A Study for the analysis of Municipal solid Waste Potential to Bioenergy for Electricity Generation in Bhopal.

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Abstract-*Once municipal solid waste management is not properly handled, the health of the environment is put at risk, as well as the aesthetics of our society. As a result, the level of living is being raised. The finest treatment for organic waste is urgently needed to neutralize the waste. In addition to being able to produce biofuels, it may also be used to create energy. Organic waste is essential to the production of energy from waste, so the energy potential of Bhopal city has been categorized into different sectors such as Urban Organic Solid Waste, Pulp & Paper, Cattle, and Poultry, in which accounts for 42%, UOLW 25%, Cattle 23%, and Pulp and Paper 8% respectively. Organic Solid waste (33 percent), Poultry (3 percent), and Cattle (63) comprise the majority of the UOSW in Slaug; the in Slaug (1%), Urban organic Liquid (98.9%) and Pulp/Paper waste comprise the remaining 0.01%. (0.10 percent). Bhopal generates 1000 TPD of trash every day, of which 54.3 percent is organic waste that can be used to make biofuel, i.e., 500 TPD, which generates 154MW of power per day.*

Keywords: - ***Municipal Solid Waste (MSW), Urban Organic Waste, Bio-methane, Electricity, Waste to Energy.***

1. Introduction

Municipal solid waste management is essential as it impacts health, the Environment, and aesthetic society if it is not managed correctly. Hence to improve quality and standard of living, the Bhopal Municipal Corporation (BMC) has proposed strengthening the covering collection, segregation, recycling, transportation, processing, and disposal with an option for composting, waste to energy, disposal in 8 Urban Local Bodies (ULBs) in Bhopal[1]. The BMC intends to institutionalize a holistic, Integrated, sustainable environment and eco-friendly Municipal Solid Waste Management System in the urban local bodies (ULBs)[2,3]. Rapid industrialization and population explosion in India have led to the migration of people from villages to cities, which generate thousands M.T. of municipal solid waste daily, one of the essential contributors to environmental degradation at the national level. Improper management of municipal solid waste (MSW) causes hazards to inhabitants. Therefore, BMC has initiated the project involving setting up an Integrated Solid Waste Management System (ISWM) for a cluster comprising ULBs within a radius of 20 km of Bhopal [4].

Biogas and biomethane have a huge technical potential that has yet to be tapped, according to a bottom-up investigation on the world's supply of sustainable biogas and biomethane. Direct biomethane from agricultural, animal, and municipal waste leftovers. Only about 35 million tons of oil equivalent of biogas and biomethane were produced in 2018, a small fraction of the entire potential. If the sustainable potential is completely utilized, it may supply around 20% of the world's current gas consumption.[5].

For the recovery of Energy from Urban, Industrial, and Agricultural Wastes/ Residues (WtE Program) in the form of Biogas/ Bio-CNG/ Power, a Waste to Energy (WtE) Program is needed. By providing Central Financial Assistance, WtE is helping the Ministry of Petroleum and Natural Gas (MPNG) fund the SATAT (Sustainable Alternative Towards a Portable Transportation) initiative in India, which aims to build 5000 CBG plants by 2023-24 with a production target of 15 MMT of Bio-CNG. Thus, "Annadaata se Urjadata" may be realized and rural economies revitalized as new job possibilities and more revenue are made available to

farmers. The WtEinitiative promotes the use of Municipal Solid Waste (MSW) to power projects, which is in line with the Swachh Bharat Mission. [6,7].

Madhya Pradesh is a state in India with a population of 73 million people and covers 9.5 percent of the country's total land (308,000 sq. Km.). The state's urban population, spread among 378 ULBs, rose by 2.2 percent from 16 million in 2001 to 21 million in 2011 [8]. The increasing pace of urbanization has resulted in a greater emphasis on urban infrastructure and municipal service delivery, which has raised the need for investment in urban development.

