, including standardization of the process and defining the roles and responsibilities of various stakeholders. The purpose of these Guidelines is to enable Distribution Licensees to get wind electricity at competitive prices in a cost-effective way.

C. Hydro Energy

Hydropower is a significant renewable energy resource across the world (Rolington, 2010). However, its growth is accompanied by environmental and societal consequences. Environmental deterioration and climate change can have a negative influence on hydropower generation. To tackle the problems, a sustainable hydropower project requires thorough planning and meticulous system design. Hydropower projects that are well-planned can help to deliver sustainable electricity. To make educated judgments on hydropower projects, energy planners, investors, and other stakeholders must have up-to-date knowledge. Existing hydropower capacity is about 77,000 megawatts (MW). Hydroelectric power plants transform the

energy in running water into electricity. From those turbines, the water released is used to produce power. There are certain systems, known as "Run of the River", which reroutes water from the river to the turbines. The most abundant form of renewable energy is hydropower, a time-tested method. Hydropower is renewable because it obtains its primary energy from the sun, which propels the hydrological cycle, which offers a constant renewable supply of water. Hydroelectric power accounts for greater than 92 percent of total renewable energy produced and continue to be one of the best and viable origins of generation of energy for the time ahead. It also offers the opportunity of saving the energy to maximize the production of electricity.

The Tehri Dam in Uttarakhand, India's highest hydroelectric power facility is at the number one spot of hydropower plants. Construction started in 1978, with the ex-Soviet Union's helpin terms of technology and was completed in 2006. The dam, which is located near the city of Tehri at the confluence of the Bhagirathi and Bhilangana rivers, is a multi-purpose rock and earth-filled embankment dam that is the highest in India at 260.5 meters. It is the world's ninth highest dam and Asia's second tallest. The dam's length is 575 meters, its base width is 1,128 meters, and its crest width is 20 meters. Its reservoir stores water not only for hydroelectricity generation (which is approximately 1,000MW in addition to 1,000MW of pumped storage hydroelectricity), but also for irrigation and municipal water supply to other states in North India, including Uttar Pradesh, Haryana, Punjab, Delhi, Chandigarh, Himachal Pradesh, Jammu & Kashmir, and Rajasthan

D. Geothermal Energy

The Earth’s core, which is located 4,000 miles under the surface, may reach temperatures of 9000° F. In simpler words, the heat in the earth's core represents geothermal energy. The term "geothermal" has been obtained from geo (earth) and thermal (heat), both having greek origins. Geothermal energy acts as a never-ending source of energy as heat is being produced within the ground constantly (Woodward, 2013). Geothermal heat is required for bathing, warming houses, and producing energy. Geothermal energy is produced by the gradual disintegration of radioactive particles in the earth's core, a process that occurs in all rocks This heat, or geothermal energy, radiates from the core, heating the surrounding region and forming subterranean reservoirs of hot water and steam. These reservoirs may be used for various of purposes comprising of energy generations or heating buildings. We can even take use of the shallow ground's steady temperature by employing geothermal heat pumps (GHPs) to heat and cool buildings.

The geothermal energy capacity in the topmost 6 miles of the Earth's crust is 50,000 times that of all global oil and gas resources. Most geothermal reservoirs in the United States are found in the western states, Alaska, and Hawaii. GHPs, on the other hand, may be utilized practically any place. While the temperature of the air may differ hugely through the seasons, the temperatures of the shallow ground usually range from 50Â° to 70Â°F, conditional to the latitude. GHPs use this near stable temperature as a source for heating the properties in the winter and maintaining them comfortably cool in the summer.

A GHP emits heat from the interiors of a building into the earth in the summer, similar to a refrigerator that uses electricity to keep its insides cool while discharging heat into the kitchen. During winters, low pressure condition prevails and the GHP reverses the cycle, extracting heat from the earth and delivering it into a building.GHPs are extremely clean and efficient since they transfer heat between households and the soil rather than burning fuels.There are approximately 340 hot springs reported in India, with the majority of them located along the following 5 major regions: the NW-SE Himalayan arc system, which extends to Andaman Nicobar Island, the son-Narmada-Tapti lineament, the West Coast continental margin and its adjacent and nearby areas, the Gondwana grabens, and the Delhi fold regions.

