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The Processing of Biomass Production in Zimbabwe from 2010 to 2019

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Conflicts of Interest
There are no conflicts to declare.

ABSTRACT

Recently the use of biomass to provide energy in Zimbabwe is estimated at 66% of the total energy used in the country. There has been a strong movement to use biomass resources for energy purposes in the past decade. Zimbabwe's significant biomass resources are crops, animal excrement, refuse, and industrial waste materials. The study aims to determine the status and trends of biomass production in Zimbabwe between 2010 to 2019. The paper analyzes how biomass crops are grown and how they are utilized and how they present problems. This research was performed using a qualitative approach and is focused on secondary data obtained from various outlets, including journal papers, conference proceedings, government records, magazine articles searched through search engines. This study's findings disclose that a total of 711 biomass plants in the country by the end of 2017, such as local plants, institutional plants, and households plants 90%, 8%, 2%, respectively. In these plants, 1% used pig manure, 8% sewage, 1% cow dung, and other digested local sources, while 90% used cattle faeces. In meat production, 97% of the working biomass is used for cooking, while 1% is used in poultry. The study determines that bioenergy is not as common as other types of energy. Education and communication concerning the benefits of biomass technology promote its use.

Keywords: ANAEROBIC DIGESTION, ENERGY SOURCES, DIGESTION, BIOMASS, ZIMBABWE

Introduction

The demand for energy consumption has risen steadily over the last 20 years. Since global energy demand is over time, fossil fuels are becoming less affordable (1). The amount of processing is currently too high, the insulation is too high, and the accessibility of power generation has become a critical threat in Zimbabwe (2). We see that less than 10% of Zimbabwe's total population has electricity access. The supply of electricity and fossil fuel extraction is enormously essential for oil provision from crude oil, fuel gasoline, crude oil, and coal.

The primary source of electricity is hydro and thermal in Zimbabwe. Producing by Zimbabwe power companies which manage five major power stations, namely Hwange thermal power station, Kariba South

hydropower station, Munyati thermal power station, Harare thermal power station, and Bulawayo thermal power station (1), are importing from Zambia, Mozambique, and South Africa (3). As of today, the circumstances have not yet been adjusted. While in a rural and remote area, most people rely on firewood to promote deforestation and desertification. According to global market statistics, biomass use is estimated to increase by 44% between 2007 and 2030 (4).

It is necessary to find different sources of energy from available resources. Perhaps except the United States, many countries favour renewable forms of energy. These sources include producing green renewable energy via anaerobic digestion of feedstocks, manure and waste products in the food industry for processing biomass generation. Energy consumption from waste products is causing ecological issues in Zimbabwe, from mills, agriculture, and homes. Incomplete combustion is an excellent way to use waste products to provide energy and is a great way to digest the organic waste as a fertilizer. One way to power homes and vehicles and all other energy uses is to use renewable natural resources. Anaerobic digestion consists of a metabolism chain carried out by a broad range of microorganisms and contains biomass such as hidrosis, acetogenesis, and methanogenesis. Biomass offers broad, sustainable bioenergy practices with a wide range of benefits, including health, food, agriculture, energy, environment, and hygiene. It would likely encourage economic growth in Zimbabwe. By providing clean fuel from sustainable feed, biomass technology will benefit African Communities (2). Different energy services, such as fire, electricity, and oil, can be used by biogas. It decreases fossil fuel energy usage, reduces climate and global warming emissions, increases sanitation, cuts down demand for wood and coal to cook, and provides better fertilizer. Biomass innovations will help overcome poverty, which is a significant impediment to Africa's economic growth (5).

The country as a whole does not have enough unused energy for the need of the people. Less than 10% of the population has electricity, making it too unreliable. The cost of electricity has to be affordable for those with access to power to make it economical. The demand for fossil fuel is growing, depleting fossil fuel supplies. It has decreased the power supply's complexity by lowering the requirement of power, power cut, and load shading. However, just as with agriculture, residential pollution, and waste disposal, the nation relies on manufacturing pollution.

