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Waste to Energy trends and prospects: A study of Indore City

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Abstract- Solid Waste Management (SWM) is a worldwide phenomenon where Improper management of solid waste causes numerous hazards to human and affects the wealth and health of "Mother Earth". Solid waste management constitutes a serious problem in many countries of the world. Most cities, towns and small town do not collect the totality of waste generated and of the waste collected, only a fraction receives proper disposal. The high generation of rate municipal solid waste is 1100 MTPD and the complexity of waste generation are major challenges that are faced by the Indore municipal corporation. A well planned city needs to maintain all the relevant facilities like structural building, medical facilities, educational development, waste management and other necessary amenities. The objective of the study is to study the energy created by wet and dry waste in study area. And to study future prospects of energy which can be created by waste in study area. The study is based on primary survey and secondary method. The data will be collected by both the primary and the secondary sources. The data will be collected by the observation method, interview and group discussion methods will be used.

Keywords- waste management, circular economy, sustainable development, trends

Introduction- The term "waste" generally refers to "unwanted things or goods" for the person who discards it; a product or material that does not have value anymore for the first user(domestic ,commercial and many more) and is thus thrown away or not taken in use. But "unwanted" is subjective because the waste could have value to another person in a different circumstance or even in a different culture. Solid waste management is the method of collecting, treating, and disposing of solid waste that has outlived its usefulness. Solid waste management is critical for the preservation of public health, safety, and the efficiency of the atmosphere. Today, there are many large industries that operate primarily or exclusively using waste materials like paper and metals as their industrial feed stocks (Scheinberg, 2001). The objective of Solid Waste Management (SWM) is to reduce the quantity of waste

to be disposed in landfill by suggesting suitable treatment options like 3R ,circular economy, biological treatment so that land requirement for the landfilling can also be reduced. Solid waste management (SWM) is one such service where India has an enormous gap to fill. SWM is given very low priorities in the developing countries and where the budgetary provision is too small to manage the solid waste. A solid waste management (SWM) system includes the generation of waste, storage, collection, transportation, processing and final disposal. This study will focus on disposal options for MSW in the study area.

Solid waste treatment and disposal is projected to have produced 1.6 billion tonnes of carbon dioxide (CO2) equivalent greenhouse gas emissions in 2016, accounting for 5% of global emissions, based on the amount of waste created, its composition, and how it is treated. This is largely due to pollution being disposed of in open dumps and landfills that lack landfill gas disposal systems. Food waste is responsible for almost half of all pollution. If no changes are made in the disposal and treatment method of solid waste-related emissions are expected to rise to 2.38 billion tonnes of CO2-equivalent each year by 2050.

The modern economy's rising scale and sophistication of waste is presenting a significant threat to habitats and human health. In an year, it is estimated that about 11.2 billion tonnes of industrial waste are produced across the planet, with organic waste decay accounting for about 5% of global greenhouse gas emissions. An approximate 11.2 billion tonnes of solid waste are gathered per year across the planet. Solid waste is the discarded or worthless solid materials produced in a given region by a combination of residential, agricultural, and commercial activities. It may be classified according to its place of origin (domestic, agricultural, commercial, construction, or institutional); its contents (organic material, glass, metal, plastic board, and so on); or its hazard capacity (domestic, industrial, commercial, construction, or institutional) (toxic, non-toxin, flammable, radioactive, infectious etc). The fastest-growing problem in both developed and developing countries is waste from electrical and mechanical devices, which contains modern and challenging dangerous substances.

In the first instance, waste minimization is the remedy for management. Recovery of goods and energy from waste, as well as remanufacturing and processing waste into useful items, can be the second solution in cases where pollution cannot be stopped. Recycling saves a lot of money and resources. For every tonne of recycled material, for example, 17 trees and 50% of water will be preserved when it recycles. Furthermore, recycling generates employment: the recycling industry alone hires 12 million workers in Brazil, China, and the United States.