E. Biomass

Amongst all sources of renewable energy, biomass is a popular option. In the developing world, it has always been widely used. Recently, the same is happening in the developed world. Identifying appropriate biomass species that can give high-energy outputs to replace conventional fossil fuel energy sources has received a lot of attention recently (Sadh, 2018). The energy conversion process and the form in which the energy is required dictate the sort of biomass required. The backdrop of biomass production (in a European climate) and plant attributes is studied in the first of three articles. The second study examines energy conversion methods, with a focus on the development of a gaseous fuel to complement the gas produced by the landfilling of organic wastes which can be utilized for different energy sources (landfill gas), in gas engines to generate power. The possibility of a recovered landfill site to serve as a biomass source, providing fuel to augment landfill gas-fueled power plants, is investigated, as well as the economics of power generation from purpose-grown biomass vs waste biomass. The third study looks at specific gasification technology and their biomass gasification possibilities.

III. BIOMASS ENERGY

The majority are under the impression that biomass and bioenergy are modern types of energy, and that the biomass energy transition is something new. It could not be farther from reality. The history of biomass dates long back to humankind’s roots. there's sufficient proof that supports the claims that we have got utilized biomass as an energy supply between 230,000 to 1.5 million years ago. Initially, humanity concentrated on using biomass for cooking and warmth. Around the nineteenth century, we began to consider more modern applications for biomass resources. While the fire is the most common kind of bioenergy, ethanol is the next great step in harnessing carbon for energy. Ethanol has been in existence for a very long time. Long before civilizations were created, humanity discovered and employed the fermentation processes. Despite this, no convincing proof of individuals distilling alcohol exists until the twelfth century in Italy. Because of its ease of use and availability, ethanol was a popular renewable energy source. It was even the ingredient used to power the first engine, coupled with turpentine, in 1826. Ethanol fuel remained a major fuel source until the 1890s.

A significant milestone in bioenergy history was the early 1900s when biomass fuel became popular again. Due to a boom in the automotive industry and the wars, scarce resources led to carmakers returning to bioenergy. The geopolitical

conflict that was felt in the 1970s brought about a fuel crisis. As a result of this, the Organization of Petroleum Exporting Countries (OPEC) reduced oil exports. This caught the attention of governments and the academic world. Many started looking into developing more renewable energy sources. Many advances in solar panel electricity were made as a result of this initiative, along with improvements in geothermal power plants, offshore wind farms, and hydroelectric power. In all nations, rural families rely on biomass for cooking more than peri-urban and urban households. Its use in rural homes varies by country, ranging from 99 percent in Ethiopia to 95 percent in Mozambique. In urban Ethiopia, biomass is used by84% of the population Furthermore, in Haiti and Nepal, 12 percent and 6 percent of the biomass is utilized for transportation, respectively. Industrial use of biomass for heating is common in Haiti (4%), Nepal (6%), Myanmar (20%), and Sudan (2%) (Masood, 2015).

A. Biomass Energy in India

Biomass is the world's fourth largest source of energy and India's first. However, owing to technological and economic restrictions, most of this energy is used inefficiently. The study of biomass energy is very important for India since most rural regions rely heavily on indigenous energy supplies. Furthermore, the high rate of population expansion, as well as growing prices for commercial energy carriers such as electricity, gas, and petrochemical products, indicate that biomass energy usage will rise.

India declared its climate targets in 2015, soon well before Paris Climate Summit, including a target of 175 GW of renewable energy by 2022, with 15 GW coming from biomass power, modest hydropower, and waste-to-energy facilities. Six years later, in 2021, the country has already met the 10 GW biomass power objective, with the current installed capacity of biomass power at 10.17 GW, up from 4.4 GW in 2015. The availability of biomass in India might equate to a potential of around 28 GW. Furthermore, around 14 GW more electricity might be created through bagasse-based cogeneration in the country's 550 sugar mills if they use technically feasible ideal levels of cogeneration to extract power from the bagasse produced by them.

B. Bio - mass energy resource

B.a.From Agricultural by-products

Such as straw or sawdust, liquid manure, and organic waste can all be utilized to create biomass (e.g., corn or potato peelings). Compressing agricultural waste items into briquettes under high pressure is the easiest technique to convert them into high-quality biomass energy. They can then be burned for cooking or heating, or used as a factory energy source (Soltero et al, 2018). Banana has valuable applications in food industry, it prevents an ultimate loss of huge amount of untapped biomass and environmental issues (Padam et al, 2012). Briquettes are a more environmentally friendly option, particularly in areas where coal and firewood are still the primary sources of energy, such as rural Kenya and India.