The research work aims to emphasis on the municipal solid waste specially generated in the Bhopal city of Madhya Pradeshto develop a comprehensive, integrated, sustainable, environmentally friendly, and implementable municipal solid waste. The best possible solution to encounter the MSW is to produce a Bioenergy form it. The survey has been conducted in some prime-area of Bhopal to know the volume and type of waste generated and with the help of Central pollution control board data. The analysis has been done and with the gasifiermass balance method and the potential of electricity than can be generated from MSW is calculated.

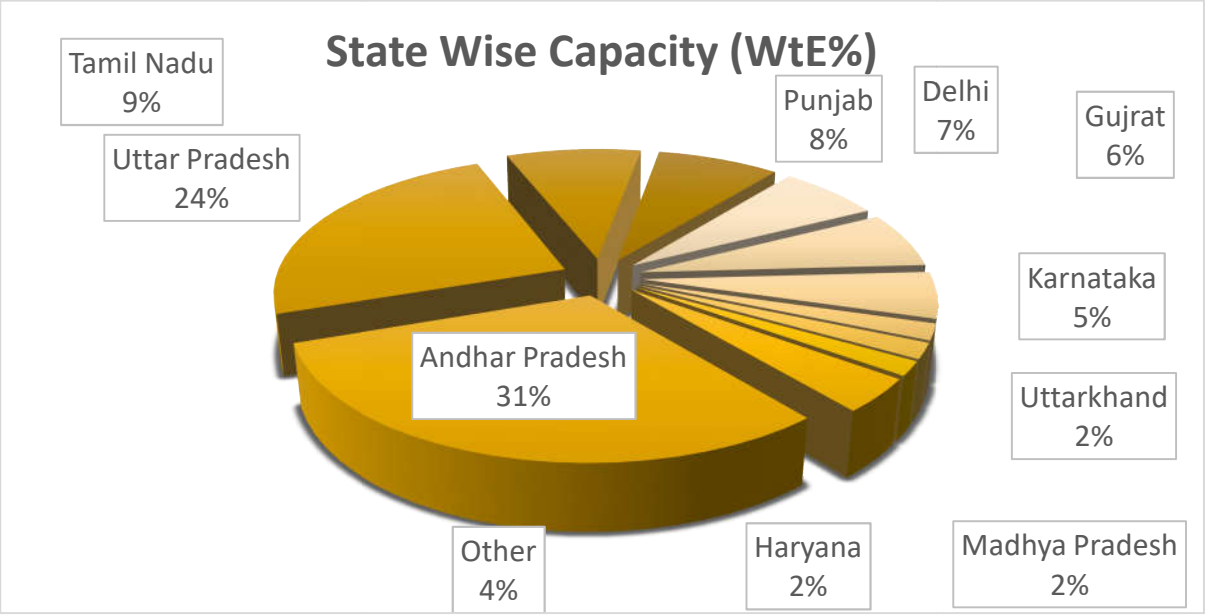


Figure 1 A Schematic of State Wise Capacity (WtE%)

Table 1 MSWcategories and Source

MSWcategories	*Descriptionofwaste*	*Source*
Food waste	Waste generated during the preparation or cooking of food and leftover food. Waste generated from storage, handling, and sale of vegetables and food products, crop residues, etc.	Households,hotels, restaurants, vegetable markets,stores,*etc*.
Rubbish	Newspaper, cardboard, leather, rubber waste, plastic material, wooden cartons, plant waste (grass leaves and yard trimmings), cloth waste, etc	Household, packaging industry and plantation

Bulkywaste	Waste from home appliances such as refrigerator, stoves, furniture, large wooden waste including crates, tree stump, branches, etc.	Households, parks, automobile industry, wood industry
Streetwaste	Dirt and dust from street sweepings, animal droppings, and plantation waste (leaves, etc.).	Streets and road
DeadAnimal	Pets including cats, dogs, and horses, poultry animals (hen and chickens), buffalos, cows, calf, etc.	Street and house
Constructionanddemolitionwaste	Cement and concrete waste, plaster waste, roofing and Industrial waste and sludge Hazardous	Home and building construction sites and building