Study area - Indore is located geographically between 22°37′29.66′′N 75°46′86′′E and 22°48′34′′N 75°56′32′′E at an average altitude of 553 Meters from the Sea Level. It is located 190 KM away from the State Capital, Bhopal on NH - 3. Indore is located at an average altitude of 550 meters above sea level it has the highest elevation among major cities of central India. The Indore city is 530 square kilometre with the most densed city in the central province. It is known as commercial capital of Madhya Pradesh .Indore is selected as one of the 100 Indian cities to be developed as smart city under the smart cities mission.

Objectives of the study –

- To study the energy created by wet and dry waste in study area.
- To study future prospects of energy which can be created by waste in study area.

Research methodology – The study is based on primary survey and secondary method. The data will be collected by both the primary and the secondary sources. The data will be collected by the observation method, interview and group discussion methods will be used.

Secondary data- The secondary data will be collected from Indore municipal corporation, Indore development authority, pollution control board, transfer stations, waste treatment plants , and other private organisations which are contributing for the waste management.

Waste Processing in Indore city

1. Dry Waste: In an automated Material recovery facility, dry waste, which accounts for around half of all waste, will be sorted. Separation and sorting of waste materials, as well as preparation of these materials for reuse or reprocessing, are all done at the MRF plant. In the waste disposal process, recycling is critical. IMC had previously built Material Recovery Facility- II at Devguradiya Trenching Ground to manage and process such large quantities of dry waste. Pre-sorting is performed by 100 mm using a trommel system at this material recovery plant. The waste that passes through is classified as inert material, which cannot be recycled and must be disposed of in a landfill. Various fractions of dry waste, such as plastic, rubber, leather, glass, metal, fabric, and so on, were segregated using licenced recyclers (Kabadiwalas). At the facility, non-biodegradable waste was separated into categories. As shown in figure 1, the recyclable low-density polyethylene (plastic bags) is washed in a phatka machine, then shredded by an egloo machine and sent to a plastic briquetting (gatta) device. The plastic briquettes are then sold to an irrigation pipe manufacturer. Paper/cartons, bottles, metals, HDPE, PPP, and PET are among the smaller-volume recyclables that are washed, sorted, bundled, and sold to wholesalers at a cost-plus margin. The Madhya Pradesh Rural Road Development Authority receives some of the shredded and purified plastic for road building. Since plastic (HMPE and LDPE) is a petroleum product, it is combined with coal tar to reduce the amount of tar by 15%. The mixture is environmentally friendly and has also proven to be cost efficient, as approximately 45,000 kilos of plastic waste is recycled and reused every day during the construction of PCC (Plastic Cement Concrete). At Devguradia Trenching Ground, IMC constructed India's first 300 MT Fully Automatic Material Recovery Facility- I, which cost 30 crores and covers approximately 3 acres. Disan, a Turkish design company, produced it. This high-tech facility is fitted with an automated sorting system that separates all types of dry waste more effectively than manual sorting, such as plastic, metal, cloths, paper, and other substances. NEPRA Environmental Solutions Pvt. Ltd built the unit, and three optical sorting machines were purchased from Tomura in Germany. Various machines, such as density sensors, gravity separators, and conveyor belts, are included in this automated waste segregation machine. The waste is lifted to a height of 40 feet, after which it is separated using separators and conveyors. All of the plastic waste will be treated in state-of-the-art recycling

facilities, with over 95% of the overall plastic waste being recycled. Sorting, shredding and drying, and polymer flake sorting are the three stages of the recycling operation.

The rejects are mechanically processed to produce refuse-derived fuel (RDF), which is used as fuel in waste-to-energy plants. The electricity generated is then exported to the grid. All multi-lead plastic (biscuit boxes, chips, etc.) that cannot be recycled because it contains a high concentration of lead. The plant's plastic to fuel capacity is 8 TPD. It can produce about 3000 litres of crude oil, from which 2600 litres of diesel, 180 litres of gasoline, and 200-300 kilogrammes of carbon black are produced.