Waste produced reveals a high degree of waste pollution affecting the region's general population. Organic waste will produce energy and digestion sources for promoting an inexpensive and environmentally sustainable country's agro-based economy. It is generally accepted that biomass can become one of Sub-Saharan Africa's main primary sources of energy, including Zimbabwe, throughout that century. Modernized bioenergy systems are essential for developing sustainable energy systems (6). The current literature for biomass use for energy generation is well documented (7,8).

Advances in renewables technology, such as biomass, are also well-known for safe, cheap, and modern renewable energy sources. The adaptation routes for energy flow, electricity, and biomass fuel are well developed and financed through continuous research and development (9). Various new biomass green tech is now being produced, presented, and commercialized at various research stages (9). Digestion of anaerobic

is an advanced technical advancement. Biomass-based electricity generation using boiler-steam turbine systems is well developed (9).

On the other hand, moving from coal to biomass or combined burning has been found and discussed by Hall and Musungwini (10,11). New technologies are also well documented within the agricultural industry and organic waste based on biomass power generation. We are very excited about the biofuels and biomass production capacity that is coming from these biotechnologies. However, there has been no research to identify the current knowledge and information on biomass production and its technology in Zimbabwe. Thus this study explores biomass development and technology and provides some basic guidelines and knowledge to encourage research and bioproducts strategies in Zimbabwe.

2. Methodology

2.1. Research Design

The author has a comprehensive literature review related to the current Zimbabwean biomass production process by collecting data such as the latest research papers, studies, articles, reports, and documents. There has been a literature review to assess Zimbabwe's biomass capacity. Qualitative research was carried out, with some growth indicators in Zimbabwe.

2.2. Search Strategy

Data has been extensively searched from multiple well-known databases such as google scholar, science web, science direct, and Springer link websites using keywords such as "biomass, renewable energy, Bio digestion, Biomass, Anaerobic digestion, Zimbabwe, energy sources in Zimbabwe, electricity in Zimbabwe, and feedstock" to secure authentic information (12). Data collection and analysis for this study were carried out in December 2020. Literature reviews are an essential part of the field's development (13). It presents the chance to generate and exemplify previous research, thus providing a secure foundation for enhancing science (14).

2.3. Data Analysis

This paper uses study, interpretation, literature research, and other research methods. The analytical research method is based on the observation and investigation topic of research to obtain objective information summarizing the nature and law of producing things in a kind of investigation method. The literary method's mechanism consists of meaningful connections, such as research design, literature compilation, and literature review. This paper uses research methods, empirical analysis, literature study, and other research methods—the literature method's projects for collecting relevant information for the objectives of study details. A research objective is typically centred on common goals of systems, where, for example, the diverse systematic approaches of research can be addressed simultaneously and with relatively low cost. The theoretical target's evaluation is the leading research aim of the literature research and other methods adopted to determine research performance. Refer to the notion of analysis or reclassification of literature based on existing theories,

proof, and requirements. The study design should first identify the research goal; the aim is to use operational methods and design or anticipate the subject's content, reproduce the research literature activities, and resolve the problem in a specific and particular way.

3. Results and Discussions

3.1 Various types of Biomass Plants

Bioenergy is a possible alternative for providing energy for households in rural areas. Figure 1 indicates that the plants are distributed into three different sizes the country institutional, provincial, households. Institutions such as hospitals, prisons, and schools had installed biomass plants. Some plants ranged from 50 m^3 to 200 m^3. Household plants had different sizes ranging from 4 m^3 to 30 m^3. The provincial plants for biomass are located in sewage treatment and places like markets sites and markets for waste management. Recently 90% of plants in Zimbabwe were planted on household lands. 8% is institutional, and 2% is provincial plants. At present, there are no industrial plant installations in Zimbabwe.