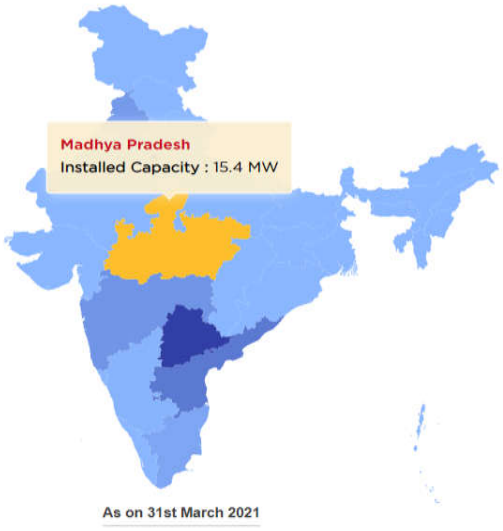


Figure 2 Madhya Pradesh Capacity (WtE%)

2. Study Area

Bhopal has an average elevation of 500 meters (1401 ft.). Bhopal is located in the central part of India, and is just north of the upper limit of the Vindhya Mountain ranges. Located on the Malwa plateau, it is higher than the north Indian plains and the land rises towards the Vindhya Range to the south. The city has uneven elevation and has small hills within its boundaries. The prominent hills in Bhopal are Idgah hills and Shyamala hills in the northern region, Katara hills in southern region. City's geography has in it two lakes namely upper lake and lower lake.The major industries in the old city are electrical goods, medicinal, cotton, chemicals and jewelry. Other industries include cotton and flour milling, cloth weaving and painting, as well as making matches, sealing wax, and sporting equipment. The residents of Bhopal also engage in large retail businesses. Handicrafts, like zardozi and batua are some of the products of the Old City.

1. Data Collection and Analysis

A solid waste management plan must include information on wastes, their composition, physical and chemical qualities, and the amount of trash created. In order to properly manage solid waste, it is required to examine the waste material's characteristics in addition to its source. As a result, they may be categorized as follows:

• Bacteria may break down organic substances that are biodegradable. Examples include food waste, fruit and vegetable trash, and garden garbage (or plant waste).

• Recyclables: Metal, plastic, and paper

Materials having high calorific value (paper, plastic, rags, etc.) that are relatively dry and easy to ignite are known as combustibles.Hospital trash, specialized industrial waste, etc., are all examples of hazardous waste because of their chemical or pathogenic nature, making them potentially harmful to human or animal health and damaging to the environment.Debris like cinders, grits, and dust are non-hazardous and hence inert.During the collection of municipal solid waste samples, the principal collection locations for a greater population are selected. Depending on the kind of region under investigation (residential, commercial, industrial, market, slum, etc.), sampling locations are dispersed across the research area in a random fashion. The research region is evenly distributed with sample locations. According to the following list of sample places, which are all included: Bhanpura Kunti and Sehore Road-Beraghat are all within easy driving distance of AIIMS Zone.

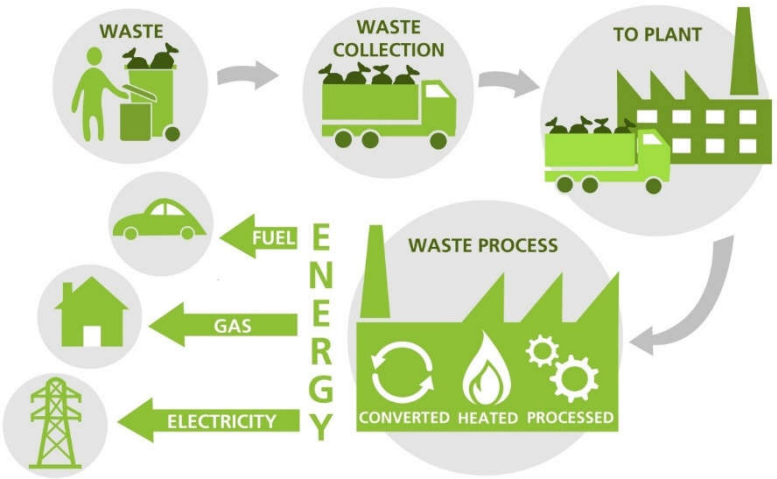


Figure 3 Illustration of Bio-energy processing.