Even though these countries appear to be far away at first look, transitioning to more sustainable energy sources improve circumstances not only locally, but also globally. Climate change is caused by fossil fuels and is not bothered with national borders

Compared to coal and firewood, briquettes made of biomass are less damaging and easy to manufacture. Moreover, they are much affordable, since they are already a waste product, no new material must be produced or unearthed, which also protects forests. Families may save more than a third on heating expenditures with biomass, while industries might save 30% on firewood consumption with this sustainable source of energy. It has been shown by a Rainforest Alliance project, which is made to help tea farmers in Kenya and factories switch to various sources of renewable energy.

B.b. Biomass briquettes

Biomass briquettes thus also give developing countries the chance to use waste products to produce in a more climate-friendly way, while at the same time improving people's quality of life and protecting our forests – a win-win situation for humans, nature, and the economy, in other words

Furthermore, it should be highlighted that direct combustion of biomass may not always be practicable in present facilities, so in many cases, biochemical and biophysical treatments are necessary to bring it up to the standard of conventional fuels. Biomass District Heating (BDH) is a very effective technology for incorporating natural energy resources into metropolitan areas, giving a 100% reduction in CO_2 emissions as compared to fossil fuels while simultaneously enhancing energy efficiency owing to the cheaper cost of biofuels. Biomass materials often occur in other forms like paper-based waste, waste from households, manure.

IV. ADVANTAGES AND DISADVANTAGES

A. Biomass offers several advantages

The capacity to produce jobs is one of its major advantages, as is the use of the land for forest purposes, which would also help to clean the forest and so reduce forest fires thus encouraging more fuelwood production which that participation in community forestry significantly (Bandyopadhyay &Shyamsundar, 2004).

The exploitation of raw resources from the countryside and the bush (Yap, 2001), is one example of how biomass creates ongoing employment.

The use of biomass as a biofuel is now a research topic of significant interest in the scientific community. The upcoming future needs cutting edge scientific returns for maintaining the balance in the world (Khan et al, 2015).

Biomass energy is the unique source of energy that possesses both the properties of a fossil fuel and the ability to be stored, replenished, and transmitted.

In the last decades, rapid population growth, unsustainable water consumption coupled with agricultural expansion, has significantly increased demand on groundwater resources (Odhiambo, 2017). Using biomass energy is a great alternative for that.

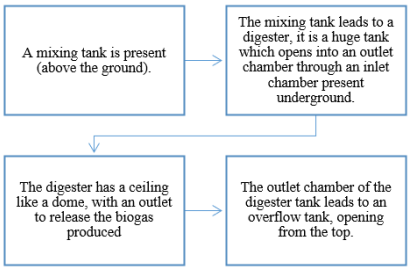
Energy from bioresource can make major contributions to decrease carbon emissions, especially from tough to decarbonize sectors like aviation, heavy transport, and manufacturing (Reid et al, 2019).

B. Some of the restraints or disadvantages includes

- Unlike other fossil fuels, biomass energy is not that much efficient. The challenge with biomass is that it is usually low in bulk and energy density, which poses a problem of handling, transportation, and storage (Kpalo et al, 2020).
- Biomass is not a pure origin of energy, because it often includes human wastes, wood as well as other natural materials. Decomposition or burning of these matter results in methane production, which causes environmental damage.
- Production of biomass energy requires lots of space. Huge research is going on currently to minimize the area utilization in the production process.
- Biomass production can lead to deforestation, since it utilizes wood as a major source of energy and power [Table 1]

TABLE I: BIOGAS PRODUCTION PLANTS IN WORLD

Countries	Biomass power distribution (2012) in %	Amount of power exported (2012) in GW
US	8.8	14.3
Brazil (developing)	10	9.7
China	2.3	7.8
Germany	9.8	7
Austria	26.8	4.5
Sweden	17	4.2
India (developing)	6.1	3.9
Italy	6.8	2.9
UK	19.9	2.8
Finland	36.7	2.1



This is the primary dataset of the year 2012 which is utterly relevant to this age with some changes in the recent years and are the primary calculations for the understanding of the relevance. The economic cost expenses have been calculated by the data collected from various latest studies. Due to its dynamic nature, more patterns are being observed in the data of costs, and that is expected to keep on changing in the long term.