2. Wet Waste: The waste-to-compost plant at Devguradia's disposal site is known as the consolidated Organic Waste Processing Unit. The plant was completed in 2009 and has the ability to process 500 metric tonnes of wet MSW. The plant was designed and run under the PPP model by a company named A to Z Infra Pvt. Ltd. The IMC terminated the company's services and took over the plant due to the company's recent poor results and failure to handle organic waste on a regular basis. Following the acquisition, IMC completed a full overhaul of the factory, including machinery repairs where necessary. As of today, the compost plant is processing 600 metric tonnes of wet waste every day. The separated wet waste is offloaded directly onto the compost plant's windrows by hook-loaders from GTS or bulk collection vehicles. It is assumed that waste will be fitted into one windrow one day. The waste leachate is stored in two Leachate storage ponds that are connected to the windrows. The wet waste that is offloaded is then processed according to normal procedures. As a result, the city's centralised processing plant processes and disposes of 600 MT of organic waste.

Waste Processing of waste in study area

Type of Waste	Quantity	Process technology	Plant location (address)	Plant capacity (TPD)
Wet	450	Aerobic Composting Unit	Devguradia	600
Wet	15	Biomethanation	Kabitkhedi Garbage Transfer Station	15
Wet	2	Biomethanation	Star Square GTS	2
Dry	309	Material Recovery Facility	Devguradia	300
Dry	206	Material Recovery Facility	Devguradia	200
Only process rejects are transported	19	Landfill Cell 01	Devguradia	Total Capacity = 3,00,000 MT
Only process rejects are transported	71	Landfill Cell 02	Devguradia	Total Capacity = 3,00,000 MT
Domestic Hazardous waste	3	Hoswin Incinerator, Common Bio-medical waste treatment facility	Sanwer Road	5

The above table reflects the waste processing and it depicts that Only process rejects are transported have total capacity 3,00,000 MT and only process rejects are transported included domestic hazardous waste have also total capacity 3,00,000 MT. In this processing technology is used like, Aerobic Composting Unit, Biomethanation,

Material Recovery Facility, Landfill Cell and Hoswin Incinerator, Common Bio-medical waste treatment facility. Now Indore is marching ahead and soon all the zones would be covered under the installation of technology for waste processing.

3. Construction and Demolition Waste: Devguradiya has built a building and demolition waste processing plant with a capacity of 100 TPD, as well as four C&D waste transfer points within the city. The plant's service and maintenance are the responsibility of Citadel Pvt. Ltd. Table 2 lists the four most important manufactured goods. The final product samples are checked according to the IS code provisions. The compression strength of a finished paver block was more than 30.00 N/mm2, which is considerably higher than 25 N/mm2.

Table 3.3: Products manufactured by C&D waste

Product	Quantity generated per day
Paver Block with Glossy Finished Surface	1200
Curb Stone	2200 – 2500
Rough Paver Block	1200
Masonry Brick	10000 - 12000

Decentralized Processing of Waste: Decentralized wet waste processing has been established at Nandlalpura vegetable and fruit market, Rajkumar mill vegetable market, and Khajrana Ganesh Mandir using the aerobic pit composting method and the Organic Waste Converter System to turn flower waste into compost. Swaaha's Mobile Composting Vans have been deployed on a contract basis to treat Organic Waste created by small food joints and restaurants. Composters of various types have been built in classrooms, parks, and zoos, among other places. Indore has also set a target of reducing waste collection and transportation by 150 TPD by treating organic waste on-site. IMC was also responsible for the waste produced by the tea sellers. Tea stalls and street food vendors were no longer allowed to use disposable materials in all 85 wards. Bottle crushing machines can also be used in places like Chappan Dukhan and railway stations.

9. Biomethanation: Indore Municipal Corporation has taken a one-of-a-kind initiative to manufacture and use Bio CNG derived from the processing of municipal solid waste. Indore has built a 20-tonne-per-day (TPD) biomethanation plant in Choithram Mandi, which is essentially a whole-sale fruit and vegetable market that generates a large amount of wet waste. The current biogas project is one such project, as it satisfies all of the mission's thrust areas, including providing greener transportation fuel, waste water treatment, zero-discharge wet solid waste, and improving amenity value by minimising emissions. ISCDL (Indore Smart City Development Limited) and IMC, in collaboration with Mahindra as a technology partner, developed a Bio-methanation project that produced Bio CNG for public transportation. It is based on the three R principles of reduce, reuse, and recycle, and it also produces methane gas, which is converted into CNG gas and then used.