The residential and commercial areas are significant sources of solid waste generation. In the following table, Per capita waste generation rates as per the CPHEEO manual are identified in Table 1. The population growth in the future and the waste degeneration have been projected to 1100(TPD) in the Year 2035. i.e.,relationship of waste generated with respect to the growth of the population.

Table 1Waste generation ratesper capita

Population range (in million)	Average per capita(kg/capita/day)
01 to 0.5	0.23
0.5 to 1.0	0.27
1.0 to 2.0	0.28
2.0 to 5.0	0.37
>5.5	0.56

3.1 Sectoral Share analysis of Energy

Bhopal city's energy potential has been categorized into various sectors such as urban organic solid waste and urban organic liquid waste; pulp and paper; cattle; and poultry; as shown in Figure 4. a total of 42 percent of the city's energy potential is derived from urban organic solid waste, 25 percent from urban organic liquid waste, 23 percent from cattle, and 2 percent from poultry.

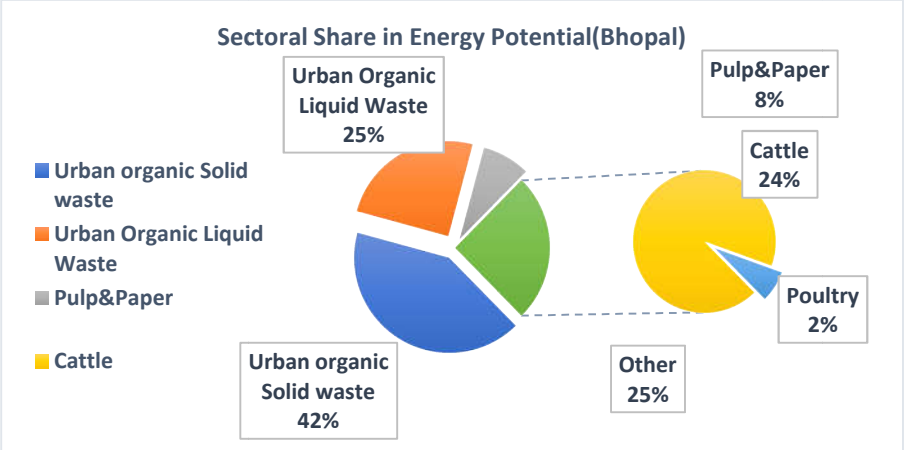
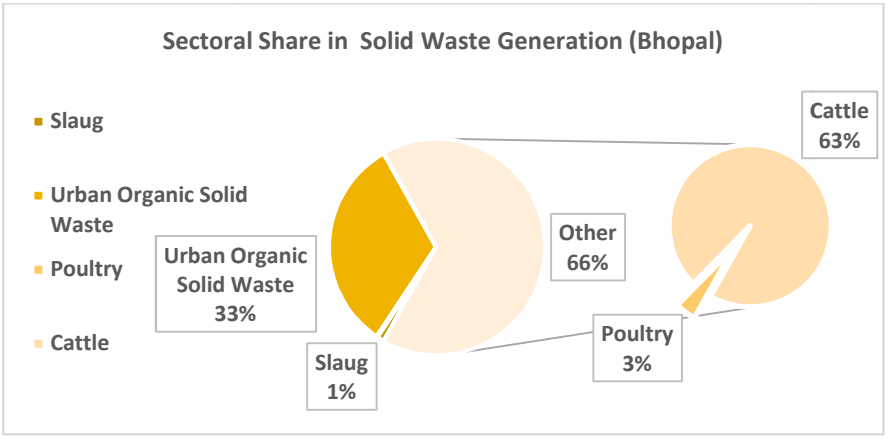