The recent most studies by The Energy 2020 sets the following goals (Scarlat et al,2015). Five energy goals are listed in the Energy 2020 strategy: lowering energy use, developing the internal market and infrastructure, extending technical leadership, ensuring secure, safe, and economical energy, and bolstering the external dimension. The purpose of this plan is to encourage the development of novel new low-carbon technologies, especially through the Strategic Energy Technology Plan, and is a component of the Europe 2020 strategy and the "Resource Efficient Europe" project. Other countries are also moving towards a carbon free source to make energy production more sustainable.

V. INSTALLATION AND ANNUAL COST ON BIOGAS PLANT

A. Biogas plant

A biogas plant is a facility that produces biogas by decomposing biomass. The substrate for the creation of this methane-containi.ng gas is often made up of energy crops like maize or waste materials like manure or food waste. Fertilizer can be crafted from the fermentation waste left over from the substances at the belief of the process.

A.a.Installation

With a brick and cement structure, a biogas plant has three sections. Following is it's procedure of installation.

A.b.Maintenance and operation

Running a biogas plant include doing small repairs on the machinery, changing the oil as needed, cleaning debris from organic waste that settles at the bottom of the tank, resolving process difficulties, and a variety of other tasks. Of course, keeping an eye out for such issues and addressing them immediately takes time and money on the part of the project developer. Maintenance costs represent around one third of the annual operating costs of a biogas plant.

The operation of a plant involves multiple processes, like

- The mixing tank serves as the biogas plant's input. The biomass is combined with water in this mixing tank to generate slurry.
- Slurry is a combination of water and cow manure (biomass). The slurry zone is another name for the mixing tank. The bio solids are then poured into the digester.
- The digester (air-tight chamber) is a zone where there is no oxygen (essentially an anaerobic environment) and microorganisms are present (the anaerobic bacteria). In the absence of oxygen, these microorganisms may decompose the chemicals.
- Thus, the microbes in the digester breakdown the biomass, or disintegrate the complex material into simple chemicals such as methane, hydrogen, carbon dioxide, and hydrogen sulfide. These gases are created and held in the gas tank before being released through the gas outlet as needed. Other than gas, the byproducts

of biomass breakdown include compounds such as manure and fertilizers

B. Cost

All expenses and misplaced earnings skilled at some stage in the plant's construction, consisting of the land, excavation work, the constructing of the digester and gasholder, the piping system, the fuel onlineutilization system, the dung garage system, and different facilities, are covered within the manufacturing costs. Wages and materials are included in the building costs.

B.a.Production Cost

The manufacturing prices consist of all costs and misplaced sales skilled in the path of the plant's construction, just like the land, excavation work, the constructing of a digester and gasholder, the plumbing system, the fuel onlineutilization system, the dung garage area, and various constructions. Wages and materials are included in the building costs.

The following factors influence the production costs of biogas plants

Buying expenses or opportunity costs for land required for the biogas plant and slurry storage; biogas plant model; size and dimensioning of the biogas unit labor input and wage influence the production costs of biogas plants

Estimating the entire cost of production

The following numbers can be used to get an approximate sense of the average costs of a basic, unheated biogas plant: The total cost of a biogas plant, including all necessary facilities but excluding land, is between Rs. 3750 and Rs. 5625 per m^3 capacity. The digester accounts for about 35 to 40% of the overall expenditures.

In general, the particular cost of gas production in community or big plants is lower than in small family units. The cost of gas distribution (mostly pipe) often rises with the size of the facility. Pipeline costs are considerable for community facilities with several end-users of biogas, and 'economics of scale' partially or entirely compensate for the degression. Large-scale plants would be more cost-effective in places where plant heating is required.

Labor provided by future biogas consumers is preferred to keep building costs affordable. Often, the entire excavation process is completed without the need for hired workers. User labor has the potential to reduce salaries by up to 15% on average. If low farm activity times are chosen for the building of the biogas plant, worker opportunity costs can be kept low (Vinterbäck & Ladanai, 2009).