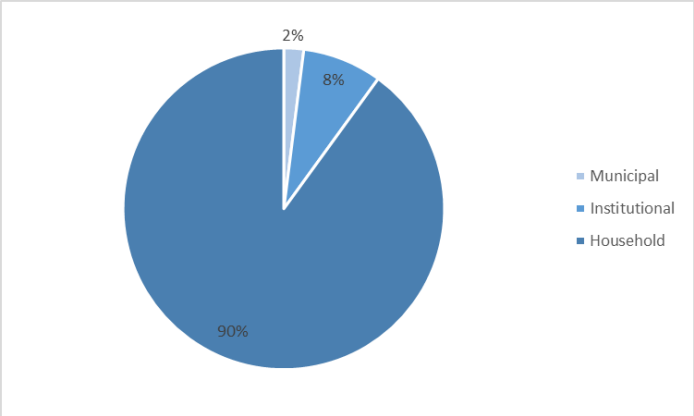

Figure 1: Various types of Biomass plants (Source: (15))

3.2 Number of Biomass Plants

In Zimbabwe, biomass energy sources are theoretically estimated at 409 PJ, and the primary sources are agriculture, municipal, and industrial waste. The environmental catastrophe has hit household, provincial, and institutional biomass plants in the country. Recently there have been 711 biomass plants installed all over the country. The development of biomass plants builds and maintains the country between 2012 and 2018 (Figure 2). The number of plants in Zimbabwe grew steadily between 2012 and 2014.

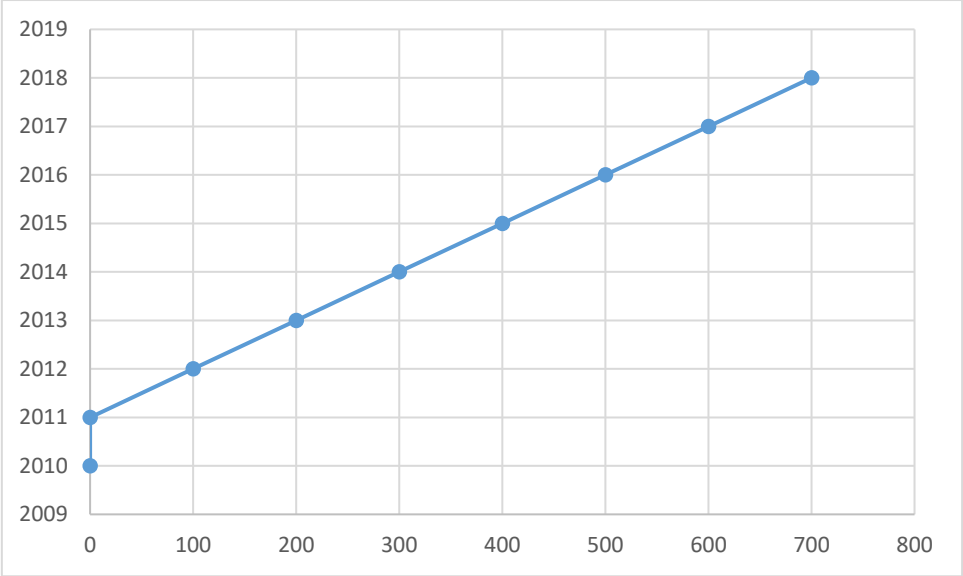

Figure 2: Number of Plants

3.3 Provincial Biomass plant

Provincial plants have been installed for waste management and energy supply at a few water treatment plants and market sites. Based on Figure 3, there are 13 provincial plants in the country. Harare has the largest number of local plants, such as crow borough and Firle, built to manage waste, and the four digesters have existed in Musika, which has yet to be commissioned for energy and waste management. Two plants were found in Manicaland, the one in Sakubva and the other in Mutare. Just one city biomass facility existed in Bulawayo and one in the Midlands. Masvingo, Mashonaland Central, Matabeleland South, Matabeleland North, and Mashonaland West were not provincial biomass plants.