Figure4 Energypotential from various sectors

3.2 Sectoral Share in Solid Waste Generation and Liquid Waste Generation

The percentage of solid waste generated by each industry has been calculated. According to Figure 4, the solid waste generation is divided into four categories: Slaug (1 percent), organic liquid waste (99 percent), poultry (3 percent), and cattle (63 percent), while the liquid waste generation is divided into three categories: Slaug (1 percent), organic liquid waste (99 percent), poultry (3 percent), and pulp and paper (approximately zero percent).



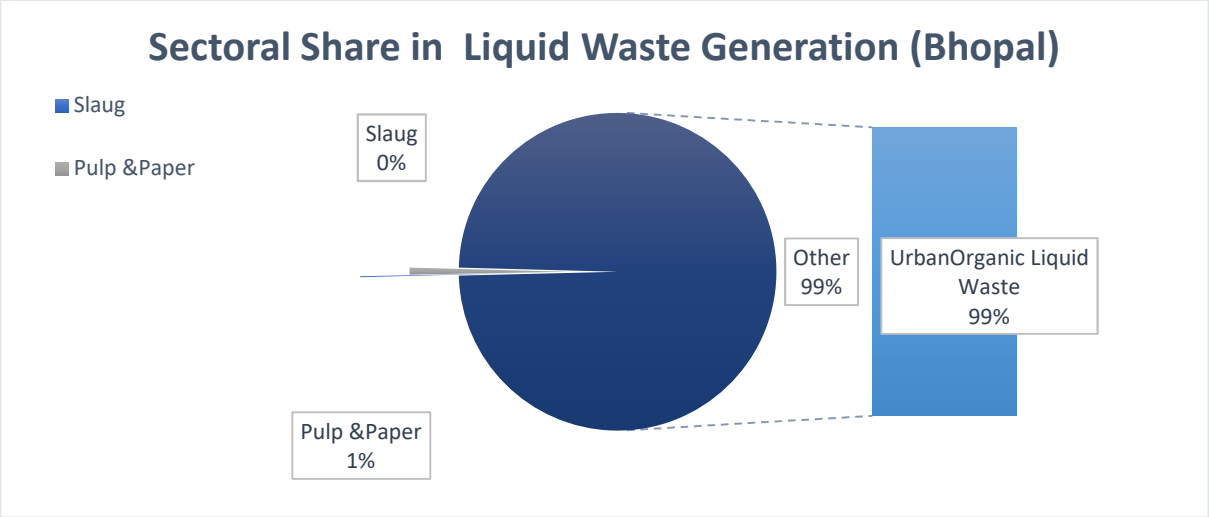


Figure 5Solid Waste Generation from differentSectors

Figure 6Liquid Waste Generation from differentsectors

3.3 Sector-Wise Utilizations of Energy

In 2018, roughly two-thirds of the time, biogas was used to generate energy and heat (with about equal percentages of electric-only and co-generation plants). Another 30% was converted to biomethane, which was then put into the gas grid or used as a transportation fuel. Biomethane Biomethane's equilibrium has been restored, and it has been integrated into gas distribution systems. Renewable energy auctions (such as power purchase agreements) that are not technology-neutral may have a negative impact on future opportunities for electricity-only biogas projects in a number of countries. Biogas facilities, unlike wind and solar PV, may operate in a variety of ways and provide a variety of grid services. Recognizing these advantages may aid biogas plants in the future in gaining public interest and support. Biogas cogeneration is more cost-effective than electricity generation alone if there is a local need for heat. As much as 35% of biogas energy and as much as 40% of waste heat may be used in co-generation to produce electricity. Several industrial subsectors, such as food and beverage and chemicals, create wet waste with a high organic content that is excellent for anaerobic digestion. Additionally, it may be used to generate heat and power at a facility. Most of the biogas that is produced across the world is turned into biomethane. However, the success of this venture will be contingent on the strength and design of decarbonization initiatives in various parts of the world.