B.b. Maintenance Cost

The maintenance costs mainly comprise of -

- acquisition (purchase, collection, and distribution of the substrate)
- water supply for cleaning the stable and mixing the substrate
- feeding and running the plant or plant monitoring
- maintenance, and repair; slurry storage and disposal; gas distribution and usage; administration

The operating costs of a biogas plant with expert management are just as essential as the building costs, including charges for painting, servicing, and repair.Large-scale biogas facilities need a lot of water. Investigations are required if the amount of water used results in greater expenditures in the long term. These might include water pipe construction costs or public water supply rates. The issue of water freedoms should be explained. Steps must be made to meet the demand for water during dry spells that need careful preparation (Vinterbäck&Ladanai, 2009).

Annual cost spent for biomass plant by the government of India vs outside countries

Till now, it has been evident that being primarily an agriculture-based economy, India heavily depends on biomass as an energy resource. Thereby, the government invests a hefty amount in biomass projects. The total cost of a biogas plant, including all necessary facilities but excluding land, is between Rs. 3750 and Rs. 5625 per m^3 capacity.

The overall operational cost of the biogas plant has raised from Rs 2.99 to Rs 4.01 Rs / h with the increase in plant size from 2 to 8 m^3. Nevertheless, the 3 m^3 size has the lowest operating cost (Rs 2.73 / h), followed by 2 m3 (2.99 Rs / h) and 4 m^3 (Rs 3.31 Rs / h). [Table 2]

TABLE II: OPERATIONAL COST OF BIOGAS PLANT

Biogas production:		
Countries	**total power generated (GW)**	**Total expenses (in million $)**
US	6.37	20
Brazil	11.02	70
China	1.66	2,780
Germany	121	16945.5
Sweden	1800	54.65
Italy	4.12	5198
UK	7.9	1.653
India	10.1	9967.5

The above-mentioned countries invest in biogas production in their own unique way.

For example:

- UK invests almost 1.6 million dollars, generating power of approximately 7.9 GW.
- In USA, biomass accounted for almost 2% of the total electricity generation. The expenses were around 20 million dollars. Also, about billion dollars were spent in the year 2012 by the government agencies in US to meet the mandate to replace 30% existing liquid transportation fuels by 2022 which is thirty-six billion gallons/year

- In Germany, biogas and biomethane acts as a major source of renewable energy, accounting for almost 5.7% of the total energy production (Venkatesh, 2014).

Estimated costs if biogas plants from organic matter are installed:

Biogas is a type of biofuel that refers to the gas created when organic materials are broken down biologically. It can be created by anaerobic decomposition or fermentation of biodegradable materials. Another method is spontaneous production through organic waste breakdown (Ivankin et al, 2014).

A Biogas Plant's Average Cost includes:

- As the volume of the digester increases, the cost per cubic meter drops. As a result, the proper size of the biogas plant should be estimated.

- The digester size for basic, unheated plants in tropical areas is around12 to 20-fold the amount of substrate put in daily at average predicted digester temperatures over 25°C, and 18 to 25-fold the amount of daily feeding between 20 and 25°C.

The exact estimates for biogas plant development and operation serve the following purposes:

- To assess the costs of competing models (optimal project selection) for the users
- Information in terms of future financial obligations the calculation of funding needs
- Including public subsidies (budget planning)

Approach to understand how much household water treatment plant from sewage can be effective in Indian Economy

In general, the cost of gas production in communities or large factories is lower than that of small households. The cost of gas distribution (mainly piping) often increases with the size of the installation. The piping costs are substantial for collective facilities with multiple end users of biogas and the “economy of scale” partially or totally compensates for the degressively. Large-scale factories would be cheaper in places where factory heating is needed. With the present capacity of 163 biogas plants India is highly keen to use biomass plant or biogas energy resource to produce most of the power supply for the country.

India is investing in the biomass resource production by investing in projects like The BPGTP program: The BPGTP program is implemented by the state's agricultural and rural development departments and dairy cooperatives. However, the program is a state with agriculture and states through the State Renewable Energy Agency (SNA), Biogas Development and Training Center (BDTC), Khadi and Village Industries Commission (KVIC), and National Dairy Development Board (NDDB). But it is being implemented. The rural development sector cannot do this. The Program Implementing Authority (PIA) provides Panchayati rajits / local legal entities (LBs) with needs-based intervention within the framework of regional development programs for rural areas and forest-edge villages in the northeast. It can be used as a comprehensive institution. High population concentration of SC / ST communities, including tribal areas (Weinmaster, 2009).India being a developing country has a bright time ahead in converting all its renewable sources into non-renewable energy and that can be highly resourced from its agriculture and sewage by products. [Table 3]

The Future approach

Throughout the study it is shown how the world is turning towards more sustainable energy sources like the renewable energy sources like solar energy, wind energy, biomass, and others. It is already in effect as The Energy 2020 states the goals (Scarlat et al,2015) towards cleaner energy sources.