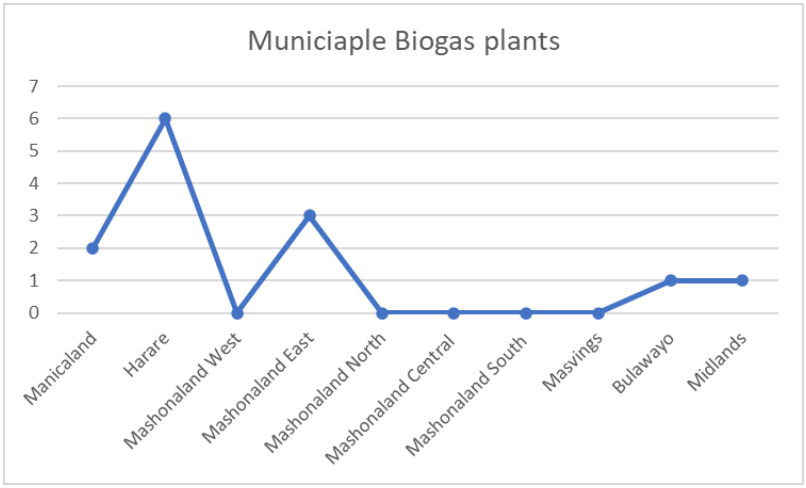

Figure 3: Provincial biomass plant

3.4 The Use of Biomass

There has been some use of biomass in Zimbabwe for cooking. Figure 4 revealed that 97% of the biomass plants feed (consume) the biomass to cook and lighting. Less than 1% of the feed is used to feed pigs for

slaughter and lighting other livestock in the pig slaughterhouses. Less than 1% of the feed is used to heat the pig and poultry trucks and boil the pig slaughterhouses' water. Moreover, the remaining 1 % of this type of biomass plants, biomass was not used. Waste treatment plants were instead developed to treat the remaining 1 %.

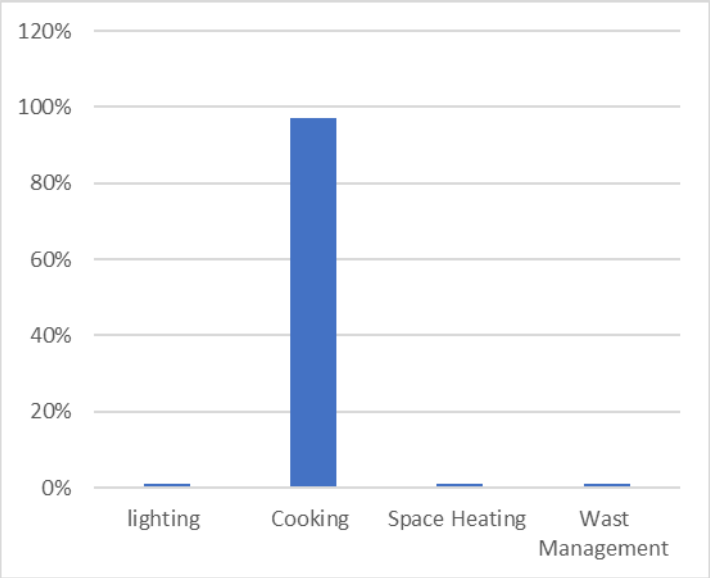

Figure 4: The usage of Biomass

3.5 Discussions

Biomass technology has been well established. As a replacement for the existing inefficient and burning of fossil fuels in Zimbabwe, the number of biomass manufacturing facilities has increased gradually over the years. The National Biomass Program is establishing approximately 711 biomass plants in Zimbabwe. Among these, 650 domestic plants, 48 institutional and 13 provincial plants have been built. Nine institutions plant located in nine provinces, but there is no plant situated in Bulawayo Metropolitan province.

The majority of plant growers use cow faeces as a substrate. Sewage is used as a handling medium by less than 8 % of the farmers. Approximately 1% of farmers use pig manure. Seeds of Jatropha and cow dung are only used in 1% of plant growers. Waste materials and poultry manure are used as additional feed in individual biomass plants. In Zimbabwe, houses have feedstocks available to generate biomass depending on where the households are and their socio-economic status. Crop residue for household biodigester holders is an abundant source of feedstock and is not used for Zimbabwe.