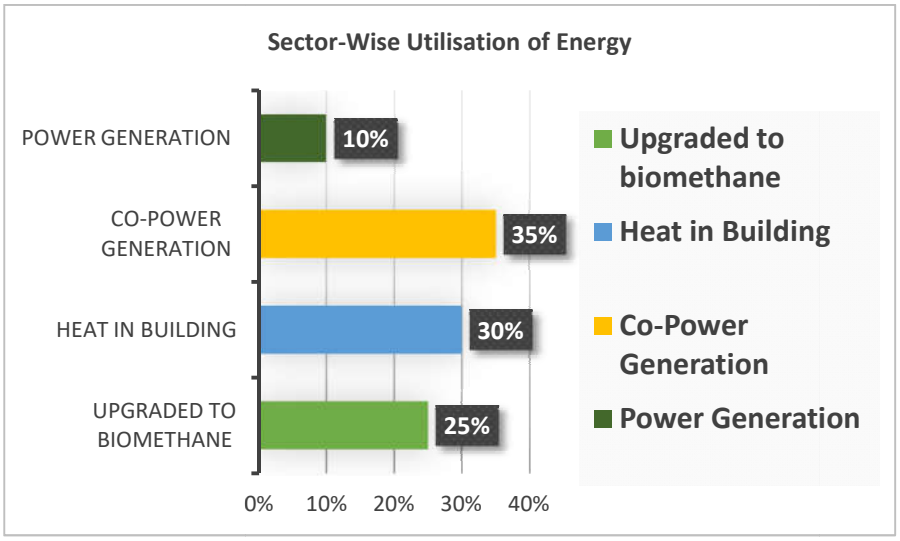


Figure 7Utilization of energy from different sector

2. Results and Analysis

The final waste analysis in Shanghai is (C: 55.75, H: 7.54, O: 34.57, N: 1.87, S: 0.27), which is quite comparable. The mass balancing is carried out under the same conditions (after drying, the moisture content is 30% w/w). Given the feedstock and moisture content homogeneity, CO and CO_2 percentages in the raw gas are estimated to be around 18% and 6%, respectively. Carbon balance is employed before and after the gasifier to compute mass balance.

Total waste Generated in Bhopal per day is 1000 TPD, out of which 54.3% is organic waste that can be used to generate Biomethane Energy, i.e., 500 TPD

The plant's capacity is 609 TPD, 25.37 tons per hour.

The high heating value (HHV) of the MSW can be calculated by Dulong Formula (Enggcyclopedia, 2015):

HHV in MJ/kg = 33.86 × C + 144.4 × (H - O / 8) + 9.428 × S

Where C, H, O, and S are the mass fraction obtained from ultimate Analysis.

According to the above Eq. and the ultimate analysis, the HHV of the MSW in Shanghai equals 23.55 MJ/kg

Therefore, the energy input from the MSW can be calculated:

Energy input = 23550 * 103 J/kg * 25.37* 103 kg / 3600 S = **154 MW**

3. Conclusion

The following conclusion has been drawn for this study.

To maximize the city of Bhopal's energy potential by converting garbage into electricity, the city's organic waste has been divided into five categories: urban organic solid waste (42%); urban organic liquid waste (25%); cattle (23%); poultry (2%); and pulp and paper (8%) (all of which are organic waste).

The sectoral proportion of the generation of solid waste was examined. Slaug (1%), Organic Solid Waste (33%) Poultry (3%), Cattle (63%) and Pulp and Paper (98.9%) have been included in the Liquid Waste Generation, whereas Pulp and Paper has been categorized in the Solid Waste Generation (0.10 percent approx. zero).Over 1123 tons of garbage are created in Bhopal daily; 54.3 percent of this trash may be utilized to generate Biomethane Energy, resulting in 609 TPD of energy intake and a daily output of 165MW.

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