This study is relevant towards how a whole biogas plant can be installed, what are it is benefit for the modern world and how most countries are choosing this to reduce the use of non-renewable energy. Modern tools of Biomass energy like the biomass briquettes, different techniques like BDH prove how this is the future of energy production. Other such biochemical importance of biofuels is the involvement of different enzymes for its production. The bacteria include enzymes such formylmethanofuran transferase, formate dehydrogenase, and methyl-CoM reductase. Enzymes are being employed more and more to boost biofuel quality, increase agricultural production, and enable cost-effective biomass conversion. Beyond chemical catalysts, enzymes have garnered increased attention as the highly efficient, sustainable catalyst (Ramos et al, 2020).

Throughout the study it is established why and how the world is choosing biomass that is not only eco-friendly but alsogenerating a bulk amount of workload and thus jobs.

TABLE III: FUTURE APPROACH

Possible projects and present biomass situations		
States	Future project capacity (m3/ day)	Present biomass power in India (MW)
Andhra Pradesh	74640	378.2
Bihar	12000	113
Gujrat	24840	65.3
Karnataka	58080	1222.1
Kerala	2760	864.4
Madhya Pradesh	5640	1386.2
Maharashtra	73080	1969.7
Punjab	33720	3177.6
Tamil Nadu	142920	1163.9
Uttar Pradesh	57200	1764.9
Uttarakhand	67200	88.3
West Bengal	14040	529.2

CONCLUSION

According to the study, it has been found that biomass is a cheaper and more efficient energy source not only in India but also across the world. The extraction of this form of energy can be from waste. Also, recent advancements through biomass briquettes and such other techniques show the indulgence of the world in this better form of energy. As a result, it is a bettereconomical example of waste to resource conversion that promisingly reduces pollution and has a vast future with new workloads and jobswhile also reducing the demand for fossil

fuels, which not only pollute the atmosphere but are rapidly diminishing. Energy is a requirement in our everyday life as a way of improving human development leading to economic growth and productivity. Despite the research on bioenergy increasing in recent years, the study of developing this renewable source of energy requires much better attention to create a greener world with the latest techniques and advancements as produced throughout this study. The confirmed ways of developing biomass energy producers and their use for large-scale energy sources by both the developed and the developing countries that furthermore improves the world economics and environment scenarios has been established through this study.

REFERENCES

Aguilar, F.X., Mirzaee, A., McGarvey& R.G. et al. (2020) Expansion of US wood pellet industry points to positive trends but the need for continued monitoring. *Socio-economic dimensions of forest-based bioenergy* (10), 3708 – 3718

Bandyopadhyay, S., Shyamsundar, P. (2004) Fuelwood Consumption and Participation in Community Forestry in India (6), 1-32

Carlos, R.M., &Khang, D.B. (2008) Characterization of biomass energy projects in Southeast Asia, *Biomass and Bioenergy*. *Elsevier* (32), 525 – 532

Energy Department (2013) Renewable Energy. US Energy Info Admin, 1-276

Energy Department (2013) U.S. Energy Information Administration, 2 – 33

Ghosh U, Das D, Banerjee B, Karmakar S, Das J (2021) Biomass Energy Potential in India: A Review*International Journalof Engineering Research& Technology (IJERT) NCETER* (09),42-45

Ishak, M., Ani, A., Syed Ismail S., Md Ali M.L., Ahmad R. (2022) Conversion of biomass to biofuels. *Value-Chain of Biofuels*,49-67

Ivankin A, Pandya U, Saraf M (2014) Intensification of Aerobic Processing of the Organic Wastes into Compost. *Springer Sustain. Dev. and Biodiverse* (3),1-290

Jowitt, Simon M. (2020) Non-Renewable Resource Depletion and Use. *obo in Environmental Science*.1-3

Kanu, I. (2021) African eco-theology: meaning, forms and expressions. *The Association for the Promotion of African Studies*, 1 – 424