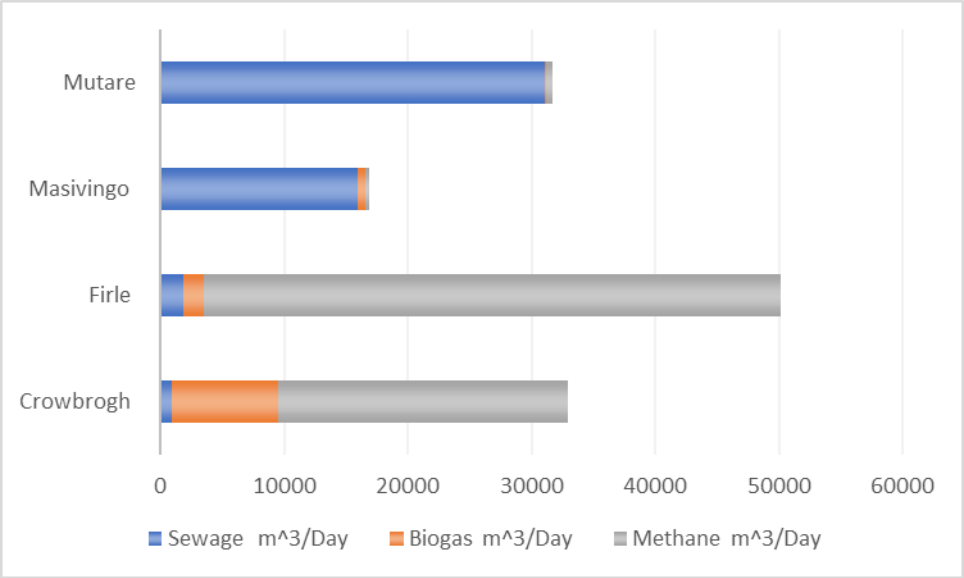

Figure 5: Potential energy harvested from sewage

Zimbabwe's manufacture of biomass capability is significantly higher than that presently being used. As of 2016, only 711 plants had been installed. Recent literature reveals 15,000 plants were installed in Rwanda, 20,000 plants in Uganda, and 10,000 plants in Ethiopia were built by 2007 (16). Sub-Saharan Africa data show that Zimbabwe's biomass technology is still at a very early level, while other Sub-Saharan African countries have evolved similar technologies. The majority of the country's sewage plants are not equipped to operate on biomass. Figure 5 indicates that at Harare Firle, the biomass can be generated within 17000 square meters, and the sewage can be collected within 8500 square meters per day.

Four sewage treatment plants exist worldwide can purify biomass energy to CH_3 and produce 72,341m^3 CH_3 per day. Methane can be reformed and processed to serve as a viable energy source for human life. At first, Zimbabwe did not use biomass technology, and only a few non-usage and municipalities are being used. High beginning costs for developing plants, a lack of biomass technology development, and insufficient installation and renovation expertise can hinder their ability to spread (17). If this biomass were used for various purposes such as electricity generation, Harare could save almost 6 million energy units annually. By adopting biomass treatment technology across the country's wastewater treatment plants, countries' total energy consumption will drastically lower. There are no industrial biomass facilities in Zimbabwe.

In an opaque beer brewing plant, the conventional opaque brewery was treated with wastewater from an anaerobic sludge blanket. The anaerobic sludge blanket reactor made it possible for the brewery to fulfil the wastewater requirements discharged into Harare's municipal wastewater and partially transformed organic matter into methane for energy generation (18). Nevertheless, the methane, rather than being released into the environment, was captured and burned. The digester has broken down to stop working. Zimbabwe's lack of advanced manufacturing biomass plants is attributable to such a pilot step failure (17). It also identified that the anaerobic digestion pilot process in South Africa led to a low adoption rate. Insufficient maintenance and support skills will contribute to the pilot step failure of biomass technology operators in Zimbabwe manufacture the extra by-products of rations from their pulp and paper making operations by burning biomass

in the sawmills, in large amounts for biomass energy generated to produce biomass for different feedstocks including organic materials of waste material, and organic waste of biomass residues and farm residues. The vital substrate used to produce manure from animals such as Sheep and Cows is animal dung. Although possible, there is little evidence that manure is not being used enough.