Bio-methanation plant for wholesale vegetable and fruit market

Choitram Mandi is Central India's largest mandi. On a regular basis, 20-25 MTPD of fruit and vegetable waste is produced. Prior to this, the waste was collected and transported to IMC's centralised waste processing and disposal site, resulting in exorbitant transportation and labour costs. As a result, IMC establishes a Bio-methanation plant (Bio-CNG Plant) with a capacity of 20 MTPD as part of its plan to advance the decentralised treatment of natural waste. IMC selected Mahindra and Mahindra Ltd. Mumbai to build the plant as part of the offering process, and they were appointed in December 2017. The total cost of the project was $15.00 crore, of which 7.2 crore was spent. IMC was the one who gave VGF. The venture has a 15-year concession period. At the moment, the Bio CNG plant collects and prepares all of the fruit and vegetable waste generated at Choithram Mandi (Figure 8). On a daily basis, around 800 kg of purified and compressed Bio CNG with 95 percent pure Methane gas is produced. A pressurised Bio-CNG gas is used to power approximately 15 city support buses. The processed slurry passes through a strong liquid separation unit, with the filtered fluid going into the making slurry and the rest being dried and turned into organic fertiliser.

Converting waste to fuel

A bio-methanation facility converts organic waste to methane for the decentralised handling of waste from the vegetable, fruit, and flower markets. According to Mahindra Waste to Energy Solutions Ltd, about 20 tonnes of waste are collected each day and converted into 750-800 kg of bio compressed natural gas (bio-CNG). The organisation has a long-term agreement with the IMC to work at the plant. The gas produced is used to power city transportation and sold at a profit to hotels and the Indian Institute of Management as a cooking fuel. Squander from the flower industry is collected separately (1-2 tonnes per day) and mixed with slurry to make compost. The pilot project is currently producing 3,000 litres of fuel from 6 tonne of plastic waste. Manufacturers of namkeen, chips, and savouries use all of the fuel generated.

Techniques used by Indore in MSW

Gasification: When organic material containing carbonaceous compounds is heated above 700 degrees Celsius, carbon monoxide (CO) is produced. A syngas is produced as a byproduct of this process, which is a renewable energy source. Solid waste is also included in the by-product (ash). Bed fluidizes bed, fixed bed in parallel, fixed bed in counter current, plasma, entrained flow, and free radicals are some of the gasifiers available.

Incineration: This entails the combustion of organic matter found in MSW, as well as the production of ashes as a by-product. Pathogens, toxins, and other hazardous wastes benefit from it. An incinerator is used to complete the process. Installation and maintenance costs are higher, and waste consists primarily of high inert content (30-50%), high organic matter (40-60%), high moisture content, and low heat content (1000 kcal/kg), making it a poor waste management option.

Conclusion – This paper presents the municipal solid waste collection, disposal, management, recycling and energy created from waste plan of Indore city in India. The plan is developed by closely monitoring the overall waste collection in the study area. Citizen involvement, especially in source segregation and treatment processes, should be encouraged to improve the efficiency of SWM in India. To reduce waste and littering, and increase reuse and recycling, the policy agenda for sustainable SWM must drive behavioural change among residents, elected officials, and decision-makers. The Indore 3R declaration is a significant outcome of the ongoing Eighth Regional 3R Forum in Asia and the Pacific, which aims to address how 3R and resource efficiency measures can work together to make cities and countries cleaner, smarter, more livable, and more resilient. The Forum also aims to generate policy, institutional, and technological insights into the effective implementation of the 3R and resource efficiency to foster circular economic development, long-term changes in current natural resource use, and ultimately a zero-waste society.

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