Khan, S.,Paliwal, V., Pandey, V., & Kumar, V. (2015) Biomass as Renewable Energy. *Special Issue (2)*, 301 – 304

Kim, L. (1980) Stages of development of industrial technology in a developing country: A model, Research Policy. *Elsevier* (9).254 – 277

Kpalo, SY., Zainuddin, MF.,Manaf, LA,&Roslan, AM. (2020) A Review of Technical and Economic Aspects of Biomass Briquetting. MDPI in *Sustainability* (12), 1- 30

Kumar, A., Kumar, K., Kaushik, N., Sharma, S., Mishra S. (2010) Renewable energy in India: Current status and future potentials. *Renewable and Sustainable Energy Reviews* 14(8),2434-2442

Lohri, C.R., Diener, S., Zabaleta, I. et al. (2017) Treatment technologies for urban solid biowaste to create value products: a review with focus on low- and middle-income settings. *Reviews in Environmental Science and Bio/Technology.* (16),81 -130

Masood M. (2015) Global Waste Management Outlook-2015Global Waste Management Outlook. UN Env Prog, 1-346

Odhiambo, G.O. (2017) Water scarcity in the Arabian Peninsula and socio-economic implications. *Applied Water Science* (7), 2479 – 2492

Padam, B., Tin, H., Chye, F., Abdullah, M. (2012) Banana by-products: an under-utilized renewable food biomass with great potential. *Journal of Food Science and Technology -Mysore-* (51), 3527 – 3545

Pal K, Yadav P, Tyagi S.K (2017) Renewable Sources in India and Their Applications. *Sustainable Biofuels Development in India*, 39-71

Ramos, Luiz &Suota, Maria &Fockink, Douglas & Pavaneli, Giuliana & Silva, Thiago & Lukasik, Rafal. (2020). Enzymes and biomass pretreatment. *Recent Advances in Bioconversion of Lignocellulose to Biofuels and Value-Added Chemicals within the Biorefinery Concept*,61-100

Reid, WV., Ali, MK., Field, CB. (2019) The future of bioenergy. *Global Change Biology* (26), 1 – 13

Rolington L. (2010) Biomass energy – optimizing its contribution to poverty reduction and ecosystem services. IIED ESPA,1-93

Sadh, P.K., Duhan, S., Duhan. (2018) J.S. Agro-industrial wastes and their utilization using solid state fermentation: a review. *Bioresources and Bioprocessing (*5), 1-15

Scarlat, Nicolae &Dallemand, Jean &Monforti, Fabio & Nita, Viorel. (2015). The Role of Biomass and Bioenergy in a Future Bioeconomy: Policies and Facts. *Environmental development* (15),3-36

Soltero, V.M., Chacartegui, R., Ortiz, C., Velázquez, R. (2018) Potential of biomass district heating systems in rural areas. *Energy Elsevier* (156), 132 – 143

Venkatesh B. (2014) Current Challenges in Commercially Producing Biofuels from Lignocellulosic Biomass. *ISRN Biotechnology*, 1 – 31

Vinterbäck, J., Ladanai, S. (2009) Global Potential of Sustainable Biomass for Energy. *SLU, Swedish University of Agricultural Science Department of energy and technology* (13), 1-32

Weinmaster M (2009) Are Green Walls as "Green" as They Look? An Introduction to the Various Technologies and Ecological Benefits of Green Walls. *Journal of Green Building* (4),3 – 18

Woodward J. (2013) Total Energy Study: Report to the Vermont General Assembly on Progress Toward a Total Energy Approach to Meeting the State's Greenhouse Gas and Renewable Energy Goals,1-38

Yadav, K., Sircar, A. (2020) Geothermal energy provinces of India: A renewable heritage. *International Journal of Geoheritage and Parks* (9), 1 – 13

Yap R. (2001) Energy Efficiency and Renewable Energy. *Dept of Energy*,1 – 33

Zaidan, E., Al – Saidi, M., Hammad S. (2019) Sustainable development in the Arab world – is the Gulf Cooperation Council (GCC) region fit for the challenge? *Development in Practice.* (29), 670 – 681

Zhang, Q., Watanabe, M., Lin T with DeLaquil, P., Gehua, W., Alipalo, M. (2020) Cleaner Energy Better Environment Higher Rural Income People's Republic of China. *Rural BiomeducalEnvironment*,1-101

***