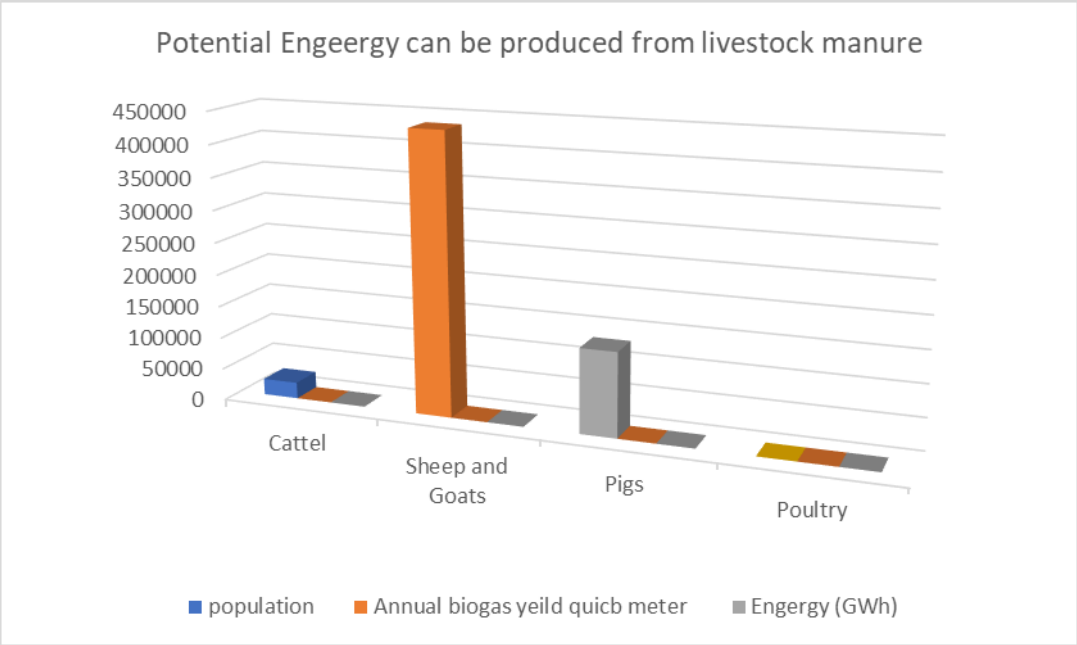

Figure 6: The energy potential generated by the livestock

However, The lack of a substratum was the most significant obstacle for oversized plants or a dramatic reduction in substratum generation after the plant was installed. Since 2012, several institutional biomass plants with about 48 institutional plants have been located across the country (17,19). The extent of biomass has been influenced by access to biomass responsive projects (20). Creating and maintaining biomass plants cannot be permitted by people at a low rate of adoption. Increased family income has proven helpful in family decisions on biomass use (17,19). The financial capacity to set up and, above all, sustain a digester is the most likely influence household income has on the use of biogas. However, high costs have been met with cheaper materials such as plastics in building biomass plants (17,19). Therefore, research into cheaper materials used in biomass plant construction is required in Zimbabwe (20).

In Zimbabwe, most biomass plants are detected as oversized and do not generate adequate biomass for cattle or swine. Therefore, before building on the digester scale for households, research and consultation are required. The main plant in the household was 6 to 9 m3, with the substrate not adequate. The 4m3 digesters also significantly improved the performance of extracting the digesters. The biomass plant owners should be educated professionals to use various (digester) substrates to feed the digester enough of the substrate into the digester to use large quantities of the substrate. It aims to use symbiotic nutrients in the digester. The government in Uganda is trying to reduce the demand for pig products for feed and soaps by encouraging biomass energy use. It takes four years to start producing feedstuffs, however (21).

On the other hand, a few biomass digesters have been under-sized and have been available with more substrate than could be used for feeding, but the biomass produced does not meet users' standard requirements.

The main explanation for biomass plants is to undersize and oversize biomass operators, such as government and research centers, or the general disregard of customer or social involvement. Thus, user involvement is essential to decide the size of the biomass plant. Comfortable use is an essential factor in adopting and using technologies (20). In such a way, a person assumes that the effort will be free to use the method in question. Some 10% of plants were located outside of feedstock, and 20% of plants surveyed indicated that the digester lacked human resources, although some biomass users identified feeding the plant as a rainy season nightmare. Biomass technology which may cause disapproval in such situations is no longer easily interpreted. The use of biomass technology resulted in reduced family labour in Central Uganda, as few families found it challenging to run the farm (21).

However, two reasons that avoid the need for a large biomass plant are described. In remote and peri-urban settings, pilot digesters can minimize fuel costs and time in limited resources. However, work on water and feed collections, and digesters should be considered to see if the total work reduction is achieved (22). The degradation or lack of fuelwood supply reliability increases the likelihood of biodigesters built by households (23). The technology has given biomass users in Zimbabwe much benefit, despite the low adoption rate of biogas. The biomass was primarily used for cooking — conventional gas burners with low pressures. Clean, transparent fire absorbs biomass such that air pollution is minimized. Biomass use has reduced the use of firewood substantially, with Zimbabwe's biomass technology significantly reducing deforestation. Biomass processing has opened the door to quality-of-life improvements in biomass consumers, decreases electricity consumption, and reduces energy poverty. Rather than just wood and coal, users preferred cooking feedstock it can be started and stopped automatically. But here in Zimbabwe we use biofuel from biomass only occasionally (22,24).

Conclusion

Given the energy shortage in Zimbabwe, efforts to use renewable energy sources are incredibly significant. The biomass technology has been implemented in Zimbabwe, but there are only about 711 biomass plants in their infancy. For biomass processing, domestic plants, institutional plants, and urban plants both need to be used. The plants are used for cow dung feed, manure, pig dung, and jatropha seed pastry. The household biomass plants upgrade mainly CAMATEC fixed-dome versions. Zimbabwe's biomass potential extends beyond the home, and the cow dung is a source of biodigesters. In Zimbabwe, it is possible, through the organic processing of municipal waste in digesters, to enhance the production and handling of solid waste in municipalities, which is an excellent opportunity. The biodigester is highly commendable in Musika for its organic waste processing. There are significant unused feedstocks in Zimbabwe's agro-processing and food production market. It is essential to ensure biogas' technical potential for investors and evaluate possible feedstocks in Zimbabwe. For most biomass consumers, biomass technology is satisfying. Biomass is mainly used for cooking purposes as a biofertilizer.

The researchers found that neither of the human decomposition substrates exists in the stigma used for

cultural discard. To stop the roadblock and resolve this stasis, the sensitivity aims to break the prejudice and overcome this stasis by encouraging the urban poor to develop their proficiency and find any means of improving their competitiveness. There must be more biomass plants, particularly in Zimbabwe, to use biomass technology for most people. To reduce these threats, biotechnology education and preparation should be implemented in public institutions and training centres. Currently, the government is, the municipalities and people are, and so is sponsoring the biomass facility building. For starters, biogas may be made to function easier if more people are involved, for example, private businesses. Also, not having enough commercial biomass plants in the area was a concern for the inhabitants living. Biodigesters and industrial waste-to-biofuels plants must be constructed for handling industrial waste and bioprocessing, and they are producing. The potential cause of the reactor's failure in the beer breweries should develop various designs. Renewable energy, waste management, and food security would benefit from biomass technology in Zimbabwe. To improve the technology, we need first to include a digester of materials considered acceptable to use. Then, to help the digester minimize the repair functions, we need to know the substrate that would be used and possible issues with the digester's goods. Bear in mind that technological advancement is fundamental to better education and connectivity. By implementing technologies such as low-cost pre-manufactured digesters, retaining successful policy and regulatory institutions, and "loan allocation", the technology's positive impact will continue. The country has an incredible opportunity to take advantage of the vast quantities of organic banana decayed biomass gathered and produced by all local governments to make it an extraordinary meaningful natural resource.

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